ICFA Beam Dynamics Newsletter, No. 18

Edited by: K. Hirata, J.M. Jowett, S.Y.Lee

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Contents

1: Forewords

1.1 From the Chairman

K. Hirata kohji.hirata@kek.jp chairman

Recently I have come to realise that the nature of the job of the Beam Dynamics Panel members, *Newsletter* editors and the chairman is not well understood by everyone in our community. Perhaps it is worth taking this opportunity to remind our readers. In fact, these are purely voluntary activities, done outside our normal work and careers in the institutions that employ us. The printing and the distribution of the *Newsletter* is achieved with the help of several of the big laboratories, for which I am very grateful. The Beam Dynamics Panel, like ICFA itself, has no resources of its own.

The panel is working simply for the future of our community. I hope we are doing so effectively. Sometimes, we receive warm and encouraging mails. Of course we are also willing to listen to any constructive criticism and advice. Please contact your nearest panel member if you would like to make any remarks.

One remark that I heard recently is that the *Newsletter* is still not well enough known even within our community. We appologise for this on the one hand but, on the other hand, ask all the community members to support our activities more. There are several easy ways you can help to market the *Newsletter*:

1. tell people about it,
2. submit interesting articles to the *Newsletter* yourself and encourage others to do so,
3. publicise the Web addresses of our home page by planting links in your own Web pages and emails,
4. refer to articles in the *Newsletter* in other writings,
5. talk about articles in the *Newsletter* with your colleagues over lunch or tea,
6. if you have a paper copy, share it with colleagues or leave it in public places for others to look at.

This *Newsletter* is meant to be a forum of physicists working in beam dynamics and to create the common basis for our community. Please think of what you can do for the newsletter instead of what the newsletter can do for you.

1.1.1 Minutes of the 13th meeting of ICFA Beam Dynamics Panel

K. Hirata chairman

The 13th meeting of the ICFA Beam Dynamics panel was held “virtually” through e-mail in the period May to November 1998. The final minutes were made on 15 November.

1. Reports of Working Groups (WG)

(a) The activity of the tau-charm WG: The group has organized an ICFA workshop with the main sponsorship of INFN/LNF in 1997. One day was devoted to the discussion on the tau-charm factory. The proceedings is under printing. Under the recent situation for the tau-charm factory, Dr.Perelstein, the leader of the group, has agreed to stop this group now and the panel starts a renewed working group for the high luminosity factories, where the discussion of the tau-charm factory will be continued.

(b) The activity of the future light source WG: The group's main activity is in organizing the 17th Advanced ICFA Beam Dynamics Workshop: Future Light Sources to be held at the Advanced Photon Source Conference Center of Argonne National Laboratory from April 6th through 9th, 1999. The first circular was sent out in the beginning of June, 1998. See 2-a for more details.

(c) The activity of the WG on High Intensity High Brightness Hadron Beams: Since the last ICFA Beam Dynamics Panel meeting, the WG has organized two ICFA mini-workshops:

The 4th mini-workshop was held November 5-7 1997 at CERN. The topic was "Transverse emittance preservation and measurements." The organizer was R. Cappi. The summary reports have been published in the April 1998 issue of the Newsletter.

The 5th mini-workshop was held February 23-25 1998 at KEK. The topic was "Beam loading and compensation." The organizer was Y. Mori. The summary report will be published in the August issue of the Newsletter.

There was a WG and mini-workshop organizing committee meeting during each of the two workshops. Two future mini-workshops were proposed to and approved by the ICFA (see 3-a and 3-b below).

The WG has been taking the responsibility of compiling and maintaining a database of hadron synchrotrons. At this moment, there are four tables in the database:

Table 1. Proton synchrotron performance. Table 2. Particle loss table. Table 3. Proton beam transverse emittance evolution and measurement. Table 4. RF parameters and beam loading.

They are partly available to the public on the WG web page

`http://www-bd.fnal.gov/icfa/`

2. Preparation of Advanced ICFA Beam Dynamics Workshops

(a) The 17th Advanced ICFA Beam Dynamics workshop: Concepts on Futuree Light Source.

The workshop will be held from April 6th through 8th, 1999, at Advanced Photon Source, Argonne National Laboratory. The woshop chair is Kwang-Je Kim, and the program chair is John Galayda.

A home page is available on the Web at

`http://www.aps.anl.gov/conferences/FLSworkshop`

3. The ICFA mini-workshops

(a) The 6th ICFA mini-workshop on high intensity high brightness hadron beams will be held on Februray 24-26 (tentative) 1999 at RAL. The title is "Injection and extraction". The organizers are C. Prior and G. Rees.

   (b) The 7th ICFA mini-workshop on high intensity high brightness hadron beams will be held on September 1999 (tentative) at Fermilab. The title is “Beam halo and scraping”. The organizers are N. Mokhov and W. Chou.

4. Reports on ICFA Advanced Beam Dynamics Workshops
   (a) 14-th workshop on Beam Dynamics Issues in e+e- Factories: a report was published in the newsletter no.17.
   (b) 15-th workshop on Quantum Aspects in Beam Physics: a report was published in the newsletter no. 16.
   (c) 16-th Advanced ICFA Beam Dynamics workshop: Nonlinear and Collective Phenomena in Beam Physics: a report was published in newsletter no. 18.

5. Newsletters

   A new editting system is under discussion between the present editors and the distributers. The conclusion will be discussed in the next panel meeting.

6. Next Meeting

   The next real panel meeting will be held on the occasion of PAC’99.

It was reported that A. Hofmann has retired from the panel, in accordance with his retirement from CERN. The chairman and all the panel members have thanked him for his long and continuous contribution to the panel activities.

1.2 The ICFA Beam Dynamics Newsletter, No. 18

John M. Jowett `John.Jowett@cern.ch` CERN

Once again, we have a newsletter packed with interesting and timely articles. It is very encouraging to see that the section devoted to announcements of recent doctoral theses contains no less than 5 items. I think we can fairly claim that this section has really caught on as a means for new entrants to the field to make their work known.

Another very welcome and valuable type of article is that calling attention to new, urgent or promising topics of research. In this issue Dimitri Petrikov introduces us to new phenomena arising from the combination of space-charge and beam-beam effects in electron-nucleon colliders. Of course, the newsletter is not a medium for publication of scientific results–that is the proper role of journals and conferences–but we hope that articles like this may help to catalyse new contacts and developments leading to future research publications.

The other classical method for kick-starting progress in a new area is to get the right people together and hold a specialised workshop. Reports from the recent Advanced ICFA Beam Dynamics and other workshops testify to the effectiveness of such events. We all know the feelings of exhilaration and rejuvenation induced by working interaction with colleagues from other places in a well-organised workshop on an interesting theme. Most workshops publish proceedings in due course but we hope that the short reports that appear in the newsletter will be especially useful to people who were not able to attend but have an interest in the topics.

Another function of meetings is to agree on the modalities of international[1] or inter-institutional collaboration. In this context, a theme of perennial debate is the question of the most profitable

[1] Although we continue to use this term by force of habit, it seems to me that it goes without saying nowadays.

way to conduct our computing activities. The pages of recent newsletters have reflected this with several letters and articles. This is of increasing importance as knowledge in beam dynamics (as in other fields) is encapsulated in computational form, whether as formulas, algorithms, Web pages, databases, special languages for describing accelerator structures . . . or even prose. All these things overlap, yet the very longevity of physicists' involvement in computational technology leads to a tendency to regard them as ontologically distinct. For example, it has been appreciated for a long time that there need be no distinction between “codes” and “data”. Going just a little further, one can ask whether we need to submit to the disciplines of one or other standard or programming methodology in order to make progress? Or will these issues be sidelined by the explosive advance of computing technique and technology? Or has it already happened?

Perhaps, then, it is time for a paradigm shift rather than a standard or a method. In any case, the questions are interesting and we hope that the newsletter will play a useful role in working out the answers.

2: Letters to the Editors

2.1 From Dimitri Pestrikov

Space Charge and the Beam-Beam Instability

Dear John,
In a recent study on the electron-nucleon collider, we came to notice an interesting problem. I hope to discuss it to call for more people to participate in the study of it.

During 1996 – 1998 a working group from the Budker INP (Novosibirsk) participated in the GSI (Darmstadt, Germany) feasibility study for the construction of new electron-nucleon collider (ENC). The facility should provide the luminosity $L = 10^{33}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$ for electron-proton collisions and about $L = 4.2 \times 10^{30}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$ for electron-bare uranium ion collisions in the energy range corresponding to the electron-nucleon center of mass energy $\sqrt{s} = 10 \div 30$ GeV. Two interaction regions should be foreseen. In addition, the colliding bunches should have the longitudinal polarization at the collision points. Many parameters of this new collider looked very similar to that of the constructing now electron-positron factories so that the desired values of the luminosities seemed to be very feasible, provided that electron-nucleon collision conditions could be set similar. That was a very interesting work both due to its subject and due to its very nice organization provided by the GSI staff. Among numerous beam dynamic issues (see, for example, in

`http://www-aix.gsi.de/~struck/contrib.html`
`http://www-aix.gsi.de/~struck/concepts.html`

,) which had to be studied to figure out a feasibility of the project, we have encountered some interesting phenomena limiting the luminosity performance in such machines due to common effect of the ion beam space charge instability and the beam-beam interaction of the colliding bunches.

A specific feature of the discussed collider was that we planned to obtain the desired luminosity values using high brightness, cooled electron and ion bunches. The cooling of electron bunches occurs naturally due to their synchrotron radiation. The cooling of (bare) ion bunches could be done using the electron cooling device (or, devices). The required electron cooling rates should enable the suppression of the blow-ups of ion bunches due to the beam-beam interaction and due to intrabeam scatterings of the ions. The designed lattice provides round cross sections for colliding bunches. The required bunch emittances ranges then, up to several nanometers, cooling time till several milliseconds. So, the cooling device for this facility should be a very serious installation itself. Apart from this and many others technical difficulties we encountered the problem that for desired parameter ranges the space charge fields in ion bunches can be strong enough to affect significantly the particle dynamics. In particular, the so-called Laslett tune shifts for ion bunches could reach, or exceed the desired values of the beam-beam parameters. More close inspection of resulting limitations change dramatically the design concepts of such colliders. Without the space charge limitations the design is rather free in a choice of the ratio of the electron and ion bunches radii. For example, we can design the rings to have the radii of electron bunches several times larger than the radii of ion bunches to simplify the beam-beam condition for ion bunches and therefore, to simplify requirements to their cooling. With the space charge dominated ion bunches we cannot do so. One of the problem is that the beam-beam interaction increases the betatron tunes of particles, but the space charge fields decrease. These tune shifts decrease with an increase in the amplitude of the particle betatron oscillations. A natural scale for the tune shifts in ion bunches due to the beam-beam interaction gives the radius of the cross section of an electron bunch. Similar scale for the tune shifts due to space charge fields gives the ion bunch radius. The dependence of the resulting tune shift on the amplitude of the betatron oscillations depends on the ratio of the radii of the electron and ion bunches. If these radii differ, the tune shift may become a non-monotonous functions of the betatron amplitude. So that depending on the ratio of the values of the beam-beam parameter and of the Laslett tune shifts it may have a minimum, or a maximum at some non-zero amplitude of the betatron oscillations. It is known, that especially in the case of the resonant perturbations, such kind of the tune distributions generally simplify the beam instability conditions. It means that the ratio of the electron and ion beam radii should be chosen to avoid such a non-monotonous tune distributions in ion bunches. It will be done, if these radii will be approximately equal. It is probably necessary to note, that the compensation of the tune shift in ion bunches due to a common effect of the beam-beam interaction and due to space charge fields is not desirable at all. The reason is that with such compensation we do not compensate the strengths of associated resonant instabilities. So, those will not be nonlinearly limited in the case of such a compensation. A requirement to have the radii of the electron and ion bunches approximately equal results in he additional demand of low emittance on the electron ring lattice design.

Another group of problems arises from the requirement of the beam stability. As we know, the beam-beam interaction produces a lot of resonances limiting the bunch parameter performances. In the case of appositively charged particles and provided that the space charge of bunches is weak (for example, in electron-positron collider), the stopbands of these resonances are placed below possible lattice nonlinear resonances. In the space charge dominated beam (ENC) the total tune shift of betatron oscillations can be either positive (beam-beam prevails), or negative (space charge tune shift prevails). In the first case, position of the stopbands of nonlinear beam-beam resonances will be same as in electron-positron collider. So, the preferable positions for the working points in betatron frequencies will lay in the regions above the parametric resonances of the lattice (slightly above). In the second case, position of the stopbands due to beam-beam interaction will be just opposite (similar to that in, for example, proton-proton collider). So, the preferable position for the working point will be in the regions below the parametric resonances. Now, we have to recall that the beam-beam interaction produces the instability of both incoherent and coherent oscillations of particles. Positions of the stopband for coherent oscillations of the bunches generally differ from that for incoherent oscillations. In the space charge dominated ion beam this difference can be especially strong. In particular, the space charge fields do not affect the dipole oscillations of bunches. It means that stability conditions for coherent oscillations still demand to place the working point in betatron tunes above the parametric resonances. The contradiction in the stability conditions for coherent and incoherent oscillations is resolved, if we demand that the tune shifts due to beam-beam interaction for ions should exceed the Laslett tune shifts of ion bunches. That rule was tested using the strong-strong simulations. The results of these simulations indicate as a safe threshold for the Laslett tune shift about a half of the tune shift due to beam-beam interaction. Above that threshold the instability manifests itself in the separation of the transverse bunch sizes mostly due to widening of the ion bunch. No flip-flop bunch size exchange was seen and was not expected due to asymmetry in the collision conditions for the electron and ion bunches. We used a simplified code for our simulations. We suppose that a comprehensive analysis of this interesting field in the beam dynamics seems to be still ahead.

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2.2 From David Bruhwiler, Svetlana G. Shasharina and John R. Cary

Accelerator Class Libraries

In a recent letter [1], John Galambos noted the relative lack of use of object oriented methods in accelerator modeling. In this letter we would like to announce the release of free object-oriented software for accelerator modeling. This is an early “alpha” release.

Tech-X Corporation is a small business engaged in scientific modeling, specifically related to the development of object oriented modeling tools in C++ and Java, Web-based client-server software for scientific applications, and Web-based scientific curricular materials. As part of our efforts to develop Mapa, an object- oriented accelerator modeling application with a graphical user interface, we have developed a C++ accelerator modeling class library. We are making this class library, including source code, available to the accelerator modeling community. This library and the libraries it depends on are available on the web at URL `http://www.techxhome.com`. They are, and will remain, free under the terms of the GNU Public Library License.

Documentation for these C++ class libraries can be found on-line at

`http://www.techxhome.com/freestuff/txac`

As noted there, our libraries permit single-particle tracking through the common accelerator elements. They work for 2, 4, or 6 dimensions. The tracking methods give the dynamical map, its derivatives (or tangent map), and the second derivatives. For particles at the design trajectory, these are equivalent to Brown’s R matrix and Transport’s second-order coefficients. However, our functions give these for non-design trajectories also. Our thick-element tracking methods are symplectic, for robust multi-turn tracking. Details are provided in Ref. [2].

The current libraries are at the first alpha release 1.0a1. We have used them to successfully model the Advanced Light Source, finding correct values for tunes and dynamic apertures. We have verified their geometry methods by parsing several lattice files, including an SIF model for the recycler lattice being designed at Fermilab. However, we recognize that our libraries need to be generalized, in particular with the addition of more elements. We intend to add capability over the coming years. Obvious needs are solenoid, beam- beam, and thick cavity elements. We expect to have radiation losses in the next alpha release, due out in the coming months. We expect to add fairly complete differential algebraic support by the end of next year.

Our accelerator modeling class library, TxAC (libtxac.a), depends on two other class libraries, which we also make freely available along with source code. The TxID class library (libtxid.a) contains data holding classes and classes that describe dynamical systems. The TxSTD library (libtxstd.a) contains a number of utility classes, such as those for tensors, linear algebra, formulas, containers, and strings. The tensor and linear algebra libraries are templated over type and reference counted for flexibility and minimization of copying operations. We expect the need for the containers to vanish with time, as more compilers come to support the Standard Template Library, with its extensive container classes. Our TxString class will eventually be a class derived from the now standard C++ string class.

Our libraries come with an SIF (MAD-8) parser that is able to create an accelerator model (beamlines and elements) from a file in SIF format. This parser supports formulas. In fact, the formula parsing has been separated into a class, TxDblFormula, that is in our TxSTD library and so may be reused in other situations. We intend to support the recent Standard Exchange Format (SXF) [3] in the near future.

Our accelerator class library also comes with several analysis classes. The current analysis classes can be used to calculate the dispersion, the uncoupled Twiss parameters, and the physical geometry. The classes are useful for immediate insertion into an application. Such an application might simply print out the results or it might display them graphically as does our Mapa application.

Our libraries are fully documented using the Doc++ method (similar to JavaDoc), in which hypertext files are extracted from special comments in the header files. As can be seen at our website, our element classes are fully crosslinked in the hypertext documentation. We provide similar documentation for our auxiliary libraries.

At our web site one can also find test executables that demonstrate the use of these libraries. One of these exercises the parser. It can be readily modified to test on your favorite SIF lattice file. Another test executable, elem.C, contains a main() routine that instantiates an accelerator, reads an input file, tracks a single particle and calculates the tangent map and tangent map derivative associated with this trajectory, checks numerically that the map, tangent map and tangent map derivative are all mutually consistent and that the tangent map is symplectic, and writes out a number of files with some diagnostics.

We provide cross-platform capability with our "rules" files, files that are included in the Makefile to take into account platform variations with regard to file locations, compiler flags, etc. These are also available at our website. With these rules files we have compiled our libraries with the egcs compiler on AIX, DECUNIX, HPUX, IRIX, Linux, and Solaris. Our libraries have also been compiled with the KCC compiler on IRIX and DECUNIX, and with the IRIX-CC and DECUNIX-cxx compilers. We are working on a port to Windows95. We will continue to expand this list of supported platforms and supported compilers. However, we will not support compilers that do not support the ANSI standard container classes (STL) and the ANSI standard syntax for template instantiation. We may further restrict this to compilers that can deal with member templates in order to use modern efficiency methods such as expression templates [4]. With time we expect most compilers to support the full standard.

Our class library is readily extensible to the addition of new elements. After defining a new element class, by using any existing element as a template, the new element class is made known to the accelerator by the addition of one line in the file TxacElements.C. This extensibility is based on our TxCreator technology, which we provide in our TxSTD library. With our inheritance scheme, parsing for that element will be automatic. The modeler need add only the physics in the advance methods and define the variables and their names in the constructor. Our long term goal, the execution of which depends on funding, is to develop a mechanism that allows other class libraries [5] to be used with our interface, so that they can be easily plugged into multiple modeling applications to be tested side by side.

We expect this library to be stable for the most part. At this point any changes we make to the accelerator or element classes will only be of implementation to, for example, improve efficiency, or of the form of interface enriching, to add capability. Similar comments apply to our ElementImg, SimpElemImg, and BeamlineImg classes used in parsing. However, we are contemplating a change to our analysis classes, to separate physical data from that used to describe a plot.

We are interested in receiving comments from the accelerator community. We have set up a web page, `http://www.techxhome.com/support`, for providing us with comments or submitting bug reports. We invite the members of the accelerator community to inform us of their needs and/or work with us to generalize this class library so that it is more useful to the community at large. This includes the porting of these libraries to any ANSI standard C++ compiler on any UNIX or Windows platfrom.

Finally we would like to acknowledge the many helpful discussions we have had with many members of the accelerator community. A nonexhaustive list includes Dan Abell, Martin Berz,

Karl Brown, Yunhai Cai, Pat Colestock, Alex Dragt, Etiene Forest, Hans Grote, Jim Holt, John Irwin, Christof Iselin, Bob Joshel, Leo Michelotti, Steve Peggs, Fulvia Pilat, Mike Reusch, Todd Satogata, Weishi Wan, Yiton Yan, and many others. We express thanks for their patience in answering our questions, thereby helping us deliver a more useful tool. Naturally, we take full credit for any errors or omissions of our accelerator modeling class library.

Sincerely,

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3: Workshop and Conference Reports

3.1 Summary of the 16th Advanced ICFA Beam Dynamics Workshop on Nonlinear and Collective Phenomena in Beam Physics

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The 16th Advanced ICFA Beam Dynamics Workshop on Nonlinear and Collective Phenomena in Beam Physics took place in Arcidosso (Italy) from the 1st to the 5th of September, 1998. The Workshop was sponsored by the International Committee on Future Accelerators, the US Department of Energy, the University of California at Los Angeles, the Stanford Linear Accelerator Center, Frascati National Laboratory-INFN (Italy), Lawrence Berkeley National Laboratory, and the KEK laboratory in Japan. The Workshop chairmen were M. Cornacchia (SLAC) and C. Pellegrini (UCLA). The meeting attracted 65 experts on nonlinear dynamics in particle accelerators and on the creation, manipulation and utilization of high brightness beams. Arcidosso is a medieval town in southern Tuscany, close to the city of Sienna. The meeting took place in the historically evocative scenario of an 11th century castle atop a hill dominating the nearby valley. The castle was restored in 1989, and preserves all the atmosphere and ruggedness of medieval times.

There were three invited lectures on Tuesday, September 1st, day that opened the subjects and three summary talks in the afternoon of Saturday 5th. All the other presentations were either informal or in the form of posters.

3.1.1 Single Particle Nonlinear Dynamics

The Group on Single Particle Nonlinear Dynamics was coordinated by David Robin (LBNL), with an introductory talk by Ezio Todesco (CERN). The Group discussed issues relevant to hadron colliders, storage ring light sources and high current linacs that were summarized by David Robin on the last day. The theoretical modeling of single particle dynamics in hadron colliders is well developed (as reported by E.Todesco, W.Scandale, Y.Papaphilippou), with conventional (symplectic, element-by-element) tracking being the most commonly used method for assessing the dynamic aperture. Faster tracking based on the one-turn map holds promise of one to two orders of magnitude improvement in speed, but is still at the testing stage (R.Warnock). The extrapolation of the tracking results from 10^5 to 10^7 turns is reliable (W.Scandale). Techniques (normal form, frequency maps, for instance) have been developed (G.Turchetti, E.Todesco, Y.Papaphilippou,) and are being effectively used for understanding tracking data and improving the models. One of the phenomena that still defies a clear understanding is that of diffusion. As discussed by J.Corbett and H.Owen, the storage ring light sources are highly nonlinear, have a small vertical aperture (a few mm) and difficult requirements (large momentum acceptance and dynamic aperture). Several 3rd generation sources (ALS, ESRF, APS) have observed a limitation in energy acceptance due to the dynamic aperture (D.Robin). In the ALS the agreement between calculated and measured momentum acceptance is very good (D.Robin). Nonlinearities affect the performance mostly through the beam halo in those high current linear accelerators where the loss of a small fraction (that could be as small as 10^{-7}) of the beam activates the accelerator. The challenge, thus, is to be able to calculate the loss rates at this small level. The group discussed whether there was a way to get some insight into the dynamics that could provide the understanding of particle loss. One possible method to achieve this is the frequency map analysis (A.Bazzani).

The influence of collective effects on the experimental studies of turn-by-turn position and angle monitoring has been studied at SPEAR (A.Terebilo) and the Photon Factory (K.Ohmi). The SPEAR study shows the conditions under which Landau damping is or is not present. In the latter case, the beam behaves as a pointlike probe, and turn-by-turn tracking can be used to study nonlinear phenomena with higher accuracy. The recent studies of turn-by-turn tracking in SPEAR demonstrate the possibilities of studying the localized impedance in the rings by moving the orbit locally across an aperture and analyzing the launched oscillations.

Other theoretical presentations and discussions included the numerical computation of the action, the Henon map approach to the off-energy transverse dynamics (G.Turchetti), the study of improved error bounds for the numerical solution of differential equations (R.Warnock), a discussion on the equivalence between nonlinear dynamics and collective instability with applications in space charge effects (K.Y. Ng), a wavelet approach to the hamiltonian (A.Federova, M.Zeitlin) and a synthetic geometrical approach to betatron motion (P.Freguglia). At the end of his summary, David Robin highlighted the following conclusions:

The analysis tools for studying the single particle dynamics in accelerators are very sophisticated, but more effort is needed to make the accelerator experts aware of them. A large effort is underway in the analysis of future accelerators. There is considerable interest in the community to model existing machines and to compare experiments with theory. The experiments show that single particle dynamics impact the operation of existing machines. One cannot separate single particle and collective effects.

3.1.2 Creation and Manipulation of High Phase Density Beams

The Group on Creation and Manipulation of High Phase Density Beams was coordinated and its summary reported by Joerg Rossbach (DESY) with the introductory talk by Bruce Carlsten (LANL).

The potential emittance degradation caused by the emission of coherent synchrotron radiation by a short bunch in the bend of a beamline was the topic that drew most discussions and interest (G.Stupakov, M.Dohlus, T.Limberg, S.Monteiro, A. Ruggiero, A.Vartolomeev, and E.Schneidmiller). The codes that simulate the electron bunch dynamics in presence of the emission of coherent synchrotron radiation from the same bunch have reached a high level of sophistication. In some aspects these codes still give considerably different results, particularly when treating short bunches passing through an undulator. Part of the differences has been traced back to different approximations used. Bench mark runs have been agreed on for further clarification. Still missing is a complete theoretical treatment that allows a deeper understanding of the parametric dependencies and experimental results. The latter should be forthcoming soon (LANL, TJNAL).

Some recent work on space charge effects in photoinjector was also presented and discussed. This included the theory of transition from laminar into thermal flow (L.Serafini), computer tracking in rf guns (A.Mizuno). Still on the study of space charge, there was a presentation (A.Agafonov) on space- charge dominated electron beams in crossed electrical and magnetic fields. On the experimental techniques, there were presentations (I.Ben-Zvi) on tomography, a method for meausuring and controlling the density distribution in phase space, and on a new design of beam profile monitor that could reach a resolution of 1 micron or less(S. Monteiro).

On general beam dynamics, there were presentations and discussions on the density effect on quantum fluctuations in synchrotrons (A. Lebedev) and on a new idea (A. Ruggiero) of a storage ring made of radio-frequency quadrupoles (RFQ). The latter concept has the potential advantage of providing a compact storage ring with a high circulating current and that is fairly insensitive to space charge detuning.

3.1.3 Physics of, and Physics with, High Energy Density Beams

The Group on Physics of, and Physics with, High Energy Density Beams was led by Ingolf Lindau (Un. Of Lund and Stanford University) and the wide field of discussion was opened by a talk by Andrew Sessler (LBNL) on the physics with photon and particle beams and on the physics of particle beams. The former covered coherent x-ray beams, gamma-gamma colliders, beams for spallation source, transmutation of nuclear waste, colliders, inertial fusion and power beaming. This Group attracted contributions from different concepts and utilizations of intense beams. The field covered free electron lasers physics (C.Pellegrini, H.D. Nuhn,E. Schneidmiller) and one of its most exciting applications, the creation of real e^+e^- pairs from the virtual vacuum fluctuations when the electric field approaches the Schwinger field (10^18 V/m). A strength close to this value can in principle be obtained from a x-ray FEL when the coherent photon beam is focussed to the diffraction limit.

There were also presentations and discussions on heavy-ion fusion (R.W.Hasse), spallation neutron sources (A.Luccio) and plasma acceleration (A.Lebedev). On the physics of particle beams, there were stimulating presentations and exchange of ideas on the quantum-like description of charged-particle beam dynamics (R.Fedele), on the thermal wave model description of high energy charged particle beam dynamics (D. Anderson), on the nonlinear pattern formation and turbulence in coasting beams (P. Colestock) and on a dynamical model for the sawtooth instability in storage rings (L. Palumbo).

The Group engaged in a review, led by I. Lindau, of synchrotron radiation facilities. The properties and experimental requirements of synchrotron radiation and their extrapolation to the next, 4th generation of light sources, based on free electron lasers were discussed.

The proceedings of the Workshop will be published by the American Institute of Physics.

3.2 CAPS'98: To Fill Need for Accelerator Scientists and Engineers

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New generation accelerators, such as Shanghai Synchrotron Radiation Facility (SSRF) and Lanzhou Heavy Ion Cooling Ring, are being constructed in China. To fill the need for accelerator scientists and engineers in the construction of SSRF and other machines, The China Accelerator Physics School (CAPS'98), was organized jointly by China Center of Advanced Science and Technology (CCAST) and US Particle Accelerator School (USPAS) in associated with Fudan University in two periods from October 12-23 and November 2-13, 1998. The CAPS'98 applied the USPAS model with an intensive program of graduate level and three semester hour courses were provided each period by the Fudan University.

The general courses were lectured by Prof. H Wiedemann of SRRL in the first period. While in the second period, the 12 specialized courses were provided in parallel. They are: beam optics (K.Brown, J. Irwin and C.Wang of SLAC), RF system (D.H.Whittum, D.T.Palmer and X.Lin of SLAC), electron beam sources and injection (C.Sinclair and B.Dunham of TJNAF), magnetic systems (R.Schlueter and J.Tanabe), microwave measurement laboratory (J.Byrd, D.Li of LBNL and D.McGinnis and R.Pasquinelli of FNAL), project management for laboratory operation (C.Geles, G.Lindecker and C.Roche of CERN), project management for accelerator construction (A.Hutton of TJNAF and A.Jackson of LBNL), synchrotron radiation to X-ray FEL's (J.Murphy of BNL and C.Pellegrini of UCLA), beam instability (A.W.Chao and X.Lin of SLAC), linear accelerators (T.P.Wangler and S.Nath of LANL), computational methods in beam physics and accelerator technology (R.Cooper and R.Ryne of LANL) and beam experiments (A.Hofmann and C.Limborg of

SLAC). Computer programs were designed and installed in dozen PC's for students to carry on their class tasks and homework. Few lab equipments were shipped from US in order that students would perform experiments in the classroom.

There were altogether 142 students attended the CAPS'98 with average age of 28.5, among whom are 32 PhD's, 32 masters and 37 graduate students. The students are highly dedicated in the study and most of them passed the exams with good scores. Among them Dr G.M. Liu of Institute of Nuclear Research in Shanghai and Dr.G.Huang of Tsinghua University received outstanding student award from Oversea Chinese Physics Association for their excellence in the study. It is indeed that the CAPS'98 has accelerated the growth-up of young scientists and engineers in the accelerator field and the new generation will play an important rule in the construction of new generation machines in China.

3.3 New Trends in Electron Cooling

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On 14–15 September 1998, the JINR (Dubna) organised a workshop on “Medium Energy Electron Cooling” — MEEC98 with 31 participating scientists from GSI, COSY, FNAL, RIKEN, CERN, Uppsala University, BINP and JINR. Two-days scientific program included 16 reports and the most interesting problems were the subjects of common discussions. Electron cooling from Budkers first idea up to now has undergone already more than 30 years development. Nowadays 10 cooler rings are in operation and electron cooler is a routine tool with a standard scheme: electrostatically accelerated (maximum energy 300 keV) magnetized electron beam at low temperature is merged with an ion beam in a straight section (1–3 metres long) of the storage ring. The progress in the conventional cooling technique concerns mainly with an increase of the magnetic field quality and generation of intense electron beam at extremely low temperature (beam expansion by factor up to 8 (at SIS), 20 (ASTRID), 25 (TSR), 100 (CRYRING and TARN II)).

The first proposal to use electron cooling in MeV energy range of electrons was made in Novosibirsk (Kuksanov, Meshkov, Salimov at al., 1986) where such a system prototype at electron energy of 1 MeV was constructed. A 1 Ampere electron beam was obtained in DC regime in energy recuperation scheme. The first MEEC project based on an proposal of T. Ellison of IUCF in Bloomington, Indiana, has the goal to increase the luminosity in the SSC by performing electron cooling of 12 GeV protons in the so-called Medium Energy Booster considered for that project. Presently the electron cooling of ions in GeV energy range is a substantial part of a number of modern projects. The Tevatron luminosity upgrade program includes the electron cooling of 9 GeV antiprotons in the Recycler ring to compensate the beam heating during stacking process. Electron cooling of 10-20 GeV protons in PETRA aiming to reduce emittance by factor 2 can permit to upgrade luminosity of the HERA collider in DESY. One plans to use an electron cooling for luminosity support in electron-ion and ion-ion collisions at ion energy up to 1.5 GeV/u for light ions and 3.5 GeV for protons in the MUSES project of the RIKEN RI beam factory (the construction of the first stage of the project was started in 1998). The operation of the ENC collider which is in the stage of conceptual design now by GSI and BINP is impossible without an intensive beam cooling at ion energy of 10-30 GeV/u. Electron cooling of protons at energy of 2.5 GeV can be used for luminosity support of the COSY ring in experiments with internal target.

MEEC98 was the forth workshop on Medium Energy Electron Cooling. In comparison with previous workshops (in Fermilab (1995, 1996) and BINP (1997)) its scientific program had more “philosophical” character. Substantial part of the reports was dedicated to new possible concepts of the cooling system. New role of the electron cooling in nearest future was discussed by A.Skrinsky in his talk “Colliders for Medium Energy with Electron Cooling”. The goal of electron cooling in such machines is not a deep cooling of ions, but is to compensate different heating effects (IBS, beam-beam effect in presence of noise, emittance grows due to noise of the magnetic system parameters and so on) and to stabilize the ion beam parameters. Cooling process is carried out under new conditions: intensive, bunched ion beam in GeV energy range, cooling section length is of a few tens of meters, required cooling time lies from several minutes to several hours. Cooling electron beam parameters differ from those in the conventional cooling systems–electron temperature is determined by the acceleration system and can lie in the range of several eV, one can expect the destruction of the flattened velocity distribution of the electrons, probably non-magnetized and bunched electron beam can be used, the power of the beam is very high. New conditions require new concepts. Only in the electron beam energy range less than 5 MeV the DC acceleration in an electrostatic device of the electron beam immersed in the longitudinal magnetic field can be used. It is possible without very large new efforts at research and development study (V. Parkhomchuk “Electron Cooling of Hadrons in GeV Energy Range”). But even in this case the new solutions of the cooling system design are necessary to reduce the cost of the installation (J.MacLachlan “Fermilab Conceptual Design for an Electron Cooler for 8 GeV Antiprotons”, S.Nagaitsev “Electron Beam Transport Scheme for the Fermilab Electron Cooling System”). The high power of the electron beam requires development of the electron transmission line with high efficiency (A.Shemyakin “Performance of Pelletron Based DC Recirculation System”).

To reduce the average electron beam power the scheme with electron beam circulating in additional ring can be used. The period of the electron beam circulation is limited by different factors, which produce the heating of the electron beam (I.Meshkov “Principles of MEEC with circulating Electron Beam”). In combination with longitudinal magnetic field and betatron acceleration of the electrons such a scheme has potentially minimal cost. However its practical realization concerns with a solution of particle dynamics problems (A.Smirnov “The Stability of the Circulating Electron Beam in the Electron Cooling System Based on Modified Betatron”).

To cool the bunched ion beam at energy 10 GeV and higher the use of bunched electron beam looks very attractive. In this case the electron acceleration can be performed with linac of relatively low frequency, which can provide the electron bunches of lengths of about one meter and small momentum spread (V.Parkhomchuk).

Electron beam quality is determined not only by the generation scheme, but by the ion beam parameters, which are to be stabilized. “There is an optimum electron temperature, where the cooling rate is higher that for cold electrons” (J.MacLachlan “Optimizing Parameters for MEEC”). Moreover, the high cooling rate can provoke the instability of the intensive ion beam. The cold central part of the ion beam has coherent oscillations and heats the particles with large amplitude of betatron oscillations (V.Parkhomchuk “Limitation of ion beam intensity in electron cooling system”).

The results obtained at the Fermilab R&D Facility for MEEC (presently the maximum recirculated electron beam current is 0.6 A at electron energy of 1.5 MeV - reports by A.Warner, S.Nagaitsev, A.Shemyakin) and new constructing facilities aiming to test the scheme with circulating (A.Sidorin) and bunched electron beam (T.Winkler) were discussed as well as new results obtained on the traditional cooling systems (M.Steck, J.Stein) and the development in the technology and the electron beam operation (P.Lebedev, E.Syresin).

Finally, we report remarks of some key participants:

Dieter Moehl (CERN): The general idea of the workshop was the comparison between different proposed schemes of a cooling system for an ion beam at medium energy (of about 10 GeV), analysis of their advantages and disadvantages and choice of a method that can be realised in the near future.

Sergei Nagaitsev (FNAL): This workshop joined together almost all leading specialists in electron cooling. The participation in the same workshop of Dikansky, Skrinsky, Meshkov, Parkhomchuk is an outstanding event.

Dag Reistad (Upsala Univ.): The Workshop was definitely a great success, enhancing the progress of the Fermilab MEEC project as well as the progress and understanding of other electron coolers.

3.4 Session on Standardization of Accelerator Description and Codes at ICAP98, Monterey, September 16, 1998

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A session devoted to the discussion of standardization of accelerator codes and description was held at ICAP 98 in Monterey. Accelerator projects in the present and even more so in the future are often large scale collaborations between national and international institutions. The easy and reliable transfer of accelerator information as well as sharing of codes are becoming real necessities if time and resources are not to be wasted in duplication of efforts. To promote discussion along those lines, C. Iselin, E. Keil and R. Talman sent a letter to the April 1998 issue of this Newsletter which called for a new accelerator description standard (ADS) in January 1998. Shortly afterwards, in February 1988, a workshop was held at BNL to coordinate software development for the US-LHC Collaboration and in this framework the issue of a standard accelerator description was further discussed. A format, the SXF (Standard eXchange Format) was proposed and agreed upon during the workshop and developed thereafter. Since then, N.Malitsky and R. Talman developed the ADXF (Accelerator Description eXchange Format) which is an answer to the ADS requirements based on industrial software standards. The purpose of the session at ICAP98 , chaired by E. Keil and R. Talman, was to initiate the discussion of lattice and code standardization among a wider audience, to evaluate what has been done so far and to form a plan for the future. Talks by Keil and Talman were followed by general discussion. A summary will appear in the proceedings of ICAP'98, and on the WWW site below.

A session dedicated to review, discussion and planning of standardization is scheduled at the upcoming PAC99 Conference in New York City in March 1999. The session will take place Thursday, April 1st, in the afternoon. Further information on this session and documentation on standardization of codes and accelerator descriptions will be soon available on the Web at the site

`http://www.rhichome.bnl.gov/AP/Standard`

3.5 CERN mini-workshop on RF impedance of thin metal films

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The question of how the impedance of thin metal walls is to be computed and measured in practical situations was addressed at a mini-workshop organized at CERN on 30 October 1998. The conclusions may have an impact on the design of future metallized ceramic chambers for kicker magnets or metal screens in the experimental beam pipes. These are examples of structures of finite length, but even in the case of (almost) infinite lengths there seems to be some disagreement about the correct boundary conditions and the resulting formulae for electromagnetic penetration.

Several presentations were given during the morning session of the mini-workshop (F. Ruggiero: Introduction and motivation, M. D'Yachkov: Impedance Measurements on the LHC Dump Kicker Prototype, E. Jensen: Numerical simulations with HFSS, G. Dome: Impedance of a pill box cavity with thin conducting layer at $r = a$, E. Karantzoulis: Experience at ELETTRA with the ceramic chamber metallization for/and the injection system, L. Vos: Shielding of electromagnetic fields by metallic screens, E. Keil: General remarks about impedance computations), while the afternoon session was devoted to discussion.

The participants to the afternoon discussion (A. Chao, F. Caspers, G. Dome, L. Ducimetiere, M. D'Yachkov, C. Gonzalez, E. Jensen, E. Karantzoulis, E. Keil, M. Morvillo, A. Piwinski, F. Ruggiero, L. Vos, X. Zhang, B. Zotter) tentatively agreed on the points reported below:

1. It is desirable to confirm the validity of the coaxial wire measurements either by simulation (e.g., using HFSS with ideal current sources) or directly by measuring with an RF probe the leakage of beam generated electromagnetic fields through a thin resistive layer. Such a measurement could be performed on a beam line or circular accelerator where a test section consisting of a resistive layer on a plastic support, with consequent poor vacuum conditions, can be installed easily.

2. In the low frequency limit, when there are no resonances due to the ceramic chamber, the formulae by A. Piwinski and B. Zotter for the effective skin depth of a thin metallic coating disagree.

3. For ultra-relativistic beams and in the asymptotic limit of very LONG structures, a thin resistive layer does NOT provide any RF shielding.

   An inductance of 100 nH, associated with the geometric step of a typical kicker tank, corresponds to an impedance of about 6Ω at 10 MHz. For a metallic layer with typical specific resistance of $1\,\Omega/\mathrm{m}$, the asymptotic regime where the image currents flow in the outer conductor and the resistive layer provides no shielding requires lengths of the order of several meters.

4. For short structures, of length much shorter than $\lambda\gamma^2$, we do not expect a strong influence of the relativistic gamma factor of the beam.

5. For short (typical kicker) structures the presence of a resistive layer with or without dielectric behind it yields an upper limit to the real part of the impedance equal to the DC resistance of the layer. This is confirmed by measurements and simulations, using the coaxial wire method, and is in agreement with observations with beam in ELETTRA.

4: Activity Reports

4.1 Beam Dynamics Studies at ORNL for the Spallation Neutron Source

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4.1.1 Introduction

The Spallation Neutron Source Project, SNS, is a collaboration of five DOE Laboratories to build an advanced spallation neutron source at Oak Ridge National Laboratory for condensed-matter neutron-scattering research [1]. The project attained line-item construction status with the approval by Congress and the Administration, receiving $130M in FY99 of the total project cost of $1334M. The SNS consists of the following sequence of accelerator systems: a 35-mA peak-current volume plasma H^- ion source; a 2.5-MeV 402.5-MHz RFQ; a MEBT that chops the beam for ring extraction; a 1.0-GeV 60-Hz 460-m proton linac operating at a 6% duty factor with an 805-MHz side-coupled linac above 95 MeV; and a 221-m-circumference 24-FODO-cell four-fold accumulator ring. The ring will be filled with 1160-turn H- foil-stripping charge-exchange injection. The 1-ms pulses from the linac will be compressed to 600 ns pulses containing 1×10^{14} protons, which will produce short-pulse neutrons from a 1-MW liquid Hg target at a maximum rate of 60-Hz. Uncontrolled beam loss is a major concern. For hands on maintenance, a full-energy loss of < 1 nA/m is required. This corresponds to an integrated uncontrolled beam loss in the ring of less than 2×10^{-4} for 1 MW of beam power.

The SNS Collaboration includes LBNL for the ion source, RFQ and MEBT; LANL for the linac; BNL for the ring and associated beam transport; and ANL for the neutron scattering instrumentation. ORNL is responsible for the target system, conventional facilities, and for integration and management of all elements of the project. The Oak Ridge accelerator physics group consists at present of Slava Danilov, John Galambos, Jeff Holmes, Dong-o Jeon, David Olsen, and JG Wang, with openings in both linac and instrumentation technology and physics. The primary responsibilities of this group are to coordinate and integrate the overall accelerator design and to prepare for commissioning and operations. In addition, the group has been developing beam dynamics expertise in areas critical to the success of the SNS project.

Two of the critical SNS beam dynamics concerns are the ring H^- injection system and space-charge-induced halo formation during injection. For this reason, and in support of the BNL ring design, we have developed space charge modules and have incorporated them within the ACCSIM injection tracking code [2]. With this model we have studied the fundamental physics of ring halo generation, optimized ring injection to reduce halo, and have made first calculations of the expected space charge halo in the SNS ring.

4.1.2 Beam Dynamics Studies of Halo

Over the last decade most work on space-charge-induced halo formation has focused on linac beams, and considerable progress has been made. Beam halo in linacs is understood through the mechanism of parametric resonances between the particle betatron oscillations and envelope oscillations that are driven by mismatch. Even though the maximum space charge tune depressions in rings are much smaller than in linacs, advanced spallation neutron source rings presents a new and more complicated regime for space charge halo studies. In particular, rings have periodic boundary conditions and dispersion, changing particle distributions during the injection process, and beam traversal through 50,000 FODO cells, compared with 300 FODO cells for linacs. Even with very weak space charge, mismatch will drive a quadrupole parametric resonance between particle and envelope oscillations.

In order to study transverse beam dynamics, and space charge effects in particular, in high intensity rings, we have adopted a particle-tracking approach using a particle-in-cell (PIC) model. The integration scheme is chosen to be second order symplectic, with a matrix representation of all linear focusing elements, including dispersion, and the inclusion of all nonlinear effects as kicks. Fast Fourier transforms are used to evaluate the space charge forces. This is carried out in a modified version of the particle tracking and injection code, ACCSIM, and in a new C++ code, SAMBA, which we are developing. Numerical convergence and accuracy test calculations have been completed. Extensive diagnostic routines for analysis of emittances, beam moments, actions, tunes, energy distributions, halo, spectra, and tracking have been completed. We have applied these computations to understand fundamental space charge physics in the SNS regime and to calculate and analyze the SNS halo.

4.1.3 Parametric Resonance in the SNS Ring

Figures 4.1 and 4.2 show results for tracking a coasting beam with an initial K-V distribution at 1 GeV in the SNS FODO lattice. The initial distribution has a mismatch parameter of 20%, an energy spread of 9.4 MeV half width, an emittance of 100 π mm-mrad, and bare x and y tunes 5.85 and 5.70, respectively. The number of beam particles is 2×10^{14}, simulated with 20000 macroparticles, a 32 by 32 FFT grid, and 480 integration azimuths.

Figure 4.1 illustrates the dynamics of halo formation. In the upper left plot, the average vertical coordinate squared, plotted once each turn, shows the envelope oscillations that drive the parametric resonance. The upper right plot shows the fraction of the beam in the halo, also versus turn number, where the halo is defined as particles having either horizontal or vertical emittance exceeding 150? mm-mrad. The plot on the middle left shows the evolution of the rms x and y emittances, as defined by Lapostolle [3]. These three plots, taken together, reveal a growth of halo over the first 200 turns, during a period of strong envelope oscillations. Beyond 200 turns, the growth ceases and the instability saturates. This saturation is accompanied by much smaller envelope oscillations, their energy now spent from driving the halo creation. The result is a steady state beam with halo. The plot on the middle right shows the final beam in the vertical phase plane. Because the y tune is lower than the x tune, the instability is strongest in the vertical direction. This can be seen in the plot of the rms beam emittances as well as in the plots at the bottom, which show the final particle actions (left side) and tunes (right side). The actions of the halo particles are the points extending along the y and x axes to large values, and the tunes of the halo particles are those points above and to the right of the beam core tunes. The strength of the halo generation due to the parametric instability is dependent on the amount of space charge and the size of the rms mismatch. Although the results in Fig. 4.1, calculated with 20% rms mismatch and 2×10^{14} particles, are dramatic, we observe this same process, with longer time scales and smaller saturation levels, for 1×10^{14} particles and 10% and 5% mismatches, also. For example, with 1×10^{14} particles and 10% RMS mismatch we obtain 0.7% of beam in the halo by 1160 turns. Typical times for this process are several hundred turns, or several thousand envelope oscillations. Although such times are slow compared to linacs, they are fast enough to occur in SNS. Dispersion effects are seen to "spread the beam" and weaken the instability.

Figure 4.2 shows the particle distribution in the vertical phase plane during halo formation. The

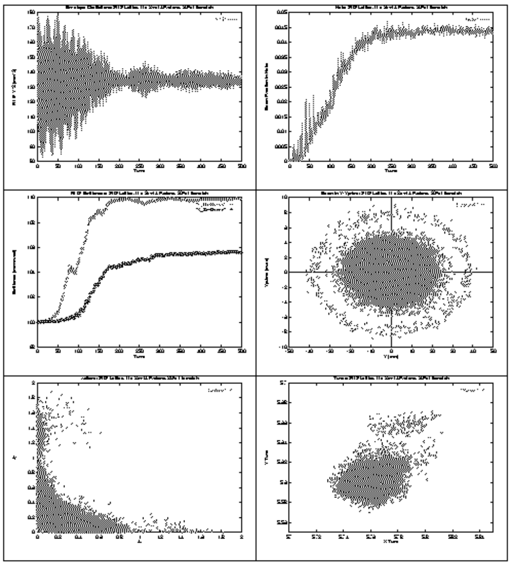

Figure 4.1: Halo formation from the parametric resonance

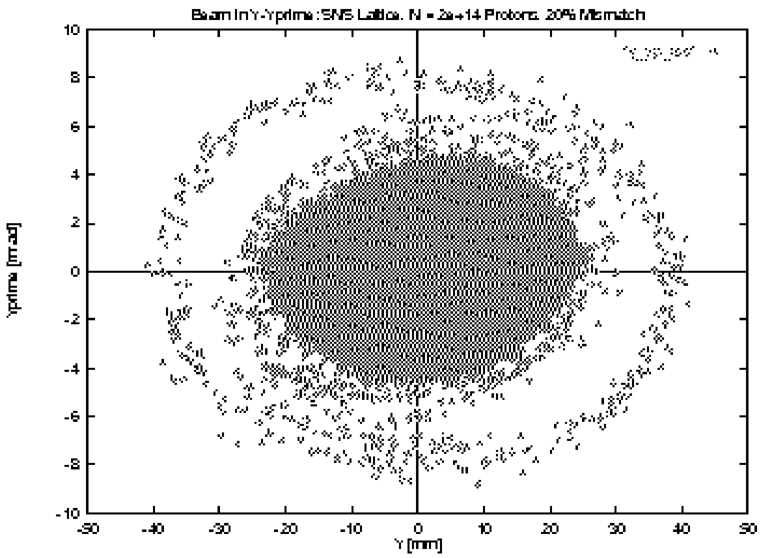

Figure 4.2: Particles enter the halo by crossing the separatrix.

islands and separatrix of the resonance are clearly visible. The process of halo formation is clear in this figure. As the beam relaxes, particles encounter the separatrix of the parametric resonance and, in the vicinity of the x points small localized turbulence sends some particles across to the outside of the separatrix, making them halo particles.

To summarize, the basic process for halo generation from this simulation as is follows: In a ring, a beam is RMS matched when the RMS beam parameters vary with the ring periodicity. RMS mismatch manifests in envelope oscillations with frequencies slightly less than twice the bare tune in the corresponding plane. These oscillations drive the parametric resonance, characterized by two envelope oscillations for each particle betatron oscillation. Because of the relationship between the betatron tunes and the envelope oscillation tunes, the resonance typically occurs in an annular region outside the beam core. For RMS mismatched beams, particles that encounter this region can wander around its edge and become halo particles. This process does not occur for RMS matched beams. During injection the beam is mismatched.

4.1.4 SNS Halo Simulations

Preliminary calculations have been completed, both to optimize the SNS injection scheme for minimum space charge halo and to provide some estimate of the expected halo that will require collimation. A total of 1158 turns of H- beam will be injected by carbon foil stripping for each macropulse. The injection process will be facilitated by painting the linac beam phase space, 0.70 π-mm-mrad, into the ring acceptance, 410 π-mm-mrad, by dynamic bumping of the ring equilibrium orbit at the injection foil, with independent bumps in both the horizontal and vertical directions. The linac beam will be painted into the ring acceptance with a 120 π-mm-mrad emittance in both the horizontal and vertical directions. Three painting options with bumping magnets have been studied:

1. direct correlated horizontal and vertical bumping of the equilibrium orbit away from the foil, so that large horizontal and vertical betatron amplitudes occur together;
2. horizontal bumping only, which produces a smoke ring distribution in the vertical phase space; and
3. anti-correlated horizontal and vertical bumping together producing a KV-like distribution at the end of injection.

Although the initial operation of the SNS will be at 1 MW, to allow for upgrades, the calculations are done for 2 MW of beam power. Some results for the injection geometry and parameters of the reference design are summarized in the table below. The first three groups of rows list results both with and without space charge. The “e-fold decays” give the rate of closed orbit movement during injection, the “initial bump offset” gives the hollowness of the beam in phase space, and the “final bump offset” gives the final beam emittance. The table shows that if the injection is optimized for minimum foil impacts without considering space charge, then including space charge effects causes over 2% of the beam to appear at extraction as halo outside of 180 mm mrad. The tune shift and spreads for the three painting schemes are similar; however, the correlated x-y painting seems superior. The foil hits per proton are substantially less, which is a very important consideration, and essentially no halo particles are predicted outside of 240 π-mm-mrad. The inclusion of transverse space charge effects has a large impact on both halo and the final beam distribution at extraction.

The last group of rows lists results from correlated painting in which the parameters have been chosen to minimize halo. Clearly there is a tradeoff between tune shift and halo growth. The last row lists a reasonable compromise in which there is both an acceptable tune shift and low halo. Collimators with apertures at 180 π-mm-mrad would intercept about 0.26% of the beam.

4.1.5 Future work

The understanding of the fundamental process of space-charge-induced halo generation developed for linacs has been extended to rings and applied to the SNS. These preliminary calculations indicate that space charge halo will require attention in SNS. Although present simulations have been extended to more than 10^5 macroparticles on individual UNIX workstations, another one to two orders of magnitude will be necessary to obtain the precision to predict 10^{-4} beam losses. To accomplish this, we have constructed a Beowulf type LINUX parallel computer from low-cost PCs with 533-MHz DEC Alpha chips. In the immediate future, nonlinear effects from random lattice errors and chromaticity will be included and studied in the presence of space charge, followed by an exploration of tune space and the detailed physics of halo generation for the SNS injection process. In the long term a complete 3D treatment with transverse wall impedances is being considered. Space charge halo calculations for existing rings may also be investigated and used to benchmark the calculated results.

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Injection Scenarios for Horizontal / Vertical Painting

Input x/y parameters				Output x/y emittance in π mm mrad					
space charge	e-fold decays	initial bump offset (mm)	final bump offset (mm)	foil hits/p	rms emit	% with $\epsilon > 120$	% with $\epsilon > 180$	% with $\epsilon > 240$	tune shift
Correlated X-Y bump									
without	6.9 / 1.3	4.1 / 6.3	38 / 23	2.5	38 / 26	0 / 0	0 / 0	0 / 0	.19 / .23
with	6.9 / 1.3	4.1 / 6.3	38 / 23	2.5	41 / 21	21./0.5	2.0/.03	0.01 / 0	.18 / .22
X bump only (Smoke ring)									
without	1.2 / NA	11 / 17	40 / 17	5.0	28 / 46	0 / 0	0 / 0	0 / 0	.24 / .24
with	1.2 / NA	11 / 17	40 / 17	6.3	35 / 44	11. / 21.	0.6 / 3.7	0.2 / 1.2	.13 / .11
Anti-correlated X-Y bump (KV like)									
without	1.5 / 1.3	2.6 / 22	40 / 9.1	5.1	25 / 33	0 / 2.0	0 / 0	0 / 0	.24 / .17
with	1.5 / 1.3	2.6 / 22.	40 / 9.1	7.9	28 / 33	3.0 / 12.	0.4 / 2.0	0.2 / 0.7	.18 / .16
Optimized correlated X-Y bump									
with	1.3 / 1.3	0.0 / 0.0	27 / 22	3.9	24 / 13	3.7 / 0	0 / 0	0 / 0	.41 / .55
with	2.6 / 2.6	2.0 / 2.0	37 / 23	2.7	31 / 22	9.3 / 1.8	0.05 / 0.2	0 / 0.01	.24 / .29
with	4.0 / 2.0	6.0 / 2.0	36 / 22	3.0	33 / 23	8.7 / 1.6	0.06 / 0.2	0 / 0	.18 / .23

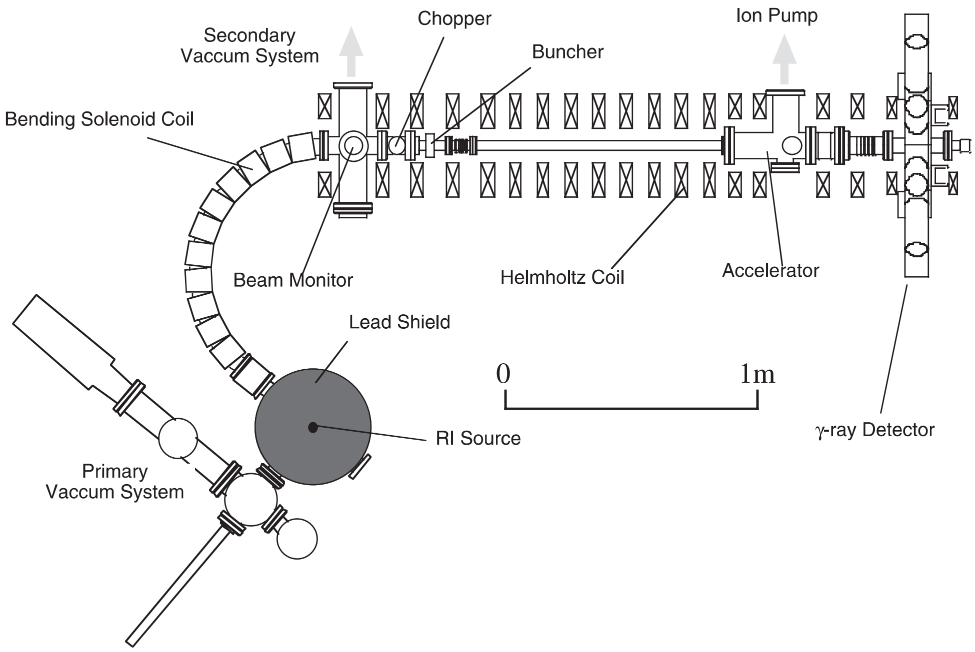

Figure 4.3: A schematic view of TOPPS

4.2 A Slow, Polarized, Pulsed Positron Beam at Tokyo Metropolitan University

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Slow positron (e^+) beams based on β^+ radio-isotope(RI) sources are becoming important tools for various fields of physics. TOPPS (TOkyo metropolitan university Polarized Positron beam System) is one of the slow e^+ beam systems which has special features, such as high intensity, spin polarization, and pulsed beam [1]. In this letter, we present the overall performance of TOPPS.

4.2.1 Generation of slow polarized positrons

Energy spectrum of β^+-rays is widely spread and difficult to handle as a beam. To produce a monochromatic e^+ beam, a solid called "moderator" is utilized. When β^+-rays are injected to the moderator, a portion of the e^+'s are thermalized and reemitted from the surface due to its negative work function.

It is well known that an e^+ emitted in β^+ decay of an RI is longitudinally polarized due to parity violation of the weak interaction with average helicity of v/c, where v and c are velocities of the positron and light, respectively. Spin directions of e^+'s are unchanged during the moderation process, so that the RI based slow e^+ beam is spin polarized. A schematic diagram of TOPPS is shown in Fig. 1. Positrons emitted from β^+ decay of a $100mCi$ ^{22}Na source which, having the diameter of 3 mm, is deposited on the Beryllium backing to suppress depolarization due to back-scattering of e^+'s. A single crystal of tungsten with $2\mu m$ thickness and 22 mm diameter is used as the moderator, which can be cleaned and annealed in the ultra high vacuum of 10^{-10} $Torr$ by electron bombardment of 3kV-50mA. About $10^{-5} \sim 10^{-4}$ of β^+'s are moderated and reemitted as slow e^+'s with an energy spread of $\sim 1eV$.

4.2.2 Beam transport

The initial polarization of generated e^+'s is subject to depolarization during beam transportation processes. The beam transport system of TOPPS is carefully designed to minimize the spin depolarization using a simulation program POEM (POlarized beam simulator in Electric and Magnetic fields) [2], which calculates the spin motion of e^+ beams by solving the relativistic equation of motion.

The slow e^+ beam is accelerated up to $200eV$ and guided with an axial magnetic field of about 100 G generated with solenoid and helmholtz coils. The beam is bent by $140°$ at the arc section to get rid of γ-rays and fast e^+'s which are not moderated. At present, 4×10^4 slow e^+'s per second are transported as a beam of 8mm diameter.

Using the retarding method, longitudinal energy spread of the e^+ beam is measured to be $50eV$ (FWHM), which is considerably larger compared with the energy spread at the moderator. This is mainly due to helical motions of e^+'s. Thus in order to improve this difficulty and attain the energy spread of $\sim 1eV$, we are now modifying the transport system to lower the e^+ energy down to a several eV.

4.2.3 Beam Buncher

Slow positrons injected on a target form positronium (Ps) atoms with electrons in the target material and decay into γ-rays. Various spin-related physics can be examined utilizing the polarized positron beam by comparing number of generated Ps atoms in the spin-singlet state and spin-triplet state. The spin-singlet (spin-triplet) Ps decays into even (odd) number of γ-rays with a lifetime of 0.125$nsec$ (142$nsec$). To distinguish them by their lifetimes, a precise timing information indicating e^+'s arrival is necessary.

Thus we set a chopper and a buncher to attain the pulseed e^+ beam. The chopper extracts every 200$nsec$ the e^+ beam with the time width of 50 $nsec$ which the buncher compress to a few $nsec$(FWHM). For velocity modulation of the e^+ beam, the ideal pulse which should be applied to the buncher is

$$V(t) = -(m_e L^2/2et^2) - E_0$$

where parameters defined as follows, m_e: e^+ mass, e: e^+ charge, L=1.8m: distance between the gap and the focusing point, E_0 : initial e^+ energy, t : time for e^+ to travel the distance L. The time dependent potential is supplied by a combination of an arbitrary wave-form generator and a post-amplifier. In order to generate electric field efficiently at the buncher, we adopted an idea of the linear induction accelerator and insert a ferromagnetic FINEMET (Fe-based nanocrystalline soft mgnetic alloy amorphous) core having large inductance i.e. 0.68×10^{-6} H inside the toroidal cavity[3], [4].

A preliminary test of slow e^+ bunching is performed and the pulse width is measured to be 2 $nsec$ (FWHM).

4.2.4 Polarimeter and Other Components

Measurement of e^+ polarization makes use of magnetic quenching of Ps due to Zeeman effect. Detailed idea and design of the polarimeter are described elsewhere[5]. The beam polarization of TOPPS will be soon determined.

We also constructed a spin rotator, Wien filter, in which electric and magnetic fields are applied perpendicularly to each other and spin directions of the beam e^+'s can be rotated without changing the beam trajectory.

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4.3 Beam Dynamics Activities on Beijing Tau-charm Factory Design

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Since the international workshop and the review meeting for the Beijing Tau-charm Factory in 1996, further beam dynamics studies were carried out to approach a reference design in 1997-98. The major issues addressed in recent studies include lattice and layout, longitudinal polarization, beam-beam simulations, etc.

1. A common 60/60 degree FODO structure is again adopted to replace the former irregular FODO lattice in order to improve the dynamic aperture, especially for the monochromator scheme. This results the sufficient dynamic aperture. The non-interleaved sextupole correction scheme is also investigated. A better dynamic aperture is obtained and a larger momentum dependence of optical parameters is seen due to the few number of sextupole families. IR design including supporting systems, vacuum pumping system and superconducting magnets is detailed. A transport line from existing linac to the main ring of BTCF is also designed.

2. Longitudinal polarization studies made remarkable progress. A pair of dipole-solenoid spin rotator are integrated into the main ring lattice. The detailed analysis of the property in spin dynamics of the ring lattice are performed. The spin-matching is applied to whole rotator-IR-rotaor region to suppress major diffusive depolarization effects. The Derbenev-Kondratenko vector is minimized to zero in the most part of the ring. Therefore the high equilibrium polarization level, say, about 80% at 1.84 GeV to 2.0 GeV, is achieved. The depolarization effect caused by closed orbit distortions is not significant. The related issues, such as local compensation of the coupling brought by strong solenoids, layout change with energy to keep the exact spin rotation conditions, dynamic aperture, etc., are studied and no fatal problem is found.

3. Beam-Beam effects on BTCF with a finite collision angle and dispersion at interaction point are simulated by the computer code BBC. Various parameters of the collider, such as tunes, beam-beam parameters, bunch length, beta functions at IP, are taken into account. It is concluded that with the current optimized parameter set, the luminosity goals of BTCF, 1E33 at 2.0 GeV with the crossing angle scheme and 1E32 at 1.55 GeV with the monochromator scheme, can be accomplished.

4.4 Beam Dynamics Studies at Rutherford Appleton Laboratory, UK

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Topics under recent and continuing study include:

1. Development of a new particle tracking code for a 4 rod RFQ, and use of the code to aid the design of a 665 keV RFQ for ISIS (A.Letchford)
2. Ion source and input transport line studies for the 665 keV ISIS RFQ under construction at University of Frankfurt. (J.Thomason and C.Bailey)
3. RFQ-DTL input matching studies for ISIS. (J.Stovall and A.Letchford)
4. Injection and closed orbit optimisation for the ISIS ring. (D.Adams and C.Warsop)
5. Lattice and injection studies for an alternative accumulator ring for the European Spallation Source, ESS, allowing either H- charge exchange or laser stripping injection. (G.H.Rees, J.V.Trotman and C.R.Prior)
6. Studies of beam loss collection for the ESS accumulator rings. (C.Warsop, thesis)
7. Studies of an alternative 1.334 GeV, 5 MW, H- linac for the ESS, including a change of frequencies and new chopper and funnel sections. (J.Stovall, A.Letchford, G.H.Rees, J.V.Trotman and C.R.Prior)
8. Lattice and injection studies for a European heavy ion inertial fusion driver ring evaluation, HIDIF. (G.H.Rees and C.R.Prior)
9. Medical Cyclotron Linac Booster (LIBO) studies (J.Stovall and J.Lipp)
10. Radioactive Ion Beam Facility study (J.R.J.Bennett and P.Drumm)
11. Preparation for an ICFA Beam Dynamics Mini Workshop on Injection and Extraction in High Intensity Proton Machines (24–26 Feb 1999)

4.5 An R&D Program for Targetry and Capture at a Muon-Collider Source

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Among the options for future high-energy accelerators, one based on muons would be advantageous in having simple leptonic couplings to fundamental particles, as well as a very well defined center-of-mass (C0M) energy since initial-state radiation is suppressed by the mass of the muon. A muon collider would be the most compact accelerator capable of (C0M) energies in the range 100 GeV-100 TeV. An international collaboration of over 100 physicists from 26 institutions has been formed to pursue R&D towards the design of a First Muon Collider that could emphasize s-channel production of a light Higgs boson. Activities of the Muon Collider Collaboration are hosted by Brookhaven National Laboratory, Fermilab, and Lawrence Berkeley National Laboratory; R.B. Palmer is the Spokesperson. In addition to accelerator theory and simulation, these activities include two hardware R&D projects: muon production and capture [2], proposed to BNL and the topic of this report; and ionization cooling [3], proposed to Fermilab.

A muon collider [1] is a future accelerator complex in which

- Muons (both μ^+ and μ^-) are collected from pion decay following a pN interaction.
- The muon phase volume is reduced by 10^6 by ionization cooling.
- The cooled muons are accelerated and then stored in a ring.
- $\mu^+\mu^-$ collisions are observed over the useful muon life of ≈ 1000 turns at any energy.
- Intense neutrino beams and spallation neutron beams are available as byproducts.

Present designs for a muon collider [1] call for a copious source of muons: 5×10^{14} μ/s distributed over 15 pulses/s, each only a few ns long. These muons arise from the decay of low-energy pions that are produced by the interaction of a beam of 1.5×10^{15}, 16-24-GeV protons/s with a high-Z target. The proton beam power is 4 MW, of which 10% is deposited in the target at a density of about 30 J/g per pulse.

The target is surrounded by a 20-T solenoid magnet that captures pions of transverse momentum up to 225 MeV/c into a decay channel. To avoid absorption of the spiraling pions near the target, the latter cannot be cooled by contact with a local thermal bath. Rather, the material of the target must move out of the interaction region to be cooled elsewhere. This procedure is incorporated in the designs of all MW-level neutron spallation facilities. The baseline design for the muon collider is for a target in the form of a pulsed jet of liquid metal such as Ga, Hg [4] or molten Bi/Pb. A backup design is a nickel target in the form of a band that moves through the interaction region somewhat like the blade of a bandsaw.

The decay channel includes a series of low-frequency rf cavities inside a 1.25-T solenoid. The cavities are phased so as to compress the energy spread of the decay muons, for better injection into the subsequent muon-cooling channel. This process of "phase rotation" is more effective when the first rf cavity is located as close as possible downstream of the target.

The targetry scenario leads to several critical technical questions, which are to be addressed in an R&D program proposed to BNL [2]. The first phase of the program should establish whether there are any major difficulties in the use of a free liquid jet as a proton target in a strong magnetic field. Should this be the case, the solid-band option then would be emphasized. Some of the initial studies will be performed in collaboration with the National High Magnetic Field Laboratory in Florida [5]. The second phase of R&D will explore pion production and capture in an intense, but low-repetition-rate beam including a 20-T pulsed magnet around the target, and a 70-MHz rf cavity inside a 1.25-T solenoid located 3 m downstream of the target.

Not covered in this program are the serious issues of operation of a moving target in a high-repetition-rate beam and in the consequent intense radiation environment. An expanded R&D program to include these issues is desirable, and might include collaboration with the ISOLDE facility at CERN as well as neutron spallation target groups such as those at PSI (Switzerland) and ORNL (USA).

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4.6 Beam Dynamics Activity at the Universities of Naples and Salerno

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4.6.1 Introduction

The Neapolitan Accelerator Physics group was born at the Department of Physical Sciences of the University "Federico II" thanks to the efforts of Prof. Vittorio Giorgio Vaccaro, who has been the leader of the group since the beginning. In the last few years its activity expanded involving cooperations with the Electrical Engeneering Department of the same University and with the Department of Physical Sciences E.R. Caianiello of the University of Salerno.

The Istituto Nazionale di Fisica Nucleare (INFN), which has a section inside the Department of Physical Sciences, has financially supported the research projects of this group with both instrumentation and personnel since the beginning. The successful development is mainly due to this support. For those people who are not familiar with the scientific organizations in Italy, it has to be stressed that INFN is an organization completely independent from university which promotes scientific research in nuclear and sub- nuclear physics and related fields.

The Neapolitan Accelerator group is composed by researchers from the Naples section of INFN and from the University of Naples and Salerno. In the past, the group received small financial supports also from the Ministry of University and Scientific Research; in the last few years the financial contributions from the European Community within the framework of The Fourth Frame Program (TMR Program) was increasing more and more, allowing the group to enlarge and participate to several new research programs.

The group carries out its activity in collaboration with different research laboratories: LNF (Frascati) and LNL (Legnaro) in Italy , DESY (Hamburg), GSI (Darmstadt), KFA (Juelich), KEK (Tsukuba) and CERN, working on general theoretical accelerator problems, experimental topics and machine projects. The group has been involved in some projects of new accelerator machines, as the European Spallation Source and Crystal. Currently a new machine collaboration is under study within the project for a protontherapy accelerator complex.

The activity covers different fields that can be summarized as follows.

4.6.2 Conventional methodologies

4.6.2.1 Machine Optics (Naples)

In collaboration with the Machine Physics group of the National Laboratories of Frascati, the optics of the DAΦNE main rings has been studied; the effects on the dynamic aperture of the expected multipolar field components of the different magnets were studied by simulations.

Closed orbit diagnostics and correction schemes have been defined both for the Accumulator ring and for the main rings with the help of the MAD code using the “most efficient corrector method” [1].

Some other correction algorithms were studied. A computer code using the harmonic method was written, tested during the commissioning of the Accumulator [2] and actually used also for the main rings. A response matrix method was also studied.
Currently there is a partecipation to the shifts during the commissioning of the DAΦNE machine.

For the European Spallation Source, studies on the closed orbit deviation and related correction schemes have been carried on [3].

4.6.2.2 Beam dynamics

Coherent instabilities (Naples) The longitudinal instability of an intense coasting beam in the ESR-GSI, heavy ion storage ring has been investigated far away from the stability boundary for several values of the machine impedance. The experiments have clearly demonstrated the exponential growth of the slow wave, the asymmetric wave steepening, generation of higher harmonics and saturation [4]. A simple one-dimensional fluid model has been used to explain the steepening and the harmonic generation. Higher values of the line charge density “propagate” faster than the lower ones because of convective and intense space charge effects.

Self forces, which are the basis for stability analysis, have been studied considering canonical solution of classical electromagnetic problems in the time domain [5]. In this frame a stable collaboration has been established with KFA in Juelich.

Impedances, image and collective effects for LHC (Salerno) The collaboration with the SL-AP Group at CERN is related to the LHC project.

A general analytic approach for computing beam coupling impedances in vacuum chambers with complex geometry, and/or complex (electromagnetic) constitutive properties, based on the combined use of the Debye potential formalism, the Lorentz (reciprocity) theorem and (extended) impedance boundary conditions has been studied. The impedances of a proposed LHC liner have been evaluated [6].

Tune shifts and Laslett coefficients for complex geometries have been computed. The tensor nature of the Laslett coefficients has been emphasized, and normal mode Laslett coefficients have been introduced, perhaps for the first time. This approach has been applied to a simplified LHC structure consisting of two pipes encircled by a common magnetic yoke [7].

Beam-beam interaction (Salerno) A collaboration with the Accelerator Theory Group at KEK started in 1996, supported by grants from the Japanese Ministery of Education and University and the Canon Foudation Europe. The effects of large dispersion at the interaction point (which plays an important role in machines with monochromatization scheme) have been studied. Several effects were found on the synchrotron motion, including synchrotron tune shift, bunch lengthening and energy spread modification, which might lead to instability, luminosity decrease and increase of the collision energy resolution [8].

Geometrical horizontal-vertical coupling (Salerno) In the framework of the collaboration with the Accelerator Theory Group at KEK, the existence, even in absence of coupling elements, of a geometrical coupling between horizontal and vertical betatron oscillations, due to the nonintegrability of the coordinates system has been studied [9].

Numerical simulation of transverse instabilities (Naples) In order to understand some features of the transverse instability dependence on chromaticity, as observed at the start-up of the HERA proton ring, a 3-dimensional multi-particle computer code for tracking beams in the presence of the realistic wake-field of an accelerating cavity was written [10]. It allowed different effects to be disentangled and to be analyzed separately.
The results of the simulations were checked against the predictions of the classical theory of transverse bunched-beam instabilities, and they were found in quite remarkable agreement. The phenomenon was recognized as an head-tail instability.

4.6.2.3 Coupling impedance and related measurements (Naples)

Impedance computation Some canonical problems can be formulated as a system of dual integral equations. In order to understand energy losses, we solved these problems by means of a Neumann series. The main project parameter is the longitudinal coupling impedance [11].

Mode matching technique (MMT) is applied according to a new formulation to evaluate the longitudinal coupling impedance of some structures (pillbox, iris, Shintake cell, T cell). By means of this new technique, ohmic losses can be simply considered in a nonperturbative way; open structures can be also taken into account [12].

Bench measurements A very accurate bench method has been developed and applied in order to measure the scattering matrix of accelerator components. The method based on the "coaxial-wire" one gives the final coupling impedance from an "ad-hoc" manipulation of the scattering matrices of the device under test and a reference line. An accurate matching between the measurement apparatus and the device is required. A kicker prototype of the DAΦNE Accumulator was tested. Measurements were performed on the prototype of the vertex-detector chamber of HERA-B experiment (DESY) in order to define the optimum internal RF shielding structure. A simple pill-box cavity has been measured and the experimantal data compared with those coming from simulations. The simulations have been implemented by means of the MMT. The comparison was really satisfactory.

Impedance and k-loss measurements with beam In the framework of the collaboration with the Machine Physics Group in DESY, the impedance of the proton ring of the HERA e-p collider has been studied from different points of view. Impedance measurements have been carried out on the accelerator with beam; k-loss measurements have been performed on a T-cavity inserted on a test beam facility installed at the National Lab. of Legnaro by using an electron beam with β varying from 0.3 to 0.6. MM technique has been applied also to this case giving good results for both working frequency.

4.6.3 Non-conventional methodologies (Naples)

The group is also involved in developing novel approaches in accelerator physics by means of *non-conventional methodologies*. In particular, recently the charged particle dynamics has been formulated in terms of a quantum-like model, the so-called Thermal Wave Model (TWM) [13]. The TWM assumes that the beam dynamics is described in terms of a complex function, called beam wave function (BWF), whose squared modulus gives the transverse density profile. The BWF satisfies a Schrödinger-like equation in which Planck's constant is replaced by the beam emittance. The TWM applications have been concentrated in the past on the following topics: aberrations, coherent states, and collective effects.

Taking into account the aberrations of a quadrupole-like focusing device, TWM was useful for estimating the luminosity in linear colliders [14] as well as for predicting, in terms of Wigner and Husimi functions, the transverse phase-space dynamics described by standard tracking code simulations [15].

Coherent states frequency cavities have been described by TWM in the case of negligible radiation damping [16] as well as when radiation damping and quantum excitation are important [17].

Taking into account collective effects, Self-focusing and self-compression of a relativistic charged-particle bunch in a plasmas has been correctly described with TWM in terms of a nonlinear Schrödinger equation (NLSE) [18], while coherent instability in conventional accelerators, in case of a purely reactive coupling impedance, and the related criteria has been explained in terms of the modulational instability associated with the ordinary cubic NLSE [19]. Soliton-like solutions for the density profile has been predicted as a final evolution of modulational instability (i.e. coherent instability) in both plasma-based [18] and conventional accelerators [19]. TWM showed its suitably in describing the potential well bunch lenghtening, as well.

More recently, the study of luminosity in the final stage of a linear collider received additional improvements by using a variational approach, already used in e.m. beam optics. This fresh approach for luminosity estimates has been applied to quadrupole-like devices with octupolar aberrations of arbitrary strength [20]. A comparison with the perturbative-based TWM results, showed a very good agreement.
Furthermore, starting from the classical phase-space equation for electronic rays, a deformation method allows to move from the classical to the quantum-like description, transforming a Liouville-like equation into a von Neumann-like equation. This procedure has allowed to recover TWM in semiclassical approximation [21].

An investigation in progress is concerned with the optics and the dynamics with new tomographic techniques [22]. The beam transport can be described in terms of a marginal distribution which has all the features of a classical probability distribution as well as all the information contained in the Wigner function.

Another research in progress concerns with longitudinal coherent instability in the presence of a non-negligible resistive part of the coupling impedance for coasting beam as well as for beams with finite size has been studied [23]. The corresponding equation for the beam wave function constitutes a new generalized Schrödinger equation, which, as far as we know, has not been analyzed before. The analysis has been also carried out in the phase-space with the Wigner function. The resulting phase-space description is fully equivalent to the one given by the NLSE in the configuration space, although it seems to be simpler in the phase space.

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[23] D. Anderson, R. Fedele, V.G. Vaccaro, M. Lisak, A. Berntson, S. Johansson, *Quantum-like Description of Modulational Instability and Landau Damping in the Longitudinal Dynamics of High-Energy Charged-Particle Beams*, to be published in Proc. of 16th Advanced ICFA Beam Dynamics Workshop on *Nonlinear Collective Phenomena in Beam Physics*. Arcidosso, Italy, September 1-5, 1998, S. Chattopadhyay, M. Cornacchia, and C. Pellegrini (Ed.s), AIP Press.

4.7 Beam Dynamics Activities at CERN

4.7.1 LEP

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LEP had a very successful run in 1998. Except for some calibration runs at the Z resonance, it operated at a nominal energy of 94.5 GeV. When operation stopped on 3 November, the integrated luminosities per experiment came close to $200\,\mathrm{pb}^{-1}$ per experiment, exceeding even optimistic expectations.

Several beam-dynamical factors contributed to the excellent performance. The superconducting RF-system performed very reliably, providing the longitudinal dynamic aperture necessary for operation at this energy. A lattice with phase advances of $(\mu_x, \mu_y) = (102°, 90°)$ in the arc cells reduced the horizontal emittance by about 30 % compared to the $(90°, 60°)$ optics used in previous years. In initial tests at the end of 1997, the luminosity performance of the new optics already approached that of the $(90°, 60°)$ optics. Still, there had been some concern about dynamic aperture and non-gaussian tails developing when the emittance was made large. The $(102°, 90°)$ optics used in 1998 profited from a specially designed sextupole configuration that reduced the detuning with horizontal amplitude whilst allowing a good correction of the non-linear chromaticity. The predicted dynamic aperture was substantially larger. No significant non-gaussian tails were found in measurements of the transverse horizontal particle distribution with artificially increased emittance (reducing the horizontal damping partition number, J_x down to about 0.2).

For luminosity production, the horizontal damping partition was increased to $J_x = 1.7$ to further reduce the emittance. The beam-beam tune shift parameter exceeded $\xi_y = 0.07$ on several occasions and, astoundingly, continued to scale nearly linearly with bunch currents (see Figure 4.4.

4.7.2 LHC

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With Version 6 of the optics, the LHC lattice hardware has been upgraded to increase its flexibility: the quadrupoles of the dispersion suppressors, formerly made of a main quadrupole in series

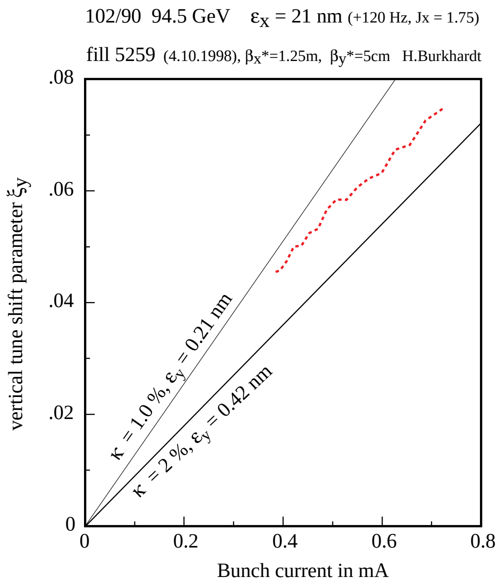

Figure 4.4: Evolution of the measured beam-beam tune-shift parameter in one of the best LEP fills in 1998. Time runs from right to left as the beam current decays. The values represent an average sustained over 15 minutes of luminosity production.

with the arc supplemented by a trim quadrupole, are now powered independently. In addition, this change allows an almost symmetrical layout about the interaction points, thereby increasing the similarity between Ring1 and Ring2 and simplifying the simultaneous β^*-squeeze. The last insertion to be designed (the momentum collimation insertion) is now close to completion: A somewhat more flexible powering scheme of the warm quadrupoles allows the required $D_x/\sqrt{\beta}$ to be reached. The beam distribution can then be cut at $\Delta p/p = 0.003$ without a significant cut in the betatron distribution.

Although the LHC has no super-periodicity, it was found that partly constructive excitation of the difference resonance $Q_x - Q_y$ by large azimuthal harmonics of a_3 and a_4 could perturb the dynamics in a significant way (large Q'' and tune modulation through chromatic coupling for a_3, amplitude blow-up on the sub-resonance for a_4). The nominal tune split between the integer parts of the tunes will be increased from 4 to 5, reducing the probability of constructive excitations. Larger tune splits (7 to 10) and specific cell phase advances are under study; they minimize the first-order driving terms of most relevant resonances. Four-dimensional tracking indicates that they are beneficial and 6D tracking studies are going on.

Now that the target of 12σ is at hand for the dynamic aperture, the most significant current issue is to decide the details of multipolar correction scheme. In addition to the correction of b_3 and b_5, the correction of b_4 is found to be effective in terms of dynamic aperture. The anharmonicity (detuning with amplitude) is reduced from 0.005 to 0.001 at 8σ. The possibility of reducing a_4 by a proper manufacturing strategy is being investigated. An expandable correction system that would allow us to react to measurements on the dipole pre-series is under consideration. *Other beam dynamics activities for LHC were reported on in the previous newsletter.*

4.8 Recent Activity of Japanese Beam Physics Club

K. Hirata hirata@soken.ac.jp Graduate University for Advanced Studies/KEK

A workshop on beam physics, sponsored by Japan Synchrotron Radiation Research Institute (JASRI), was held for 3 full days (from 4 to 6, November) at the SPring-8 laboratory in Hyogo, Japan. It is the fourth annual meeting organized by the Japanese Beam Physics Club (See ICFA Beam Dynamics Newsletter No.12 and 15). There were around 70 registered participants, including graduate course students. Five invited talks, 18 genaral talks and 24 posters were presented.

Invited talks were intended to include subjects outside the usual accelerator physics as follows:

- Interference in Cold Neutron Beams and Experiments on Quantum Phenomena, (T. Ebisawa, Univ. Kyoto)
- Acceleration Mechanism of Charged Particles in Space (H. Takahara, Osaka Univ.)
- Charged (Non-Neutral) Plasma (H. Mohri, Univ. Kyoto)
- Laser-Compton Scattering and Related Topics, (T. Hirose, Tokyo Metropolitan Univ.)
- Physics of High Intensity Hadron Beams, (S. Machida, KEK and H. Okamoto, Hiroshima Univ.)

In the Club meeting held at the same time, it was agreed that the Club shall become more official and more organized. I will serve as a temporal president until the formal organization is created. We will try to create a division of beam physics in the Japanese Physics Society. As the first step, we intend to have a symposium in the next annual meeting, although it contradicts partly with PAC'99.

At the same time, it was disscused that the concept of the “beam-physics” is still not clear. The most narrow point of view may be that the beam physics is the same as the beam dynamics with critical and constructive attitude to the “standard” theories. One of the extreme opinion is that it is the physics on the ensemble of many identical particles. (Thus, the electron gas in a metal is also a “beam”.) The standard undersatanding may be that “beam-physics” is a science on accelerator beams without particular interest in the direct application to accelerator projects. I myself think it not clever to define beam physics too rigidly. It is always a pleasure to discuss with a colleague who shares the “love” to the beam, even if it is not well defined.

4.9 New Doctoral Theses in Beam Dynamics

4.9.1 Stefano De Santis

Author: Stefano De Santis (`sdesantis@lbl.gov`), LBNL-ALS Accelerator Physics Group

Supervisor: Prof. Luigi Palumbo (`lpalumbo@axrma.uniroma1.it`) Universita di Roma “La Sapienza”, Dip. di Energetica.

Institution: Universita di Roma “La Sapienza”, Rome (Italy)

Title: Radiation Effects of Slots and Coupling Holes in the Vacuum Chamber of Particle Accelerators

Date: 4 May 1998.

Abstract: The work deals with the problem of the theoretical calculation of the effects of coupling holes and slots on a particle accelerator vacuum chamber. The method proposed is based on a modified version of the classical Bethe diffraction theory. Through the analysis of the electromagnetic fields induced in the regions coupled by the apertures, it is possible to calculate such relevant parameters, for the particle dynamics, as the coupling impedance and the loss factor.

Those quantities have been calculated in the case of an external resonant structure too. Since the method is entirely analytical, it is possible to obtain an immediate knowledge of the influence of the geometrical variables on the beam. Furthermore, the effect of the interference between the fields scattered by multiple apertures, uniformly or randomly spaced, has been studied and an extension of the method to the case of slots longer than the wavelength has been derived as well. The results have been confirmed after comparisons with simulation codes, other numerical methods and, more recently, experimental measurements.

4.9.2 Takao Ieiri

Author: Takao Ieiri (takao.ieiri@kek.jp),
High Energy Accelerator Research Organization 1-1 Oho, Tsukuba, Ibaraki 305-0801, Japan

Institution: KEK.

Title: Hysteresis Phenomena at Bunch Lengthening Process in Electron Storage Rings.

Date: 30 September 1997.

Supervisor: Prof. Kotaro Satoh (kotaro.satoh@kek.jp), KEK

Abstract: The bunch length was measured using a real-time bunch-length monitor based on the beam spectrum in the accumulation ring. Hysteresis phenomena were observed in the bunch lengthening. That is, two bunch lengths existed depending on changing the direction of the beam current. A longitudinal instability of a bunch was simulated using calculated wake potential by a computer code based on a linearized Vlasov equation. The growth rate was calculated as a function of the energy spread at a fixed beam intensity. It was found that the growth rate did not decay monotonously, but had an unstable peak after decaying to a stable minimum value as the energy spread increased. There are two stable regions of the energy spread on both sides of the peak, suggesting the hysteresis.

4.9.3 Jukka Klem

Author: Jukka Klem (Jukka.Klem@cern.ch)

Institution: CERN, SL division and Helsinki Institute of Physics, Finland

Supervisor: Dr. Werner Herr (Werner.Herr@cern.ch) CERN, SL division

Institution: Helsinki University of Technology

Title: Proton Extraction from a High Energy Beam with Bent Crystals
http://wwwinfo.cern.ch/~jklem/Crystal/Crystal.html

Date: 24 August 1998.

Abstract: Extraction with a bent crystal seems to be the only feasible option for providing the possibility for a fixed-target facility at future high-energy hadron colliders such as the LHC. If the extraction set-up is carefully designed and integrated with the beam cleaning system, a crystal could be used in a parasitic mode, i.e. without disturbing the collider experiments and using only particles that would be lost otherwise.

Crystal assisted extraction has been studied at the CERN SPS. Different crystal designs and beam excitation methods have been used. Extraction efficiencies above 15% have been measured. The existence and importance of multi-pass extraction has been demonstrated with a crystal that does not allow single-pass extraction. The energy dependence of crystal extraction has been measured at three beam energies, and found to be in very good agreement with expectations. It has also been shown that the procedure for setting up extraction with a crystal is fast and easy, and that the extracted beam is very stable.

During the measurements at the SPS, significant progress has been made in the understanding of the extraction process.

4.9.4 Ina Reichel

Author: Ina Reichel (reichel@slac.stanford.edu) MS 26, SLAC, P.O. Box 4349, Stanford, CA 94309, USA

Institution: III. Physikalisches Institut, Rheinisch Westfälische Technische Hochschule, Aachen, Germany

Title: Study of the Transverse tails at LEP

Date: July 1998.

Supervisor: Priv.-Doz. Dr. Manfred Tonutti, RWTH Aachen

Abstract: The transverse beam profile in LEP has been studied. Non-Gaussian tails of the distribution have been limiting the maximum current that could safely be collided and are a potential source of background to the experiments. Scattering processes have been identified as a mechanism which launches particles to large amplitudes. Simulations of the relevant scattering processes have been implemented in the tracking code DIMAD. Results from the tracking agree with measurement results for a single beam and for colliding beams with a low beam-beam tune shift. Tail measurements also helped in understanding the dynamic aperture measurements at LEP.

Note: Published in at the RWTH Aachen as PITHA 98/6 and at CERN as SL-Note-98-061 OP and CERN-Thesis-98-017.

4.9.5 Yasuhiro Takayama

Author: Yasuhiro Takayama (takayama@phys.metro-u.ac.jp),

Institution: Department of Physics, Facility of Science, Tokyo Metropolitan University.

Title: Comprehensive determination of the coherence of synchrotron radiation in soft X-ray region

Date: 21 October 1998.

Supervisor: Prof. Tsuneaki Miyahara (miyahara@comp.metro-u.ac.jp), Department of Physics, Facility of Science, Tokyo Metropolitan University.

Abstract: The first order spatial coherence of the synchrotron radiation is measured in soft X-ray region at BL-28A (undulator beamline) and BL-12A (bending magnet beamline) of the Photon Factory, KEK. A newly developed Young's interferometer is used to measure the coherence. This apparatus can be rotated around the optical axis keeping high vacuum, which enables the measurement in the arbitrary direction. Since the interferometer contains the grating monochromator, the selection of wavelength is possible without the beamline monochromator. The experimental result shows that the spatial coherence is better in the vertical direction than in the horizontal direction due to the difference of electron beam emittance in these directions. In order to explain the experimental result, a new theorem to describe the spatial coherence is presented using the Gaussian beam approximation. The validity of this approximation is also discussed by the numerical simulation based on the first principle.

5: Forthcoming Beam Dynamics Events

5.1 Comments on how to organize future International Conferences on High Energy Accelerators (HEACC): Report of the ICFA ad-hoc Committee on HEACC

Compiled by
F. Willeke `ferdinand.willeke@desy.de` DESY

5.1.1 General Remark

On the initiative of ICFA, a small committee has been formed to discuss the essence and purpose, and the future prospects of the International Conference of High Energy Accelerators HEACC in the presence of large regional accelerator conferences.

The committee members have been proposed by the important accelerator institutions. A memo, which was the result of the work of this ad-hoc committee, has been presented to ICFA in February 1998. ICFA did not make a final decision of how to proceed with HEACC. But the proposals made by the ad-hoc committee have been well received and the committee was encouraged to continue. It has been suggested to invite more members in order to broaden the spectrum represented by the committee and to work out a concrete programme example of a future HEACC conference.

The following accelerator experts from the large accelerator laboratories have responded to a request to participate in the extended HEACC-committee and have agreed to contribute to the discussion:

P.Colestock; FNAL M. Harrison, BNL, K. Hirata, KEK, Gerald Jackson, FNAL Philippe Lebrun, CERN, Igor Meskhov, JINR, Dieter Moehl, CERN, Stephen Peggs, BNL, Dieter Proch, DESY, R. Schmidt, CERN, John Seeman, SLAC, Robert Sieman, SLAC, F. Willeke, DESY, M.Yoshioka, KEK

The discussions were carried out by exchange of e-mail. Not all controverial issues could be discussed sufficiently and a consensus could not always be reached. The following report is a short version of the report submitted to ICFA. It summarizes the status of the discussions. The report has been written by F. Willeke who takes the responsibility for the correct compilation of the opinions of the committee members.

5.1.2 Introduction

The International Conference on High Energy Accelerators (HEACC) is the traditional accelerator conference of the high-energy physics community. It has been held every three years since 1950. Discussion within the community of accelerator physicists seems to indicate that there is considerable interest to keep this forum alive, where accelerator theory, performance and technology has been discussed and whereby the emphasis is put on new developments and options for future accelerators for particle physics. There is another aspect, which is important. In order to assure further strong, international cooperation on future large-scale accelerator projects, a truly international forum, which is not dominated by regional interests and influences is important. HEACC has been such a worldwide forum in the past and therefore should be preserved as such.

On the other hand, there are two large well-established accelerator conferences, the American PAC and the European EPAC, which take place alternately every two years. In addition, a third conference, the Asian APAC has been organized for the first time in 1998. On top of the three international general accelerator conferences there is the LINAC conference, which is held every two years, a number of accelerator technology- related conferences such as the magnet conference and a number of accelerator-related workshops. Furthermore, ICFA seminars are being organized every two years. The topics presented at these conferences represent a complete overlap with the topics of HEACC.

Noting the tight resources of the accelerator laboratories, it is a fair question to ask whether all these meetings must be supported in the future. In particular one has to discuss whether HEACC has become obsolete by the establishment of new international accelerator conferences during the last decade.

5.1.3 Relationship with Regional Accelerator Conferences

The EPAC and the PAC are very important meetings for the accelerator community. They have a number of very interesting features:

- The PAC and EPAC programs provide complete coverage of the whole field of accelerator-theory, -technology and -operation experience. Therefore these meetings provide a very good overview of the state of the art including recent developments and activities.

- The broad coverage of accelerator related topics makes EPAC and PAC interdisciplinary meetings which provide many possibilities for contacts between experts from different fields, for which there is otherwise little opportunity.

- The PAC and EPAC schedule review talks. Some of them have a pedagogical nature. This is interesting for students and newcomers to the field.

- PAC, EPAC (and certainly APAC as well) conferences, though being meetings with international attendance, have a more regional character. A majority of PAC attendees comes from the US or Canada. The same applies to EPAC and APAC where the majority of participants are from European and Asian laboratories respectively. This regional character helps to limit the costs of these meetings.

On the other hand the large regional conferences have a number of disadvantages, which a conference like HEACC can avoid more easily:

- The PAC and the EPAC are conferences with more than a thousand participants. This does not create an ideal environment for intense communications. It is sometimes difficult to even find a particular partner for discussions. Most of the participants do not know each other. In the large plenary sessions, no discussion takes place. Most of the participants are very reluctant to raise their hand and express their opinion in a large anonymous audience. The larger the number of the participants, the more passive the audience tends to be.

- The fact that PAC and EPAC cover the whole field of accelerators also has the disadvantage that it is more difficult to concentrate of special topics of interest. Thus the interest of the participants is very distinct and there are many closed groups of people with little desire to communicate with other groups.

- In order to squeeze the large programs of PAC and EPAC into a limited time, several parallel sessions are unavoidable. Despite the efforts of the organizers, it often occurs that two interesting topics, which attract the same group of attendees, are scheduled the same time. Much interesting information is presented in the form of poster sessions, which are often in competition with the oral program.

These disadvantages of PAC and EPAC can be avoided in a small conference. This can only be achieved by focusing on a narrower spectrum of topics. The most important task is to define this focus and match the organization of the conference accordingly. The following is an attempt to define "rules" which may serve as a guideline for future organization of HEACC.

The way the committee views PAC and EPAC is thus as broad FORUMS, whereas HEACC is a specialized conference. It is not a workshop because it covers many aspects of the subjects within its focus.

5.1.4 HEACC Programme Rules

- HEACC should specialize to accelerators, which are operated or developed to be operated at the frontier of high beam energy and related topics and technological aspects. An important aspect of the HEACC programme is that it emphasizes projects, which require international collaboration because of its scale, the technical challenge, the large amount of R&D and the intense use of resources. The HEACC programme should feature pioneering accelerator and acceleration techniques especially that these issues have been neglected somewhat in the recent past. The committee however does not agree on the question whether High Luminosity facilities like B-Factories, Tau-Charm Factories should be in the scope of HEACC. In each case, HEACC should not exclude any accelerator topic a priori, but conference organizers should always be conscious about the relevance of the topic under consideration to the objectives of the conference. For example, while synchrotron light sources are clearly outside the scope of HEACC as an independent topic, certain aspects or techniques described in the context of synchrotron light sources may, however, be relevant and interesting. New developments in the low energy part of an accelerator chain are sometimes important for the choices and performance at the high-energy end. Therefore, one should not exclude such "low energy" topics from the HEACC program. A case to case judgement has to be made. The HEACC topics should concentrate on accelerator physics and accelerator technology. Operational aspects and existing facilities should only considered only to the extent that they are relevant to the main objective of HEACC.

- The HEACC programme should feature new technical developments relevant to high-energy accelerators and should avoid standard accelerator technology, which is well and comprehensively covered by other meetings.

- The programme of HEACC should avoid laboratory status reports. These reports are usually very redundant and do not provide much new information to HEACC participants. Reports on accelerator performance should emphasize the technical and beam-scientific aspect.

- The HEACC programme must concentrate on new effects and should avoid pedagogical review presentations. The HEACC program committee should not hesitate to reject contributions, which have obviously been published or presented elsewhere. Contributions to HEACC must provide new, original information. Contributions with redundant or obsolete material should be rejected. Summary reports from other meetings are to be avoided because the information is mostly redundant.

- The HEACC programme should leave sufficient room for contributed papers. Contributed papers are a necessary compliment to invited talks. New topics are likely to be introduced into the conference by contributed papers.
- Poster sessions are a good complement to oral presentations. They are recommended. Oral papers may also additionally presented as posters.
- Parallel sessions are to be avoided.
- The raporteur talks as they are practised in the high-energy physics conferences summarize the contributions on a certain subject. These are an interesting possibility to make the meeting more effective. The HEACC program should include such raporteur talks. The rapporteurs should be chosen the same way as invited speakers. They should be supplied with the abstracts of contributed papers referring to a certain topic well before the conference. Authors can be contacted before or during the conference. Rapporteur talks might be a nice way of closing the conference (in analogy to workshop summary reports).
- As a complement to rapporteur talks, at the end of the conference there should be a summary or concluding talk, which could be presented by the chairman of the programme committee or the session chairpersons.
- For a conference like HEACC, a round table discussion is a possible and useful tool to enhance the interactions and communications. The session chairman must be carefully selected as real senior expert in the field covered by their sessions. They must be able to stimulate and lead the discussion of oral presentations.
- Imbedded workshops have been proposed as a further means for stimulating discussions and enhancing interactions among participants.

5.1.5 HEACC Organization Rules

5.1.5.1 Organization

The HEACC is to be organized by one of the big accelerator laboratories respectively which appoints a conference chairman and a local organizing committee. The host laboratory provides the legal framework and the financial management of the conference. It may approach potential sponsors to obtain support for the conference. The local organization committee is responsible for the conference facilities. It should in particular provide an appropriate auditorium, meeting rooms and space for poster sessions. It organizes the registration procedure and hotel accommodation of the participants. The organization committee will arrange for publishing and for distribution of the proceedings. It is responsible for printing and distribution of information bulletins, a conference poster, the conference programme and a booklet with the abstracts of the conference contribution. The organizing committee decides on parallel meetings such as an industrial exhibition. It also takes care of the social programme.

5.1.5.2 Programme Committee

The composition of the programme committee should be international. The committee should be able to cover the full spectrum of the expertise on high energy and high luminosity accelerators. In order to provide continuity and experience in making a good conference programme, it is proposed to form a permanent programme committee. The members should never be exchanged at once but there should always be members from the programme committee of the previous conference. Correspondingly, a large fraction of the current programme committee members should serve on the programme committee of the next conference. Thus committee members should in general serve for more than one term. ICFA should take the initiative to propose an initial programme committee. The permanent committee could for example be constituted as an ICFA sub-panel. Furthermore, the chairman of the local organization committee and members of the current committee should have the possibility to propose candidates and to take part in the election of new members. This form of conference organization has proved to very useful for EPAC and PAC. Operating rules for the programme committee are discussed in more detail below.

An international scientific committee should support the programme committee. The advisors should be invited to comment about topics and to propose invited speakers on the base of a first draft of the conference programme.

The HEACC programme committee should invite an observer of the organization of the other big conferences to co-ordinate the conference schedule and to avoid unnecessary duplications in the conference programmes.

5.1.5.3 Participation

The HEACC should be a relatively small conference with not much more than 200 participants. The participation should be by invitation only but there should be an open call for abstracts and the programme committee should decide the invitations on the basis of the abstracts or on recommendation from its members and/or the laboratories. This way, HEACC can continue to be the forum where those responsible for decisions meet the technical experts to discuss the future of our field. HEACC should not be primarily a conference for students and newcomers in the field. This should not exclude students from participation but the program should not be compromised in order to be useful for students and newcomers. HEACC should however not be a conference for senior scientists only. Young scientists should be encouraged to submit contributions to the conference, which must comply with the scope and the requirements of the conference programme.

The programme committee, the scientific advisory committee and the accelerator laboratories can propose participants. The conference chairman submits a call for papers based on their proposals. The intended contributions are reviewed and refereed by the programme committee on basis of submitted abstracts. Only new and interesting material will be admitted to the conference. In order to allow for a judgement on the contribution, abstracts should be larger than usual. Up to a full page should be possible. Ambiguous abstracts, which do not allow a judgement on the work to be presented, should be rejected. On the other hand, judgement on abstracts should be such to leave room for reports on work in progress and for results to be expected in the near future. The committee however recognizes that this rule might be difficult to enforce. At least it puts a heavy burden onto the programme committee who has to select the papers. The committee's opinion on this point is not unanimous. The conference chairman sends out the invitation to the conference based on the evaluation of the programme committee.

5.1.5.4 Conference Proceedings

Contributions to the conference should only be published in proceedings if the contribution has been presented at the conference. There should be no "publish only" option. The contributions should only be published in the proceedings if they have been presented at the conference. The conference chairman is encouraged to make use of an accelerator journal for publishing. Refereeing of the contributions is recommended, if serious refereeing can be assured in an appropriate time. The discussions and questions on contributions during the oral sessions should be recorded and should become part of the proceedings.

5.1.5.5 Co-ordination of HEACC with other Conferences

The committee discussed the possibility to organize only one large accelerator conference per year as proposed by some of the members. This apparently does not comply with the need of the whole accelerator community and was in particular rejected by the organizers of the PAC conference. Thus there will be every year a PAC or an EPAC conference. The current frequency of HEACC is one meeting every three years. As a relatively small conference, HEACC thus not really compete with PAC or EPAC. HEACC has to be viewed as a specialized meeting like the LINAC conference or similar meetings. The three-year cycle of HEACC appears to be an appropriate average frequency to assure that there is sufficient new and interesting material to discuss.

It is not recommended to organize HEACC together with PAC, EPAC, APAC or the high-energy physics conferences. HEACC would be reduced in this case to just an appendix label to the names of these conferences.

Since the HEACC scope overlaps with the programme of the international ICFA seminars and since there is a large overlap of potential HEACC and ICFA seminar attendees, one should avoid that both meetings take place independently. Moreover it is proposed to organize these meetings at the same time and at the same place with a large common programme.

In order to avoid a situation like in 1998 with four accelerator conferences taking place in 2004, it is proposed to organise the next HEACC in 2000 and continuing with a frequency of 1/3y. Another possibility would be to shift the phase of APAC by one year. In this case the next HEACC would be held in 2001, which would be the natural continuation of the 1/3year frequency.

5.1.6 Proposal for HEACC Permanent PC Operating Rules as a base for Discussion

5.1.6.1 The HEACC permanent programme committee (PC) has the following functions

:

- It provides continuity in the organization of HEACC
- It helps to avoid, that the rules be re-invented at each conference
- It helps the conference chairmen to form a competent and experienced programme committee
- It keeps the contact with regional conferences for coordination and to avoid unnecessary programme overlaps
- It keeps contact with and informs ICFA
- It evaluates possible conference sites and prepare for decision by ICFA.

5.1.6.2 Requirements

- The conference chairperson must have a strong influence on the HEACC programme.
- It has to be made sure in the process of choosing the programme committee chair, that conference chair and programme committee chair are able to cooperate closely.
- The experience made at one conference must be carried over to the next one

- The programme committee should evolve continuously. Therefore members must be replaced from time to time.

5.1.6.3 Consitution of the Permanent Committee

The permanent committee is proposed to be constituted as a panel of ICFA. The panel and delegates from the local conference organization form the programme committee for each conference.

5.1.7 Summary

The committee arrives at the conclusion that it is worthwhile to preserve HEACC. However it must focus on high-energy and in the opinion of some members also on high-luminosity accelerators. The program must be limited to new information. The number of attendees must be kept around 200. Intense interactions and discussion among participants must be encouraged. The coexistence with other important accelerator meetings must be carefully co-ordinated.

5.2 Workshop on Polarized Protons at High Energies—Accelerator Challenges and Physics Opportunities

DESY, Hamburg, Germany: 17 –20 May, 1999.

D.P. Barber `mpybar@mail.desy.de` DESY,
Deutsches Elektronen–Synchrotron,
22603 Hamburg, Germany.

Following the successful attainment and routine use of longitudinal $e^{\pm}$ spin polarization at HERA, the $e^{\pm} - p$ collider at DESY in Hamburg, there is now great interest in complementing the polarized $e^{\pm}$ with high energy spin polarized protons.

A stored polarized proton beam can only be obtained by injecting and then accelerating a pre-polarized beam provided by a suitable source. But a major difficulty for reaching high energy with the polarization intact is that the polarization can be lost at spin–orbit resonances. These come in groups recurring every 523 MeV. Thus to reach a HERA proton energy of 800 GeV or more, several thousand resonances would have to be crossed. This problem can be ameliorated by the use of Siberian Snakes. However, detailed spin–orbit tracking simulations show that the attainment of useful proton polarization at hundreds of GeV still presents a major challenge (see
`http://www-mpy.desy.de/proton_pol/`). Moreover, apart from the fact that suitable high polarization, high current sources must be developed, it has become clear that the precise measurement of proton polarization at high energy is non–trivial.

The purpose of the “Workshop on Polarized Protons at High Energies – Accelerator Challenges and Physics Opportunities” is to bring together accelerator experts in the field so that the various aspects can be examined in detail and know–how can be exchanged with a view to

finding practical solutions for HERA and other future high energy machines. Experience from design work and calculations for RHIC will be particularly valuable.

We also hope that accelerator physicists with little or no experience of spin dynamics will take part and thereby feel motivated to contribute. In addition to the sessions on accelerator physics there will be sessions dedicated to updating the physics case for polarized collisions at high energy. Polarimetry will be covered in joint sessions.

Full details on the Workshop are posted at:

http://www.desy.de/heraspin/

5.3 International Symposium on New Visions in Laser-Beam Interactions—Fundamental Problems and Applications of Laser-Compton Scattering

Tachishige Hirose hirose@comp.metro-u.ac.jp Tokyo Metropolitan University

October 11-15, 1999
International House of Tokyo Metropolitan University, Tokyo

This symposium was announced in the previous issue of this newsletter. Now, a WWW home page is prepared where more detailed and refreshed information is available and the on-line regiostration is possible:

http://heal1.phys.metro-u.ac.jp/ laserb/

5.4 VLHC Workshop on Accelerator Technology

John Marriner marriner@fnal.gov FNAL

February 8–11, 1999
Thomas Jefferson Laboratory, Newport News, Virginia
Organized under the auspices of the VLHC Steering Committee
by the
Accelerator Technology Working Group
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The VLHC is the acronym for the proposal to build a Very Large Hadron Collider at Fermilab. The VLHC would collide two high intensity, 50-TeV proton beams to study elementary particle physics in a regime where the limitations of the "standard model" must manifest themselves. A steering committee with representation from BNL, Cornell University, FNAL, and LBNL has been formed to facilitate the planning and R&D efforts. This workshop on accelerator technology has been organized as part of that effort.

Accelerator Technology is defined to include those technologies that are required for the design, fabrication, and installation of the accelerator except for the magnets and related components. Accelerator Technology includes tunnels, distribution of electrical power, cryogenics, controls, beam-line components, and other technologies. The subjects to be included at this workshop include:

- Cryogenics
- Rf, instabilities, and feedback
- Instrumentation, Controls, and Alignment

For more information of this workshop see
http://vlhc.org/ATWorkshop.html
For general information on the VLHC see http://vlhc.org

6: Announcements of the Beam Dynamics Panel

6.1 ICFA Beam Dynamics Newsletter

Editors in chief

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6.1.1 Aim of the Newsletter

The ICFA Beam Dynamics Newsletter is intended as a channel for describing unsolved problems and highlighting important ongoing works, and not as substitute for journal articles and conference proceedings which usually describe completed work. It is published by the ICFA Beam Dynamics Panel, one of whose missions is to encourage international collaboration in beam dynamics.

6.1.2 Categories of the Articles

It is published every April, August and December. The deadlines are 15 March, 15 July and 15 November, respectively.

The categories of articles in the newsletter are the following:

1. Announcements from the panel
2. Reports of Beam Dynamics Activity of a group
3. Reports of Beam Dynamics related workshops and meetings
4. Announcements of future Beam Dynamics related international workshops and meetings.

   Those who want to use newsletter to announce their workshops etc can do so. Articles should typically fit within half a page and include descriptions of the subject, date, place and details of the contact person.
5. Review of Beam Dynamics Problems

   This is a place to put forward unsolved problems and not to be used as the achievement report. Clear and short highlights on the problem is encouraged.
6. Letters to the editor

   It is a forum open to everyone. Anybody can show his/her opinion on the beam dynamics and related activities, by sending it to one of the editors. The editors keep the right to reject a contribution.
7. New Doctoral Theses in Beam Dynamics

   Please send announcements to the editors including the following items (as a minimum):

   (a) Name, email address and affiliation of the author,
   (b) Name, email address and affiliation of the supervisor,
   (c) Name of the institution awarding the degree,
   (d) The title of the thesis or dissertation.
   (e) Date of award of degree. (For a while, we accept the thesis awarded within one year before the publication of the newsletter.)

(f) A *short* abstract of the thesis is also very desirable.

8. Editorial

All articles except for 6) and 7) are by invitation only. The editors request an article following a recommendation by panel members. **Those who wish to submit an article are encouraged to contact a nearby panel member**.

The manuscript should be sent to one of the editors as a LaTeX file or plain text. The former is encouraged and authors are asked to follow the instructions below.

Each article should have the title, author's name(s) and his/her/their e-mail address(es).

6.1.3 How to Prepare the Manuscript

Here, the *minimum* preparation is explained, which helps the editors a lot. The full instruction can be found in WWW at

`http://www-acc-theory.kek.jp/ICFA/instruction.html`

where you can find the template also.

Please follow the following:

- Do not put comments (%) when sending the manuscript through e-mail. Instead, you can use `\comm` as `\comm{your comments}`. It is defined as \newcommand\comm[1]{}.
- Start with `\section{title of your article}`. **It is essential**.
- Then put your name, e-mail address and affiliation.
- It is *useless to include any visual formatting commands* (such as vertical or horizontal spacing, centering, tabs, etc.).
- Do not define new commands.
- Avoid TEXcommands that are not part of standard LaTeX. These include the likes of `\def`, `\centerline`, `\align`, ...
- Please keep figures to a minimum. The preferred graphics format is Encapsulated Postscript (EPS) files.

6.1.3.1 Regular Correspondents

Since it is impossible for the editors and panel members to watch always what is going on all around the world, we have started to have *Regular Correspondents*. They are expected to find interesting activities and appropriate persons to report them and/or report them by themselves. We hope that we will have a "compact and complete" list covering all over the world eventually. The present *Regular Correspondents* are as follows

Liu Lin (liu@ns.lnls.br)	LNLS	Brazil
S. Krishnagopal (skrishna@cat.cat.ernet.in)	CAT	India
Ian C. Hsu (ichsu@ins.nthu.edu.tw)	SRRC	Taiwan

We are calling for more volunteers as *Regular Correspondents*.

6.1.4 Distribution

The ICFA Beam Dynamics Newsletters are distributed through the following distributors:

W. Chou	chou@adcon.fnal.gov	North and South Americas
Helmut Mais	mais@mail.desy.de	Europe* and Africa
Susumu Kamada	kamada@kekvax.kek.jp	Asia** and Pacific

(*) including former Soviet Union.
(**) For mainland China, Chuang Zhang (`zhangc@bepc5.ihep.ac.cn`) takes care of the distribution with Ms. Su Ping, Secretariat of PASC, P.O.Box 918, Beijing 100039, China.

It can be distributed on a personal basis. Those who want to receive it regularly can ask the distributor to do so. In order to reduce the distribution cost, however, please use WWW as much as possible. (See below).

6.2 World-Wide Web

The home page of the ICFA Beam Dynamics Panel is at the address

`http://www-acc-theory.kek.jp/ICFA/icfa.html`

(which happens to be in Japan). For reasons of access speed, there are mirror sites for Europe and the USA at

`http://wwwslap.cern.ch/icfa/`
`http://www.indiana.edu/~icfa/icfa.html`

All three sites are essentially identical and provide access to the Newsletters, Future Workshops, and other information useful to accelerator physicists. There are links to information of local interest for each area.

6.3 ICFA Beam Dynamics Panel Organization

The mission of ICFA Beam Dynamics Panel is *to encourage and promote international collaboration on beam dynamics studies for present and future accelerators*. For this purpose, we publish *ICFA Beam Dynamics Newsletters* three times a year, we sponsor *Advanced ICFA Beam Dynamics Workshops* and *ICFA Beam Dynamics Mini-Workshops*, and we organize *Working Groups* in the panel to promote several important issues.

Chairman K. Hirata

Chief Editors of ICFA Beam Dynamics Newsletter K. Hirata, J. M. Jowett, S. Y. Lee

Distributers of ICFA Beam Dynamics Newsletter W. Chou, H. Mais, S. Kamada

Leader and Subleader of Future Light Source Working Group K. J. Kim and J. L. Laclare

Leader and Subleader of Tau-Charm factory Working Group E. A. Perelstein and C. Zhang

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The views expressed in this newsletter do not necessarily coincide with those of the editors. The individual authors are responsible for their text.