ICFA Beam Dynamics Newsletter, No. 17

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

August 1998

Contents

1: From the chairman

Kohji Hirata kohji.hirata@kek.jp The Chairman of ICFA Beam Dynamics Panel

Since the "Renaissance" of the beam dynamics panel around 1994, the panel has become more and more active. It was partly because of the efforts of the panel members but was mainly because of the strong support of the world-wide beam dynamics community. Although such a community is still "under construction", its necessity has been well recognized by many. The accelerator society needs more beam dynamics specialists.

In fact, the number of beam dynamics specialists is increasing. It is not only because of the increase of the modern accelerators, but also because of the increase of the demands on the beam quality. To proceed further, it seems that we should establish a better contact and collaboration with physicists in other fields of physics. We need the knowledge of other fields. If the only outcome of the beam dynamics is, however, to construct good accelerators, and if the beam dynamics does not create enough outcomes useful to other disciplines, it cannot attract physicists outside the accelerator community. The relationship should be mutual and reciprocal.

A good example is the research of the nulear fusions. It has produced the plasma physics which has shed light on astrophysics, geophysics, and even to accelerator physics. I believe the beam dynamics can produce similar outputs, useful and interesting for many other disciplines, because the beam is a very special state of the matter and its understanding should reveal new properties of the matter. Recently, for example, while working for KEK B factory, I have been dreaming of the "thermodynamics of the beam". Such a thing should exist, although it might not directly be useful for constructions of accelerators. As the chairman of this panel, I hope to encourage the activities which deepen and widen the beam dynamics.

– – – – – – –

This year, we do not have the panel meeting. Instead, a virtual meeting is under way through e-mail. The report will be published in the next issue.

A.Hofmann has retired from the panel, in accordance with his retirement from CERN. He has been an active member since 1991. He worked very hard for realizing 6-th Advanced ICFA Beam Dynamics workshop on "Synchro-Betatron Resonances" (Madeira, 1993) in a quite difficult time for the panel. I would like to thank him for his contribution to this panel.

2.1 Call for Creation of Accelerator & Beam Physics Forums

Dear Members of the Accelerator & Beam Physics Community,

Particle accelerators are used in almost every field of physics from elementary particles to solid state physics. Accelerators are finding a variety of applications such as ion implantation and lithography in industry, medicine radiotherapy and food sterilization. The need and importance of accelerators, and its impact on the society need no elaboration.

As you are aware, that the *Accelerator & Beam Physics and associated technologies* are **not yet** part of the regular university curriculum in most parts of the world! The learning of such an important interdisciplinary science is done to a very large extent individually and through the very few Schools *when & where* available. This very curious scenario is exacerbated by the near total absence of **Divisions of Accelerator & Beams** in most of the Physical Societies all over the world.

It is interesting to note that in recent years, many very interesting and useful developments in Beam Physics have taken place in remote departments outside the accelerator laboratories, by physicists with a primary training in other areas of Physics. From these it is evident that they can collaborate with accelerator physicists and produce interesting and useful results in areas of beam dynamics, free electron lasers and several other topics. A symbolic event justifying the above statements is the last ICFA Advanced Beam Dynamics Workshop on Quantum Aspects of Beam Physics, held at Monterey, bringing together over a hundred physicists. A detailed report of this historic meeting is to be found in the ICFA Newsletter No. 16 April-98 and the numerous contributions in the proceeding (*in press*, Ed. Pisin Chen, World Scientific, Singapore, 1998). Such a workshop became relevant only recently. ¿From such meetings it is evident that Beam Physics is growing rapidly in remote departments outside the big accelerator laboratories. We need more of such meetings to cater to the topics not yet addressed in the existing Meetings. To keep up with the growth of the beam physicists community, it is essential to have additional Meetings to accommodate the growing number of personnel and wider range of topics.

By introducing Beam Physics in the regular university curricula it is sure to attract more minds to tackle some of the open and very challenging problems, which are drawing a new attention with ever increasing demand for higher energies and luminosity and lower emittance beams with ever increasing particle species and saturation in the existing methods of particle acceleration. We need new results and revolutionary techniques for future machines.

Another point which I would like to bring to focus is the steady growth of Accelerator and Beam Physics Community in the developing world, who have little or no access to accelerators in their own regions. We need to enhance their participation in the existing Schools through more Fellowships, particularly for the travel. The Abdus Salam International Centre for Theoretical Physics, **ICTP**, Trieste, Italy can provide an excellent venue to hold such Schools. ICTP in its long and very generous tradition has been doing so in many other areas of Physics and other sciences. This will take care of the participants from the developing countries, and also the wide range of topics of interest to the community world-wide, by bringing together physicists and accelerator personnel together. This will definitely compliment the existing prestigious Schools and the few efforts in the developing countries. Thus strengthening the community in more than one way!

For a complete and natural growth of any field it is essential to have a proper Forum. To facilitate the required growth of the Accelerators & Beam Physics Community we need, immediate inclusion of *Accelerator & Beam Physics in regular University Curriculum* on a global scale, more *International and National Schools*, creation of active *Divisions of Accelerators/Beams* in various Physical Societies, and new Forums in the form of *Beam Physics Clubs/Societies*. All these shall have a very significant role, through their Regular Courses, Periodic Schools, Newsletters, Fellowships and shall strengthen the Accelerator & Beam Physics community world-wide. This has been the case in various other areas of Physics, for a very long time! Why should beam physics make an exception?

It is noteworthy to see how the ICFA Beam Dynamics Panel has contributed to the accelerator & beam physics. The well-attended ICFA Beam Dynamics Workshops are one of the proofs of its big success. It would be worthwhile to hold **Beam Physics Schools** under the auspices of ICFA. Such Schools would be extremely useful, particularly to the beginners in the field. We can be sure that these Schools will be very successful like the ICFA Workshops. The widely circulated Newsletter is providing an excellent medium for communication & discussion. It can be further used for the creation of new Forums appealed in this Letter.

It is hoped that the decision-makers take notice of this appeal and do the needful without any further delay.

Sincerely yours,

Sameen Ahmed KHAN khan@pd.infn.it INFN-Padova,
Via Marzolo 8, Padova 35131
ITALY
http://www.pd.infn.it/~khan/welcome.html

2.2 From K. Makino

Dear Hirata san,

A recent visit to KEK reminded me of the period when I had been a graduate student in Japan. Having completed a Ph.D. in a US university recently, I have experienced both the Japanese and American graduate school systems, which is somewhat unusual for Japanese. Following your suggestion, I would like to share some thoughts about the difference of graduate study between Japan and the US with the community.

To begin with, let me address some characteristics of the Japanese educational system. Some people know that the emphasis is put on the mere admission to a university or a college, which is determined by very challenging exams. The exams are so competitive that names of schools are a measure of students, hence the quality of their later jobs and lives is very much determined. Not only high school students, but the whole society view it as a goal to pass entrance exams, even occasionally starting from the preschool period as kindergarten exams. As a consequence, the educational level of freshmen of universities and colleges is very high, but almost all of them are burned out. It is even customary to view college life as a relaxation period, sparing serious efforts for a later job life. In both undergraduate and graduate schools, the course work is not very demanding, so serious students usually motivate themselves, and graduate students use most of the time for research work right away.

Because I came to the US to pursue a Ph.D. I went through a series of graduate school requirements including substantial course work for the first years. I had known the hard requirement of course works in the US as a story, but the reality was tougher yet. It is understood that only three graduate courses per semester kill almost all the time of a serious student. Usually graduate students start research work after the course work of the first years. Another aspect to mention is there are many graduate students who come to school after some job experience, which is still rather uncommon in Japan.

With such a remarkable contrast, I am not ready to make any judgement which of the systems is better than the other; but I certainly appreciated the fact that I could experience both.

Kyoko Makino `makino@nscl.msu.edu` Michigan State University
National Superconducting
Cyclotron Laboratory

3.1 14th Advanced ICFA Beam Dynamics Workshop on Beam Dynamics Issues for e^+e^- Factories

L. Palumbo lpalumbo@axrma.uniroma1.it Univ. La Sapienza, Roma /LNF-INFN

The Advanced ICFA Beam Dynamics Workshop on "Beam Dynamics in e^+e^- Factories", was held at Frascati National Laboratories (LNF) of INFN from the 20th to 25th of October 1997. The workshop was organised by ICFA, INFN, the University of Rome "La Sapienza", with the scientific sponsorship of BINP (Novosibirsk), CESR (Cornell), IHEP (Beijing), KEK (Tsukuba), LBNL (Berkeley), SLAC (Stanford). About 80 participants attended the workshop.

The aim of the workshop was to gather world-wide experts on theoretical and experimental issues related to the high luminosity, with particular regard to the development, commissioning or design of Φ, B and tau-charm factories and LEP and CESR colliders.

The workshop started with a plenary session devoted to the luminosity performances of the CESR (J.T. Rogers) and LEP (J.M. Jowett) colliders, and to the state of several projects: DAΦNE (G. Vignola) , BINP Round Beam (Y.M. Shatunov), PEP-II (J.T. Seeman), KEKB (K. Oide), TCF (Y. Wu). Four review talks on "Interaction Regions" by H. Koiso, "Single Particle Dynamics" by J. Irwin, "Beam-Beam" by M. Furman and "Instabilities" by S. Heifets, introduced the discussion to the working groups organised in parallel sessions. A full day was devoted to the discussion of TCF beam dynamics issues. Summary talks of working groups concluded the workshop.

The working group on Interaction Regions was chaired by D. Rice. Two major subject were discussed: comparison of the choices made in the design of IRs for several projects, and how the present interaction regions can be modified in order to increase luminosity by one order of magnitude. A deep analysis was done on the optics design, solenoid compensation, chromatic correction, beam separation and comparing the relative advantages and disadvantages of different schemes. The group discussed the background levels in the detectors as it is the most uncertain operating parameter in IR realisation. The "round beam" optics was of particularly interest because of the expected larger beam-beam parameter which offers a possibility of luminosity increase.

The group on Single Particle Dynamics, chaired by J. Jowett, covered a variety of subjects. The "Model independent use of BPM families" presented by J. Irwin in the plenary talks was discussed further. Features of the lattice design for maximum optics flexibility and chromatic correction up to the 3rd order, and the latest progress in the commissioning of PEP-II were presented. Several methods relying on the kicked beam measurements exploring the lattice non-linearities were discussed. A novel and elegant method for dynamical aperture measurements based on the detailed understanding of the Touschek effect was described by A. Valishev. Fringe-fields in short magnets, particularly those in the detector solenoids, and their effects on the dynamical aperture calculations were also discussed.

The group on Beam-Beam was chaired by K. Hirata. The main topics covered in the session were: Beam-beam limit, crossing angle beam-beam tail, coherent modes, monochromatization, round beam, strong-strong simulation. Two semi-empirical laws reproducing reasonably well the observed beam-beam limit for e^+e^- machines were presented. Of particular interest were the presentations and discussions on the coherent modes and Landau damping, and in particular on the role of the beam-beam parameter ξ^+/ξ^-. The Möbius option which permits round beams and easy chromaticity correction was also discussed in detail.

The working group on Impedance and Instabilities, chaired by L. Palumbo, covered longitudinal single bunch instability, conventional coupled-bunch mode instability and cures, fast ion instability and electron cloud instability. A bunch-lengthening law, reproducing the experimental data, based on the quantum random kick in energy and longitudinal position was presented. The Fast Ion Instability measurements made at ALS confirmed some of the features of this instability, although the exact growth rate law is still not defined. There was strong interest in the experimental and simulation results of Photo Electron Instability. Dedicated measurements done at BEPC (Beijing), have found that although the threshold is very low (20 mA of positrons), it is strongly dependent on the gap between bunches, and suppressed by chromatic correction. Several computer codes have been implemented in order simulate the mechanism of the electron cloud formation, and the interaction with the beam. It seems that the cloud oscillations have effect over a short range of 3–4 bunches. The computer codes reproduce qualitatively the PEI, but their reliability still seems uncertain.

The proceedings, collecting most of the papers presented in the workshop, are being published.

3.2 Summary of the 5th ICFA mini-Workshop on Beam Loading

R. Baartman krab@triumf.ca TRIUMF

3.2.1 Introduction

The Working Group on High-Brightness Hadron Beams of ICFA Beam Dynamics Panel sponsored a Mini-workshop on “Beam Loading” in high intensity hadron synchrotrons at KEK-Tanashi from February 23 to 25, 1998. It was chaired by Y. Mori (moriy@kekvax.kek.jp), and C. Ohmori (chihiro@kekvax.kek.jp) acted as secretary. The purpose of the workshop was to discuss the basic problems of beam loading and to examine their cure and compensation in high intensity hadron synchrotrons. Other topics such as barrier bucket and impedance control were also covered. The beam loading issues of the JHF 3 GeV and 50 GeV rings, in which a magnetic-alloy loaded RF cavity is to be used, were examined as a case study.

The workshop was attended by 48 people, roughly equally split between foreigners, KEK, and non-KEK Japanese.

3.2.2 Existing Machines

Existing machines have used a wide variety of techniques to combat beam loading. Presentations were as follows. M. ,Yoshii (KEK-PS), M. Blaskiewicz (BNL-AGS, AGS-Booster), W. Chou (FNAL), R. Garoby (CERN-many), T. S. Wang (LANL-PSR), P. Barratt (DRAL-ISIS).

Of these, the PSR is probably not a fair comparison, since it is fixed frequency and so can use a cathode follower configuration with no additional feedback. Of the others, the CERN performance is not fairly represented by such a table, considering that there are many rf systems at different frequencies in the PS complex, and debunching and recapture have been successfully performed under conditions of heavy beam loading.

Machine	Current (Amps)
Achieved:	
Rutherford ISIS	11.
AGS Booster, AGS	6., 7.3
CERN PSB, PS	4.3, 4.3
KEK Booster, PS	4.8, 1.0
LANL PSR	~ 30
FNAL Booster	0.8
Proposed:	
JHF Booster, PS	13, 13

Table 3.1: AC beam current achieved

The AGS is noteworthy as achieving the highest beam-loading ratio for a synchrotron in the many-GeV range. Of particular interest is the longitudinal phase space dilution. This is performed using a cavity running at 33.75 times the beam frequency. A barrier-bucket scheme is under development in collaboration with KEK.

The ISIS beam current is quite impressive and is encouraging for development of higher intensity machines using conventional ferrite tuning. With respect to beam loading, the high current is achieved using a combination of feedback compensation of the induced voltage in the cavities and de-Q ing using a $CuSO_4$ resistor.

3.2.3 The JHF

High time-averaged intensity is achieved by combining high circulating current with rapid cycling. This will be the approach in JHF as well. The latter implies large rf voltage per turn, while the former implies heavy beam loading. In order to achieve high rf voltage, it is advantageous to go to higher rf frequency where resonant structures can be built which do not include large volumes of lossy ferrites to bring the frequency down. This was the approach adopted for the FNAL booster, and the (defunct) SSC and KAON proposals. Unfortunately, such efficient rf cavities are so because of their high Q and R_s, and this combined with high circulating current means that there will be a problem with parasitic cavity modes. A way around this is to choose low Q cavities, where all modes are naturally damped. Unfortunately, such cavities have small gap voltages and therefore a large number are required. This increases both capital and running costs.

An innovative approach being pursued in the JHF design is to use a metallic magnetic alloy instead of ferrite. Since these materials have higher Curie temperature and saturation magnetization, higher rf flux densities and gap voltages are possible. Resistivity can be in the realm of stainless steel. This combined with the relatively low rf frequency yields a large-enough skin depth: cores can be comprised of wound tape, a few tens of microns thick.

Extremely low Q is possible in such a design, without lowering R_s to the point that excessive power is required to drive the cavity. In fact $Q \sim 0.6$ has been demonstrated, with $R_s/Q \sim 250\,\Omega$. There are two advantages to this type of cavity design. Wakefields decay between bunches, so coupled-bunch modes are not dangerous, and no tuning of the cavity is required. On the other hand, the broad impedance would lead to large potential-well distortion. In other words, beam induced voltage must be compensated not only at the fundamental, but at other harmonics as well. The JHF team is aware of these difficulties and presented schemes for compensating up to 3 harmonics. The beam loading modelling was performed for a case with all buckets occupied. Partially-filled rings and kicker-gap cases were modelled by simulation.

The discussion brought up a number of other issues to consider before this can be considered a viable rf system for high intensity synchrotrons.

- The properties of the magnetic alloy should be checked to make sure they do not change under conditions where the excitation frequency varies quickly with time. This is a potential problem in fast-cycling synchrotrons, as has been the experience with the FNAL booster ferrites.

- The standard beam-loading theory needs to be generalized to cover the case of such low-Q cavities, since in some approximation, the usual model of a parallel RLC circuit is not applicable.

- The measured impedance for the prototype cavity was found to be low enough for frequency below 30 MHz. There may be high-Q resonances in the range of 100 MHz to beam-pipe cutoff. This should be measured.

  An interesting aspect of low-Q acceleration cavities is that there is no longer any reason to use a single Fourier component to accelerate the beam. In fact, the rf system is meant to accomplish 3 purposes. (1) Energy gain to maintain synchronism with the magnetic fields; (2) Slope in energy gain to keep the bunches longitudinally focused; (3) Some non-linearity to Landau-damp instabilities. In a sinusoidal rf system, these 3 are fixed by choice of V and ϕ_s. However, in a broad-band rf system, the 3 can in principle be independently varied. This may provide a better, more flexible rf system and may turn out to be no more complicated than feedback systems to zero out the higher harmonics.

3.3 Strong-Strong Beam-Beam Workshop at SLAC

J. Irwin `irwin@slac.stanford.edu` SLAC

A small 3-day workshop on the strong-strong beam-beam was held at SLAC June 8-10th, 1998, on the occasion of a two-month visit to SLAC and LBL of Srinivas Krishnagopal (Centre for Advanced Technology, Indore, India), who was responsible for the first truly strong-strong beam-beam simulations devoid of assumptions on the form of bunch distributions [1]. Also attending the workshop were Joe Rogers and his student, Edwin Anderson (Cornell), who is currently completing a strong-strong simulation code, Miguel Furman (LBL), Donald Kouri (Univ. of Houston), Vladimir Shiltsev and Jim Holt (FNAL), Robert Ryne (LANL) and participants from SLAC including Yunhai Cai, Kwok Ko, Witold Kozanecki, John Irwin, Boris Podobedov, John Seeman, Bob Siemann, Kathy Thompson, Bob Warnock, Yiton Yan and Frank Zimmermann.

The workshop began with a historical perspective on theory, experiment and simulations delivered by Bob Siemann, followed by a talk on strong- strong simulations for neutralized beams by Boris Podobedov. Miguel Furman described the simulations he had done for PEP-II. A session on the status of current simulation efforts included detailed talks by Krishnagopal and Anderson. Following this Rob Ryne led a discussion of the gains one can expect from parallelization and existing relevant algorithms. A morning was devoted to the consideration of possible improvement of solvers using DAFs (Distributed Approximating Functionals) which were described and invented by Don Kouri [2]. In a session devoted to experimental issues Joe Rogers gave a talk on beam- beam observations at CESR, Witold Kozanecki presented plans for beam- beam measurements at PEP-II, and John Seeman gave a perspective on PEP-II luminosity upgrade options.

Siemann commented that: i) all published data on beam profiles average over many turns, so there is no definitive evidence for or against turn-by- turn variations, ii) halos can be produced by modulation of cores in high current proton beams, iii) 0- and π -mode dipole oscillations are observed, iv) observations, simulations and theory show flip-flop behavior which is observed to be extremely sensitive to machine conditions, v) theory and simulations predict so-called higher-order mode period-N behavior, vi) the Vlasov equation solutions by Derbenev [3], Dikansky and Pestrikov [4] and Ruth and Chao [5] show period-N behavior but do not agree on details. Neutral-beam simulations by Podobedov had period-N behavior agreeing with reference [4]. The neutral beam case is richer presumably for lack of Landau damping.

The simulation codes of Krishnagopal and Anderson use similar, though not identical, Poisson solver routines. As of the workshop the Krishnagopal code lacked longitudinal slicing and did not yet allow for asymmetric beam-beam parameters [6]. Anderson's code contained these features but was still being bench-marked against actual machine conditions and observed beam sizes. It is the intention of both of these authors to make their codes available for public use.

Joe Rogers emphasized the importance of machine conditions in the beam-beam behavior and described a bunch-by-bunch profile monitor under development (original idea by Tong Chen) using optical fibers and a photo- multiplier array, a new operating point near the half-integer that gives a larger beam-beam tune shift, and the first experiments on the Mobius-twisted lattice which looked promising.

Seeman emphasized the importance of the beam-beam phenomena for PEP-II, and described pathways, such as higher currents, lower $\beta*$, increase beam-beam tune shifts, and relaxed transparency conditions, being considered that, in the best of all worlds, could lead to luminosities as high as $3 \times 10^{34}/(cm^2 s)$. The surprises that may be offered by the asymmetric conditions are being cautiously awaited.

Because of its small size the workshop could be highly informal. There was ample time for discussion and debate. There was a general appreciation that the beam-beam comes in many flavors (when linear colliders are also considered) and can be a very rich and complicated phenomena when all the real-life conditions are included. It can be expected to be an area of increasing importance with many applications.

We wish to apologize to anyone that would have liked to attend but did not receive notice. Arrangements were very last minute, and grew larger than originally expected. We would also like to express our gratitude to all participants for their efforts and thoughtful contributions.

References

[1] S. Krishnagopal and R. Siemann, Phys. Rev. Lett. 67, 2461 (1991), and S. Krishnagopal, Phys. Rev. Lett. 76, 235 (1996).

[2] D.K. Hoffman et. al., Variational derivation and extensions of distributed approximating functionals, Journal of Mathematical Chemistry 20, p117 (1996).

[3] Ya.S. Derbenev, N.S. Dikanskii, Damping of coherent beam oscillations in a storage ring, SLAC-TRANS-0106 and Novosibirsk preprint, IYF-69-315 (1969).

[4] N.S. Dikanskii and D.V. Pestrikov, Colliding beams coherent instability, Part.Accel.12:27-37 (1982).

[5] A.W. Chao and R.D. Ruth, Coherent beam-beam instability in colliding beam storage rings, Part.Accel.16:201-216 (1985).

[6] Shortly after the workshop Krishnagopal included the possibilities for asymmetric collision parameters. First results should be available soon.

3.4 Shelter Island Workshop on Space Charge Physics in High Intensity Hadron Rings

Alfredo U. Luccio `luccio@bnl.gov` BNL
Brookhaven National Laboratory

On May 4-7, 1998, we held a Workshop on Shelter Island, New York, at the Pridwin Hotel on the waterfront. The main purpose of the Workshop was to review recent progresses and the current state of understanding of space charge related phenomena in high intensity hadron synchrotrons and accumulator rings, with special attention to new machines being considered (such as the SNS, ESS, JHF, μ-Collider Driver...). Attendance was by invitation.

In choosing a location for the Workshop we wanted a place both not too far from Brookhaven and a secluded location. Shelter Island came to mind, as it has been the location of a number of conferences through the years, not the least being the very famous conference of 1947.

The idea of organizing arose at Brookhaven during discussions on the physics of the Accumulator Ring for new Spallation Neutron Source (SNS) to be built at Oak Ridge. This is a 1 GeV proton ring characterized by a very high beam current and therefore dependent on space charge effects. We had a long history of operations of high intensity proton synchrotrons from the U.S., Europe, and Japan. However, in terms of average beam power, they are all in the range of a few to two hundred KW. The new generation of applications both in the spallation neutron source and μ-collider drivers requires average beam power from a few MW to 10 MW. This presents a new challenge in the precision of accelerator analysis and control of beam losses

The dynamics of beams in circular accelerators, when space charge is important, is widely studied, but there are few experimental data. The theory is in evolution and the numerical simulation still needs a solid validation. We felt that, by inviting many of the key players of this game, discussing and comparing experimental results, theories and simulation codes, we could give an important contribution not only to the SNS, but to the field in general. We also hoped that the Workshop could give a start to new collaborations.

3.4.1 Workshop Lay-out

¿From the Workshop, some answers we were trying to find are:

What are the experimental observations of high intensity effects.

What are the theoretical explanations and predictions.

What computer simulation codes are available.

The following kindly agreed to set up a Program Committee:

S. Chattopadhyay LBL, T-S.Wang LANL, S-Y. Lee Indiana University, A.U. Luccio, BNL (vice-chair), D.K. Olsen, ORNL, M. Reiser University of Maryland, W-T. Weng BNL (chair).

Registered participants were 57. They gave 14 plenary papers + 23 topical papers. The Workshop took 3 and 1/2 days.

3.4.2 Plenary Sessions

In the first two days we had plenary presentations on different topics, by the following speakers:

1. Review of experimental results: Tom Wangler (Los Alamos) and Ingo Hofmann (GSI)

2. Review of the theory: Bruno Zotter (CERN), Rick Baartman (TRIUMF), and S-Y Lee (Indiana)

3. Review of simulation computer codes: Shinji Machida (KEK), and Chris Prior (ARL)

4. Existing High Intensity Rings: Chris Warsop (ISIS), Robert Macek (PSR), Chuck Ankenbrandt (Fermi), and Thomas Roser (AGS)

5. New Proposed Facilities: Chris Prior (ESS), Miloslav Popovic (MuonCollider Driver), and Bill Weng (SNS)

3.4.3 Working Groups

To help workshop discussions and focus on the present issues for the design of new high power facilities, we assigned specific tasks to the three Working Groups, chaired by

Observation WG: Roberto Cappi (CERN)

Theory WG: Rick Baartman (TRIUMF)

Simulation WG: Alfredo Luccio (BNL)

Contributed papers were presented during Working Group sessions. These presentations were less formal that in the plenary sessions, and served as the basis for discussions.

Questions for Beam Observations Group were. (1) What are the ways to observe emittance growth, their reliability and precision. (2) What are the ways to observe particle losses, their reliability and precision. (3) Observation and experience of particle losses in existing facilities. (4) Suggestion of methods to be adopted for high intensity synchrotrons in emittance and particle loss observation. (5) What is the best strategy to design and place collimators in rings to reduce halo?

Questions for Theory Group

(1) Relationship between single particle and coherent picture of resonances in synchrotrons.

(2) Methods and accuracy of emittance growth and particle losses calculation by resonance models.

(3) Mechanisms of halo generation in synchrotrons.

(4) Methods and accuracy of emittance growth calculation by particle-core models.

(5) How to minimize halo generation in synchrotrons.

Questions for Simulation Group

(1) Characteristics, strength and weakness of existing 6-D, space-charge dominated tracking codes.

(2) What are the specific recommendations to improve them, algorithms, speed, convergence, relevance, ...?

(3) How to validate a tracking code, self-consistency, reliability, convergence, calibration with observations and other codes.

(4) Is it possible to build a code everybody agrees to use?

All the papers given will be published in a book by the American Institute of Physics.

3.4.4 Results of the Workshop. Conclusions

The Workshop reached its goals to bring people together to discuss. The field is in evolution, so it is hard to get final conclusions, or to agree on final answer or established facts. The chairmen of the Working Groups tried to give answers to the specific questions stated above, but in general those answers were in turn questions and new questions were generated at each step.

One fact is clear, namely, from circular high intensity hadron accelerators there are not enough experimental data on space charge effects, and what is available is sometimes controversial. Theory and Simulation are acting in parallel since theoretical work generally needs numerical simulation to confirm results. Simulation is complex and often very computer time intensive. So, one should find new ways to use computers to solve them in a reasonable time. Validation of codes and theory by comparison with experimental data is a very important effort.

All this suggests three main directions on which to move:

- Give more financial support to dedicated machine experiments.
- Acquire new, faster computers (build arrays of PC's?)
- Create more collaborations to share results and findings.

4: Activity Reports

4.1 Beam Dynamics Issues at MUSES Project of RIKEN Radioactive Isotope Beam Factory

Yuri Batygin batygin@rikaxp.riken.go.jp
RI Beam Factory Project Office, RIKEN, 2-1 Hirosawa, Wako-shi, Saitama 351-01, Japan

Takeshi Katayama katayama@insac8.cns.s.u-tokyo.ac.jp
Center for Nuclear Study, School of Science, University of Tokyo, 3-2-1, Midoricho, Tanashi, Tokyo 188, Japan

In RIKEN, the Radioactive Isotope Beam Factory Project has been approved by the Government as a new stage of fundamental research in heavy-ion physics. This project includes new types of facility to accelerate extremely rare unstable heavy ions up to energy of 1-3 Gev/u. Extensive use of heavy ions is assumed to be done in the following branches of science:

- creation of new isotopes
- study of exotic nuclei and reactons unduced by them
- study of nuclear structure
- development of new cancer treatment
- ion implantation into materials to change materials properties
- diagnostics of material components.

Existing accelerator facility in RIKEN consists of heavy-ion linac for energy of 0.7 - 4 MeV/u followed by Ring Cyclotron for energy of 150-200 MeV/u. The first stage of the new project assumes construction of two extra cyclotrons (4-sector Intermediate Ring Cyclotron and 6-sector Superconducting Ring Cyclotron), with final energy of 400 MeV/u. After acceleration in cascade of cyclotrons, primary heavy ion beam interacts with a target and is converted into radioactive isotope (RI) beam via projectile fragmentation process. Created unstable particles come through RI separator to be selected for further experimental usage. Cyclotron facility as injector will be operated in two modes, one is CW mode with average beam current of 1 particle μA, and the second mode is pulse mode with peak current of 100 pμA and repetition rate of 1 kHz. Typical RI beam characteristics are estimated as follows: the production rate is 10^7 -10^{11} particles per second, momentum spread is $\pm$ 0.5 %; the phase width relative to RF frequency is 1 5 degrees; and the transverse emittance is 4.5 π mm mrad in both horizontal and vertical directions. Due to large momentum spread of the RI beam after target, beam has to be debunched before injection into Accumulator Cooler Ring. For that beam is transported from the target to the injection point along the length of 70 m. At the end point of transport line, a debuncher system with 8 MV voltage will be installed to reduce the momentum spread to 0.1%.

The second stage of the project is MUSES (Multi Use Experimental Storage rings) facility, which consists of Accumulator Storage Ring (ACR), Booster Synchrotron Ring (BSR) with an injector electron linac and Double Storage Rings (DSR). ACR works for accumulation and cooling of RI beams and for atomic and molecular physics experiments. BSR works only for acceleration of ions and electron beams. DSR permits various types of unique colliding experiments. Due to short life time of radioactive isotopes, the main design efforts are focused on accumulation and collision of largest possible number of particles with small emittance to obtain high value of luminosity.

4.1.1 Accumulator Cooler Ring

The Accumulator Cooler Ring will be used to provide high intense and quality RI beam. ACR serves as injector for Booster Synchrotron and independently as an accelerator for nuclear and atomic physics experiments.

ACR is a ring with circumference of 168 m, which consists of two arc sections and two long straight sections. Both stochastic cooling and electron cooling are examined to decrease phase space volume of RI beam. It is turned out, that for multi-turn injection and for typical RI beam with small number of particles and large values of beam emittance and momentum spread, stochastic cooling is much faster, than electron cooling. Electron cooler with 3 m length provides cooling time of 380 sec for ^6He and 0.42 sec for ^{232}U, while the stochastic cooling with 10 kW and a band width of 2 GHz feed back amplifier provides 0.2 sec and 5 msec cooling time, respectively. Meanwhile, utilizing of one-turn injection scheme permits faster electron cooling due to dependence of cooling time of beam emittance as $\tau_{cool} \sim \varepsilon^{3/2}$. Comparable study of one-turn injection with electron cooling against multi-turn injection is carried out [2].

Beam cooling is accompanied with particle accumulation utilizing RF stacking technique. Injected beam is captured into bucket via applying of RF voltage. RF operation frequency is changed adiabatically to shift the stacking orbit. After that the RF voltage is switched off and the beam is released and remains at the stacking orbit. Optimization of initial momentum spread and RF bucket height in presence of cooling forces is made to provide high stacking efficiency. Accumulated RI beam is fast extracted from the ACR and injected into Booster Synchrotron. The final momentum spread is less than 0.15% and emittance is 1 π mm mrad.

4.1.2 Booster Synchrotron Ring

The Booster Synchrotron Ring is used exclusively for acceleration of ion and electron beams. The maximum accelerating energy is 3 GeV for proton, 1.45 GeV/nucleon for light ions of q/A=1/2 and 800 MeV/nucleon for heavy ions of q/A=1/3. Electron beam is accelerated up to 2.5 GeV from the injection energy of 300 MeV. Accelerated ion and electron beams will be fast extracted and injected into the Double Storage Rings (DSR) by one turn injection. As another operation mode, ion beam will be slowly extracted for the experiments.
Lattice of the BSR consists of two arc sections and two long straight sections. Natural chromaticity of -8.670 (horizontal) and -8.320 (vertical) are corrected by two families of sextupoles. The normalized field strengths of sextupoles required to correct chromaticity are 9.236 m $^{-3}$ and -15.889 m^{-3}. Dynamic aperture is seriously affected by chromaticity correction. Multi-turn (10^4) tracking indicates, that dynamic aperture of BSR is ϵ_x = 125 π mm mrad and ϵ_y = 5 π mm mrad. Further tracking is required to define limits of dynamical aperture and to estimate the tolerable level of misalignment in the ring.

Table 4.1: Parameters of proposed RIKEN Double Storage Ring collider.

Circumference	258 m
Beam Energy	
proton (GeV)	3.55
ion (Z/A=0.5), Gev/nucleon	1.45
ion (Z/A = 0.387), Gev/nucleon	1.00
Max Bρ	14.6 Tm
Transition γ	
electron	4.819
ion	5.236
Number of ion bunches	50-100
Merging angle, 2φ	10°
Betatron tune value ($Q_x x/Q_y$)	
electron	4.793/7.687
ion	6.668/5.661
Beta function at Interaction Point (β_x^*/β_y^*, m)	0.1/0.1
Beam sizes at interaction point ($\sigma_x/\sigma_y/\sigma_z$, mm)	0.4/0.4/100

4.1.3 Double Storage Ring

Double Storage Rings (DSR) will be used for various experiments of collision or merging of radio-isotope beams with ions, electron beams and X-rays produced by an undulator. DSR consists of vertically stacked two rings of similar specification (see Table 1). Each lattice structure takes a form of a racetrack to accommodate two long straight sections. The experiments will be performed at two crossing points. One is for collision of RI beam with electron beam with crossing angle of 20 mrad. Another is for merging of ion beams with angle of 170 mrad. To perform these experiments with high luminosity, electron beam has two different operation modes. One is used for collision with ion beam. In this case, the size of electron beam at collision point has to be equal to the size of ion beam. It is attained utilizing small value of β function in the collision point and rather large value of electron beam emittance. Electron beam with emittance of 10^{-6} m$\times$rad is prepared for this mode. Another mode employs electron beam for production of high brilliant X-ray. For this mode electron beam with emittance of 10^{-8} m$\times$rad is provided.

The electron-RI beam collision is a direct way to determine the charge and current distribution in neutron or proton-rich radioactive nuclei. To keep a sufficiently long Touchek lifetime, an RF voltage of 2 MV is applied to electron beam. The number of stored electrons is estimated to be 2.7×10^{12} particles, which is limited by the longitudinal coupled-bunch instability. Luminosity of electron-ion collision as a function of beam-beam parameter is:

$$L \leq \frac{f_o N_b N_i \gamma_i}{\beta^* r_p} (\frac{A}{Z}) \xi_{\rm max} = 5 \times 10^{18} (\frac{A}{Z}) N_i^{\rm total} \frac{1}{\rm sec\ cm^2} \ ,$$

where ξ_{max} = 0.005 is the typical maximum value of beam-beam parameter in hadron colliders and $N_i^{\rm total} = N_b N_i = 10^7 - 10^{12}$ is a total number of stored ions. Therefore, the maximum achievable value of luminosity is

$$L_{\rm max} = 10^{31} \frac{1}{\rm sec\ cm^2} \ .$$

Beam-beam instability is usually attributed to excitation of set of nonlinear resonance islands, which, being overlapped, create stochastic particle motion. Another factor in instability of collided particles is the noise in beam-beam interaction. Random fluctuations in the opposite beam size $\sigma_n = \sigma_o(1 \pm u \cdot u_n/2)$, where u is a noise amplitude, n is a turn number, and u_n is a uniform random function with unit amplitude, result in beam emittance growth [3]

$$\frac{\epsilon_{\rm n}}{\epsilon_o} = \sqrt{1 + D\,n} \ ,$$

where diffusion coefficient D is a function of the beam-beam parameter, noise amplitude, and ratio of ion beam size, a, to electron beam size, 2σ:

$$D = (\pi \xi u)^2 (\frac{a}{2\sigma})^4 \ .$$

Electron cooling is anticipated to be a way to suppress beam-beam instability. Taking the expected number of damping turns to cool the beam as $N_{damp} = 2 \times 10^7$, which corresponds to cooling time of 20 sec, and the expected noise amplitude $u = 6 \times 10^{-3}$, the maximum value of beam-beam parameter is

$$\xi_{\rm max} = \frac{1}{\pi u} \sqrt{\frac{2}{N_{damp}}} = 0.017 \ .$$

Utilizing the beam cooling can result in increasing of luminosity at least by a factor of 4.

Merging beam collisions is a new technique for study of nuclear fusion processes. In merging collisions two comoving beams intersect each other at small angle $2\varphi = 10^o$ to provide low collision energy just above the Coulomb barrier threshold. Luminosity of merging beam-beam collisions is given by expression:

$$L = \frac{f_o N_b N_1 N_2}{4\pi \sigma_y \sigma_z \cos\varphi} \sqrt{\frac{1 - \beta^2 \cos^2\varphi}{1 + (\tan\varphi\ \sigma_x/\sigma_z)^2}} = 1.2 \times 10^5 N_b N_1 N_2 \frac{1}{\rm sec\ cm^2} \ .$$

In merging collisions achievable value of luminosity is several order of magnitude less than that in head-on collisions, because colliding beams are almost parallel to each other. Analysis shows, that in merging collisions beam-beam effects impose less severe limitation on intensity of collided beams than that of incoherent space charge effect. Assuming, the beam intensity is limited by incoherent space charge effect, the maximum number of stored ions is $N_1 = N_2 = 2 \times 10^{10}(A/Z^2)$, and maximum available luminosity is

$$L_{\rm max} = 2.4 \times 10^{27} (\frac{A}{\rm Z^2})^2 \frac{1}{\rm sec\ cm^2} \ .$$

Another planning experiment is collision of RI beams with high brilliant X-rays generated by an undulator. This experiment is aimed to be used for precise measurement of isotope shift and hyperfine structure in atomic transitions of highly-charged radioactive isotopes. The X-ray energy of 30-800 eV is required to excite the transition for elements of Z = 40 - 92. In order to resolve the isotope and the hyperfine structure in the transition, the energy resolution of the X-ray should be better than 2×10^{-4} with largest possible photon flux. Undulator of 6 m length with the period of 3 cm, number of periods 200, gap width 2.9 cm and pole tip field of 1.3 T is placed in dispersion free section of the ring together with small compensators. Extracted X-ray is injected into another ring to collide with stored RI beam. The maximum photon flux density is estimated to be 10^{18} photons/sec mrad^2 0.1 b.w.

Additional important application of Double Storage Ring is a high temperature plasma target physics study for Heavy Ion Fusion. HIF experiments will be performed with $^{232}U^{+49}$ ion beam with energy 150 MeV/u, number of ions 2×10^{11} with pulse width 20 nsec. Basic studies of high temperature plasma target physics will be done up to the plasma temperature 10 - 50 eV with symmetric beam radiation of the target. Study of space charge effects in RF linac and ring are conducted.

Further information about RIKEN RI Beam Factory Project can be found in WWW page

`http://www.rarf.riken.go.jp/rarf/index.html`.

References

[1] T.Katayama, Y.Batygin, N.Inabe, K.Ohtomo, T.Ohkawa, M.Takanaka, M.Wakasugi, S.Watanabe, Y.Yano, K.Yoshida, J.Xia, Y.Rao and Y.Yuan, Nuclear Physics A626 (1997), 545-560.

[2] I.Meshkov, E.Syresin, T.Katayama and Y.Yano, RIKEN AF-AC-8, 1998.

[3] Y.Batygin and T.Katayama, NIM A, Vol. 404 (1998), 1-16.

4.2 Activity in Padova University (Physics Department) and at Legnaro National Laboratory–INFN–Legnaro (Padova) on theory of beams and applications

M. Pusterla `pusterla@pd.infn.it`

Dipartimento di Fisica Galileo
Galilei Università di Padova
Istituto Nazionale di Fisica
Nucleare (INFN) Sezione di Padova
Via Marzolo 8 Padova 35131
ITALY

`http://www.pd.infn.it/~pusterla/welcome.html`

The research group in accelerator physics and beam dynamics in Padova University (Physics Department and INFN) has mainly focussed its interests on the “Quantum Aspects of Beam Dynamics of spin-$\frac{1}{2}$ charged-particles (protons, antiprotons, electrons, and positrons)”. More specifically we have dealt with the derivation of the canonical beam maps from the Dirac formulae for spin-$\frac{1}{2}$ particles (in collaboration with M. Conte, INFN-Genova and R. Jagannathan, & S. A. Khan (now at Padova), IMSC, Madras, India[1, 2]).

We also worked on the definition of the Stern-Gerlach force at a relativistic energy and the study of its use for obtaining a polarized beam from an unpolarized one by repeated Stern-Gerlach kicks on the particles is a storage ring. These kicks may be either longitudinal (along the particle trajectory) or transversal[3, 4].

The beam physics activities at the Legnaro National Laboratory is mainly addressed to heavy ion beams transport and acceleration, strictly related to the accelerators developed in the laboratory. Moreover in the last years theoretical studies have been carried out on space-charge dominated beams, addressed to two specific problems: the possibility of crystalizing an ion beam in a storage ring and the study of the origin of small beam losses in a high intensity proton linac (beam halo formation). The latter is a central point of the high intensity accelerator development in which LNL is involved, together with other INFN structures like LNS (Catania), INFN-Groups of Bologna, Napoli, Bari, Milano and Genova, and in close contacts with other international institutions like CEA in France.

First results for the beam halo formation studies are being obtained by applying to this problem the Frequency Map analysis technique, already used in celestial mechanics and single particle accelerator physics.

"Halo problem" and "Stern-Gerlach" kicks are under continuous study by detailed simulations.

References

[1] M. Conte, R. Jagannathan, S. A. Khan and M. Pusterla, *Part. Accel.* **56** (1996) 99.

[2] M. Conte, R. Jagannathan, S.A. Khan and M. Pusterla, "A quantum mechanical formalism for studying the transport of Dirac particle beams through magnetic optical elements in accelerators", `in preparation`.

[3] M. Conte and M. Pusterla, *Il Nuovo Cimento A* **103** 1087.

[4] M. Conte, Y. Onel, A. Penzo, A. Pisent, M. Pusterla and R. Rossmanith, The spin-splitter concept, `Internal Report`: INFN/TC-93/04 (INFN, Genova, 1993).

4.3 LHC Collective Effects

F. Ruggiero `Francesco.Ruggiero@cern.ch` CERN

In connection with electron-cloud induced heating of the LHC beam screen, an intensive research program has been set up at CERN to measure the relevant physical quantities, such as photon reflectivity, photoelectron and secondary electron yield, to validate analytic estimates and simulation results, and to propose effective remedies: a fairly complete account of the contributions to this 'crash program' can be found in the World-Wide Web page `http://wwwslap.cern.ch/collective/electron-cloud/`.

A simple and reliable technique, based on amplitude modulation of the input signal, has been developed to detect electronically the onset of multipacting in a resonant coaxial cavity. The results obtained during cold tests in a superconducting magnet show that the electron cloud build-up is not suppressed by a strong dipole field, while a weak solenoid field of about 50 Gauss is usually sufficient to stop the multipacting. A substantial decrease of the multipacting threshold is observed for a dipole field intensity such that the electron cyclotron frequency is equal to the resonant frequency of the coaxial cavity.

Computer codes have been developed, debugged and used to predict the heat load on the LHC beam screen under several conditions and the rise time of a multi-bunch instability associated with the electron cloud wakefield. The results are in agreement with quasi-analytic estimates of the critical secondary-emission yield, and indicate that doubling the LHC bunch spacing would be an effective back-up solution. Alternative cures, including low-emissivity coatings, clearing electrodes, and an increased surface roughness, are under study together with their possible impact on the impedance budget. The latter is being revised also in view of new analytic estimates of the interference among pumping slots and of ongoing measurements of the kicker impedance.

4.4 Beam Dynamics Activities at the Brazilian Synchrotron Light Source

Liu Lin liu@ns.lnls.br
A.L.Xavier Jr. xavier@ns.lnls.br LNLS
C.P.6192
13083-970 Campinas,SP,Brazil

Recent beam dynamics activities at the Brazilian Synchrotron Light Source (LNLS) are mainly directed to improve the electron storage ring performance parameters: design of a synchrotron booster to increase the injection energy, improvement in the beam orbit stability and optics calibration. In addition we have also measured the linear coupling coefficient by analyzing the transverse beam profile near the difference coupling resonance.

4.4.1 Design of a synchrotron booster

The electron storage ring at LNLS operates presently at 1.37 GeV with a 120 MeV injector linac. The storage ring has been operating routinely with users since July 1997 and its performance parameters have improved steadily during this first year of regular operation, reaching a maximum stored current of 170 mA at operating energy with 11 hours lifetime. These parameters already exceed those specified during design. The need for an increase in the injection energy arose with the demand for the installation of insertion devices. The present injection at low energy does not allow these devices to be installed since the reduction in the vertical acceptance of the ring would decrease the injection efficiency. Considerations on the cost of the project, injection and ramping efficiency and physical space available to install the booster with minimum modifications to the storage ring have lead us to the choice of an intermediate energy booster (500 MeV) placed inside the storage ring. In addition, the booster will be designed to operate with long ramping cycles allowing the use of conventional vacuum chambers and power supply topologies already developed at LNLS for the storage ring. The advent of the booster will also provide more opportunities for machine experiments since it will be used for accelerator physics studies when not used as injector.

4.4.2 Improvement of the orbit stability

In order improve the stability and reproducibility of the x-ray beam position delivered to the users we are presently reviewing the vast number of topics related to the subject, applied to our specific case, such as: orbit stability requirements, techniques to identify undesirable sources of beam motion, capabilities of orbit monitoring equipment at LNLS (e.g. position measurement dependence on beam current), parameters for automatic orbit correction, relation between beam stability at the monitors and at the source points, etc. Efforts made up to now include the increase in the number of vertical correctors in ring (which were already available, but were not powered), increase in the resolution of the applied corrections, stabilization of the magnets temperature, installation of a x-ray beam position monitor, and experiments with the users during special sessions dedicated to verify the orbit correction system performance for various scenarios. The orbit repeatability from fill to fill has already improved from about 80 μm to about 5

μm. Once the main limitations of the present system are identified, further upgrade plans will be proposed.

4.4.3 Measurement of the linear coupling coefficient by analysis of the transverse beam profile

During the machine study times reserved for the accelerator group at LNLS, we have performed several experiments with linearly coupled transverse beams in the vicinity of a difference resonance [1] $\nu_x - \nu_y = 3$ excited by skew quadrupoles. This is the coupling resonance closest to our standard operating point $\nu_x = 5.27$, $\nu_y = 2.17$. Close to this resonant condition, the dynamics of linear coupling can be described [1] by a single complex parameter: the coupling coefficient κ. These studies [2] consisted in observing the time evolution of the transverse beam profile for a few milliseconds (a time short if compared to the synchrotron damping time, but long compared to the betatron oscillation period) after exciting the beam with a fast (few hundred ns) horizontal kick. The acquired image is a projection onto the xy plane of a phase-space distribution function integrated over a very large number of turns. Many geometric characteristics of the phase space orbits appear in the time averaged profile (in particular the transverse beam profile border) which enabled the development of new experimental method [3] to measure several aspects of this phase space geometry provided the tune difference is close to the resonance . Hamiltonian formalism [1] applied to the resonance region of interest provides a transverse map from which the beam profile contour can be extracted. The reverse process allows the determination of both $\Re = [\kappa]$ and $\Im[\kappa]$ given the beam contour by a least-square minimization. This procedure was then applied to experimentally obtained contours which yields experimental estimates of the modulus and phase of κ.

A pair of skew quadrupoles was installed in one of the long straight sections and used to drive the coupling resonance. One of the injection kickers was used to excite a coherent betatron oscillation and the subsequent evolution of the transverse beam profile was observed with a synchrotron radiation monitor. The beam energy was 600 MeV and the current a few dozen milliamperes to avoid collective effects. We used two different modes of operation during the experiments: the standard optics and the low vertical beta optics. In the first operation mode, the horizontal and vertical betatron phase advances from one skew quadrupole to the other is small (β_x and β_y large in the section). Also they are symmetrically installed with respect to the straight section center so that the value of $|\kappa|$ and $\arg(\kappa)$ does not change from one quadrupole to the other (measurements made with quadrupole powered in series). In the standard mode a significant agreement between the theoretical and experimental values (obtained from the profile border analysis) of $|\kappa|$ was observed (all the results here described agree within 15 %). Also a phase difference close to π was measured when the current in the quadrupoles was inverted (which makes $\kappa \to -\kappa$ according to the theory). For the low beta optics, in the straight section containing the pair of skew quadrupoles there is a large betatron phase advance from one skew quadrupole to the other due to the smallness of the vertical betatron function (the horizontal phase jump is kept small) which allows the observation of large phase jumps in κ. For this case, each skew quadrupole was powered independently and we observed that $|\kappa|$ is largely insensitive to the betatron phase advance from one quadrupole to the other which corresponds to the theoretical prediction. The determined values of $|\kappa|$ reasonably agree with the theoretical calculations. As each quadrupole is individually powered, there is a phase jump which causes a significant change in the beam profile. The resulting calculated change in the phase of the coupling coefficient also agree with the experimentally determined values.

Therefore we have shown that this new experimental method (based on the beam profile border analysis) gives useful information on the phase-space properties of the beam described by the complex parameter κ. However the method can not be blindly applied since one should carefully choose the resonance region (to guarantee closeness to resonance and validity of the theory) as well as a suitable value for the kicker strength. If the kick amplitude is very large other non-linear phenomena may appear and the linear theory does not apply; if the kicker strength is small, the finite beam size may smear out the beam profile so as to render the determination of κ very imprecise. Within these limits, however, the method gives values for $|\kappa|$ and $\arg(\kappa)$ in good agreement with theoretical estimates as well as with the results of more conventional measuring techniques.

4.4.4 Optics Calibration of the LNLS Storage Ring Via Response Matrix Theory.

An effort has been dedicated to the development of a special procedure for calibrating the LNLS storage ring using the response matrix formalism. The response matrix theory correlates the amplitude observed in a given beam position monitor Δx_i with the intensity of a given kicker $\Delta\theta_j$ by the relation $\Delta x_i = 3DM_{i,j}\Delta\theta_j$. The response matrix $M_{i,j}$ is the input for the optics calibration by an inverse procedure [4]. It consists in minimizing a figure-of-merit function χ^2 that fits the calculated $M_{i,j}$ to the experimentally determined $\bar{M}_{i,j}$. The first step is the development of a special software using MAD [5] which adjusts an "experimental" $\bar{M}_{i,j}$ (that is, a response matrix calculated by MAD with a known magnetic lattice). The program simply tries to re-obtain the initial lattice, thus confirming whatever introduced errors. The second step would be the calibration itself, i. e., the minimization of χ^2 according to the experimental matrix. We are now (step 1) testing several procedures for the calculation of $\nabla M_{i,j}$ (the gradient of $M_{i,j}$ in the parameter space) required for the fitting procedure, admitting errors in the quadrupole fields and in dipole fields of quadrupole magnets. We plan to test the calibration to several energy ranges (from the injection energy of 120 MeV to 1.37 GeV).

References

[1] G. Guignard, CERN 78-11 (1978).

[2] Liu Lin, ICFA Beam Dynamics Newsletter,**15** (1997).

[3] P. F. Tavares, A. L. Xavier Jr., Liu Lin, L. Jahnel and R. H. Farias, *Measurement of the modulus and phase of the linear coupling coefficient by analysis of the transverse beam profile, submitted to Phys. Rev. Special Topics: Accelerators and Beams.*

[4] J. Safranek, Proceeding of the 97 EPAC.

[5] F. Christoph Iselin, J. Niederer, The Mad program 7.2, CERN 88-38 (1988).

4.5 New Division of Accelerator and Beam Science in the Atomic Energy Society of Japan

Mitsuru Uesaka `uesaka@tokai.t.u-tokyo.ac.jp` Nuclear Engineering Research Laboratory
University of Tokyo

On behalf of the chief promoter, Prof. M. Matoba (Kyushu University, Japan), I would like to send you the information about the new division of Accelerator and Beam Science in the Atomic Energy Society of Japan.

The division is planned to be established this September at the autumn topical meeting of the society held at Fukui Institute of Technology, Japan,and the opening ceremony is to be held, too. Tentetive administration and scopes are written in the following. One of the important missions of the society is radiation source and application. Most research activities on accelerator and beam science are related and based on nuclear technology. Unfortunately, the atmosphere surrounding nuclear technology does not look warm due to several unpleasant nuclear affairs in the world. The new division is expected to be a key to stimulate the nuclear society and make it more attractive to academics, industries and publics.

Division of Accelerator and Beam Science in the Atomic Energy Society of Japan

1. General Affairs

   Public information/ University matters/ Laboratory matters/ Industry matters/ Educational program (summer or winter school).

2. Accessment and research

   1). Energy production 2). Nuclear waste processing by spallation 3). Target system, Reactor characteristics 4). Radiation shielding 5). Measurement and control of subcritical reactor 6). Analysis of material and surface 7). Micromachining 8). Collaborative operation of academic and industrial organization 9). Nondestructive testing 10). Environment and accelerator 11). Accelerator for medical use 12). Accelerator for cancer therapy 13). Synchrotron light source 14). Free electron laser, Optical quantum science 15). Atomic physics, Atomic data and accelerator 16). Electron linear accelerator and Electrostatic accelerator 17). Cyclotron and synchrotron 18). Super large-sized accelerator 19). New principle of acceleration 20). Accelerator technology (ion source, beam transportation) 21). Related technologies (superconductivity, ultra low temperature, high frequency, laser) 22). Radiation diagnosis 23). Systems control, operation and management. 24). Safety technology. 25). Big projects.

3. Examples of research fields to be included

   (1) Accelerator and technology of beam acceleration.

   (a). Methodology and technology of acceleration: Beam physics, Beam engineering, New principle of acceleration Non-linear beam dynamics, Electron accelerator, Electrostatic accelerator, Cyclotron, Synchrotron,Storage ring etc. (b). Beam technology: Beam transportation, Beam control, Beam cooling, Magnet design, Component technology, Power source, Beam formation, Micro beam, Beam monitor, Beam diagnosis etc. (c). Technology of ion and electron sources: Ion source, Electron (Positron) source, Secondary beam, Non-charged particle beam, Polarlized particle beam, RI beam. (d). Technology of System and Control: Shielding design , Accelerator design, Mechanical design ,Component controling system, Construction of accelerator, Operating management, Safty system, Accelerator for medical care, Synchrotron light source, Free electron laser, Accelerator facility complex.

   (2) Application of beam

(a). Energy and resource: Accelerator reactor, Spallation, Accelerator Breeder, Intense neutron flux, Muon beam, Inlerial confinement fusion, MHD electricity generation of, Development of material. (b). Advanced analysis: Microanalysis, PIXE, Micro beam, Chronological measurement, Beam experiment technique, Measuring devices, Application of neutron, Application of RI beam. (c). Advanced manufacturing: Beam-irradiated effect, Surface analysis, Changing quality, Characterization, Lithography, Micro-machining. (d). Medical care, Biotechnology and Environment: Cancer therapy, Diagnosis, CT, Isotope production, BNCT, Nuclear chemistry, Beam-bio-interaction, Biotechnology, Environmental protection, Waste gas treatment Waste fluid treatment. Plastic solidification. (e). Fundamental science and data: Nuclear physics, Elementary particle physics, Physics of matter, Space science, Geophysics, Archaeology, General fundamental science, Optical quantum science, Cool neutron, Beam plasma, Nuclear transformation , Low energy, Neutron data, Electron data, Reactor physics data, Middle or high energy, Super-high energy, Nuclear data for medical care and space science, System data, Nuclear energy data.

(3) Basic beam technology

(a). Information and Data about nucleus, atom and molecule: Nucleus data, Data of atom and molecule, Data of energy loss, Data of radioactivation, Integrated data, Database for shielding, Charge transformation, Laser-beam interaction. (b). Diagnosis and data processing: Radiation diagnosis, Multi-dimensional data processing, Data analysis and processing, Sensor and detection device, Electronics, Signal processing. (c). Technology of target and nuclear heat: Target technology, Critical nuclear thermal design, Neutral beam heating, Large apertured ion source. (d). Method of control and intelligent support: Theory of control, High speed control, Robot, Intelligent support. (e). New device: Superconductivity, Ultra low temperature, High voltage, High frequency, Ultra high vacuum, Laser, Neutron guide, Mirror technology, X-ray focusing.

4.6 Accelerator Physics Activities in Spain

A. Faus-Golfe	`Angeles.Faus-Golfe@uv.es`	IFIC Instituto de Física Corpuscular University of Valencia
R. Pascual	`pascual@ifae.es`	IFAE Instituto de Física de Altas Energías University Autonoma of Barcelona

Although Theoretical and Particle Experimental Physics have become mature subjects in Spain, Accelerator Physics is in a gestational period and the birth of the first real installation does not seem imminent.

Currently the most important and promising activity is at the Synchrotron Light Laboratory (LLS) in Barcelona. In this laboratory a young team of thirteen people are developing a third generation synchrotron radiation source.

Besides this, there are small groups in some universities and research institutes, mainly in Madrid and Valencia, collaborating with CERN colleagues on specific aspects of the Large Hadron Collider.

4.6.1 Synchrotron Light Laboratory of Barcelona

In July 1992 a Committee was created to study the feasibility of a Synchrotron Light Source in Barcelona to be used by Spanish and users in south-western Europe. The committee produced a report demonstrating that such Spain could afford an installation provided that staff were adequately trained. Moreover it was the most suitable type of installation, both for Spanish scientists and industries.

In February 1993 the project was approved at the level of the regional government of Catalonia and the Steering Committee was created at the same time that the Spanish minister of Education and Science expressed its interest in participating in the project. An Advisory Committee at International level recommended that a director of the project should be found and proposed same names. One of them, Dr. J. Bordas was appointed to the position.

At the beginning of 1994, a team of 12 postgraduate or postdoctoral scientists were selected to compose a task force to be trained in the different fields of accelerators and synchrotron light sources. Since then they have been working under the direction of Dr. Bordas in order to analyse the characteristics of the most suitable source for the users and to prepare a detailed Design Study. The Central and Regional governments wanted this to be finished at the end of 1997. The study has indeed been completed and the final approval by both administrations is expected before the end of 1998.

The solution proposed to satisfy the requirements of Spanish users is a SL source capable of delivering useful light over a range of photon energies exceeding 25 keV. In addition, the source has beam lifetimes in excess of 24 hours, delivers low emittance (8.5 nm.rad) and has a small (by current standards) accelerator circumference (250 m). This can be achieved with the construction of a 2.5 GeV accelerator based on a Triple Bend Achromat lattice. The technical feasibility of such a facility has been throughly checked out and its engineering requirements carefully evaluated. Such a machine provides up to 10 free straight sections (7 m long) for the possible inclusion of readily upgradable insertion devices as well as up to 24 bending magnets that can act as optimised SL sources.

On the other hand, the LLS lattice allows for many future upgrades (e.g., energy, exotic insertion devices, use of superconducting magnets and further improvements in emittance). These upgrades, if and when needed, could be added with comparatively modest additional investment and without adverse effects on the operation of the facility.

Naturally, the LLS would also provide a base of technical expertise in the area of accelerator technology and its exploitation that is currently lacking in Spain. This would make it easier to create a R&D and commercial opportunities for Spanish industries whose involvement in the construction will be necessary. In fact this effect has already occurred, albeit at a modest level, during the course of this design study. The test of a first dipole prototype, with a field gradient, is expected to start in about September 1998.

In addition, given the interdisciplinary nature of SL facilities and in line with the current studies in similar installations elsewhere, the LLS would provide a very fertile ground for the development of future generations of Spanish scientists, engineers and technologists.

4.6.2 Other activities

To our knowledge there are essentially two activities related to the design of the LHC. A group at CIEMAT in Madrid is collaborating in the study of the training of LHC sextupole correctors using superconducting coils. The second one is the collaboration of the IFIC, University of

Valencia, in the feasibility study of a high-beta insertion optics for the TOTEM experiment at the LHC.

Elsewhere, other groups are working in more general theoretical topics, like Fokker Planck equations and symplectic integrators, that could be applied to accelerator physics.

You can find more details about these small-scale activities dispersed in the proceedings of the EPAC 98.

4.7 Activities with SAD (Strategic Accelerator Design) in KEK

K. Hirata `Kohji.Hirata@kek.jp`
K. Oide `Oide@kekvax.kek.jp` KEK

SAD (Strategic Accelerator Design) is a computer program complex for accelerator design. It has been developed in KEK since 1986. More and more functions are being added. SAD has proven to be powerful and useful in designs, simulations, commissioning, and improvement of TRISTAN, KEKB, FFTB, ATF, JLC, NLC, JHF and others.

SAD has a home page:

`http://www-acc-theory.kek.jp/SAD/sad.html`

In KEK, from 7 to 9 July 1998, there held the first workshop on SAD. The purpose was threefold: 1) review the present feature of SAD which has been continuously growing and has undergone several metamorphoses so that the whole structure of SAD is now difficult to see. 2) think of the future of SAD and activities associated with SAD and 3) prepare a reference book which one can quote in papers.

4.7.1 History of SAD

First, let us briefly review the historical development of SAD.

1986: A project was started by K. Hirata, S. Kamada, K. Oide, N. Yamamoto, and K. Yokoya to develope a new code for accelerator design.

1987: The first version of the new code ran on HITAC, with Lie methods, 6D tracking, and emittance calculation[1] with beam matrix, under MAIN level.

1988: An optics matching code FFS was installed. Applied for NLC/FFTB final focus system[2] at SLACVM. The name "SAD" was established[3].

1989: FFS was modified to design a periodic optics. The initial version of KEKB ring was designed with SAD.

1990: FFS was extended to x-y coupled optics with solenoid. FFS/COR orbit correction system was developed.

1992: A spin calculation SODOM was first developed and linked with SAD.

1993: Ahsad workstations started with four HP735/755s to separate SAD from HITAC.

1994: Mathematica-style functions were introduced to FFS. TRISTAN started to use SAD for regular operation.

1995: Acsad server started with DEC8000 (7 CPUs). Taylor map, beam-beam was linked to SAD.

1996: EPICS was first linked to SAD for KEKB control. Parallel processing was extensively used in tracking and optics matching.

1997: Python and Tkinter were embedded in SAD/FFS. A few GUI libraries was built with them. Acsad was upgraded to 10 CPUs.

1998: SAD/KBFrame has been applied for commissioning of KEKB Linac.

4.7.2 The First SAD Workshop

The workshop was organized as follows.

Organizing committee S. Kurokawa (chairman), S. Matsumoto, H. Koiso, K. Hirata

Program committee S. Kamada, K. Oide, K. Hirata

Proceedings committee K. Oide, K. Hirata

Here is the list of talks:

1. Opening address (S. Kurokawa)

Physics in SAD (review of physics underlying in SAD)

2. Overview of SAD (K. Oide) — Coordinate systems, Tracking (symplectic integrators, radiation), Geometrical and Optics (finite amplitude and off energy) matching , etc.
3. Taylor Map analysis in SAD (K. Ohmi)
4. Orbit and Dispersion Corrections (M. Kikuchi)
5. Emittances in Electron Rings (K.Hirata) (Comments on the anomolous emittance[5] by K. Oide)
6. Spin in SAD (K. Yokoya) — SODOM

Applications of SAD

[General]

7. Beam-Beam Interactions with nonlinear lattice (Weak-strong model) (K.Ohmi)
8. Simulation of Electron Beam with Space Charge Force (K.Oide)
9. Emittance Growth Due to Intra-Beam Scattering (K.Oide)
10. Synchrotron Radiation (near fields) (S.Kamada)

11. Nonlinear Machine Study (S. Kamada)

[Design Study]

12. KEKB Collider (H.Koiso)

13. VSX: The Future Project of VUV and Soft X-Ray High Brilliant Light Source (H.Takaki)

14. Hadron Accelerators (S.Machida)

[Simulation]

15. Study of 3D Laser Cooling by SAD (T.Kihara)

16. Wake Fields and CBI (H.Fukuma)

17. Estimation of the Beam Loss in KEKB Transport Line (Y.Funakoshi)

[Machine Study]

18. SAD in ATF Operation and Study (K.Kubo)

19. Detection and Correction of Machine Errors by π-bump (S.Matsumoto)

20. Mini-beta/xy coupling compensation — Perfect matching (S.Kamada)

21. Commisioning of KEKB J-Linac (H.Koiso)

[Computers]

22. SAD/Tkinter; KB Frame (N.Akasaka)

23. User Remote Environment (K.Furukawa)

24. SAD comupter system (T.Mimashi)

25. SAD in Python (N.Yamamoto)

26. Object Oriented Programming in SAD Script (N.Akasaka)

27. SAD + $\mathrm{C}^{++} = \mathrm{SAD}^{++}$? (K.Ohmi)

[Discussion]

28. Future problems (Y.Kamiya, N.Kumagai, Y.Mori)

29. Closing Remarks (K.Hirata)

SAD has many new and useful features. These were implemented according to the various demands at various stages. Tracking through a solenoid with an angle, for example, was generated to design KEK B factory. Also, SAD consists of many levels to meet the requirements of different types of users. The whole structure is not simple, because the speed of the calculation has been thought to be the most important. Accordingly, adding new elements in the deepest level of the tracking is becoming more and more laborious. In addition, it is very difficult for remote users to enjoy really characteristic features of SAD. (Of course, one can login and run SAD through the internet. To make clever use of all the equipments in SAD, however, one should better consult the specialists.)

As a conclusion of the workshop, it was pointed out that the activities with SAD should be more organized as an intra- and inter-laboratory project.

References

[1] K.Ohmi, K.Hirata and K.Oide, *From the beam-envelope matrix to synchrotron-radiation integrals*,Phys.Rev.**E49**, 751 (1994).

[2] K.Oide,*Synchrotron-Radiation Limit on the Focusing of Electron Beams*, Phys.Rev. Lett.61, 1713 (1988).

[3] K.Hirata, *An introduction to SAD*, Second Advanced ICFA Beam Dynamics Workshop, CERN 88-04 (1988).

[4] K.Oide and H.Koiso, *Dynamic aperture of electron storage rings with noninterleaved sextupoles*, Phys.Rev.**E47**, 2010 (1993).

[5] K.Oide and H.Koiso, *Anomalous equilibrium emittance due to chromaticity in electron storage rings*, Phys.Rev. **E49**, 4474 (1994).

4.8 New Doctoral Theses in Beam Dynamics

4.8.1 Kyoko Makino

Author: Kyoko Makino (`makino@nscl.msu.edu`),
National Superconducting Cyclotron Laboratory Michigan State University address: NSCL at MSU, S. Shaw Lane, East Lansing, MI 48824-1321, USA

Institution: Department of Physics and Astronomy Michigan State University.

Title: Rigorous Analysis of Nonlinear Motion in Particle Accelerators.

Date: March 16, 1998.

Supervisor: Prof. Martin Berz (`berz@pilot.msu.edu`), Department of Physics and Astronomy National Superconducting Cyclotron Laboratory.

Abstract: The Differential Algebraic (DA) techniques have been widely used for various computational problems such as the determination of high order Taylor transfer maps of accelerators. A new approach, the Remainder-enhanced Differential Algebraic (RDA) method, extends the method to determine remainder bounds for functional dependencies, and more importantly, solutions of ordinary differential equations. The latter required to overcome the so-called wrapping effect, a common problem in other approaches for the verified solution of differential equations. Altogether, the methods now allow the rigorous computations of tight bounds of transfer maps. The basic theory and its applications as well as its implementation in the code COSY INFINITY are discussed.

Furthermore, the thesis discusses the derivation of a Lagrangian and Hamiltonian formulation for the motion in electromagnetic fields in three dimensional curvilinear coordinates including torsion and with arc-length as independent variable, as well as a wavelet-based method to include measured field data in the equations of motion.

4.8.2 Zhirong Huang

Author: Zhirong Huang (`zrh@aps.anl.gov`),
ANL

Institution: Stanford University.

Title: Radiative Cooling of Relativistic Electron Beams.

Date: May, 1998.

Supervisor: Prof. Ronald D. Ruth (`Ronald.Ruth@cern.ch`), SLAC.

Abstract: We attempt to make a complete analysis of the process of radiation damping and quantum excitation in various accelerator systems, such as bending magnets, focusing channels and laser fields. Because radiation is formed over a finite time and emitted in quanta of discrete energies, we invoke the quantum mechanical approach whenever the quasiclassical picture of radiation is insufficient. We show that radiation damping in a focusing system is fundamentally different from that in a bending system. Quantum excitation to the transverse dimensions is absent in a straight, continuous focusing channel, and is exponentially suppressed in a focusing-dominated ring. Thus, the transverse normalized emittances in such systems can in principle be damped to the Compton wavelength of the electron, limited only by the Heisenberg uncertainty principle. In addition, we investigate methods of rapid damping such as radiative laser cooling. We propose a laser-electron storage ring (LESR) where the electron beam in a compact storage ring repetitively interacts with an intense laser pulse stored in an optical resonator. The laser-electron interaction gives rise to rapid cooling of electron beams and can be used to overcome the space charge effects encountered in a medium energy circular machine. Applications to the designs of low emittance damping rings and compact x-ray sources are also explored.

Text: posted at `http://www.slac.stanford.edu/pubs/slacreports/slac-r-527.html`

4.8.3 Jiuqing Wang

Author: Jiuqing Wang (`Wangjq@bepc5.ihep.ac.cn`),
Institute of High Energy Physics (IHEP), Chinese Academy of Sciences, P. O. Box 918 (9) Beijing 100039, P. R. China

Institution: IHEP.

Title: Design of a lattice with negative momentum compaction factor for a tau-charm factory and preliminary research to the related microwave instability.

Date: June 23th, 1997.

Supervisor: Prof. Shouxian Fang (`Fangsx@bepc3.ihep.ac.cn`), IHEP

Abstract: The possibility and a method of designing a high luminosity collider with negative momentum compaction factor ($\alpha_p < 0$) lattice are studied. It is envisaged that in a collider with ($\alpha_p < 0$) the bunch lengthening will be weaker than that in the $\alpha_p > 0$ case for the same bunch current so that the high luminosity can be promised. As a practical example, a tau-charm factory (TCF) with $\alpha_p < 0$ lattice is proposed and designed. A preliminary research to the longitudinal microwave instability in a ring with $\alpha_p < 0$ is also included and the beam instabilities in the $\alpha_p < 0$ TCF are investigated. The bunch length was simulated with the longitudinal wake field. It was confirmed that bunch lengthening is weak in the case of $\alpha_p < 0$.

5.1 International Symposium on "New Visions in Laser-Beam Interactions"

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

International Symposium on "New Visions in Laser-Beam Interactions"
— Fundamental Problems and Applications of Laser-Compton Scattering —
October 11-15, 1999

The above symposium will be held in the International House of Tokyo Metropolitan University, Tokyo JAPAN which will be organized by Tokyo Metropolitan University (TMU) and High Energy Accelerator Research Organization (KEK).

Recently rapid development of super low-emittance electron beams and high power short-pulse laser beams is opening a new interdisciplinaly field of laser-beam interactions which is related to various traditional fields such as high energy physics, nuclear physics, laser science, plasma physics and so on. This symposium, shedding light on new aspects of laser-Compton scatterings, is intended to discuss the most recent results on the following topics.

* Generation of polarized gamma-rays and polarized positron beams
* Gamma-gamma Colliders
* Non-linear effects in laser-Compton scattering
* Femtosecond X-ray production
* Laser cooling of accelerator beams
* Topics in the high field science
* High quality electron beams
* High quality laser beams

The contact person (Scientific Secretary) is Dr. R Hamatsu:

hamatsu@comp.metro-u.ac.jp TMU

5.2 Workshop on Space Charge Dominated Beam Physics for Heavy Ion Fusion

Y.Batygin batygin@rikaxp.riken.go.jp RIKEN, Wako-shi, Japan

RIKEN, 10-12 December 1998

In RIKEN, the Radioactive Isotope Beam Factory Project has been approved by the Government as a new stage of fundamental research in heavy-ion physics. Among the variety of planning experiments the high temperature plasma target physics study for Heavy Ion Fusion application is of the main importance. Beam space charge effect remains the key problem for designers of high intensity accelerators. Purpose of the Workshop is to review the present understanding of space charge phenomena in high intensity accelerators for HIF and to discuss possible solution of unresolved problems. The following issues are expected to be discussed: high intensity particle sources: parameters and beam transport, mechanisms of emittance growth and halo formation; transverse and longitudinal beam equilibria; equipartitioning in linacs; space charge in recirculators and storage rings; beam bunching, cooling and stacking; simulation codes. Detailed information is available at

`http://rikaxp.riken.go.jp/ batygin/`

6: Announcements of the beam Dynamics Panel

6.1 Advanced ICFA Beam Dynamics Workshops

6.1.1 Nonlinear and Collective Phenomena in Beam Physics

M. Cornacchia cornacchia@ssrl.slac.stanford.edu SLAC

The 16th Advanced ICFA Beam Dynamics Workshop on "Nonlinear and Collective Phenomena in Beam Physics" will be held in Arcidosso, Italy, on September 1-5, 1998. The workshop will be used to discuss the theoretical and experimental tools needed to study the beam physics for present and future accelerators. The workshop will be organized with three initial general review presentations, after which the participants will divide in three working groups. The working groups and initial talks are:

Group 1: Single Particle Non-linear Dynamics: recent advances in nonlinear dynamics, including frequency analysis and mapping. Group Leader: R. Robin (SLAC), Speaker: E. Todesco (CERN)

Group 2: Creation and Manipulation of High Phase Density Beams: advances in production, acceleration, transport and monitoring of high brightness beams, including coherent and radiation effects. Group Leader: J. Rossbach (DESY), Speaker: B. Carlsten (LANL)

Group 3: Physics of, and Physics with, High Energy Density Beams: advances in longitudinal and transverse dynamics, emittance preservation and beam loading in plasma systems. Group Leader: I. Lindau (Un. of Lund), Speaker: A. Sessler (LBNL)

For information and registration please contact

Ms. Melinda Laraneta laraneta@physics.ucla.edu UCLA,
Department of Physics &
Astronomy,
Box 951547, LA, CA 90095-1547,
ph:(310) 206-2499
fax:(310) 206-1091

.

Also visit the UCLA page:

http://pbpl.physics.ucla.edu.

6.1.2 Future Light Sources

K. J. Kim kwangje@aps.anl.gov ANL

The 17th Advanced ICFA Beam Dynamics Workshop on "Concepts on Futuree Light Source"

Advanced Photon Source, Argonne National Laboratory

April 6-9, 1999

With the success of current-generation synchrotron radiation research, it is important to anticipate future development of radiation sources. There are several directions to pursue: higher brightness, full coherence, shorter time resolution, extension of spectrum, compactness, etc. The linac-based self-amplified spontaneous emission is being actively pursued by several laboratories because it promises to deliver x-ray beams about ten orders of magnitude brighter than the current-generation sources. The storage ring-based free-electron lasers are breaking the long-held 2400$\AA$ barrier. Recent developments in accelerator technology and high-power solid state lasers could play an important role in the future light source scheme, such as femtosecond x-ray generation. The goal of the workshop is to provide an opportunity for the experts in these fields and those in current synchrotron radiation research to evaluate the proposed schemes for future light sources and to explore new ideas through vigorous interdisciplinary discussions.

The worshop is intended to be a sequel to the similar workshop held in Grenoble on January 22-25, 1996. In view of the success of the Grenoble workshop and the significant progress made since then, we expect this workshop will have an important impact on the future course of radiation source development.

Topics to be discussed include:

- Scientific opportunities
- Self-amplified spontaneous emission
- Free-electron-laser oscillators
- Extension of storage ring capabilities
- Femtosecond x-rays
- Novel sources employing high-power lasers

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`

6.2 ICFA BEAM DYNAMICS MINI-WORKSHOP

ICFA BEAM DYNAMICS MINI-WORKSHOP
on
Injection and Extraction in High Intensity Proton Machines
24-26 February 1999
CLRC Rutherford Appleton Laboratory, Chilton, Didcot, Oxon, UK.

A workshop is being organised by RAL for February 1999 on aspects of injection and extraction, mainly in high intensity proton machines. The meeting will be held at Cosener's House in Abingdon and will be the sixth in a series of mini-workshops held under the auspices of ICFA. The topics covered will be of interest in relation to the new large-scale spallation neutron source s (ESS, SNS, JAERI-SNS), the proton driver of a muon collider and other high intensity proton machines (JHF, AGS upgrade, PSR upgrade, a New Proton Source at Fermilab, etc.). Issues to be discussed will include:

- charge exchange injection by means of stripping foils, as used in ISIS and proposed in designs for a number of new machines;

- the laser stripping ideas for charge exchange injection under study at JAERI, in Europe and elsewhere;
- chopping, longitudinal and transverse phase space painting;
- techniques of fast and slow extraction.

Suggestions for topics for inclusion in these areas and offers of contributions will be welcomed.

Organizers:
C.R. Prior and G.H. Rees
Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire OX11 0QX, United Ki ngdom
Tel: +1235-821900, Fax: +1235-445607
E-mail: C.R.Prior@RL.AC.UK, G.H.Rees@RL.AC.UK

6.3 ICFA Beam Dynamics Newsletter

Editors in chief

Kohji Hirata (hirata@kekvax.kek.jp)
John M. Jowett (John.Jowett@cern.ch)
S.Y. Lee (shylee@indiana.edu)

6.3.1 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.

6.3.2 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).

6.3.3 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.

6.3.3.1 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*.

6.3.4 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).

6.4 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.

6.5 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.