# Session MOPA: High Energy Hadron Accelerators and Colliders (2 of 2)
## Grand Ballroom (Session A) at 15:40
## Session Chairs: Satoshi Ozaki (BNL) and Ferdinand Willeke (DESY)

### MOPA007 VLHC -- The Farthest Energy Frontier (Invited)

*WILLIAM A. BARLETTA (LAWRENCE BERKELEY NATIONAL LABORATORY)*

The Very Large Hadron Collider (VLHC) represents the most credible approach to exploring the energy frontier at the 10 - 40 TeV scale in the constituent center of mass. This translates to a proton collider with beams of 20 - 100 TeV. The U.S. accelerator community has recently evaluated the potential of constructing a ~ 240 km storage ring complex utilizing the Fermilab site. The first stage collider in this tunnel would be a low field realization of VLHC at 20 TeV per beam. A second phase would use the low field rings as a full size injector into a collider using high field magnets to reach energies of 200 TeV per beam. This talk will summarize the findings of the evaluation and will also describe significant progress in the constituent technologies.

### MOPA008 Accelerator Physics Issues for Future Electron-Ion Colliders (Invited)

*STEVE PEGGS, ILAN BEN-ZVI, JORG KEWISCH, JAMES MURPHY (BROOKHAVEN NATIONAL LABORATORY)*

The desirability of colliding electrons with heavy ions has been raised by more than one group, with implementation suggested at BNL, MIT-Bates, or DESY. This paper addresses the accelerator physics issues common to any such implementation, using RHIC as a particular example of the parameters encountered. Two scenarios are considered: ring-ring and linac-ring collisions. In the second scenario, the considerable beam power is recuperated by an energy recovery linac. Straw man electron optics are presented, preserving longitudinal electron polarization at the interaction points. Electron and ion intensity limitations are investigated. Synchrotron radiation, beam-beam, electron cloud, and cryogenic heat limits are examined. The implications for ion ring systems are discussed, including electron cooling and abort dumps.

### MOPA009 Intra-Beam Scattering Scaling for Very Large Hadron Colliders

*JIE WEI (BROOKHAVEN NATIONAL LABORATORY)*

For Very Large Hadron Colliders (VLHC), flat hadron beams with the vertical emittance much smaller than the horizontal emittance are often proposed to maximize the design luminosity. Intra-beam scattering (IBS) often is a concern on the realization of such flat-beam conditions. Based on existing IBS formalism on beams of gaussian distribution, we analytically derive the IBS growth rate and determine the condition for preserving a flat beam. Further information is available ["Evolution of Hadron Beams under Intrabeam Scattering", J. Wei, Proc. 1993 Particle Accelerator Conference, Washington, D.C. (May 1993) p.3653].

**Work performed under the auspices of the US Department of Energy.*

### MOPA010 Skew-Quadrupole Focusing Lattices and Their Applications

*BRETT PARKER (BROOKHAVEN NATIONAL LABORATORY)*

Here we consider accelerator lattices with primary focusing coming directly from magnetic skew-quadrupole fields rather than normal upright quadrupole fields as are used in most particle accelerators built to date. Such skew-focusing lattices may have advantages for making compact arc focusing structures in a Neutrino Factory Muon Storage Ring and for a Very Large Hadron Collider (VLHC). Arc cell configurations using both superconducting separated-function and combined-function skew-focusing magnets are examined and examples using standard prescriptions for dispersion suppression are presented. With the substitution of skew-sextupoles for standard sextupoles, the usual chromaticity compensation schemes are found to work well. All lattices considered in this paper are fully decoupled and mainly differ from standard lattices in that their betatron eigenplanes are oriented at ±45° rather than the horizontal and vertical axes.

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### MOPA011 Electron Cooling for RHIC

*ILAN BEN-ZVI, LEIF AHRENS, MICHAEL BRENNAN, MICHAEL HARRISON, JOERG KEWISCH, WILLIAM MACKAY, STEPHEN PEGGS, THOMAS ROSER, TODD SATOGATA, DEJAN TRBOJEVIC, VITALY YAKIMENKO (BROOKHAVEN NATIONAL LABORATORY), IVAN KOOP, VASILY PARKHOMCHUK, VLADIMIR REVA, YURI SHATUNOV, ALEXANDER SKRINSKY (BUDKER INSTITUTE OF NUCLEAR PHYSICS)*

We describe plans for electron-cooling of the Relativistic Heavy Ion Collider (RHIC). This project has a number of new features as electron coolers go: It will cool 100 GeV/nucleon ions with 50 MeV electrons; it will be the first attempt to cool a collider at storage-energy; and it will be the first cooler to use a bunched beam and a linear accelerator as the electron source. The linac will be superconducting with energy recovery. The electron source will be based on a photocathode gun. The project is carried out by the Collider Accelerator Department at BNL in collaboration with the Budker Institute of Nuclear Physics.

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### MOPA012 Recent Beam Study Results of POP FFAG Proton Synchrotron

*MASAHIRO YOSHIMOTO, TOSHIKAZU ADACHI, MASAMITSU AIBA, KIYOMI KOBA, SHINJI MACHIDA, YOSHIHARU MORI, RYOUSAKU MURAMATSU, CHIHIRO OHMORI, IZUMI SAKAI, YASUO SATO, MASAHIRO SUGAYA, AKIRA TAKAGI, RYOUICHI UENO, TAKEICHIRO YOKOI, MASATO YOSHII, YOSHIMASA YUASA (HIGH ENERGY ACCELERATOR RESEARCH ORGANIZATION)*

In order to investigate a Fixed Field Alternating Gradient (FFAG) principle and pursue its application to a high intensity proton synchrotron, a small POP (Proof Of Principle) FFAG has been developed. After a successful first operation in June 2000, [reference EPAC or CERN C], we continue beam study in the following items. First, a proton beam was accelerated from 50keV to 500keV within 1 millisecond. That means that the very rapid acceleration in momentum range of more than three is confirmed. Secondly, multi-turn injection is demonstrated. With use of decay curve of pi-section bump, beams are stacked in the horizontal phase space. As a result, the beam intensity was increased about seven times. Thirdly, the acceptance was surveyed. The results indicate huge one as expected. So far, all the results are consistent with the design values.