A Summary Note of the Ring Cooler Workshop on March 20, 2003 at UCLA

Al Garren opened the meeting with his talk on the design of the muon cooling rings with Lithium lenses by using the SYNCH code. He designed Lithium lens with the beta at 1 cm (22 cm long) sandwiched by matching lithium lenses with the equilibrium beta at 4 cm. (each is 6 cm long). The nominal muon momenta was set at 250 MeV/c. He designed a complete muon cooling ring with matching cells and straight cells with quadrupole magnets, and 90 degree bending cells with dipoles with edge focusing. He also showed his recent design of a matching cell with a solenoid to reduce the maximum beta from around 10 m to 2 m.

Scott Berg discussed his study on the effect of the fringe field of dipoles and quadrupole magnets in cooling rings, which were designed by Al Garren. He observed significant change on the energy acceptance and the dynamic aperture of a cooling ring by adding a thin non-linear fringe field, using COSY. Scott explained why only the vertical is affected by the added thin fringe field, in both the energy acceptance and in the dynamic aperture, with a longitudinal field linear in y. The vertical force is proportional to $p_x B_s$, which is proportional to yp_x, which is $D'_x dy$, which is affected by the chromaticity.

Bob Palmer made a status report of all kinds of Ring Coolers available in the NuMu collaboration, in particular the Quadrupole focused rings, the Bend (Weak) focused rings, the TETRA solenoid rings, and the RFOFO alternate solenoid focused rings. The merit factors of those rings are typically 16, 99, 16-103, and 47 respectively with different parameter settings. The simulation of the RFOFO is most realistic with the simulation of coils, RF windows, and absorber windows, and injection schemes. He commented that with the transverse acceptance of 30 pi*mm, the cooling channel gives only a factor 1.5 increase in the mu/p ratio, hence no cooling is needed for the Neutrino factory. The cooling channel is needed only for the muon colliders.

David Cline welcomed participants of the workshop and talked about the status of the SUSY search. He had just returned from the SUGRA 2003 conference at Boston. The BNL g-2 experiment reports 3 σ deviation in the e^+ or e^- channel. Much of the SUSY particles are beyond the reach of the NLC, and the A and H are observed with difficulty in the LHC. The muon collider can be a SUSY Higgs Factory. Dave claimed that two detectors---the off-axis NUMI neutrino beam to a Liquid Argon detector in Canada (1000 km) as well as in the Sudan (700 km)---might give enough data on the neutrino oscillation, and we may not need the Neutrino factory.

Yasuo Fukui reported on his study on the muon beam dynamics through straight channels of (1) the central Lithium lenses with β at 1 cm, (2) a set of Lithium lenses with the β at 1 cm sandwiched by matching Lithium lenses with equilibrium β at 4 cm., (3) a set of Lithium lenses sandwiched by matching quadrupole magnet cells, and (4) a set of Lithium lenses sandwiched by matching solenoid magnet cells. Momentum acceptance of the channel is a key issue in the muon transverse cooling with Lithium lenses. The ICOOL simulation code was used in the tracking simulation where the 200 MHz RF

cavities with negligible depth were used to recover the dE/dx energy loss through Lithium lenses, and the dipole/quadrupole magnets are modeled with hard edges. Implementing the set of Lithium lenses in a ring cooler with wedge absorbers is the next step.

Harold Kirk reported on the performance of the muon cooling ring with double bend dipole lattice with edge focusing with 45 degree bending with the muon momentum at 250 MeV/c. The dipole magnets in the ICOOL simulation have hard edges, and the wedge absorbers are made of liquid Hydrogen. He reported a merit factor of around 80 in this ring cooler model. He observed a resonance or a stop band in the simulation that limits the momentum acceptance of the cooling ring. He saw 2 stop bands in the cooling ring with bending cells with double combined function dipoles, which seems to be related to Scott's talk in the workshop.

The workshop attendees included Bob Palmer (BNL), Harold Kirk (BNL), Scott Berg (BNL), Gail Hanson (UCR), Amit Klier (UCR), David Cline(UCLA), Yasuo Fukui (UCLA), Al Garren (UCLA), and Ping He (UCLA). We thank UCLA colleagues Jim Kolonko, D. L. MacLaughlan-Dumes, and Sylvia Vartan for their assistance.

Yasuo Fukui (Ring Cooler Workshop organizer)