Minutes of the 11th PAF working group meeting

21 November 2005

******* FINAL VERSION *******

Participants:

M. Benedikt, A. Cecucci, R. Garoby, R. Ostojic, G. Rees, F. Ruggiero, H. Schönauer, E. Shaposhnikova.

1) Approval of the last minutes:

The minutes of the last meeting were approved.

2a) RCS for Low-Energy Injectors (H. Schönauer)

- H. Schönauer gave a presentation on the potential of Rapid Cycling Synchrotrons (RCSs) as low energy injectors. He focused on alternative solutions to Linac4 as PSB injector and also presented a 2.2 GeV RCS as a possible PS Booster replacement.

- The basic requirements for the injector complex are set by the LHC and CNGS beam specifications (intensities, emittances, #bunches). In the present schemes, the brightness (ratio of bunch-intensity and normalised transverse emittance) of these beams is limited by incoherent space charge effects at injection (50 MeV) into the PS Booster: the Laslett tune shift is directly proportional to the beam brightness and decreases with increasing energy like $1/(\beta\gamma^2)$. Linac4 aims at doubling the beam brightness (intensity) in the PSB by injecting at 160 MeV instead of at 50 MeV as presently with Linac2.

- Options using Linac2:
When considering the option of an RCS (or any synchrotron) to accelerate from 50 to 160 MeV it is important to note that the Laslett tune shift (at a given energy) does not depend on the machine circumference when assuming machines with identical average transverse beta-functions (in this case, an increase in circumference is exactly compensated by a decrease in line density of the bunch so that the overall space charge detuning is constant.). This means the new machine will experience similar space charge limitations as the present PSB. Therefore a performance increase can only be achieved by providing more bunches (factor 2 with 8 instead of 4 PSB bunches, i.e. by doubling the number of rings or increasing the pulse rate).

- An RCS option (50 Hz) is excluded since Linac2 can neither achieve the repetition frequency nor provide a long pulse covering 7 consecutive RCS cycles (8 injections).
- If the Linac2 pulse length can be increased to ~10 ms, an FFAG, operating at very high pulse rate could be considered. The FFAG (fixed field) is limited only by the accelerating voltage and a repetition time of ~1 ms might be feasible with Finemet cavities and a total RF voltage approaching 30 kV

- A factor 2 performance increase (not brightness in the PSB!) could be achieved (without an additional machine) by increasing the Linac2 + PSB repetition rate to ~2Hz.

- Options using a new pre-injector (Linac4 DTL, ~40 MeV):
With a new pre-injector (with higher repetition rate), both options RCS and FFAG can be considered. In this case the cost of an RCS (40 to 160 MeV) need to be compared to the cost of the part ofLinac4, covering this energy range.

- H. Schönauer also showed layout and parameters of a 2.2 GeV/50 Hz / 0.44 MW RCS Booster. This machine was studied within the CERN neutrino factory scenario and is based on the AUSTRON lattice. Such an RCS (then with the RAL 180 MeV/50 Hz injector) could replace the PS Booster and needs to be looked at in more detail in the context of PS replacement. Its cost was estimated in 2002 at 80 – 90 MCHF.

2b) Discussion

- G. Rees explained the Rutherford high-power neutrino scenario, based on the 180 MeV H^-linac, injecting into a 3 GeV/50 Hz RCS that is then followed by an FFAG to go up to 10 GeV. He pointed out that the RCS is the preferred option after the linac since the feasibility of an H- injection into an FFAG is not clear (quasi no tuneability of the optics, space restrictions). However, once the beam is bunched, the FFAG offers advantages:

- Nearly the complete cycle time is available for acceleration (no magnetic cycle) thus halving the voltage requirements.
- The collimation system design is more straightforward. Due to the orbit variation with momentum, the vertical collimation system can be tailored to account for adiabatic damping. Horizontal collimation happens only during the last orbits towards the end of acceleration.

It was noted that the only operating FFAG (Japan) provides a low-intensity 150 MeV proton beam and that the typical operating range of FFAGs covers at most a factor 3 in momentum.

3) Miscellaneous

- The meeting with R. Aymar has been fixed for the morning of 21st December.

- The next PAF meetings are scheduled for:

Monday 28 November at 16h00:
- FFAG options as low energy injector in the PSB – F. Meot (CEA/IN2P3).

Monday 5 December at 16h00:
- Needs of Beta-beams – M. Benedikt
- Organization for the report.

Monday 12 December at 16h00:

- Discussion & Preparation of report.

Monday 19 December at 16h00 (together with POFPA).

- Finalization of report and message to R. Aymar.

- Elena communicated the result of a complementary analysis by G. Rumolo of TMCI at injection in the SPS. A significant (?) improvement is also expected by raising the injection energy from 26 to > 40 GeV. The crucial role of bunch length in these investigations is underlined. The basic assumption is that it will be kept constant (4 ns total).

- Michael reported that, in the frame of the beta-beam study (work package in the EURISOL Design Study), GSI machine physicist have designed a lattice for a new PS which eases separation of particles with different charge/mass ratio. A presentation of this work will be asked in a future meeting, next year.

- For information, PAF members were informed of a recent document , summarizing improvement possibilities for CNGS and SPS fixed target physics programmes ("Possible means to increase the efficiency of the PS-SPS complex to serve the LHC, CNGS and the North fixed-target experiments", G. Arduini, F. Ruggiero, E. Shaposhnikova).

- Roland showed a presentation of F. Willeke on e-p collisions in the LHC. Francesco will analyse the major consequences for optics/IR design/separation etc. based on existing reports. POPFA has been asked to comment on the physics interest of this high cost option which PAF will only scrutinize if declared of high potential value for physics.

Minutes by M. Benedikt
26.11.2005