

Accelerator Design meeting

Monday 27/06/2022, 16:00 – 17:30

(<https://indico.cern.ch/event/1175142/>)

Chair: Daniel Schulte

Speakers: Daniel Schulte, Fabian Batsch

Participants (zoom): 26 *Adrian Cross, Akira Yamamoto, Alexej Grudiev, Bernd Stechauner, Cary Yoshikawa, Chris Rogers, Christian Carli, Daniel Schulte, Daniele Sertore, David Amorim, Elias Métral, Fabien Batsch, Francisco Saura, Heiko Damerau, J.S. Berg, John Hauptman, Jose Antonio Ferreira Somoza, Luca Bottura, Marchand, Nadia Pastrone, Mark Palmer, Pieter Sievers, Philip Burrows, Sergio, Ursula Van Rienen, Vladimir Shiltsev.*

MEETING DECISIONS

- None.

MEETING ACTIONS

- None.

1. NEWS (DANIEL SCHULTE)

- This Friday, on 01/07/22, there will be the MUON Collider Study Meeting #2 (<https://indico.cern.ch/event/1174411/>), where the status of the physics, detector (and MDI) and accelerator will be presented. Furthermore, the proposed organisation / governance will be discussed.
- The Annual meeting is currently foreseen to take place in person at CERN on 11-14/10/2022.

- IPAC22 took place one week ago, where Daniel had an invited talk (https://ipac2022.vrws.de/talks/tuizsp2_talk.pdf). IPAC22 was smaller than usual (~ 800 compared to 1200 before the pandemics). The participation from US and Asia was reduced. There were several posters on muon colliders.
- VladimirS informed us that the Muon Collider Forum report is available at: https://indico.fnal.gov/event/54953/sessions/20614/attachments/156153/204320/MC_Forum_Report-v06232022.pdf.

2. STATUS OF THE STUDIES FOR THE RF OF THE PULSED SYNCHROTRONS (FABIAN BATSCH)

- Fabian gave a presentation on 2 main subjects
 - o 1) Beam propagation under the influence of short-range wake field, fundamental beam loading, high synchrotron tune and the number of RF stations for the 3 RCS and in particular the RCS1 (17 turns to accelerate between 63 GeV to 314 GeV)
 - ⇒ Studies have been made with 1.3 GHz Tesla cavities and 30 MV/m per cavity
 - o 2) RF requirements and accelerator performance for non-linear B-field ramping functions
- Conclusions for Part 1)
 - o **BlonD code adapted for ring with multiple RF stations as tool for studies of longitudinal beam dynamics**
 - o **Simulations of the short-range wake field and the fundamental beam loading (single turn) show induced voltages of around 1-1.5 MV/m (i.e. also per cavity) each, and around 2.2 MV/m in total (total induced voltage per cavity = short-range wake field + fundamental beam loading)**
 - o **The induced voltages do not harm the beam transport with only small emittance growth**
 - o **Studies of multi-turn wakes to be followed up**
- Conclusions for Part 2)
 - o **The baseline values for the magnetic field strength of the hybrid RCSs is $\pm 1.8\text{T}$ normal-conducting and 10T super-conducting NbTi magnets**
 - o **The increase from 1.5T to 1.8T gives more space for RF components or for more compact rings**
 - o **Proposed non-linear ramping functions to reduce peak powers in magnets can be realised with an only 12% increase in RF power and a sweeping phase**
 - o **Future plans: confirmation of this with BLonD simulations**

- o **Updated design with Bnc, Bsc, gradient in cavities and ramp rate limitations as input parameters to also level out peaks in the ramp rates by conserving the muon decay rate**
- It is clear that we need a certain amount of RF stations to avoid / control the longitudinal mismatch to a defined longitudinal emittance (blow-up) budget.
- Following a question from VladimirS about the momentum compaction factor of the RCSs, it was answered that it is given in the Tables mentioned by Fabian (see <https://cernbox.cern.ch/index.php/s/I9VpITncUeCBtiz>), where we can see that the gamma transition = 20.41, which gives a momentum compaction factor of $\sim 2.4E-3$. VladimirS added that the bucket size dE/E (how much of mismatch one can afford) scales as $\text{Sqrt}(V_{RF}/\eta)$, so smaller η may reduce RF voltage-per-turn requirement. ScottB mentioned that we could change the η (which is based on a lattice which has been done in the past) but then we would have to go to longer quads, which means less dipoles and we would pay then with the reduced dipoles packing. AlexejG added that Fabian showed that the strong Q_s helps to keep under control the short-range wake and that therefore it is better to have this large η .
- ScottB mentioned that 1.8 T seems challenging from point of view of maintaining linearity in the response from magnets to current. Daniel said that even if this is not linear with current, but if it is reproducible, this is fine. ScottB added that it is just something to keep in mind and to pay attention to. TorR said that we need to understand what the shot-to-shot reproducibility is. Luca added that the energy goes more than linear so all this has to be computed carefully.
- VladimirS commented that how much linearity of the ramp is required depends on the available RF voltage and lattice parameters (η - momentum compaction). To save on magnets and pulsed PSs, one may want to have quite nonlinear ramp (magnetic field as in RLC charge-discharge) and some RF over-voltage. He is not sure that changing the phase instead of changing the voltage will be easier. VladimirS added that the linearity of the ramp is not necessary if we are close to $\eta = 0$. ScottB stressed that he is more worried about mismatch between energy and magnetic field, which can lead to issues for the transverse beam dynamics.
- ChrisR mentioned that the FFA is the solution with 0 momentum compaction, etc. Daniel said that we saw a 1st FFA design in the past so it would be important to see the progress there and VladimirS added that indeed the lower-energy RCS could be an FFA (that's where very fast acceleration and dB/dt would be required). ScottB agrees for the FFA but he added that the big issue with FFA is the fact that larger RF cavities are needed, which has a significant cost.
- LucaB commented that we will have to work hard now to optimise the magnets design etc. but it is a very good starting point to work with, for which Fabian showed that we have a solution.
- ChristianC asked about the bunch length entering the collider and DanielS stressed that the bunch length compression is indeed a very important item and that it will have to be carefully simulated in the future from the end of the cooling till the entrance in the collider.

- Elias mentioned (for LucaB who had to leave) that LucaB et al. had a discussion with Hans Schneider-Muntau (consultant at LNCMI) on a design for 60 T solenoid. This will be followed up in the MUON Collider Magnets WG meeting.

3. AOB (EVERYBODY)

- The next meeting will be announced in due time.

Reported by E. Métral and D. Schulte