2nd MuCol WP6 Task 6.1 Meeting – 12/12/2022 – *with updates (answers by Heiko Damerau)*

via Zoom

Participants: Simon Adrian (UROS), Dario Giove (INFN LASA), Claude Marchand (CEA), Rocco Paparella (INFN LASA), Daniele Sertore (INFN LASA), Ursula van Rienen (UROS), Sosoho-Abasi Udongwo (UROS)

Hindered: Enrico Cenni (CEA), Guillaume Devanz (CEA)

Ursula (Uni Rostock):

- Candidate for PhD position was selected for the Gentner grant
- He is to start working on the SRF cavity studies on the 1st of April, 2023
- Postdoc position for Sosoho-Abasi Udongwo will be financed for 12 months in 2024 through the EU funding
- Timeline: Kick-off of MuCol project shifted to March 2023 due to the delay in the start of the EU project
- **Task 6.1 meeting thought to be once a month. Currently agreed on 3 PM on last-but-one Mondays of each subject to adjustments, e.g. in March**
- **Next dates Jan. 23th and Feb. 20th**; an Outlook invitation with Zoom link will follow

Claude (Saclay):

- Is the RF length determined or still open?
- Then: What is the most favourable frequency? 1300 MHz?
- Handling of the longitudinal beam dynamics: Which part of the system should be regarded in task 6.1 - also the accelerators before the RCS?

Daniele (INFN - LASA):

- Fast tuner and how to implement
- HOMs should be investigated

Claude:

- Proposed an initial study of existing accelerators before the RCS

Rocco (INFN – LASA):

- Remarked that we're still in the region of conventional cavities

Claude:

- Remarked that there should also be a study on the fundamental power coupler (FPC). Guillaume from SACLAY has experience with this and could look into it
- On slide 16, RCS system choices to be studied – advantages and disadvantages of the frequency choices between 800 MHz and 1.5 GHz
- Inquiry on the optimum pulse length
- Enrico and Guillaume have good experience with beam-loading simulations
- Contacts Roger Ruber concerning reviewing existing SRF technology and achievable gradients; Update after the meeting: *see the Excel sheet with an actual summary table of existing SRF*

cavities by Roger & Co. We can use it as a starting point to optimize - if necessary – the frequency for « our » RCS cavities for the muon collider, which is at present foreseen at 1.3 GHz.

Task assignments

- SRF cavity study, especially frequency choice, by the University of Rostock (Sosoho-Abasi Udongwo)
- Beam loading by Saclay (Guillaume and Enrico)
- FPC study by Saclay (Guillaume)
- Frequency sweep and HOM by INFN

Heiko: "On the RF side at CERN, mainly Fabian is following the beam dynamics simulations for the RCS chain."

To do - Ursula

- Contact Heiko, and ask these questions based on the meeting:
    - Is the RF length determined or still open?

      "The total RF length is not yet fixed. As a work hypothesis we assume that a certain fraction of about 15-17% of the circumference (presently: 15.6% for RCS1/2 and 16.7% for RCS3) of the total circumference will be available for RF cavities. This is a fraction of the total straight section length, but space will be occupied by injection, extraction, collimation, etc."

    - Which part of the system should be regarded in task 6.1 - also the accelerators before the RCS?

      "So far we have not been involved in the accelerators upstream of the RCS, below an energy in the ~60 GeV range. Sorry, I may not have the latest documents of the approved EU study, but in a potentially not up-to-date version of the work package description it says 'Task 6.2 Baseline concept of the RF system for acceleration to the High Energy Complex (HEC) (UROS, INFN LASA Milano); This task, led by the University of Rostock, aims to provide a preliminary design concept for the SRF cavities for acceleration in the Rapid Cycling Synchrotrons (RCS) of the HEC of the muon collider.'?"

    - Questions came up about the fast tuners and how to implement them: what is possible for modern digital RF control? Would using a phase shift be an alternative?

      "We are admittedly not yet at that level of detail. However, if we would have to design this now, this should most likely be a combination of a conventional resonance frequency regulation (slow) performed via phase (cavity drive versus return), together with an adaptive feed-forward programming of the frequency offset for piezo tuners. This is part of the LLRF system, but to my knowledge nobody looked into a design. Where would this actually be covered in the study?"

    - Where do the bunches cross? Is there a section where the beam loading is compensated?

"By default, for an evenly distributed RF system (which we presently assume with many RF stations around the entire circumference), the time distance between almost zero and half a turn. Maybe one can find a clever scheme similar to the full-detuning in the LHC, but this needs to be studied."

- What would be the optimum pulse length?

  "The minimum pulse length (slide 17, https://indico.cern.ch/event/1175126/contributions/5024249/) are ~0.34 ms (RCS1), ~1.1 ms (RC2), ~2.4 ms (RCS3) and 6.4 ms (RCS4). Additional time needs to be added to fill the cavity, switch on the loops, etc. In the ILC this time was apparently about 1-1.5 ms (0.7 ms beam pulse, total RF pulse length ~2 ms)."

- Would it be okay to assume 35 MV/m for the moment?

  "The gradient values we agreed on with Akira during the workshop were 30 MV/m (conservative) and 45 MV/m (optimistic, aggressive)."

Heiko and Alexej noted that, in general, despite focusing on the 1.3 GHz technology for muon acceleration so far, we should note that even the frequency of the RF systems in the RCS chain is still subject to discussion. Especially wake-field considerations may force us to go to a lower RF frequency. Fabian is presently looking into this issue.

Shortly, the highest priority lies in the wakefield and HOM power calculations for the 1.3 GHZ cavity as their results will decide on the frequency choice.

- Send out invitations for Jan. 23 and Feb 20 meetings - *Done*
- Send meeting notes (to email or Indico) - *Done*