Accelerator Design meeting
Monday 14/06/2021, 16:00 – 18:00
(https://indico.cern.ch/event/1048515/)

Chair: Daniel Schulte
Speakers: Daniel Schulte and Chris Rogers

AGENDA
Meeting Decisions 1
Meeting Actions 2
General Information and News (Daniel Schulte) 2
1 Test Facilities’ Goals (Chris Rogers) 3
2 AOB (Everybody) 5

MEETING DECISIONS

- 2nd Muon Community Meeting will take place during 3 days (July 12-14), in the afternoons only (from 14:00 to 18:00, Geneva time) after discussion with our American and Japanese colleagues, to try and maximize the good time for all regions:
o Indico site can be found here [https://indico.cern.ch/event/1043242/](https://indico.cern.ch/event/1043242/), and the registration is open.
o All the information should be already available on the overview page with in particular the proposed structure of the 3-day meeting
  ⇒ July 12: plenary introduction, parallel working groups finalise list of required R&D (which is different from the list of challenges which we identified during the 1st community meeting)
  ⇒ July 13: plenary: working groups present lists of required R&D and resource estimates
  ⇒ July 14: plenary: first prioritised list of R&D items, opportunity to express interest
o Reminder: Working groups should prepare beforehand and only finalise at the workshop (R&D lists should be available before the meeting for discussion and finalisation during the meeting)!

**MEETING ACTIONS**

1: Roberto Losito
Try and estimate the cost of the 2 proposed options by Chris, as this will be essential to guide further discussions and see what we can afford (and what we cannot).

2: Marco Calviani
Confirm, or not, some predictions about the effect of the bunch length on the thermal shock, which depend on other factors as well, and quantitatively establish the potential limits: do we need to go down to bunch lengths of ~ 1-2 ns or could ~ 100-200 ns be OK?

3: Everybody
Continue to progress in the different Working Groups and prepare the 2nd Muon Community Meeting of July 12-14.

**GENERAL INFORMATION AND NEWS (DANIEL SCHULTE)**

- Daniel mentioned that, as foreseen for beginning of June, a first short report was sent to the LDG. Next the muon beam panel will need to prepare and send the interim report to the LDG by end of July.
- The 2nd Muon Community Meeting will take place on 3 days ⇒ See Meeting decisions. It is quite an ambitious programme as we included in the 3rd day the stakeholder meeting which was initially foreseen to take place another day.
- Another thing that Daniel would like to do after the 2nd community meeting is to write a combined list of R&D, as we did after the 1st community meeting with the challenges.
- Daniel mentioned also that he is currently optimizing the number of working groups (11 now compared to 8 initially and then 9 for the 1st community meeting) and that some more conveners are being added to cover better the community. Once approved, the names of the new conveners will appear here: [https://muoncollider.web.cern.ch/organisation](https://muoncollider.web.cern.ch/organisation) and [https://indico.cern.ch/event/1043242/](https://indico.cern.ch/event/1043242/).
1 Test Facilities' Goals (Chris Rogers)

- Chris discussed the demonstrator for the cooling and design considerations.
- He started to remind last time’s discussion, mentioning that today will be devoted to a bit more detail on potential baseline and first thoughts on the challenges (i.e. optics and engineering work).
- He also reminded us that reacceleration was not done by MICE and that therefore it should be demonstrated this time. He proposed in fact these 3 items to be demonstrated
  - 6D cooling
  - Reacceleration
  - Cooling at low emittance (both longitudinal and transverse)

- There are 2 cooling channel options which should be considered here (there are several other options)
  - HFoFo: easier engineering but higher emittance => Most conservative option
  - Rectilinear B8: harder engineering but lower emittance => Most aggressive option

- Reminder: B7 is an earlier stage than B8 which might be attractive in case the engineering challenges of B8 are really too hard.

- Reminder: gas-filled RF cavities are used to prevent the RF breakdown.

- Thin Berylium window stops the RF fields such that we really have something like pill-box cavities.

- Challenges (Chris raised questions for all of them)
  - The top challenge is engineering integration
  - Then, the high gradient RF => Challenge to operate it in magnetic fields because of breakdown. Note the interesting new concept to pulse the RF power before spark has time to build (from Sergey Arsenyev).
  - Fancy optics => Chris explained how the magnetic field is important (by mixing different harmonics of Bz) for the cooling and the aperture, raising some questions:
    - How short can we make the cells?
    - How high field?
    - How tunable is the optics
  - High-field magnets
  - Absorber integration
  - Beam instrumentation
  - Alignment and correction for misalignment

- Conclusions
  - Tried to give a feel for the job list from physics point of view
  - Lots of things to think about
  - Many challenges ahead!

- Discussion
  - Following a question from Alexej about some parameters, Chris replied that the HFoFo comes right at the start of the cooling while B8 is close to the end (explaining the difference in aperture and frequency).
  - Tord asked about the interest of testing at different intensity levels? Vladimir (and Scott) reminded that to be in similar conditions as for a muon collider, we would need ~ 10^{12} muons / pulse, which is currently impossible to do at any facility.
Mark mentioned that within the MAP studies, testing the HFoFo was never considered as a convincing test. For him, the real question is: can we make the final stage work? => The rectilinear B8 is the only one we have and we need to test that. Following a question from Alexej, Chris answered that he would prefer (if possible) to start with the HFoFo and then move to the B8, even if it true that with the HFoFo we cannot study the 3rd critical aspect of the cooling at low emittance.

- B8: there are many cells but they are all the same.
- Scott asked whether it wouldn’t be better to not go to the engineering limit with B8 and step back a bit with the B7, which is the back-up option and it will depend on the money we have and the careful evaluation of the risks.

Following a question from Vladimir about the ultimate goals for the test, Chris reminded what he said before (6D cooling; Reacceleration; Cooling at low emittance – both longitudinal and transverse) and Daniel added that we want to see a significant emittance reduction and an engineering demonstration of a long-enough piece to be relevant (i.e. to address the integration issue), operating it safely, i.e. without too many breakdowns, etc.

- As concerns the instrumentation, Scott reminded that the longitudinal diagnostics are harder than transverse ones. Indeed, and Daniel stressed that the instrumentation will be critical to define which charges we can accelerate, etc.

Roberto reminded us that we need to present a plan in September, i.e. it becomes now urgent and we will have no time to perform detailed studies before. So, we need to make a guessestimate. Reminder: ~ 50-60 millions will be used for the infrastructure, so it means that only ~ 90-100 millions are available for the rest. So, the question is: what can we do with ~ 100 millions? For the next community meeting we need to fix the target and there is nothing wrong with having 2 baselines at the moment.

- Daniel mentioned that at this stage it would be good to have an idea of the cost of these 2 options => See Action 1.

Performing some tests without beam were also mentioned as well as performing some tests with protons only.

Following a question by Tord about the timeline, Daniel mentioned that the ~ 150 millions (which are for material only) correspond to ~ 25 millions / year over 6 years (3 to construct + 3 to operate) but it looks maybe a bit too ambitious. Furthermore, Roberto mentioned that the test facility could only start in 2032-2033 (within current CERN constraints), so this is another constraint which needs to be taken into account.

- Daniel reminded us to think “modular” such that it could be stretched in the future following partners’ interest and budget.

Following a comment from Tord about the importance of the bunch length on the thermal shock, Peter Sievers mentioned that below ~ 100-200 ns (with the relevant intensity) we are in a similar regime for the thermal shock as for ~ 1-2 ns. Above that, i.e. for instance above ~ 1 micros, this is another regime => This is a very important and interesting information as this relaxes quite a lot the constraint on the bunch length and this should be taken into account for the further analyses. Daniel added that ESS would be a very interesting option if/when the accumulator would be available to have bunch lengths of ~ 100-200 ns => See Action 2.
A target in liquid lead is still possible in EU but not liquid mercury. Peter mentioned that “a solid target will explode after the pulse” and that a liquid target is better with this respect ⇒ Where is the limit? (Marco commented after the meeting that it would not happen with graphite, for example). Furthermore, Peter stressed that one should speak in terms of Joules per pulse and not in terms of Watts.

2 AOB (EVERYBODY)

- See Action 3.
- The agenda of the next meeting will be announced in due time.

Reported by E. Métral and D. Schulte