



Joint HiLumi WP2/WP4 Meeting

Friday 6th December 2024, 09:00 – 10:00

Chair: Rogelio Tomas, Rama Calaga

Speakers: Rama Calaga

Participants: Yannis Angelis, Chiara Antuono, Hannes Bartosik, Xavier Buffat, Rama Calaga, Riccardo De Maria, Andrea Fornara, Lorenzo Giacometti, Ivan Karpov, Lotta Mether, Nicolas Mounet (minutes), Adrian Oeftiger, Felix Soubelet, Guido Sterbini, Rogelio Tomas, Georges Trad, Michail Zampetakis

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MEETING ACTIONS

Rogelio, Riccardo, Rama et al: set up a discussion at the TCC about the swap of the IPs (for crab cavities), after checking with **Cedric Hernalsteens** and **Daniel Wollmann** about their timeline for the corresponding CLIQ studies.

1. GENERAL INFORMATION (ROGELIO TOMAS & RAMA CALAGA)

Rogelio noted there were no major developments to report.

Rama then discussed the status of the RFD module. The module has been successfully warmed up, and testing results were promising:

- Cavity 1 achieved 2.1 MV in continuous wave mode (CW), with expectations of further improvements - optimistically it should be able to reach 3 MV (there are no obvious signs that something is happening at 2.1 MV). Parts of the higher-order modes (HOMs) couplers operated above the desired temperature of 2 K - it was not obvious for cryogenics to reach 2 K due to some calibration issues in level gauges. Optimizations are underway to address this.
- Cavity 2 (the one which had a small vacuum leak), reached 3.4 MV after repairs. It is now fully functional and ready for use.

The module is scheduled to be transported to the SPS tunnel on December 13th, 2024. While there is optimism to be able to improve cavity 1, the short YETS left limited time for preparation (there are only 4 weeks to install the module, and every day counts). The current voltage levels of 2.1 MV and 3.4 MV are a strong starting point.

Rama mentioned that the topic of this meeting was triggered by **Rogelio**, following the issues in the US/Canada and the concerns on the schedule. **Rogelio** wanted a clear statement about where we stand.

2. SCENARIOS OF AVAILABLE Ccs/CRYOMODULES IN RUN 4 (RAMA CALAGA)

The presentation is based on the information available since the end of October.

Rama first reminded us that there is one spare cryomodule (two cavities) foreseen for each IP, which adds some flexibility.

Regarding the double quarter-wave (DQW) cavities, all cryomodules will be at CERN on time. Four cavities were tested at CERN, for two of them up to 4.7 MV, and for two others up to 3.7 MV only. There is no fundamental difference between the two sets of cavities, hence no physical reason for this difference in voltage reach. Further testing is ongoing, and ultimately a decision will be taken to accept or not the 3.7 MV ones. The cryostating is to take place in the UK, and has already started. The first cryomodule (CM) is expected next October (it is CM2). CM1 was supposed to be at CERN but will actually come later. In the end CM2 and CM1 should arrive at the end of 2025. The rest is being welded. There is sufficient float before the insertion date (end of Q3 2028), also for the next two CMs. There are non-conformities (NCRs) on two DQWs; one could either re-use the SPS-DQW in case (provided the impedance is compliant), or build two new cavities at CERN. In conclusion, for the DQW we are in a comfortable position, and technical issues are expected to be solved.

Conversely, there were quite some discussions during the annual meeting about the schedule for the RF dipole (RFD) cavities. All production of cavities takes place in the US, including couplers - CERN is not involved. Then they should be shipped to TRIUMF. The program is very challenging for the US - up to now only two cavities have been produced. If everything was as planned initially, CM1 to 4 should be here by Q2 2028, with some margin to install them in ATLAS - this was the baseline. Now, everything is shifted because of accumulated delays at US-AUP and TRIUMF new dates because of internal constraints. CM1&2 have still around three months of margin before installation. CM3, instead, barely makes it, so most probably it might not work. CM4 is after the deadline (Q3 2028). With the LS3 shift, one gets two additional months, and CM4 is still outside the window - we would be able to put only three modules in. But the schedule is still fluid - also TRIUMF might reshuffle its own schedule.

The options to improve the RFD issue are:

- Use the SPS-RFD with minor improvements. CM4 will then be in. There is still a possible issue with the cavity 1 limitation in voltage.
- UK will finish in 2027, hence one could swap the DQW spare (DQW #5) assembly with a RFD one. TRIUMF could do DQW-CM5 much later. However it requires a full tooling exchange and not trivial
- CERN could do an additional CM RFD #6 in 2026 when the DQW CMs are finished.
- RFD #4 could be installed after LS3 - this is being studied by the HL project (**Paolo Fessia** and **Markus Zerlauth**). The installation could happen before the 2nd year, which implies some warm up.

In conclusion, the baseline is to install all modules in both IPs - there are several options to realize this. The situation is also still unclear on the TRIUMF side for the 2026 shutdown, and negotiations could take place. Some decisions could be made during the Chamonix workshop - **Rama** has a talk there, where he will show these options.

Discussion:

- **Riccardo** asked if 3.4 MV is the specification of the cavities. **Rama** answered that the engineering specification gives 4.1 MV (17% margin).
- **Rogelio** asked to clarify the schedule. **Rama** said that at the cost and schedule review (CSR), the length of LS3 was a bit longer (~4 months). **Rogelio** said that now the new schedule should be available. **Rama** indicated that **Paolo** showed the impact. The bottom line is that with the LS3 shift, all the blue part in the schedule shifts, but the dashed line does not move a lot (only by two months). Maybe this will be more precise in the future.
- **Nicolas** mentioned that **Serge Claudet** said during the CSR that crab cavities cannot be installed during YETS. **Rama** answered that there is indeed a warm up, which the cryo team does not like. The issue is to put it in the baseline, but it is still possible - it goes clearly beyond WP4, it has to be decided rather at the HL level.
- **Rogelio** summarised that two options end up being nominal, another one (using the SPS RFD) exhibits just a smaller voltage in one cavity (2.1 MV), and the last (worst) option is to install the last CM during the first YETS.
- **Georges** asked whether all of this is about just 3 months above the deadline. **Rama** answered positively - maybe slightly more, around 4 months. He added that the deadline is still to be taken with a grain of salt - many other pieces of equipment have to be installed. **Georges** argued that we are still very far from the beam commissioning (mid 2030s). **Rama** answered that the worry is about what happens if we do nothing. Most probably the TCMs assembly/test etc. will slide further. One should gain floats by putting things somehow forward.
- **Rogelio** asked whether there is a scenario to study the case with a full IP with only 3 CMs, hence with only one IP fully crabbed. **Rama** replied that WP2 could study it. Even if CMs 3&4 are not in, they are confident one can have 2 CMs in, plus the SPS-RFD, so indeed 3 CMs for sure. **Rogelio** said that in that scenario the maximum crabbing would be half the design value in one IP. **Rama** concluded that in that case the third module would be useless.

- **Georges** asked about the additional 3-4 weeks needed in case of installation in a YETS. **Rama** said the new module will take longer in terms of RF commissioning. **Georges** wondered if this takes 3-4 weeks out of the production of the year. **Rama** answered that maybe the crab cavity commissioning is in the shadow of the magnet training. **Georges** wondered if 3-4 weeks are not added to the YETS. **Rama** answered in the negative, and identified the source of the confusion in the last slide - he later removed the mention of 3-4 weeks of additional time from the slide. **Rama** also mentioned that it is clear for **Paolo** that this installation cannot be done in a standard YETS, it has to be done during an extended YETS.
- **Guido** asked whether the warm-up of IR magnets would be only up to 20K (in case of installation during a YETS). **Rama** answered in the negative, it will be up to room temperature. **Guido** also wondered if one needs to warm-up half the IR or all of it. **Rama** said it is better to warm up just one side, and he assumed the cryo has this possibility. Concerning the schedule, **Guido** asked whether once cavities are done in 2025, the error bar on the schedule will be reduced, or if jacketing, testing, etc. is still quite uncertain. **Rama** answered that indeed the error bars will be reduced. If the cavities are all dressed, one could cryostat them at CERN, or in the US, or in Canada. Technically it is not an issue, but there are political implications.
- **Riccardo** commented that no final decision can be taken now, but still, the crossing plane has to be decided. Since there is only a marginal advantage in putting the DQW in IP1, he wondered if there is any difference in the schedule if one swaps IP 1 and 5. **Rama** replied there is no difference for them, but **Paolo** said it may add one month - this should still be taken with a grain of salt, as it has to be optimised. The installation sequence is not visible in the schedule. Installation is done in batches of 6 weeks. If one swaps, the maximum one can gain is 12 weeks (actually, less than that). **Paolo** might actually object about what is shown here (the dashed line in slides 1 & 2). In the installation sequence the whole IP1 & 5 is done in 12 weeks. For **Paolo** a swap is a big change, and gaining one or two months is marginal. One needs rather a 6-month float. **Rogelio** proposed to fix a date for a TCC in Spring. **Riccardo** argued there will be no additional info in Spring. One should just ask for this discussion to happen. **Rogelio** agreed, and asked whether **Riccardo** would present both options. **Riccardo** answered in the positive, mentioning also aperture that he will address. He also mentioned roman pots. **Rogelio** reminded also the issue with CLIQ, where maybe some extra information will come from **Cedric Hernalsteens** (e.g. the minimum beta*). **Rama** also agreed to launch this discussion. **Rogelio** mentioned that one should ask **Cedric** and **Daniel Wollmann** about their timeline, then one should put in place a TCC discussion (**Action: Rogelio, Riccardo, Rama** et al).

3. AOB

None.

Reported by Nicolas Mounet