

Minutes of Module Review 2015

(Participants list attached)

Welcome & Introduction (Steffen Doebert)

Less formal review this time, no committee no written feedback report. Outline and review of the first review. Presentation of agenda: results of the first T0, installation in CLEX and outcome, new setup for LabModule developed, future plans. Goals of the review: present progress, current and future plans, harvest opinions and convince CLIC steering committee of the quality of this workprogramm.

Things not covered:

Stabilization: very few progress due to lack of resources, some work in ISR and PACMAN, needs to feed back into Module integration work.

Fabrication, assembly, transport strategy: CDR strategy needs revision, but this work has not yet really started, need to wait for the outcome of current campaigns for defining new strategy.

PACMAN: link is very clear and much appreciated. Outcome will go into the next generation module and we will try to work closer together.

A word on tolerances: need further understanding in order to renegotiate some tolerances with beam dynamics team.

New layout 0-0-1. New vacuum system, real magnets, new AS mockups.

Scope and resources 2014 – 2016 (2019?)

Nuria: question concerning number of vacuum pumps. Strategy is to review the vacuum specifications and the layout as well. Vacuum requirements are given by beam dynamics team.

Thermal & Mechanical Test Results of T0#1 (Eleni Daskalaki)

Review of the aims of the first measurement campaigns. Introduction to a theoretical thermal analysis of the Module and to the FEA simulator. Review of publication and key results presented in last Module review 2012 already:

Steady state: Discussion about the drivebeam displacements measurements trying to understand the cause of the not matching slopes between simulator and real measurements. Especially DBQ are particularly discussed about (they are not cooled and only heated, position measurement accuracy 10um).

Transients: comparison of various transient cases. Movement and temperature dynamics are similar; time constant can be calculated for the temperature. Discussion about the fitting function used (simple exponential function). Additional discussion about the 4 point measurement of the AS with respect to the one point real time measurement (one point is more precise in terms of measurement strategy, but 4 point delivers the relevant numbers -> potential improvement of 4 point method).

SAS breakdown: temperature drop and time evaluated of an AS coming back to nominal operation temperature with constant water flow (between 7-15 mins).

To be shown: heat dissipated to air for various cases to be evaluated against the budget in CDR (Philippe pointed out the 150 W/m to air are well exceeded in the current configuration).

Alignment and Survey results from CLEX and Lab module (Mateusz Sosin)

Review of CLIC pre-alignment requirements and strategy (short range), results of fiducialization, results of alignment of components on girder.

Question concerning the alignment achieved numbers of the AS on the girders in CLEX (revision of numbers for AS and PETS in CLEX -> individual AS straightness is good (several μm) but the brazing of the two AS to one SAS is done without much precision).

Continuation of results: pre-alignment in the tunnel (sensor development: wire sensors, tilt meter, RAS Chain, bad performance of the girder-cradle-connection, mechanical dependence between MB and DB in LAB and in CLEX

Lessons learned from Installation in Lab and CLEX (Steffen Doebert)

Review of general issues: AS, DBQ plus WFM as one unit, low focus and integration of cooling and cabling (ad hoc solutions), communication issues, wrong phased splitter, waveguide components need phase specifications, CLEX alignment, coupling between the MB and DB girder, longitudinal constraints not adjustable (need design). Experimental program for CLEX module: RF games, Alignment games (in radiation environment), BPM studies, Wakefield monitors, Temperature management, find shortfalls of current design.

Question concerning the longitudinal adjustment of the AS. Range of mm. Current strategy is that the AS is put exactly in the right place, but no hard reference! Need for having an adjustment for both, MB and DB.

Beam tests and performance of CLEX module (Wilfried Farabolini)

Review of the probe beam setup: alignment of RF components very good thanks to the survey team (beam goes through no need for correctors), Quadrupols also very well aligned (not module DBQ). Problems of the module: hybrid coupler wrong phase (mentioned by Steffen), problem of longitudinal position of the AS (+chuck mode flange (but is designed for being insensitive for misalignment and elongation)), phase specification for AS with respect to beam needs to be clarified, problem with RF behavior of 4th AS (2nd part of 2nd SAS), WFM (a) changes in operation frequencies b) different placement of pick-up cells (end of first AS versus beginning of second AS (current option)) c) pick up modes), phase tolerance specification to be developed, significant amount of manual labor in order to cope with the entire RF adjustment, significant amount of work to be done on the development of the WFM.

Design: Current Test-Modules vs. CDR Modules (Jukka Väinölä)

Review about CDR models vs. Test Module program vs. Baseline update and Project phase, highlighting every individual subsystem of CDR defined module.

Question on the choke mode flange in the waveguide network (Walter): more design work needs to be done for decoupling the movement and not fixing the distance of the bellows.

Installation plan for Lab-Modules (Alex Vamvakas)

Review of the current T0 module; AS 2m long structure not very straight with 2m long heater (no individual control) vs. new SAS mockups (vacuum, individual heating), DBQ mockups (not cooled, artificially heated with 2m heating element going through PETS as well) vs. real DBQ (real coils and cooling)

Question Walter: heating of DBQ is not realistic due to experimental setup (in T0#2 real magnets will be used). We have 8 real DBQ, so why not use them in the T0#1 as well?

Support system Epucret is not used so far in any module, will be in the T1; cooling system and control are extensive in order to be flexible and can simulate a lot of different operation conditions. Needs evaluation which sensors and valves will be relevant for a real accelerator.

Installation can be done in system groups (e.g. complete RF parts as unit onto the module) or as parts arrive. First hint towards a potential transport test and validation of installation strategy.

Experimental plan for Lab-Module array (Eleni Daskalaki)

Objectives of the upcoming measurement campaign: Active-pre-alignment, Observation, Action

Walter comment: revisit the strategy of on how to react to a breakdown (currently 2 min no power time after incident)

Active pre-alignment part: Fiducialization work of entire new Modules, Alignment of components on girders, alignment of girders, installation of sensors, testing of active controlling algorithm

Observations part: Articulation point, thermomechanical test without vacuum, Vacuum tests, Thermomechanical tests with vacuum, Failure modes, Vibration tests

Philippe: adding to Observations: "balance of heat to water and air"

Action part: Inverse alignment, regulate breakdown displacement, displacement prediction, CTF3/CLIC

Outcome of this measurement campaign: Evaluation whether the CLIC tolerances are met, finalize the measurement methods and the operation procedures to be used in a potential collider

Walter: longitudinal thermal expansion (potentially dangerous stick-slip) to be characterized.

Philippe: explore operation strategies with the simulator and adapt and improve the simulator to the new setup.

Helen: importance of precise simulations for predicting necessary and relevant mechanical measurements
→ decrease work load for survey team.

Proposal for a Mechanical Test Bed (Markus Aicheler)

Dedicated test bed for numerous complementary issues which could go for low material cost in parallel to the main measurement campaign.

Philippe and Nuria: Concerns about the quality of implementation and the relevance of the installation. Observations of critical issues should be implemented into the baseline experimental program. Concerns also about the timescale of the test bench (fear of being only operational in one year). No decision taken, further discussion below.

Helene: human resources for the survey team are critically low and cannot cover the additional effort in the current budget situation.

Proposal for Roadmap 2016-2019 (Carlo Rossi)

Next Generation module → production phase module

Credible implementation scheme for mass production and installation.

Various constraints and tolerances review possible. Individual topics requiring further improvements to be identified through their contribution to the beam emittance.

Single support girder for DB and MB are united to be looked more in detail.

Material choice for girder reviewed and options shown. Epucet could be a very interesting technology because of pricing and flexibility, potentially integrating a significant amount of subsystems.

Analysis of industrial processes: clarify benefits of “industrialization”; two different approaches to production analysis (“external” manufacturing vs. “internal” manufacturing). Take advantage of experience available in industry for production of small series of complex products (e.g. Ferrari & Fraunhofer).

Steinar: imperative to benefit from findings of current module program, advise resources necessary for verifying the production phase paper study. Redo cost exercise for current module specifically look into the girders.

Philippe: screen list of cost saving options developed during the cost review for the CDR

Comments and feedback

Steffen: referring to the first block of measurements: do we do better measurements are we hunting for a better understanding?

Nuria and others: repeatability is still a bit unclear and could be shown better (Helene assures that the repeatability is very good within the measurement accuracy). Module work should communicate and accommodate tolerances. Potential philosophy change: from very accurate components fixed together versus relaxed tolerances and adjustable supports. But, work needs to aim at mass production of modules, not only LabModules.

Steffen: measurements aim at increasing confidence in results in order to create a solid base for potential resolution of various issues.

Steinar & Daniel: what does the Simulator cover (entire module with girder)

Nuria: Simulations and measurements ok.

Philippe: why do we need 5um tolerances on the WFM. The "banana" (AS) spoils this tolerance anyway; Daniel (answer): interlinked effect combining various imperfections. Philippe (answer): with current tolerances we have extreme rejection rates. -> we need to evaluate coherent tolerances in order to address to industry. Walter (answer): tolerances are more complex as simple numbers, and need much more understanding in the frame of the implementation. Nuria (answer) explaining again the tolerances relating to the AS and how they are relevant. Again, a combination of various effects. Discussion very focused on the AS. Steffen (answer) exactly the mandate of the module working group to implement and integrate these tolerances discussions. Walter (answer) interesting to understand the different the free state of an AS and constraint conditions.

Herman: what is the role of the old T0? (showcase and black box for the alignment studies) Possibilities: upgrade to current T0#2 status, throw it out and put the mechanical test bed in the place, keep it in and use it as part of the train to avoid "border effects",

Steffen: CLEX very valuable experience and we will continue to exploit it.

Steffen: Future...

Philippe: What about the compact RF loads? Efforts ongoing for technology development. Mockups represent promising design, but no real test done so far. Change may have significant impact on module implementation.

Steffen: CDR review for the sake of what we have done and what is there still to do and which decisions need to be taken.

Philippe: experimental program good. Balance of heat to air and water and make better use of the simulator!

Steffen: Mechanical Test Bench opinions: Walter: only worth it if we agree on an incremental change of the module design. Do we do this or not? Hermann: make a price tag and then yes or no. Philippe: only worth it if the lessons we learn can go into the next generation module. Hermann: just do it. Makes no sense to ask for permission to the review committee.

Steinar: in the light of the budget changes it is important to keep some kind of module working initiative ongoing. Things to do quickly: revisit costing of current module and streamline the future initiatives; develop reliability strategy as an integral part of CLIC closely linked to the hardware of the CLIC module.

Steffen: resources should reflect engineering man power for design work and work with companies.

Helen: pointing out that human resources in the survey team are critically low and the available resources cannot cope with the experimental program foreseen in the LabModule nor the Mechanical Test Bed