Summary of the Collaboration Meeting at CERN, 26-27 February 2013

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1st presentation, R. Garoby: LINAC4 and the Upgrade of the LHC Injector Complex, short summary:

- presentation: https://edms.cern.ch/file/1272592/1/Presentation_01_Roland_-_Linac4_in_LIU_26Feb2013.pptx
- challenging modifications of the PS Booster for H- stripping, necessary tests needed during Linac4 reliability run in 2016.
- strong intention to connect Linac4 before 2018, in order to reduce number of new systems installed during long shutdown 2 around 2018
- it is essential that **Linac4 is fully ready by end of 2016** (having completed a one year reliability run)

2nd presentation M. Vretenar: Linac4 Status and Schedule, short summary:

- presentation: https://edms.cern.ch/file/1272592/1/Presentation_02_Maurizio_-_Linac4_PIMS_02_13.pptx
- RFQ being conditioned, 340 kW (nominal 500 kW) (26.02.2013); visited in the afternoon
- H- source has delivered 15 mA, next week Ion beam into RFQ
- DTL tank 1 segment 1 installed and aligned, measured at CERN; visited in the afternoon
  DTL tank 1 will be completed by segment 2 in autumn 2013
- CCDTL: 4 modules delivered to CERN, 2 installed and ready for high power tests, 1 already high power tested; visited in the afternoon
- modulator prototypes tested, series being delivered
- LEP klystrons being installed, 2x 2.8 MW klystrons tested and installed, remaining 6 to be delivered in 2013
- planning: Linac4 up to 50 MeV shall be ready beginning of November 2014 as an emergency backup for Linac2
- planning: Linac4 must be ready end of 2015 for beam tests and a reliability run in 2016 so that Linac4 can be connected to the PS Booster any time from beginning 2017 onwards

3rd presentation, F. Gerigk: Linac4 accelerating structures - status and installation plan, short summary:

- presentation: https://edms.cern.ch/file/1272592/1/Presentation_03_Frank_-_Linac4_installation_planning.pdf
- overview over Linac4 structures in terms of parameters, structure properties, status and timeline for

RFQ, DTL, CCDTL and PIMS
- assembling, welding and testing a PIMS cavity out of the 15 discs and rings at CERN takes at least 6 month from the moment of reception of all parts, cavities can be assembled in parallel
- cavity installation will take place during CCDTL installation phase and from April to June 2015
- the last PIMS cavity needs to be ready for installation (fully assembled and tested) end of March 2015
- **the last parts of the last cavity need to arrive at CERN end of September 2014**
- if the remaining parts of the 1st cavity (M) arrives at CERN in June 2013, it leaves 15 month to deliver the remaining 11 cavities (on average nearly 1.4 month for producing and delivering a cavity)

4th presentation, R. Wegner: Results of short module and qualification strategy, short summary:

- presentation: https://edms.cern.ch/file/1272592/1/Presentation_04_Rolf_-_Results_of_short_module_and_qualification_stra
- status of qualification in April 2012 and progress toward general qualification for series production
- analysis of Quality Assurances Reports to original specifications and acceptable tolerances (EDMS 1209460) and comparison to CERN metrology measurements, example https://edms.cern.ch/file/1272592/1/Presentation_04_Rolf_-_Disc_G_2-3_-_Analysis_and_Comparison_CERN
- vacuum tests at CERN
- brazing test from NCBJ
- summary of reports from parts analysed at CERN (end discs M_1 and M_14, discs M_6-7 and G_2-3 and rings M_13-14 and G_13-14), (EDMS 1272696 for cavity M, EDMS 1272700 for cavity G):
    - a remarkable progress has been made during the past year
    - discs and rings are close to the acceptable dimensions
    - the assembly diameter 524.720 mm with tolerance 0.025 mm seems to be well under control
    - remaining problems to reach the required coaxialities and perpendicularities. Marek explained that these difficulties are related to the milling technology and Kaiser tool used
    - more parts need to be analysed at CERN for the general qualification of the series production
- assembly of the short module went smoothly
- preliminary results of the RF check:
    - clamping was needed to increase the Q value from 1'000 to 20'000
    - Q-values measured are reasonable
    - the field profiles measured and simulated are very similar
    - the frequency shift of 700 kHz between simulation and measurement needs to be understood (therefore preliminary results)
- next activities:
    - qualification of vacuum check procedure (visit of experts to CERN and thereafter visit of experts to NCBJ)
    - vacuum check of remaining elements of cavity M at NCBJ (discs M_2-3, 4-5, 6-7, 8-9, 10-11, 12-13, rings M_1-2, 3-4, 5-6, 9-10, 11-12, waveguide ring M_7-8)
    - after satisfying inspection of all elements of cavity M at CERN, the general qualification for the series production can be given
- it has been agreed to give the green light for finishing discs and rings of the 2nd cavity **apart from the waveguide ring** in the meantime in order to advance the series production

RF simulation updates after presentation:

- new results: https://edms.cern.ch/file/1272592/1/Update_of_short_module_RF_check_-_Rolf.pptx
- two small errors in the parameterisation of the two-cell simulation model have been corrected
- for the first 2 modes, the resonant frequency and field profile of simulation and measurement are nearly identical now
- the Q-values measured are reasonable in comparison to the simulation with 90% for the upper cell and 80% for the lower cell (with ring G_13-14); the difference between the 2 cells can be explained by the slightly uneven flatness of the faces of ring G_13-14 (Q-values are very sensitive to surface contacts)
- in conclusion: **the RF check of the short module confirms the good quality of machined pieces as**

well as it confirms the RF design of 12 PIMS cavities

5th presentation, M. Marczenko: Status of PIMS production and planning, short summary:

- presentation: https://edms.cern.ch/file/1272592/1/Presentation_05_Marek_-_Status_of_PIMS_production.ppt
- machining procedures for discs explained in detail, remarks:
  - temperature influence needs to be well controlled (temperature changes during the day, temperature of copper piece and air is measured regularly, machine warm up time 1 hour)
  - position of tables and tools is check before every production step involving tool or position changes
- machining of rings is more complicated
  - wall thickness 10 mm => temperature influence stronger compared to massive discs
  - deformation of walls during movement of Kaiser tool => difficult to control dimensions, outside clamping for reinforcement under preparation
  - remark: during the very first visit to NCBJ and CPL in April 2011, milling of rings was discussed in detail. All concerns raised by Maurice Favrel (CERN workshop) turned out to be challenges at the edge of feasibility: "doubts of surface quality, deformations during milling, tight tolerances, concentricity if machined from 2 sides" (EDMS 1141661)
- quality control explained in metrology lab with DEA Global Advantage 09.15.08 and on machines with FARO Gage (also used for F1 metrology measurements)
- production at CPL (external company):
  - machining of end discs, central discs (unsymmetric) and waveguide rings
  - more machines available than in NCBJ, but quite busy machining pieces for other projects at the moment difficulties to meet deadlines set by NCBJ
  - CPL is visited once per week by Marek, during visits the installation and machining of parts is correct, same tools and clamping is used as in NCBJ
  - however machining is done quicker in compromising the quality => clear differences can be seen in Quality Assurance reports (disc G_2-3 made by NCBJ https://edms.cern.ch/file/1272592/1/Presentation_04_Rolf_-_Disc_G_2-3_-_Analysis_and_Compariso - compared to disc M_6-7 made by CPL https://edms.cern.ch/file/1272592/1/Disc_M_6-7_-_Analysis_and_Comparison_CERN.pdf and https://edms.cern.ch/file/1272592/1/Presentation_06_Rolf_-_Improvements_for_next_parts.pptx); NCBJ is concerned about the quality delivered by CPL, parts will be carefully analysed
- status of PIMS machining:
  - all 48 standard discs have been rough machined to an overlength of +1 mm; 13 have been semi-finished (base machining, outside diameter, cooling channels); 5 have been fully finished
  - all 24 central discs have been rough machined to an overlength of +1 mm; 4 have been semi-finished (base machining, outside diameter, cooling channels); 1 (M_6-7) has been fully finished
  - all 24 end discs have been rough machined to an overlength of +1 mm; the 2 end discs of module M have been fully finished. The 2 end discs of module N (debuncher) are also machined to final dimensions but severe problems have been seen, they will be completed/repaired at the end of the series production
  - 40 out of 48 standard rings have been rough machined to +1 mm, 28 are ready for welding, 8 have been welded
  - 20 out of 24 pick-up rings have been rough machined to +1 mm, 14 are ready for welding, 3 have been welded and 1 is fully finished
  - 2 out of 12 waveguide rings have been rough machined to +1 mm (module G and M)
  - all 42 support spacers SPLHAPMS0003 are welded
  - all 14 single supports SPLHAPMS0004 are welded
  - all 14 double supports SPLHAPMS0005 are welded

    - all 28 target supports SPLHAPMS0007 are finished
- welding in Jülich, review and results:
    - EB welding in Jülich qualified after 4 attempts in October 2011
    - 2 pick-up rings (G_1-2 and G_13-14) welded for deformation tests in November 2011, both weldings on ring G_13-14 showed defects (deep craters on the outer weldseam), ring G_13-14 was locally repaired
    - to overcome the problems seen on ring G_13-14, a cosmetic pass is added after each weld to smooth the outer weldseam; qualified in July 2012
    - 2 pick-up rings (M_1-2 and M_13-14) welded in summer 2012; M_1-2 had a defect on the tuner port and was repaired in November 2012.
- X-ray checks of EB welds are done by NCBJ, analysis and reports are made by the certified laboratory 'Przemysłowe Laboratorium Badawcze "TEST"'
- final machining of a standard disc takes about 40 hours (on DMU 70) which gives for the 48 pieces needed a total machining time of 1920 hours ~ 300 working days ~ 60 working weeks in 1 shift; a reduction to ~ 20 weeks could be possibly by introducing a 2nd shift new staff has already been employed and by operating a 2nd machine (lathe)
- machining of central discs takes longer as both sides are different
- advancement limit in NCBJ given by available machines discs and rings are partly machined on the same machine (TOS)
- a new machine, Chiron Mill FX800, is being purchased and is foreseen to become operational in autumn 2013; the cooling liquid is temperature stabilised so that precision machining will become much easier
- production time of 2nd cavity (L) presented but not representative for series production as there several cavities will be fabricated in parallel (e.g. EB port welding)

Discussion after presentation:

- estimation of cavity production: about 3 month for a cavity at the beginning (waiting for lathe to become operational, qualification process), about 1 to 1.5 month per cavity towards the end of the series production
- **goals discussed:**
    - **2013: qualification of cavity production and qualification of vacuum testing at NCBJ**
    - **2013: delivery of 3 cavities to CERN and completion of 4th cavity at NCBJ**
    - **2014: completion of series production (8 cavities) and delivery of all parts to CERN until end of September**
- **preparation and brazing of waveguide ring of cavity M shall be advanced quickly** in order to have time to find solutions if difficulties are met and to be able to complete cavity M
- **EB port welding** of rings should be advanced as far as possible to avoid delays in case of welding problems (as experienced for the short module)
- M. Marczenko confirms again that all threads specified as "repulsed" are truly repulsed

6th presentation, R. Wegner: Improvements for next parts, short summary:

- presentation: https://edms.cern.ch/file/1272592/1/Presentation_06_Rolf_-_Improvements_for_next_parts.pptx
- mostly positive points seen, amongst them:
    - transport boxes and styrofoam protection
    - protection of CF flanges of rings
    - delivery of slotted rotatable UHV flanges together with ports
- a few points to improve:
    - **chamfering of edges with R≤0.2** as specified on the drawings and in the technical specifications, particularly for **cooling channels and alignment surface** (outside) of rings
    - use of heat sealed plastic bags filled with nitrogen to enclose and protect cleaned PIMS elements

    - use of more bubble wrap for better protection
    - **handling of parts with great care particular in CPL** (so much effort is made in reaching the required tolerances !)
    - visual inspection report for each PIMS element as a separate document (PowerPoint, Word, PDF, etc.)
- warning: radial scratches on the faces of discs and rings between ø524.720 and ø538.720 can cause problems for vacuum tests

7th presentation, L. Remandet and R. Wegner: Technical discussion, Metrology, short summary:

- presentation: https://edms.cern.ch/file/1272592/1/Presentation_07_Rolf_-_Technical_discussion_-_Metrology.pptx
- Quality Assurance Reports exactly as desired
- desired change: measurement of profile II (circularity) of rings at ø524.720, not at outside ø538.720 as initially foreseen, as the ø524.720 is critical for assembly
- if target holes 8H7 for target spheres are found out of tolerance (target holder lose), CERN shall be informed; holes can be opened to 10H7 without degradation in functionality
- surface roughness measurements were discussed; the same device type, filters and averaging principle are used at NCBJ and CERN; values measured can easily differ by 20% depending on the measurement positions
- measurement principle of the perpendicularity has been discussed; G. Brzezinski will prepare a detailed description of the procedure used at NCBJ which then will be discussed with the CERN metrology experts
- severe problems experienced at NCBJ to extract data from metrology software of DEA into Excel; DEA was contacted but could not help; metrology data are currently transferred by hand which leads to certain transfer errors

Spare material left:

- discs (standard and central): 4 pieces
- end discs: 2 pieces
- rings (standard and pick-up): 6 pieces
- waveguide rings: 2 pieces

Summary and Decisions taken:

- a considerable progress has been made since last year, machining procedures have been established, NCBJ is eager to advance the series production and to improve the quality further
- qualification for series production will be given after all elements of cavity M have been inspected at CERN
- a short module out of 3 discs and 2 rings was assembled without difficulty
- the RF measurements of the short module confirm the good machining quality and the RF design of 12 PIMS cavities
- intermediate green light has been given to finish parts of a 2nd cavity (L) **apart from the waveguide ring**
- **preparation and brazing of waveguide ring of cavity M shall be advanced quickly** in order to have time to find solutions if difficulties are met and to be able to complete cavity M
- **EB port welding** of rings should be advanced as far as possible to avoid delays in case of welding problems (as experienced for the short module)
- goals discussed:
    - 2013: qualification of cavity production and vacuum testing at NCBJ
    - 2013: delivery of 3 cavities to CERN and completion of 4th cavity at NCBJ
    - 2014: completion of series production (8 cavities) and delivery of all parts to CERN until end of September

EDMS-link: " target="_blank">https://edms.cern.ch/document/1272592/]]
Twiki-link: https://twiki.cern.ch/twiki/bin/view/SPL/PIMS26February13]]
Indico-link: " target="_blank">http://indico.cern.ch/conferenceDisplay.py?confId=236481]]

Action-list:

- CERN: prepare addendum to contract with new delivery date
- CERN: prepare payment of 16% of contract value linked to the successful tests of the short module
- CERN: send disc M_6-7 and ring G_13-14 to NCBJ
- CERN: discuss simplified Quality Assurance Report and/or sample rate for full metrological control

- NCBJ: advance the fabrication of the **waveguide ring of cavity M** with high priority
- NCBJ: advance the EB port welding of rings
- NCBJ: prepare report with details on the metrology measurement procedure applied, particularly for comparing perpendicularity measurements
- NCBJ: implement points for improvements discussed above
- NCBJ: ship finished auxiliary equipment to CERN
- NCBJ: finished support spacers SPLHAPMS0003 and ship them to CERN

-- RolfWegner - 08-Mar-2013

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