LHC Injectors Upgrade

LS1 Mid-Point Status Report of the PSB Low Level RF, Transverse Feedback & High Level RF. Autumn 2013

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CERN

Introduction

- The status of the Low Level RF
- The status of the LL RF Controls
- The status of the Transverse Feedback
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- Summary

Status of the Low Level RF

Development & Production of Hardware:

- Pre-series production of the Carrier, Rear Transition, VXS Switches, ADC, DAC & DDS boards tested and validated.
- Tests went well with no problems to report that will hold back series production.
- Series production underway, all hardware expected to be delivered late Autumn as planned.
- Hardware also being used for other projects including MedAustron, with Finemet cavity servo loop tests on test bench presently underway.
- Hardware may be used with beam at MedAustron before end of LS1, offering a good opportunity to gain operational experience.
- Integration of new HW advancing well now that PSB cabling campaign paused in BOR.
- As no radial pick-ups were re-cabled, having to rethink how to supply beam control with sigma and delta signals.

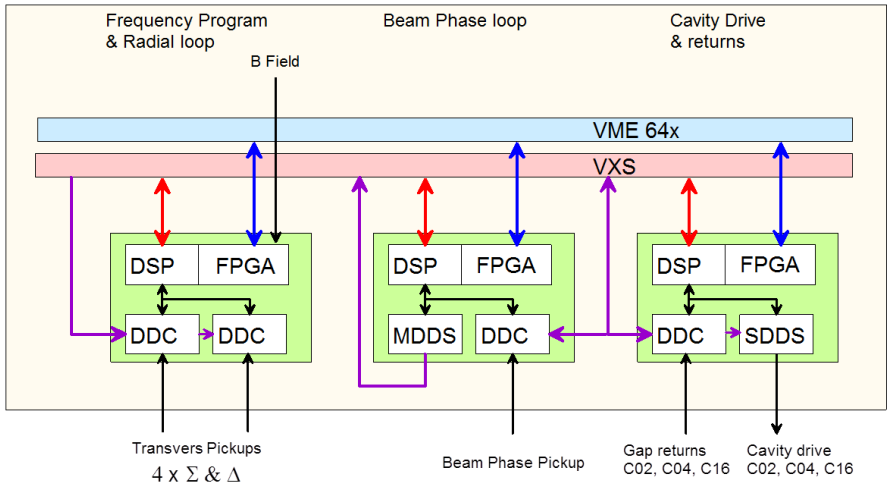




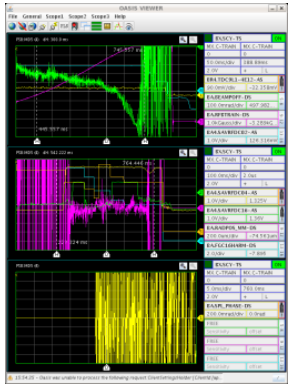

Status of the Low Level RF

Development of Software & Firmware:

- Good progress for the 3 Carrier Board system required for the PSB.
- Development Scripts & Tools previously written now paying dividends.
- FPGA & DSP code can be loaded remotely.
- Firmware and software progressing according to plans.



Status of the Low Level RF Controls



- LL hardware can supply OASIS & “sampler” digital data.
- Reference functions & soft timings integrated into LL hardware.
- Integrated functions compatible with standard function editor application.
- OASIS requirements defined and confirmed with CO.
- OASIS hardware ordered and installation planned for Autumn 2013.
- Digital & analogue OASIS signals will be available with same time base.
- OASIS for Finemet prototype also defined and ordered.
- OASIS integration yet to be done, a few weeks of work.
- Sampler implementation looks to be reasonably straight forward, with FESA class to be run in a crate outside of the RF LL crates(simple crate may need to be purchased)
- CO HW order: Crates+CPUs delivery Oct 2013, CTRVs order Oct 2013 & delivery Dec 2013.
- FESA classes for timings done
- Work underway for LL systems 3rd Carrier board (Cavity gap returns & drives)
- Synoptics to control LL system yet to be done .
- Initial measurements indicate fully compatible with delaying/advancing cycle (<100ms)
- RF-CS manpower yet to be confirmed for this work.

Status of the Transverse Feedback

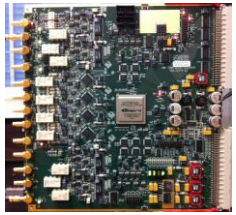
Existing TFB System Modifications:

- PLC control of power amplifier power supplies and cooling water installed and ready for testing.
- The PLC control & water cooling fully compatible with existing & future systems.
- Existing TFB HW has been moved to make space for future system.
- Electricity and plumbing complete, system tests started.
- All 100W power amplifiers need to be checked and repaired where necessary, as several found broken during MD at end of run. (start Nov 2013, ~4 weeks total)
- Beam testing with modified TFB estimated 4 days.

Status of the Transverse Feedback

New TFB System:

- New 800W power amplifier prototype under test and on track.
- Once tests completed (end Oct 2013) 20 units will be prepared for installation April 2014.
- New power amps fully compatible with existing system, hence after testing with beam, will replace old power amps (expected by August 2014).
- A study to decide upon which HW to base the new TFB system electronics resulted in the decision to update the existing PS 1 Turn Feedback board developed by D.Perrelet.
- The initial analogue bandwidth is 13MHz to match the existing system, but later beam tests will investigate increasing this to 20-30MHz.
- The plan remains to have a complete system installed in parallel on all rings for end May 2014.
- The above HW is outside of the ring and will be tested with beam in PPM by switching with existing system on R4.
- Testing with beam estimated at 2 months, planned to start mid-August 2014.
- After successful beam tests, all 4 rings will be brought into operation by end November 2014.
- Upgrade to 100MHz BW option to be studied late 2014 once new system in operation.



Status of the Transverse Feedback

New TFB Head Amplifier:

- New Head amplifier study underway, prototype being built and tested.
- This is advancing but delayed by ~ 2 months w.r.t. to planning.
- Delay will probably not allow prototype HW to be ready for installation before end LS1, but R4 will be equipped to welcome the new amplifier during a suitable technical stop.
- R4 will be used as the test ring for the new amplifier, and it'll be designed in such a way to use the same connections/cables as we use presently to the surface equipment.
- As this will have to be swapped with the existing head amplifier, tests will be carried out once the new TFB system is stable.
- This is not essential for the new system at this stage.

Status of the Transverse Feedback

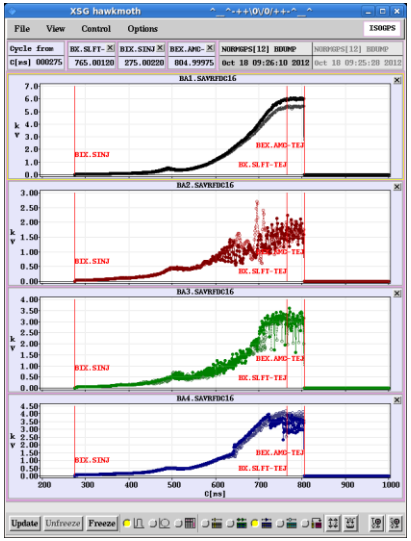
New TFB System Cables:

- The existing cables between the machine & surface were recently measured and the required extensions to connect to the new HW ordered.
- A. Blas is presently investigating if the cables from the TFB surface equipment to the machine need to be changed in LS1.5 or 2.
- The existing cables are presently believed to be fully compatible with the new HW.

Status of the High Level RF

Existing C02, C04 & C16 Systems:

- Several relay gaps for the C04 & C16 must be replaced after a measurement campaign showed several were broken.
- A relay gap must be installed on the Ring 4 C02 cavity ahead of the Finemet® cavity tests.
- The above is planned, along with the regular cavity maintenance, before the HW cold-check in May 2013.



Status of the High Level RF

Finemet® Prototype Cavity:

- Despite short delays in the delivery of the vacuum tube, the cavity is 80% ready and is expected to be finished ready for installation December 2013.
- 5 Power amplifiers already delivered and being tested, next 5 delivered by end October to be tested by end November 2013.
- Spare power amplifiers will follow and be ready soon after.

Dedicated Digital LL RF:

- This will be the Ring 0 LL beam control that will be switched with the R4 Digital Low Level.
- This is included in the New Digital Low Level planning and on track.

Status of the High Level RF

Interlocks:

- These are finished and being installed, so will be ready for PSB HW cold check out.

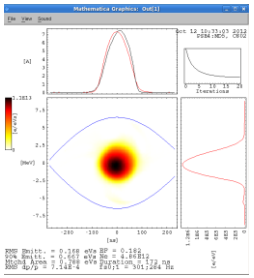
Power Convertors:

- Installation underway and on track to be finished by end November 2013.

Cabling:

- Power cables being replaced for power convertors, on track for delivery end November 2013.
- Initial cable order completed for connections to machine and surface equipment during PSB cabling campaign.
- A new request for further cables has been approved for the 2nd phase of the PSB cable campaign with delivery by February 2014.

Status of the High Level RF



Cooling:

- Slight delay in program but remains on track for delivery by end Jan 2014.

Beam Tests:

- Position of prototype cavity means it experiences ~200 times the radiation of the existing cavity positions, hence the power amplifiers require a means of compensating this.
- This has been introduced for the power amplifiers that will be installed for 2014, but has yet to be tested.
- As a precaution, it will be necessary to remove the power amplifiers after the HW cold check and before the beam is injected, to save the critical components.
- Before the beam tests start the amplifiers will need to be re-installed during a technical stop, which will take approx. 6 hours including cool down and testing.
- Due to workload of RF specialists, the earliest possible date for beam tests would be September 2014.

Summary

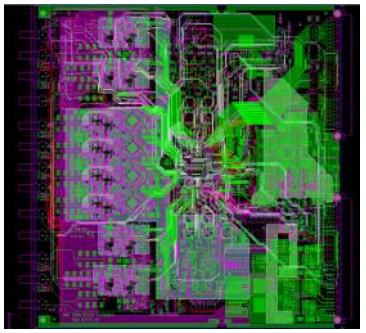
Low Level RF:

- HW & SW on track for delivery April 2014.
- Start up after LS1 with commissioning of new Digital Beam Control with beam.
- Big challenge to get system operational, but must be done while all experts are available at start of run.
- Existing Low Level system remains in parallel in case of major problems.

Low Level RF Controls:

- OASIS & “samplers” work underway, HW ordered or being installed, integration to be done early 2014.
- Synoptics to program/control low level and OASIS+”samplers” essential before commissioning can start.
- Heavy work load for RF-CS section means waiting for confirmation that manpower will be available.

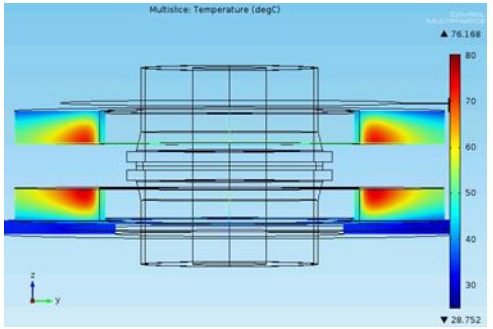
Summary



TFB:

- Existing system will be available after a few days of re-commissioning.
- The new TFB system installation is progressing as planned, the HW choices have been made or are towards the end of the prototyping stage and all 4 rings are expected to be equipped with new system by May 2014, ready for beam tests in August.
- New 800W power amplifiers expected to be operational with existing system by mid-August 2014.
- 2 months beam tests required with new system on R4 only, meaning HW validated for 13MHz BW with increased power by mid-October.
- All 4 rings to be brought into operation by end November 2014.
- New head amplifier expected to be installed on R4 once new system is stable, ~ December 2014.
- 100MHz system upgrade will be studied once new HW fully operational, but present planning for delivery stands at April 2016.

Summary



High Level RF:

- Existing system will be ready for cold check after maintenance.
- Finemet® Cells and their associated power amplifiers are expected to be ready for installation in December 2013.
- The dedicated Low Level RF is expected to be installed and ready for tests May 2014.
- Power convertors & interlocks ready for testing by end November 2013.
- Initial cabling complete, second request approved for January 2014.
- To protect the power amplifiers, they will be removed after cold check and re-installed before the beam tests.
- Beam tests will not start before September 2014.

Acknowledgments

With thanks to all the project team members for their essential input.