MSWG Meeting #7, 15-June-2018

Present: F. Antoniou, F. Asvesta, H. Bartosik, R. Calaga, L. Carver, K. Cornelis, D. Cotte, G.P. Di Giovanni, L. Esposito, M. Fraser, F. Galluccio, A. Guerrero, W. Hofle, L. Jensen, M. Kaitatzi, T. Levens, B. Mikulec, V. Myklebust, G. Papotti, W. Scandale, L. Stoel, F. Tecker, F. Velotti.

The minutes of the last meeting were approved. The proposal to re-cable the SPS octupoles in ITS2 for machine development tests will be presented at the next IEFC meeting.

Agenda:

Link to the Indico Event:

- Approval of minutes – Karel Cornelis
- Status of operational Beams – Machine supervisors
- Main presentations:
    - Results and analysis of first beam tests with the TPSWA – Linda Stoel
    - Crab cavity MD's: results with first beam – Lee Robert Carver

Status of operational Beams

PSB – Gian Piero Di Giovanni

All OP beams are OK with slightly lower availability this week at 91% due to the activation of an AUG button by accident in B361 causing a total of about 14h of downtime. The diagnosis and restart of the machine was troublesome with ensuing issues explained in detail. Timing issues on the TFB and extraction synchronisation caused particular problems. A patched version of LHCINDIV was prepared to allow for the start of an LHC MD on time. Since theAUG incident the high intensity beams on Ring 2 were tripping at a higher rate, affecting in particular TOF (produced on Ring 2). No causal effect to the AUG problem identified and was caused by a broken power amplifier; situation has improved (not clear why) but will survive until ITS1 to replace the converter.

GP. Di Giovanni explained to **H. Bartosik** that this problem would also affect ISOLDE but not to the same extent as this beam rely less on the TFB. Also, ISOLDE is not presently taking beam constantly, so it was decided to postpone the intervention to ITS1, when all RF experts would be back, and produce TOF on Ring 3.

PS – Ana Guerrero

Operational beams OK with over 90% availability. Yesterday the cause of beam disruption in recent days inducing occasional beam loss was attributed to LEMO connectors affecting the measurement of the RF cavity return sum. Two access were needed this week to repair cavities C51 and C76. Beams for LHC MD were prepared: LHC50 ns ready for SPS, LHC100 ns with 18b is ready and a late request for

LHCINDIV for 5 – 22E10 protons in 2 – 3 um emittance has been taken by SPS. A version of the nominal ion beam with 200 ns spacing (2b) with re-bucketing is being prepared.

SPS – Francesco Velotti

The North Area is now back in physics since Friday after replacement of the MBB power converter. ZS4 vacuum is under control and preparations are being made for improving the pumping in ITS1. ZS park activity now under SIS surveillance. The extraction losses and stability are back to before the incident.

LHC scrubbing took place over the weekend and appears to have reduced the emittance blow-up. Investigations were made to reproduce the flat-top instability with radial trims and chromaticity changes, but were unsuccessful. The LHC50 ns beam is still to be taken and has not be seen this year.

The LHC ion beam has been accelerated and ongoing preparations for the partially-stripped ion MD has been made with 81^{+} and 80^{+} making it to the SPS injection dump.

H. Bartosik stated that from the emittance vs. intensity plot for the OP LHC beam it is not clear if there is any impact on emittance before and after scrubbing: further analysis and sorting for time is needed for these plots.

Main presentations:

Results and analysis of first beam tests with the TPSWA – Linda Stoel

The SPS slow extraction scheme and instrumentation in LSS2 was outlined before the principle of a passive wire diffuser (TPSWA) was introduced: simple tantalum wire array (20 wires, 200 um diameter, second set of 10 offset by 60 um) scattering beam around the electrostatic septum (ZS). The beam dynamics simulations tools used to predict the extraction losses in the presence of the diffuser were explained: MADX, pycollimate and FLUKA, as well as a more simplistic python routine used to speed up systematic studies. MD tests with beam from 5 and 25 April, and 9 May were presented. The results reproduced very well the expected functional dependence of the specific (per proton) extraction loss (measured on BLMs) with a linear scan of the TPSWA across the extracted beam and ZS, with a 15% loss improvement summed over all BLM's. The TT20 TED was inserted: it will be interesting to see whether the increased population of the tails increasing losses in the transfer line of at the splitter, or if the tails can be transported to the targets. Good agreement with simulations was demonstrated, consistent with an effective ZS thickness of 600 um, compared to the expected value closer to 200 um (wire thickness and misalignment tolerance). The data had to be flipped in sign (direction of the TPSWA actuation) to match and investigations are ongoing to see if this is a bug in the code or caused by the actual ZS alignment in the machine. Further results of extraction losses vs. TPSWA linear scans with voluntary misalignments and different extraction optics (Constant Optics Scaled Extraction) were presented. Some interesting features on the curves might imply issues with the alignment of ZS1 and ZS2. In the final MD carried out, the intensity was increased to 1E13 ppp without any impact on the loss reduction attained.

Conclusions were made before next steps were outlined. Operation of the TPSWA is simple and reproducible with only one degree of freedom. Up to 30% loss improvement could be expected if the TPSWA thickness is optimised to the apparent 600 um effective thickness of the ZS. Thermomechanical

checks are ongoing to check the TPSWA wire integrity at higher operation along with FLUKA checks of the expected increase in induced radioactivity at the TPSWA upstream of QFA216. Future MD's were outlined along with a proposal to voluntarily misalign the TPSWA to increase its effective thickness. The upgrade of the ZS in LS2 will hopefully allow improved ZS alignment compared to today.

Discussion:

K. Cornelis pointed out the issues raised by RP for the presence of tantalum (half-life of about 100 days) in the wires and that this might have implication for putting the TPSWA in operation. **M. Fraser** explained that tantalum was used as the tungsten-rhenium wire originally planned for installation were not ductile enough to successfully string on their support without bowing. **M. Fraser** stated that FLUKA and thermomechanical studies are on-going to understand the safe intensity limits of the TPSWA but operation of this device was not foreseen. With crystal shadowing MD's being planned, activating the area is not desirable to swap out the TPSWA for a crystal: to be discussed.

K. Cornelis asked how much of the beam scattered back into the machine comes back after 3 turns. **L. Stoel** explained that almost all of the beam returns and is extracted: in simulation very little additional beam loss is observed in the ring and the extraction efficiency is boosted.

M. Fraser explained to **K. Cornelis** that the next steps are to potential voluntarily misalign the diffuser, trasnfport the beam to the targets with the TPSWA in operation and increase the intensity on the TPSWA to operational levels, validating its principle.

K. Cornelis asked if the impact of the 50 Hz ripple on effective thickness of the separatrix presented to the ZS has been studied. **M. Fraser** explained that it has and was presented at IPAC this year by **J. Prieto**: the amplitude of the 50 Hz ripple seen in the machine is not enough to impact the extraction efficiency.

SPS Crab Cavity MDs: First results with beam – Lee Carver

The SPS-BA6 installation was quickly reviewed before first MD without beam was detailed. The cavities were moved into their in-beam position and interlocks were tested and movements surveyed. The synchronisation of the crab cavities with the beam can only be made 1 s after injection at 26 GeV and again 7.4 s after injection (0.2 s after reaching flat-top) at 270 GeV: during the ramp the beam is not synchronised with the cavities. The first MD at 26 GeV was outlined with phase and voltage scans with single-bunch intensities of up to 8E10 ppb reached without issue, and without need for RF feedback. The Head-Tail monitor is only diagnostic device available to measure the crabbing effect and as a result it was discussed in some detail, along with the details of how the crabbing signal is extracted from the data using a baseline subtraction technique before the beam and the cavities are synchronised. The orbit response measured on the Head-Tail monitor is converted to voltage by invoking the MADX model parameters. An important Heat-Tail asymmetry in the crabbing voltage observed on the beam orbit perturbation is thought to come from systematic errors in the monitor, e.g. from cables etc. The second MD saw an intensity ramp to nominal single-bunch intensities at 1.1E11 ppb. The beam was also bumped vertically to find the electrical centre of the cavity: further studies of the HOM coupler response is needed. Closest tune measurements were made before ramping to 270 GeV. Phase scans for different synchronous phases were presented at 1 to 2 MV voltage. No systematic vertical emittance blow-up was observed on the 20 second cycle. The issues encountered and solution found during the MD's were outlined. In summary, crabbing was demonstrated for protons for the first time

with the use of the Head-Tail monitor. No MD's are planned in June with an attempt to reach 2K in the cavities. Higher intensity/trains are the next priority with MPP discussions ongoing for MD's in July.

Discussion:

W. Hofle pointed out that the beam loss observed on the ramp to 270 GeV was not an instability but resonant betatron excitation from the cavity as it was wrongly powered from the start of the cycle at 1 MV.

K. Cornelis asked for clarification on the bunch intensities. **L. Carver** stated that the beam loading for the moment is very small, nothing seen so far. **R. Calaga** stated that beam loading is zero to first-order as the fundamental mode does not couple when the beam is on the electrical axis of the cavity. Nevertheless, beam loading is expected when the beam is offset and the vertical orbit scans will give important information on this effect.

M. Fraser asked if the Head-Tail asymmetry is present as the synchronous phase is swept. **T. Levens** explained that it is as it is an artefact of the measurement and the sum signal is over-estimated at the end of the bunch.