Minutes of the Linac4 Diagnostics Working Group Meeting held on 19 January 2009

Present: U.Raich, J.Tan, G.Bellodi, L.Soby, G.Tranquille, C.Dutriat, F.Lenardon, J-J.Gras, A.Lokhovitskiy, R.Scrivens, C.Carli, T.Hermanns, K.Hanke, B.Mikulec.

Agenda:

1. Communications

2. Follow-up of open actions

3. Highlights from the CARE emittance measurement workshop

4. Feschenko monitors (R.Scrivens)

5. Summary of the APL proposal on laser profile monitors (K.Hanke)

6. Relative current measurement precision with Linac2 transformers (F.Lenardon)

7. AOB

1. Communications

PSB review: Last week the PSB review with Linac4 took place. K.Hanke mentioned that there has been an ad-hoc discussion on diagnostics after the presentations. The review committee underlined the importance of sufficient beam instrumentation. The following diagnostics were mentioned in particular: a large view screen to visualise both the injected and the circulating beam at once; measurement of the electrical signal from the stripping foil; at least 3 PUs in the ring that can measure turn-by-turn; BLMs; segmented H0/H- dump (foil degradation) with view screens in front; laser emittance measurement (not only after the Linac4 exit, but another one as close as possible to PSB injection). The slides of the committee recommendations can be found here (closeout.pdf).

Diagnostics WG: K.Hanke started compiling an EDMS document summarising the current conclusions of the diagnostics working group before handing over the organisation of the working group to BI (U.Raich and J-J.Gras). L.Soby underlined the importance of having clear written specifications available as soon as possible.

2. Follow-up of open actions

Simulations for emittance meter slit: U.Raich reported that O.Aberle started to work on the slit simulations.

BLMs: One of the upcoming meetings should be dedicated to a status report and discussion on BLMs. In this context it would be good to have G.Bellodi commenting on the loss distribution along the Linac4 line. Will it be possible to simulated the PS fringe field to finalise the loss distribution along this part of the Linac2 transfer line?

Dimensions of BI equipment for diagnostics bench: U.Raich said that the longitudinal dimensions of the BI equipment to be installed on the diagnostics movable bench are known and that they fit with the proposal made by G.Bellodi (see last minutes). He has a meeting this week with the drawing office to discuss how to proceed in order to obtain rapidly the required drawings. One worry is that the French deny to have the drawings of their magnets to be installed on the bench still available. It has to be seen if they can be found back or if enough information can be found in the CATIA drawings.
Link to the planning of the 3 MeV test stand: https://twiki.cern.ch/twiki/bin/view/SPL/TestStand

Wire scanners for 3 MeV test stand: C.Dutriat has found a motor to replace the contaminated motor for one of the 3 MeV test stand wire scanners. He would first like to confirm that the motor is really equivalent and will then proceed to its exchange.

3. Highlights from the CARE emittance measurement workshop

An emittance measurement workshop took place in Bad Kreuznach (Germany) in December 2008 within the CARE framework (http://adweb.desy.de/mdi/CARE/Bad_Kreuznach/ABI_workshop_2008.html). As reported shortly by R.Scrivens, presentations were given on the following basic transverse emittance measurement methods:

- 3-profile measurements
- pepper pots: quite a few presentations; nice devices as it is possible to obtain a full 3D image including halo in one shot; but also applicable only at low energies
- slit-and-grid method
- systematic studies on different scintillator materials and screens by the GSI group
- laser detachment: SNS

4. Feschenko monitors

R.Scrivens showed the presentation he gave at the CARE workshop (CAREWorkshopOnBSMs.pdf). The underlying principle is that the beam hits a wire (at -5 kV potential), which produces secondary electrons having the same bunch structure as the primary beam. The electrons pass through a set of slits and a RF deflecting plate (biased to focus electrons onto second slit); only those electrons close to the RF zero crossing are transmitted and measured by a detector. The measurement is therefore done at a defined beam/bunch phase; for the next pulse the RF deflecting phase is shifted.

At CERN 3 different flavours of this device are installed: a bunch shape monitor (Linac2 p at 10 and 30 MeV), a 3D bunch shape monitor (Linac2 p at 50 MeV) and a bunch length and velocity monitor (Linac3 Pb27+ at 4.2 MeV/u).

Bunch shape monitor: measurement of bunch shape, limited halo investigation (wire cannot be used in bunch centre to avoid wire damage) and RF characterisation of RF systems.

Bunch length and velocity monitor: measurement of bunch profile and position; measurement of beam energy and Time of Flight by moving the detector (very reproducible velocity measurement). With the help of a buncher cavity, the bunch centre can be determined (bunch centre as function of cavity phase and amplitude). In addition, the buncher cavity allows for a longitudinal emittance measurement via the bunch rotation technique (relies on RF measurements for the cavity effective voltage).

3D bunch shape monitor: In this configuration the second slit plus detector is replaced with an array detector. The wire can be stepped horizontally through the beam and the slit can be moved vertically for the vertical resolution. The third dimension is given by reading out the segmented detector as a function of time during the beam pulse. This means that the bunch form can be measured as a function of H and V as well as the 3D bunch volume density when averaged over many bunches. Projections in all 3 dimensions allow measurements of the bunch profile (and of the longitudinal emittance with a cavity), investigations of the halo or transverse profile measurements (and transverse emittance measurements with a quadrupole).

As a summary, although being powerful devices, non of them is still used in operation at CERN due to their obsolete or non-standard control systems. This is a lesson that should be learnt for future Feschenko monitors.

Longitudinal emittance measurement with Linac4: For the installation of the Feschenko monitor at the Linac4 exit it should be studied if the last PIMs cells could provide sufficient rotation in phase space for the emittance measurement. In this case adequate drift space would be required with the drawback of a deteriorated bunch

shape measurement.

Assigned to	Start date	Description	State	Result	
G.Bellodi	2009-01-19	Check the maximum obtainable longitudinal phase space rotation when varying the parameters of the last 2 PIMS cells.			edit

If this doesn't work, another option would be to install 3 Feschenko monitors at appropriate positions to reconstruct the longitudinal emittance. This option might be excluded due to budget restrictions (the cost of each Feschenko monitor being approximately 150 kEuros).

5. Summary of the APL proposal on laser profile monitors

In December a meeting between BNL, LBNL and CERN colleagues took place to define one of the proposals for a U.S. contribution to LHC within the APL framework (U.S. LHC Accelerator Project for LHC), to be submitted to the U.S. Department of Energy. The aim of this proposal (APL_L4_LPM_minutes_final.pdf) is to construct and install a Laser Profile Monitor system in Linac4. The technical objectives are to measure horizontal and vertical beam profiles and sizes and a measurement of the horizontal and vertical emittance. Transverse profiles will be obtained sweeping a laser across the H- beam, extracting the stripped electrons through a short series of weak magnetic toroids and then counting the electrons (silicon strip detector or Faraday cup) to get a measure of the density of the H- beam at that transverse location of the laser 'wire'. Emittance measurements will be made by combining profile measurements with measurements of the angular distribution of the neutral H0 beam that emerges from the 'slit' defined by the laser. These angular distributions will be observed downstream of the laser in a neutral beam detector (the horizontal dipoles at the start of the new transfer line are needed to separate the neutrals from the H-). It might be possible to measure in addition the energy spread of the Linac4 beam for machine tuning and the bunch length (only when the laser is synchronized with the RF timing system; at significantly increased cost).

The accuracy of the beam size measurement has been specified with 5%. The mirror system will allow the laser to scan across the beam within one linac pulse. For the emittance measurement a pulsed laser might be required; the neutral detector will probably use solid state strip detectors. The monitor will be delivered with a controls software based on LabView.

A second possible location would be just upstream of the LBE/LBS line to make use of the horizontal bending LTB.BHZ40.

6. Relative current measurement precision with Linac2 transformers

F.Lenardon has studied the precision of a relative current measurement that can be achieved between 2 current transformers. The question was whether a sensitivity <1% is realistic to determine the stripping foil efficiency at PSB injection with Linac4. For the measurement he chose the 2 transformers LTB.TRA50 and LTB.TRA60 (~20 m distance) applying the same calibration. As can be seen in his report (ValeurMoyenneCalibrationLTB.pdf), apart from an offset of 6 bits (due to low quality cables with different signal rise times) the measured sigma of the distribution was about 1% (not sufficient). Using a simple sliding average filter, this value could be reduced to a satisfying 0.5% level.

These results show that in principle it should be possible to achieve the desired sensitivity. In the case of Linac4 the transformers will be located closer together and better shielding will be used. Care has to be taken to install equal lengths of cables and to chose higher quality cables. The only unknown factor will be the noise of the environment (pulsed magnets etc.).

7. AOB

Status of the Feschenko monitor order: U.Raich gave a short progress report on the moveable bench (movableProgress1.pdf). Concerning the Feschenko monitor order he has written the required technical specification paper; only the test procedure still has to be added this week. This will allow sending an official request for an offer to INR and hoping for an answer within 2 weeks. Once the purchase order will be placed one has to count with a delay of about 18 months.

Transformers for LEBT line: F.Lenardon informed us that the drawings for the transformers in the LEBT line have been finished. He expects delivery of the transformers in June 2009.

-- BettinaMikulec - 19 Jan 2009

- closeout.pdf: Recommendations of PSB with Linac4 review committee.
- CAREWorkshopOnBSMs.pdf: The Feschenko bunch shape monitor - User experience at CERN
- APL_L4_LPM_minutes_final.pdf: Summary of Linac4-APL Meeting on Laser Profile Monitors.
- ValeurMoyenneCalibrationLTB.pdf: Delta calibration LTB.TRA50 - LTB.TRA60.
- movableProgress1.pdf: Movable bench progress; Feschenko order.

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