Linac4 Beam Coordination Committee - Meeting 4 held on 08 September 2009

Present: Philippe Baudrenghien; Giulia Bellodi; Jan Borburgh; Laurent Ducimetiere; Brennan Goddard; Klaus Hanke; Alessandra Lombardi; Bettina Mikulec; Mauro Paoluzzi; Suitbert Ramberger; Gianfranco Ravida; Richard Scrivens; Maurizio Vretenar; Wim Weterings; Thomas Zickler.

1. Minutes of the last meeting

The minutes of the last meeting have been approved without changes.

2. Geometry of the PSB injection region (B. Goddard)

The PSB injection region for the injection of Linac4 beams has been designed keeping the present layout and positions of the main magnets. The beam is injected horizontally using a new chicane bump (BS) and a painting bump (KSW) that will slowly decay to provide for transverse phase space painting of the PSB beam acceptance. The layout considerations and assumptions have been detailed in the sLHC Project Note 0004.

Outstanding issues concern the location of the BS magnets inside or outside vacuum depending on rise-time requirements, the design of the foil exchanger unit, the integration of the H^0/H^- dump, the magnet type and powering of the DHZ70/DVT70 line steerers, and the feasibility of a PSB aperture reduction using a collimator.

2.1. Discussion

B. Mikulec would like to know if the collimator would be fixed or movable. B. Goddard comments that it would likely be movable but this is still to be studied.

B. Mikulec remarks that the diagnostics have not been mentioned. A screen needs to be integrated and that it should not be put at the foil location. M. Vretenar remarks that the screen would be required to set up the steering. W. Weterings responds that this has already been discussed and must soon be decided.

M. Vretenar would like to know how many foils would be installed. B. Goddard comments that there will be 4 or 5 per ring. The exchanger is planned with 5 foils. In principle, one could be replaced with a screen but it is preferable that the functions remain independent in view of the fragility of the 1-2 µm thick carbon foils. M. Vretenar recalls that there were no problems with the Linac3 foils, of similar thickness. W. Weterings mentions that here the foils will be 20 x 50 mm and free hanging. He remarks that it is no problem to integrate the screen but a camera would need to be integrated, too. K. Hanke reports that also the review board did not like the idea of integrating the screen with the foils because of a higher probability of foil breakage due to more mechanical movements for the screen.

M. Vretenar notes that the geometry is frozen but that there are still some issues. W. Weterings remarks that BS magnets outside vacuum is OK to integrate but inside vacuum might lead to further issues. He asks if the areas 16L1 should be reserved for Linac4. K. Hanke has no plans for these areas.

3. Test results of the distributor pulse generator (G. Ravidà)

The new distributor pulse scheme foresees maximum pulse lengths of 20, 120, 220, 320 and 420 µs for the 5 individual distributor magnets DIS0-5. Contrary to the

current installation on Linac2, the Linac4 pulse generators will have a fixed pulse length but flexible timing. This distributor pulse scheme has been tested and shown to work.

Several cost optimizations have been undertaken: A GTO design is favoured instead of the current Thyratron design but this leads to longer rise-times of up to 1 μs. The lifetime of a Thyratron is limited to about 1 year and would incur costs of 20 kCHF per generator or 100 kCHF in total per year The Impedance of the Pulse Forming Network (PFN) might be reduced to 12.5 Ω instead of 25 Ω which would lead to an increase in ripple to up to 2 % compared to the current Linac2 system. B.Goddard said that this should not be a problem for the injection but needs to be properly checked. The pulse period is set to 900 ms but could later be improved to 600 ms at a cost of ~150 kCHF.

In case that there is no beam tail, the distributor DIS0 could be suppressed and ~10% on the distributor system could be saved.

3.1. Discussion

The basic parameters have been accepted in the meeting.

B. Goddard would not suppress the DIS0 as he prefers to send the beam tail to the dump instead of relying on a fully chopped beam. Ph. Baudrenghien thinks that the chopper should chop the beam anyway and considers it dangerous to install an additional distributor system just for safety. W. Weterings says that any beam tail left from the chopper would enter the injection then. B. Goddard thinks that if the chicane would fall at that moment, the beam tail would be spread and lost around the PSB ring. Ph. Baudrenghien remarks that the tail beam would not be the same as other beams. B. Mikulic asks if one could be sure that there is no tail beam.

Decision: The DIS0 distributor shall remain and kick any tail beam (up to 20 μs) should it be left from the chopper. This would be required for a back-up scenario to be adopted in case of chopper failure, where chopping would be produced by the pre-chopper (**M. Vretenar**).

Action: M. Vretenar requests that the transmission of partly chopped pulses in the Linac4 shall be checked (**A. Lombardi**).

M. Paoluzzi confirms that the chopper should be capable of chopping beams for more than 1 μs. Ph. Baudrenghien confirms that up to 1 μs chopped beam are acceptable for the low-level RF system.

K. Hanke mentions that ISOLDE would be interested in 600 ms beam repetition. M. Vretenar comments that Linac4 is designed for 900 ms. 600 ms are not in the scope and would have to be financed by a different project at a later moment. It would always be possible to upgrade in the future.

Ph. Baudrenghien thinks that the timing might be slightly different for each ring. B. Mikulec comments that the timing has to be adapted accordingly.

4. The Linac4 pre-chopper (R. Scrivens)

The initial reason for a design of a pre-chopper was to remove a potentially long rise-time of the source of more than 50 μs. A new request is to sharpen the beam head and tail to avoid losses on the head and tail dumps in case the pre-chopper would temporarily replace the chopper. A blank flange on the diagnostic unit is currently foreseen to insert a pre-chopper on the LEBT. So far the pre-chopper has been

conceptually designed and only a preliminary version of the pre-chopper driver has been built with a fall time of 2 µs, which does not fully correspond to the specification. The current design was intended for chopping the beam head. It would still leave about 50 µs of beam head due to the time constant of around 30 µs for the space charge compensation to build and stabilise the beam. Few percents of beam would still pass the pre-chopper due to space charge compensation. For chopping the beam tail, the pre-chopper driver would need to be rebuilt for around 15 kCHF and 0.3 man-months.

4.1. Discussion

M. Vretenar clarifies that 50 µs pulses would only be sent on the head dump in case of problems with the chopper (incident scenario).

B. Mikulec remarks that due to the fall time, 2 µs of beam tail would be left. M. Vretenar comments that the chopper would need to be switched again to get rid of it. W. Weterings remarks that this would fall partly into the rise time for the distributor towards the tail dump. M. Paoluzzi comments that the chopper could also chop 2 µs of beam.

M. Vretenar clarifies that the pre-chopper is required to protect the RFQ. It is not required to sharpen the tail as the chopper can do it under normal operation. However a failure scenario in the case of a chopper break-down would be required otherwise there would be no beam operation without the chopper. It should also be considered that so far there is no working fast chopper in the world, SNS uses a pre-chopper and also J-PARC has some worries.

B. Goddard thinks that it might be possible to continue running with just one booster ring. R. Scrivens remarks that beam intensities can be varied at the source instead of chopping.

Decision: The pre-chopper is required for the RFQ and for failure scenarios and shall be capable of chopping the beam tail. (**M. Vretenar**).

Action: It shall be checked if the pre-chopper could create the required distributor gap and what would be the neutralisation in the LEBT in that case. (**R. Scrivens**).

Action: Operation without chopper using the pre-chopper and other means of beam shaping (source modulation, head and tail dumps) shall be studied. (**M. Vretenar**).

5. AOB

No AOB.

Suitbert Ramberger

Next meeting: Tuesday 6 October, 16:00, room 354 1-001