Linac4 Beam Coordination Committee - Meeting 5 held on 6 October 2009

Present: Giulia Bellodi; Alessandro Bertarelli; Pierre Bourquin; Christian Carli; Jean-Marc Cravero; Yves Cuvet; Frank Gerigk; Klaus Hanke; Mark Jones; Alessandra Lombardi; Remo Maccaferri; Stephan Maury; Bettina Mikulec; David Nisbet; Uli Raich; Suitbert Ramberger; Carlo Rossi; Richard Scrivens; Lars Soby; Michael Sordet; Jocelyn Tan; Maurizio Vretenar; Thomas Zickler.

1. Minutes of the last meeting

The minutes of the last meeting have been approved with the following changes:

The line steerers are DHZ70/DVT70 not DHZ70/BVT70.

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

The last action item on beam scenarios without chopper will be assumed by M. Vretenar.

The statement on the PSB booster is incorrect and shall be removed.

2. Integration of the intertank areas (Y. Cuvet)

An integration solution for the tightest intertank area between tank1 and tank2 has been found; the end-walls of the DTL cavities including two permanent magnet quadrupole (PMQ) magnets, a pick-up, a steerer dipole magnet and an electro-magnetic quadrupole (EMQ) as well as a vacuum bellow have been integrated within a distance of 278 mm. The inner geometric aperture diameter of the pick-up is 34 mm in order to be able to integrate the electric connections of the pick-up in the available space of the steerer. In other intertank areas, the pick-up will have an aperture diameter of 40 mm. The pick-up will remain within the dimensions of the opening of the current EMQ design that is foreseen for all intertank areas. As the integration was rather intricate, all details of the pick-up had to be included to check for interferences and to get to a final solution.

The PIMS design currently foresees flanges that stick-out by 40 mm on either side of the PIMS cavity. Changing the design would provide more space in areas where a profile monitor should be integrated in addition to pick-up, steerer and EMQ.

A list of structure lengths and intertank spacings has been created by F. Gerigk 2 years ago. The list is not up-to-date but it could serve well as a centralised place for all the information that is required in the integration, in order to guarantee compatible sets of data.

2.1. Discussion

K. Hanke would like to know how the EMQ and the pick-up are aligned. Y. Cuvet explains that shims are used to correct the position of magnets on the support according to alignment data. This principle has also been retained for the LEBT and MEBT lines and it will be used on all intertank areas. The pick-up however is precisely centred mechanically on the end wall of the DTL tank which is again precisely centred on the DTL tank.

P. Bourquin details that the general principle in all the Linac4 design is that anything that will not need to be aligned in the tunnel shall be aligned by precise machining in

order to avoid accidental movements. This might take a bit more time in setting it up but avoids further alignment work in the tunnel as the alignment is done according to measurements only once at the installation in the workshop. The advantage is that alignment can be guaranteed not to change with time. R. Maccaferri adds that a flexible alignment would require targets which would need space that is hardly available.

B. Mikulec asks how an exchange of a magnet would be done then. P. Bourquin replies that the magnet has to be prepared together with its individual shim but this can be done from measurements in the workshop. In case of an EMQ exchange, the whole intertank region would have to be dismounted as the pick-up is inside. In order to dismount the pick-up, the steerer has to be removed first. A. Bertarelli remarks that for mounting or dismounting the pick-up in the EMQ, a welding or cutting operation is required respectively.

M. Vretenar asks what the margin in displacement allowed by the bellow is. Y. Cuvet responds that it has been designed for a displacement of up to ±2 mm, including "cardan"-like movements. It needs to be mounted with care and only after pre-alignment of the structures but the range should be sufficient during operation. R. Scrivens reminds us that Linac2 has seen movements of up to 2 mm between tanks.

M. Vretenar remarks that a change of the PIMS flanges would mean that Helicoflex gaskets would be required instead of Conflat flanges. For Helicoflex gaskets surface quality on copper is critical. Y. Cuvet responds that the Helicoflex gasket needs to be selected and dimensioned correctly but he does not see problems with this.

A. Lombardi remarks that as an alternative solution, the PIMS intertank distances could be extended by up to 100 mm though less is preferable for beam physics and other reasons.

J.-M. Cravero asks if no shielding between magnets is required. T. Zickler responds that this needs to be checked in simulations. J.-M. Cravero remarks that if two EMQs are in series, each close to a steerer with different settings, it would not be possible to correct the influence of each steerer on the EMQ separately. K. Hanke prefers to have each EMQ on a separate power converter. M. Vretenar comments that in Linac2 up to 3 EMQs are on one power converter, and that in Linac4 only few quadrupoles in the PIMS are supposed to be connected in pairs to the same power converter. R. Maccaferri reminds us that in the CCDTL already two out of three EMQs have been replaced by PMQs and therefore each of them will need a separate power supply. D. Nisbet states that he will need the exact quantity of power converters only at mid-2010, which will leave time to do some calculations on the consequences of having two quadrupoles on the same power supply.

Action: The interference between magnets needs to be simulated (**T. Zickler**).

A. Lombardi remarks that the inner aperture in the intertank areas of the CCDTL and PIMS must be 40 mm in diameter and not 34 mm as in the DTL. Y. Cuvet comments that the smaller pick-up dimensions for the DTL are due to smaller inner steerer dimensions in the DTL. T. Zickler explains that the steerer for the DTL is smaller because it has to provide only a small correction field. In other intertank areas where the required integrated field is much higher, the aperture is smaller and the magnet is longer in order to deliver the required field strength. T. Zickler says that the design could still be changed and that he will study whether it is possible to find a common design for the whole linac.

Action: It shall be checked if a common steerer design can be found (**T. Zickler**).

M. Jones mentions that detailed measurements of magnet and instrumentation alignment in the tunnel are difficult and might lack precision due to limited available space. Any such measurement should be done on the surface.

A. Lombardi remarks that it would be preferable to have magnetic axes aligned with the mechanic axis by construction as this would maximize the available aperture of magnets.

Action: A table on intertank spacings is to be kept up-to-date (**R. Maccaferri**).

3. Linac4 Pick-ups: Position, Intensity and Phase (L. Søby)

A table on pick-up versions and dimensions is presented that needs some correction after the previous discussion: the aperture dimension of pick-ups in the CCDTL and PIMS has to be increased to 40 mm. Further minor details would equally need to be corrected.

Equally the specification table needs to be updated as a 0.1 deg resolution which can be achieved in principle is not compatible with the 2 μs time resolution that was requested as well and that has to be checked

A mechanically critical area on the pick-ups is the electron-beam weld on the feed-throughs. In case that the feed-through breaks and a vacuum leak develops, quick access to this area is required.

It is planned to standardise electronics for all pick-ups. A time of flight measurement will also allow for calibration of cable errors.

A centralized table for intertank data is required also for the pick-ups.

3.1. Discussion

K. Hanke remarks that for the pick-ups so far 0.1 deg phase resolution have been assumed; this has been in the specs elaborated by the Beam Instrumentation Working Group, and this figure has also been presented at the diagnostics review as well as at the general Linac4 review. 0.5 deg resolution should be acceptable for a chopped beam though a higher resolution would be nice.

Action: The specification parameters have to be corrected (**L. Søby**).

U. Raich asks what the intensity of the commissioning beam is. A. Lombardi responds that it is foreseen to reduce the beam size transversally using an iris. Longitudinally the commissioning beam would remain nominal.

C. Carli comments that 2 μs beams will never exist in operation as it is planned to chop patterns for intensity modulation into the beam. L. Søby comments that a functional specification for beams is required then. M. Vretenar clarifies that high precision time of flight measurements should only be done on un-chopped beams that would be sent on the dump. A. Lombardi adds that position measurements however need to be reliable also for chopped beams.

M. Vretenar asks if a quick fix on the feed-through can be envisaged in case of a leak that would allow to get to the next shutdown at which moment the pick-up can be exchanged. L. Søby considers this to be possible in many cases. T. Zickler comments that at least for the first DTL intertank area, a full spare intertank assembly should be

provided as the magnet-pick-up combination cannot be assembled quickly as it requires a welding operation.

S. Ramberger asks if a sufficient number of spares will be available. L. Søby thinks that for pick-ups, spares will be available. Remo comments that the spare policy needs to be studied in detail also for the other intertank areas. M. Jones notes that the alignment needs to be guaranteed also for spares.

U. Raich asks for the estimated lifetime of the feed-throughs. L. Søby answers that this is still to be tested as aging effects are difficult to simulate. M. Vretenar does not expect much aging as there is about no radiation and the structures will not be baked out. In addition, the pick-up connections are protected against shocks from outside as their location is within the steerers.

4. EMQs in the intertank areas - update (T. Zickler)

Not much has been changed since the last presentation at the BCC-3 and the magnet design which immediately followed. The design fits all intertank areas with a maximum current of 100 A that is in line with the power converter. 2 EMQs can be put in series if required. Currently a 1 ms stabilization time on the flat-top is foreseen which could potentially be reduced to 0.5 ms.

4.1. Discussion

R. Maccaferri asks if the air-cooled magnet could be replaced by a water cooled magnet for the HP-SPL. T. Zickler answers that a standard magnet with water cooled conductor would never fit the available space. In this case other options have to be investigated as forced air cooling, external water cooling or a hybrid concept. M. Vretenar comments that also PMQs could be considered. One could also consider to remove a pick-up at that moment as the line will have been run for several years and experience will have been gained. K. Hanke comments that pick-ups are absolutely required under all circumstances as they also serve several other purposes.

5. Power supplies for the EMQs in the intertank areas (J.-M. Cravero)

Both options have been studied as alternatives; a power supply for single magnets and a power supply for two magnets in series. So far only the first option is being retained. A flat top duration of 2 ms is considered providing for 1 ms of stabilization and 1 ms beam time.

The maximum current and flat-top is limited by the linear stage based on the cooling requirements and lifetime expectancy. Changes in the load are critical in the power converter design.

5.1. Discussion

S. Maury would like to know if power converters for measurement and testing would be available at an earlier stage. J.-M. Cravero responds that single power converters can be supplied earlier.

S. Ramberger would like to know if an increase to 200 A with a considerable reduction in inductance would not be favourable. J.-M. Cravero responds that a lower current is preferable and considerably outweighs a higher inductance.

R. Scrivens remarks that several magnets will be exchanged in the transfer line. S. Maury responds that also some of the corresponding transfer line power converters will have to be exchanged.

6. Intertank areas: Discussion (R. Maccaferri)

The study for the DTL intertank areas is well advanced. For the CCDTL and the PIMS some intertank areas still need to be studied in more detail. Changes in the instrumentation need to be confirmed.

6.1. Discussion

K. Hanke is fine with the current distribution of instrumentation in the CCDTL intertank areas. M. Vretenar therefore concludes that the scheme is approved.

For the PIMS, K. Hanke points out that the position of pick-ups is not correct.

Action: The scheme in the PIMS intertank areas needs to be verified (**K. Hanke**).

M. Vretenar asks if the regular lattice must be maintained or if it would be acceptable to add space only in areas where this is required. A. Lombardi is not sure and would have to check this. The integration however should first show how much space is really required.

P. Bourquin requests that for further intertank area studies in general, it should first be decided what should be studied and only if this is clear the study should be started as otherwise frequent changes would interfere in finding a solution and the study would require considerably more time.

7. AOB

No AOB.

Suitbert Ramberger

Next meeting: Tuesday 20 October, 16:00, room 354 1-001