# Linac4 Beam Coordination Committee - Meeting 7 held on 17 November 2009

Present: Giulia Bellodi; Alfred Blas; Christian Carli; Klaus Hanke; Thomas Hermanns; Mark Jones; Alessandra Lombardi; Bettina Mikulec; Uli Raich; Suitbert Ramberger; Maurizio Vretenar; Wim Weterings.

## 1. Minutes of the last meeting

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

## 2. Follow-up of action items

No updates.

## 3. Transverse Emittance Measurement in the Linac4 Dump and LBE Lines (B. Mikulec)

The Linac4 dump line is located in a straight line from Linac4 at the end of the Linac4 building. At injection, a bending magnet deviates the beam towards the transfer line. The LBE (beam emittance measurement) line is located towards the end of the transfer line and before the PSB injection region. For measurements a bending magnet is used to direct the beam towards this line. The same line also has to serve for ion beam measurements.

Both lines use the measurement principle of the 3 monitor method in order to measure the emittance. Simulations on the transfer matrices (TRACE-3D) and beam sizes (Path) at the 3 monitor locations are used to analyze the emittance including space charge effects. Monitor positions and resolutions have been defined to minimize the measurement errors. The influence of emittance growth and different beam currents on the measurement has been estimated. For Linac4 commissioning with the dump line, the method appears not to be suitable; however the same monitor setup could be used with a forward method. Once normal operational conditions have been established, the 3 monitor technique is robust and well adapted to measure the Linac4 emittance. For the LBE line the method is robust and precise. After the meeting, a note on the measurement has been published: Transverse Emittance Measurement with the Three-Monitor-Method at the CERN Linac4

### 3.1. Discussion

U. Raich wonders if the use of two codes is not rather just a comparison of codes. K. Hanke responds that this would indeed be the case if space charge were not included. If the two codes do not agree, this is not just because the codes are different; it also allows a check of the reconstruction algorithm.

M. Vretenar would like to know if the method is a one shot measurement. B. Mikulec replies that three shots are required and the monitors have to be inserted and retracted subsequently. M. Vretenar asks about the time for such a measurement. U. Raich comments that the actuation of the monitors requires few seconds. M. Vretenar concludes that the measurement could be thus integrated in 3 supercycles and the measurement would require around 40 s. K. Hanke reminds us that this measurement does not need to be done all the time.

U. Raich asks if the 50 µm resolution of the second monitor is really required. B. Mikulec responds that 50 µm where chosen instead of 10 µm after discussions with

the BE-BI responsible even though in a note a 10 µm resolution was considered feasible (F. Roncarlo et al., Notes on Scintillating Screens for Linac4-PSB H-Transfer at 160 MeV, 2009. To be published). A. Lombardi asks why such a small beam is used in the measurement. B Mikulec responds that a beam waist is required at the central monitor to achieve the 'ideal' phase advance of 60 degrees between the monitors. One could vary the quads, but the errors would have to be recalculated.

M. Vretenar would like to know how the costs of alumina screens with cameras compare to SEM grids. U. Raich responds that alumina screens are cheaper than SEM grids but have a limited lifetime due to irradiation.

M. Vretenar asks if software for the monitors is available. U Raich explains that the front-end software is available, but the higher level software for the 3 monitor system has to be written.

U. Raich wonders what the advantage of using monitor 1 as reference for the emittance measurements is. K. Hanke comments that any reference point could be used if appropriate transfer matrices are known. T. Hermanns adds that the measurement precision depends on the intrinsic physical model used by the simulation. A. Lombardi remarks that the problem in the simulations is the precision of the input parameters. B. Mikulec reminds that due to a big uncertainty on the input parameters the method cannot be used for Linac4 commissioning.

M. Vretenar would like to know why the horizontal measurement in the dump line is more critical. B. Mikulec responds that the horizontal emittance evolution between the 3 monitors is not as flat as the vertical; in addition phase space distributions could be less favorable.

U. Raich remarks that there are 2 quads after the linac which allow for an emittance scan and thus there are a lot more ways to check the system. B. Mikulec has confirmed that making quadrupole scans is clearly also an additional measurement variant, which will be useful to cross-check the results.

K. Hanke mentions that there is no beam dump along the line that can stand the full beam over a long time. M. Vretenar responds that this is true only for activation reasons.

B. Mikulec remarks that the beam dump hole dimensions of the dump line dump needs to be changed; F. Cerrutti has been contacted already. C. Carli asks if the LBE beam dump is limited to 100 µs of average current. M. Vretenar responds that this beam dump has not been specified yet, but should stand the same beam as the one of the dump line. However less shielding might be required. The commissioning of the transfer line has to be done on this dump.

U. Raich wonders if the reason for the constant emittance on the three monitors in the LBE line is due to the fact that the beam is debunched and thus there is less effect from space charge. B. Mikulec responds that this is the case.

C. Carli wonders about the difference between the reconstructed and simulated beam size. T. Hermanns responds that the errors are of the order of max. 15% for the worst case.

W. Weterings would like to know if the old BHZ40 magnet can be kept in the LBE line. B. Mikulec comments that this is the case if the cooling can be improved. From discussions with A. Newborough so far this seems to be the case but needs to be further checked.

A. Lombardi wonders if it has been considered to use the method directly in the transfer line. B. Mikulec answers that this has been considered, but then proper dumping of the stripped beam particles cannot be accomplished. C. Carli cautions that the beam loss might not be acceptable.

## 4. Longitudinal Beam Diagnostics with the LBS Line (T. Hermanns)

The LBS line is located next to the LBE line just before the PSB injection region. The line serves for measurements of the beam energy and the energy spread. A proposal for this measurement line has been presented including the basic functional specification of the elements and the physical performance has been analysed. The current analysis is seen as a starting point for an iterative process to find the exact element parameters. A note on that topic is under preparation.

### 4.1. Discussion

C. Carli wonders if the error analysis has been done correctly: Assuming a 0.1% error on the B-field of the spectrometer magnet and a 0.1% error on the particle momentum, the particles would follow the same trajectory with a difference of 0.2% in the energy.

**Action**: The error study needs to be checked in particular towards the way how systematic errors have been summed up (**T. Hermanns**).

U. Raich would like to know how critical the resolution of 1 μs for the SEM grid is. B. Mikulec responds that the 1 μs correspond to one injected turn of the PSB and this resolution needs to be reached if one wants to measure energy deviations turn-by-turn with longitudinal painting.

M. Vretenar mentions that there are some concerns on the space requirements for the integration of the dump on the ceiling. T. Hermanns responds that, according to Y. Kadi, the remaining current after the slit is low enough to avoid installing a proper beam dump. In any case the area needs to be modified and integration studies are required.

M. Vretenar took note that the slit in the line will be fixed as otherwise the dump would have to be designed corresponding to the worst conditions.

**Decision**: The studied setups for all three measurement lines will be kept as the baseline (**M. Vretenar**).

K. Hanke requests that the required elements are included in the various work-packages. M. Vretenar would like a budget estimation. K. Hanke responds that this is the task of the various work package providers. No further big optimisation is required such that budget estimations should become feasible.

**Action**: Follow-up on the integration of the elements in the work-packages and the integration study with the design office. It is important to make sure that the final designs are compatible (**B. Mikulec, T. Hermanns**).

## 5. AOB

No AOB.

**Suitbert Ramberger**

**Next meeting**: Thursday 19 November, 14:00, room 6-2-004