Minutes of the SPL working group

meeting no. 82

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present: G. Bellodi, P. Bourquin, C. Carli, F. Caspers, S. Cousineau (ORNL), C. De Almeida Martins, M. Eshraqi, R. Garoby, F. Gerigk, K. Hanke, S. Lanzone, E. Mauro, S. Maury, T. Meinschad, B. Mikulec, M. Paoluzzi, Y. Papaphilippou, M. Pasini, S. Ramberger, C. Rossi, E. Sargsyan, H. Schoenauer, M. Timmins, M. Vretenar, R. Wegner

agenda

1. General remarks (Roland Garoby)
2. Summary of initial ORBIT simulations of the CERN PSB (Sarah Cousineau)
3. Comparison of pi/2 mode standing wave structures for Linac4/SPL (Rolf Wegner)
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1. General remarks (Roland Garoby)

R. Garoby reported that the collaborations with India and Russia do not run as smoothly as it was hoped. In the recent "white paper" issued by the DG the importance of renewing the CERN proton injector chain is clearly stated. Linac4 together with PS2 and "probably a superconducting proton linac (SPL)" now rank at the second highest priority. It is expected that Linac4 will have a "slow" start in 2007 with increased funding from 2008 onwards. A serious start on SPL and PS2 may be possible in 2011.

2. Summary of initial ORBIT simulations of the CERN PSB (Sarah Cousineau)

S. Cousineau reported (slides) on the capabilities of the ORBIT code and on her simulations during the last few months to compare ORBIT and ACCSIM simulations . ORBIT is a parallel PIC 6D tracking code which was initially developed from the ACCSIM source code. The code was developed and (is) maintained at SNS with an emphasis on modularity and employment for high-intensity rings and transport lines. The physics modelling includes foil injection, painting, conducting walls, apertures, collimation, acceleration (under testing), magnet errors, impedances, closed orbit calculation, 3D space charge, feedback, electron clouds and 3D magnetic field maps. ACCSIM and ORBIT simulations agreed in case of linear tracking without space-charge. Initially a comparison of runs with linear tracking **and** space-charge showed a big difference in emittance evolution but this behaviour was pinned down to a different treatment of longitudinal space-charge in the codes. If both codes are using a simplified (averaged) longitudinal line density the results agreed perfectly. Non-linear tracking with and without space-charge was only done with ORBIT and showed significant differences with respect to linear tracking. The simulations had triggered a discussion with the ACCSIM author Fred Jones and he explained that the ACCSIM default is to simulate with an averaged longitudinal line density. In order to take into account the calculation of the actual longitudinal density profile the keyword (TSCBUNCH=True) must be activated, which is not documented in the manual.

In the subsequent discussion M. Martini showed (slides) his most recent ACCSIM results comparing the emittance evolution for injection on a 50 MeV or 160 MeV energy plateau, respectively. He used the single batch CNGS beam with 1.25×10^{13} particles in case of 160 MeV and with half the number of particles in case of the 50 MeV beam. Both cases were simulated using the default calculation of the longitudinal line density

and using the TSCBUNCH keyword. This test revealed significant emittance growth when the keyword was set to

"true". However, the emittance growth for 50 and 160 MeV was basically identical for each case, which means that one can still claim to double the particle density within the same emittances if Linac2 is replaced with Linac4. Also it became clear that there is still a lot of optimization work to be done (in the coming months) to find a suitable working point and an optimum longitudinal and transverse painting scheme. K. Hanke reminded that the working point used in the simulations correspond to the "old" working point (5.47 [V], 4.28 [H]) and not the "new" working point (4.47 [V], 4.28 [H]), which is presently used in the PSB. M. Martini replied that both working points have been tested in ACCSIM but that no difference was seen.

3. Comparison of pi/2 mode standing wave structures for Linac4/SPL (Rolf Wegner)

R. Wegner compared (slides) the three best-known pi/2 mode structures (ACS - Annular Coupled Structure, OCS - On-Axis Coupled Structure and the SCS - Side Coupled Structure) in terms of shunt impedance, size, Q-value, peak fields and length. For this purpose he outlined the simulation / tuning procedure and described the simulation effort required to obtain reliable results. The shunt impedances for all three structures turns out to be very similar with the SCS being slightly ahead. The OCS was discarded because if the structure is built with cooling channels (which is necessary for the SPL) then the shunt impedance drops by almost 50%. Comparing the ACS and the SCS one finds that the SCS has smaller outer dimensions, resulting in a smaller amount of solid copper that needs to be procured. Furthermore the stop band between the accelerating mode and the first higher order modes is much higher in case of the SCS (600 MHz) than in case of the ACS (40 MHz). Analysing in more detail the voltage stability as a function of single-cell frequency errors, he suggested to increase the nominal cell-to-cell coupling coefficient from 3 to 5%, which reduces the voltage error by almost a factor of three while the shunt impedance only drops by 3%. Previous calculations (which were not done as thoroughly) had shown a much sharper drop in shunt impedance if the coupling was larger than 3%. At the same time the voltage and phase droop can also be reduced by almost a factor of three. The analysis of the voltage errors is based on an eigenvalue approach which was recently suggested by V. Vaccaro.

4. LEP accelerating modules versus SCL (Frank Gerigk)

F. Gerigk reviewed (slides) the choice to use a 704 MHz Side Coupled Linac (SCL) for the energy range of 90 to 160 MeV in Linac4/SPL. A viable alternative would be to use a scaled version of the pi-mode 352 MHz LEP accelerating cavities. 128 of these cavities were constructed by ACCEL and were operating reliably in LEP for many years. All mechanical solutions were developed at CERN and there are still people at CERN who were actively taking part in the development of these cavities. They are made out of discs and cylinders which are then electron-beam welded together from the outside of the structure. The cooling channels are completely separated from the vacuum and the overall construction seems much simpler than the construction of a SCL. The structure was extended to 7 and 8 cells and its properties were simulated by R. Wegner with GdfidL. Their shunt impedance is slightly lower than that of the SCL. However, using them for the energy range of 110 to 160 MeV would avoid to change the frequency from 352 to 704 MHz and would simplify the RF system. Using 2 cavities (of 1 MW) each per (2.5 MW) klystron one arrives at a structure length of ~17 m instead of 21 m for the SCL. In order to make a final choice on the structures all options (SDTL, SCL, pi-mode) will be revisited until March and their cost will be compared.

Tour de table

- **M. Paoluzzi:** was in St Petersburg last week to check on the progress of the chopper pulsers. The original delivery date of June was delayed and the device is still not ready for delivery. The company

has difficulties to achieve all of the required specs at the same time. While the core elements seem ok (voltage amplitude, rise time, etc), the surrounding electronics is not yet up to specifications. They promised to send measurements on a 2nd prototype which is under construction now before the end of the year.

- **T. Meinschad:** reported that he made a budgetary estimate which projects the kind of work that can be done on the H- source if the funding does not arrive as requested.
- **K. Hanke:** introduced Bettina Mikulec, who is working in the operations group on all PSB related issues. She will participate in the PSB studies related to the injection with Linac4.
- **C. De Almeida Martins:** reported on the progress of the pulsed power supplies for the LEP klystrons. The hardware tests planned for the end of this year have to be delayed due to delivery problems of solid state HV switches from Belke. The order was cancelled and a new order will be made probably with ABB in Switzerland. Delivery delay is three months and the price is approximately twice as high as for the previous offer from Belke. In return a much more solid design is exptected.
- **M. Pasini:** reported on this years high-power tests on the CERN CCDTL prototype. One of the cooling channels in one of drift tubes is blocked and the Q-value was at 65% of the values predicted from Superfish. Nevertheless the nominal effective voltage of 1.1 MV per half-cell was achieved. The drift tube will be repaired and the low Q-value was caused by not copper-plating the area around the RF joints. After plating of the joints new high-power tests are foreseen. From the experience and the tests that have been done so far it is clear that the CCDTL will need cooling even when operated at the Linac4 duty cycle of 0.1%.
- **C. Rossi:** reported that the preparation of the 3 MeV test stand is advancing well. Part of the budget was diverted to the PO group for the construction of the pulsed modulators for the LEP klystrons. By now the complete budget is spent and a summary is in preparation.

next meeting:

to be announced

-- FrankGerigk -

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