

# Minutes of the SPL steering group

## meeting no. 7

**date:** 14 March 2008

**present:** S. Calatroni, E. Ciapala, R. Garoby, F. Gerigk, A. Lombardi, V. Parma, C. Rossi, M. Vretenar, W. Weingarten

**excused:** R. Losito

## Agenda

1. General news and facts
2. Cryo-modules for different frequencies and at different temperatures (V. Parma)
3. Review of maximum surface fields at JLAB (S. Calatroni)
4. Frequency and temperature optimisation (W. Weingarten)
5. Round table
6. Next meeting

## 1. General news and facts

- a half day SPL review meeting will take place on April 30th, Dave McGinnis from FNAL has accepted an invitation to attend. In the morning Dave is asked to give a talk on the status of Project X.
- the main goal of the review meeting will be the frequency and cryogenic temperature of the SPL.
- the preliminary schedule for the afternoon meeting is:

### Status of analysis of SPL RF frequencies and cooling temperature

Wednesday, 30 April 2008, CERN building 864/1-C02

title	subject	speaker
Introduction	Characteristics of the different SPL implementation stages, design constraints, meeting goals	R. Garoby
Potential linac architecture & beam dynamics	several (frequency) options for the layout and their impact on beam dynamics	F. Gerigk/A. Lombardi
Cryogenics	Consequences of tunnel slope, cryo-module design, possibility to reuse ILC/XFEL experience	V. Parma
SC cavities	performances and overall efficiency as a function of temperature and frequency	W. Weingarten + S. Calatroni, F. Gerigk
RF frequency	impact on RF hardware	E. Ciapala
SC cavity parameters	Impact of cell number, frequency, and current on the cavity/beam dynamics performance	J. Tuckmantel
Discussion, other arguments, criteria, optimisation	how far are we from making a choics, which criteria, open questions	all
Wrap-up		R. Garoby, F. Gerigk

## 2. Cryo-modules for different frequencies and at different temperatures (V. Parma)

- If possible one should avoid the use of superfluid helium (<2.17 K) in order to reduce the complexity, cost, maintenance effort,

- At 704 MHz it now seems that there is no point going to superfluid helium, at 1408 MHz in pulsed operation it seems necessary but must be studied in depth (tests!) if one really needs to be < 2.17 K.
- For 704 MHz, 4.5 K the cavities can probably fit into the ILC outer tubes, but it is likely that most of the openings will change position. However, to take into account the slope of the tunnel the interior of the tubes (helium vessels, pumping pipe, shielding) will have to be completely re-designed, so that there will be little benefit from ILC/XFEL work. Probably one can reduce the size of the pumping pipe, but then one has to make sure that the structural stability is still sufficient. Also, there may be a risk of helium dripping down the slope in one direction, while the gas is pumped in the opposite direction.
- **Conclusion:** at 704 MHz, 4.5 K it is very unlikely that we can profit from ILC/XFEL work on cryo-modules, at 1408 MHz, 2.1 K a reuse of this design is very likely,

### 3. Review of maximum surface fields at JLAB (S. Calatroni)

G. Ciovati from JLAB made a summary of cavity test data for S. Calatroni, which was distributed to the steering group members. The summary should not be distributed any further. S. Calatroni presented the main findings on a few slides ( pdf, ppt ), which show that the maximum surface fields reached with BCP treatment at JLAB were between 31 MV/m (field emission onset) and 44 MV/m (average peak surface field). Electropolishing and baking can increase these values by 20%. At DESY up to 40% better results have been achieved but it is not completely clear where the differences in the procedure are.

It was also found that the maximum peak fields for single and multi-cell cavities do not seem to be different. However, the success rate can vary considerably and confirm that it is much easier to get high gradients out of a single cell. E.g. 70 MV/m were achieved with 30% success rate, 50 MV/m with 80% (1300 MHz).

### 4. Frequency and temperature optimisation (W. Weingarten)

W. Weingarten continued his work on the frequency and temperature optimisation (pdf, pptx). The following results assume that we use 5-cell cavities at 704 and 1408 MHz, which does not seem to be attractive (for 1408 MHz). The numbers indicate that:

- **transfer efficiency (grid to beam) vs freq/temp:** for 4.5 K there is a relatively broad maximum for frequencies above 1 GHz, while for 2.5 K it is clearly advisable to go to higher frequencies. Starting with a fixed frequency there is generally a higher efficiency for the 1.4 GHz case, but the dependance on the cryogenic temperature is very low.
- **electrical power for the cryo-plant vs freq/temp:** for 4.5 K the lowest power consumption occurs for frequencies around 700 MHz, for 2.5 K one should be at or above 700 MHz, the optimum temperature for both frequencies is around 3 K,
- **RF power:** the needed RF power for the whole linac decreases for all temperatures towards higher frequencies,
- **total power consumption vs freq/tempe:** the dependance on the temperature is very low, while one can find an optimum for 4.5 K at ~1.5 GHz and for 2K one should be at or above 1.5 GHz,
- **capital investment vs freq/temp:** for 4.5 K there is a minimum at around 700 MHz, for 2.5 K there is a very broad minimum at >700 MHz, The optimum temperature for 700 MHz is around 3 K and for 1400 MHz around 2.5 K (broad minima).

### 5. Round table

- A. Lombardi reported that first test have been made for the SPL layout, which changes from 352 to 1408 MHz. It seems that the transition energy has to be shifted from 160 MeV to 250 MeV to achieve acceptable beam performance. Further simulations will be done.

- By now it seems to be clear that for 704 MHz we do not need superfluid Helium. For 1408 MHz it may well be enough to have temperatures around 2.5 - 3 K, which would also be above the lambda point. But this needs to be tested and the efficiency of the cryo plant needs to be estimated.
- There was a discussion on the influence of higher order modes for 704 and 1408 MHz. Cavity designers recommend not to increase the number of cells above 5 for "high-current" applications and this may pose a severe limit for the SPL. It is clear that 5-cell 1408 MHz cavities are not an interesting option for the SPL. This point needs investigation and may decide the frequency choice for the SPL.
- S. Calatroni had found a paper [\[3\]](#) on a statistical model to predict cavity performance (electropolished, baked).

## 6. Next meeting

will take place on April, 11th 2008, 16:00 in 865-1-D17

-- FrankGerigk - 26 Nov 2007

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