«To Do List» for the Fukuoka-Meeting

Draft

Peter Sievers

21. May 2018

Introduction

- This is a suggestion of issues, to be considered in the forthcoming discussion at the Fukuoka meeting, for the Undulator as well as for the e-driven ILC-Positron source.
- The situation, as it represents itself today and what has to be treated in the future, is listed below.
- This list may not be complete, some points are obsolete, some are obvious and some may be wrong.
- I have refrained from attaching to each item a »Qualification Letter» and leave that to the consideration of the working group and to additional specialists, who can contribute by qualified advice.
- No oportunist or popular voting should be exercised.

Undulator Driven Positron Source

Item	Description	Actual situation	To be done	To be done	To be confirmed
Ti-Target	Ti-7.0 mm. Only a small part of the incident beam power, 2 kW is deposited in the target.	Temperatur and stress studies finished. Looks ok.	Test of cooling by radiation in a laboratory mock up for validation.	Mechanical fatigue test of Ti at 500-600 oC and 100-200 MPa over 3 10^6 cycles.	Are small shocks at temperature rises over 50 µs tolerable?
Rotating Wheel	Carrier wheel at 2000 rpm.	No design. Only sketch.	Engineering design. No problems expected.	Fitting the rim with Ti-blades. No problems expected.	

Rotating, vacuum compatible bearing	Permanent and/or electromag-netic bearing for 33 Hz.	Available in industry. No ILC specific design exists.	Write perfor-mance speci-fication, including mechanical, dynamic and radiation loads.	Place a feasibility study with industry	Build a real size prototype for test of robustness and lifetime.
QWT	d.c. solenoidal field of 1.04 T	No engineering design.	Engineering looks feasible, beam heating and cooling to be verified.	Field dragging by the fast rotating wheel and influence on yield.	QWT should be part of the global prototype test of the wheel.

Radiation Issues					
Upstream protective collimator with r=2.5 mm aperture.	Colliamtor placed upstream of the wheel to absorb useless photons.	No design exists. Material of collimator to be selected.	PEDD, thermal loads, cooling and radiation resistance to be done.		Feasibility to be confirmed.
Protection of downstream cavities.	Collimators and masks to protect cavity from beam pulses.	Do we know what are the limits the cavities can stand?	If protection is necessary and feasible, design masks and their cooling.		Integrate the protective masks into the cavity layout.

Target Handling	Radiation doses and remanent activity in the target station.	Initial studies have been started.	Establish detailed maps of PEDD, Gy, dpa and Sv of all components of the source and its shielding.	Select appropriate materials and assess the expected life time of components	Elaborate appropriate engineering solutions for removal and exchange of used components Involve industry.
Space Require-ments.	Initial space require-ments for the tools around the target zone have been proposed.	Principal tools for handling have been proposed.	Check that space require-ments are compatible with envisaged tools.		Consult with specialists.

Beam Dumps

Beam Dumps					
Electron Dump.	Dogleg separates e-beam downstream of the undulator from the photon beam.	Do we need an emergency dump? Failure of the dogleg?			Consult with safety authorities.
Ti-Window for the Photon Water Dump.	Ti-window at the interface of beam vacuum to atmos-phere.	When placed at 2 km from the target, window design looks ok.	No show stoppers with Ti-windows at accelerators have been reported.	Detailed comparison with successfull use of Ti-windows elsewhere .	Validation of perfor-mance and life time with beam conditions, similar to the ILC photon beam.

Water Dump for the Photon Beam.	Photon pulses are absorbed in a windowless water flow.	Placed at 2 km from the target. Technical study is success-fully com-pleated.	The results of the water dump should be confronted with those of the ILC-main dumps.		If the main ILC water dumps work, the photon dump can be built.
Inclined Graphite Photon Dump placed at 2 km. Cooled by conduction into a water cooled Cu-bed.	Grazing incidence of the photon beam along a 10 mrad inclined C-surface. This lowers PEDD in the C by a factor 2.5.	No window required. Very first study made. Peak tempera-tures in C of about 1200 oC plus 70 oC per pulse.	Steady state temperature and pulsed stresses, fatigue, radiation effects in C to be assessed.	Robustness of thermal contact of C with the Cu-cooler to be validated.	Design values to be compared to those achieved in operating devices of similar nature.

The e-driven Positron Source

Item	Description	Actual Situation	To be done	To be done	To be confirmed
Water Cooled Target Wheel, rotating at about 200 rpm.	W-Re, 15 mm thick, at most 35 kW in the 500 mm diameter target wheel.300 Hz scheme at 5 Hz.	Studies of tempera-ture and stresses look ok. Extrapo-lation of shocks from SLC look ok.	Engineering of thermal W-Cu contact and Cu-wheel.	Detailed comparison of thermal shocks of the ILC 1 μs pulses with the SLC beam pulses and target design.	Life time estimates is based on number of SLC pulses. Is this sufficient?
Rotating Shaft.	Rotating at 200 rpm and carrying the load of the target wheel.	Cooling water is led through the shaft, completely confined inside Cu.	Water circuit completely inside Cu is ok. Strength of the Cu-axis to be checked.	Strength of the Cu-axis may have to be increased with a steel jacked.	Re-engi-neering is possible.

Ferro Fluid Rotating Seal	**The seal represents the only barrier between atmosphere and the vacuum.**	**Rotating seal is under test. Origin of leaks and/or outgassing not fully understood.**	**Develop means to completely eliminate the risk of degraded vacuum.**	**Develop auxiliary means to improve and maintain sufficient vacuum along the beam line over long times.**	**Validate the rotating seal in laboratory tests with realistic loads: weight and moment of inertia of the wheel, vibrations,…**
Radiation Resistance of the Seal	The seal is the only organic component in the highly radioactive and chemically agressive environ-ment.	Radiation resistance of isolated oil sambles has been done with a Gamma source up to 4.7 MGy with good results.	Radiation resistance to electron and neutron rich radiation fields should also be done.	Radio-chemical and physical parameters of the irradiated oil and of the permanent magnets to be checked.	Long term performance and life time should be assessed in realistic radiation environment.

Flux Concen-trator.	Straight slit F.C. with a primary driving coil and a single body Cu-secondary.	Required peak field and quality looks ok. Yield not yet optimised.	Mapping in the Cu of the short beam and electrical pulses and their energy deposition. Mecanical loads from the field of the F.C. on the target wheel.	Engineering: cooling of ohmic and beam heating. Long term operation and lifetime. Fatigue and radiation damage of the Cu.	Life time of the F.C. should be longer than the target wheel.

Global Radiation Problems.

Global mapping of the beam power .	Nearly all of the incident beam power is deposited in the immediate vicinity of the target components	Mapping of the beam power has been done. Most of the components in the target station have to be water cooled.	More detailed studies of the radiation resistance and damage in components	Detailed studies of the remanent activities from the components and the local shielding, to assess their handling.	Get guidance from radiation spécialistes and safety authorities.

Target Handling	**All components must be designed to be handled by remote manipulator and/or robots.**	**No detailed design has been done.**	**But industry is capable to provide adequate design and make the engineering in due time.**		**Such develop-ment must be done in close collabo-ration with alignment specialists, radioprotec-tion and safety authorities.**

Conclusion

- The positron source must provide the highest possible yield with highest possible efficiency and availability over extended running periods.

- The Undulator driven source:
- By reducing recently the beam parameters, energy of 125 GeV and 1312 bunches, the undulator driven target could be substantially simplified: Radiation cooling, weight of the wheel, QWT.
- The crucial issue is the rotating magnetic bearing.
- By laboratory prototype tests, if successfull, this issue can bring the Undulator source close to realisation!
- Since only little beam power is deposited inside the target station, radiation issues and handling is managable.
- The Undulator has not been assessed in this survey.

- The e-Driven Source:
- The organic Ferro Fluid Seal merits intensive validation. This must happen in the near future at least to a stage, that one can conclude that with further well defined optimisations, adequate vacuum levels and life time can be guaranteed.
- Only then one can judge how far the target is close to realisation.
- Due to the very high radiation level inside the target station, the reliability, its maintainability and finally its production efficiency for positrons over extended periods must be evaluated.

Final Question?

- What are the necessary conditions, which have to be provided and at what time, so that we can propose a choice among the two types of positron sources?
- Do we, at that moment, have enough information to judge the potential for future upgrading of the proposed solution?
- Or can the technical solution for upgrading be worked out once operational experience has been gained with the selected, first generation positron source? Consolidatation programs is a common practice in the accelerator field.