Engineering and Design
Kick Off Meeting Summary

Version 1.1

Technical system: e^+ Source

Date:	8 October 2007
Location:	Cockcroft Institute, UK
Host:	Jim Clarke
Secretary:	Junji Urakawa
Meeting:	e^+ Source Kick Off Meeting

Table of Contents

1 Goals

– to be done –

2 Kick Off Meeting Organisation

2.1 Agenda

The agenda of the meeting is available from the InDiCo page together with the presentation material.

http://ilcagenda.linearcollider.org/conferenceDisplay.py?confId=1859

e^+ source – Kick-off Meeting – 8-9 October 2007, Cockroft Institute.		
Monday 8 October 2007		
Introduction	9:00	Jim Clarke (STFC Daresbury Lab)
View from the Project Management Office	9:10	Nicholas Walker (DESY)
The RDR Design	9:40	Vinod Bharadwaj (SLAC)
break	10:40	
The RDR Cost Estimate	11:00	John Sheppard (SLAC)
CF & S for the Positron Source	12:00	John Andrew Osborne (CERN)
lunch	13:00	
Potential Design Changes and Constraints	14:00	Jim Clarke (STFC Daresbury Lab)
Planning the EDR Phase	14:30	Jim Clarke (STFC Daresbury Lab)
Work Packages & Organisational Structure	15:00	Jim Clarke (STFC Daresbury Lab)
break	15:30	
System Integration	15:50	Jim Clarke (STFC Daresbury Lab)
The role of S5 in the EDR	16:50	Eckhard Elsen (DESY)
Tuesday 9 October 2007		
Alternative Source Design	9:00	Alessandro Variola
Alternative Source Cost Estimate	9:30	Alessandro Variola (LAL)
Planning for the Alternative	10:00	Alessandro Variola (LAL)
break	10:30	
Target System	10:50	Ian Bailey (Cockcroft Institute/ University of Liverpool)
Capture Magnet	11:35	Jeff Gronberg (LLNL)
lunch	12:20	
Remote Handling	13:20	Vinod Bharadwaj (SLAC)
Auxiliary positron source	14:05	John Sheppard (SLAC)
RF Systems	14:35	Juwen Wang (SLAC)
Lattice design	15:05	Feng Zhou (SLAC)
break	15:35	
Discussion and Wrap-Up	15:55	

2.2 Host

Jim Clarke at Cockcroft Institute, UK.

2.3 Attendance

Ian Bailey, Vinod Bharadwaj, Jim Clarke, Eckhard Elsen, Jeff Gronberg, Tom Himel, Alexander Michailichenko, John Osborne, Duncan Scott, John Sheppard, Junji Urakawa, Nick Walker

On the phone: Peter Garbincius, Gudrid Moortgaart-Pick, Sabine Riemann, Omori, Nobu Toge, Kaori Yokoya

2.4 Secretary

These notes were taken by Junji Urakawa and Eckhard Elsen.

3 Documentation

The topics of the kick off meeting are displayed below and followed by the conclusion or recommendation. The factual basis is given. The material has been posted with the agenda on the web and will be complemented by this document.

All RDR cost numbers, except those which were at a level high enough to be included in the RDR itself, must be password protected (or have an equivalent access restriction).

3.1 Review the requirements provided by Area Systems with a focus on missing or incomplete items

3.1.1 Target Lifetime

Recent calculations on target lifetime (radiation dose) between the ANL and DESY Zeuthen group seem to be inconsistent by a factor ten. The impact on the target handling strategy is huge.

The target must be designed for long lifetime (two years). The exchange of the target should be foreseen in the long shutdowns and should not take more than a week. The design must be robust so that the residual probability of target failure during operation is small. What are the exact criteria for successful design?

Depending on the radiation load the exchange of the target will necessitate expensive remote handling equipment. The cost has not been given in RDR.

Recommendation

> *The lifetime calculation issue should be resolved. Once understood it should be demonstrated how reliability issues in the target operation have been addressed. In particular, the rate of failures in the highly radioactive region should be estimated along with the repair time so their effect on the availability can be estimated.*
>
> *The remote handling must be properly engineered.*

3.1.2 Target Material

The selection of target material and thickness should be experimentally verified. It is possible that the properties of the TTF beam (time structure and beam dimensions) could provide a meaningful testing ground.

Depending on adiabatic matching device there will be implications from eddy currents. The effects are being addressed and need to be fully quantified.

Recommendation

> *Explore the test options at TTF and possibly verify the target calculations experimentally.*
>
> *Address the eddy current problem and discuss the power requirements for the motor drive of the rotating target in terms of reliability.*

3.1.3 Downstream Target Window

The RDR does not have a window downstream of the target. Introducing one would decrease the vacuum requirements at the target. However, a downstream target window may not survive the beam. A double window with gas cooling in between is being considered.

Recommendation

> *Evaluate if the double window will work.*

3.1.4 Positron Yield

The safety margin in the positron yield is not large. Currently 1.5 e^+ in DR are assumed for every e^- in undulator. Depending on operating conditions, and in particular with polarized beams, the yield may be too low.

Recommendation

> *Optimize the length of the undulator vis à vis capture technology: cost versus risk is the issue and a plan should soon be presented. Indicate the uncertainties in the yield estimates and show how the margins could be used during operation.*

3.1.5 Flux Concentrator

The flux concentrator (AMD/OMD) could provide a factor two or more in captured positron yield. The current QWT seems fairly conservative.

A lithium lens between two windows has also been proposed as a target and a priori has very good focussing properties. There may be issues with thermal stress in the Li lens or its window which should be addressed.

Is Aluminium a viable alternative to Copper in the capture section? The radiation levels in Al could be considerably lower.

Recommendation

> *Maximize the effort on the flux concentrator.*
>
> *Document the use of a Li lens in full including the mechanical and thermal effects to see if it is a viable option.*
>
> *An Aluminium capture section should be explored first to check if it significantly reduces the residual radiation and then to see if there are technical problems such as welding.*

3.1.6 Emittance Growth in Undulator

The polarized e^--beam may be affected by higher magnetic multi-poles in the undulator and by the misalignment of the individual undulator segments. How much does the emittance deteriorate? Is the polarization affected?

Recommendation

> *Assess the performance with detailed simulations that include the various magnetic field components. Discuss the effect on emittance and polarization.*

3.1.7 Experimental Verification of Undulator performance

Consider the experimental verification of the undulator performance in an electron beam. What can be learnt from the 4 m prototype? What is the sensitivity required for such a test? What beam profile is required? Is the flat beam particularly critical? What is the additional effect of the alignment of undulator components? What diagnostics is required?

Recommendation

If it is determined that there is sufficient sensitivity, consider testing the prototype in a beam.

3.1.8 Polarization

The positron beams will be naturally polarized at a level of 30% or so. (The positron polarization has to be measured at the IP). From the physics point of view it will be advantageous to flip the spin on a rather short time scale to produce e.g. an unpolarized event sample. The current *baseline* does not include highly polarized positrons. Has the upgrade path to high polarization been worked out and what are the implications for the current design? Has the cost impact been addressed?

Recommendation

Assess the technical implications of handling an inherently polarized beam: what are the requirements for flipping the beam polarization? How can this be achieved and what are the cost implications? What is the upgrade path to higher polarization? What is the implication on the positron yield?

3.1.9 RF section

The capture and acceleration section consists of several normal and super-conducting sections.

Recommendation

The need for prototyping larger parts of the RF should be quantified.

3.1.10 Optics

The DR injection optics has been well developed. It must keep pace with possibly proposed changes of the design

Recommendation

An optics expert is required.

3.2 Examine plans to initiate the cost reduction and value engineering process

3.2.1 Cost Assessment and Comparison between various Source Options

At the meeting it was not fully transparent whether all implied cost of the undulator-based e^+-source have been attributed to the positron source. Examples are the extra linac length to recover the 3 GeV energy loss of the e^--beam, the CF&S cost for the wider tunnel etc. It is important to have a full account of all cost related to a particular choice so as to enable the comparison with alternative proposals.

Recommendation

Examine allocation and consolidation for the cost items.

3.2.2 Distance between Photon and Electron Beam lines

It may be possible to optimize the distance between the photon beam line and the electron linac, e.g. from 2.5 m to 1 m? The larger diameter tunnel in this section entails an extra cost of about $10M. Would it be possible to house both beam lines within the standard ILC tunnel cross-section?

Also, is it clear that the two beam lines have to be parallel? A 3-bump insert, single kink, or a dog-leg arrangement could give significant cost savings. However, the two latter solutions lead to a non-coaxial linac and hence has implication for operations (MPS etc.).

Recommendation

Examine more cost effective solutions with possibly a smaller distance between the beam lines. Use 3D CAD tools to verify viability.

Non-axial linac arrangements should be discussed with project management and the integration manager as it has implications on possible upgrades.

3.2.3 Ample Damping Ring Aperture

The aperture limitations for the positron beam currently derive from the 5 GeV pre-accelerator. The DR aperture is consequently not exploited.

Recommendation

The Damping Ring group should examine the effects of a smaller DR aperture and assess the cost savings.

3.2.4 Overall Layout and usage

The essential parts of the layout of the positron source were fixed during the conceptual design phase and saw some minor modifications with the introduction of the central campus. It is not evident that the original decisions still hold, in particular when a cost/benefit analysis is added. Examples are the location of the source at 150 GeV vis a vis at the end of the linac, the arrangement of the two pre-accelerators in each of the lepton arms, the power requirements. When addressing these issues there may be impacts on the physics performance. An example could be the location of the undulator and the attainable luminosity for Z^0 running.

Recommendation

Re-examine these issues and indicate the cost/performance figures for proposed changes.

3.2.5 Keep-Alive Source

The Keep-Alive Source (KAS) yields an increase in availability if the source turns on in a fairly small time (<2h switchover). A stand-alone source is likely to be needed for commissioning. Initial commissioning may even demand the availability of an electron beam. There are various topological arrangements for production, acceleration and DR injection of electrons and positrons in each lepton arm. The cost / benefit should be indicated.

The technology for a standalone target may cover liquid targets, channelling crystal targets etc.

Recommendation

> *The usage cases for electrons and positrons in the electron and positron arm should be elaborated and the necessary intensity should be stated for each case. The benefits should be compared to the cost impact.*

3.2.6 Energy Upgrade

The energy upgrade will entail changes to the layout. The higher energy electron beam in the undulator requires a longer special linac section. It is not a priori clear how much of the energy upgrade should be incorporated in the layout of the positron source.

Recommendation

> *The Project Management should specify an energy upgrade policy.*

3.2.7 Compton Source as an alternative

The viability of the Compton source scheme depends centrally on the success of beam stacking into the damping ring to reach the required intensity of the ILC beam. Lossless injection is hence critical for the technical demonstration of this e^+ source.

To date the problem of stacking and cooling within the tight time requirements of the damping ring has not been solved. The laser intensities are still somewhat low although there has been steady progress using laser cavities. Currently three schemes are being explored and there is considerable synergy of this research with other albeit less demanding projects.

It is unlikely that the Compton source will become the baseline source on EDR timescales.

Recommendation

> *The Compton community will have to demonstrate a viable alternative to the current baseline. A report on the stacking issues should be presented at the Sendai meeting.*
>
> *The Compton Source should be included in the WBS of the positron source.*

3.3 Examine proposed Work Packages and comment on how they support the EDR goals

3.3.1 Prioritisation of Work Packages

The WBS for the positron source must include the accelerator components involved and should include magnets, vacuum and diagnostics.

Recommendation

The ED plan should comprise all accelerator components.

3.3.2 Work Package: Integration

The Work Package Integration will be the primary interface to CF&S. The excavated underground volume, the water, the power and the cooling requirements have to be reviewed out and should be seriously reconsidered. Currently 17 MW are specified for cooling water. It is not clear how these requirements have been optimised.

Recommendation

A full assessment of the requirements and the optimization method should be presented.

4 Action List

The Action list below has been derived from the recommendations.

Reference Topic	Responsible	Identifier	Action
3.1.1 Target Lifetime	ANL & DESY Zeuthen	ILC-ED-EP-01	Resolve the lifetime calculation issue as soon as possible and inform the Area Leader. The reliability issues should be addressed by the time of the Sendai Meeting.
3.1.1 Target Lifetime	e^+ Source Target WP Leader	ILC-ED-EP-02	Provide a robust target design
3.1.2 Target Material	e^+ Source Target WP Leader	ILC-ED-EP-03	Explore the test options at TTF. Address the eddy current problem and report on the solutions at the Sendai Meeting.
3.1.3 Downstream Target Window	e^+ Source Target WP Leader	ILC-ED-EP-04	Evaluate the viability of a downstream window at the target and report at the Sendai Meeting
3.1.4 Positron Yield	e^+ Source Area Group Leader	ILC-ED-EP-05	Describe the yield optimisation strategy and document the result for the Sendai Meeting
3.1.5 Flux Concentrator	e^+ Source OMD WP leader	ILC-ED-EP-06	Recollect the arguments for capture yield and compile the list of arguments for the Sendai-Meeting
3.1.5 Flux Concentrator	e^+ Source Cornell	ILC-ED-EP-07	Document the details of the Li lens as a flux concentrator for the ILC in a written report for the Sendai Meeting.
3.1.6 Emittance Growth in Undulator	e^+ Source Undulator WP Leader	ILC-ED-EP-08	Evaluate impact on emittance and polarization and report at the Sendai-Meeting
3.1.7 Experimental Verification of Undulator performance	e^+ Source Undulator WP Leader	ILC-ED-EP-09	Develop an plan for the experimental test of the undulator and present at the Sendai-Meeting
3.1.8 Polarization	e^+ Source Polarization WP Leader	ILC-ED-EP-010	Provide a written report on the treatment of the inherent polarization and how it could be exploited for the Sendai Meeting. Address the systematic uncertainties for physics

			measurements and address remedies. Discuss the upgrade path to maximum polarization.
3.1.9 RF section	e^+ Source RF WP Leader	ILC-ED-EP-011	Describe the prototyping requirements for the Sendai Meeting.
3.2.1 Cost Assessment and Comparison between various Source Options	e^+ Source Area Group Leader and Cost Control	ILC-ED-EP-012	Revisit the costing of the positron source and present at Sendai Meeting
3.2.2 Distance between Photon and Electron Beam lines	e^+ Source Area Group Leader and Integrations Manager	ILC-ED-EP-013	Report on beamline configurations at Sendai-Meeting
3.2.3 Ample Damping Ring Aperture	Integrations Manager & DR area group leader	ILC-ED-EP-014	Optimize Resource Usage: Report at Sendai-Meeting
3.2.4 Overall Layout and usage	e^+ Source Area Group Leader	ILC-ED-EP-015	Compile the arguments for the design choices and report at Sendai Meeting. Involve the physics groups as necessary.
3.2.5 Keep-Alive Source	e^+ Source Area Group Leader	ILC-ED-EP-016	Report on the usage cases for the various (extra) beams and recommend an option for the Sendai Meeting. Find cost effective solutions.
3.2.6 Energy Upgrade	PM	ILC-ED-EP-017	Report on an Energy Upgrade Policy at the Sendai Meeting
3.2.7 Compton Source as an alternative	e^+ Source Compton WP Leader	ILC-ED-EP-018	The Compton Community should indicate the most likely path to success for a viable Compton Source. The stacking issues should be addressed at the Sendai meeting. This path should be documented in the WBS of the Technical Area.
3.3.1 Prioritisation of Work Packages	e^+ Source Area Group Leader	ILC-ED-EP-019	The complete Work Package list should be presented, preferably by the FNAL meeting
3.3.2 Work Package: Integration	e^+ Source Compton WP Leader	ILC-ED-EP-020	A complete and critical assessment of the requirements should be presented at the Sendai Meeting.

5 Summary of Meeting

– to be done –