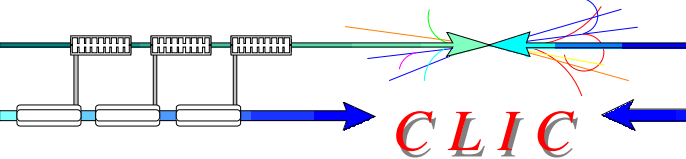


# The CLIC/ILC common issues for the sources

Jim Clarke and Louis Rinolfi



*CLIC*



# "ILC/CLIC $e^+$ generation" working group

Officially set-up at University of Illinois Chicago - UIC  
during ILC08 workshop: 15<sup>th</sup> - 20<sup>th</sup> November 2008

ILC convener: J. Clarke (Daresbury)

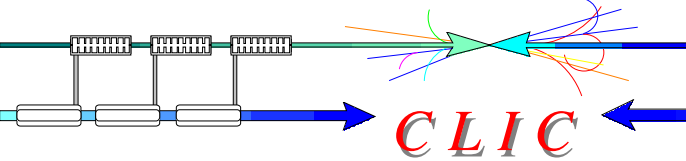


CLIC convener: L. Rinolfi (CERN)



Monthly regular Webex meetings, called "ILC/CLIC  $e^+$  studies" managed by T. Omori / KEK

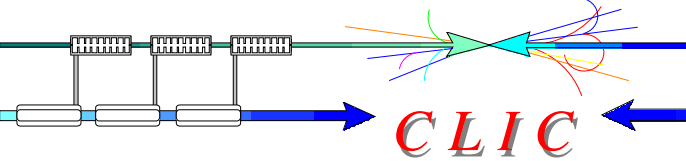
Distribution list managed by G. Moortgat-Pick at: [owner-ph-ilc-clic-positronsource@durham.ac.uk](mailto:owner-ph-ilc-clic-positronsource@durham.ac.uk)



## Some challenges for the e<sup>+</sup> source



- 1) A single hybrid targets station or several stations to cover all the CLIC needs
- 2) Devices for Undulator scheme (Helical undulator, collimators, dumps,...)
- 3) Devices for Compton schemes (Optical cavities at IP, powerful laser systems,...)
- 4) Targets issues (Heat load dynamics, beam energy deposition, shock waves, breakdown limits, activation, ....)
- 5) Adiabatic Matching Device (AMD)
- 6) Capture sections (Transport and collimation of large emittances, high beam loading)
- 7) Trade off between yield, polarization and emittances
- 8) Design and implementation of the spin rotators
- 9) Polarization issues (Analyze systematic errors of polarization measurements)
- 10) Efficient use of existing codes (EGS4, FLUKA, Geant4, PPS-Sim, Parmela, ...)
- 11) Integration issues for the target station (remote handling in radioactive area)
- 12) Radioactivity issues
- 13) .....



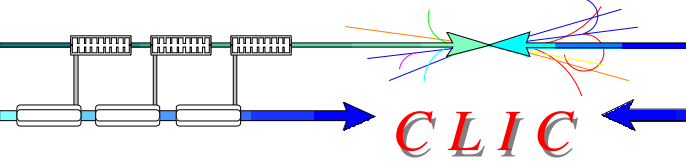
## Mandate of the working group



The ILC study considers the Undulator option as the base line while the Compton schemes are alternative options. The CLIC study considers the Compton schemes as the base lines while the Undulator is an alternative option. Additionally, both projects are interested in the development of conventional sources (ILC as an auxiliary source and CLIC as an alternative baseline).

The working group should:

- Develop the synergy between the ILC and CLIC  $e^+$  studies.
- Evaluate the common technical issues related to both options for the production of polarized positrons.
- Prioritize R&D.
- Review the existing technical and tests facilities where further tests could be performed.
- Evaluate where cost savings could be obtained.
- Promote common meetings and workshops.



## Updated mandate of the working group

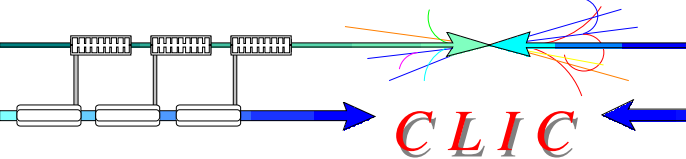


For polarized electron sources, ILC and CLIC studies are based on photo-injectors using a DC gun with different parameters.

For polarized positron sources, the ILC study considers the Undulator option as the base line while the Compton schemes are alternative options. The CLIC study considers the Compton schemes as the base line while the Undulator is an alternative option. Additionally, both projects are interested in the development of conventional sources (ILC as an auxiliary source and CLIC as the baseline for the CDR).

The working group should:

- Develop the synergy between the ILC and CLIC  $e^+$  and  $e^-$  studies.
- Evaluate the common technical issues related to production of unpolarized and polarized positrons.
- Prioritize R&D.
- Review the existing tests facilities where further tests could be performed.
- Invite experts from different institutes to contribute to the studies.
- Evaluate where cost savings could be obtained.
- Promote common meetings and workshops.

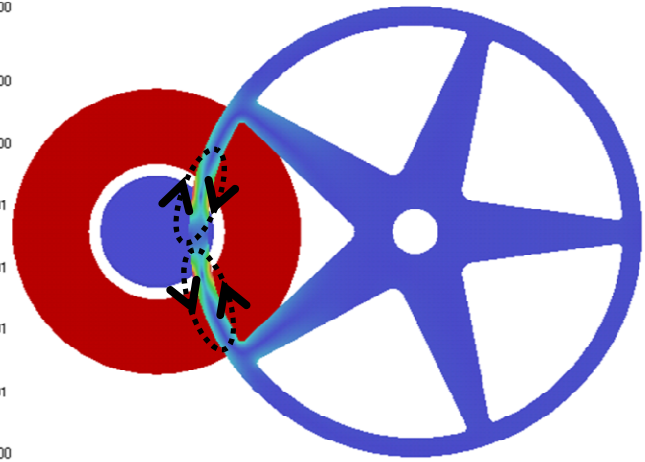
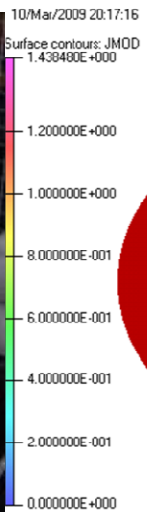


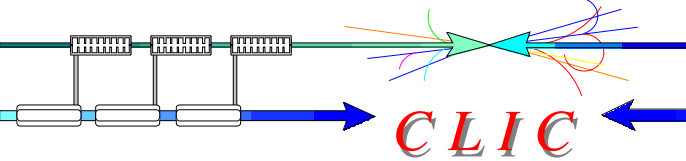
*CLIC*

- ILC Target

- Rotating titanium wheel
  - Eddy current heating (~ 5kW for 1T)
  - Photon beam heating
  - Pressure shock waves
  - Cooling/vacuum/radiation resistance
  - Prototype exists and Eddy current effects are being carefully measured and quantified/benchmarked
  - Analysis of pressure shock waves ongoing

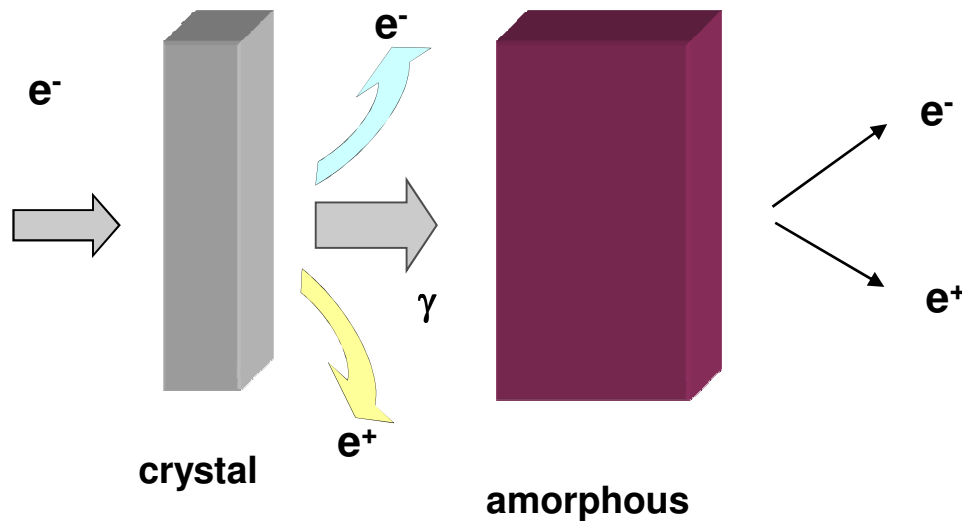
Rotation reduces the energy density to 24 J/g





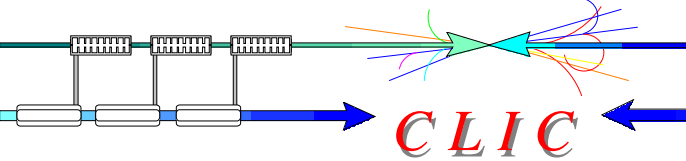
## CLIC Target

- Fixed tungsten targets
  - Electron and photon beam heating
  - Pressure shock waves
  - Cooling/vacuum/radiation resistance
  - For 500 GeV, PEDD is very close to the limit
  - Prototype does not exist and carefully tests should be performed
  - KEK experiments ongoing (see Takahashi-san presentation later)

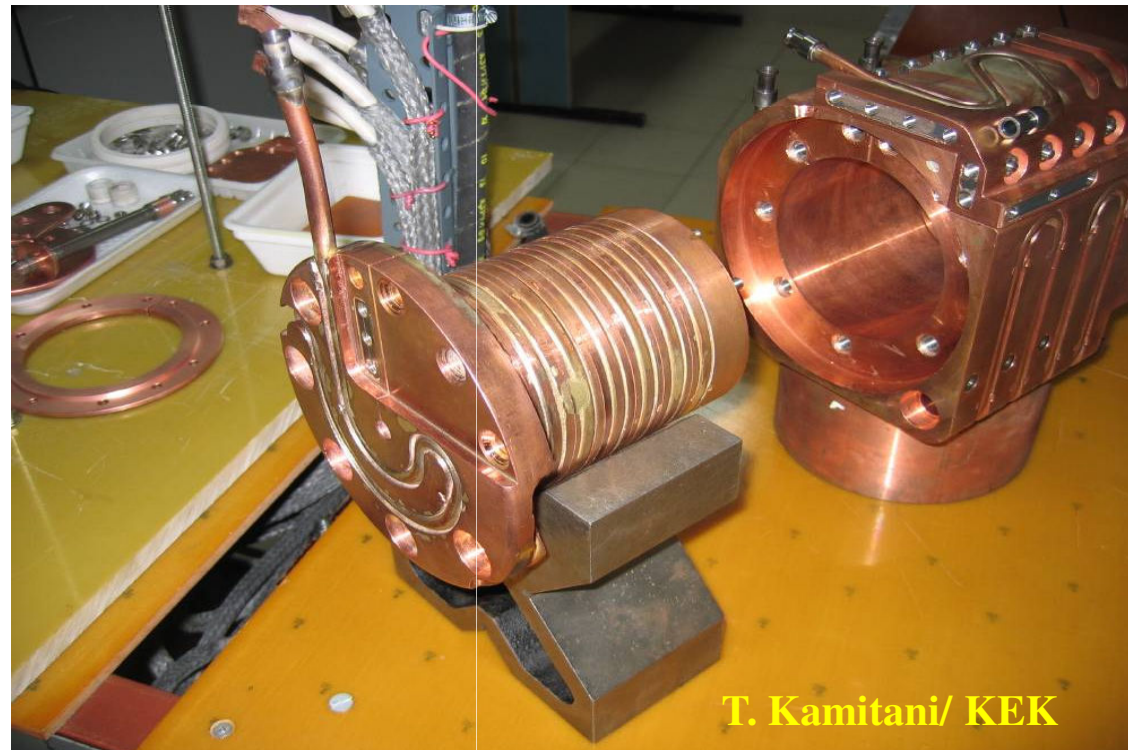


Hybrid targets reduce the energy density in the range  
**16 to 26 J/g**  
(For an primary electron beam energy of 5 GeV)

# Flux concentrator issues



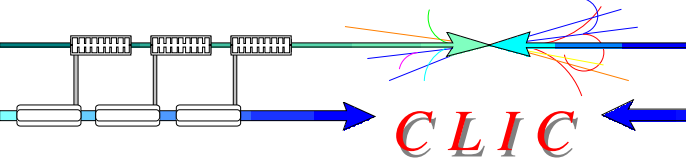
- Magnetic field on the target
- Long pulse (ILC), high repetition rate (CLIC)
- Power supply
- Engineering to handle cooling and forces



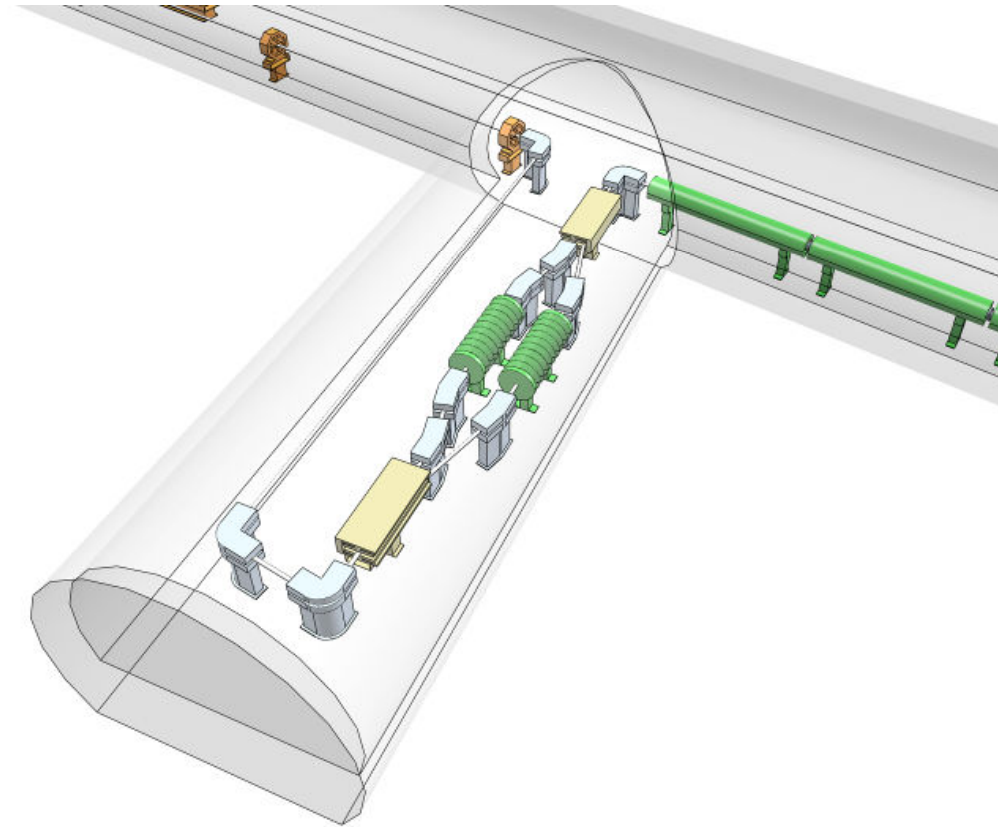


# Spin rotators before DR

K. Moffeit / SLAC

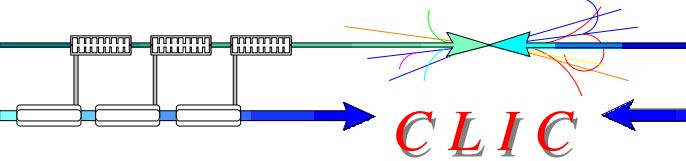


- Proposal to move from 5 GeV to 0.4 GeV in ILC
- Considerably easier magnets
- 5Hz flipping much simpler and looks tolerant



For CLIC, the spin rotators would be installed at 200 MeV

50 Hz flipping needs to be investigated



# CLIC/ILC work plan (1)



Short-term plan 2008 - mid-2009

## a) Undulator-based source

Develop Geant4 model of collimator, target, capture optics, and capture RF assembly.  
Optimise parameters wrt yield, polarisation and cost (Collaboration with ANL).  
Consider timing constraints issues and upgrade paths.  
Consider electron beam quality issues.

## b) Compton source

Design of the Compton ring (Collaboration with NSC KIPT).  
Optical stacking cavity (Collaboration with LAL and KEK).  
High power lasers.  
Stacking simulations.

## c) Lithium lens capture optics

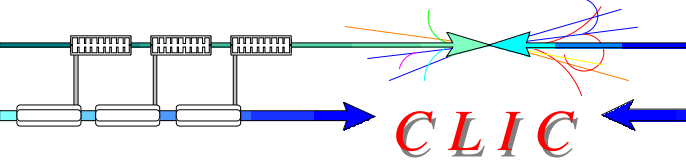
Evaluate suitability for Undulator and Compton schemes (Wide collaboration needed).

## d) Conventional sources (Conventional targets and hybrid targets)

Simulations to optimize the unpolarized  $e^+$  yield (Collaboration with LAL).  
Evaluate the applicability of the Li lens.

## e) Electron source

Set-up the CERN, CI, JLAB, SLAC collaboration for tracking studies.  
Preliminary tests at HV for the DC gun.



Long-term plan mid-2009 - mid-2010

## Undulator-based source

Consider optimal target technology: thermal load, shock waves, activation (Collaboration with LLNL).

## Compton source

Extend Geant4 model to Compton source (Collaboration with LAL)  
Stacking simulations studied in 6D.

## Lithium lens tests

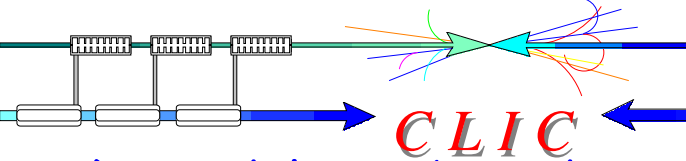
Participate to the BINP tests and CEsrTA tests.

## Conventional sources

Channelling measurements on NA63 experiment at CERN  
Perform experiments at KEKB positron source.

## Electron source

Perform tracking studies (Collaboration with JLAB and SLAC).  
Hardware tests at JLAB and SLAC for the DC gun at very HV.



## a) Undulator-based source

Develop Geant4 model of collimator, target, capture optics, and capture RF assembly.

*Studies performed by L. Zang for his phd for CLIC*

*Loss studies remain to be done.*

*Comparison with ANL results should be done.*

Optimise parameters wrt yield, polarisation and cost (Collaboration with ANL).

*Simulations and optimization performed by ANL for ILC and CLIC.*

*Report by W. Gai to this workshop.*

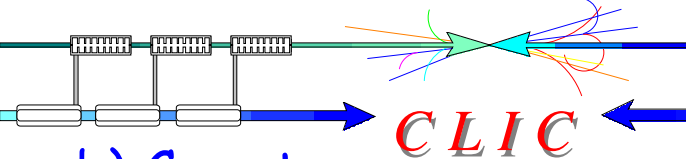
*The cost is not yet evaluated.*

Consider timing constraints issues and upgrade paths.

*No progress*

Consider electron beam quality issues.

*Report "Emittance change in the main ILC electron beam due to interaction with the positron source undulator: A review of the studies" by J. Clarke*



## b) Compton source

Design of the Compton ring (Collaboration with NSC KIPT).

*Design advanced for a CLIC Compton Ring at 1.06 GeV and double chicane.  
Report under preparation with E. Bulyak and P. Gladkikh.*

Optical stacking cavity (Collaboration with LAL and KEK).

*Cavity tested at KEK with 2 mirrors.*

*“Photon Generation by Laser-Compton Scattering Using an Optical Resonant Cavity at the KEK-ATF Electron Ring” by H. Shimizu et al., Journal of the Physical Society of Japan, Vol. 78, No. 7, July, 2009, 074501*

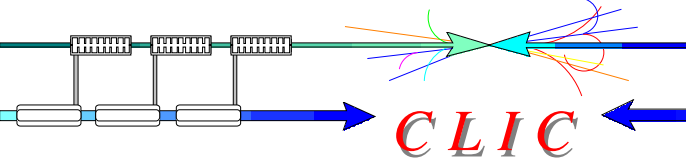
*Cavity under development at LAL with 4 mirrors (present issue is related to the laser noise)*

*“High finesse Fabry–Perot cavities in picosecond regime” by V. Brisson et al., NIM A 608 (2009)*

High power lasers.

*Important progress obtained by CELIA on a laser providing 200 W of average power with 178 MHz repetition frequency*

*“200 W picosecond fiber laser for external cavity enhancement: toward 1 MW average power” by L. Meignien et al.*

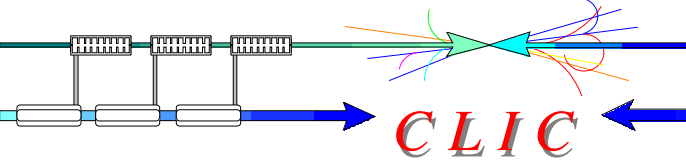


## b) Compton source

Stacking simulations.

*Simulations performed for the longitudinal plane by F. Zimmermann.  
No progress for stacking in the transversal plane.*

*A new proposal for a CLIC scheme using 2 storage rings (T. Omori & L. Rinolfi)  
Presented at POSIPOL 2009 workshop.*

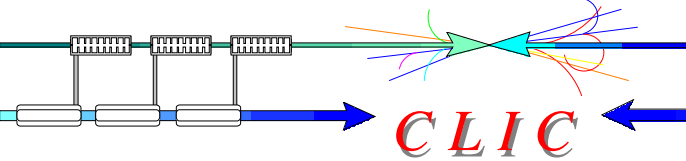


## c) Lithium lens capture optics

Evaluate suitability for Undulator and Compton schemes (Wide collaboration needed).

*Report about capture efficiency by W. Gai /ANL for the undulator  
and about feasibility of the lens by A. Mikhailichenko at ALCPG09*

*No progress for Compton schemes.*



## d) Conventional sources (Conventional targets and hybrid targets)

Simulations to optimize the unpolarized  $e^+$  yield (Collaboration with LAL).  
Evaluate the applicability of the Li lens.

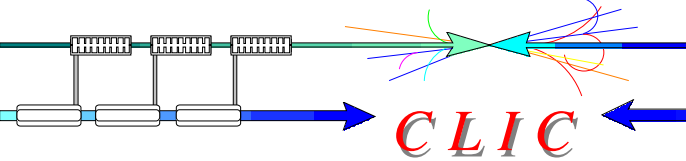
*Important progress made by LAL and CERN for the simulations.*

*A CLIC Note, written by O. Dadoun / LAL, proposing an optimized configuration for CLIC parameters, is under approval.*

*Simulations being performed up to the CLIC Pre-Damping (2.8 GeV) by A. Vivoli.  
See presentation later*

*No progress for the applicability of the Li lens*





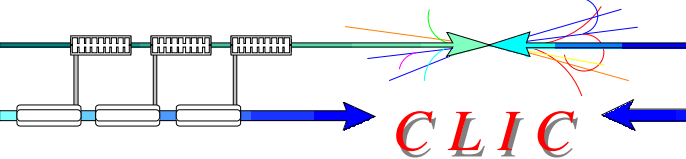
## e) Electron source

Set-up the CERN, CI, JLAB, SLAC collaboration for tracking studies.  
Preliminary tests at HV for the DC gun.

*Several official agreements signed but the complete collaboration is not yet completed.*

*Important progress have been made at JLAB for HV tests. Presentation by Matt Poelker*

*Report at this workshop by J. Sheppard for the preliminary tests for CLIC.*



# CLIC/ILC work plan (2)



Long-term plan mid-2009 - mid-2010

## Undulator-based source

Consider optimal target technology: thermal load, shock waves, activation (Collaboration with LLNL).

*Under study*

## Compton source

Extend Geant4 model to Compton source (Collaboration with LAL)  
Stacking simulations studied in 6D.

*Not yet started*

## Lithium lens tests

Participate to the BINP tests and CsrTA tests.

*Under discussion*

## Conventional sources

Channelling measurements on NA63 experiment at CERN  
Perform experiments at KEKB positron source.

*Not yet started*

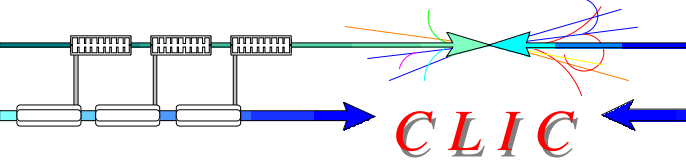
*Initial tests have started*

## Electron source

Perform tracking studies (Collaboration with JLAB and SLAC).  
Hardware tests at JLAB and SLAC for the DC gun at very HV.

*Report at this workshop by J. Sheppard / SLAC*

## Summary



- a) Major milestones have been achieved for the short-term plan 2008 - mid-2009
- b) For the long-term plan, also important results have been obtained regarding the conventional targets and the DC gun for the electron sources.
- c) Nevertheless some milestones remain to be demonstrated for the short-term plan.
- d) Time to update the plan based upon progress made and new priorities