Target Design and Photon Collimator Overview

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EUROTeV: WP4 (polarised positron source) PTCD task

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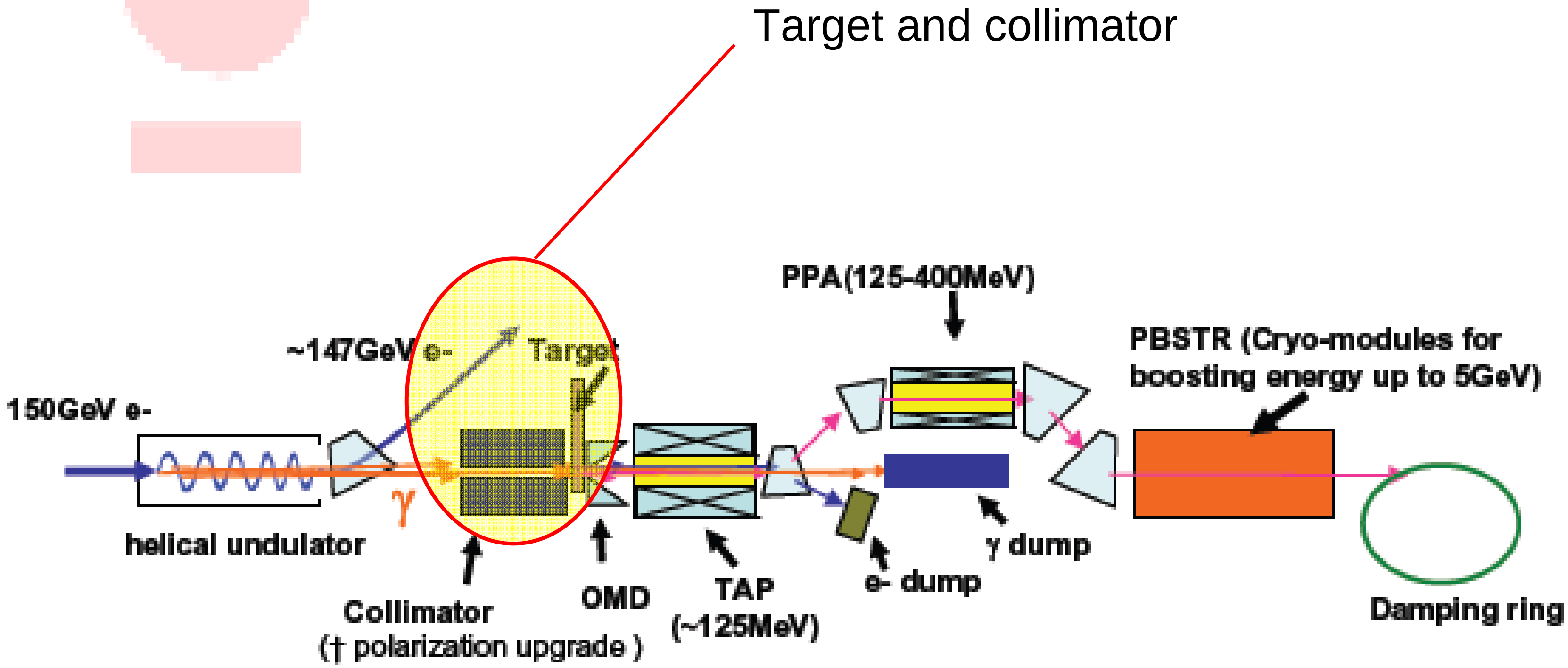
In collaboration with

Jeff Gronberg, David Mayhall, Tom Piggott, Werner Stein (LLNL)

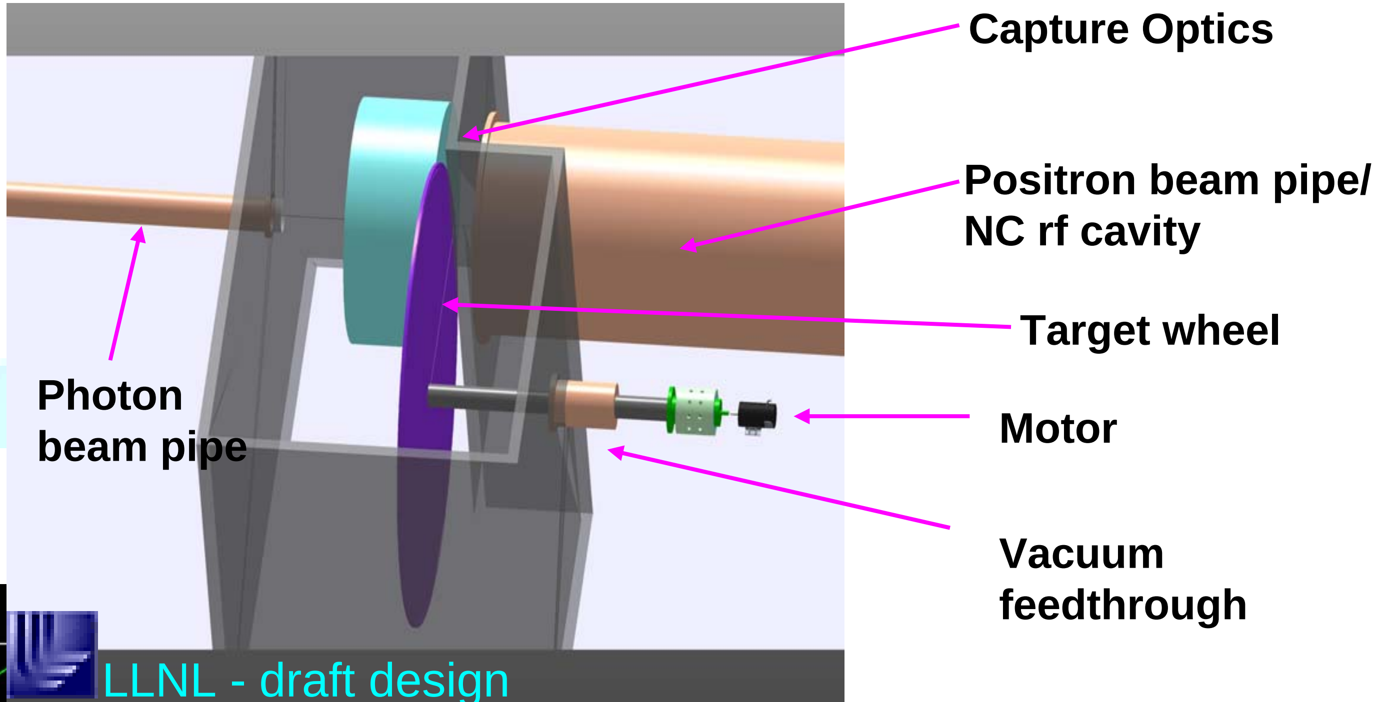
Vinod Bharadwaj, John Sheppard (SLAC)

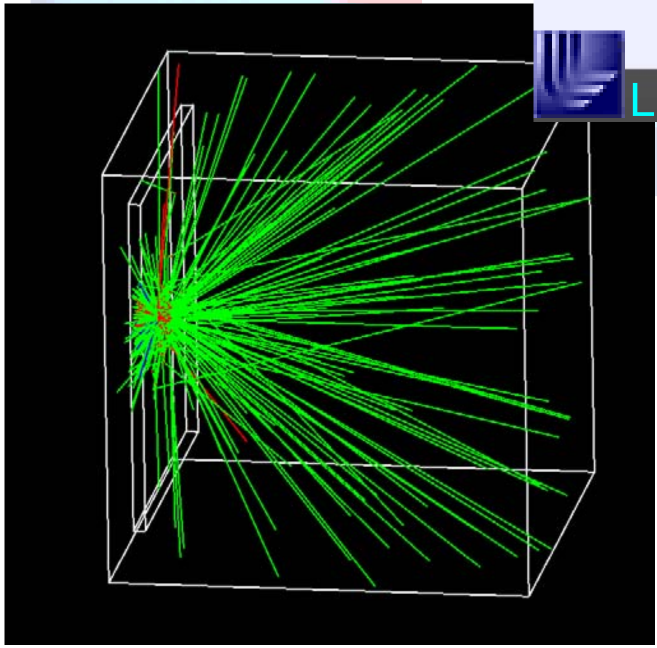
PPS Schematic - Single Target Station



Target Systems

PTCD is the EUROTeV-funded task to carry out design studies of the conversion target and photon collimator for the polarised positron source.



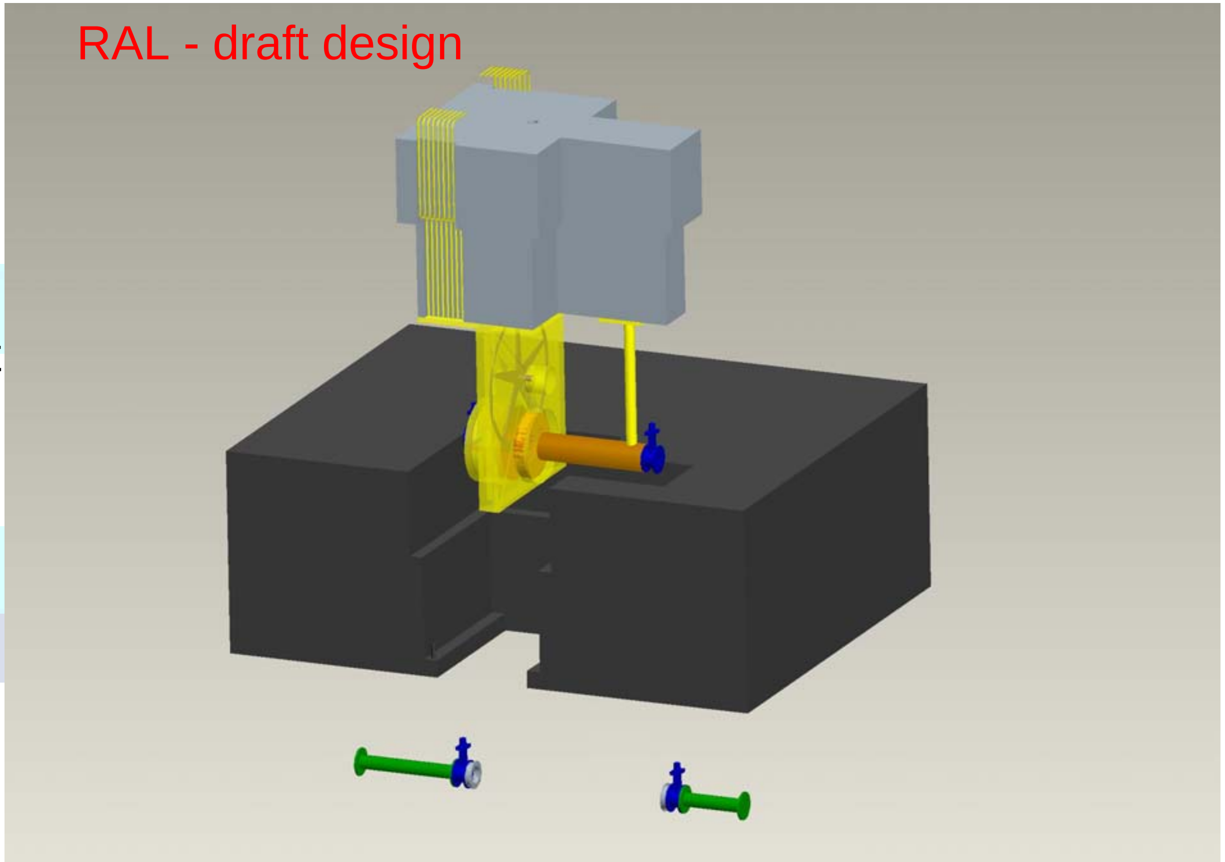


- Working in collaboration with SLAC and LLNL.
- Developing water-cooled rotating wheel design.
- 0.4 radiation length titanium alloy rim.
- Radius approximately 0.5 m.
- Rotates at approximately 2000 rpm.

Target Station - Remote Handling

Vertical remote-handling design to mimimise footprint of target hall and therefore minimise civil engineering costs.

Change over times dominated by cooling / heating of OMD magnets?



Target Wheel Design

Iterative design evolution between LLNL and DL

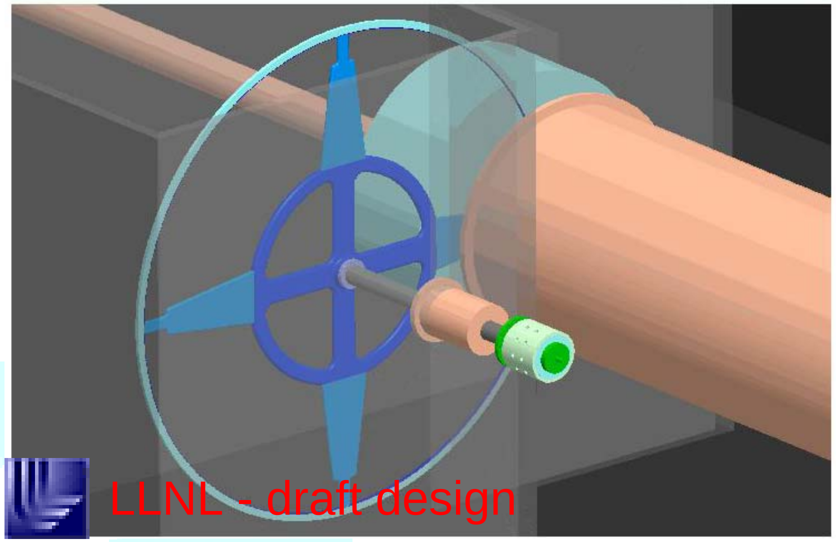
Constraints:

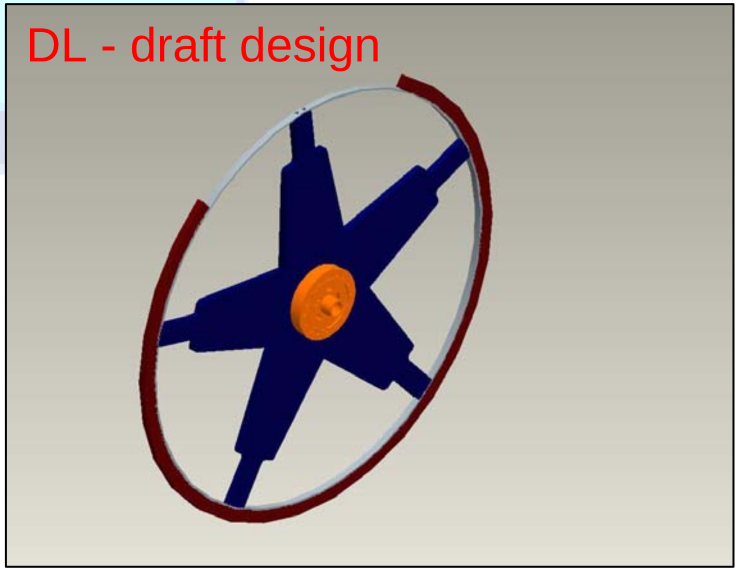
• Wheel rim speed fixed by thermal load (~30kW) and cooling rate

•Wheel diameter (~1m) fixed by radiation damage and capture optics

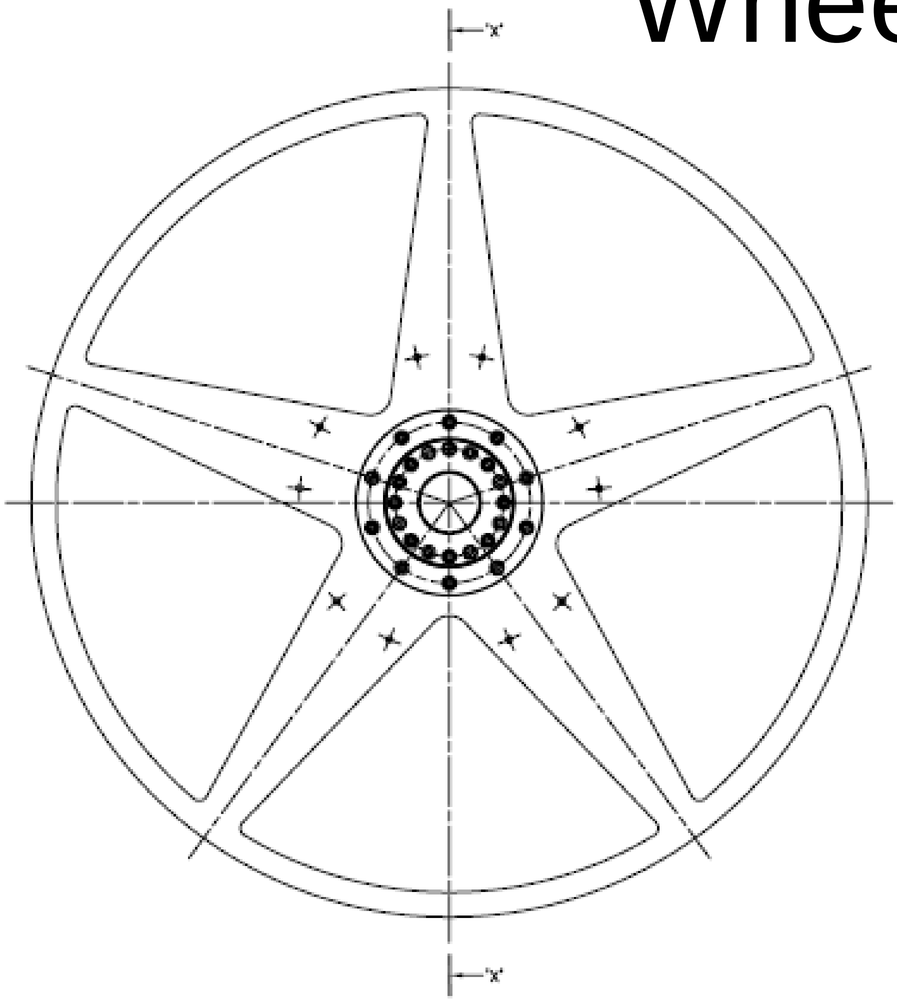
•Materials fixed by thermal and mechanical properties and pair-production cross-section (Ti6%Al4%V)

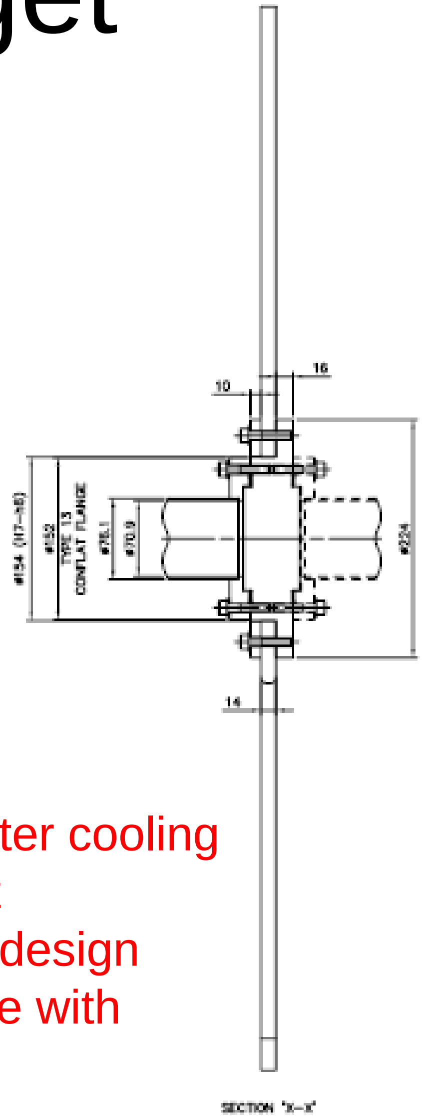
•Wheel geometry (~30mm radial width) constrained by eddy currents.





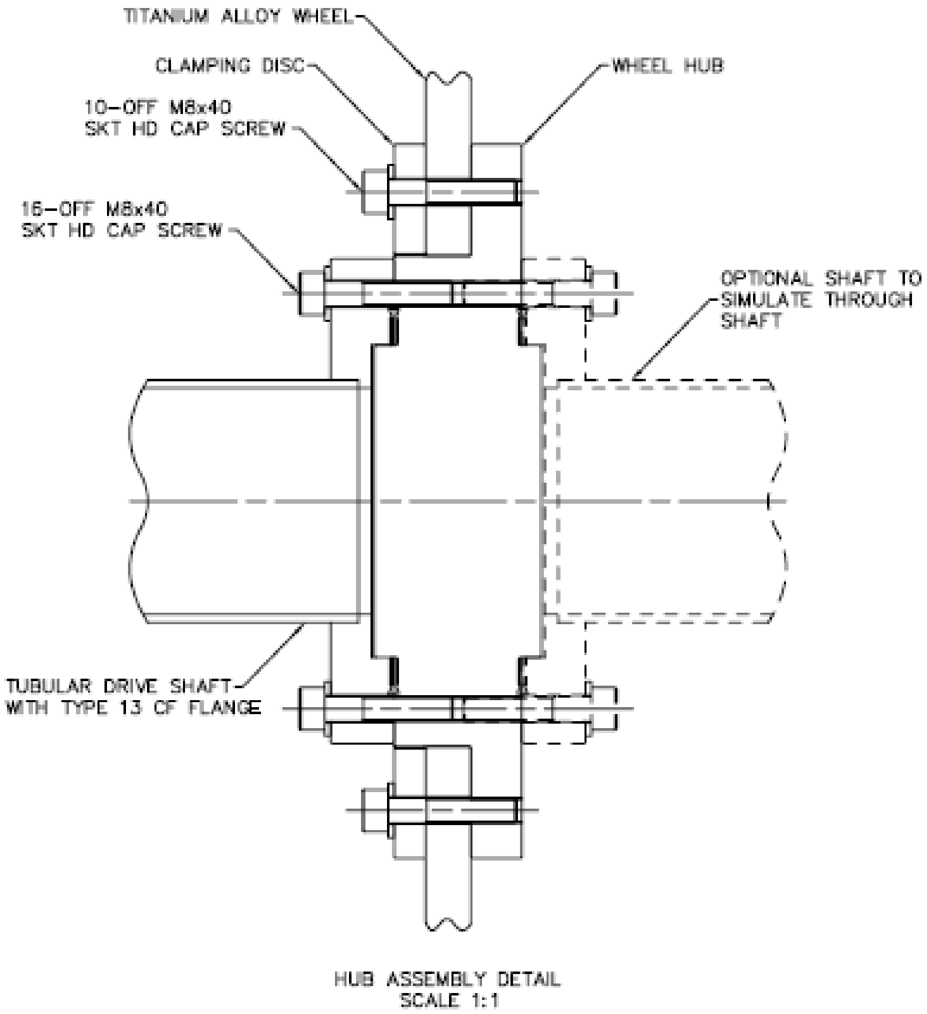
DL Prototype Target Wheel





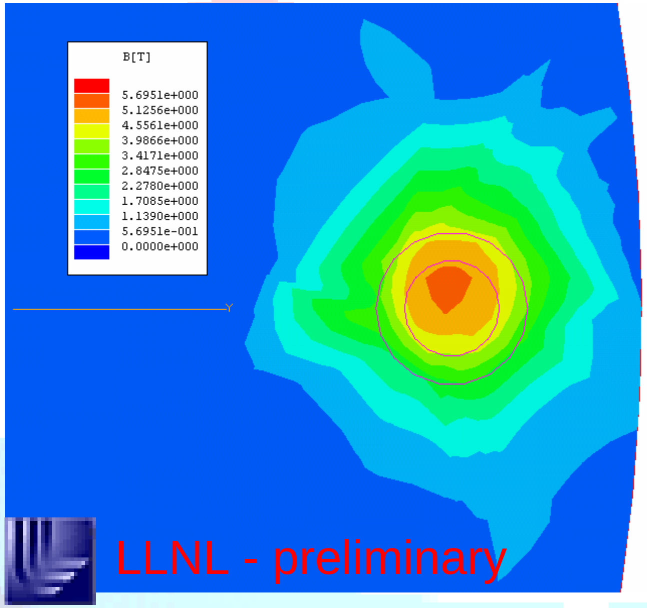
No internal water cooling channel in first prototype, but design fully compatible with channel.

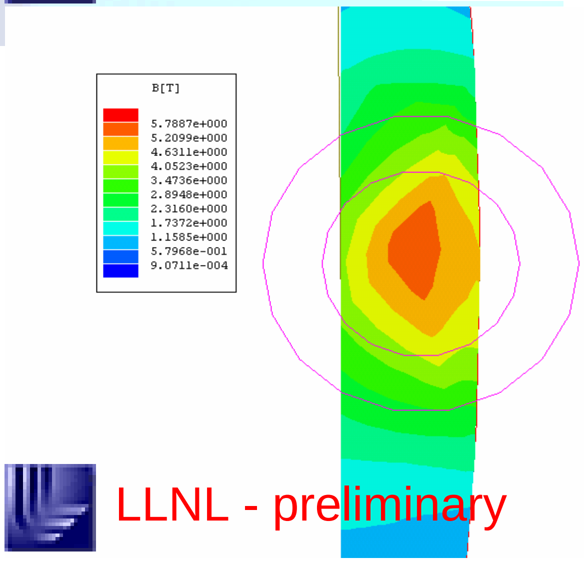
DL Prototype Target Wheel (2)



- Detail showing drive shaft and wheel hub.
- Option of cantilevered or pass-through drive shaft.
- Reducing drive shaft to 2” diameter allows use of standard feedthrough and water coupling.

Eddy Current Simulations

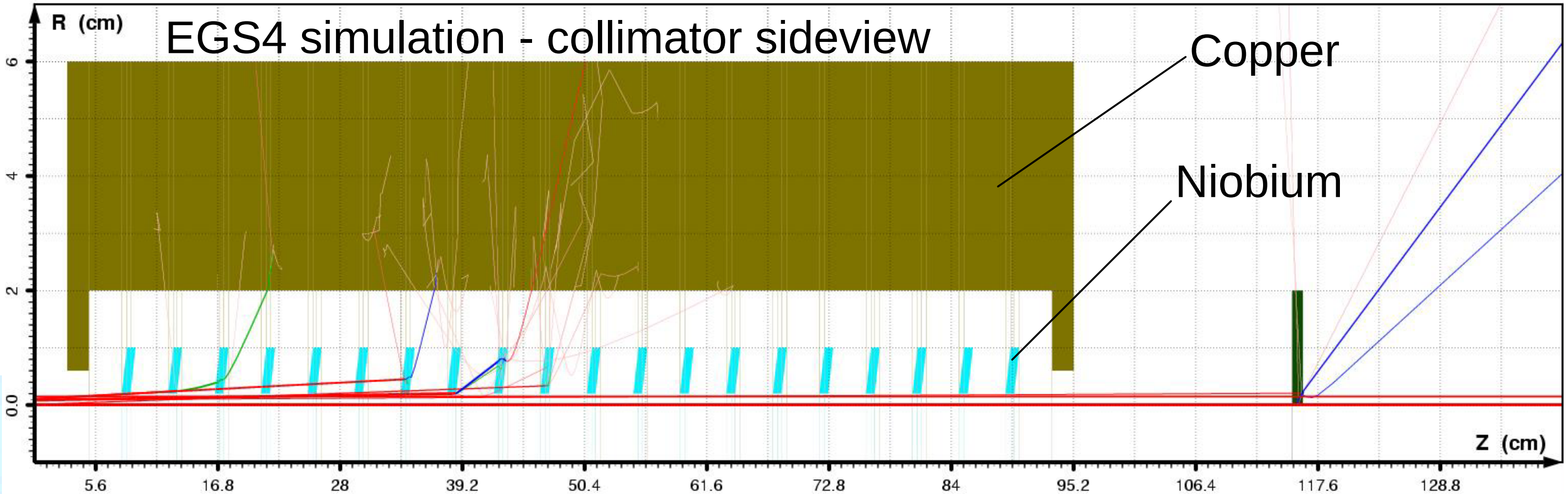


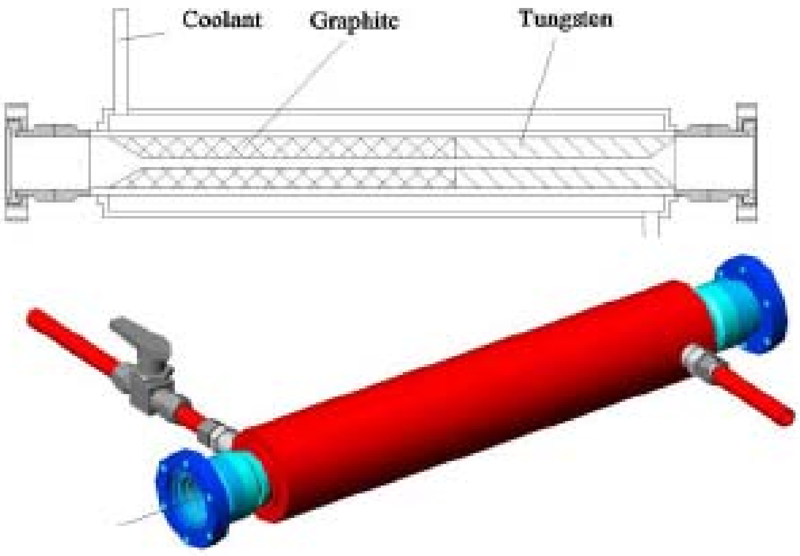


Initial “Maxwell 3D” simulations by W. Stein and D. Mayhall at LLNL indicated:

- ~2MW eddy current power loss for 1m radius solid Ti disc in 6T field of AMD.
- <20kW power loss for current 1m radius Ti rim design.
- However - LLNL simulations do not yet agree with SLAC rotating disc experiment.
  - 8” diameter Cu disc rotating in field of permanent magnet.
- OPERA-3D simulations are starting at RAL + FEMLAB at ANL.

Photon Collimator





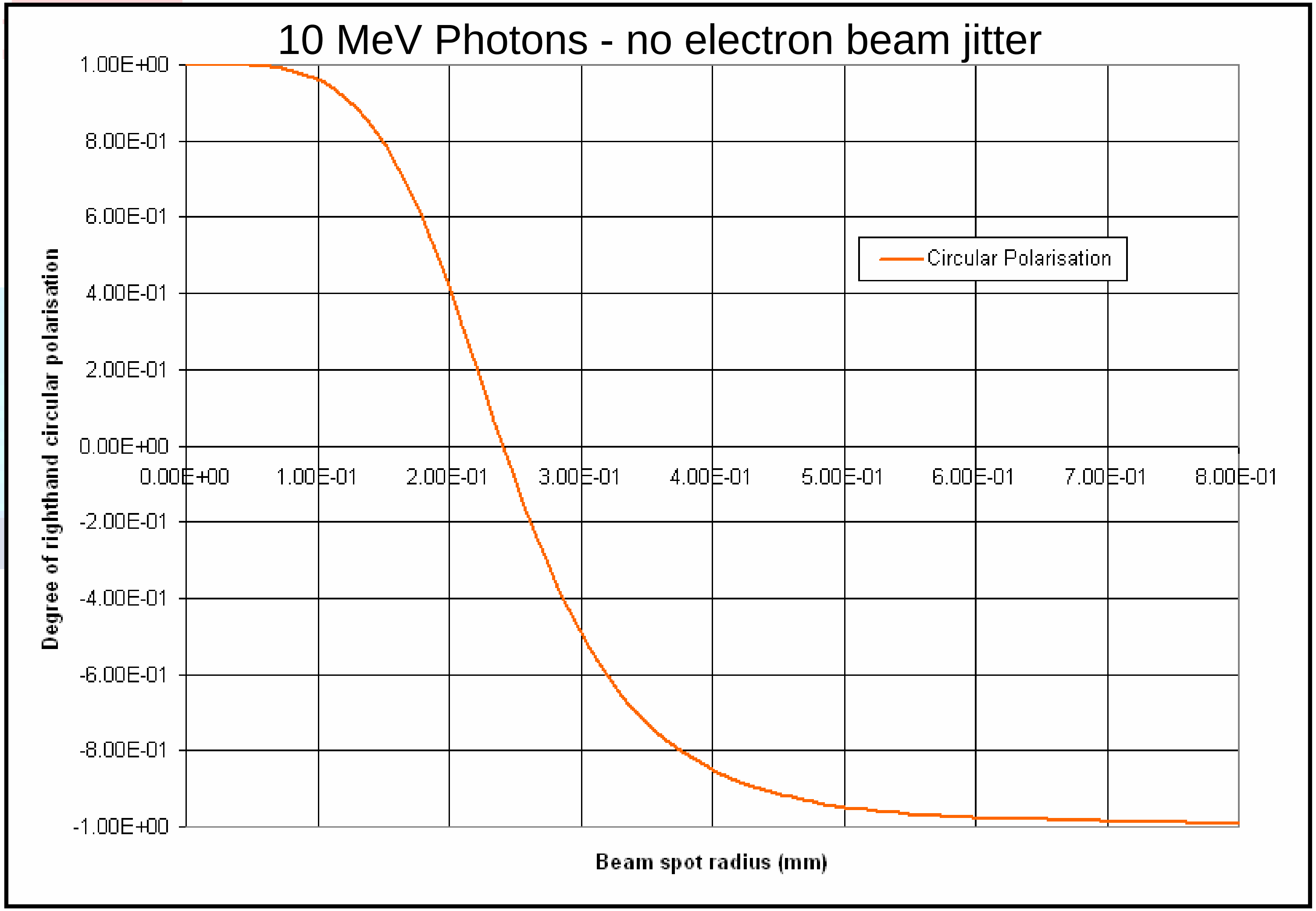
Purpose of collimator

- Scrape beam
- Adjust beam polarisation

N. Golubeva and V. Balandin, DESY

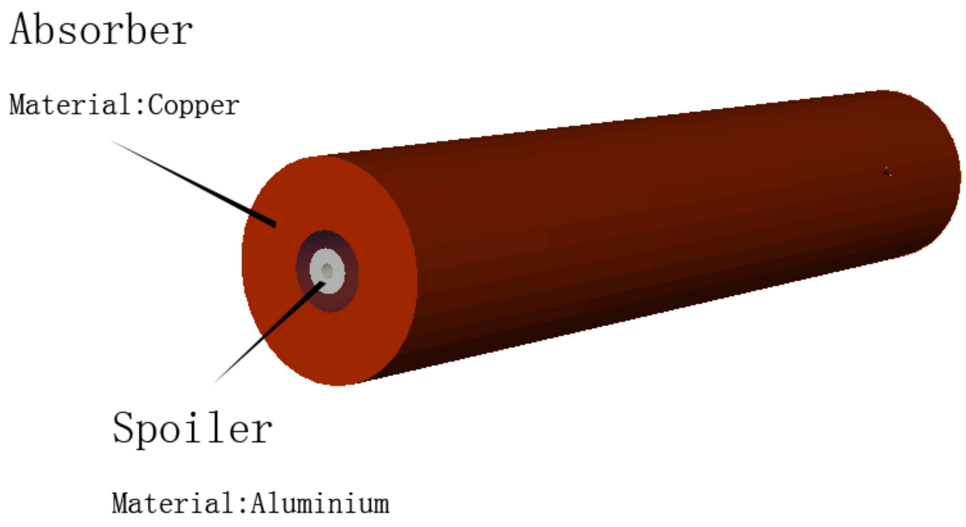
A. Mikhailichenko, Cornell

Photon Beam Polarisation



SPECTRA simulation

FLUKA Photon Collimator Simulations (1)



Starting collimator geometry:

Inner radius of spoiler 1.2mm

Thickness of spoiler 2.3mm

Inner radius of absorber 53.5mm

Thickness of absorber 160mm

Collimator length 1500mm

Assume a 300kW 10 MeV photon beam with Gaussian transverse beam profile (1mm rms):

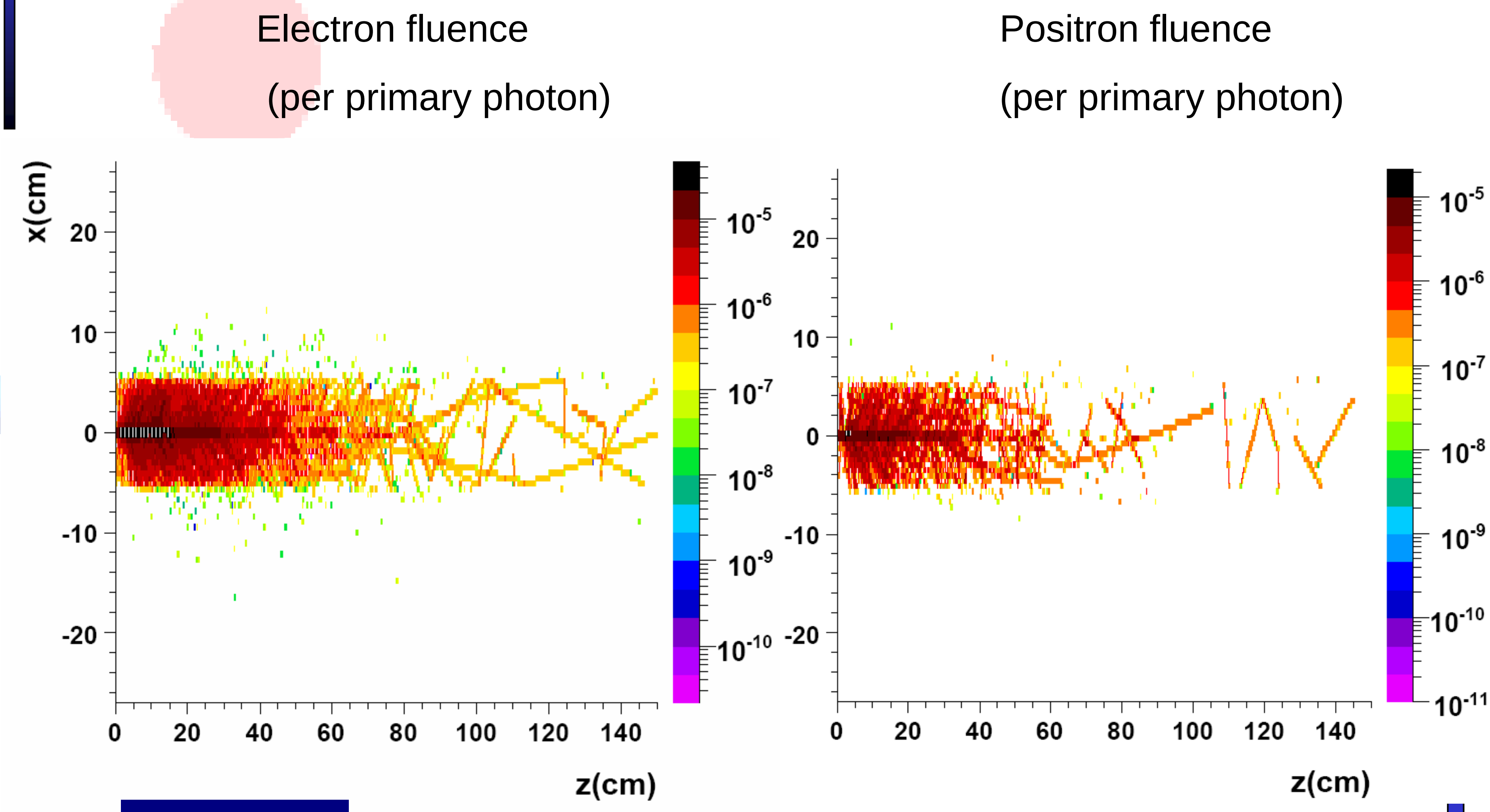
Power deposited in spoiler: ~2.5 kW

Power deposited in absorber: ~3 kW

(1.8% of total beam power)

Lei Zang, University of Liverpool

FLUKA Photon Collimator Simulations

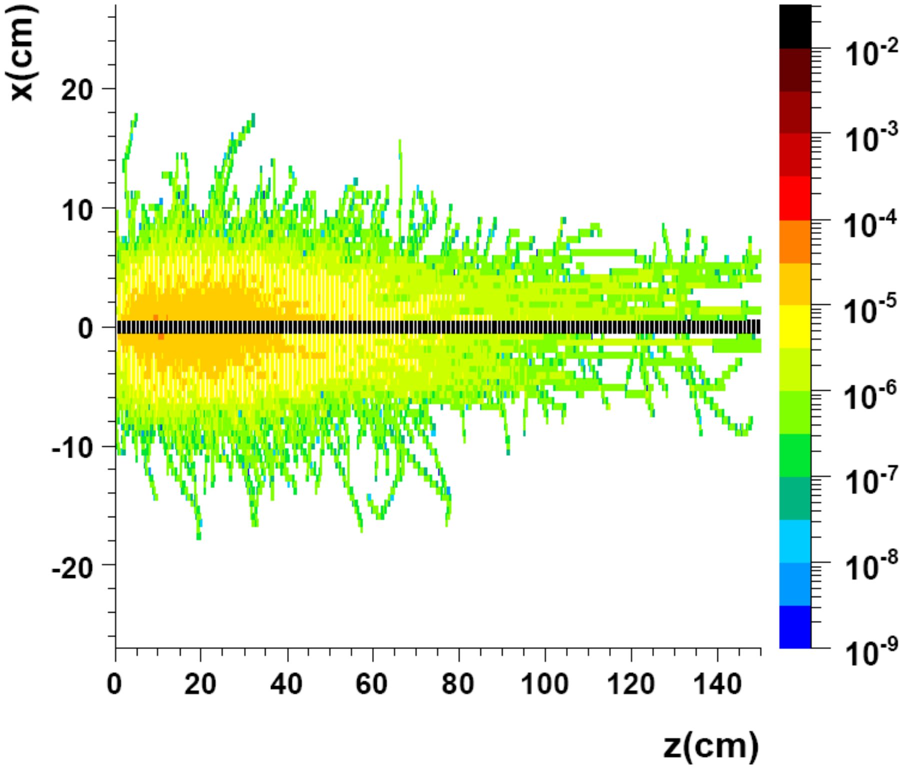


10^5 Events

FLUKA Photon Collimator Simulations

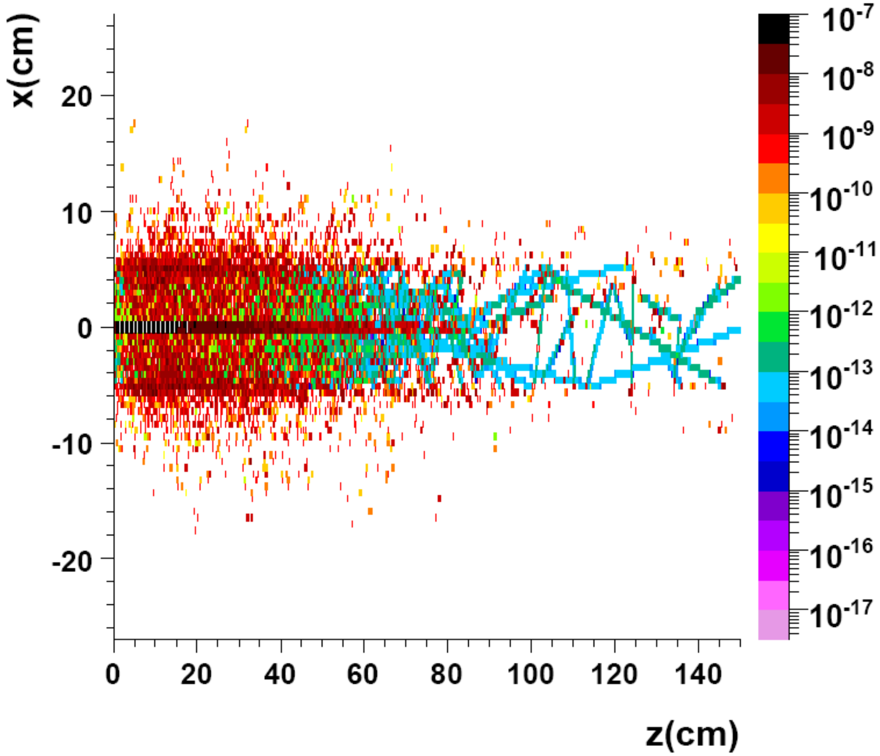
Photon fluence

(per primary photon)



Energy deposition

(GeV per primary photon)



Future PTCD Activities

Target Prototyping

- Proposing 3 staged prototypes over 3 years (LC-ABD funding bid)
- Measure eddy current effects
  - **top priority**
  - **major impact on design**
- Test reliability of drive mechanism and vacuum seals.
- Test reliability of water-cooling system for required thermal load
- Develop engineering techniques for manufacture of water-cooling channels.
- Develop techniques for balancing wheel.
- First prototype mechanical deisgn progressing well.
- First prototype instrumentation and electronics design starting.

Remote-handling design

- Essential that remote-handling design evolves in parallel with target design.
- Determines target hall layout and cost.
- Evaluaitng change-over times.

Photon Collimator design

- Use realistic photon beam.
- Activation simulations (in collaboration with DESY).
- Thermal studies and cooling design.
- Variable aperture (optimise in association with beam jitter simulations)?