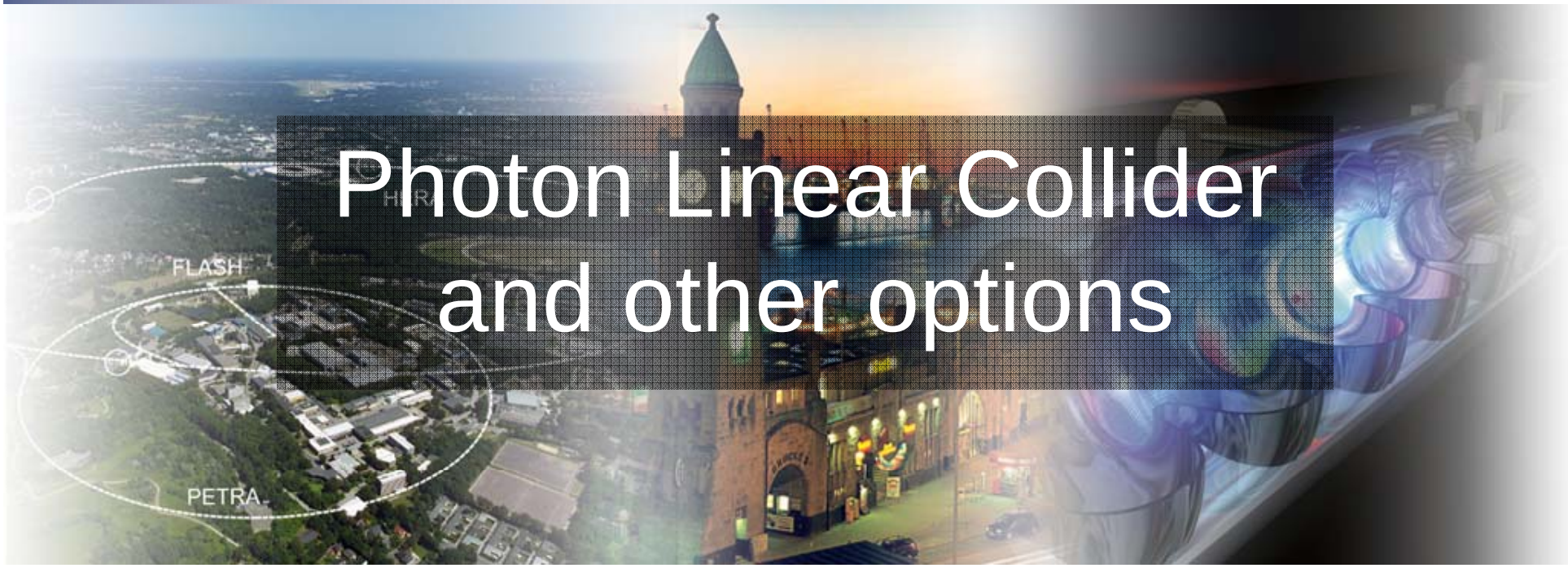
2007 INTERNATIONAL
LINEAR COLLIDER WORKSHOP

May 30 until June 3, 2007

Worldwide Study of the Physics and Detectors for Future Linear e^+e^- Colliders

DESY



Photon Linear Collider and other options

Jeff Gronberg / LLNL

June 3, 2007

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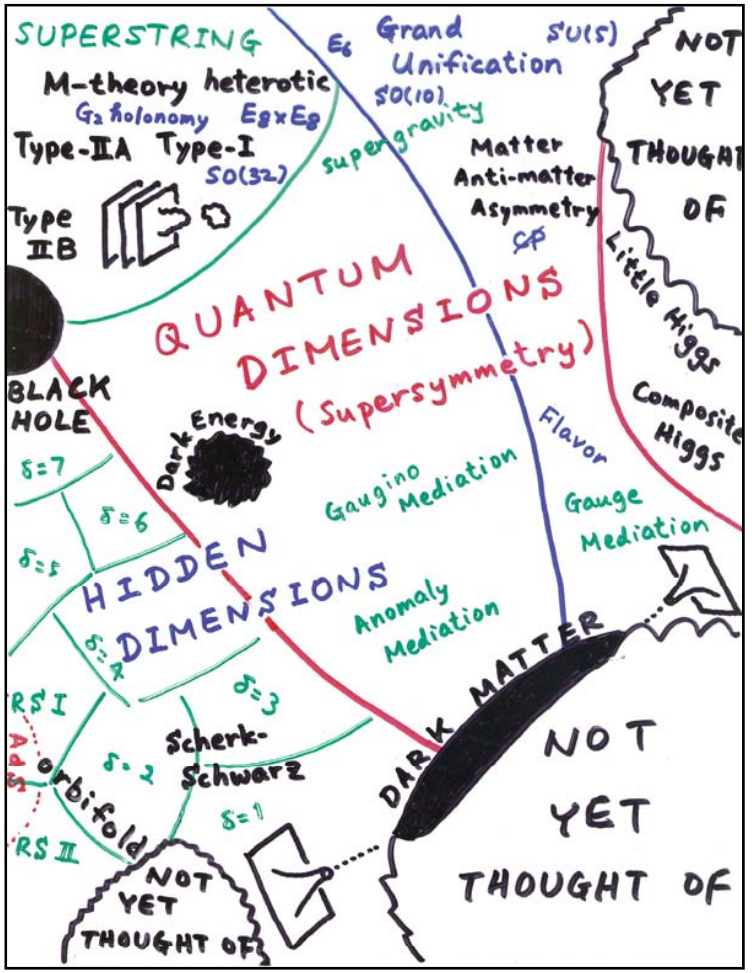
The ILC will be a critical tool for understanding the new physics beyond the Standard Model

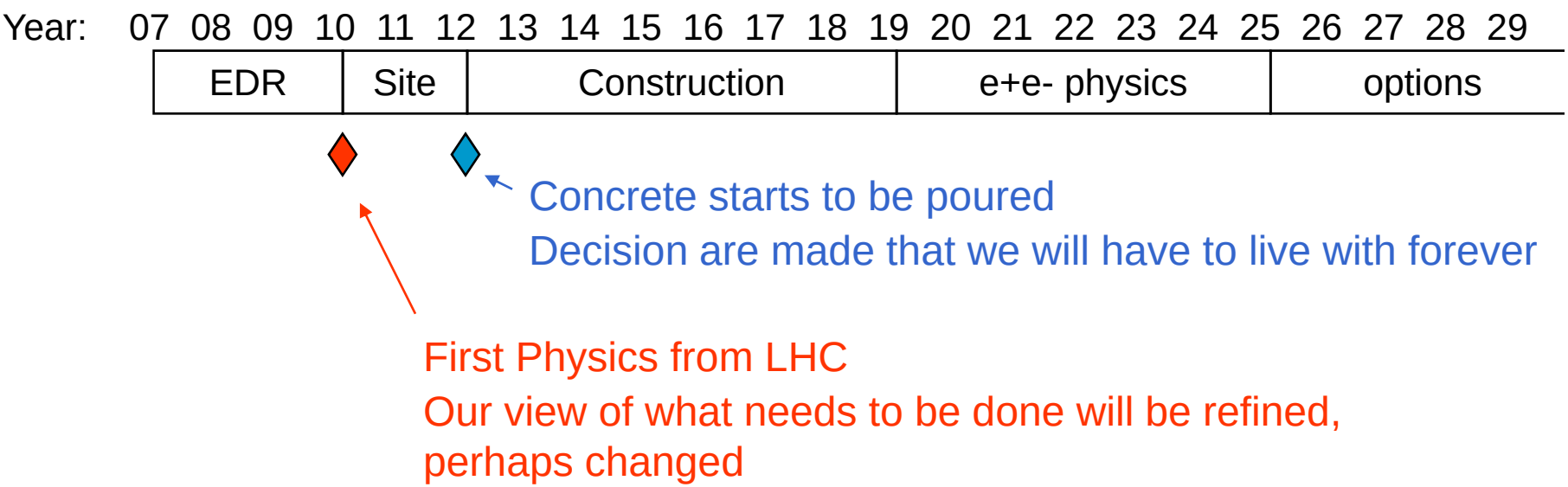
- Various options exist to enhance the capabilities of the basic machine to study new physics
  - e^-e^-
  - Polarized positrons
  - Giga-Z
  - Photon Linear Collider
  - Energy upgrade

- All have implications for the design of the baseline machine
  - Does including capability in the baseline significantly reduce cost compared to later retrofitting
  - In the post-baseline running does construction interfere with running and impose an opportunity cost



H. Maruyama

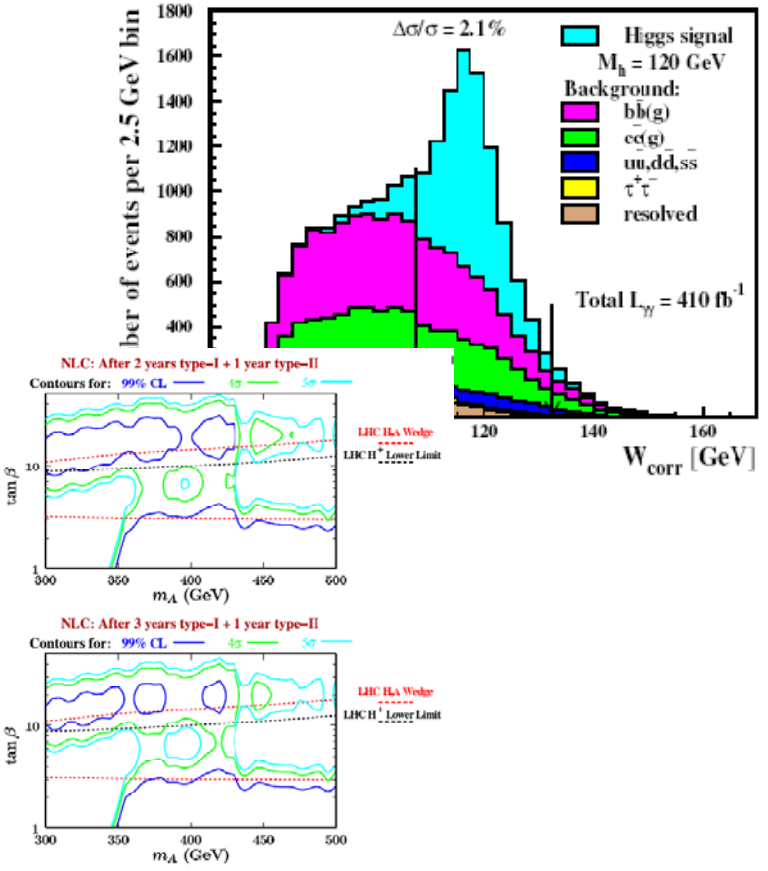
The options seem a long way off but some critical decisions are coming soon



We need to be ready to make decisions for the baseline machine to maximize it's physics potential for the long term.

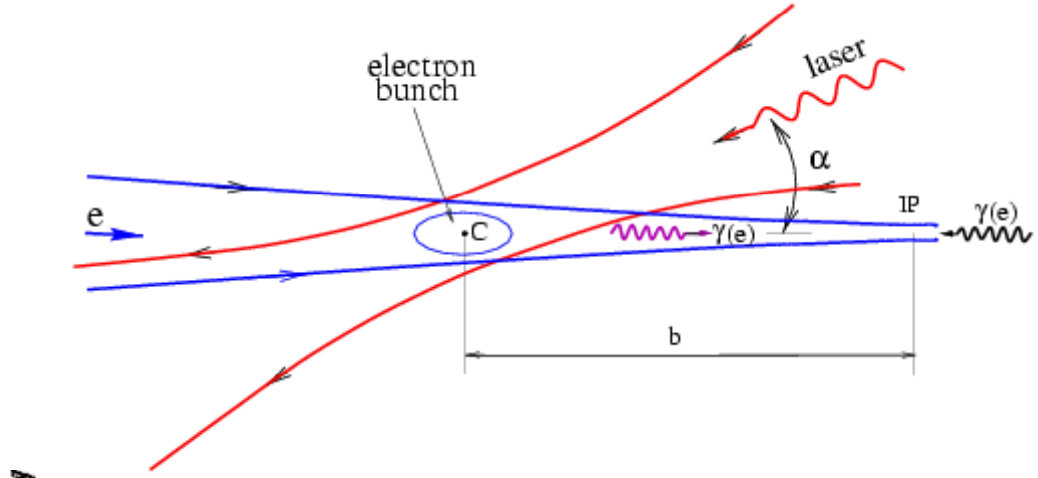
Photon Linear Collider physics is a valuable addition to the base program

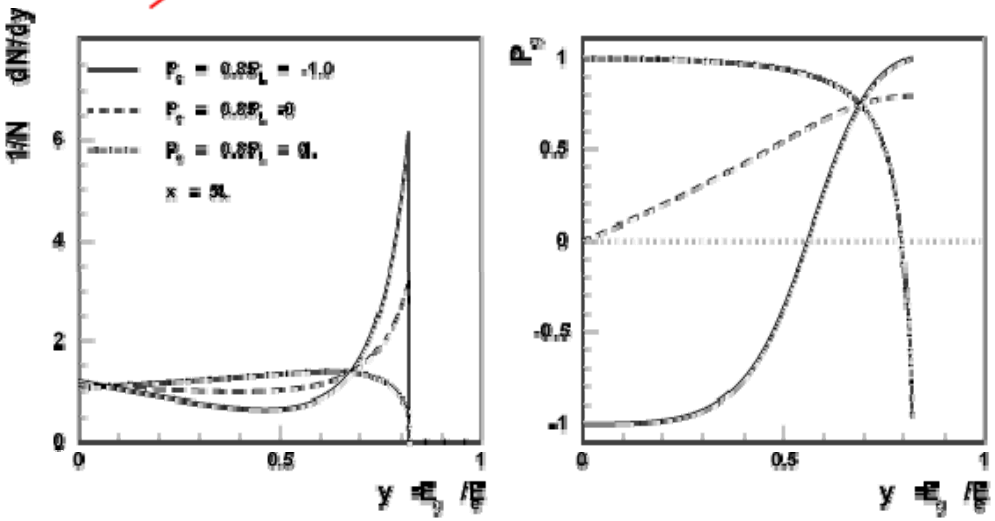
- PLC allows direct production neutral C=+ parity spin zero objects
  - Higgs
- Greater energy reach for SUSY H and A
  - Covers LHC wedge
- Linear polarization allows initial state of definite CP
- Double and single W production probes anomalous couplings
- Etc.



Physics case was reviewed at Jeju 2002 by the wider community
Photon Collider was determined to add real value to the physics program

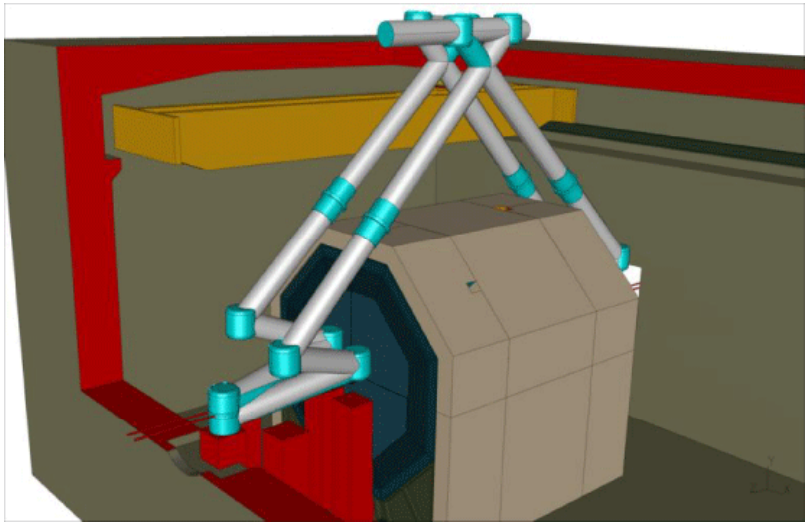
Photon Linear Collider (PLC)

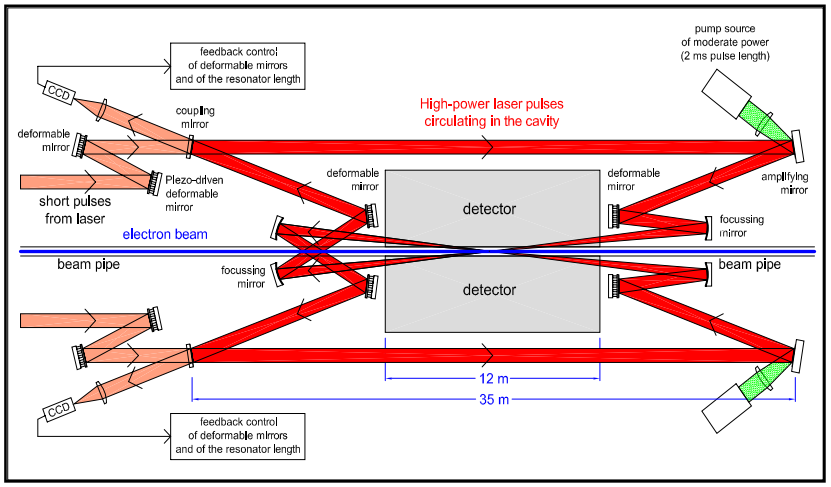




- Laser Compton interaction produces beam of high energy photons
  - Eg <= 0.8 Ebeam
- Peak has high circular polarization
  - Linear polarization is also possible
  - CP studies

The baseline laser is two resonant stacking cavities

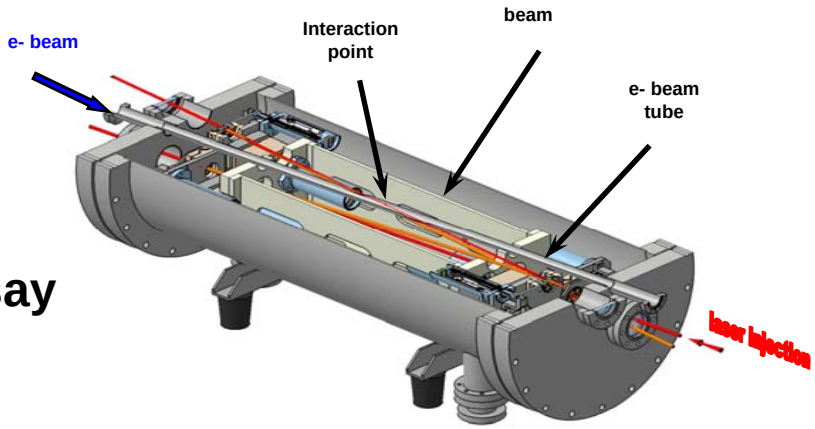




- DESY-Zeuthen/MBI design
  - One cavity per beam
  - 369ns round trip matched to the beam spacing
  - Factor 300 enhancement of laser energy in the cavity
    - Enormous reduction in laser power is gained

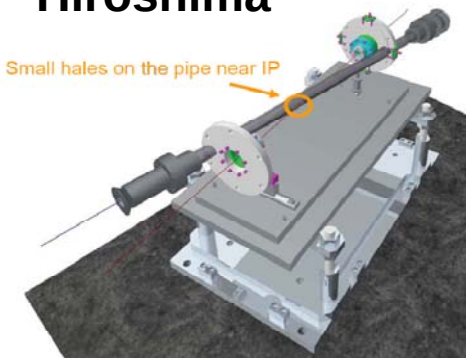
Compton light sources are developing the laser technology

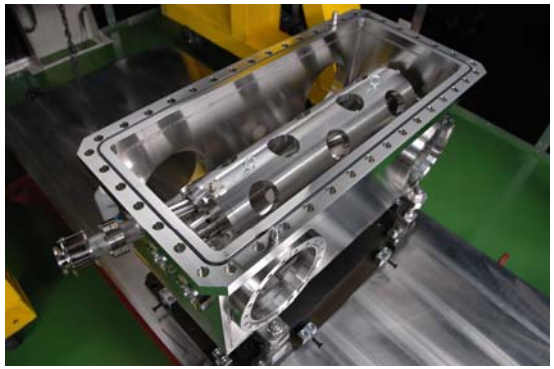
LAL - Orsay



- Resonant cavities are being developed for:
  - Polarized positron source
  - Laser wire
  - Beam diagnostics
  - Medical and industrial applications
  - Photon collider

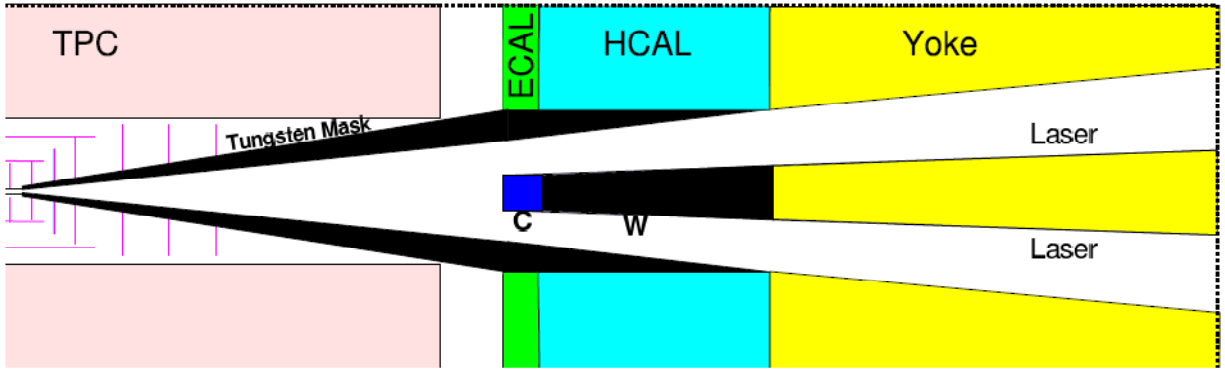
KEK - Hiroshima



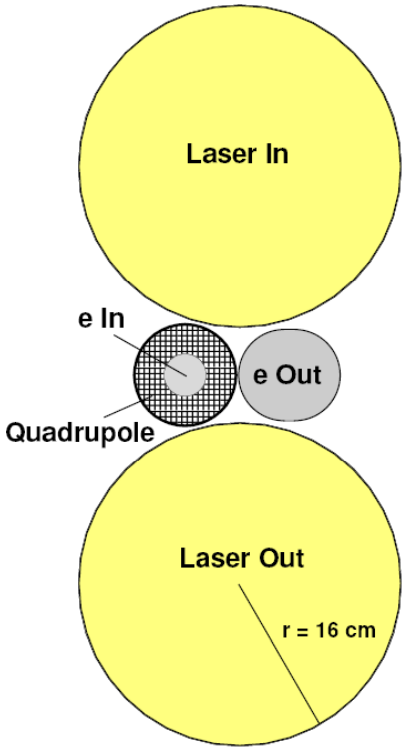


Laser development is being pushed by applications inside and outside of HEP

PLC modifications required from the detector



- Photon collider requires:
  - Line-of-sights for each laser cavity
  - Expanded aperture exit line
  - Modified masks
  - Space in the hall for laser plant
  - etc.



K. Moenig

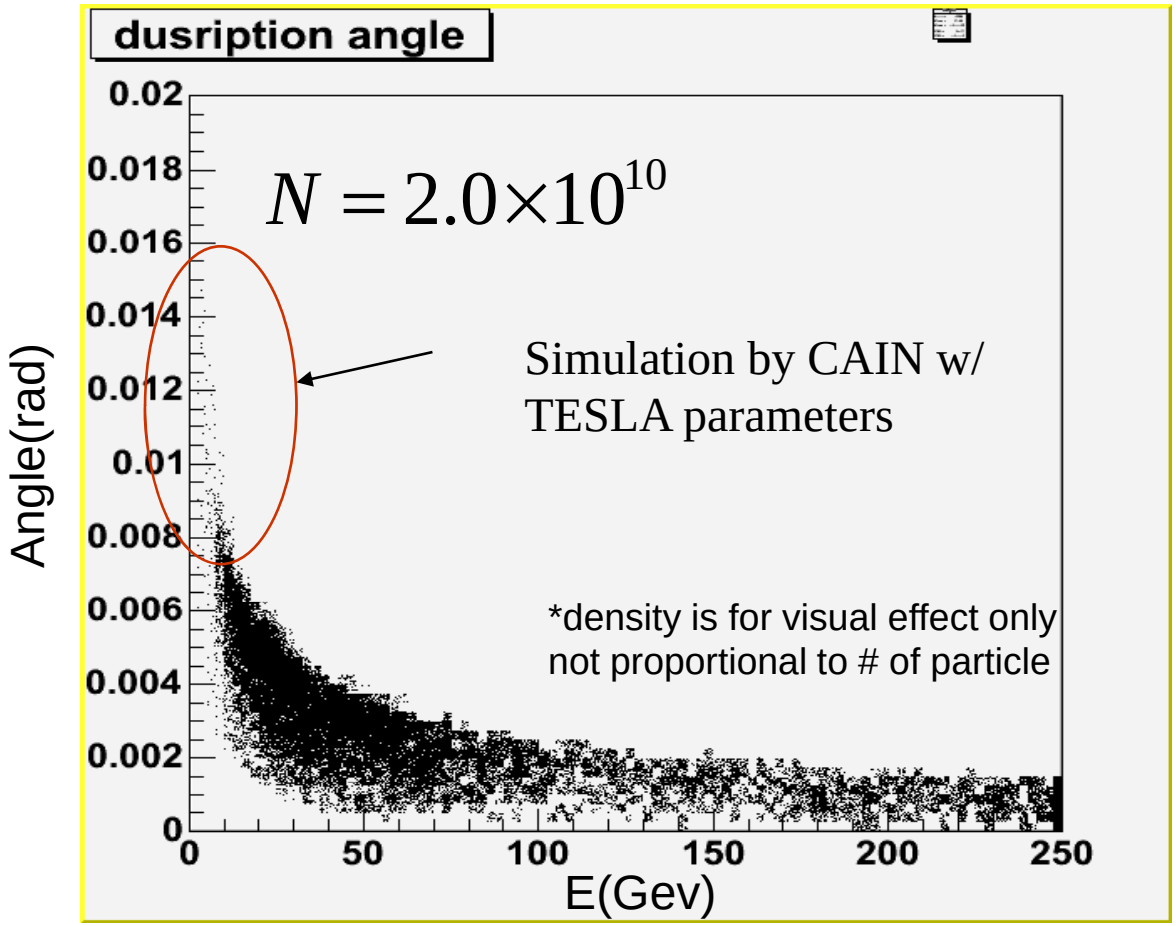
It will be enormously cheaper to retro-fit a detector for photon collider operations if some attention is paid today

PLC requires e-e- running

- e-e- option requires that the positron arm be converted to electron running
- Photon collider requires e-e- operations.
  - Positrons can Compton backscatter, but…
  - High electron polarization increases gg luminosity
  - e-e- collisions reduces physics backgrounds
- For electron operation in the positron arm some capabilities must be in place
  - Polarized electron source
  - Capability to switch some magnet and kicker polarities
- Polarized electron source requires infrastructure upfront
- Magnet polarities may be nothing more than being aware upfront that it may need to be done.

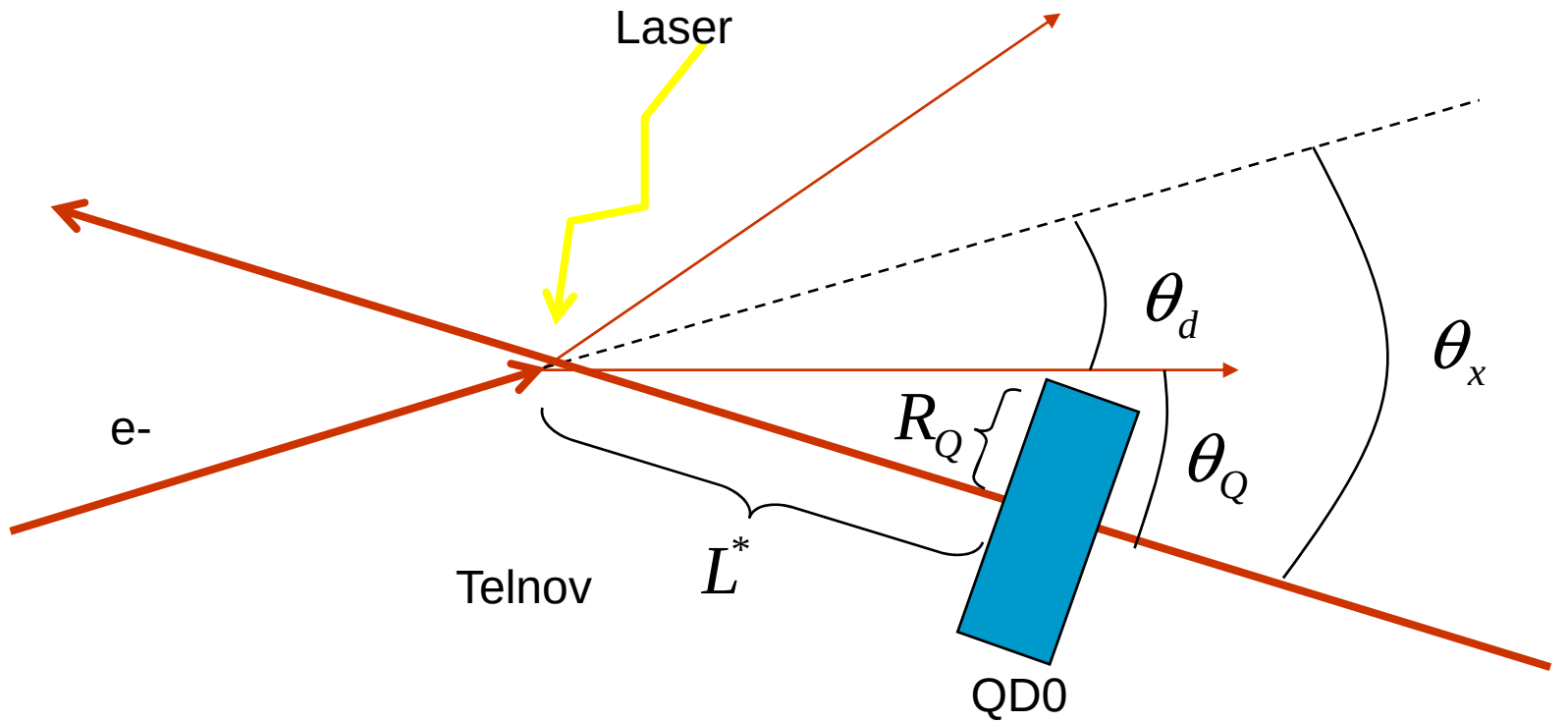
Disruption is a limiting factor in the γγ Interaction Region design

- Compton backscattering leaves a large energy spread
- Beam-beam deflection at the IP gives an angular kick to the beams



T. Takahashi

The Photon Linear collider must have a 25 mr crossing angle



T. Takahashi

- Physical overlap between the extraction line and the final focus quad sets the minimum crossing angle

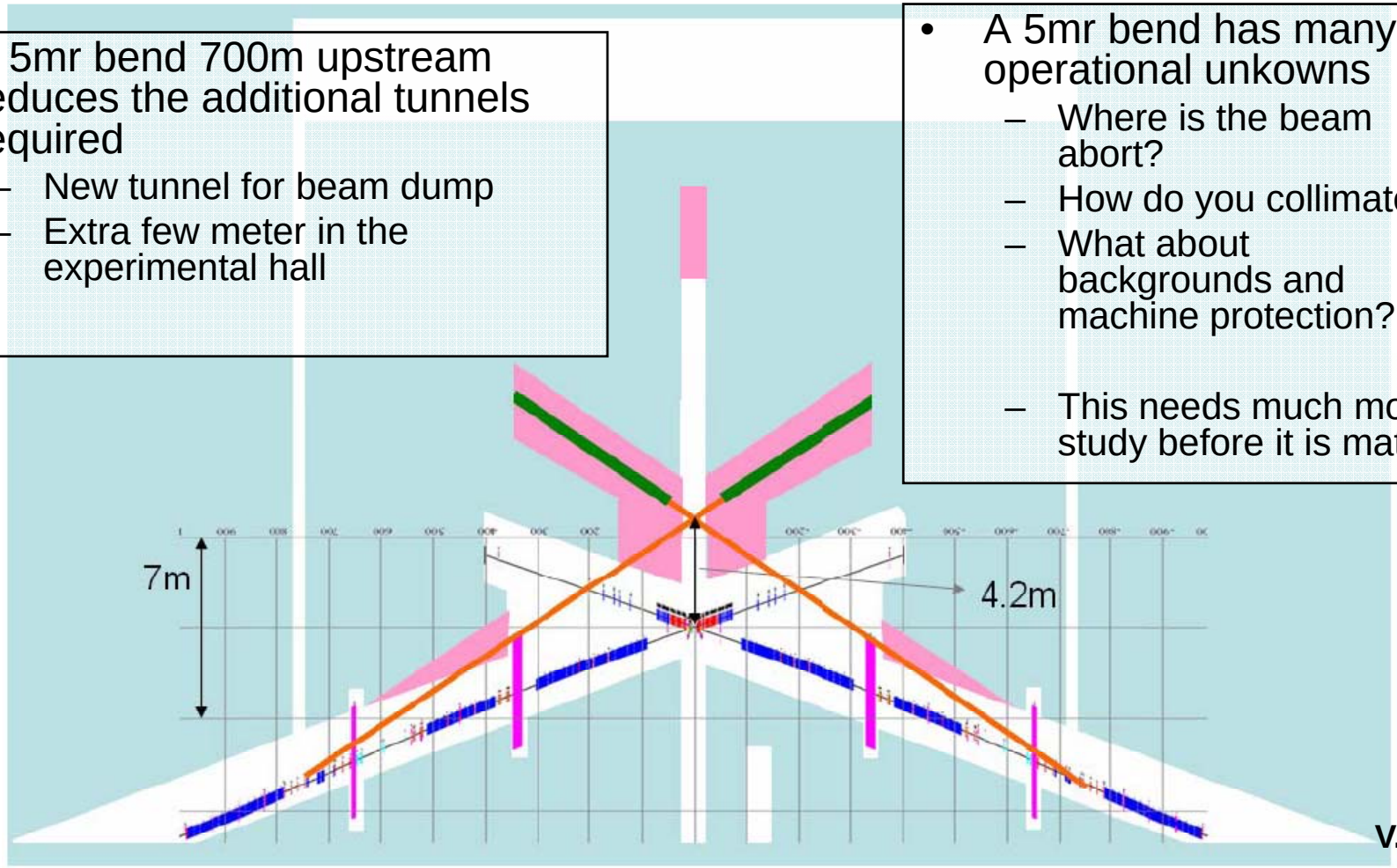
Bend at 700m has cheaper conventional facilities but has operational issues

14mr => 25mr

A.Seryi, LCWS06

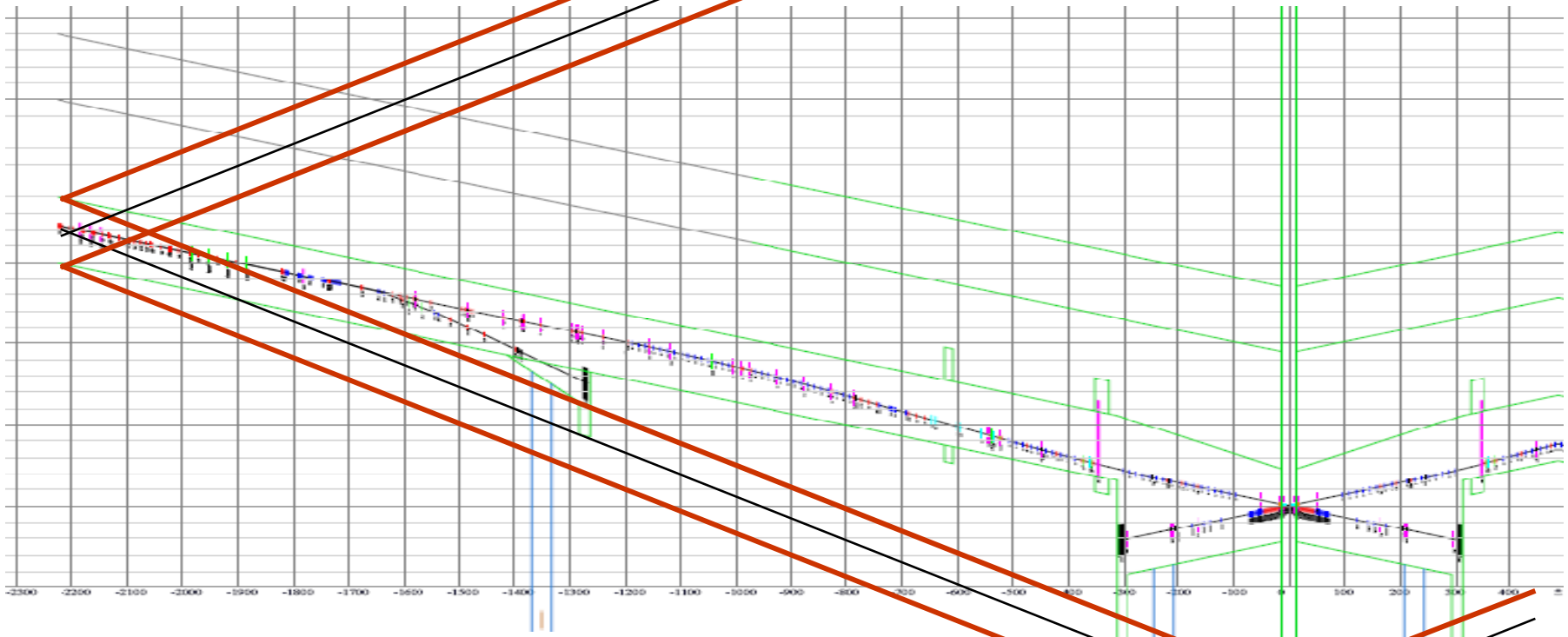
- A 5mr bend 700m upstream reduces the additional tunnels required
  - New tunnel for beam dump
  - Extra few meter in the experimental hall

- A 5mr bend has many operational unkowns
  - Where is the beam abort?
  - How do you collimate?
  - What about backgrounds and machine protection?
  - This needs much more study before it is mature



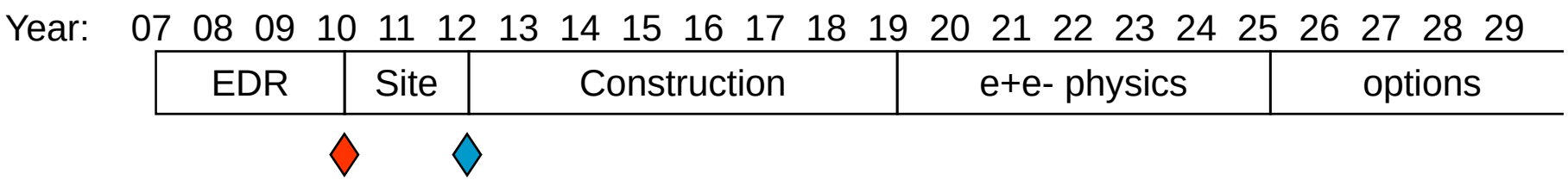
V. Telnov

Additional full length tunnels for 25mr will be expensive and may interfere



- Putting in a second tunnel will be expensive but is well understood
- Positioning the tunnel beside the first may save some money
  - We need to know where the tunnel will go so we can avoid interferences in the baseline
  - It may be worthwhile to add tunnel stubs

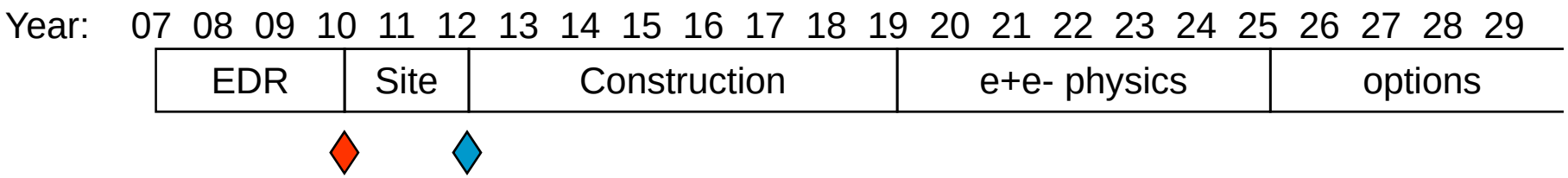
Opportunity costs – Fitting it all together



- Implementing an option in the future is more than just money and time
  - Disruptions to operations can weigh against shutting down for modifications for an option
  - Alternately, if a long shutdown for energy upgrade is required, perhaps that increases the attractiveness of options

We need to have a better idea of probable scenarios for post-baseline operations

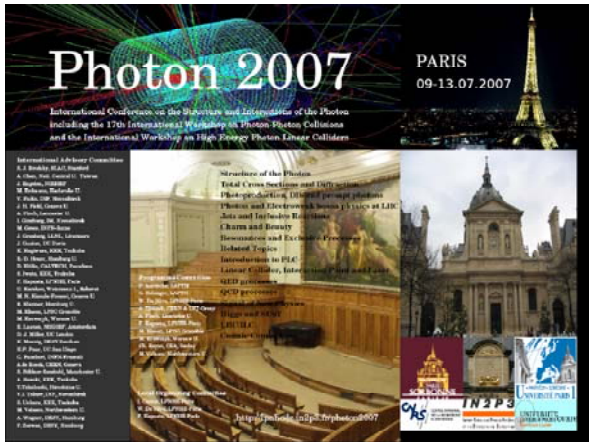
We would like to have some studies in place around the same time as the EDR



- Establish a baseline upgrade plan
  - Especially understand the BDS
- Costing
  - Estimate cost to retro-fit for plc after baseline running
  - Determine the cost of “hooks” that can be put into place in the baseline to reduce later cost/time
  - Ensure that zero cost baseline choices which enhance/block the plc are chosen to enhance.
- Program impacts of required construction
  - Does shutdown for energy upgrade leave time for a plc program?
  - Is energy upgrade construction concurrent with running, no gap?
  - Do PLC modifications cause issues for returning to 14mr?
- Physics justification

Upcoming PLC related conferences and workshops

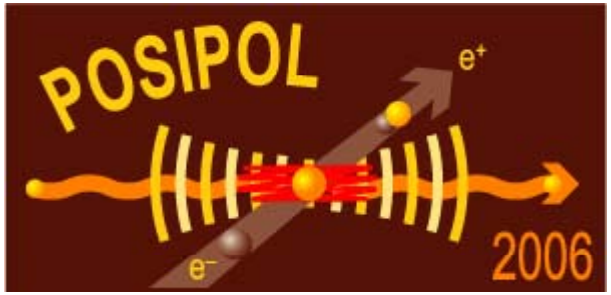
- Photon 2007 Paris in July
  - Workshop on photon linear colliders and physics of photon-photon collisions



- Hiroshima workshop on intense laser electron beam interactions, Dec 2007

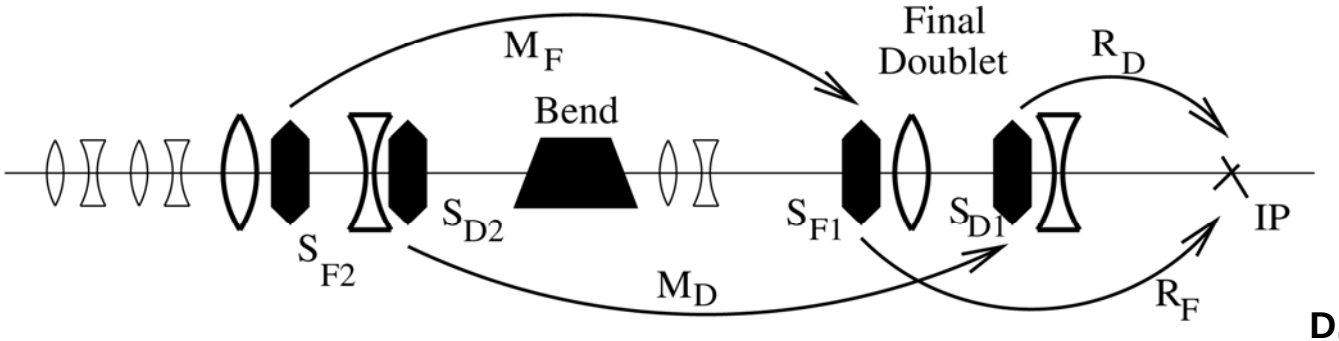
広島大学

- Posipol 2008, Hiroshima in May
  - Laser and resonant cavities for photon beam production



Extra slides

A dedicated final focus design can maximize luminosity

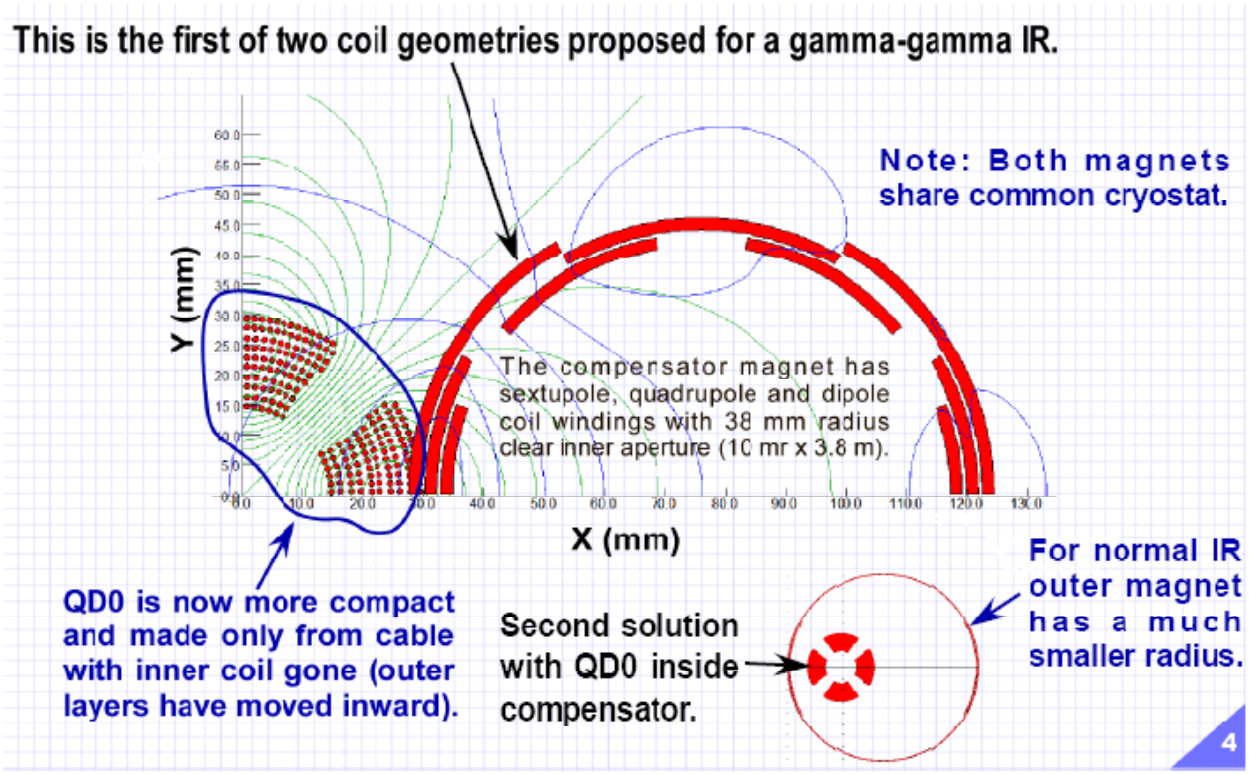


D. Asner

- Beam-beam interaction does not limit our usable luminosity
  - We want a small spot size at the IP
  - We should have our own optics which reduces the β_x
- There is a limit to how useful this is, dependent on the energy spread and the emmittance

- A beam transport simulation should be performed to decide on a baseline for our optics system

Real designs for the extraction line magnets have been produced



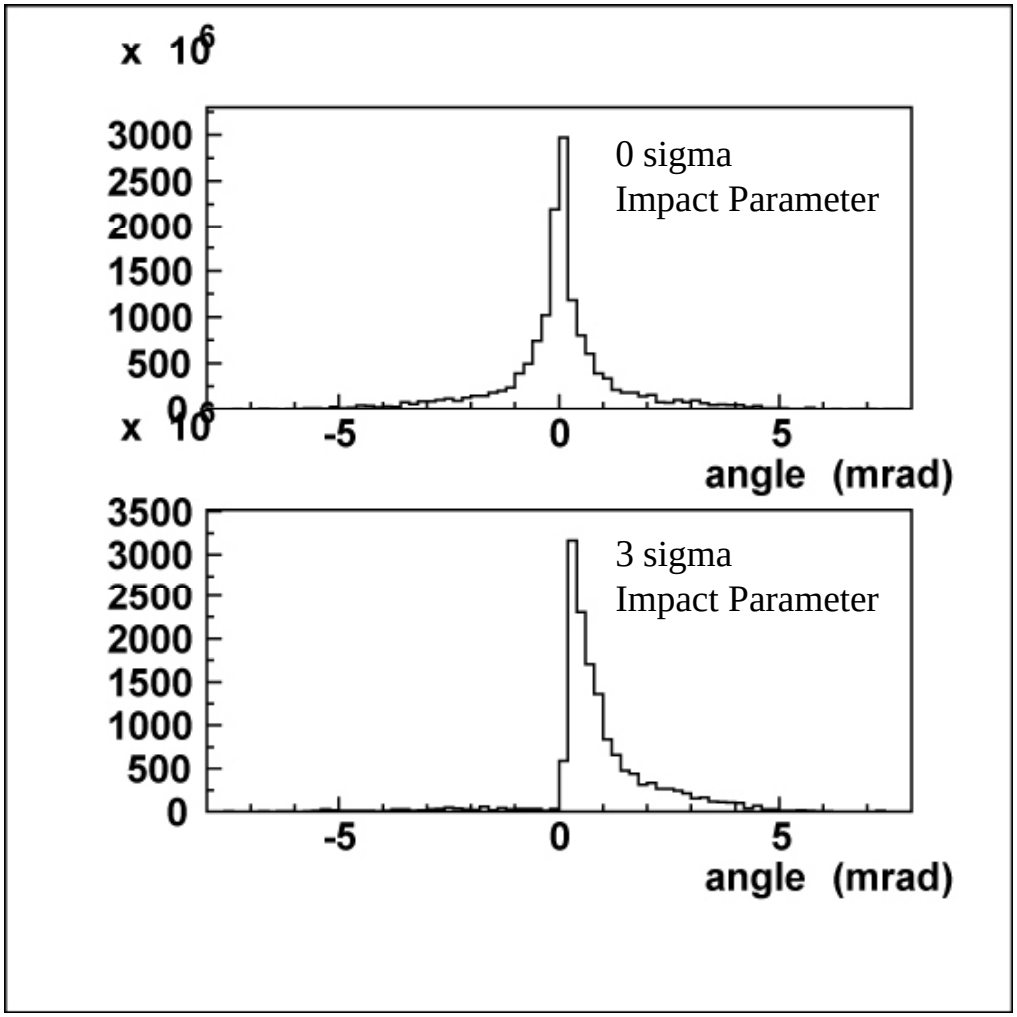
B. Parker

- The requirement of a field free extraction line is hard due to fringe fields from the final quads
- Some kind of compensation system is needed to cancel that
- Designs have been made that minimize the fields, but…

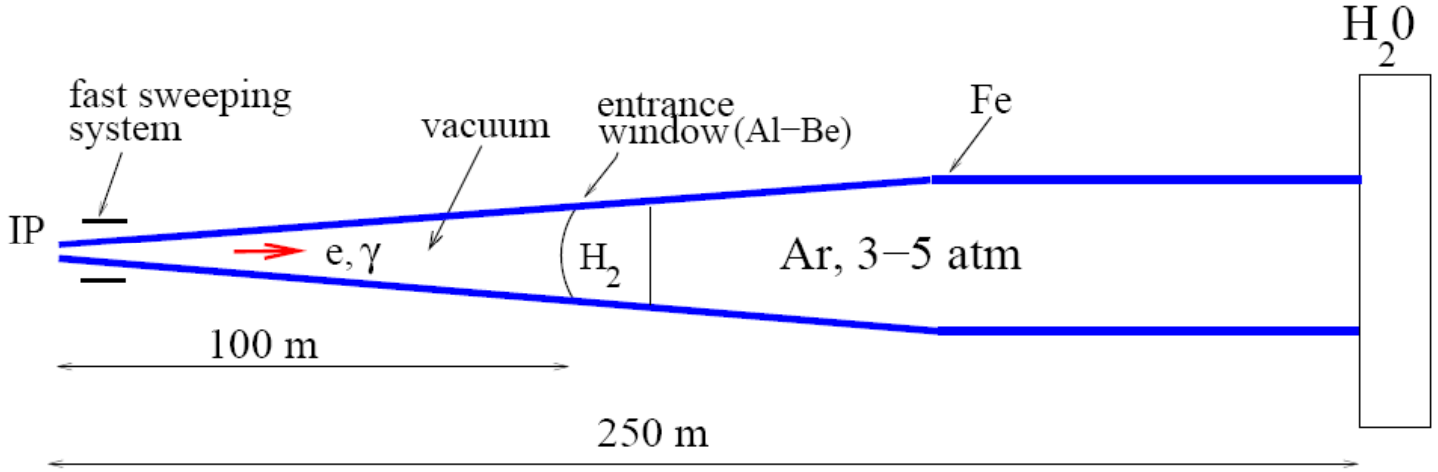
- We need to analyze the effect on the outgoing bunch
- We need to determine the heat load on the superconducters to see if it is workable

Beam deflection feedback system must be redesigned for disrupted $\gamma\gamma$ beam

- ILC uses beam-beam deflection to bring the beams into collision
- The disrupted beam in $\gamma\gamma$ complicated this
  - Low energy particles will dominate the effect
  - Can BPM's extract useful info from these disrupted bunches?
  - Can we design a workable feedback algorithm
- I think yes but this needs someone to do a detailed study



The beam dump has special considerations



V. Telnov

- An undisrupted beam deposits enough energy to boil the water in the dump. ILC uses a fast sweeping system to disburse the beam.
  - This does not work for γγ
- Converting the photon beam to e+e- may be the only way to solve this problem

We can use lower emmittance beams than e+e- but we don't need them

- There are ideas to modify the damping ring to reduce emmittance (Telnov)
  - Photon collider can take advantage of smaller spot sizes
- These ideas should be pursued but very important that the baseline use standard ILC parameters