Detector Issues for a Photon Collider

Klaus Mönig

This talk is meant as an introduction to the MDI $\gamma\gamma$ discussion. It loosely follows a list of questions posed by the MDI panel.

Physics motivation

Strongest point: Higgs physics

- For a light Higgs the $H\gamma\gamma$ coupling can be measured to 2%
  - sensitive to H coupling to heavy particles
  - unique for $\gamma\gamma$ collider
  - however new physics probably below 1 TeV if sensitive
- Heavy SUSY Higgses
  - unique discovery window for $0.5\sqrt{s}_{ee} < m_{\mathrm{H}} < 0.8\sqrt{s}_{ee}$
  - $H\gamma\gamma$ couplings sensitive to SUSY parameters
  - in theory good sensitivity to CP properties
    needs to be verified experimentally
    more studies needed what is possible in $\mathrm{e}^+\mathrm{e}^-$

Other areas

- SUSY:
  - Large cross section with large background
  - Can measure decay properties of SUSY partners
  - However no comparative study in e^+e^- yet
- Some couplings of $t\bar{t}\gamma$ and $WW\gamma$ slightly better than in e^+e^-

When do we want the $\gamma\gamma$ collider?

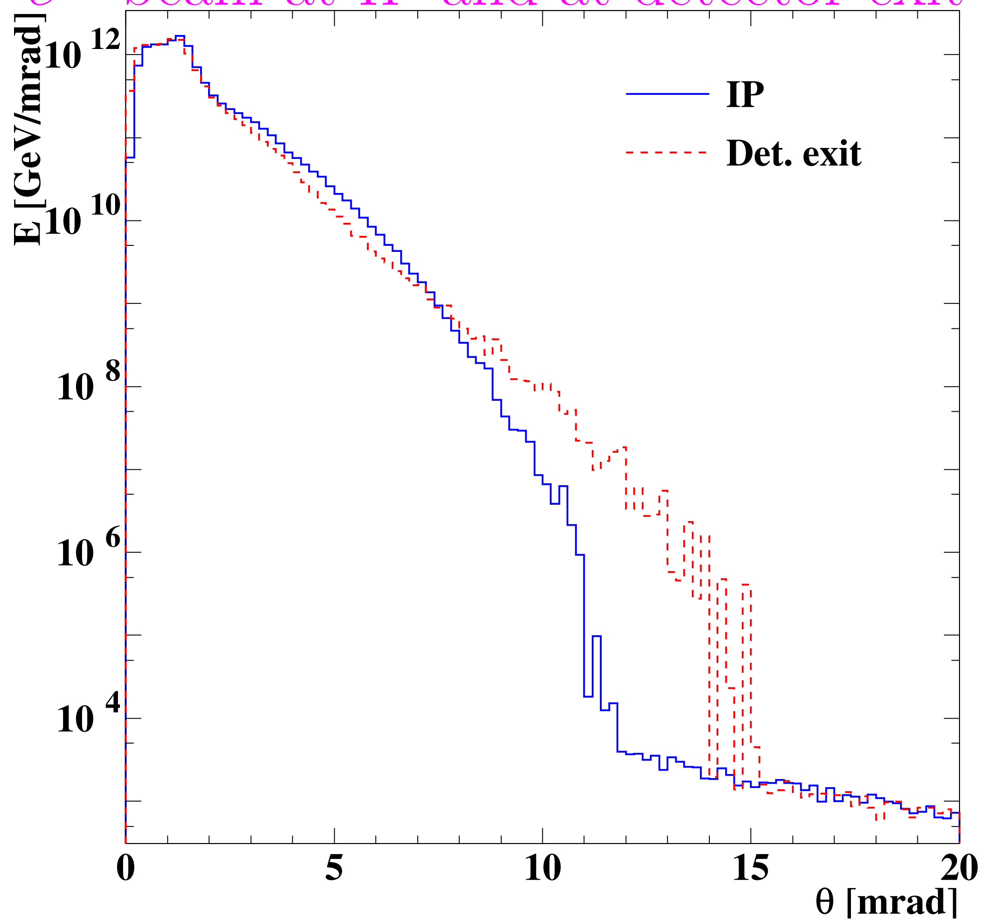
- Certainly when there are strong indication that H,A is in the discovery window
- If there are signs for CP violation in the Higgs system we may also want it
- There may well be scenarios we don't think of yet

Crossing angle issues

The disruption angle of the outgoing electron beam is $\sim$ 15mrad

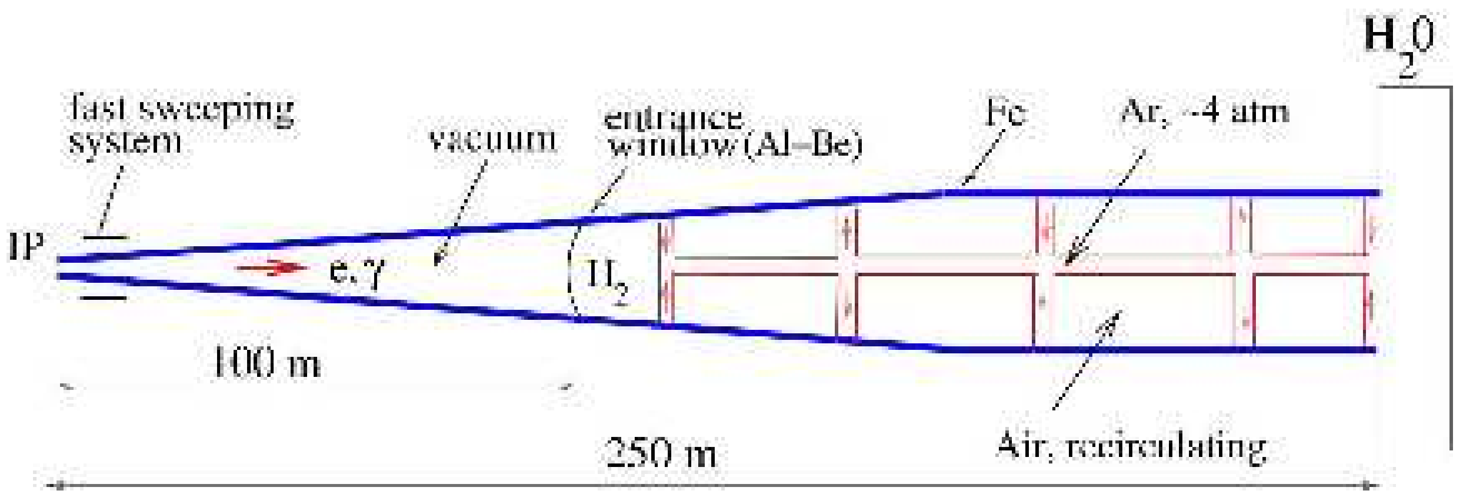
- A "small" crossing angle is definitely not possible
- A "large" crossing angle must be $\sim$ 10mrad larger than in e^+e^- (assuming a 2 cm hole at 2 m
- The e^+e^- community will certainly not accept this
  ➠ have to change crossing angle for $\gamma\gamma$ running

e^- beam at IP and at detector exit



The beam dump

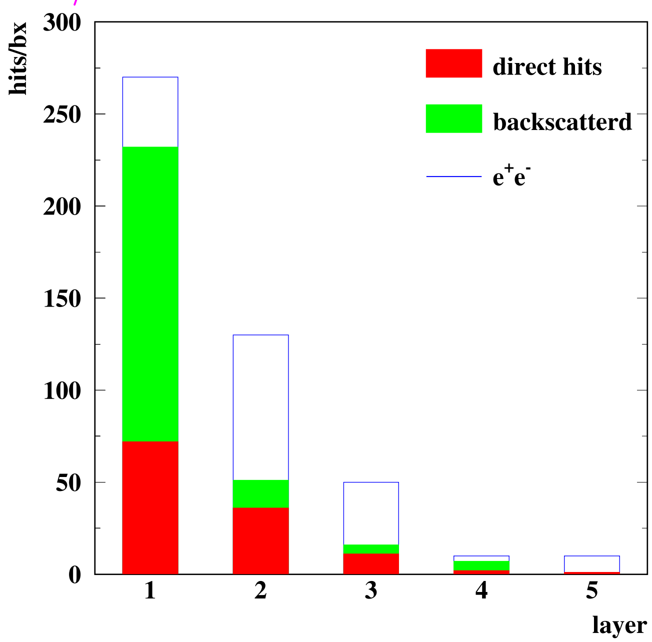
- For $\gamma\gamma$ there has to be a straight line from the IP to the dump
  ➠ neutrons can fly back into the detector this way
- $\mathcal{O}(10^{12})$ neutrons/cm^2/a for a water dump, starts to be worrying
- If the same dump is used for e^+e^- and $\gamma\gamma$ this problem is solved automatically in e^+e^- if the crossing angle is changed
- The entrance window seems to be feasible
- The energy density in the core of the γ beam is to high for a water dump
  ➠ may use an Argon tank in front to widen the beam (V. Telnov)

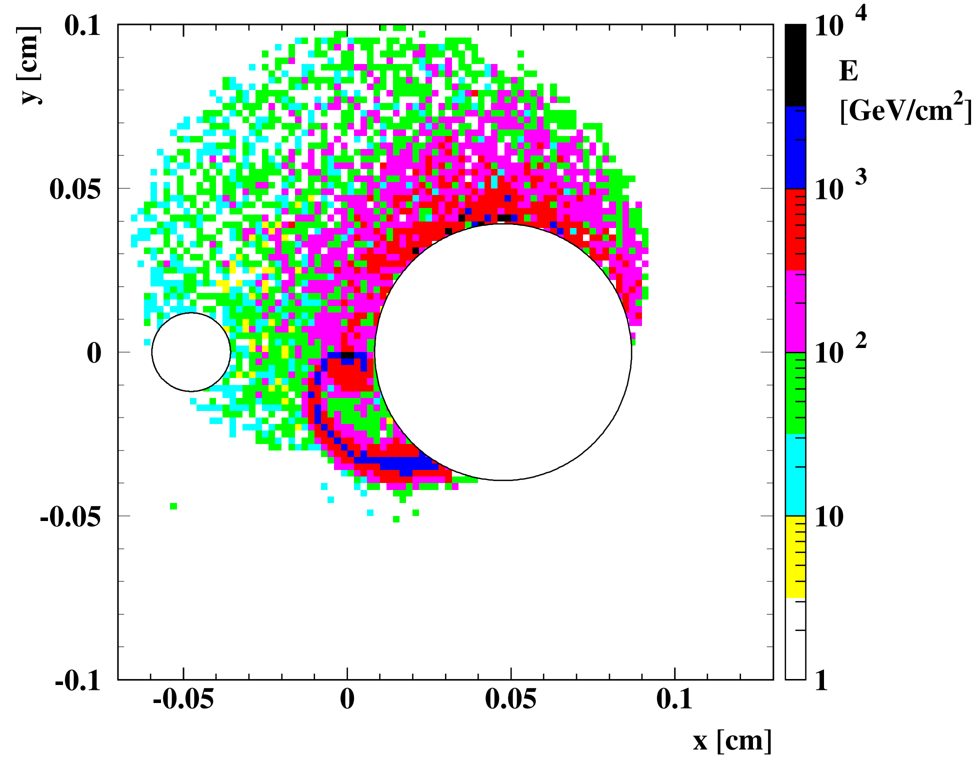


Background

- Neutron background is critical
- Direct pair background from the IP is smaller than in e^+e^- because of the anti-pinch effect
- However large potential background from backscattering at exit

Hits/bx in microvertex detector





- Need a sophisticated masking system to suppress this background
- Final background at same level as in e^+e^- in vertex detector and TPC

The Detector

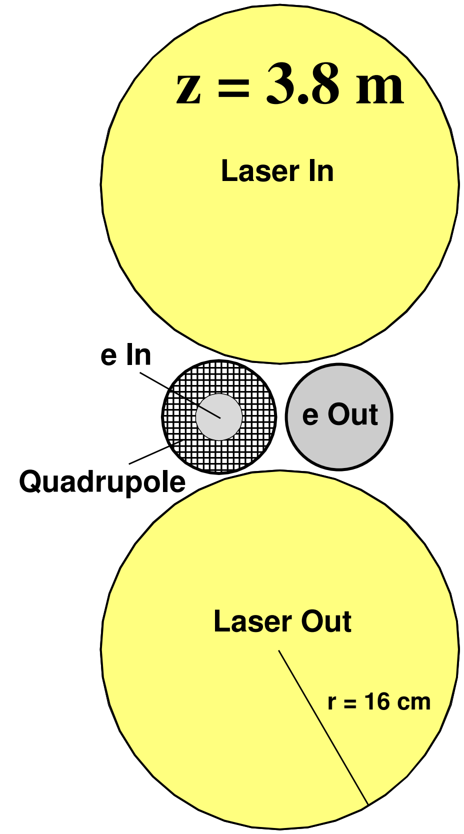
$\gamma\gamma$ requirements

- Space for the laser pipes
- Masking system against background

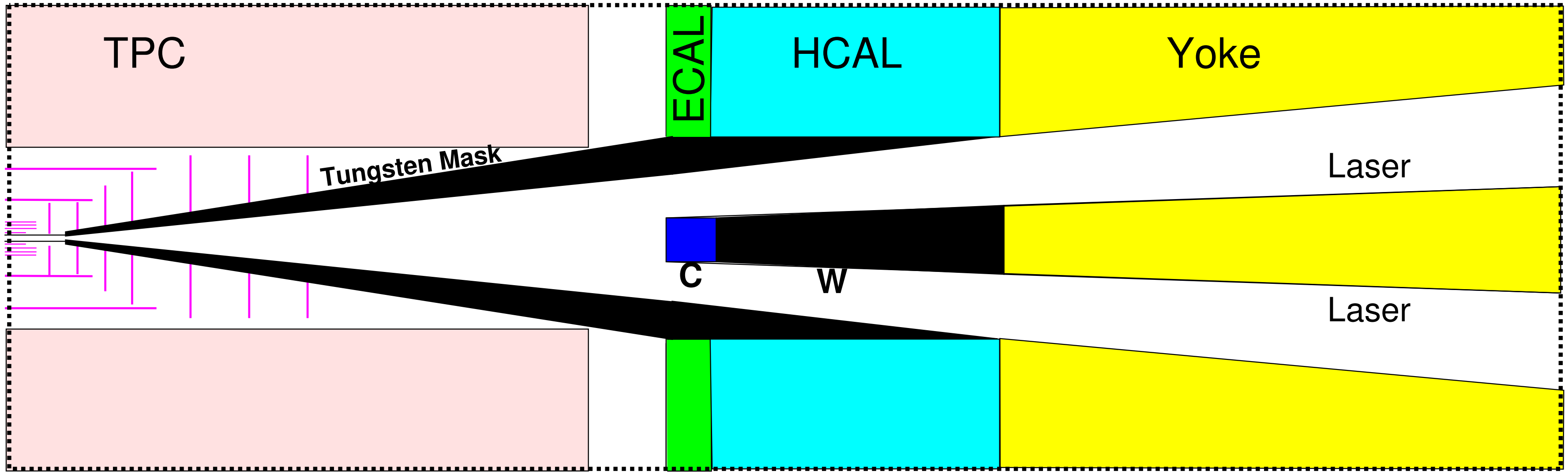
Everything can be fit at $\theta < 7^\circ$

The tracking in the concepts starts at this angle

It should be possible to use the central detector for both modes



y-z projection of the central detector



Beam-beam feedback

Beam-beam deflection is a step function because of small beam size
(Is this still true with more recent parameters?)

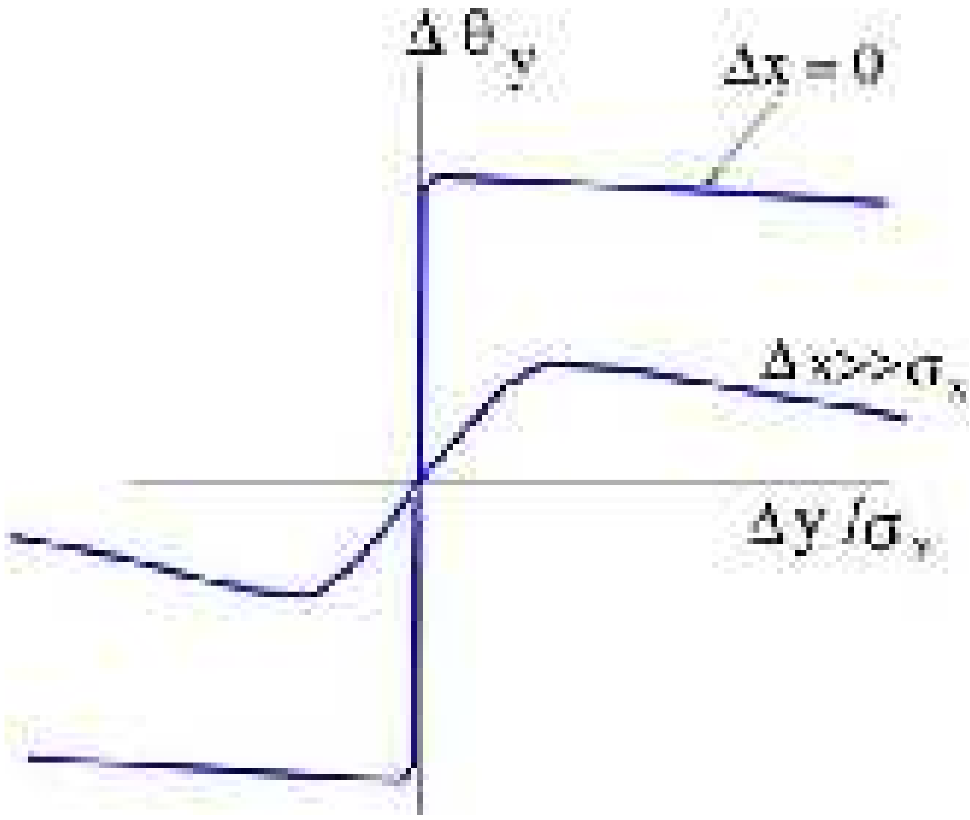
➠ Anyway need different algorithms (scanning) than in e^+e^-

Interplay of crossing angle and solenoid shifts charge centre

Scanning algorithm OK if laser stable in time (can this interfere with laser feedback loops?)

Other possibility is intermediated low q bunches (N. Walker)

In any case the BPMs need very large aperture



How to switch from e^+e^- to $\gamma\gamma$ and back

In the common IP:

- Move beam delivery system and detector to new crossing angle
- Replace low angle region of detector
- Install/remove laser system
- Commission laser without beam
- Remove/install post IP diagnostics
- Replace full extraction line

How long does this take? 1-2 years?

In the full linac

- Switch positron arm to electrons
- Retune polarisation to new crossing angle
- Commission laser with beam

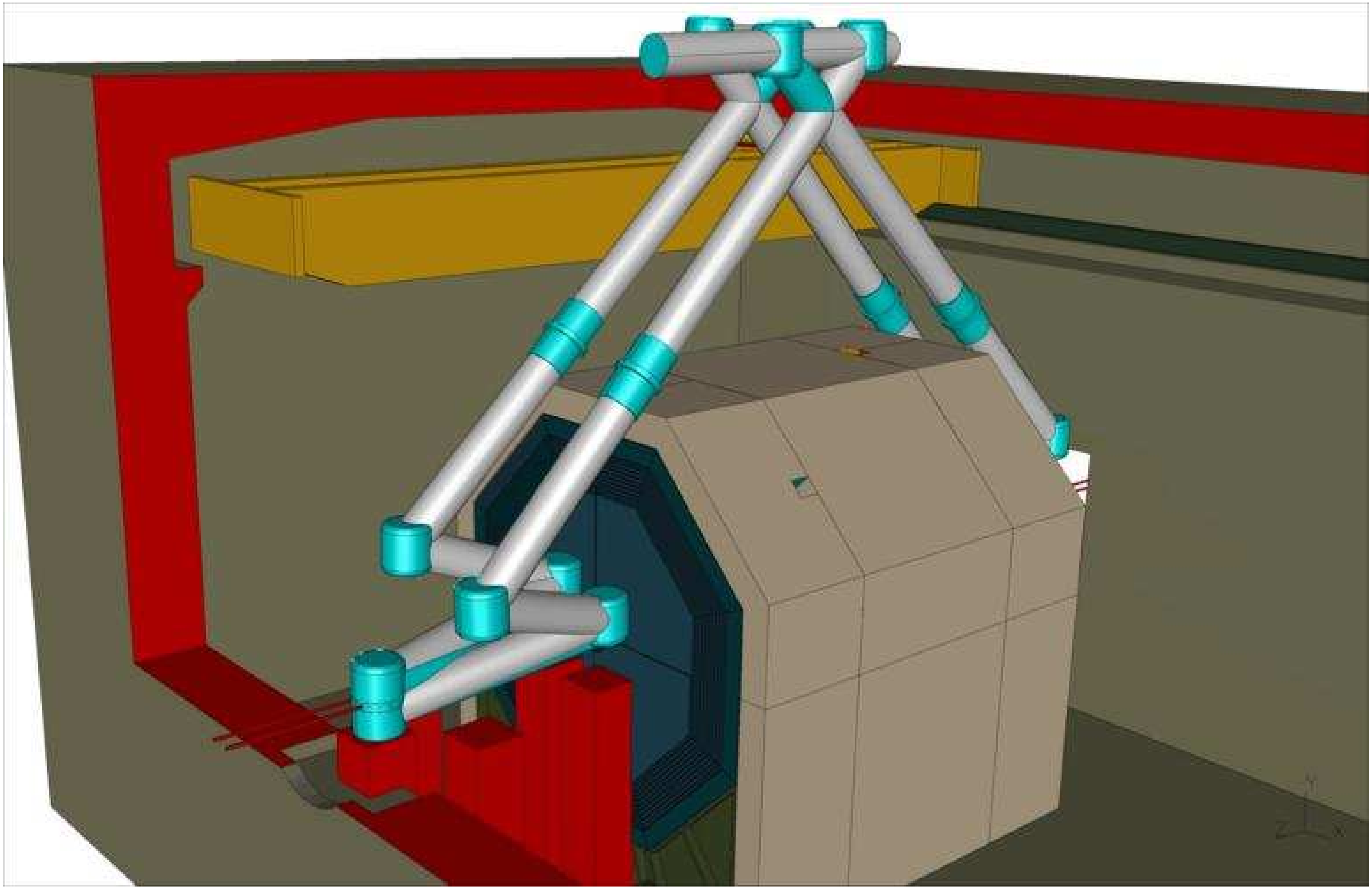
How long? Few months?

Switch scenarios

- Going back and forth with one IP seems unrealistic
- Two possible alternatives:
  - 2nd IP at least for $\gamma\gamma$ running (preferred)
  - run $\gamma\gamma$ at the very end of the e^+e^- program

Requirements for common IP

- Transverse size of hall and tunnel prepared for crossing angle change
- Hall needs to be long enough for laser pipes
- Laser hall above the detector needed (on surface?)
- Piping above the detector constrains crane



Discussion points

- When do we decide to go to $\gamma\gamma$?
- Does it make any sense in a 1IP scenario?
- Is it realistic to go back to e^+e^- in the $\gamma\gamma$ IP?
- What is the switchover time for the IP, the linac?
- Can we really use the same detector?