Forward tracking in the LDC

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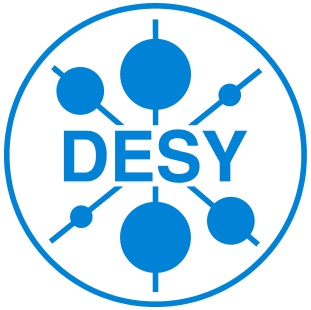
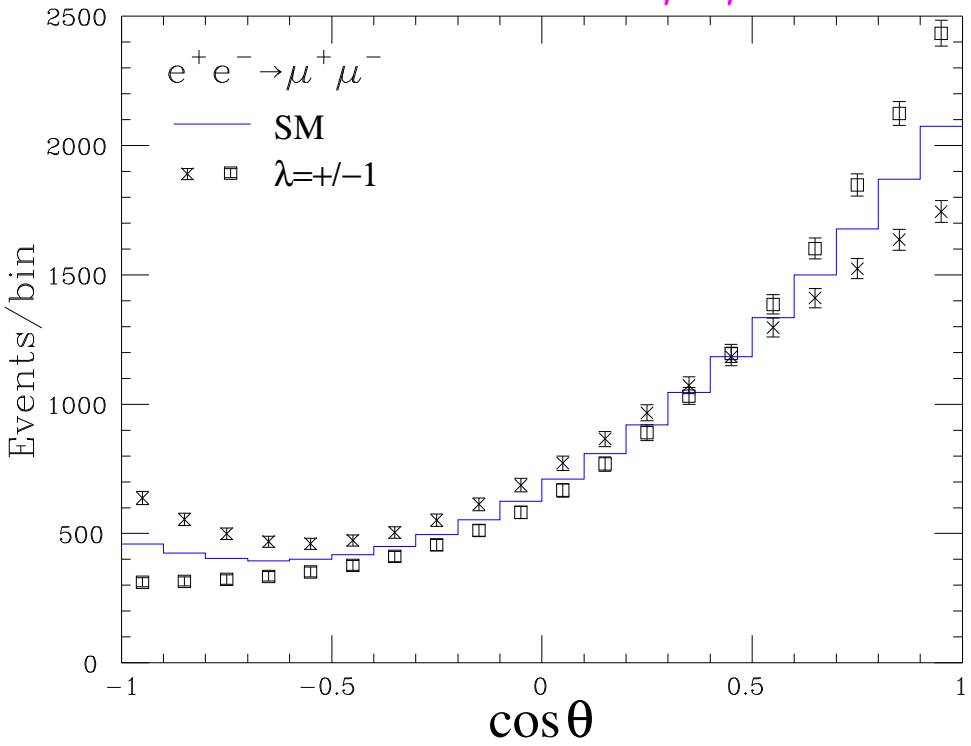


Why forward tracking?

- Many processes at LC are peaked in the forward region like Bhabha scattering or W-pair production
- Fermion pair production has highest sensitivity to forward-backward asymmetry or to distinguish Z' effects from extra dimensions in the forward region

G^*-effects in $e^+e^- \to \mu^+\mu^-$



- W-pairs forward peaked with high momentum muons due to W-polarisation

➠ Good momentum resolution in the forward region is essential for charge determination and W suppression

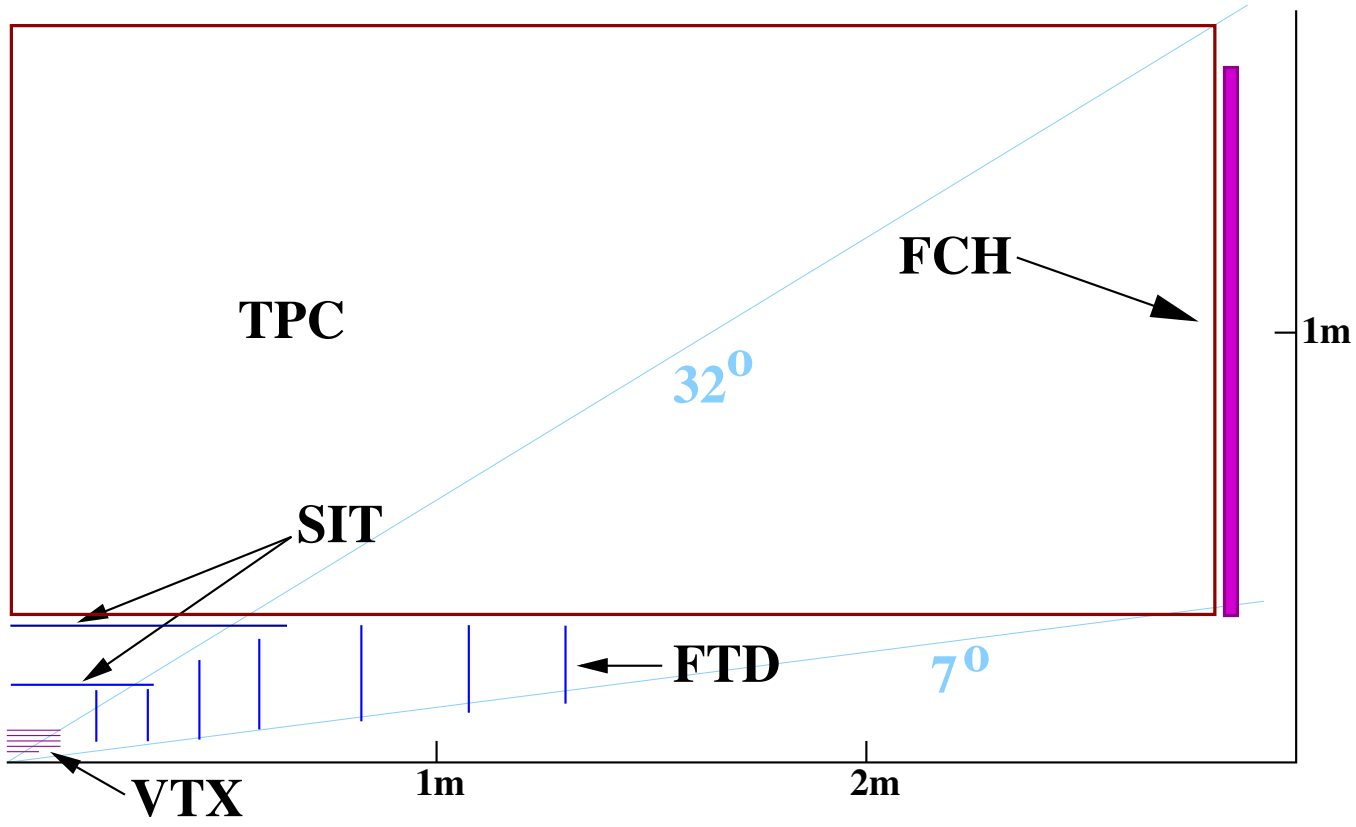
Bhabha scattering

- ideal calibration process for the beam spectrum
- again strongly forward peaked ($d\sigma/d\theta \propto 1/\theta^3$)
- reconstruct $\sqrt{s'}$ of e^+e^- system from polar angles assuming energy momentum conservation and only one radiated photon
- want to measure beamstrahlung ($\mathcal{O}(10^{-2})$) and beam energy spread ($\mathcal{O}(10^{-3})$)
- $\sqrt{s'}$ error from angular reconstruction method: $\Delta\sqrt{s'}/\sqrt{s'} \approx \Delta\theta/\sin\theta$
  ➠ need $\Delta\theta < 10^{-4}$ in forward region
- electrons radiate in material and cylinders (e.g. TPC field cage) are crossed with small angles
  ➠ better assure angular resolution close to the IP

➠ good angular resolution close to the IP is key point for Bhabha

Forward tracking in LDC

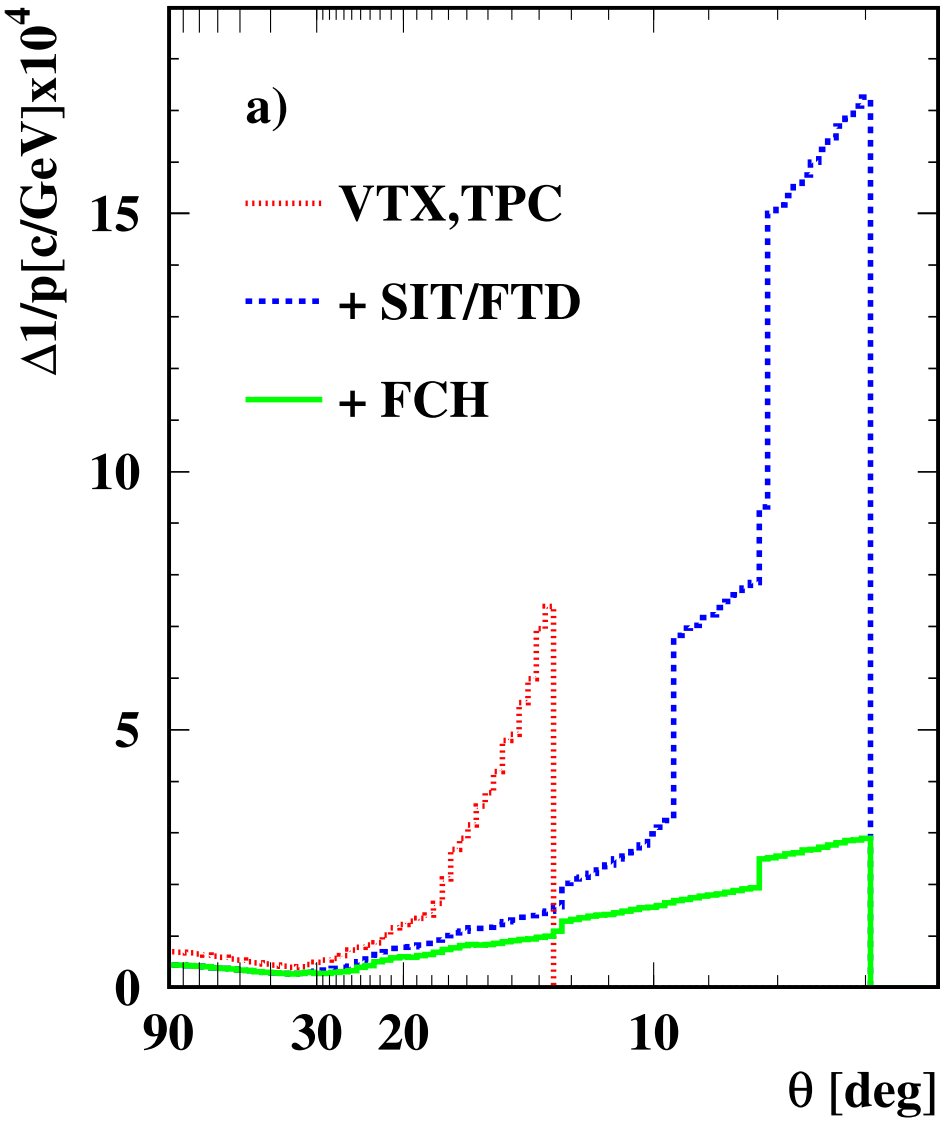
- Charged particle tracking above $\theta = 7°$
- Main tracker: TPC (gradually getting weaker below $\theta = 32°$)
- Silicon tracking between VTX and TPC (FTD)
- Forward chamber behind TPC endplate



Momentum resolution in the forward region

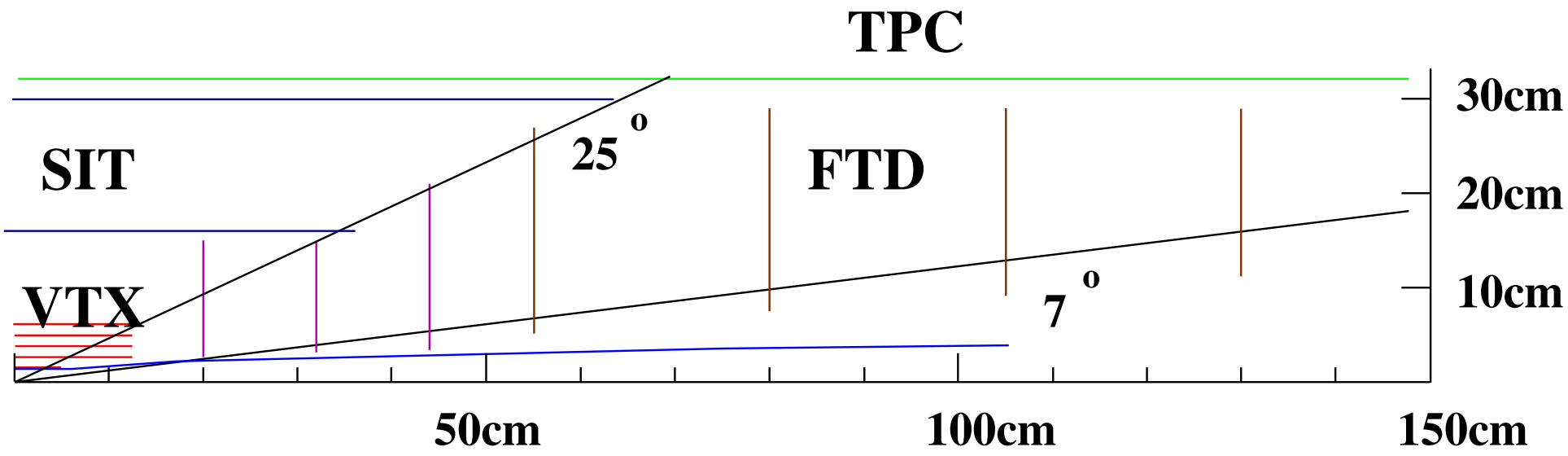
- Without specialised forward tracking resolution gets weak around 20° and stops at 12°
  ➠ FTD mandatory for muons and hadrons
- FCH improves resolution for $\theta < 10°$
  ➠ useful for muons, for hadrons should be discussed

$1/p$ resolution for 200 GeV muons vs θ



The FTD

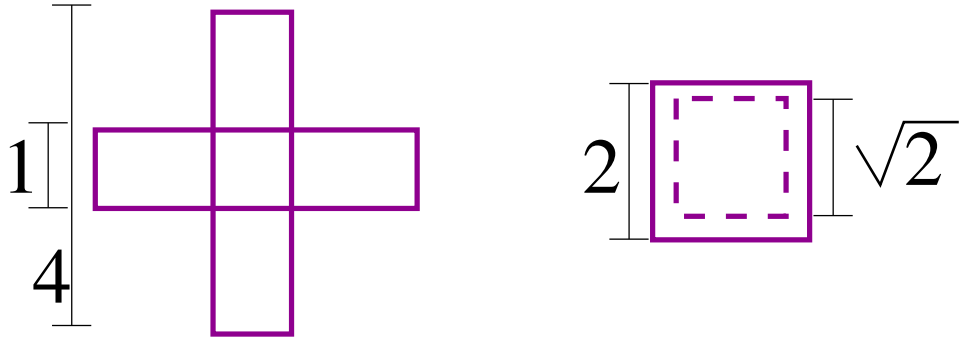
- (two barrel layers, $r = 16,\ 30\,\mathrm{cm}$, $\sigma = 8\mu\mathrm{m}$
  resolution similar to LEP, but larger)
- Optimised for the TESLA TDR ➠ should be updated
- three pixel disks $\sigma = 50 \times 200\mu\mathrm{m}$ crossed basically a copy of ATLAS
- four strip disks, $\sigma = 25\mu\mathrm{m}$ ($90\mu\mathrm{m}$ strip pitch, $270\mu\mathrm{m}$ readout pitch)
  back-to-back or double sided



Some details

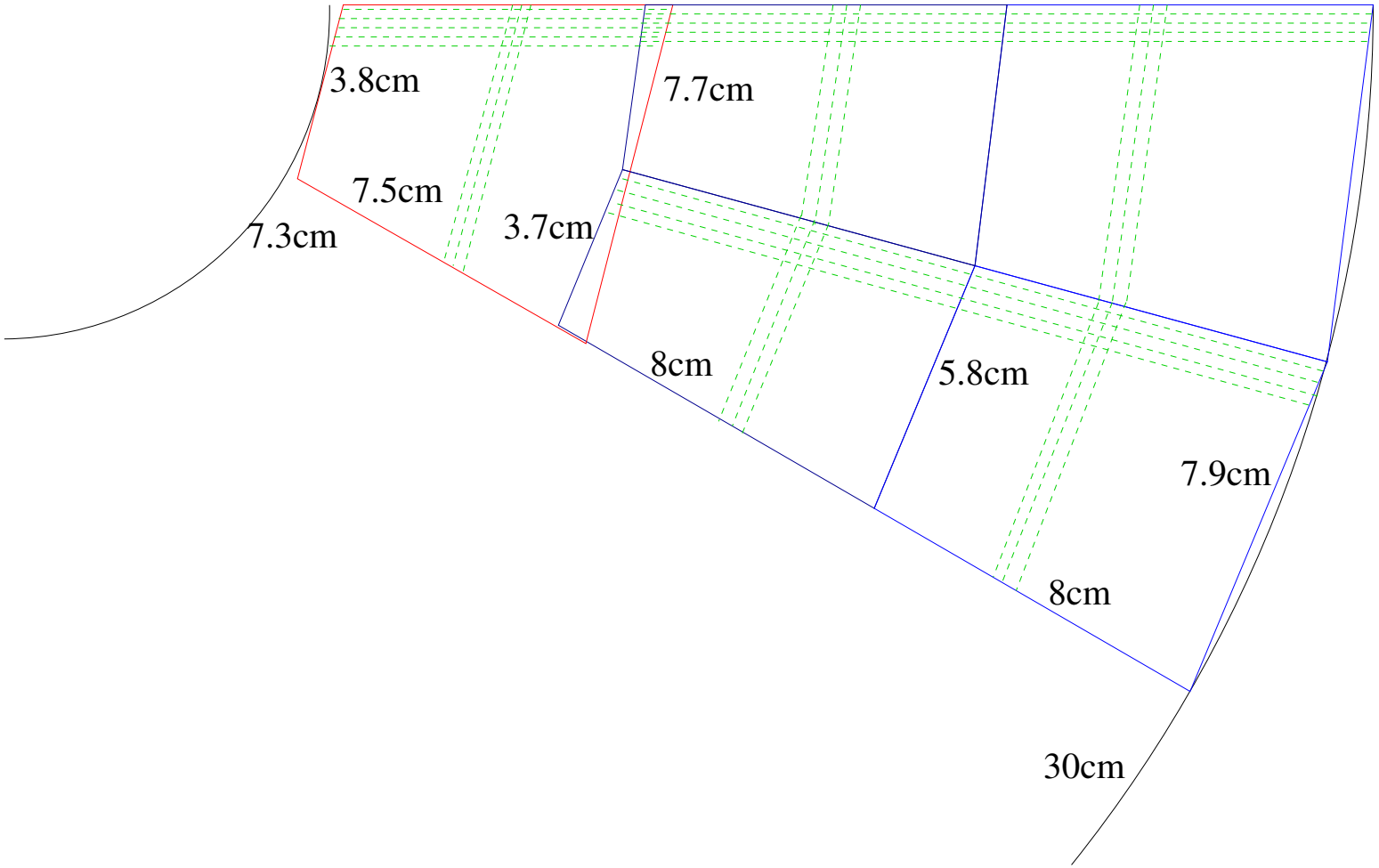
- Decision pixels/strips:
  - pixels are more expensive
  - pixels are less sensitive to background
  - pixels give less ambiguities in pattern recognition
  - strip resolution usually better
- For the pixels the very rectangular shape from ATLAS ($\sigma = 50 \times 200\mu$m) is taken

  ➠ if the narrow direction is alternated resolution is better than squares with same area



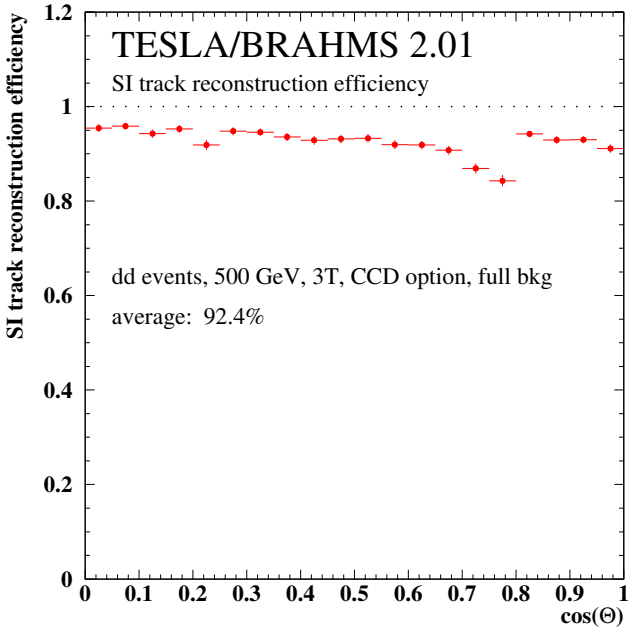
- How to avoid too many ambiguities in strips in hadronic events?
  - chose trapezoidal modules
  - strips parallel to one edge

➠ flipping modules gives stereo angle with only one module type

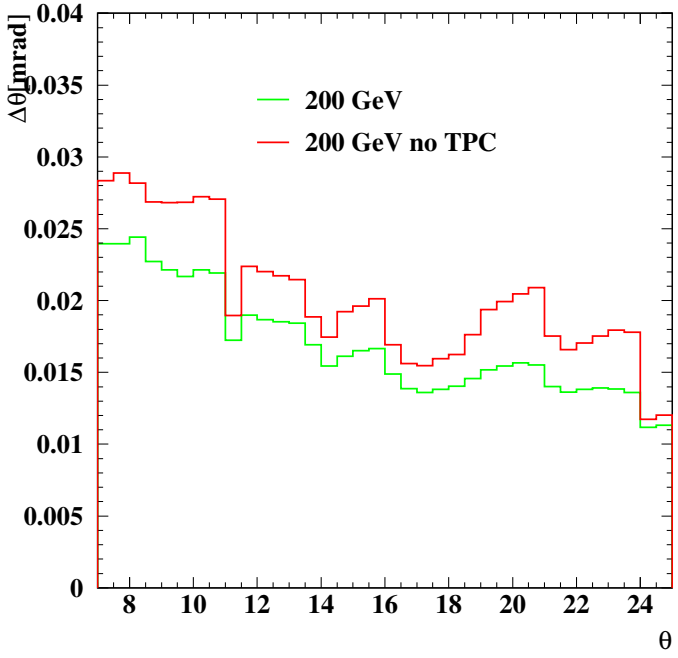


Efficiency vs $\cos\theta$ in FTD/SIT for hadrons

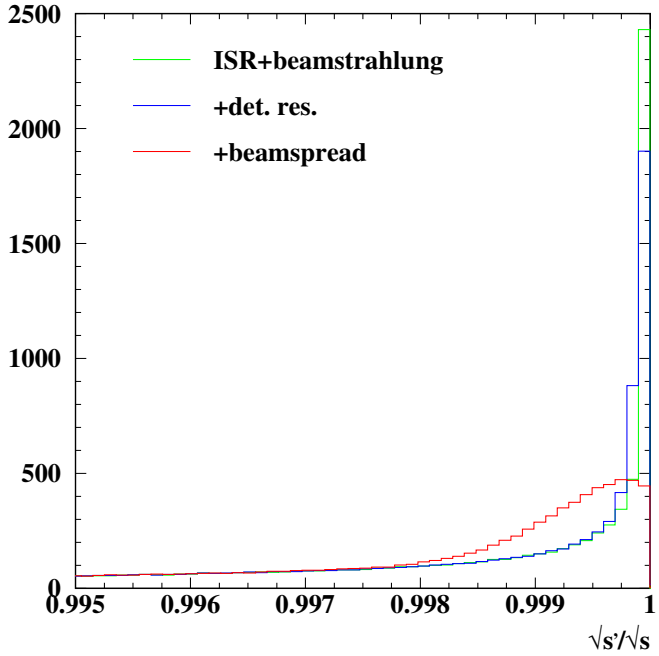
The present FTD design reaches sufficient θ resolution for Bhabha acolinearity measurement and $\sim$ 90% standalone pattern recognition efficiency in hadronic jets



Polar angle resolution in forward region

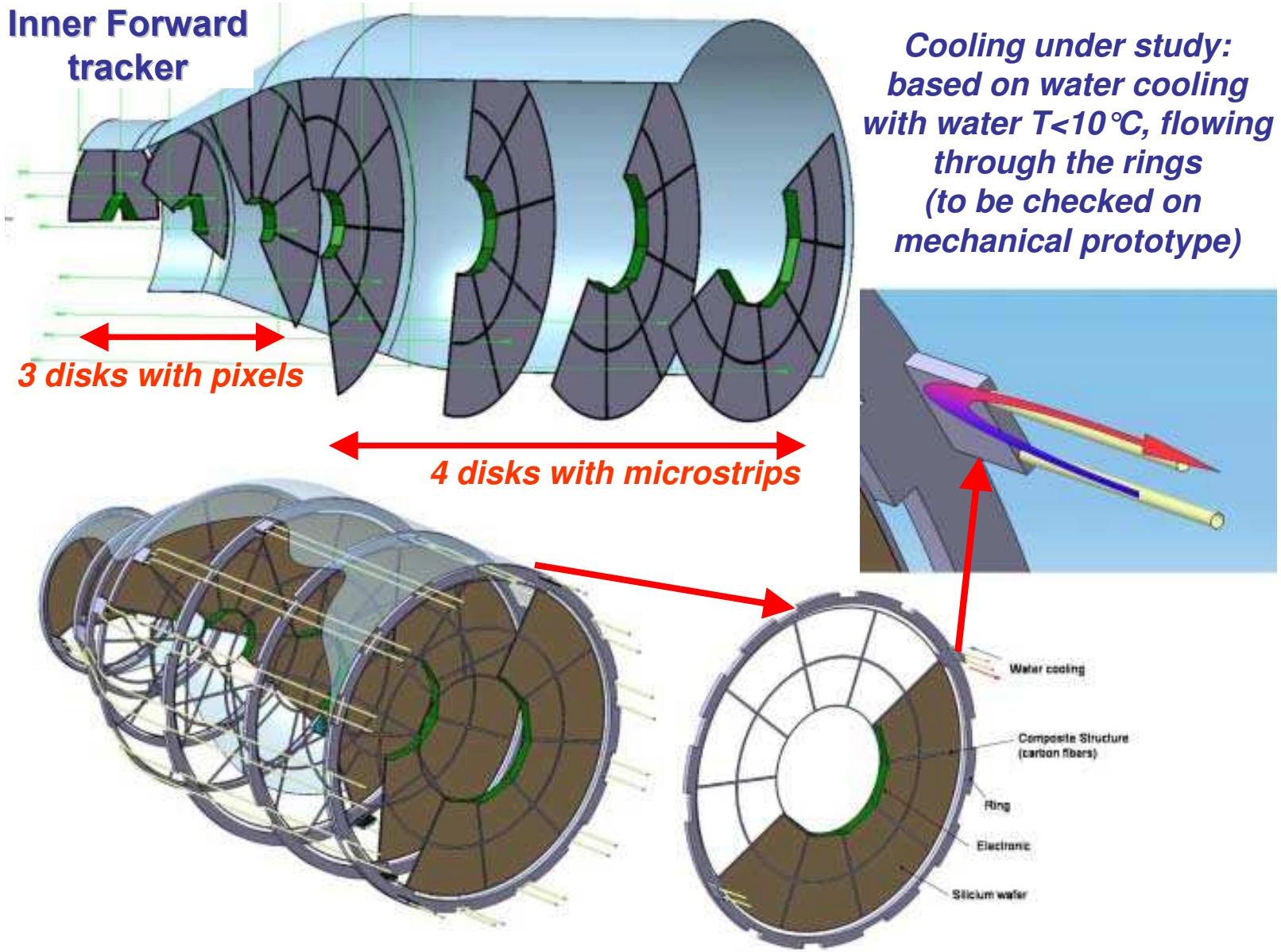


$\sqrt{s'}$ spectra from Bhabha acolinearity



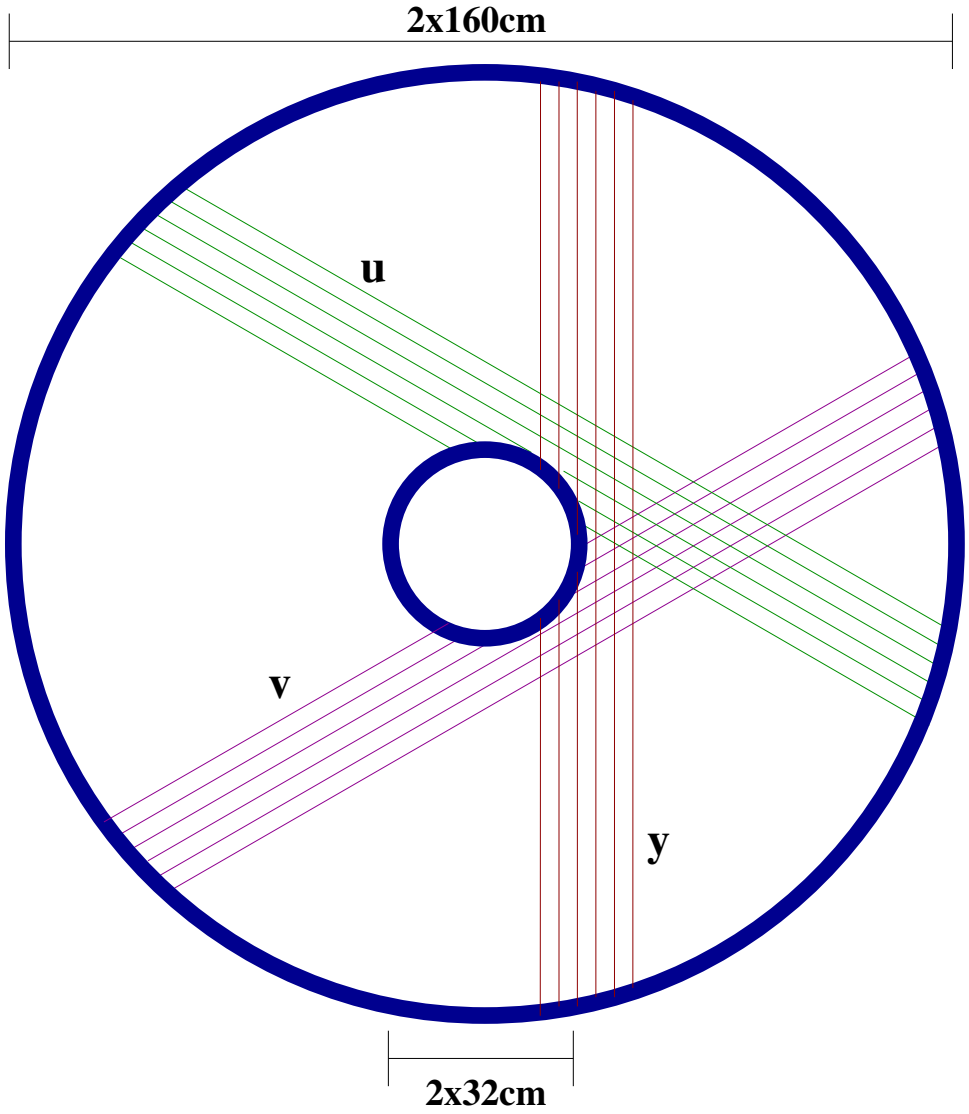
Next step: optimise design to keep systematics below resolution

➠ see Aurore's talk



Forward chambers

- TPC gets weak around $\theta = 12°$
- ➠ Add a precise forward chamber between TPC and ECAL eq. point res.: ($\sigma \approx 50\mu$m)
- Possible technology: 12 planes of straw tubes in three orientations ($\sigma_{\mathrm{Pl.}} \approx 100\mu$m)
- Attention: Design was done for 170 μm TPC resolution, should be reconsidered for better resolution



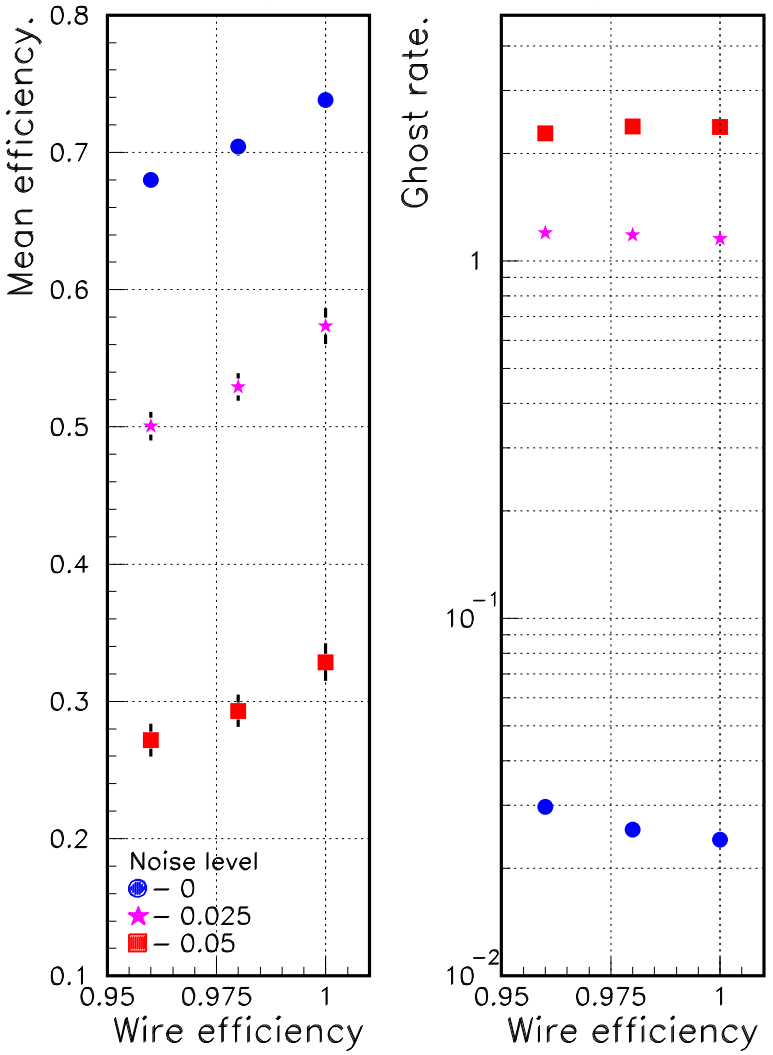
Design considerations

- FCH behind thick TPC endplate
  $\Rightarrow$ only useful in p-measurement for high momentum particles
- For isolated particles straws are sufficient
- However efficiency in jets only marginal

➠ Need to know if FCH useful in energy flow algorithms (e.g. track-shower matching)

- If yes, better designs are possible, e.g. silicon

FCH reconstruction efficiency in jets (primary tracks)



Conclusions

- Special forward tracking devices are mandatory in a hermetic e^+e^- detector
- Most of the job is done with silicon disks between the vertex detector and the TPC
- Some additional improvements from forward chamber in front of ECAL
- Still need optimisation for best performance and minimal systematics