The Tracking Section in the TDR

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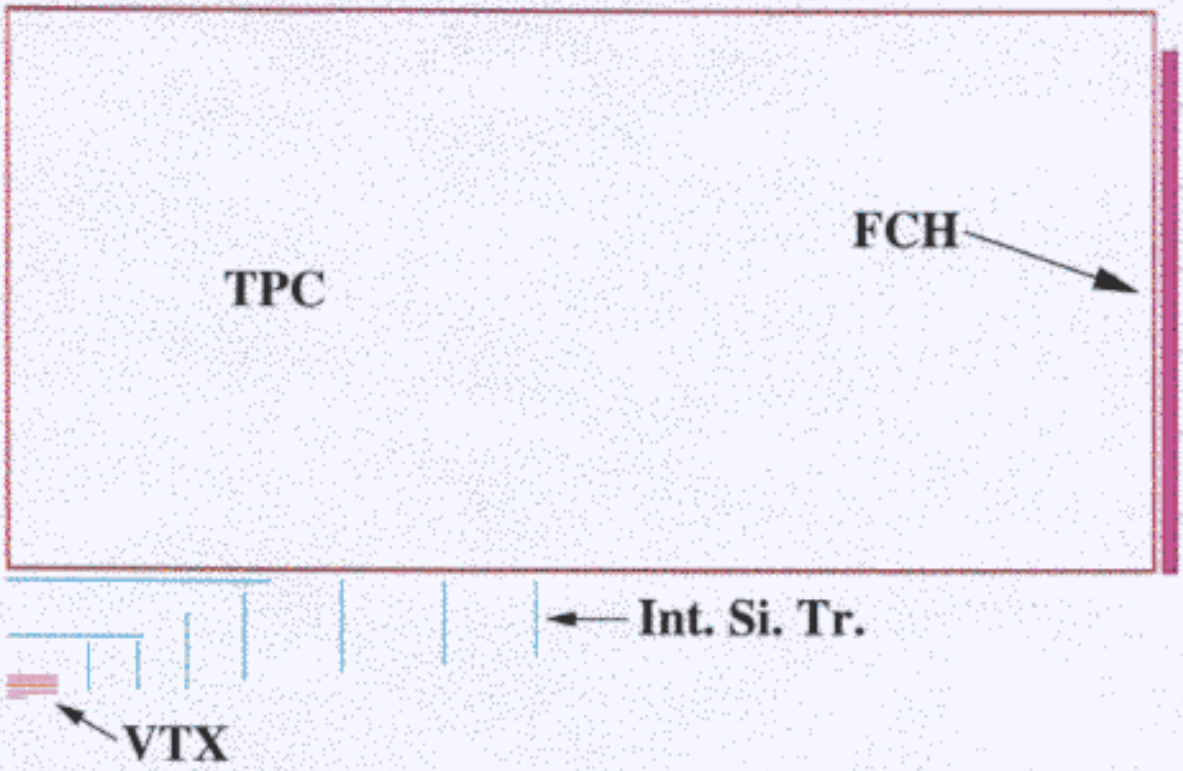
- Overall setup
- Some performance plots
- Conclusion

Motivation

We need:

- very good momentum resolution ($\Delta 1/p = 5 \cdot 10^{-5}$) in the central region to measure recoil masses with optimal precision;
- very high b- and c-tagging capabilities to identify c-jets in a huge b-background for BR($H \to c\bar{c}$) and to measure multi-b final states like ZHH and $t\bar{t}H$;
- good momentum resolution in the forward region to identify charges unambiguously down to the lowest angles and highest momenta and very good angular resolution in this region to measure the luminosity spectrum from the acolinearity of Bhabha-events;
- very good pattern recognition capabilities to find tracks in high-energy jets with a very high local track density;
- minimal material to be able to measure also electrons and to avoid additional background to the calorimeters.

Overall setup

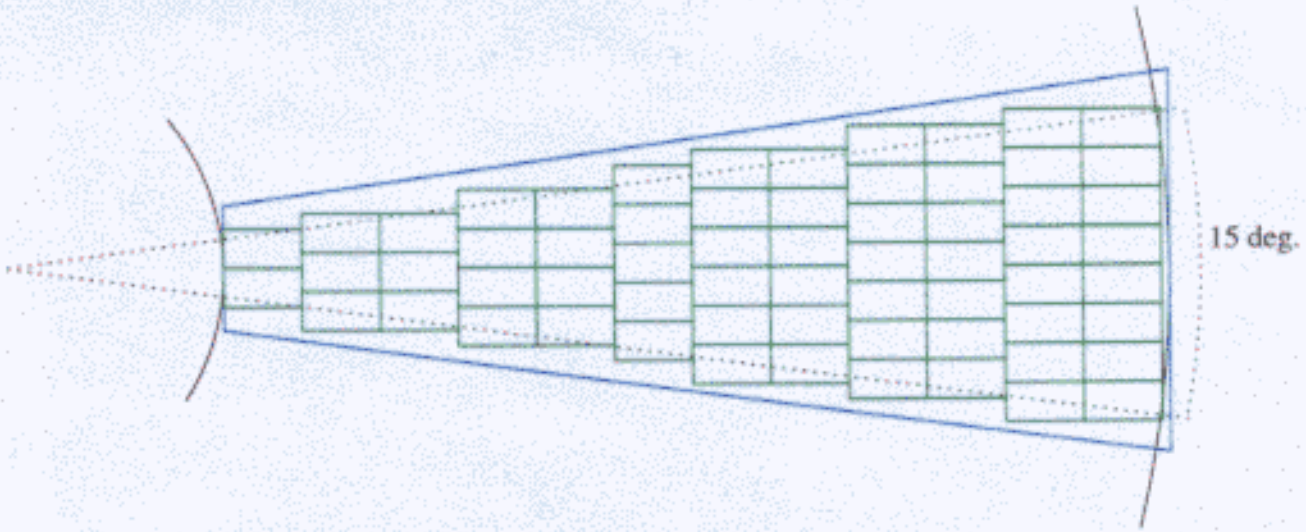


- superconducting magnet 3-4T
- main tracker TPC → M. Schumacher
- vertex detector → C.Damerell
- intermediate silicon tracking
- additional endcap chamber

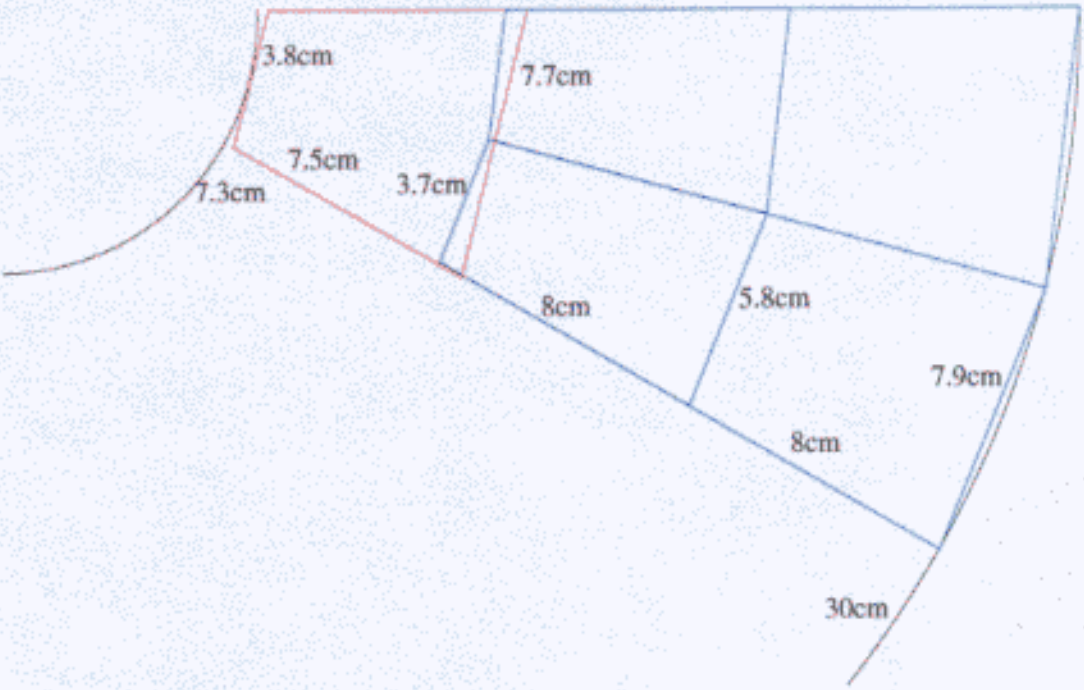
Intermediate Silicon Tracking

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

Layout of a pixel module:

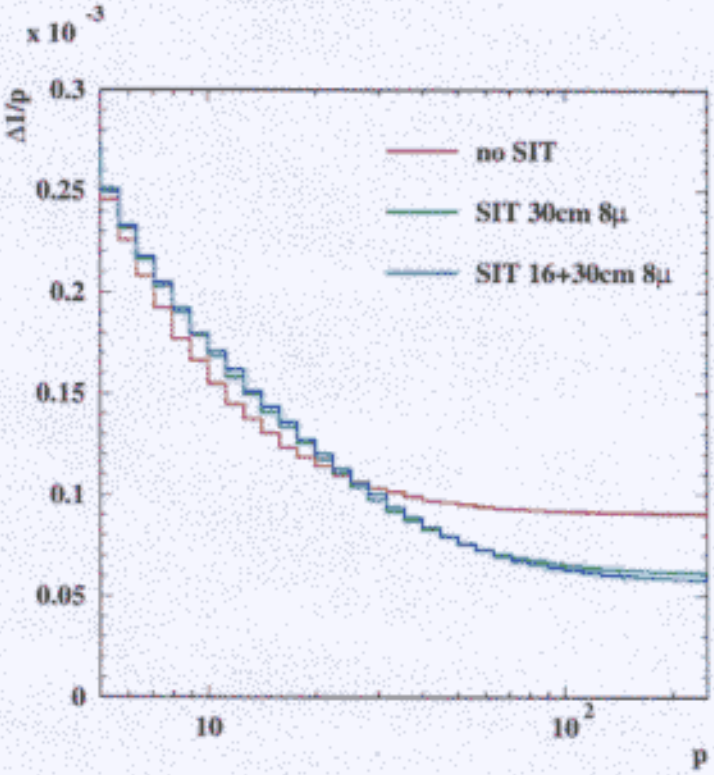


Layout of a strip module:



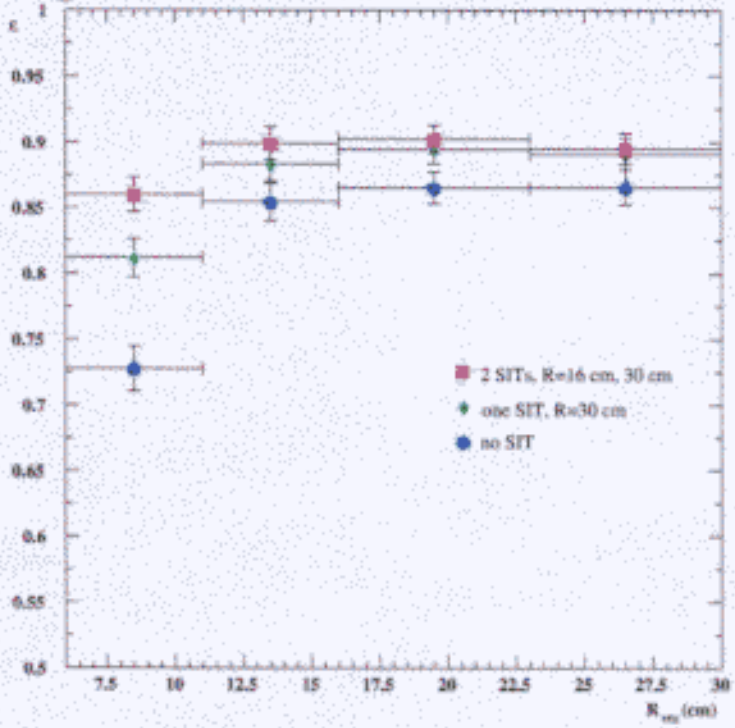
Barrel intermediate tracker

30cm layer improves significantly momentum resolution



16cm layer mainly for pattern recognition efficiency

K_s^0 reconstruction efficiency



Forward silicon disks

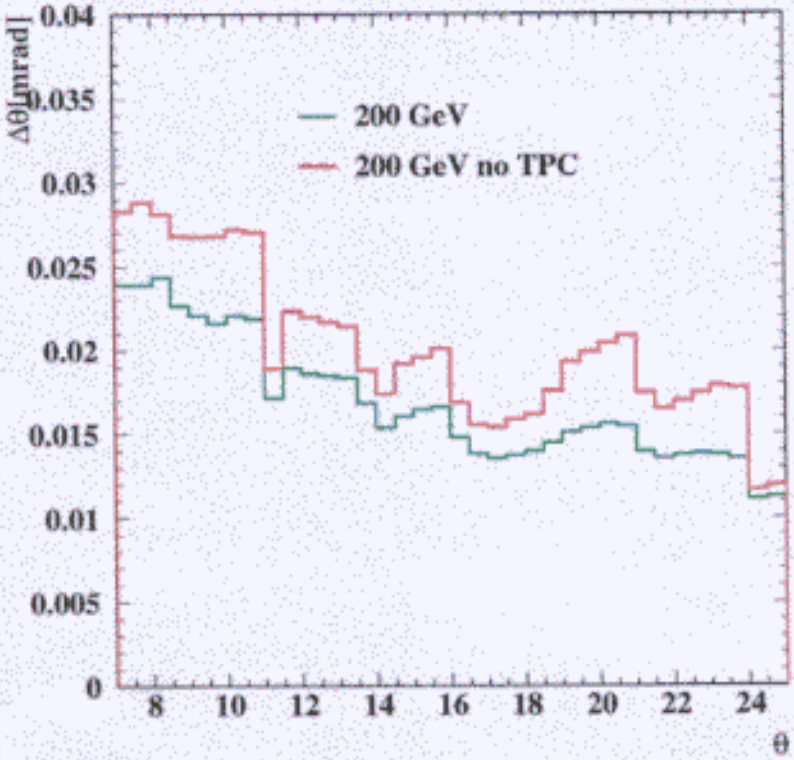
Polar angle (θ) resolution:

- mainly for Bhabha acolinearity to measure beamstrahlung and beamspread
- beamspread $\sim 10^{-3}$
- effect of detector resolution $\Delta\sqrt{s'} = \Delta\theta / \sin\theta$

➠ need $\Delta\theta \sim$ few $\times\, 10^{-5}$

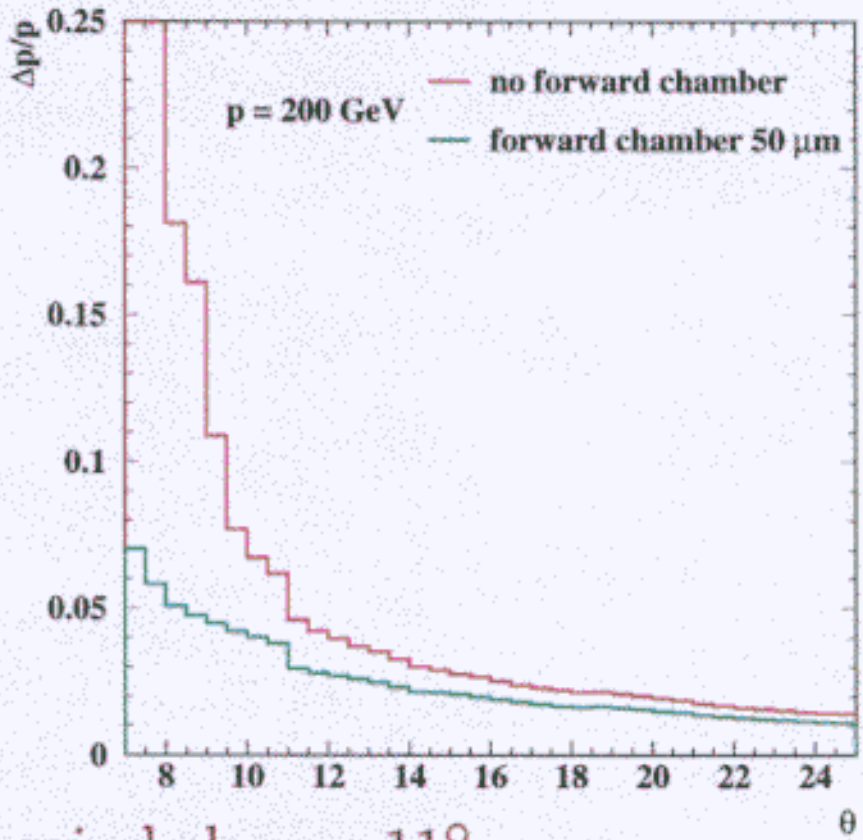
- electrons pass TPC field cage/cables with a very small angle

➠ better assure resolution with silicon only



Forward chamber

- Many processes (e.g. $e^+e^- \rightarrow W^+W^-$) have forward peaking particles
  $\rightarrow$ need good momentum resolution down to lowest angles where TPC gets weak
- Mainly interesting for high momentum muons, so material not crucial
- Add a precise forward chamber between TPC and ECAL ($\sigma \approx 50\mu m$)



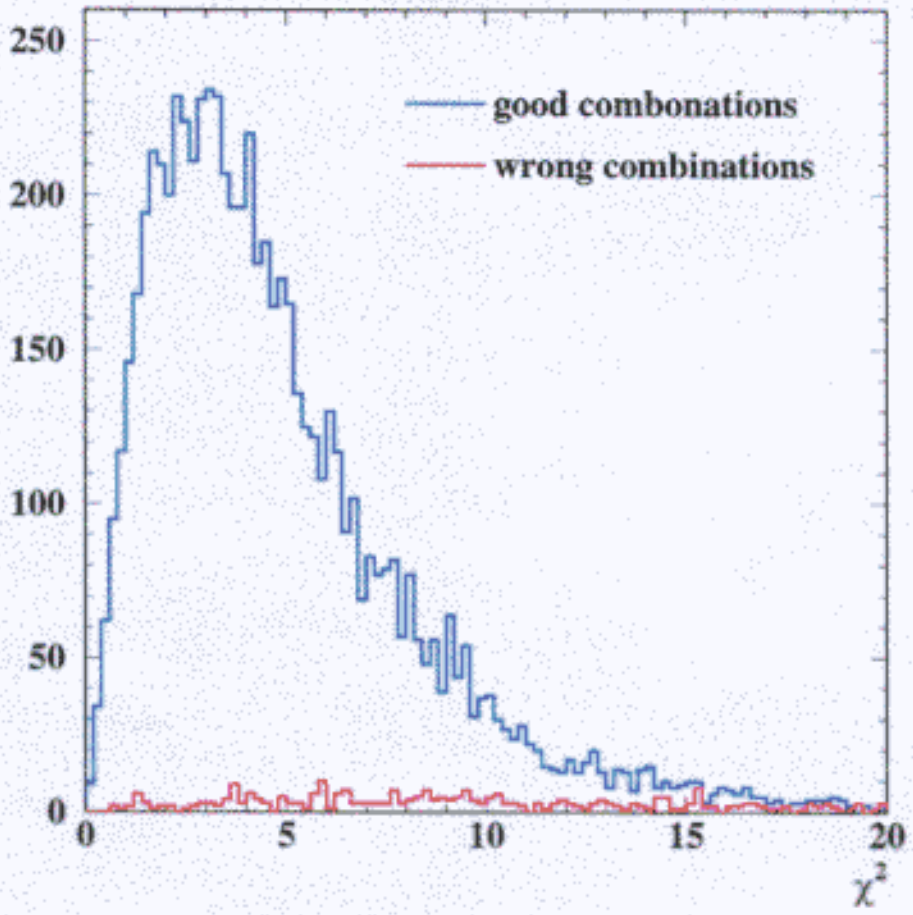
- Huge gain below $\sim 11°$

➤ Need at least device of 60cm radius although a larger one is certainly easier to align

Technologies

- Straw-tubes with 0.5cm diameter (ATLAS, HERA-b study)
- 12 planes with wire orientation $2 \times (xx'uu'vv')$
  y' staggered by half a wire distance wrt. y
  u, v rotated by $\pm 60°$ wrt. x
- need resolution of 120μm, reached by ATLAS already with faster gas
- first studies indicate that the pattern recognition capabilities in jets are sufficient.

Matching of FCH-tracks with extrapolation

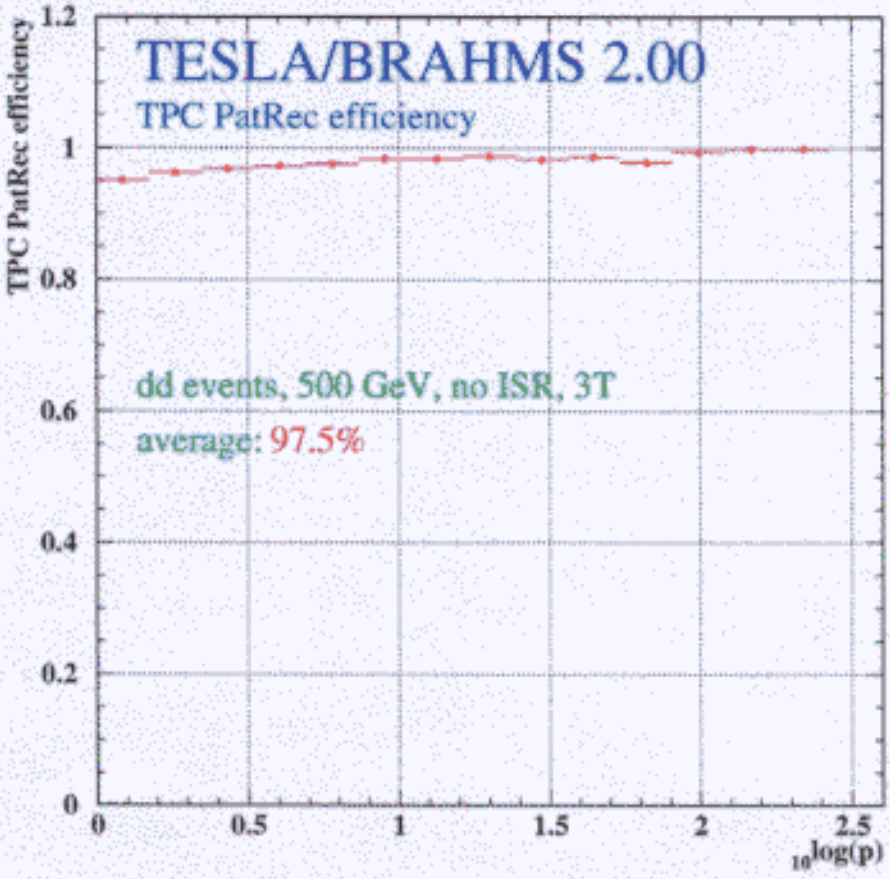


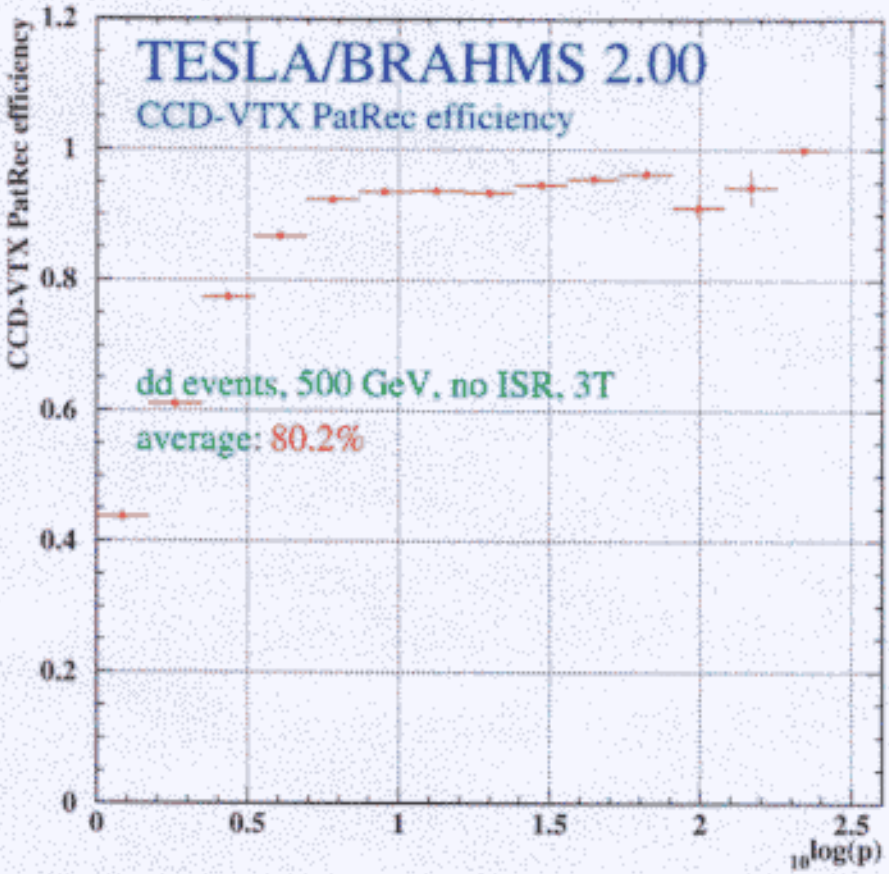
Performance

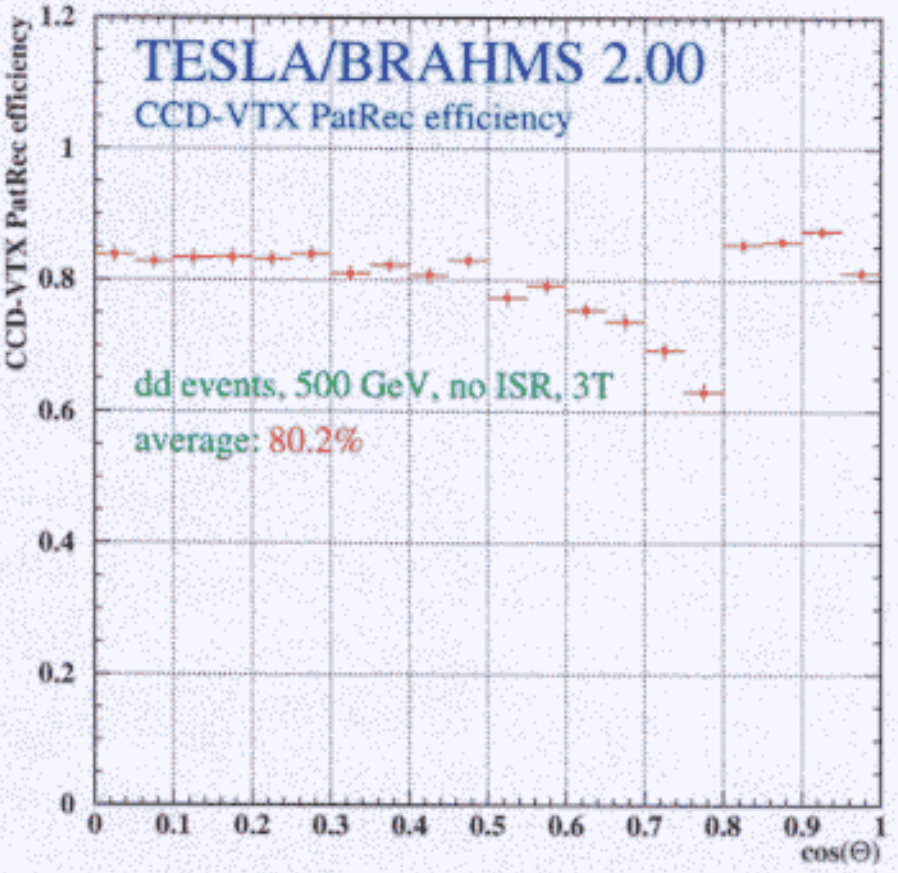
The pattern recognition chain

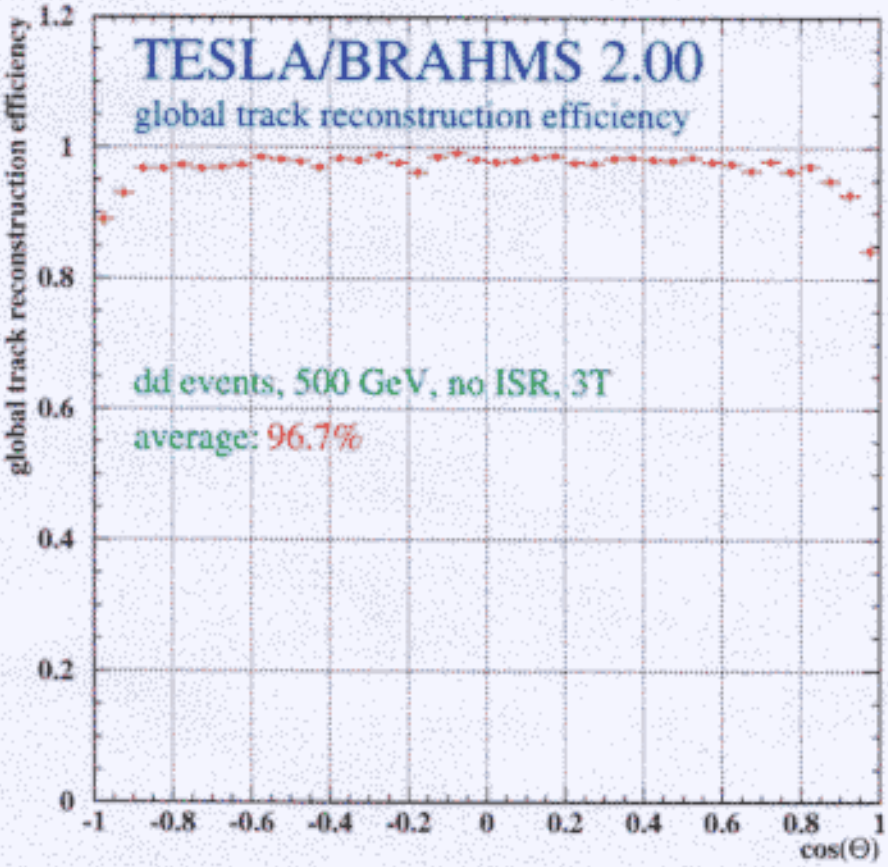
- local pattern recognition in TPC, silicon, FCH (under way)
- track search and ambiguity processor from DELPHI
- Kalman-filter track fit with full account of material

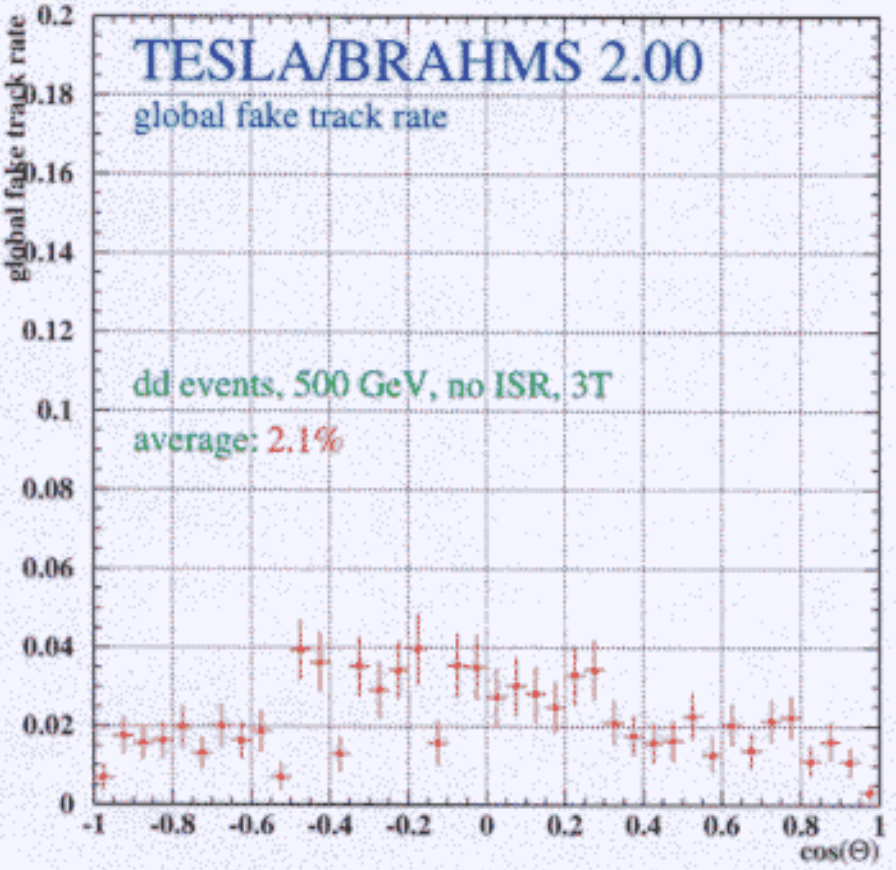
Efficiency plots (Need update!)



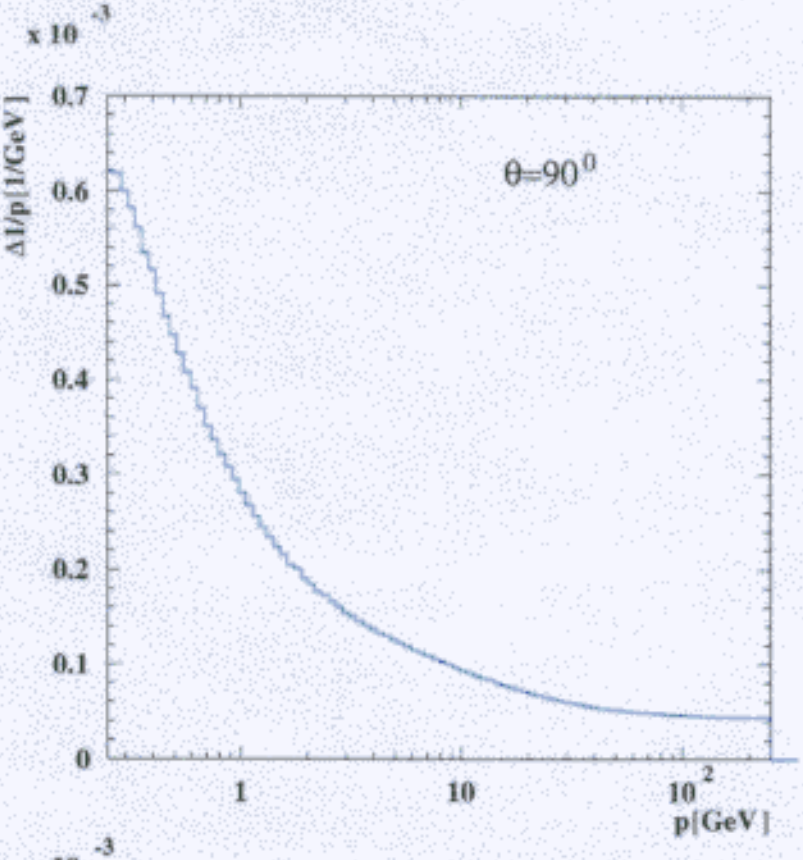

TESLA/BRAHMS 2.00
CCD-VTX PatRec efficiency
dd events, 500 GeV, no ISR, 3T
average: 80.2%
CCD-VTX PatRec efficiency
log(p)
1.2
1
0.8
0.6
0.4
0.2
0
0.5
1.5
2
2.5

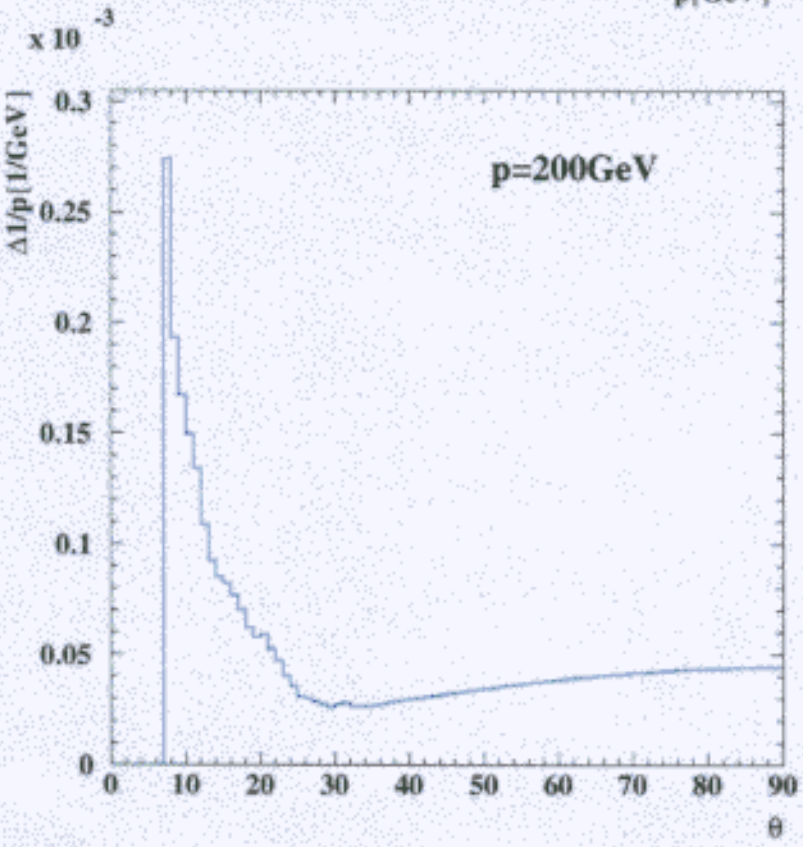

TESLA/BRAHMS 2.00
CCD-VTX PatRec efficiency
dd events, 500 GeV, no ISR, 3T
average: 80.2%
CCD-VTX PatRec efficiency
cos(Θ)
1.2
1
0.8
0.6
0.4
0.2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.9


TESLA/BRAHMS 2.00
global track reconstruction efficiency
dd events, 500 GeV, no ISR, 3T
average: 96.7%
global track reconstruction efficiency
cos(Θ)
1.2
1
0.8
0.6
0.4
0.2
0
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1


TESLA/BRAHMS 2.00
global fake track rate
dd events, 500 GeV, no ISR, 3T
average: 2.1%
global fake track rate
cos(Θ)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1

Resolution for single particles

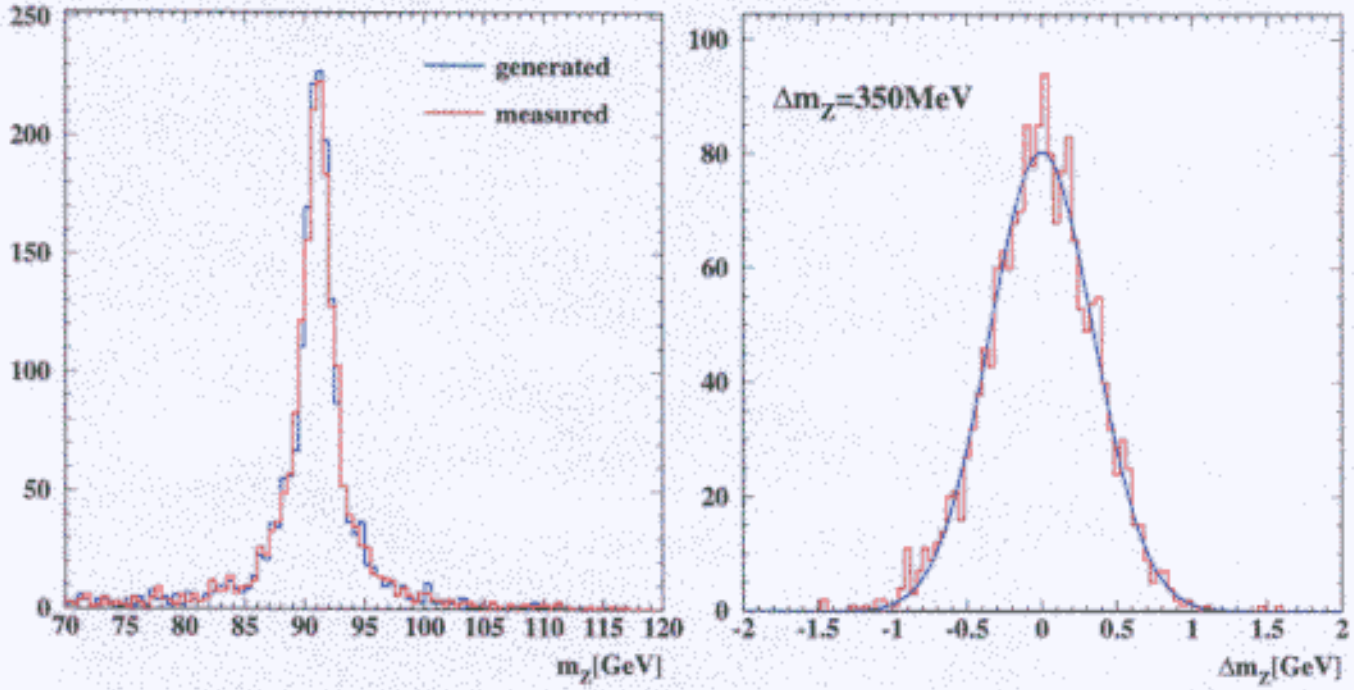




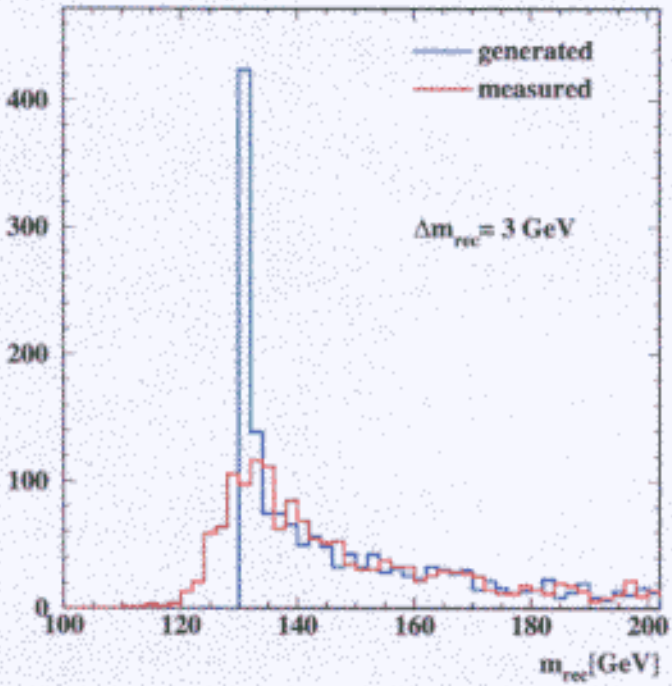
Design resolution reached for $\theta > 20°$ and $p > 30$ GeV

Physics performance for few particle systems

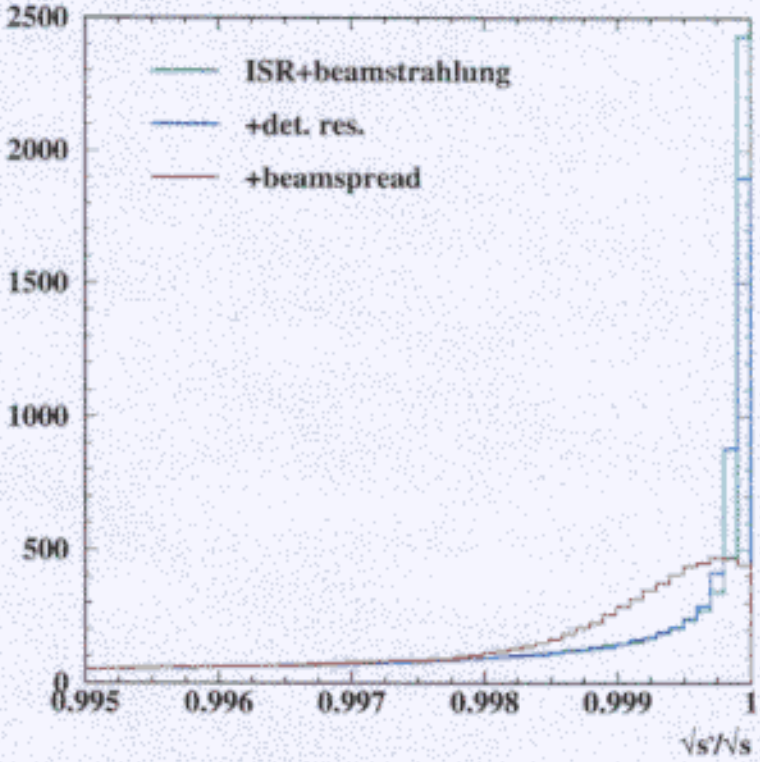
Z-mass resolution in $e^+e^- \to ZH \to \mu^+\mu^- X$



And missing mass resolution



Analysis of beamstrahlung by far not limited by detector effects



Performance in complicated events:

- b-tagging: See VTX talk by C. Damerell
- track reconstruction: See energy flow performance in talk by

Conclusions

- The TDR describes a tracking system with a large TPC and inner silicon tracking.
- The system can be build with almost present day technology.
- The needed performance can be reached over the full angular range for few particles and multi-jet events.