

Shrinking the TPC

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DESY

Detector Performance

ECFA Study
Physics and Detectors
for a linear collider
Durham

Outline

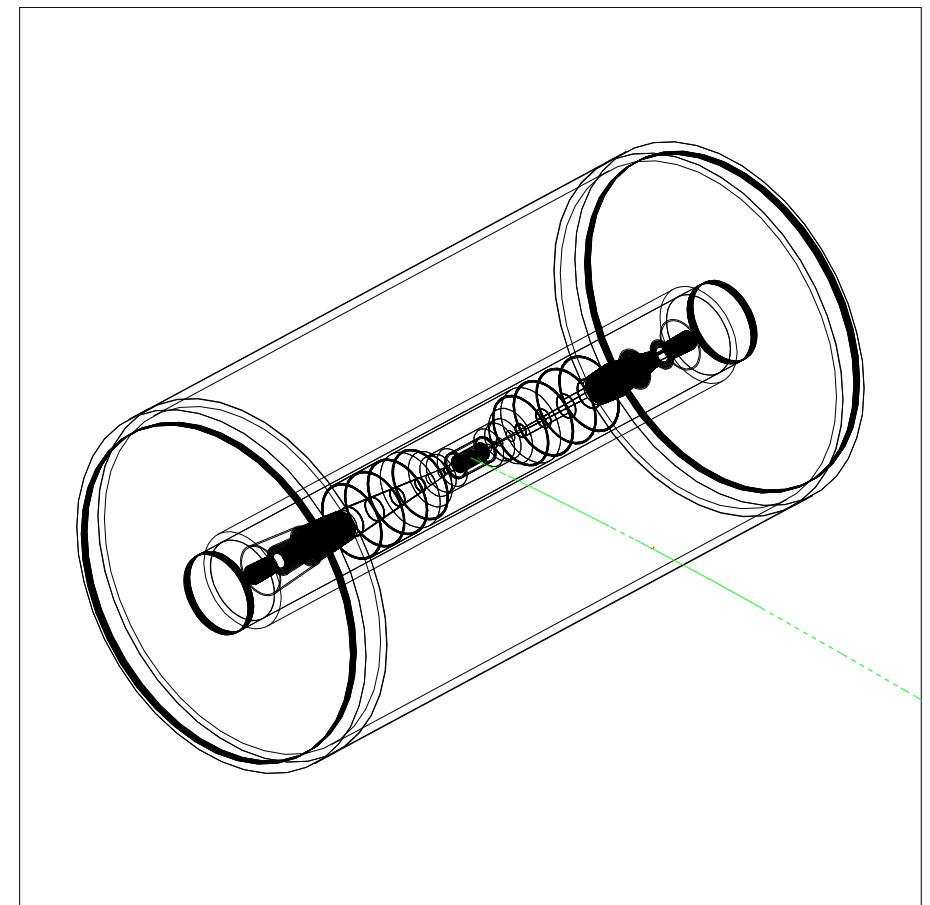
- Motivation
- Simulation
- Resolution of the TPC
- Resolution of combined tracking system
- Effect of TPC point resolution
- Room for improvement
- Conclusion
- Outlook

Motivation

- What effect would reducing the outer radius of the TPC have on the overall momentum resolution.
- What TPC point resolution would be needed to compensate any loss in performance due to reduction of radius.

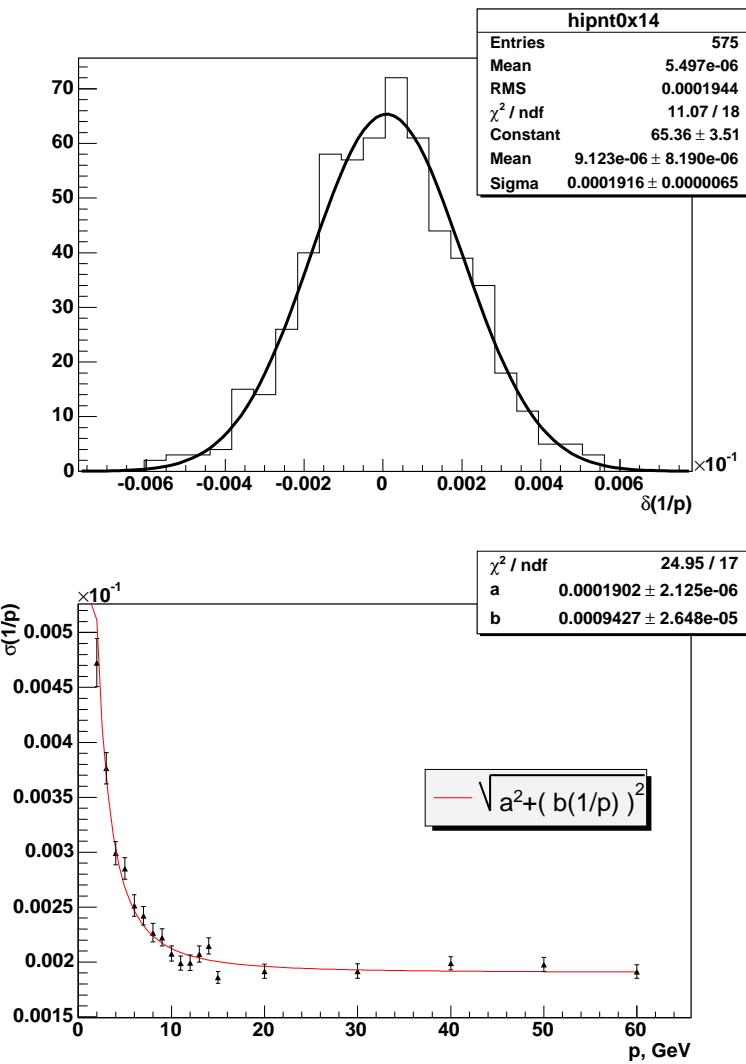
Simulation

- Simulation of single muons over the momentum range $2\text{-}60\text{GeV}/c$, $\theta=90^\circ$
- Start with TDR specs
 - outer radius 162.2cm
 - radial pad size 0.62cm
 - point resolution $190\mu\text{m}$
 - B field 4T
- Simulation and reconstruction performed using Brahms (Geant3 and LEP Tracking Software)



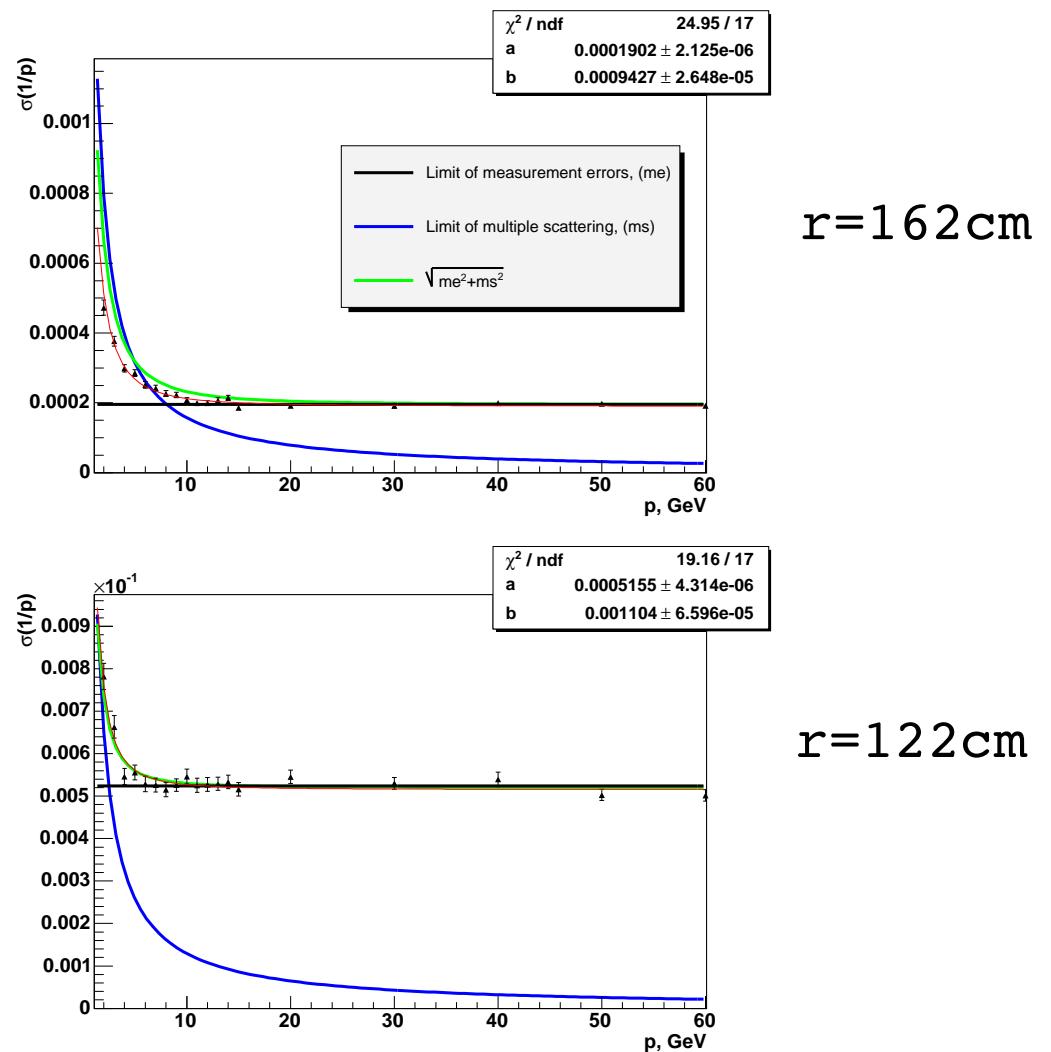
Momentum Resolution

- Determine $\delta(1/p)$ versus momentum over 2–60 GeV/c
- Fit Gaussian and plot σ versus p
- Parameterise curve with
 - Intrinsic detector term (a)
 - multiple scattering term (b)



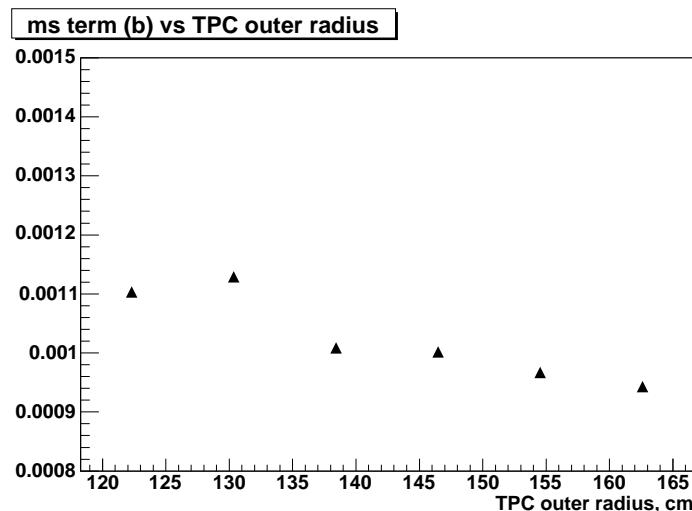
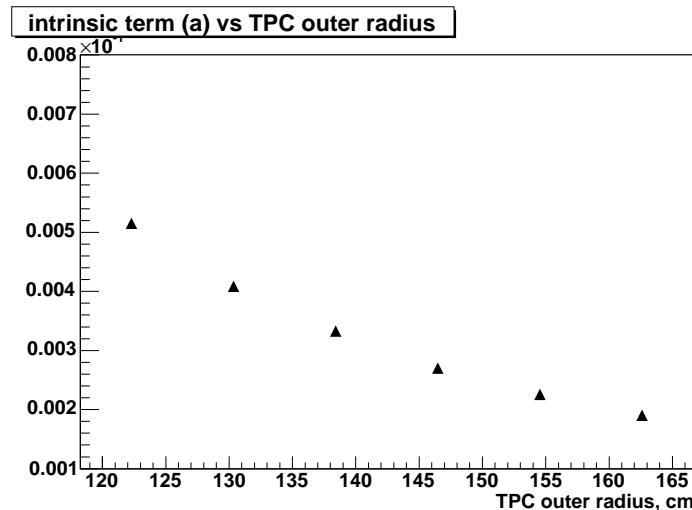
Gluckstern Formula

- For the TPC the Gluckstern formula can determine the expected momentum resolution analytically
- Comparison with the simulation confirms that Brahms performs well for a smaller TPC radius
- Above 10GeV/c intrinsic detector resolution starts to dominate



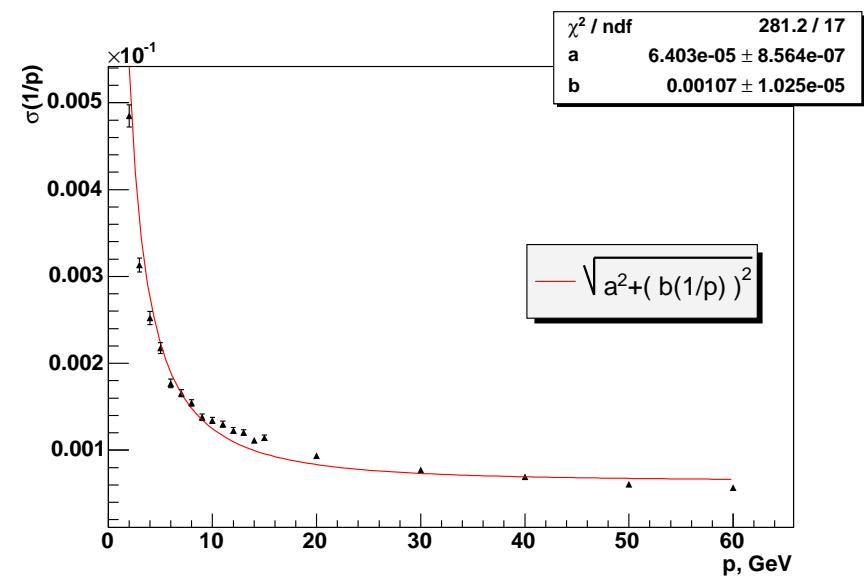
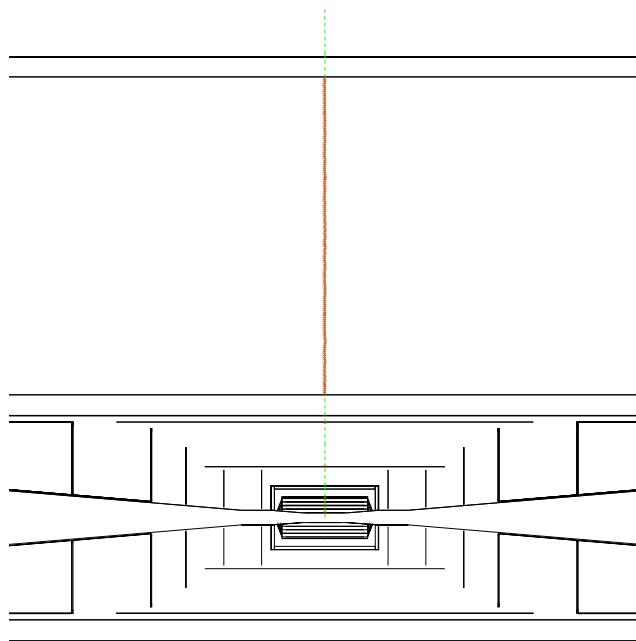
Impact of Reduced TPC Radius

- Reduce outer TPC radius in steps of 8cm
- Reduction by 40cm leads a factor 2.5 deterioration in momentum resolution
- Multiple scattering term not strongly effected



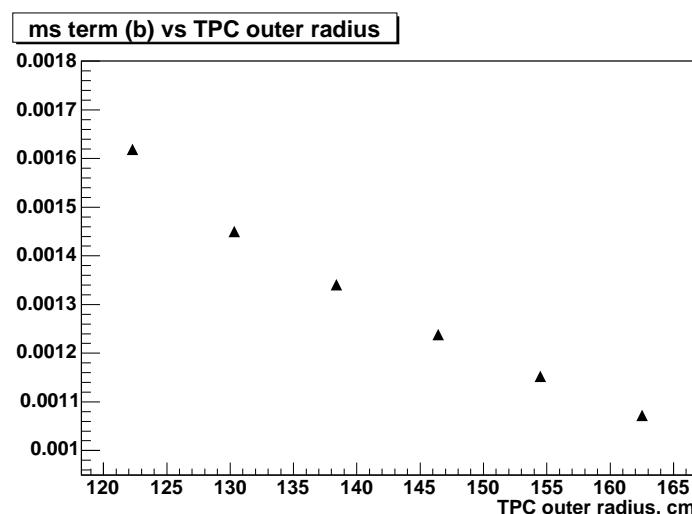
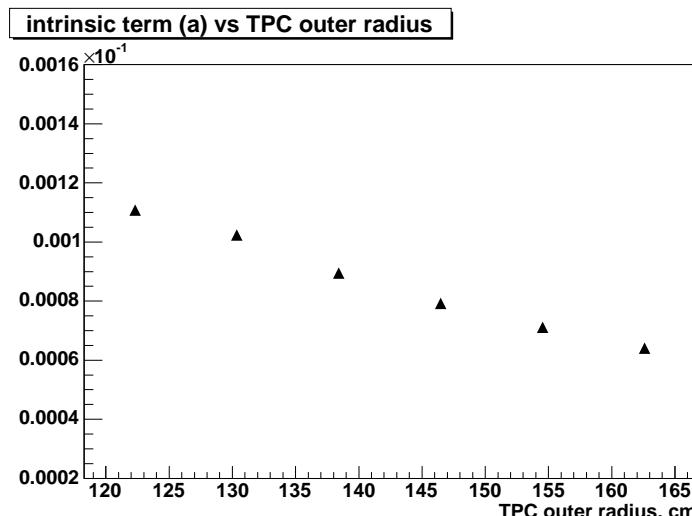
Resolution of Combined System

- Including the vertex detector and SIT reduces the momentum resolution to the desired level of $\sim 10^{-5}$



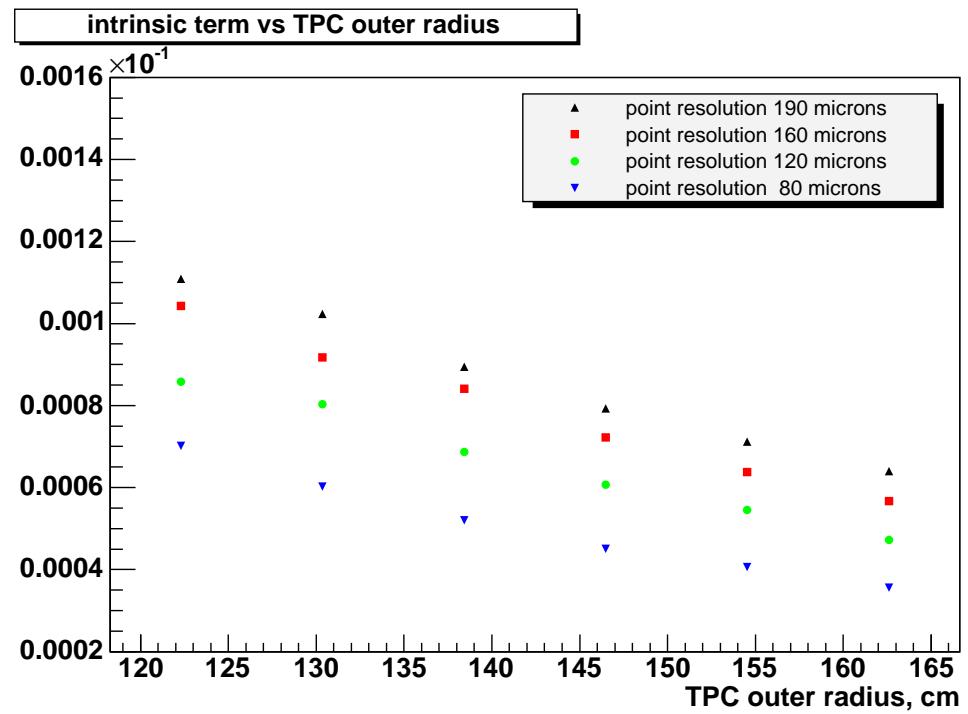
Impact of TPC Radius on Overall Momentum Resolution

- Reduction by 40cm leads to a factor 1.5 deterioration in momentum resolution for the complete system
- Multiple scattering term more strongly effected due to increased material



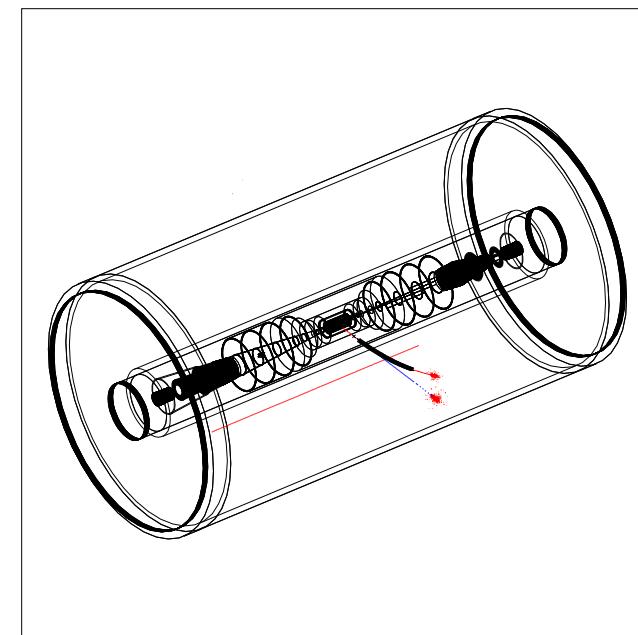
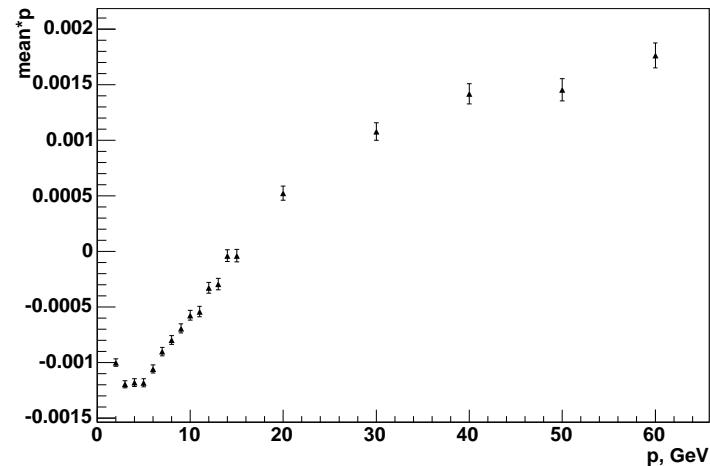
TPC Point Resolution

- By improving the point resolution it will be possible to counter the effect of the reduced length
- Comparable performance can be achieved:
 - $R = 155\text{cm} : \sigma \sim 160\mu\text{m}$
 - $R = 138\text{cm} : \sigma \sim 160\mu\text{m}$
 - $R = 122\text{cm} : \sigma \sim 80\mu\text{m}$



Room for Improvement

- Momentum dependant bias centered at 10GeV/c
- Very low energy curlers can leave no hit in TPC
- Ineffeciency of SIT in Brahms



Conclusion

- This study has shown that reducing the TPC radius by up to 122cm should not adversely effect momentum resolution for isolated tracks in the barrel region
- This assumes a point resolution of 80microns can be achieved

Outlook

- Study of Forward region
- Investigate impact on dE/dx
- Investigate impact on PATREC
- Consider TPC geometry in overall detector optimisation
- We need to update or move on from Brahms