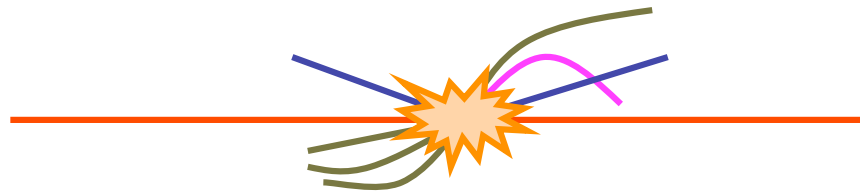


ATLAS: Minimum Bias



W. H. Bell

Université de Genève

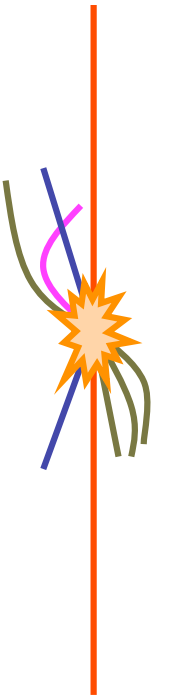


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DE GENÈVE

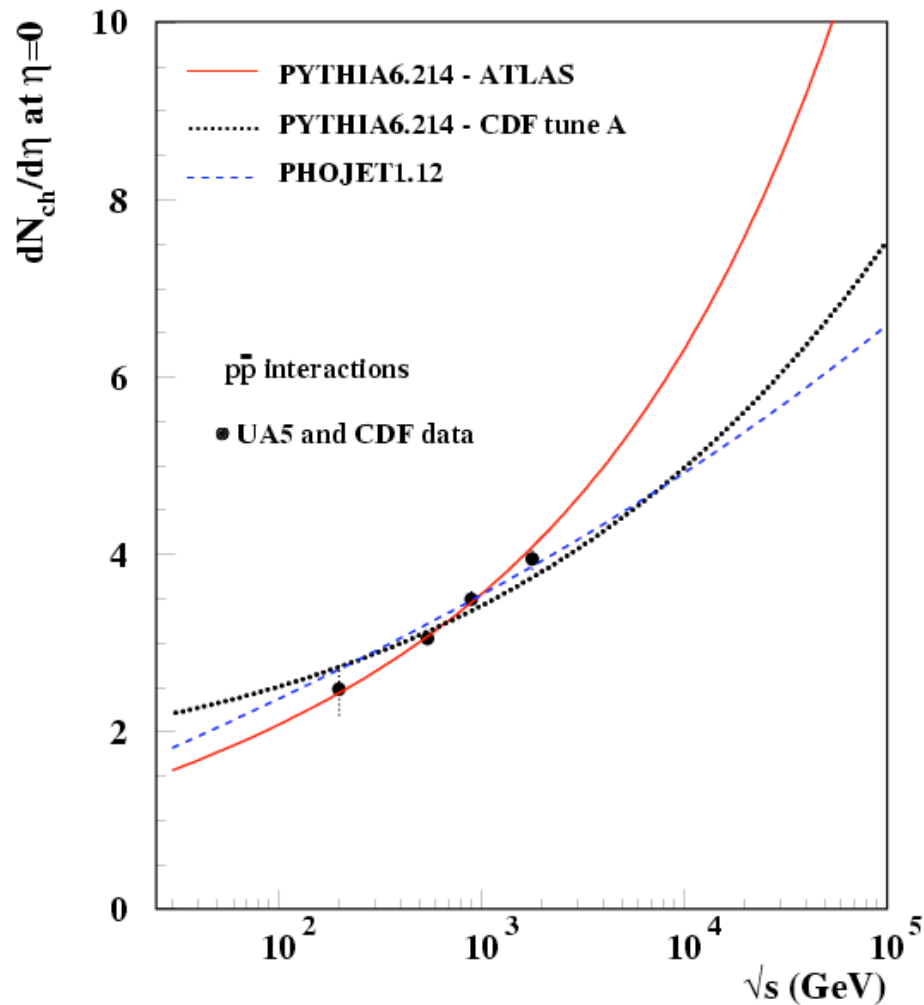
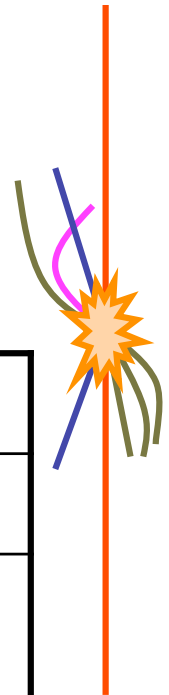
MPI LHC08, 28th Oct, 2008

Overview

- Predictions from Previous Data
- Analysis Goals and Strategy
- Monte Carlo Analysis Studies
- Trigger Performance and Readiness
- Tracking Performance and Readiness
- Conclusions and Outlook



Predictions from Existing Data



Process	Cross-section (mb)	
	PHOJET	PYTHIA
Non-Diff.	69	55
Single Diff.	11	14
Double Diff.	4	10
Central Diff.	1	-
Inelastic	85	79
Elastic	35	23
Total	120	102

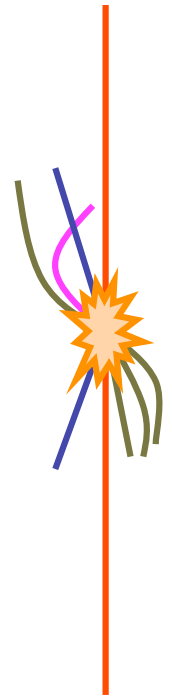


Physics Goals at Start-Up

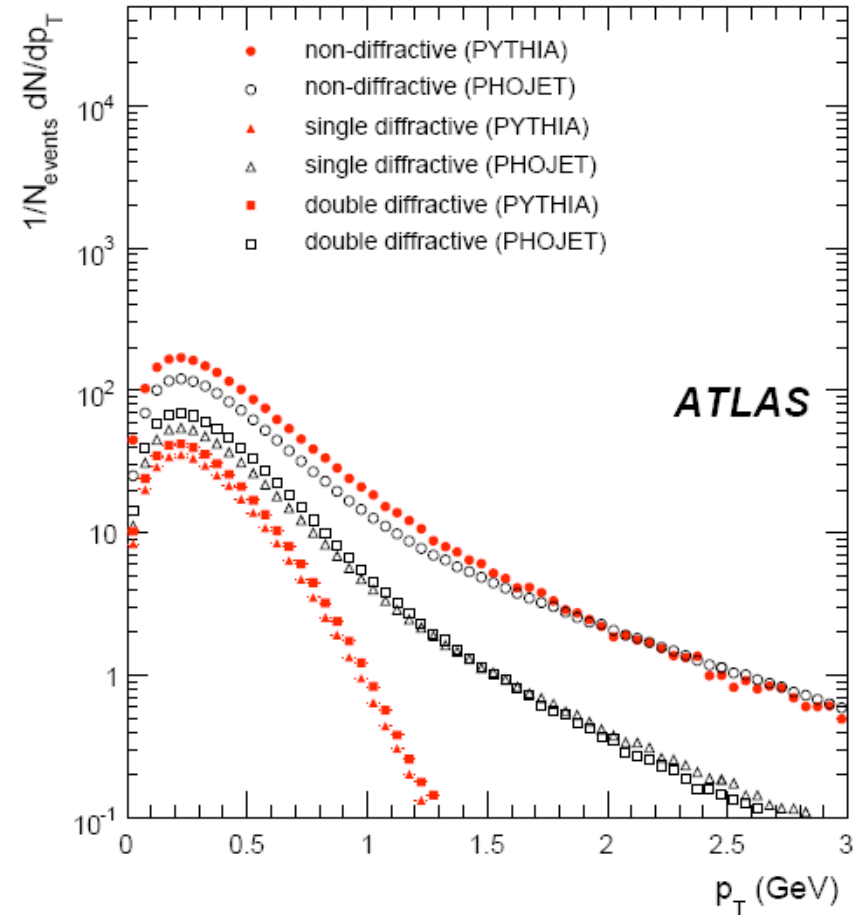
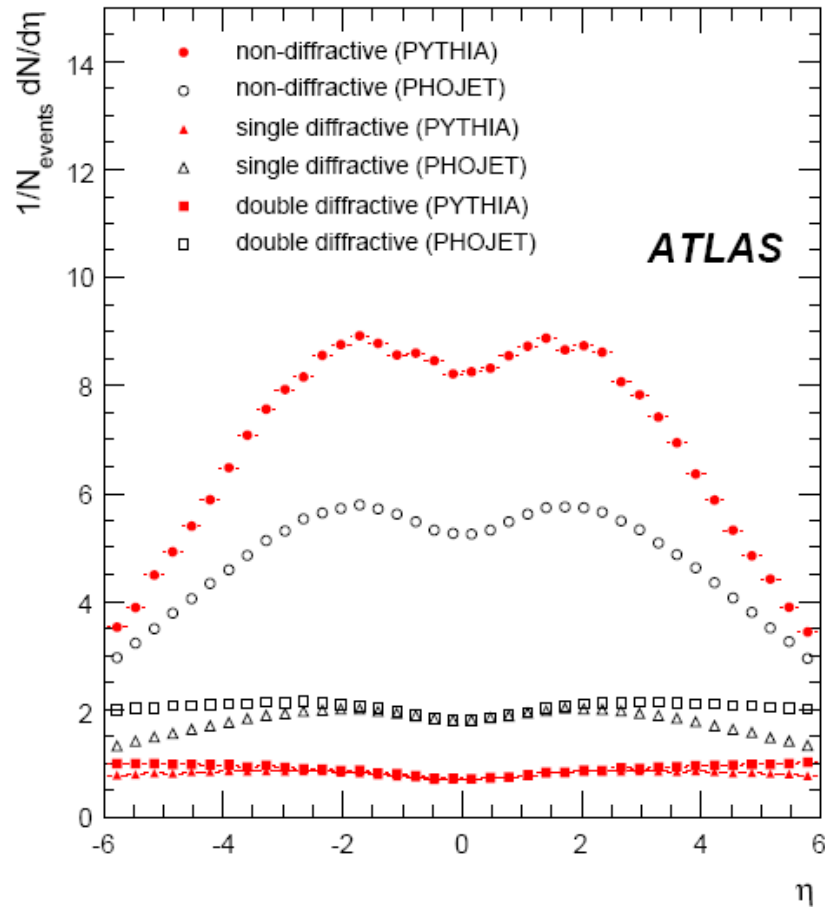
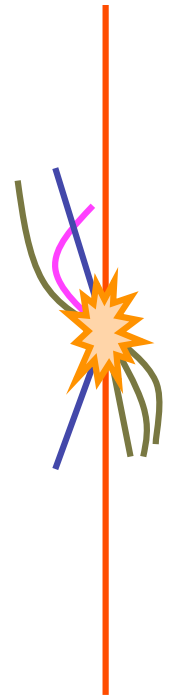
Event estimates based on statistical errors

- Charged particle $dN/d\eta, dN/dp_T > 10K$
- Charged particle multiplicity (KNO) $> 400K$
- $\langle P_T \rangle$ vs $N > 1M$
- UE distributions (E_T up to 150GeV) $> 10M$

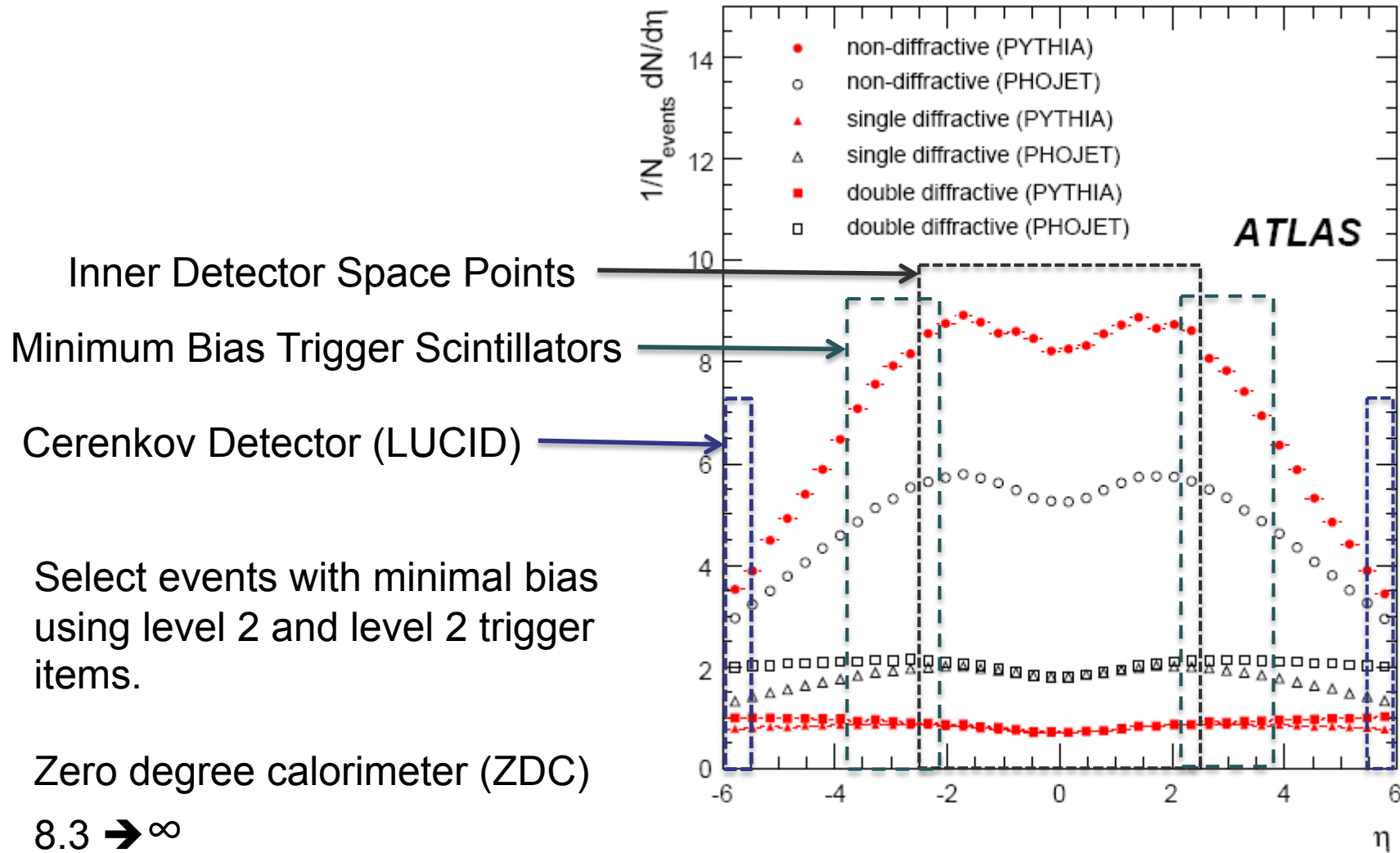
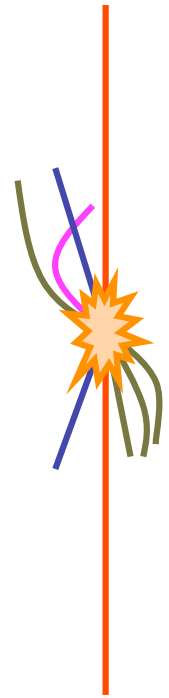
Time needed to perform analysis depends on bandwidth allocated.



Predicted Properties



Triggering on Minimum Bias



Inner Detector Space Points

Minimum Bias Trigger Scintillators

Cerenkov Detector (LUCID)

Select events with minimal bias using level 2 and level 2 trigger items.

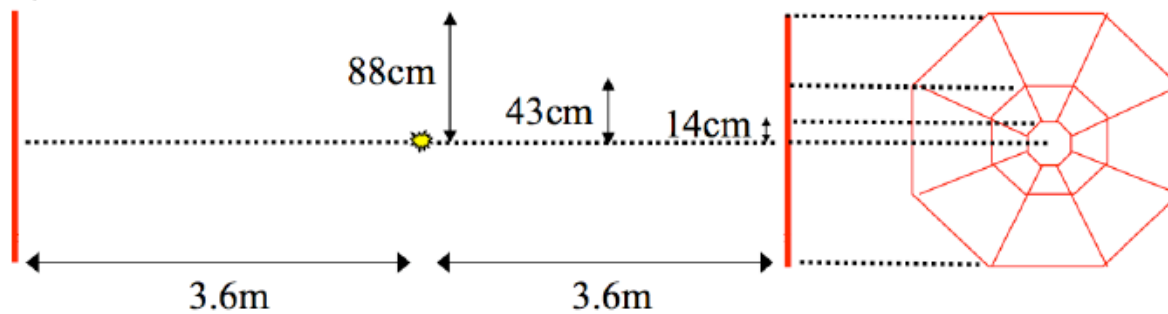
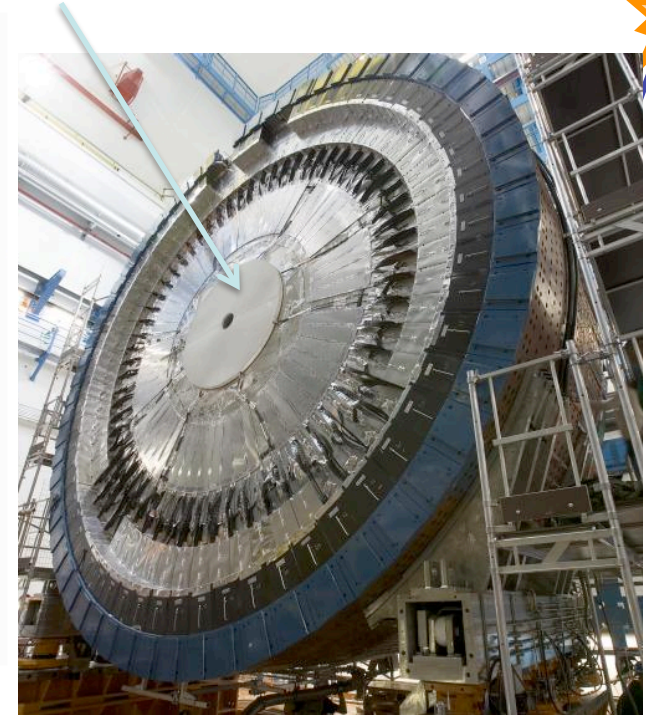
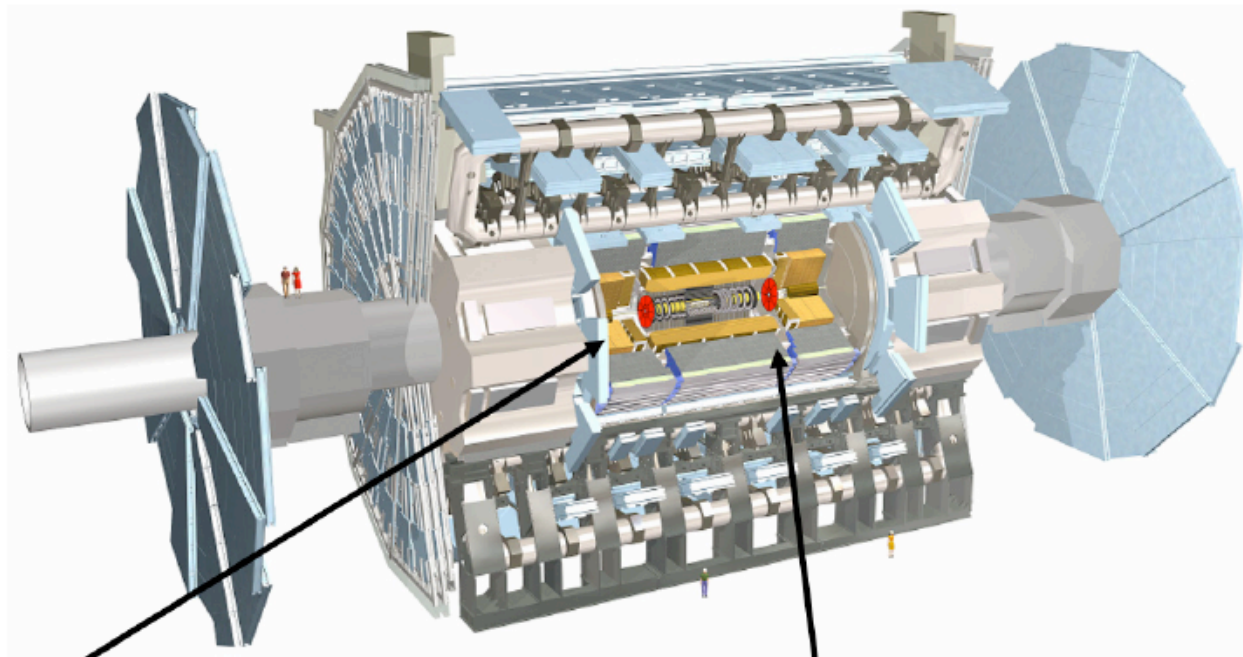
Zero degree calorimeter (ZDC)

8.3 $\rightarrow \infty$



Triggering on Minimum Bias: MBTS

Minimum Bias Trigger Scintillators (MBTS)

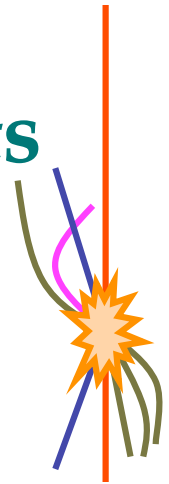


$$2.12 < |\eta| < 2.83$$

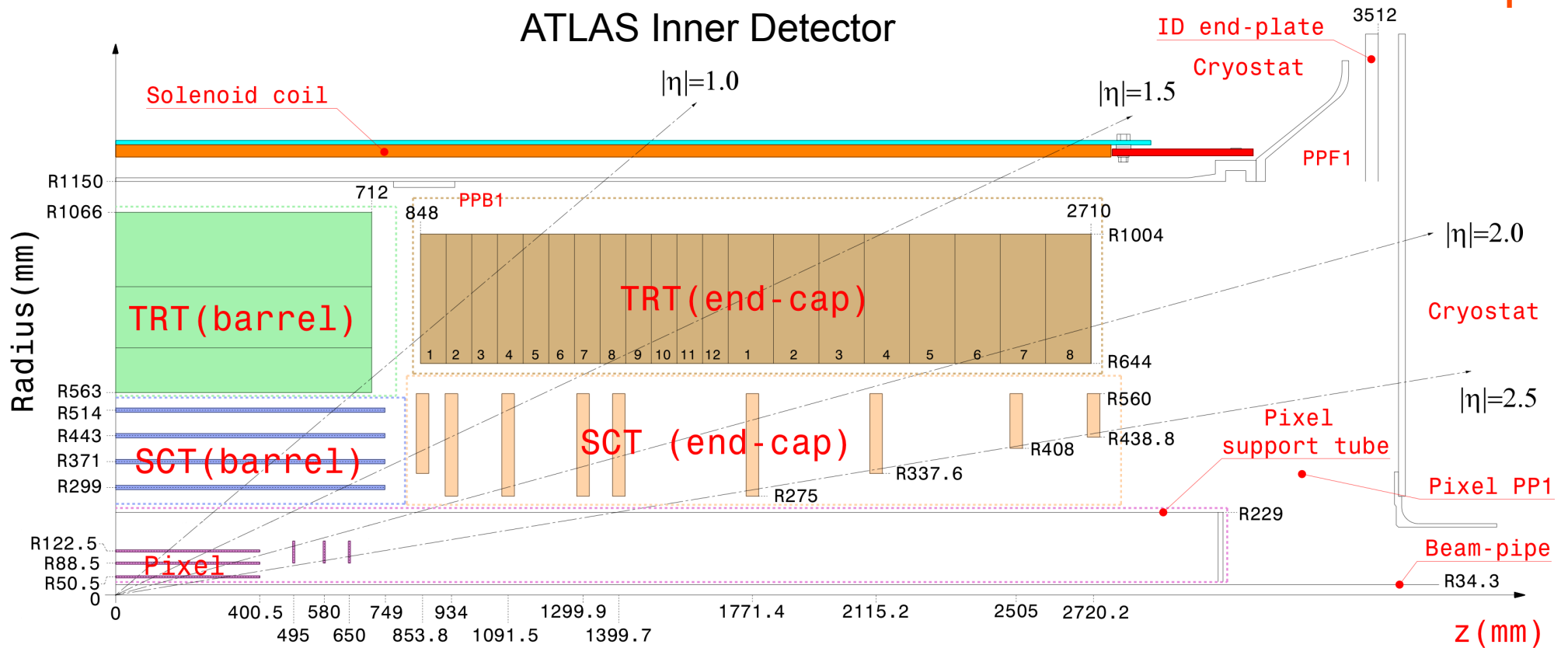
$$2.83 < |\eta| < 3.8$$



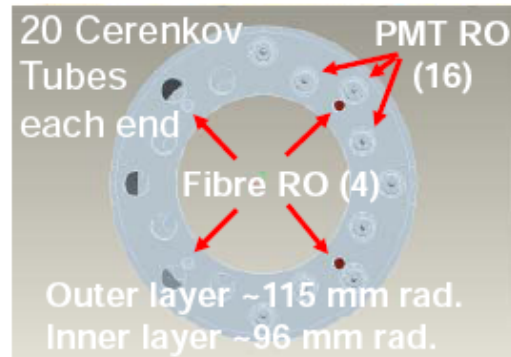
Triggering on Minimum Bias: Space Points



Pixel and silicon microstrip (SCT) detectors provide space points at level 2.

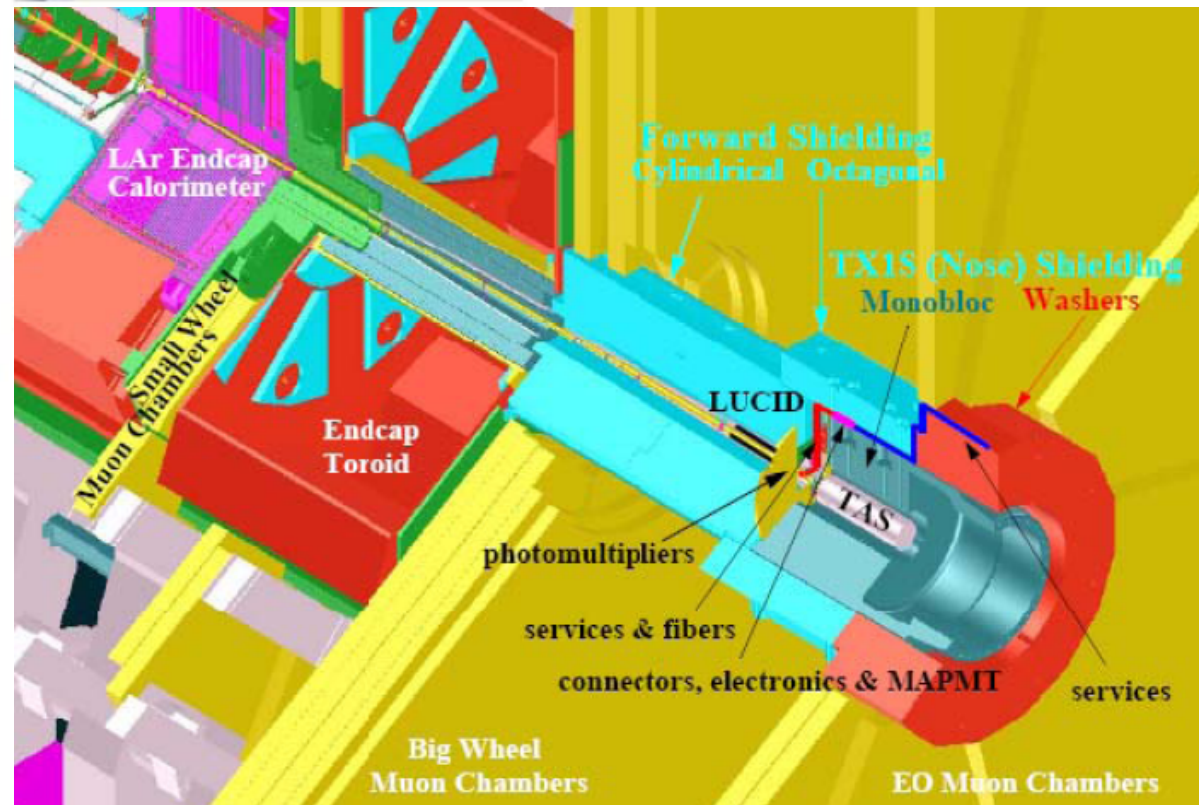
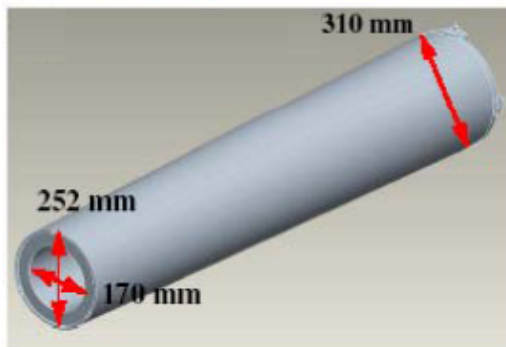
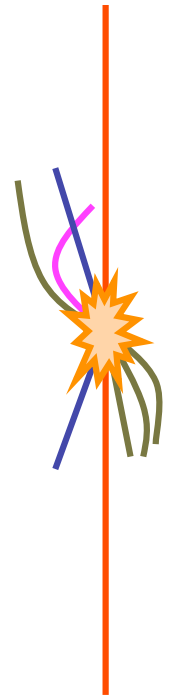


Triggering on Minimum Bias: LUCID



Cerenkov Detector (LUCID)

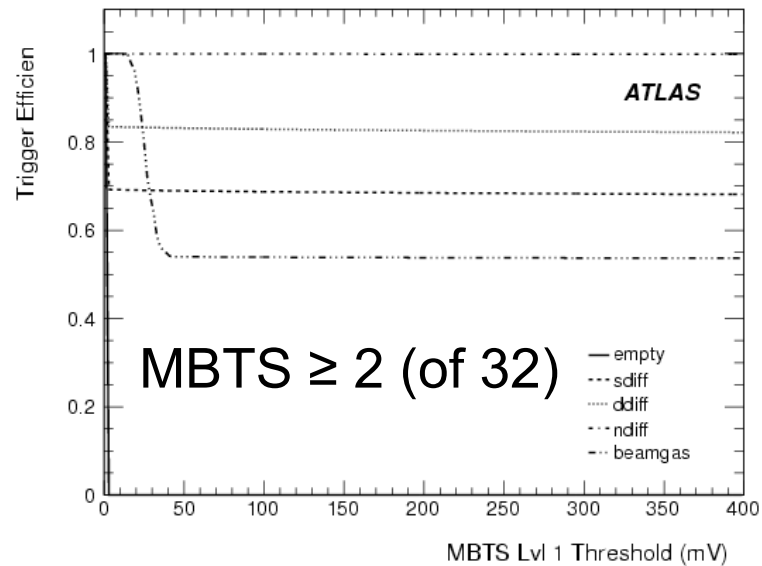
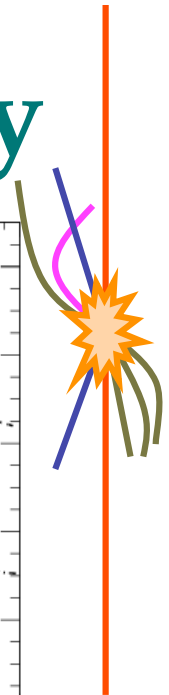
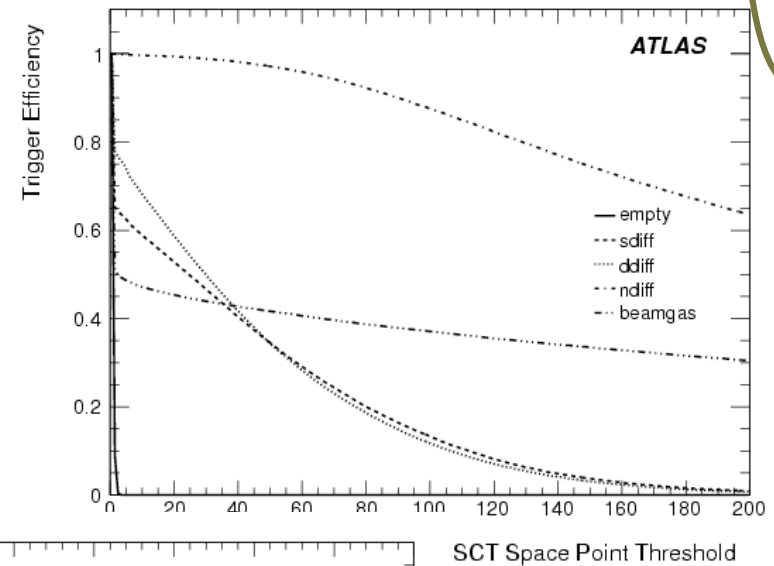
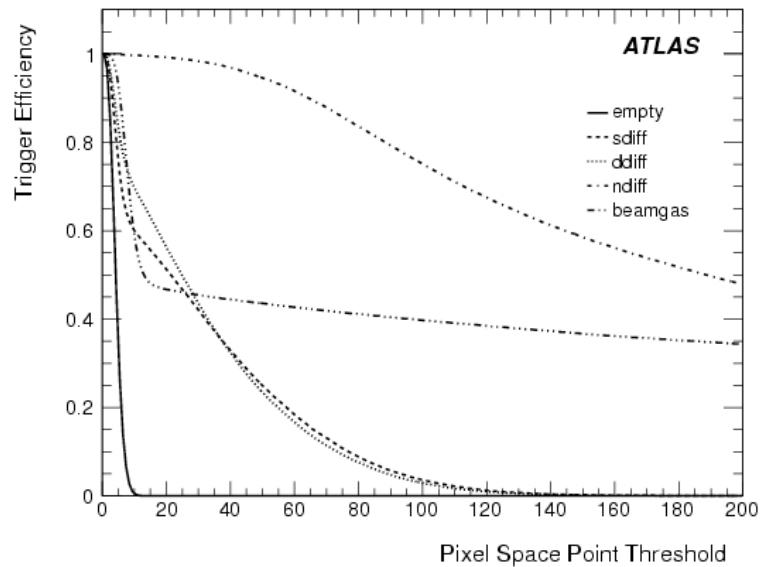
+/-17m from IP
 $5.61 < |\eta| < 5.93$



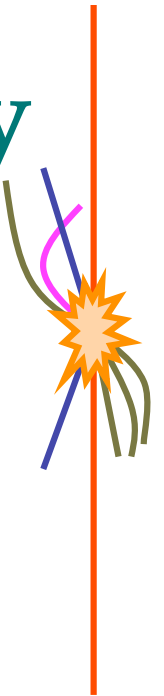
Require 1 or more tube one side



Event Selection: Trigger Efficiency



Event Selection: Trigger Efficiency

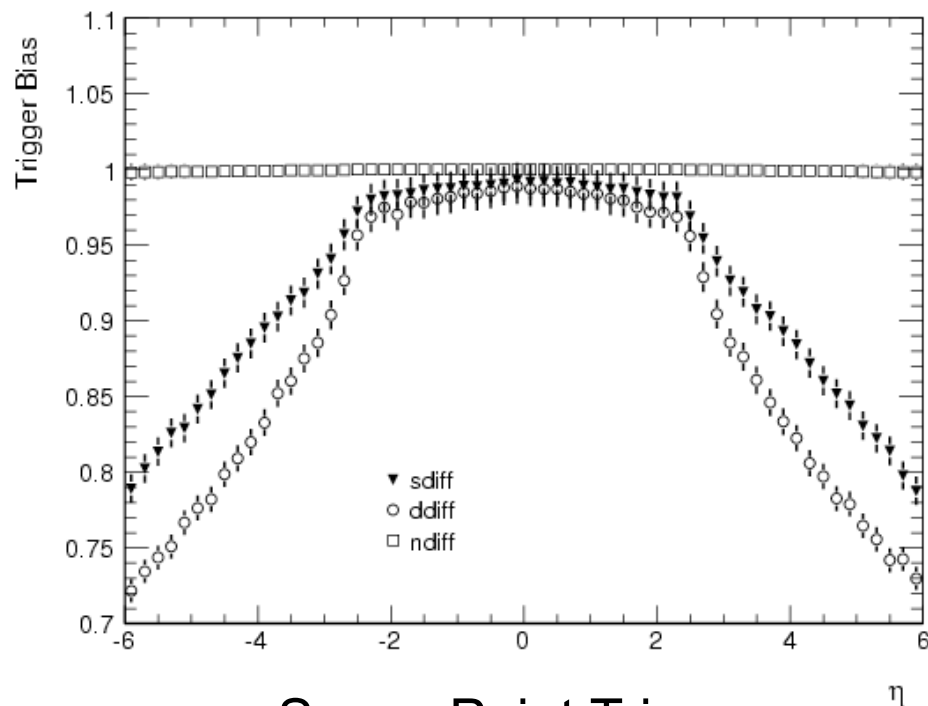
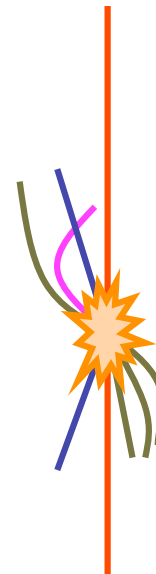


	MBTS_2	SP
Ndiff	100%	100%
Ddiff	83%	66%
Sdiff	69%	57%
B. Gas	54%	47%

- MBTS ≥ 2 (of 32),
Threshold @ 40mV from
cosmic data
- Space Point (SP) trigger
SCT ≥ 3 & Pixel ≥ 12

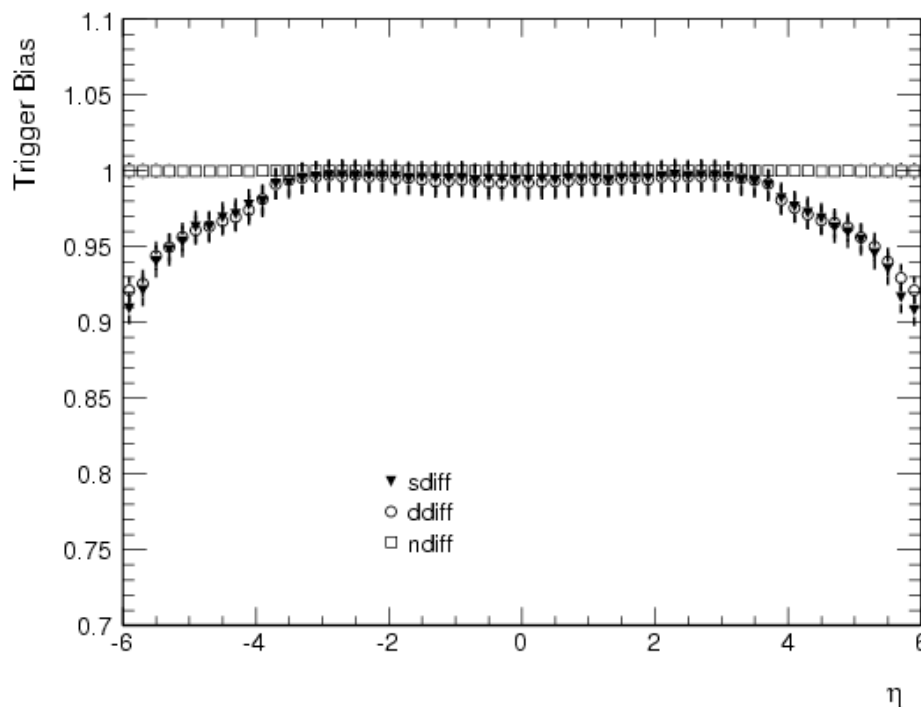


Event Selection: Trigger Bias



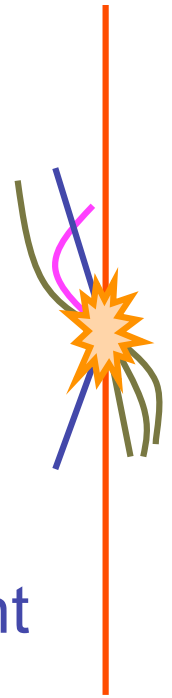
Space Point Trigger
 $SCT \geq 3$ & Pixel ≥ 12

MBTS ≥ 2 (of 32)
Threshold @ 40mV



Analysis Strategy

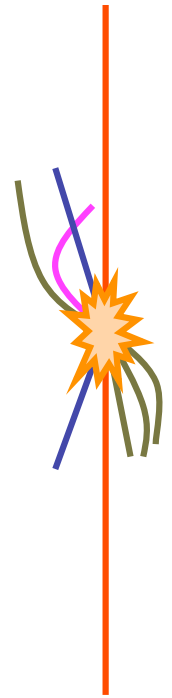
$dN/d\eta$, dN/dp_T



- Record events with Minimum Bias trigger
 - Selection required while $N_{\text{inter}} \ll 1$
 - Combination of MBTS and Inner Detector space point
 - Comparisons with LUCID
 - Diffractive content estimation ZDC
- Measurement with tracks
 - Utilise low p_T tracking down to 100MeV
 - Efficiency studies with track insertion cross checked with $K_s \rightarrow \pi^+\pi^-$
 - Sensitive to material model and misalignment



Track Selection



- Using loose track cuts to
 - Remove fake and secondary tracks
 - Select tracks with reasonable fits

Quality cuts	No. of b-layer hits ≥ 1 No. of Silicon hits ≥ 5 $P(\chi^2) > 0.0$
Resolution cuts	$ \sigma_{d_0} < 1.6$ mm $ \sigma_{z_0} < 6.0$ mm $ \sigma_\phi < 0.03$ $ \sigma_\theta < 0.015$ $ \sigma_{q/p_T} < 0.0003$ (GeV) $^{-1}$
Track-to-vertex cut	$N_\sigma < 3$

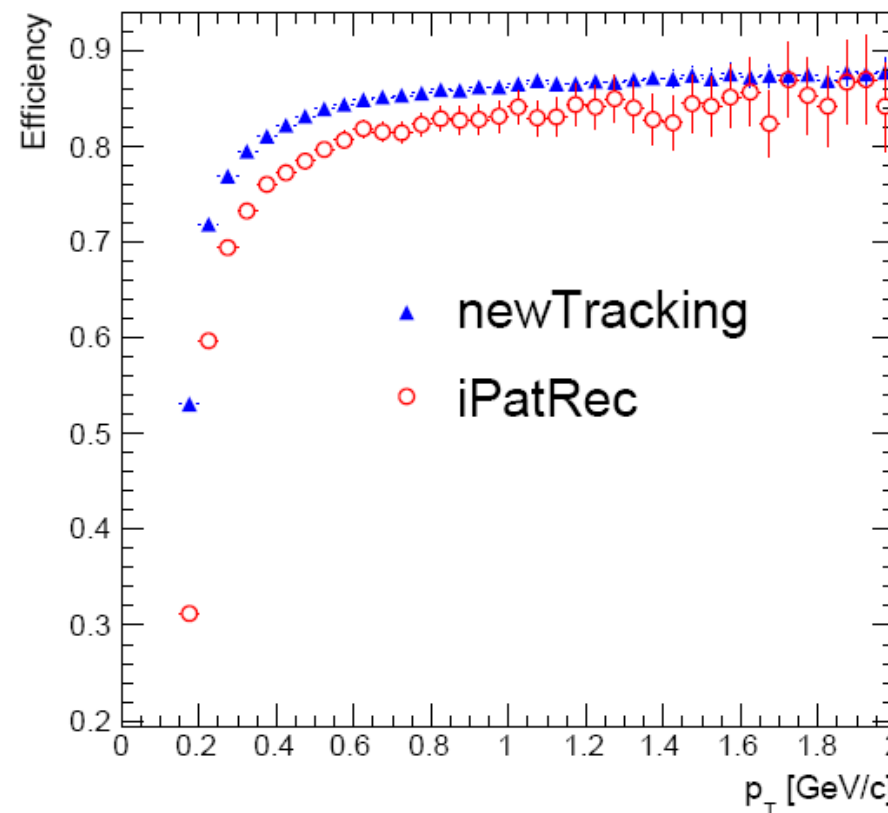
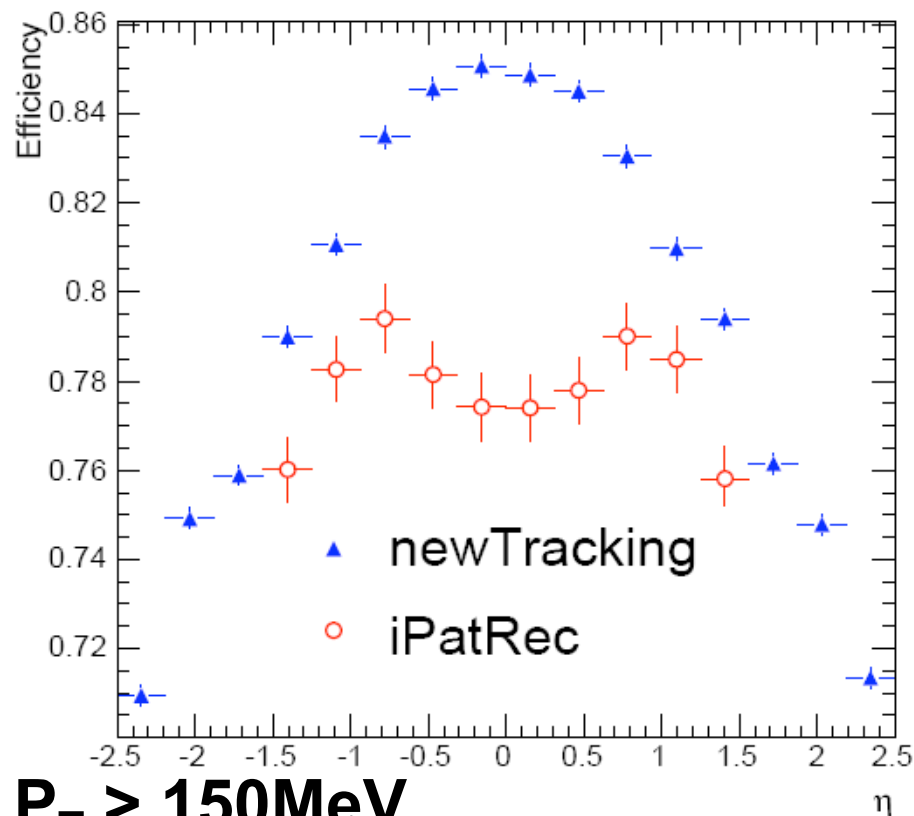
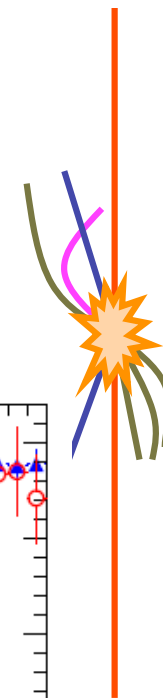
Using Gaussian fits to parameters, cuts are 3σ



Tracking Efficiencies

$$\text{truth probability} \equiv \frac{\sum_{i=\text{subdetector}} w_i C_i}{\sum_{i=\text{subdetector}} w_i T_i}$$

Truth probability $\geq 50\%$ => Matched



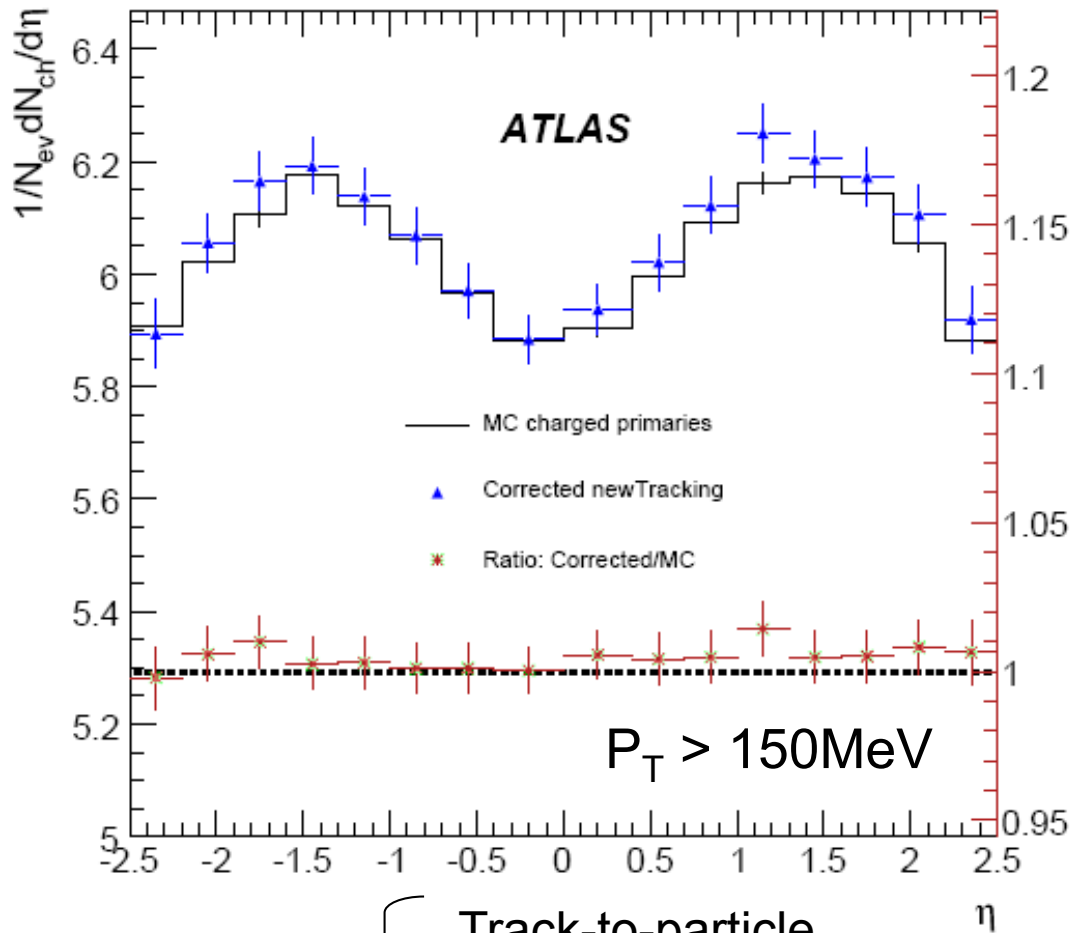
$P_T > 150 \text{ MeV}$

$$\epsilon_{tr} \equiv \frac{\text{No. of found generated primaries}}{\text{No. of generated primaries}}$$

$|\eta| < 2.5$



dN/d η and Systematics

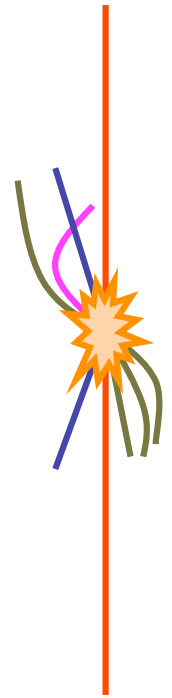


Corrections: {
 Track-to-particle
 Vertex reconstruction
 Trigger bias

Name	Estimated Uncertainty
Track Selection Cuts	2%
Mis-estimate of Secondaries	1.5%
Vertex Reconstruction Bias	0.1%
Misalignment	6%
Beam-gas and pileup	1%
Particle Composition	2%
Diff. Cross Sections (NSD)	4%
Total	8%



Trigger Readiness

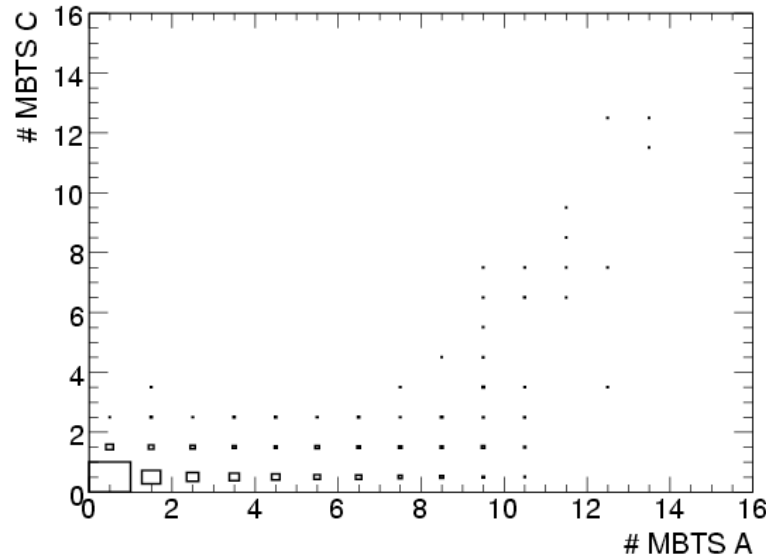
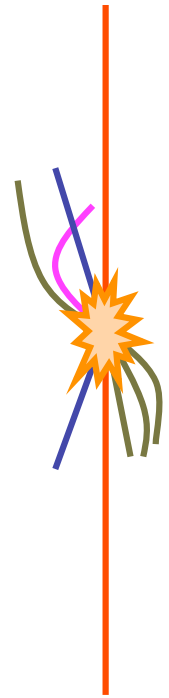


- All triggers will be ready for next beam
 - MBTS trigger stable with beam and cosmics
 - Use cosmic running to study Space Point trigger performance.
 - LUCID performed well with beam.
 - ZDC cabled up.
- Additional trigger menu tuning will follow new series of performance studies.
 - Motivated by physics and trigger commissioning
 - Real data creates new challenges

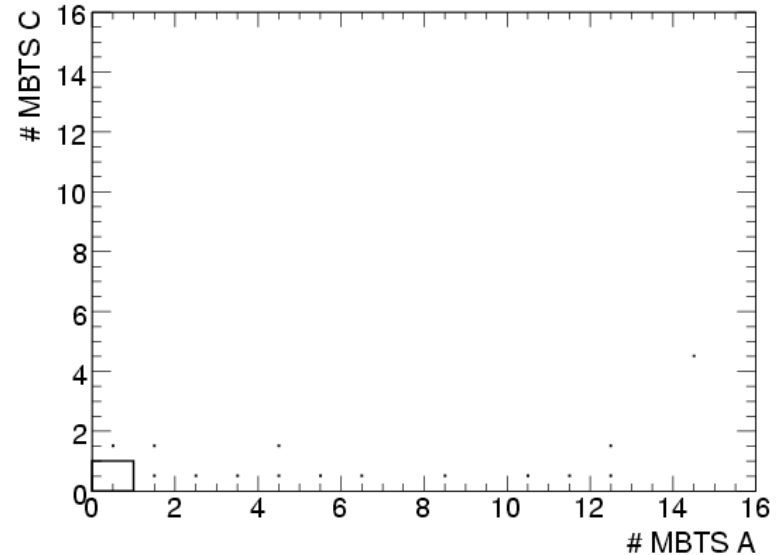


Trigger Readiness

- During September ATLAS was triggering on beam pickups and MBTS
- Saw single beam collimator splashes and stable single beam
- MBTS A in time, MBTS C out of time.
- Plot MBTS A and C side multiplicities



Beam 2 with collimator
"splashes", few turns only before
being lost



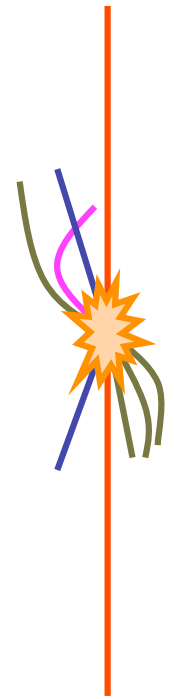
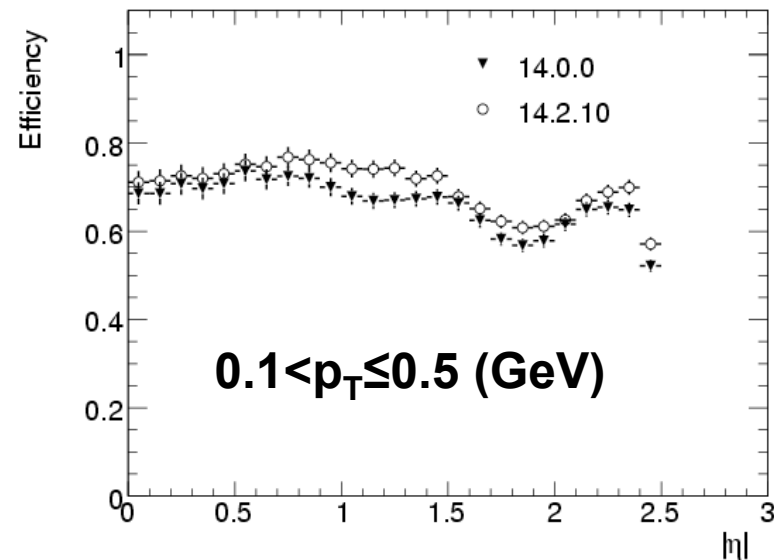
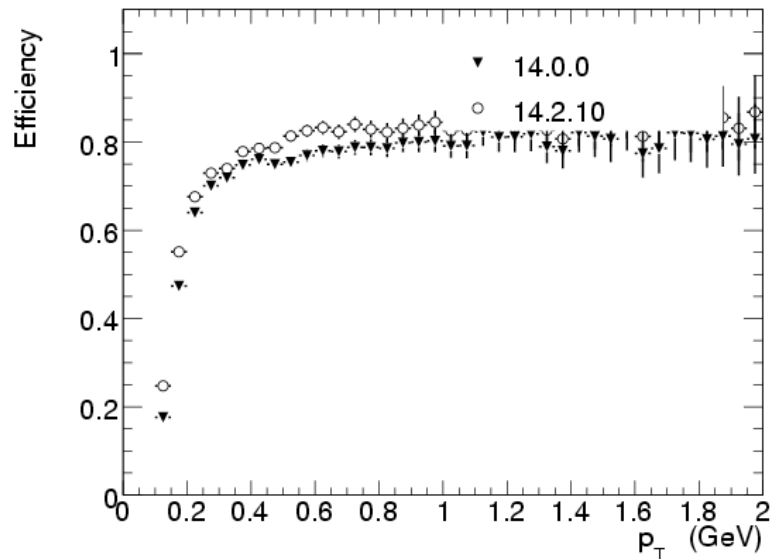
Injecting and circulating Beam 2

MBTS provides a stable activity trigger

(Lvl1 MBTSA timed in with opposite side BPTX)



Tracking Readiness



20000 Simulated Pythia Non-diffractive inelastic events.

- Reconstructing tracks down to 150MeV
- Further tracking performance enhancements may be possible through parameter tuning



Conclusions and Outlook

- Analysis has been developed through a full Geant simulation.
 - Expect to be able to make improvements on this analysis.
- Trigger commissioning well underway
 - Single beam showed MBTS stability
- Further Tracking Studies
 - Fine tune parameters
- Shutdown period provides additional time for development of tools.
 - Preparation for a fast analysis from the first colliding beam data.

