

ATLAS Commissioning

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on behalf of the ATLAS collaboration

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Tracciatore

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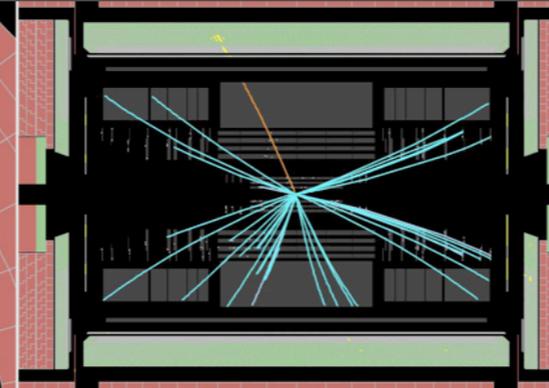
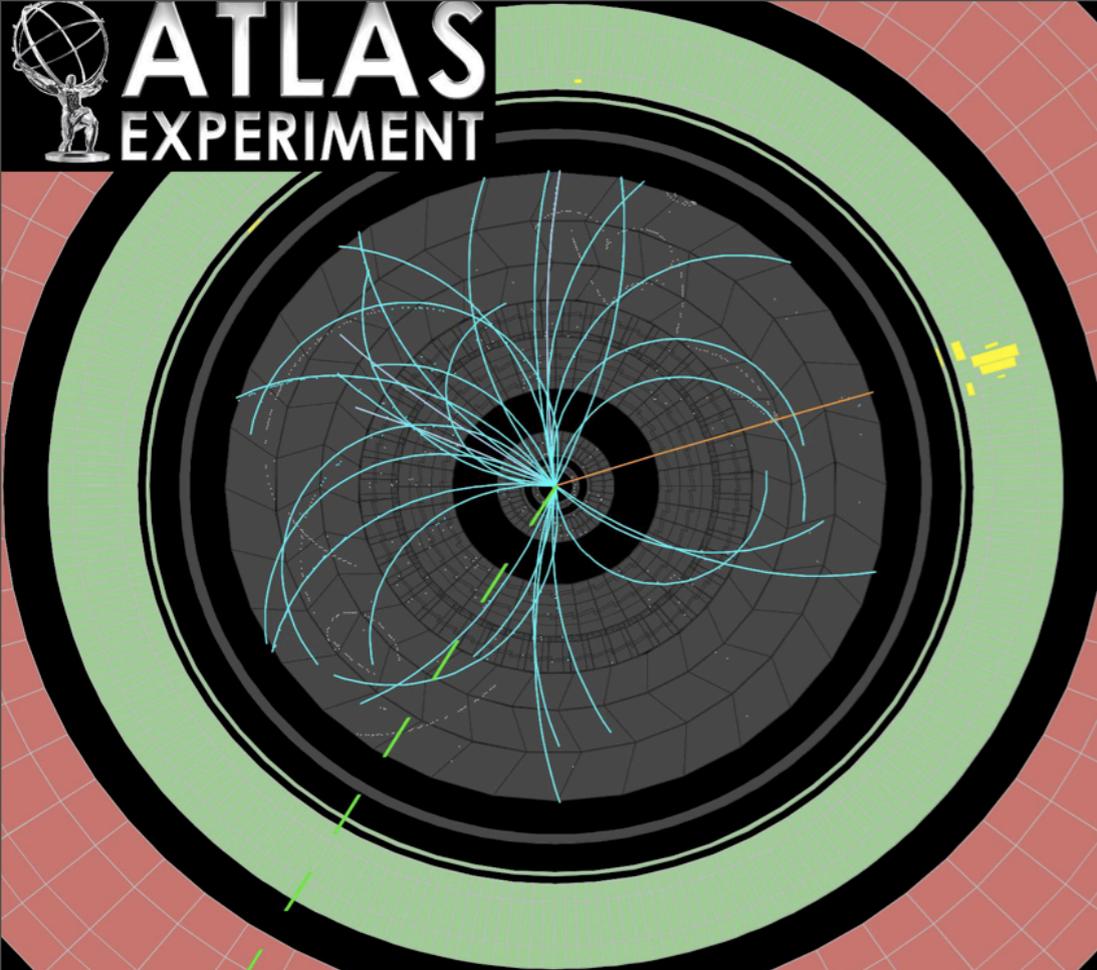
Spettrometro a muoni

NB: in questa presentazione solo i run del 2009 a 900 GeV ($\sim 9\mu\text{b}^{-1}$).
L'analisi dei run del 2010 a 7 TeV e' in corso
e ha gia' fornito i primi risultati

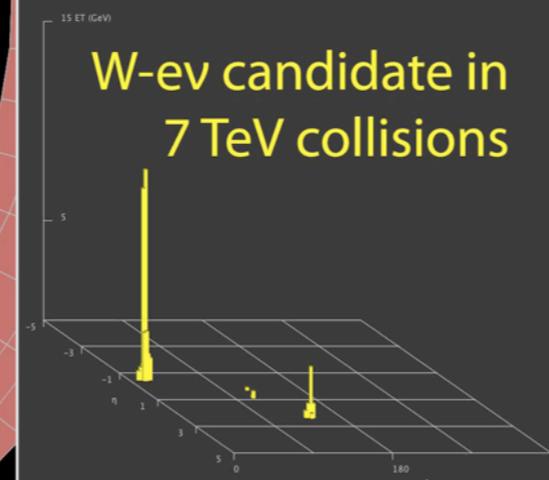


ATLAS EXPERIMENT - Public Results

<https://twiki.cern.ch/twiki/bin/view/Atlas/AtlasResults>

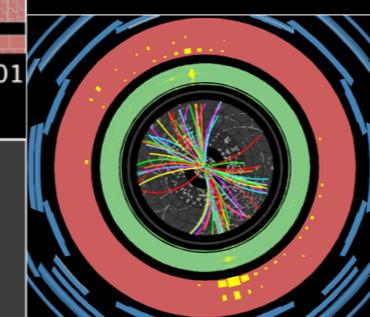


Run Number: 152409, Event Number: 5966801
Date: 2010-04-05 06:54:50 CEST

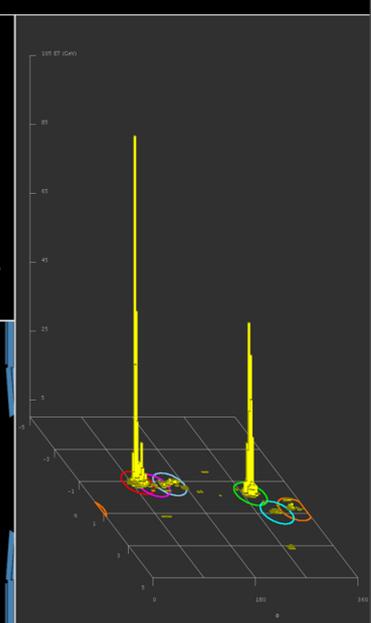


W-ν candidate in 7 TeV collisions

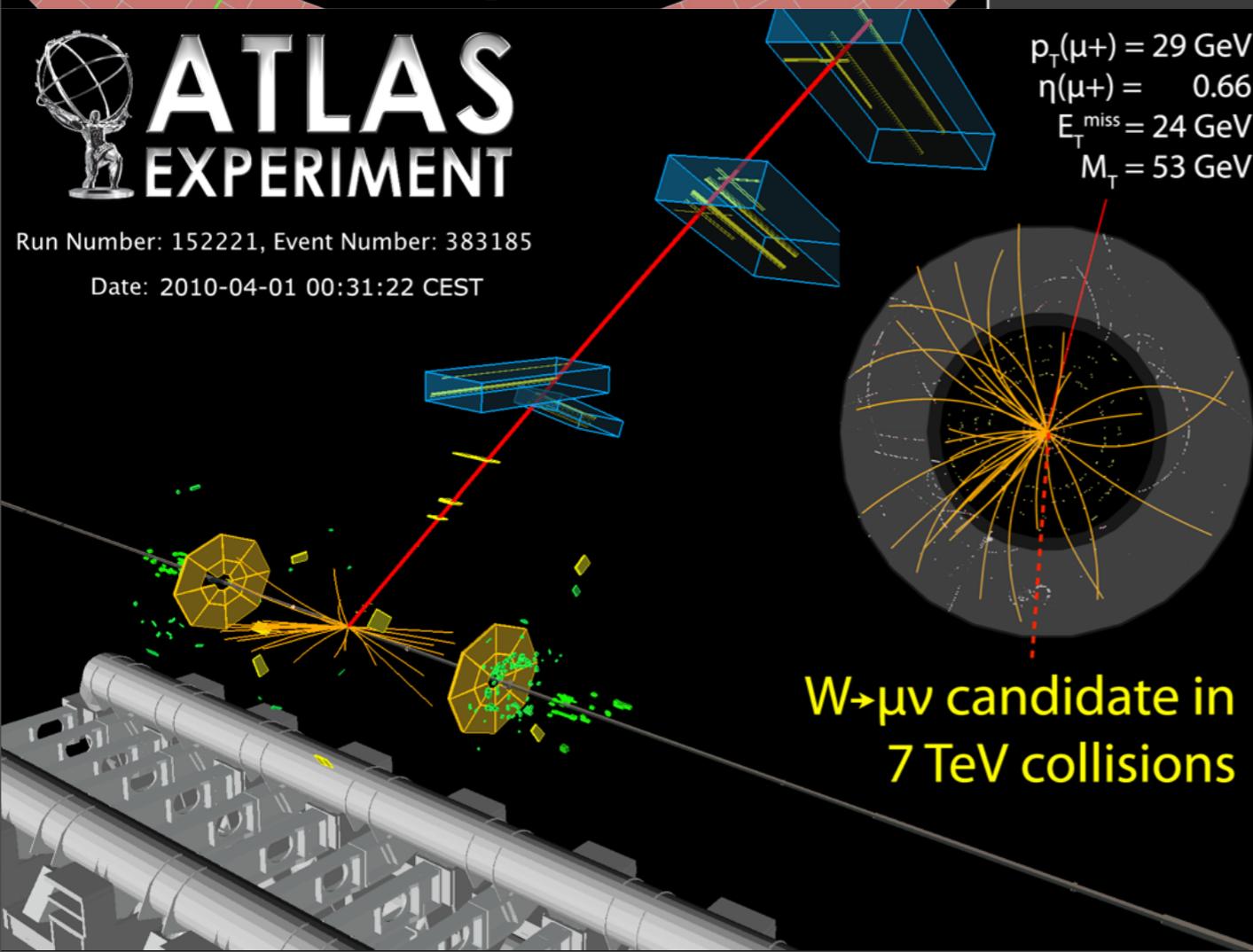
7 TeV runs



ATLAS
EXPERIMENT
Run Number: 152166, Event Number: 810258
Date: 2010-03-30 14:56:29 CEST
Di-jet Event at 7 TeV



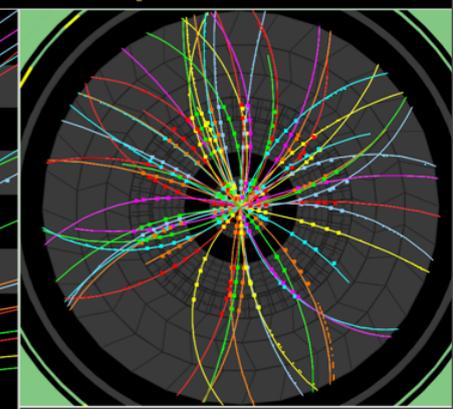
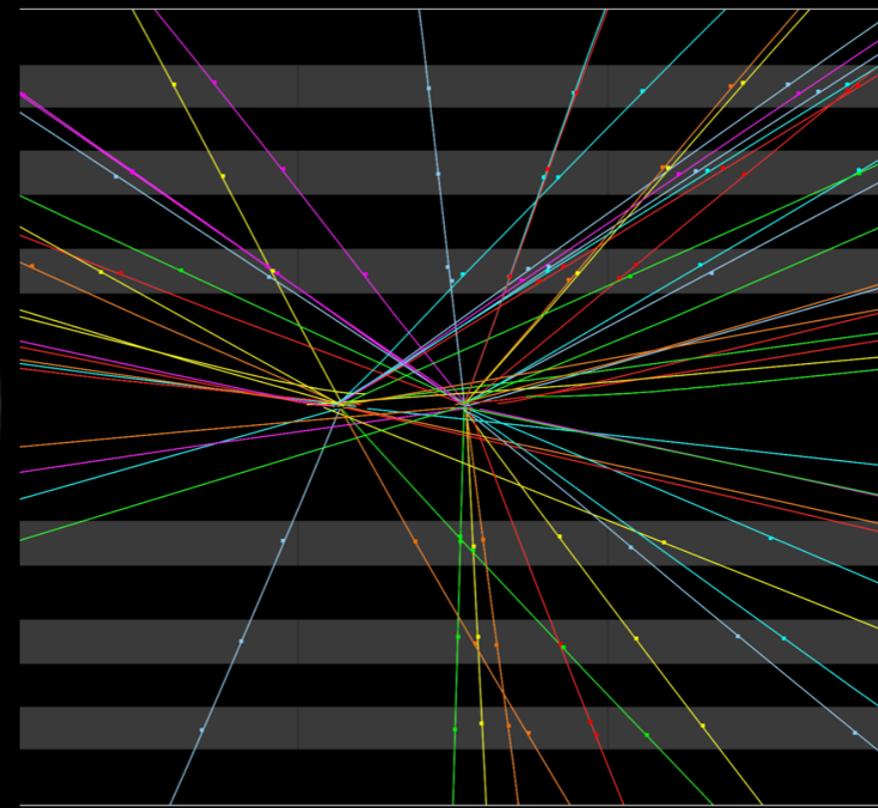
Run Number: 152221, Event Number: 383185
Date: 2010-04-01 00:31:22 CEST



$p_T(\mu^+) = 29 \text{ GeV}$
 $\eta(\mu^+) = 0.66$
 $E_T^{\text{miss}} = 24 \text{ GeV}$
 $M_T = 53 \text{ GeV}$

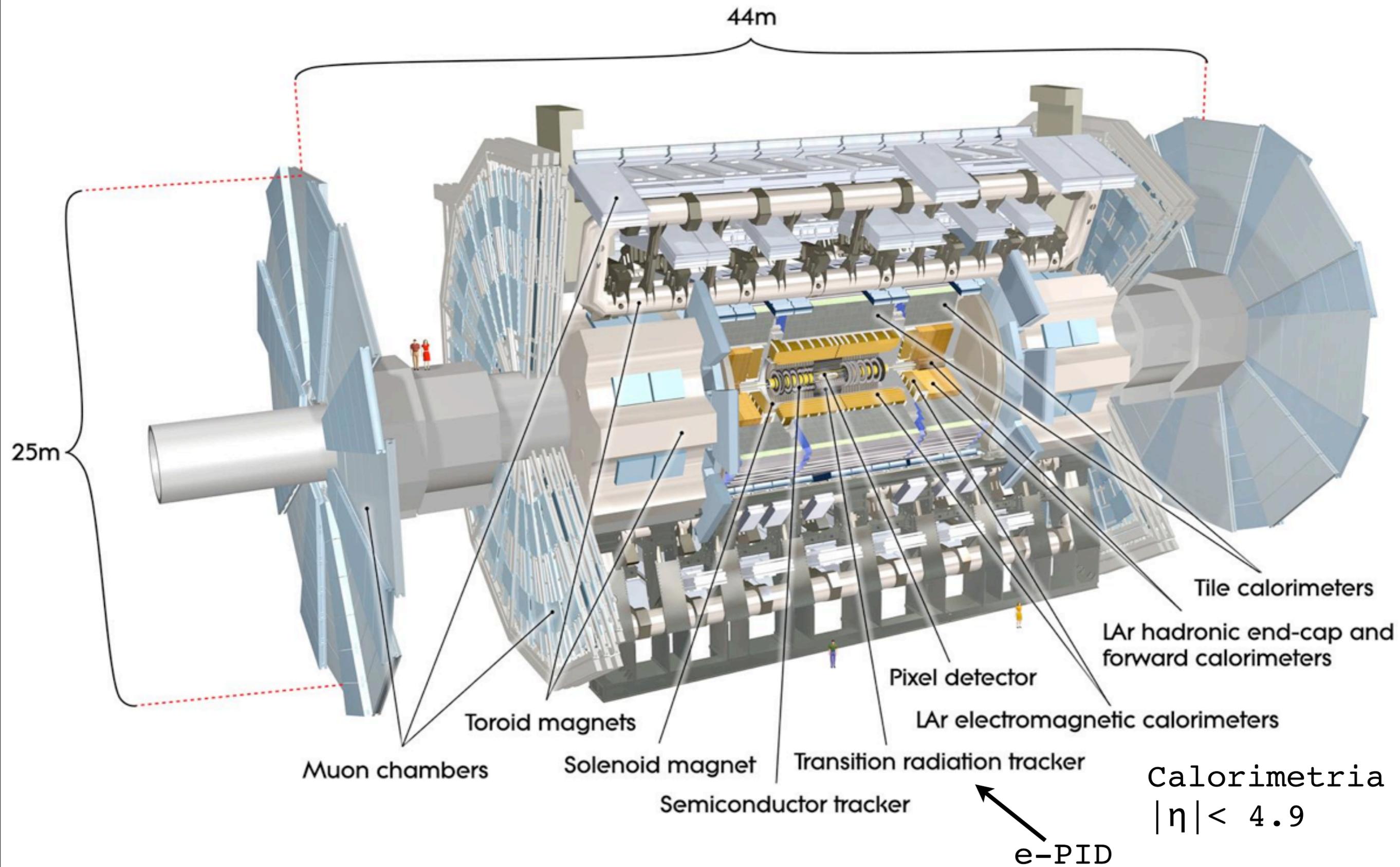
W → μν candidate in 7 TeV collisions

Collision Event at 7 TeV with 2 Pile Up Vertices



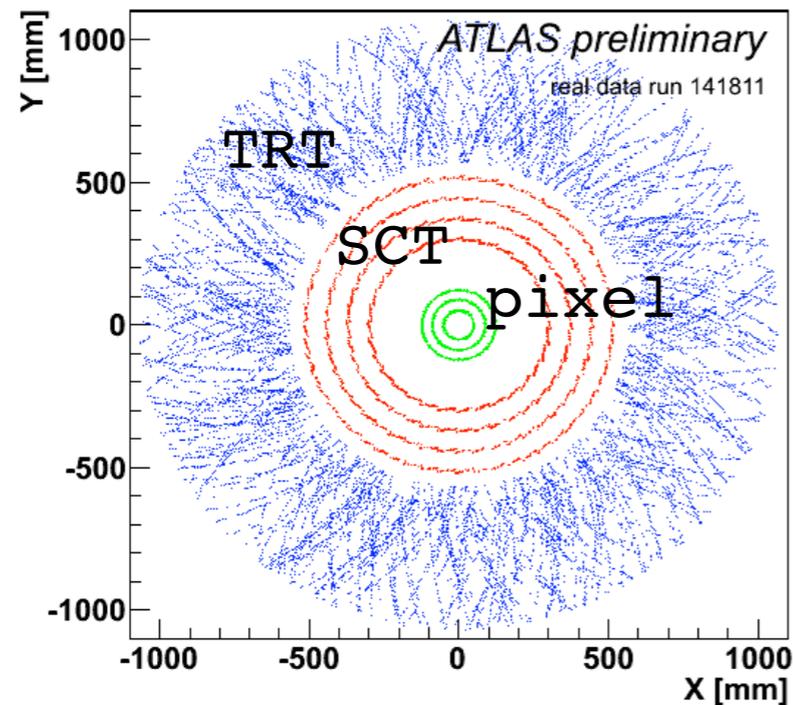
Run Number: 152166, Event Number: 467774
Date: 2010-03-30 13:31:46 CEST

ATLAS

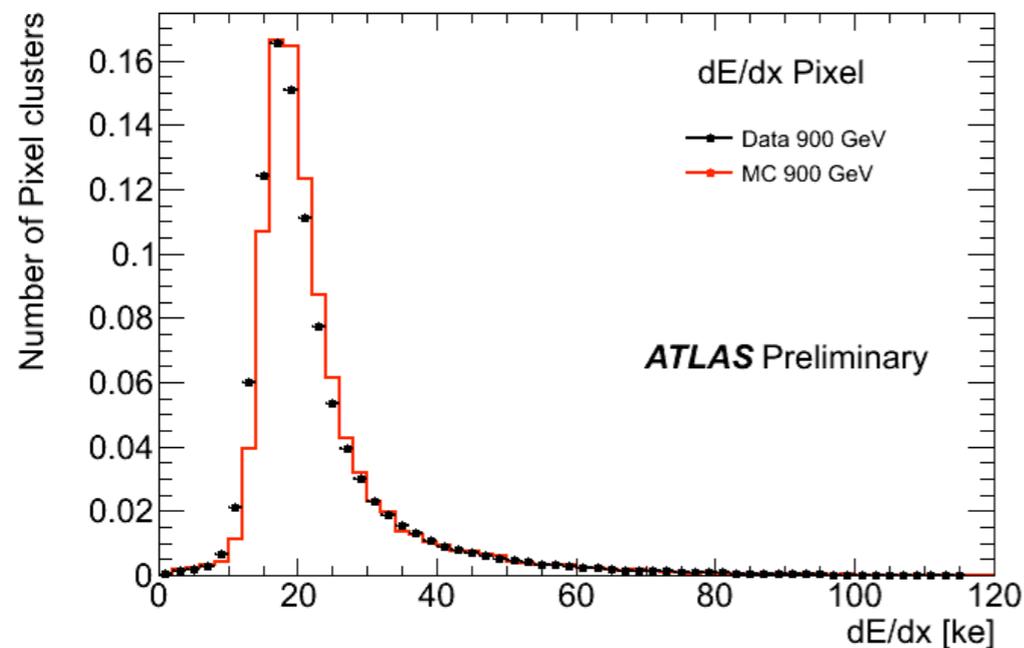
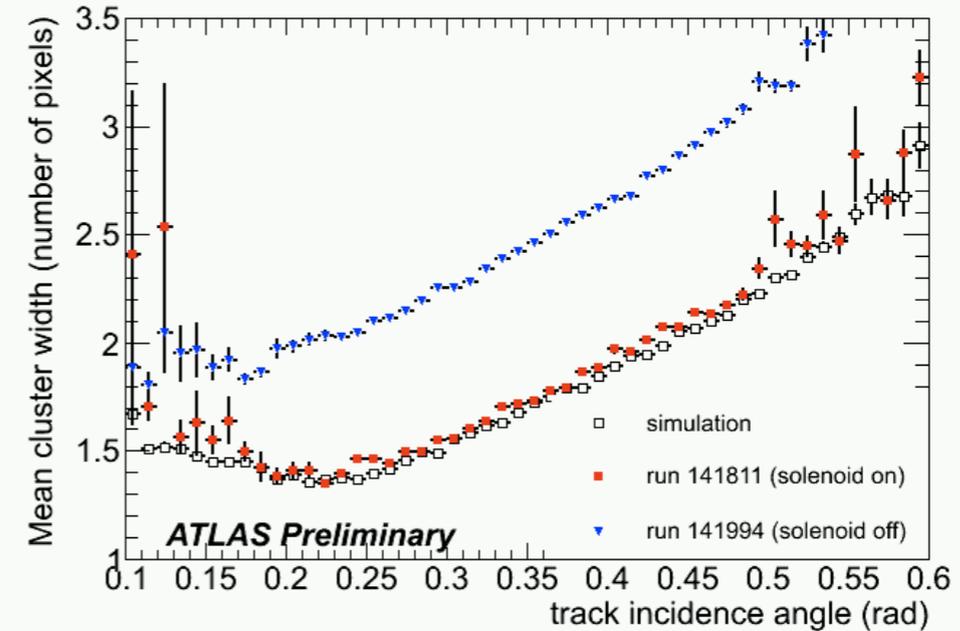


tracciatore

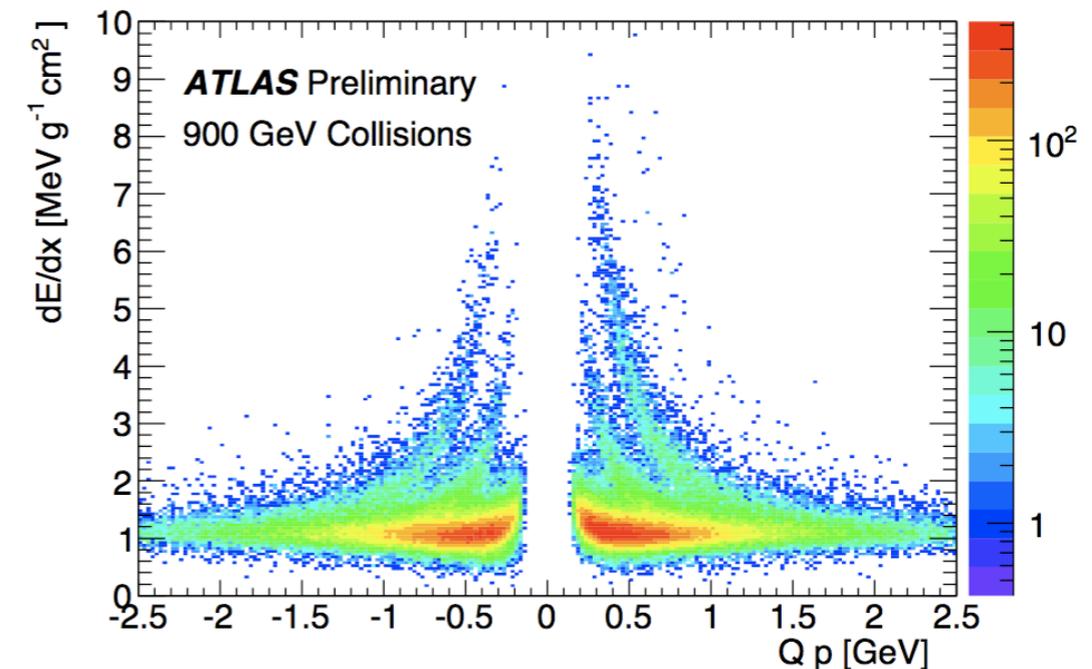
Scatter Plot of Hits on Tracks



Angolo di Lorentz



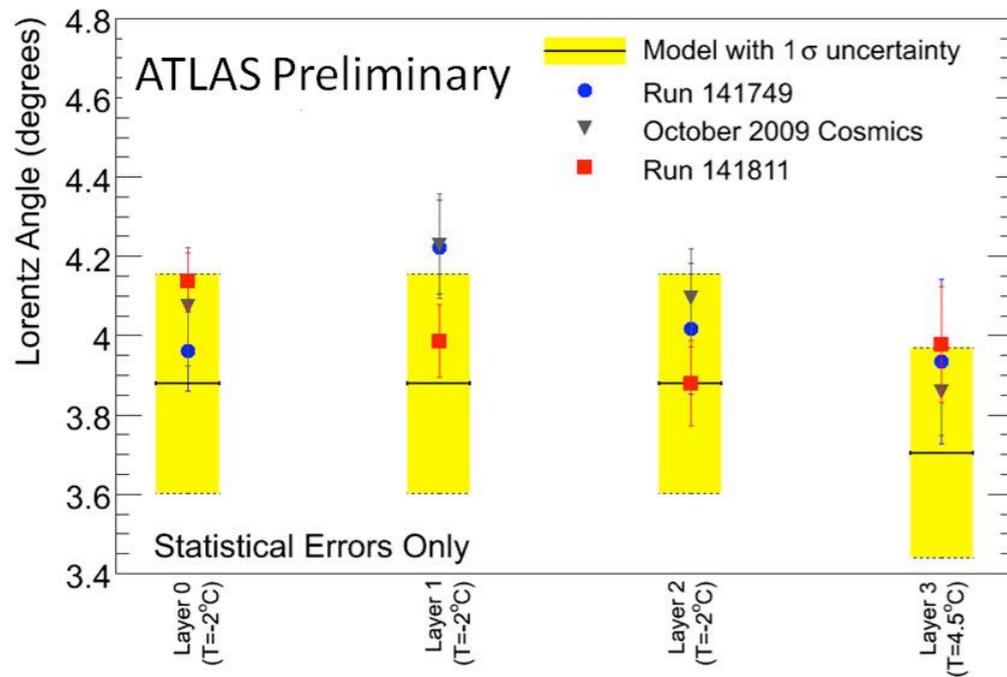
Carica del cluster corretta per la lunghezza della traiettoria ($p_T > 100$ MeV)



Particle identification: lettura digitale, carica depositata ricavata dalla misura del time-over-threshold

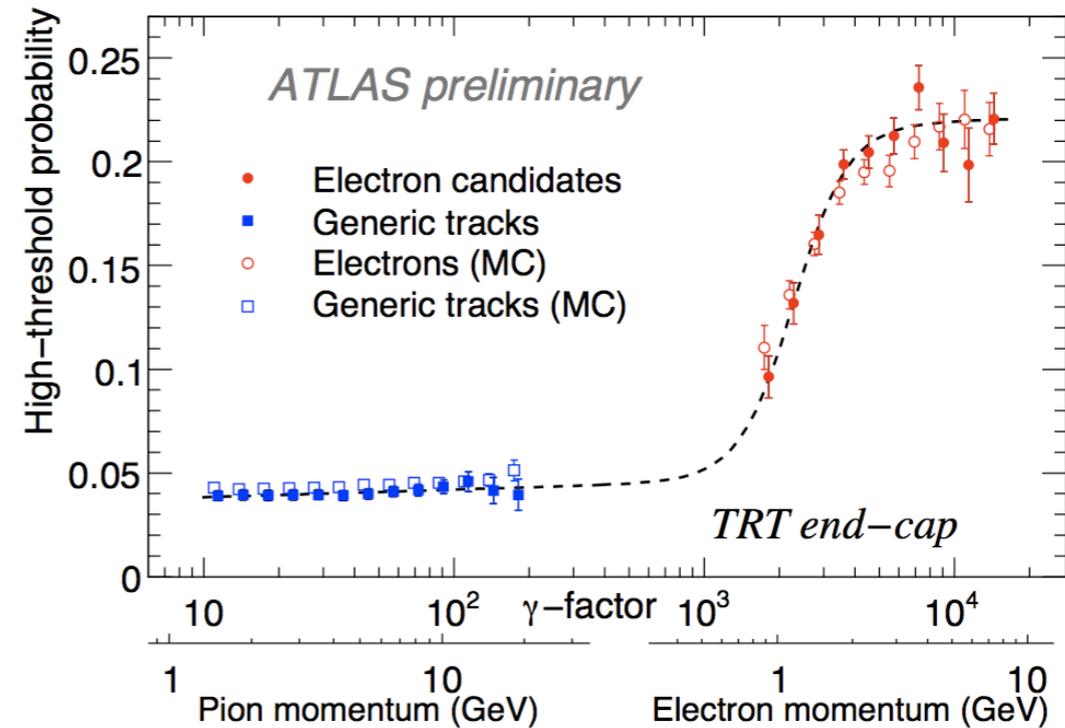
tracciatore

SCT: Silicon tracker

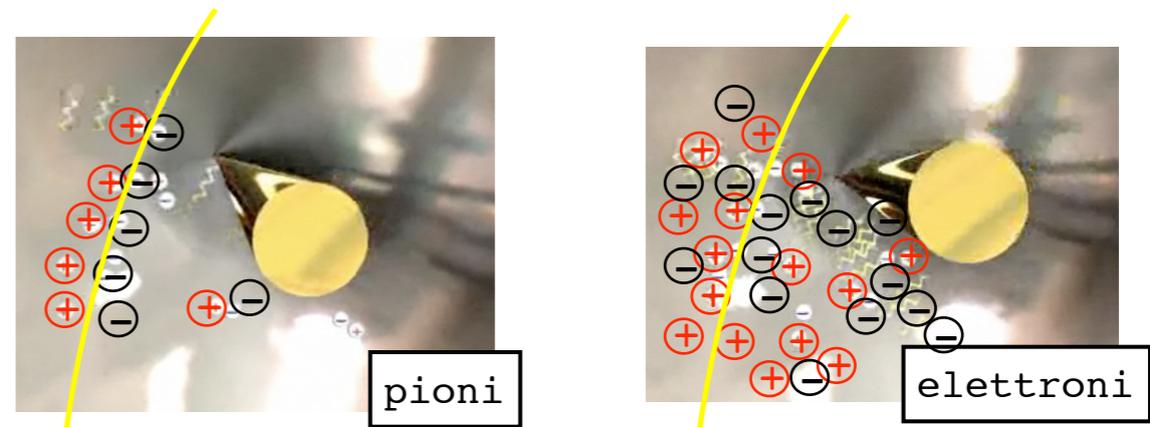


La risposta delle parti attive del tracciatore e' gia' descritta con grande accuratezza dalle simulazioni.

TRT: Transition radiation tracker



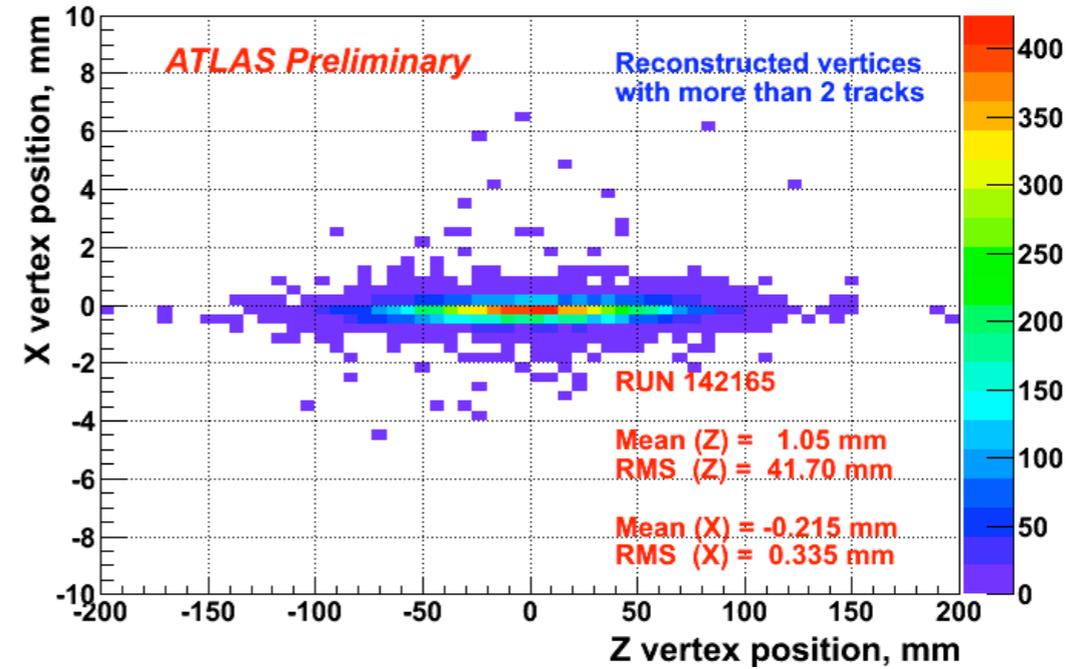
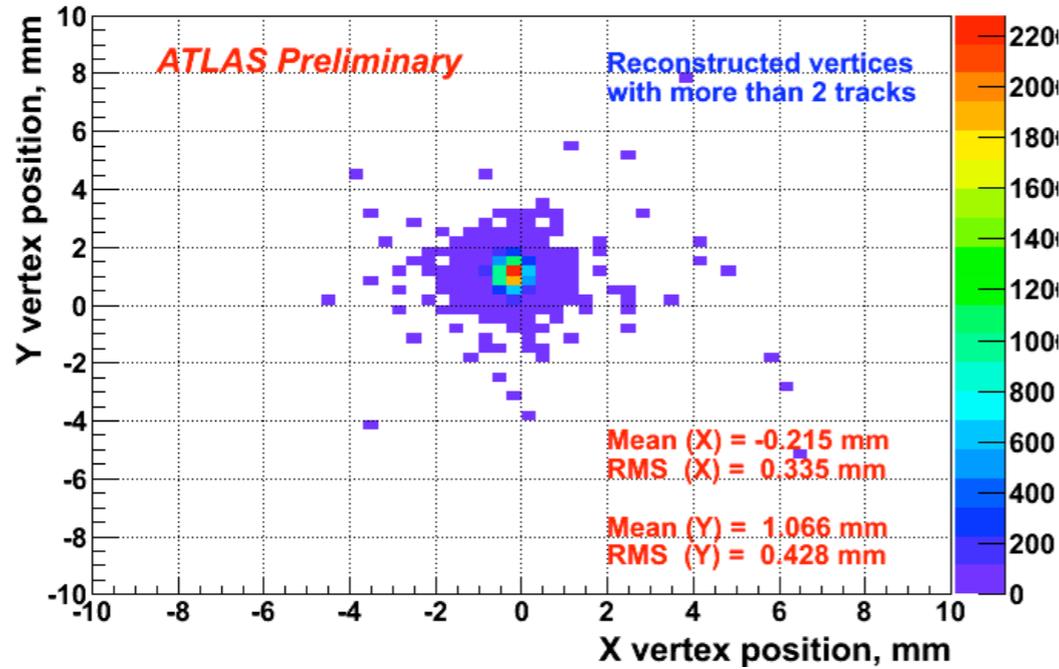
PID: discrimina elettroni dalle altre particelle attraverso la radiazione di transizione creata nel materiale radiatore e convertita in e^+e^- nella miscela di gas (Xe)



vertici primari

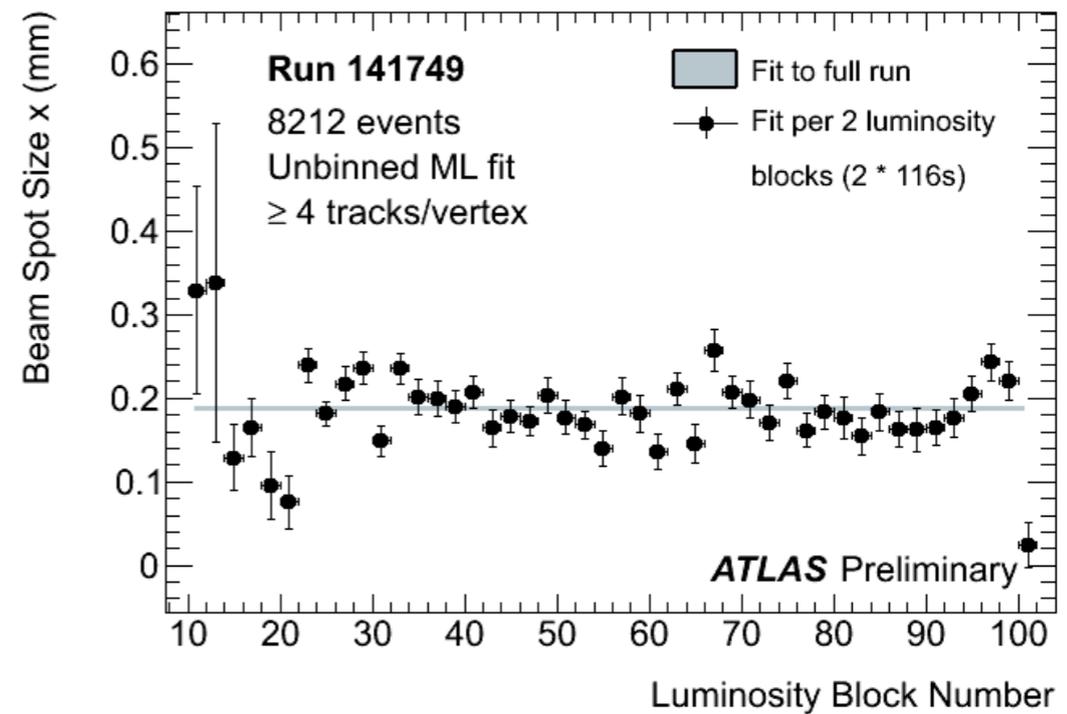
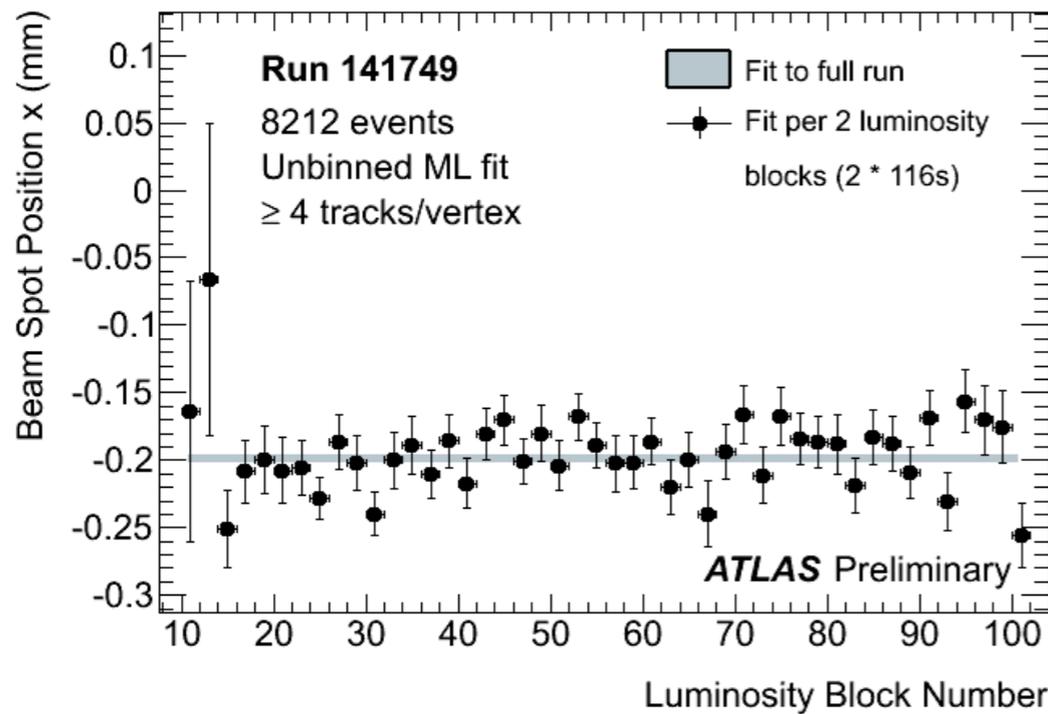
Vertici ricostruiti con tracce $p_T > 100$ MeV

Posizione del beam spot



beam spot centrato in ATLAS

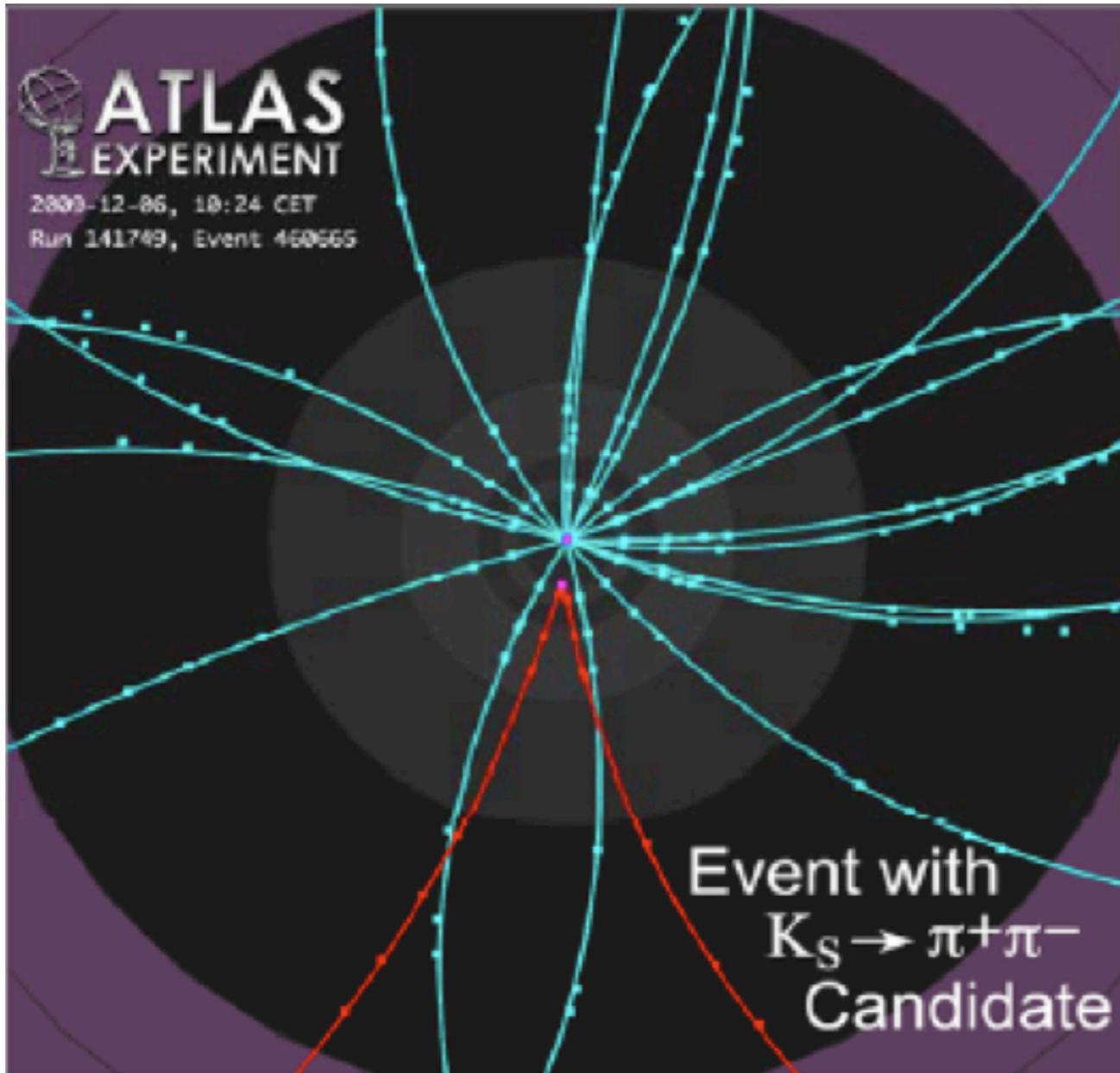
piu' corto del previsto



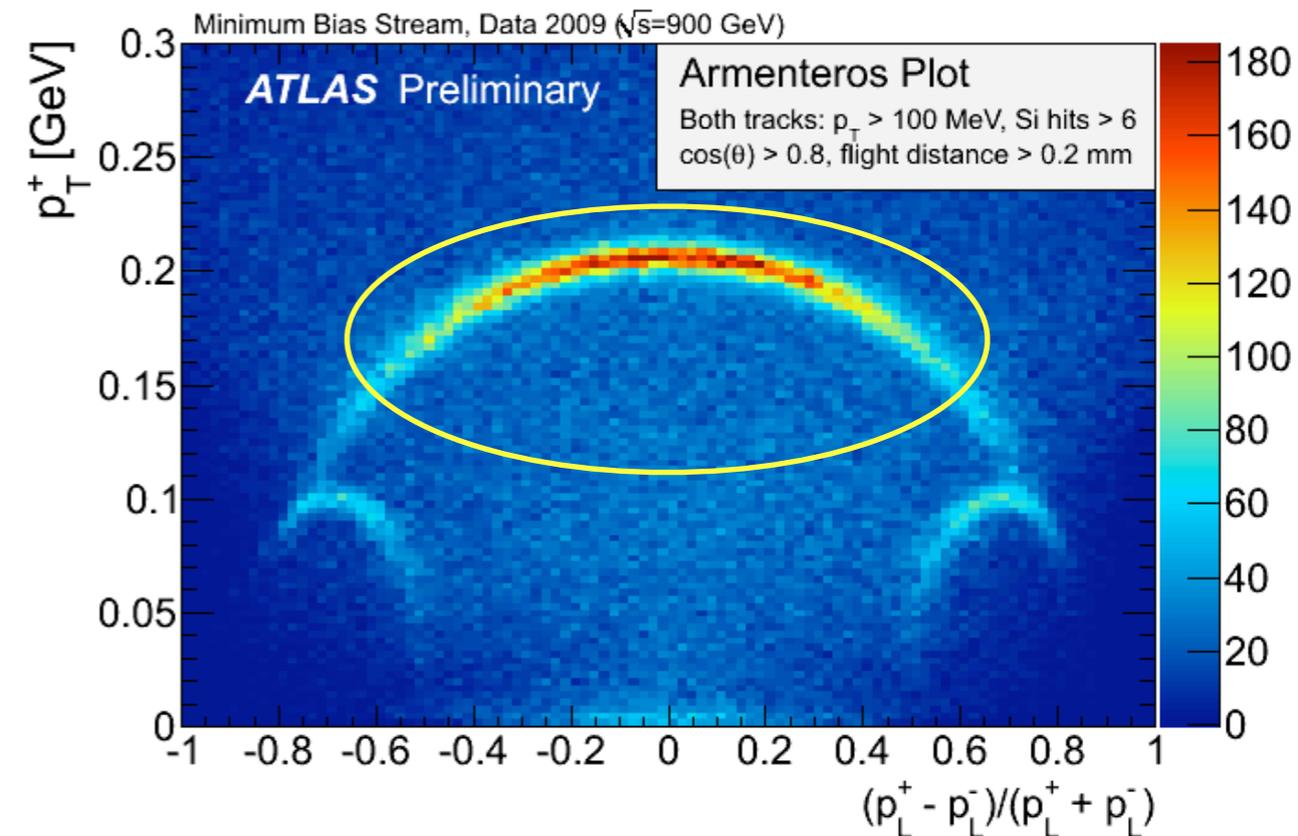
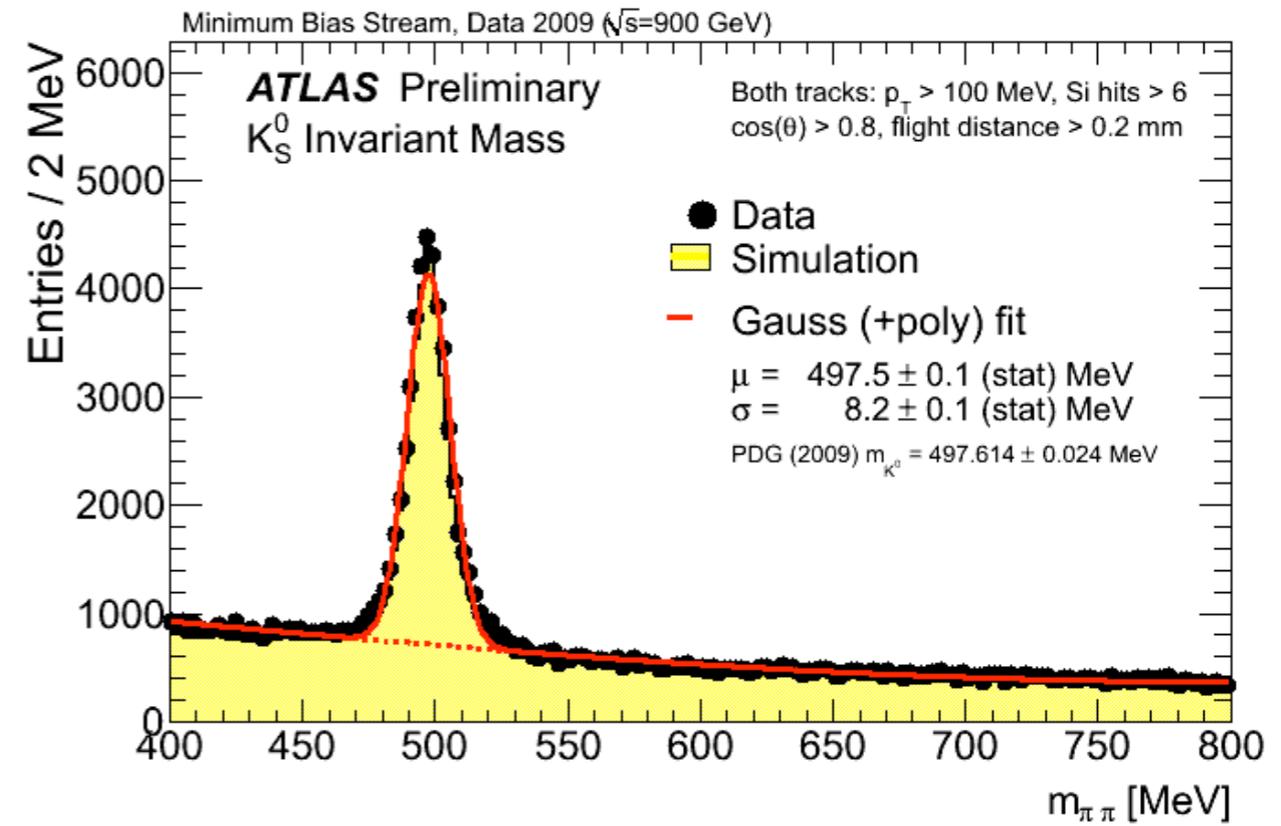
Buona stabilita' durante il run

vertici secondari

Prime risonanze: K_S^0



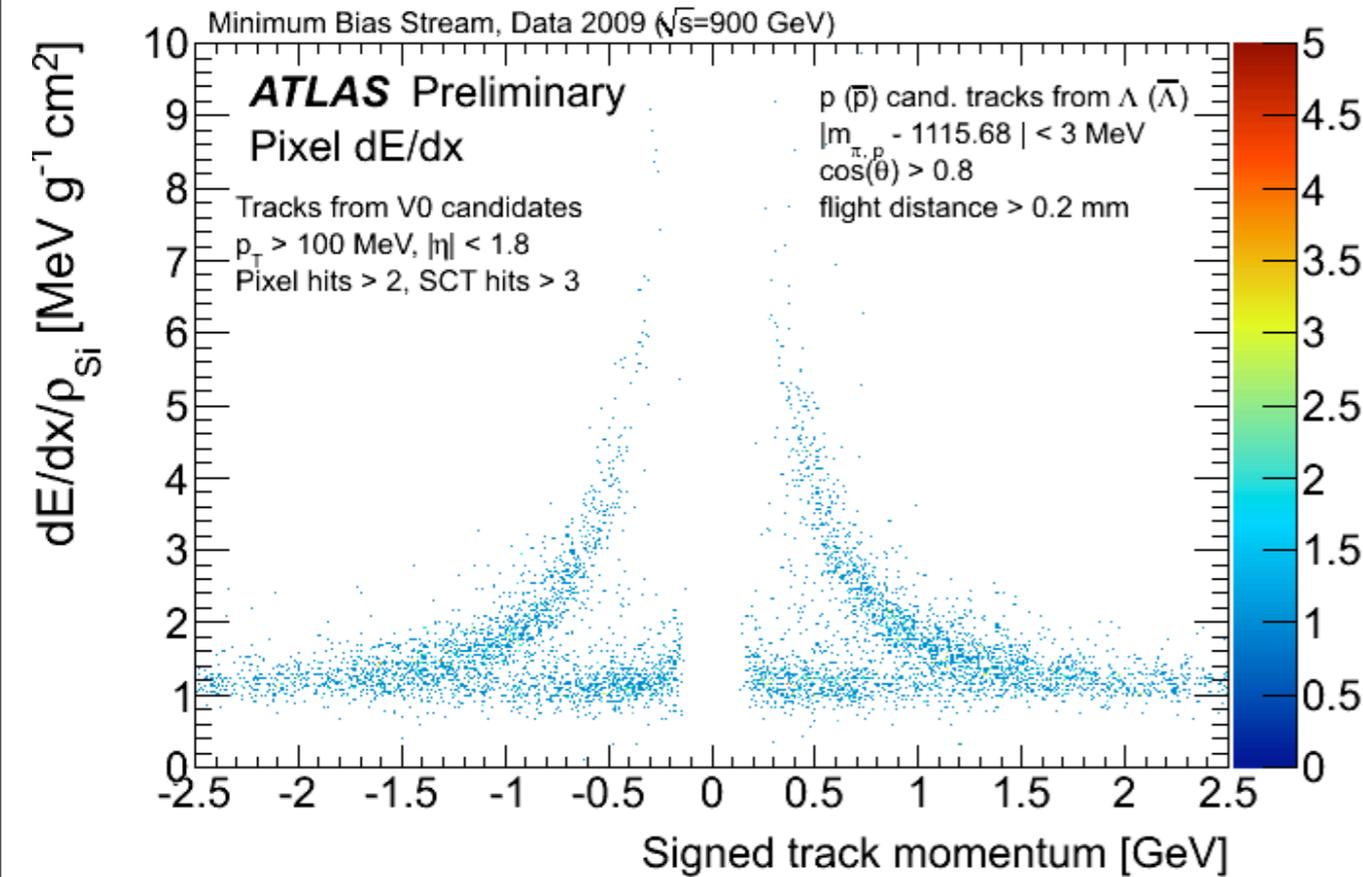
Tagli di selezione: $q_1 \cdot q_2 < 0$
 $N_{Si} > 6$
 p_{T1} AND $p_{T2} > 100$ MeV
 $L_{xy} > 200$ μm
pointing



vertici secondari

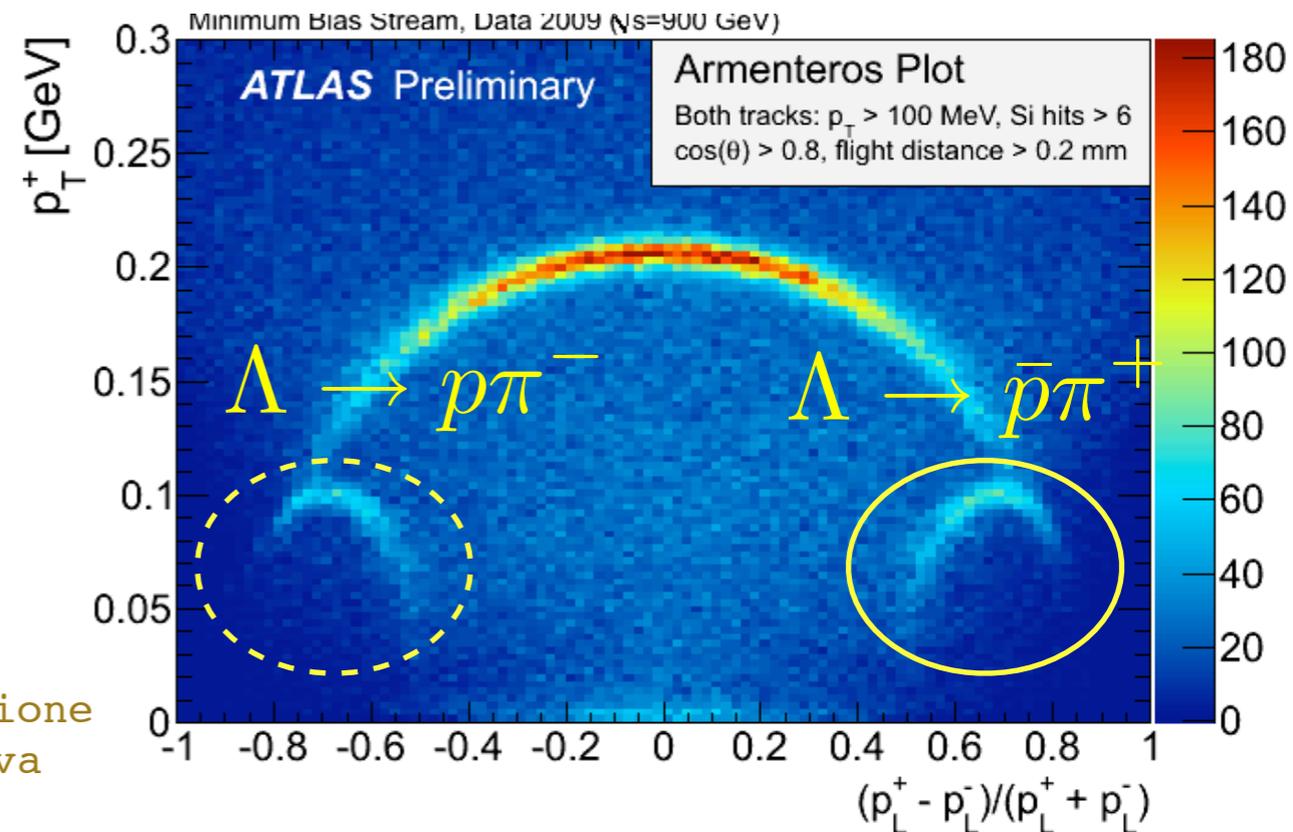
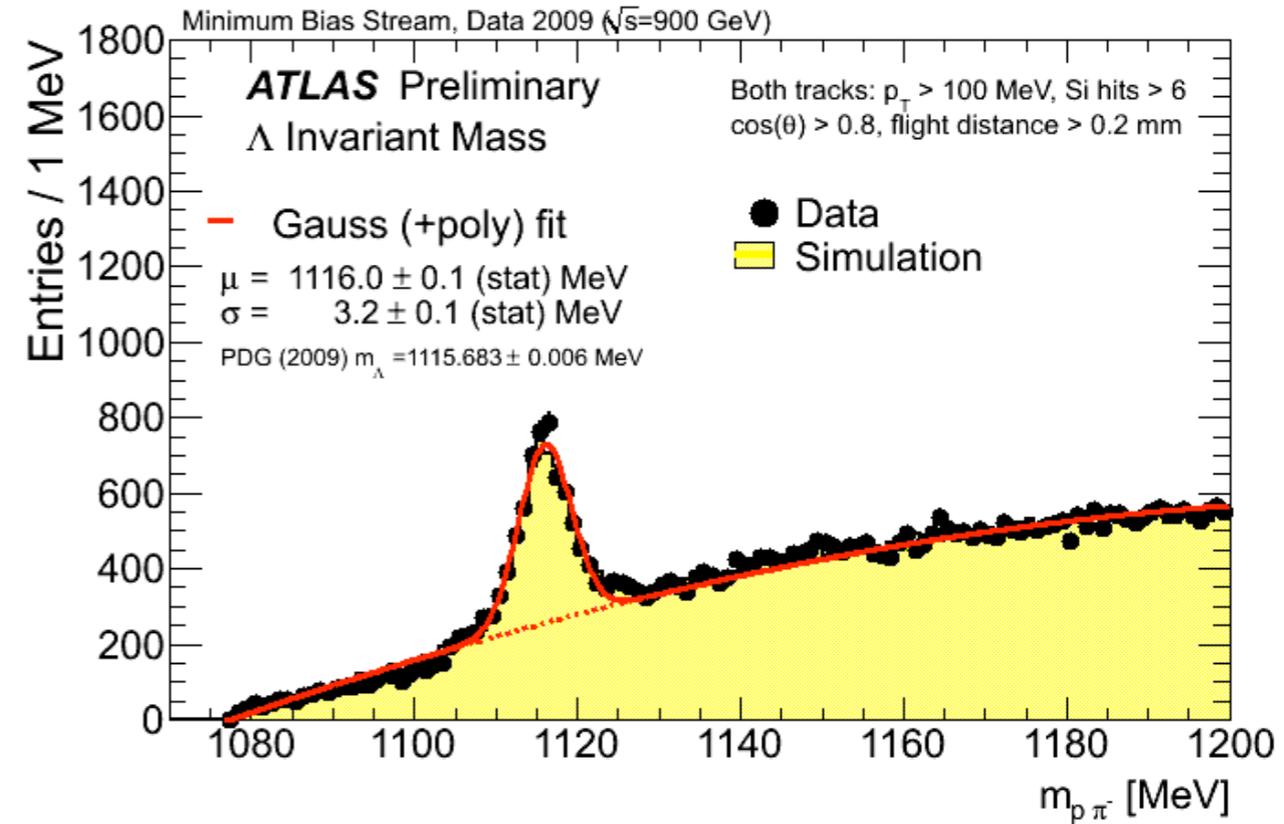
Prime risonanze: $\Lambda \rightarrow \bar{p}\pi^+$

Verifica della selezione
con il dE/dx nei pixel



Tagli di selezione: $q_1 \cdot q_2 < 0$
 $N_{Si} > 6$
 p_{T1} AND $p_{T2} > 100$ MeV
 $L_{xy} > 200$ μm

- pointing
- la massa invariante e' calcolata assumendo la massa del protone/pione per la particella positiva/negativa



verso il b-tagging

Molti studi effettuati sulle caratteristiche delle tracce da usare per il b-tagging.

Algoritmi di tagging:

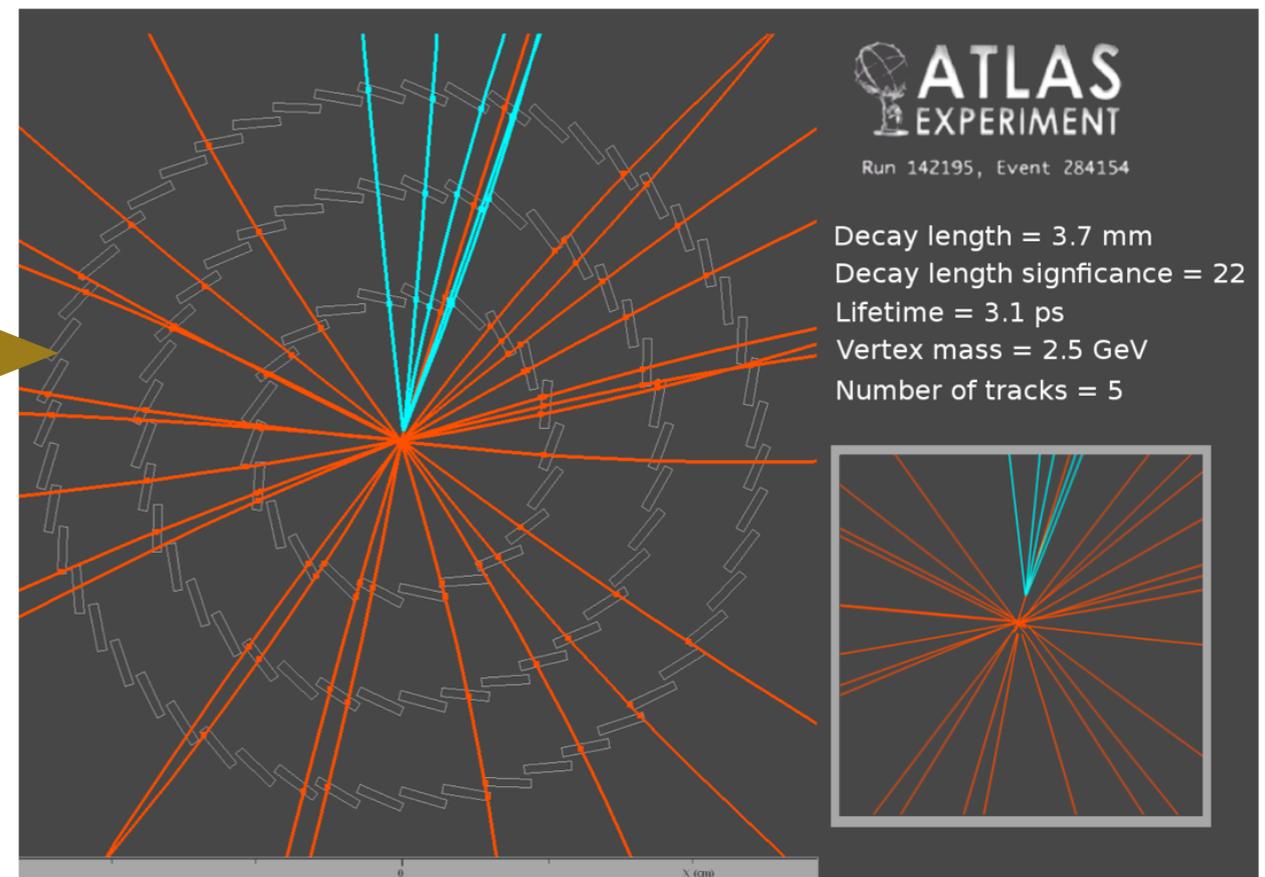
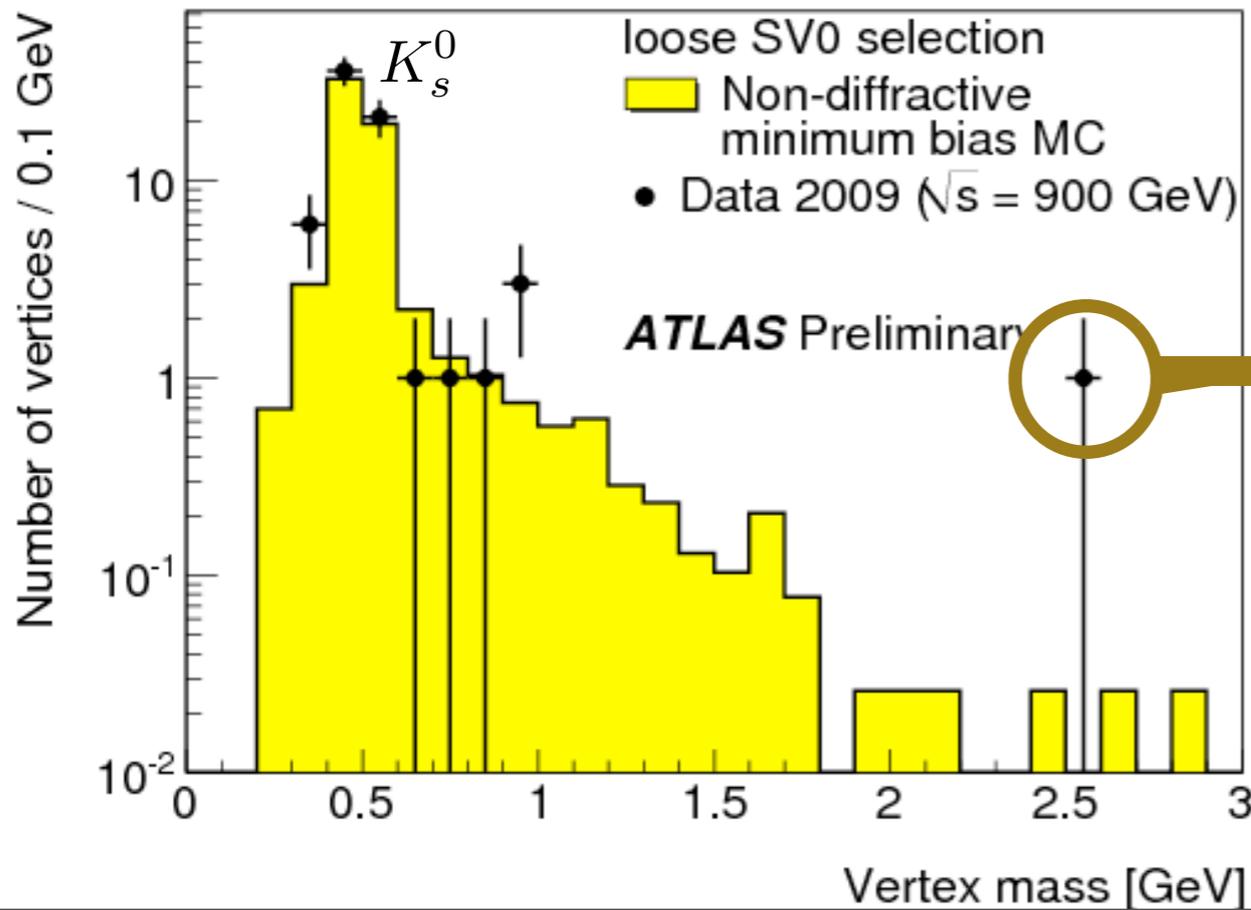
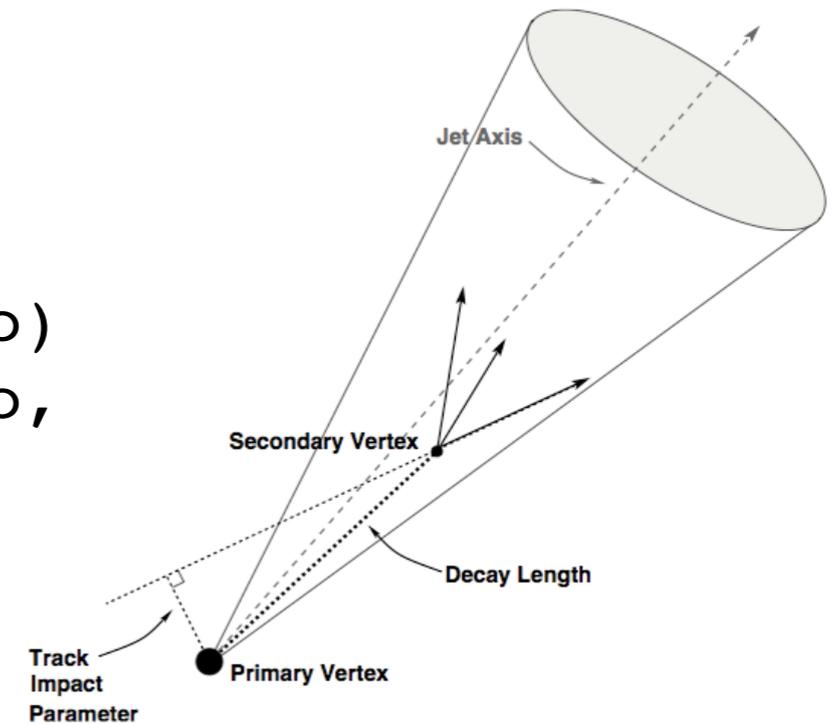
SV0 (ricostruzione del vertice secondario)

JetProb (significanza del parametro d'impatto, probabilita' che una traccia provenga dal vertice primario)

Un primo esercizio, cercare vertici secondari nei dati a 900 GeV:

rimosso il veto su K_s^0 e Λ

(70 candidati, attesi 63 di cui 2.3 b con $p_T > 5$ GeV)

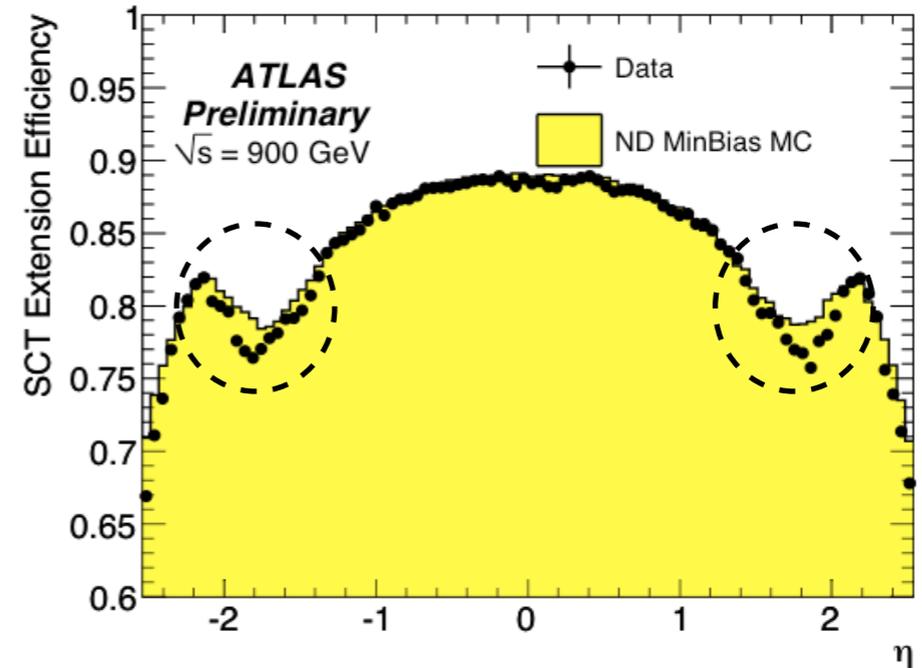


materiale passivo

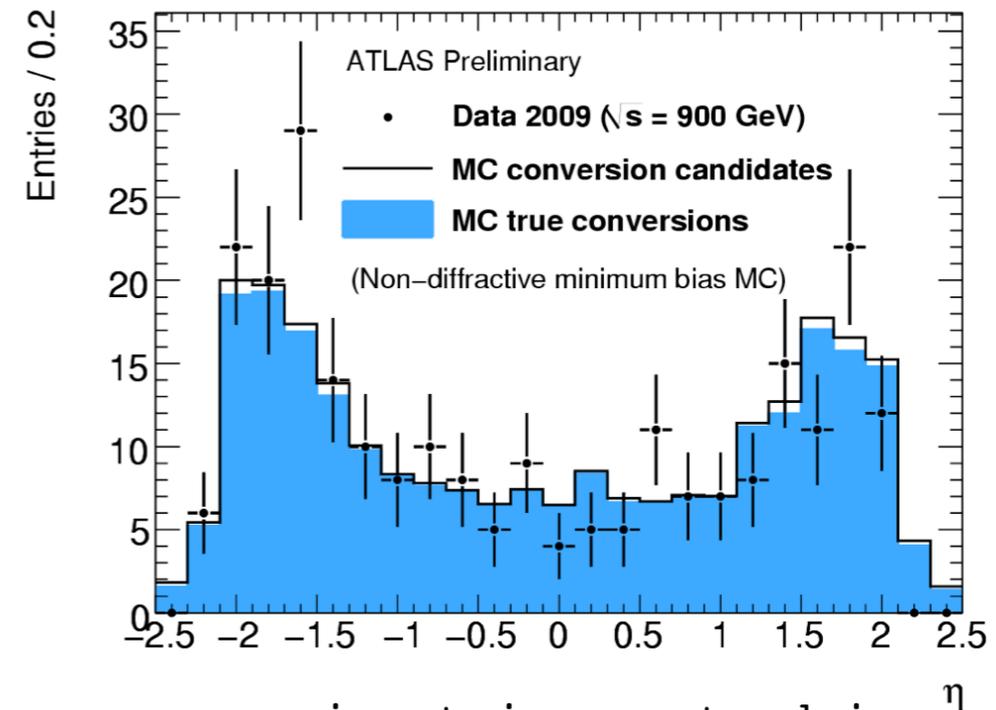
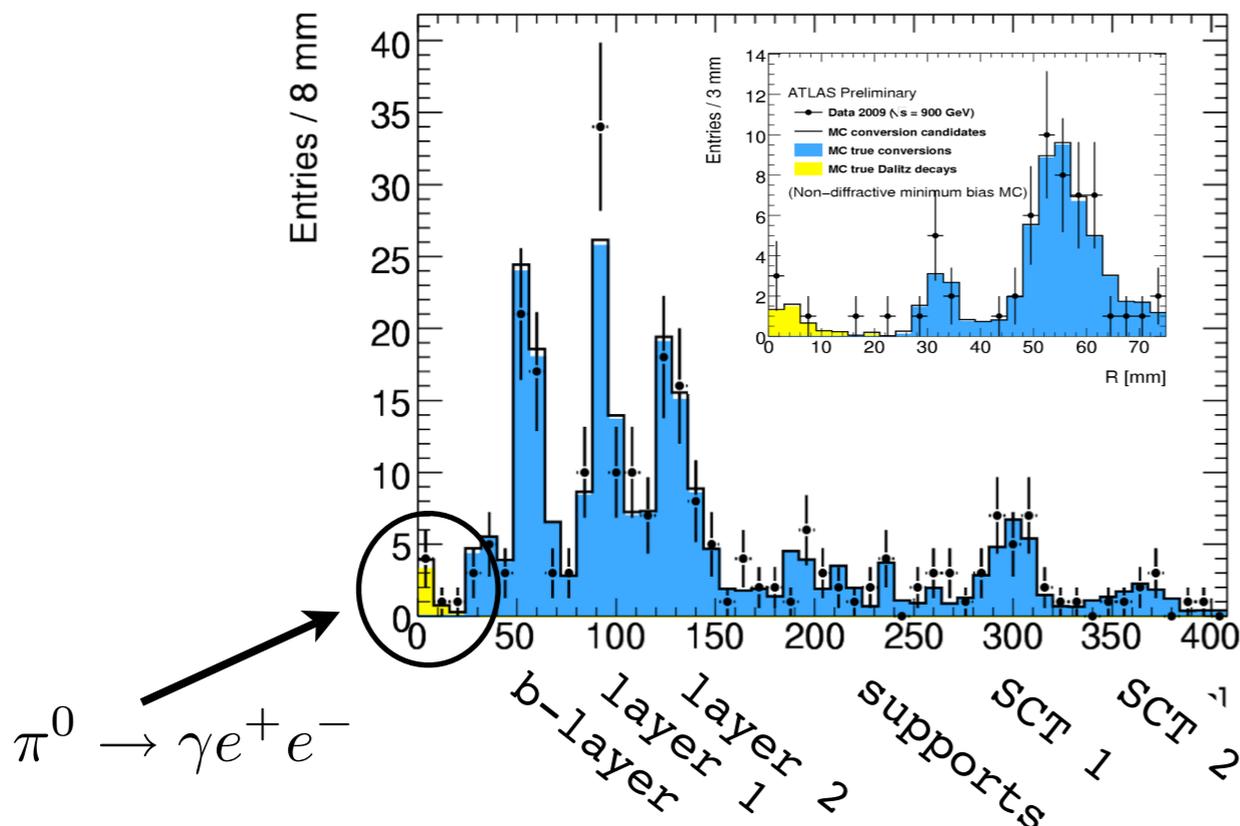
Il materiale passivo nel tracciatore e' stimato in piu' modi: stabilita' delle risonanze vs. pT, posizione delle conversioni, lunghezza delle tracce, tracklets, residui sui singoli hit, bremsstrahlung, etc...

L'accuratezza del metodo dipende dalla statistica degli oggetti considerati. Al momento le tracklets hanno la meglio.

Con piu' statistica le conversioni potranno dare la posizione in 3D del materiale passivo (radiografia)



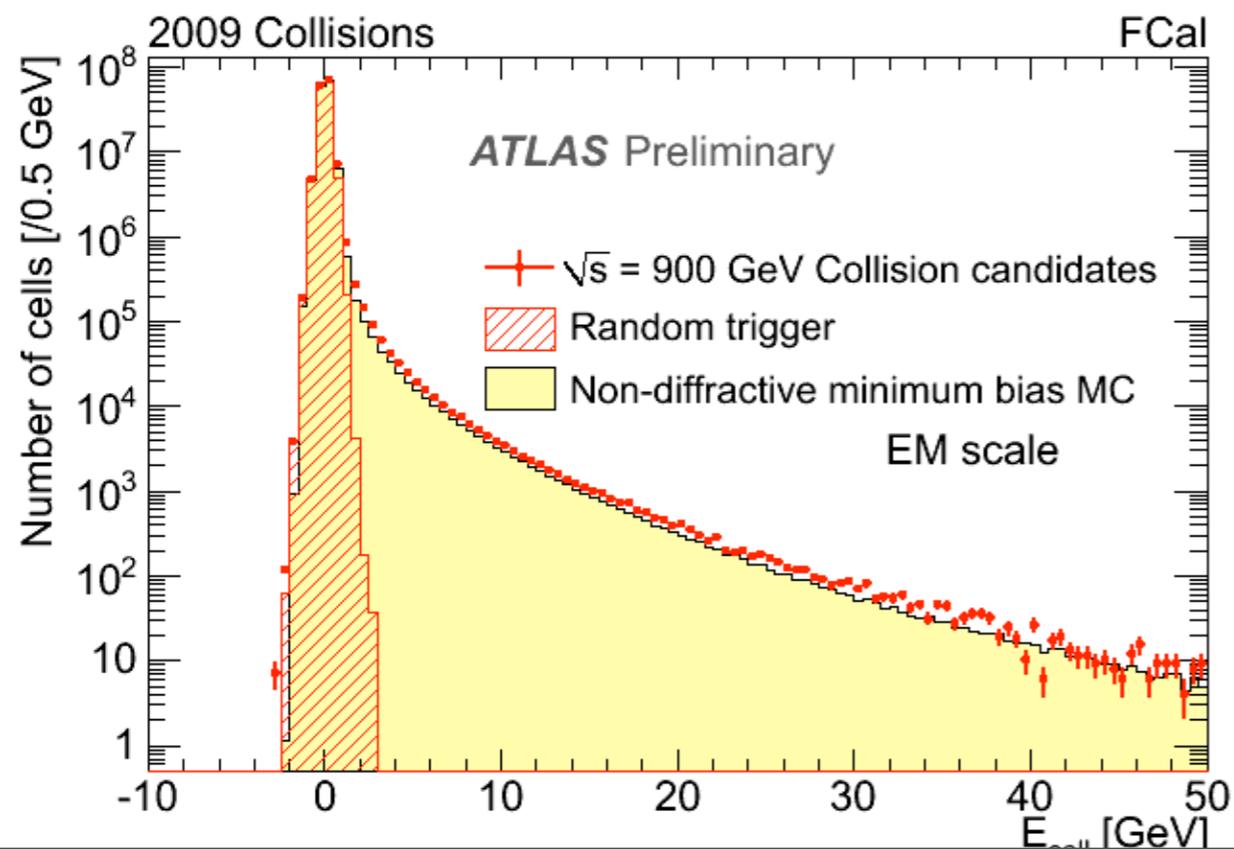
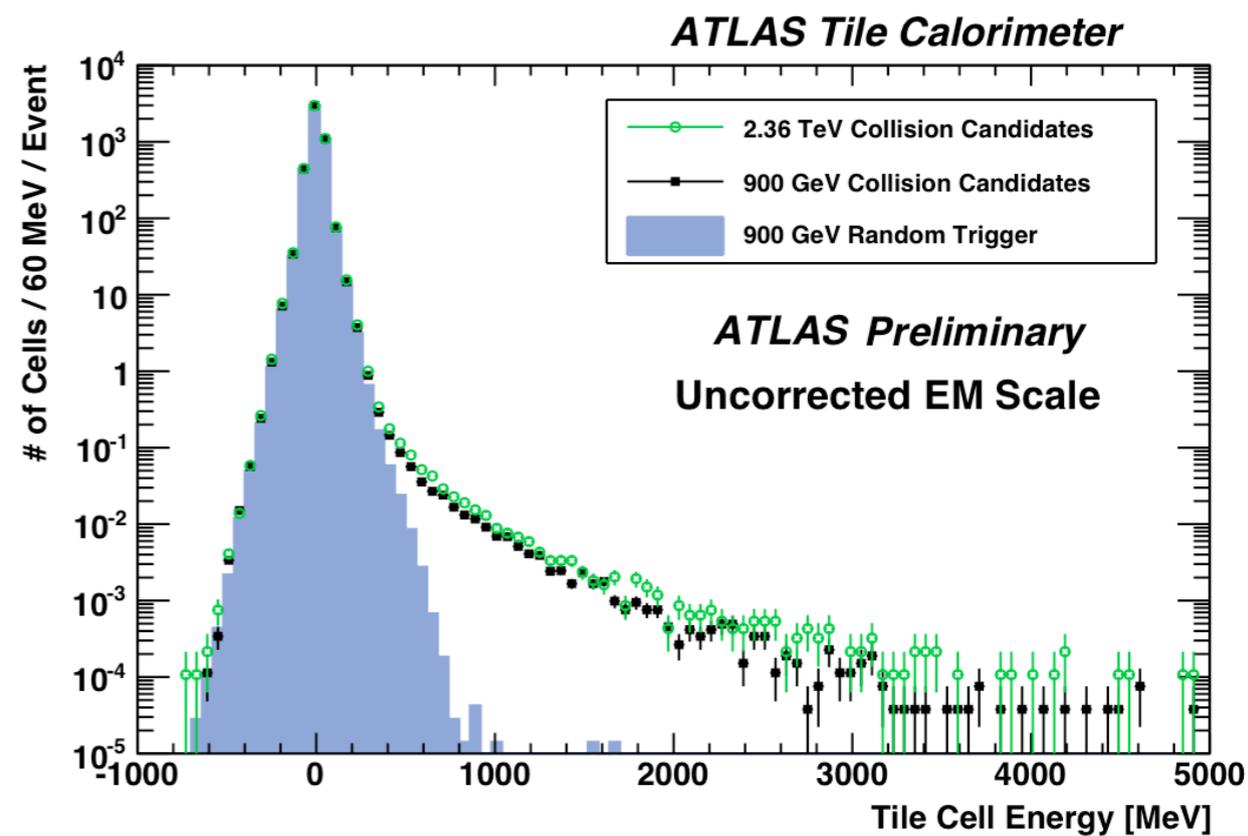
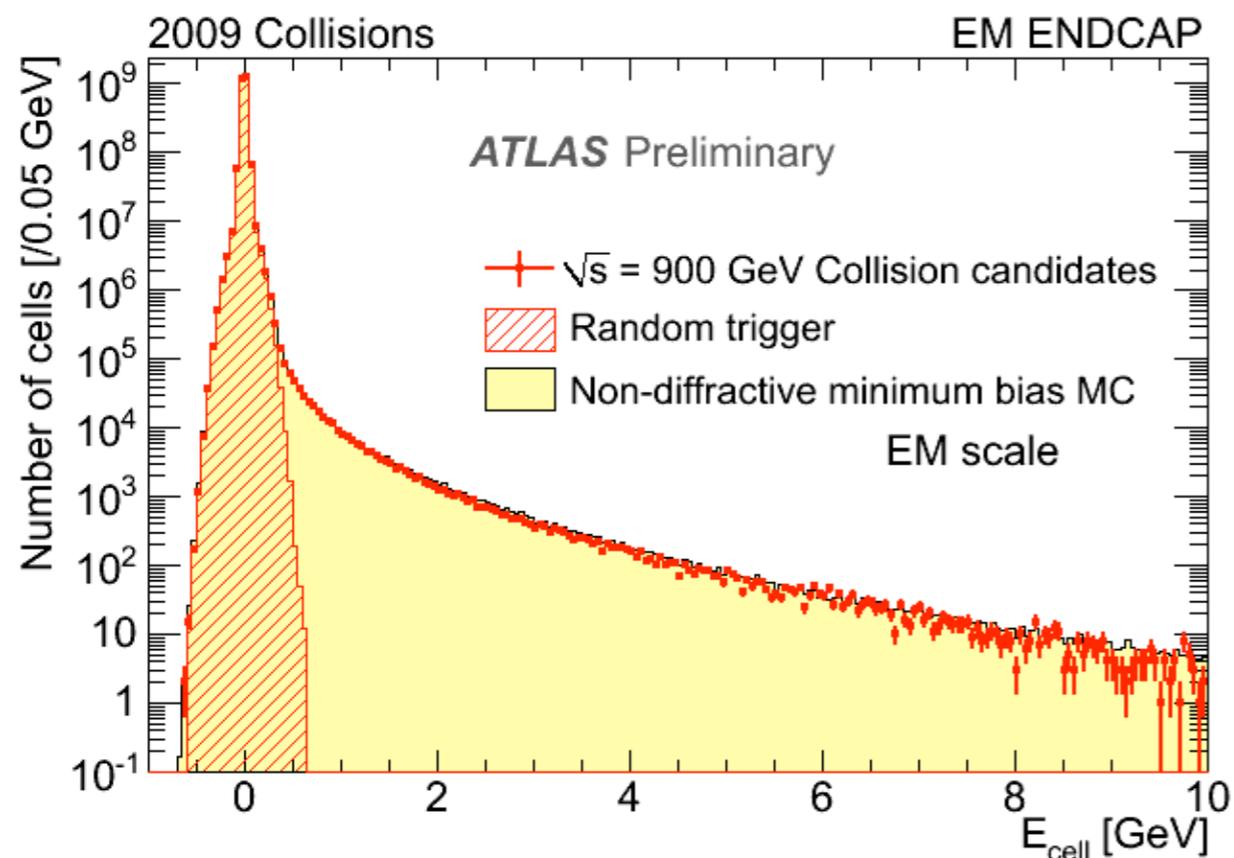
(cfr. Leonardo)



asimmetria creata dai moduli disabilitati

calorimetrica

energia - EM scale

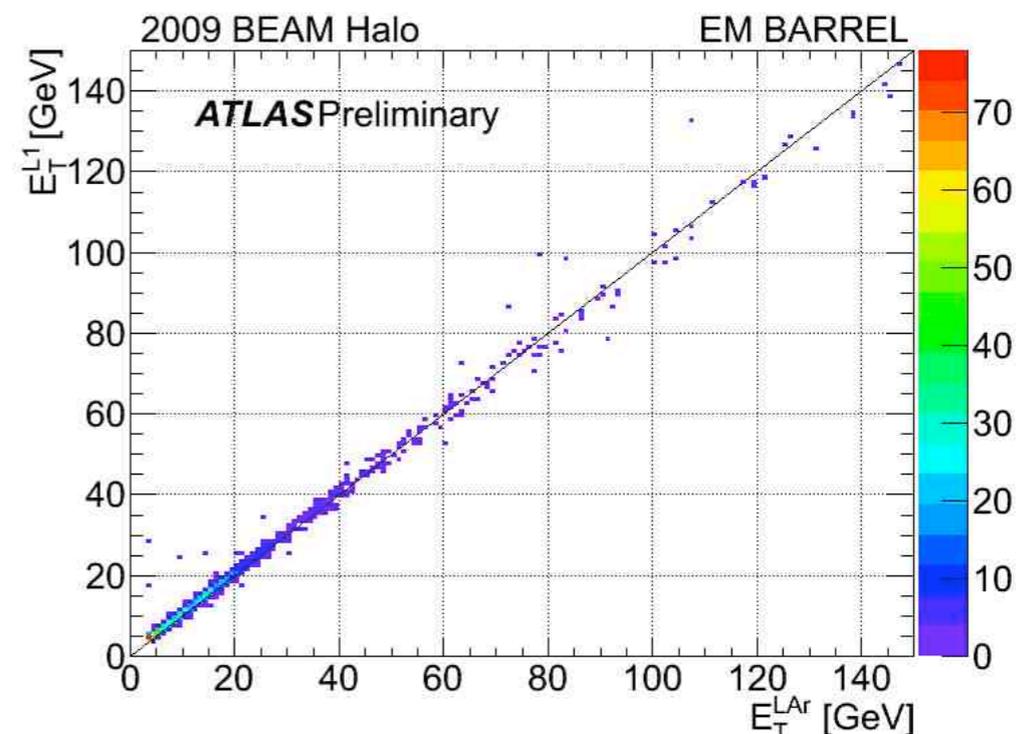


Buon accordo dati/MC al livello dell'energia delle celle

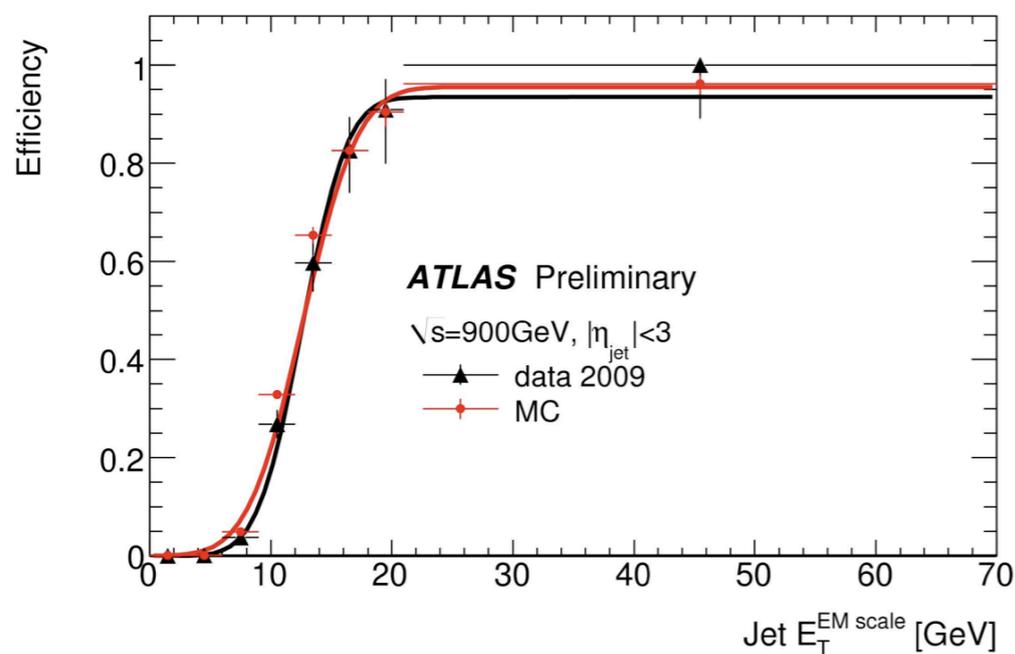
calorimetria

Trigger primo livello

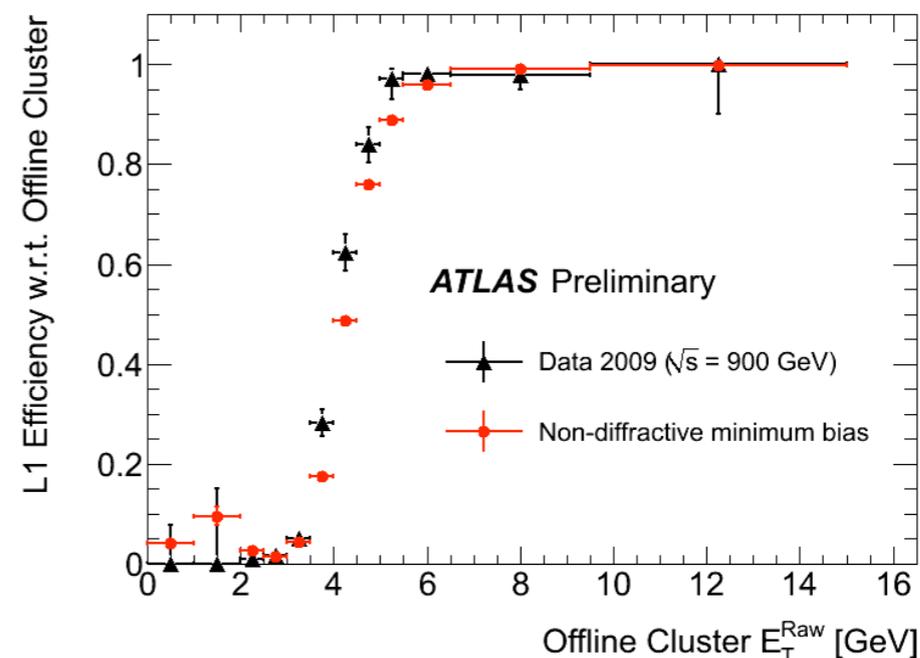
Primo sguardo al trigger di L1.
L1: risoluzione(ET) < 5%



jet trigger



EM trigger



Buon accordo dati/MC

(Gli eventi sotto soglia sono dovuti alla piccola differenza tra la taglia delle torri di trigger e quella offline.)

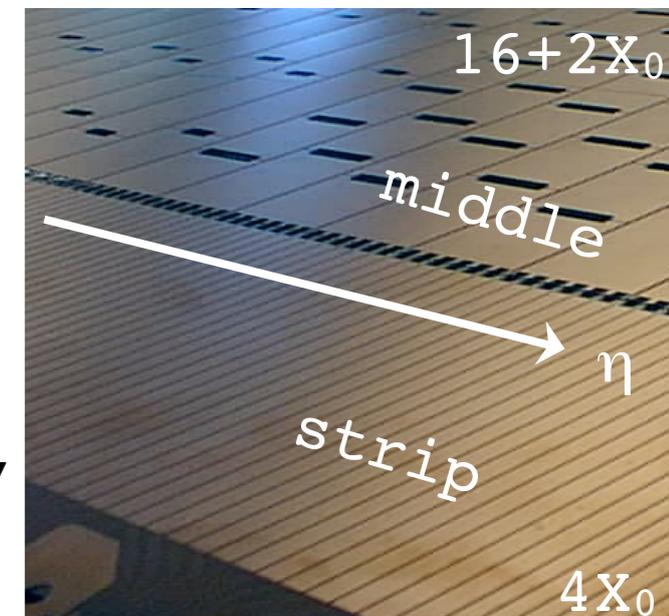
elettroni/fotoni

Ricostruzione:

- usa un algoritmo "sliding window" (finestra $\Delta\eta \times \Delta\varphi = 5 \times 5$)
- trova un massimo locale
- match traccia/vertice di conversione
per separare elettroni da fotoni dall'inizio
- ricostruisce un cluster
 - $\Delta\eta \times \Delta\varphi = 3 \times 5$ per fotoni non convertiti
 - $\Delta\eta \times \Delta\varphi = 3 \times 7$ per elettroni e fotoni convertiti
- energia nelle celle del cluster viene sommata
- applica calibrazioni

Identificazione:

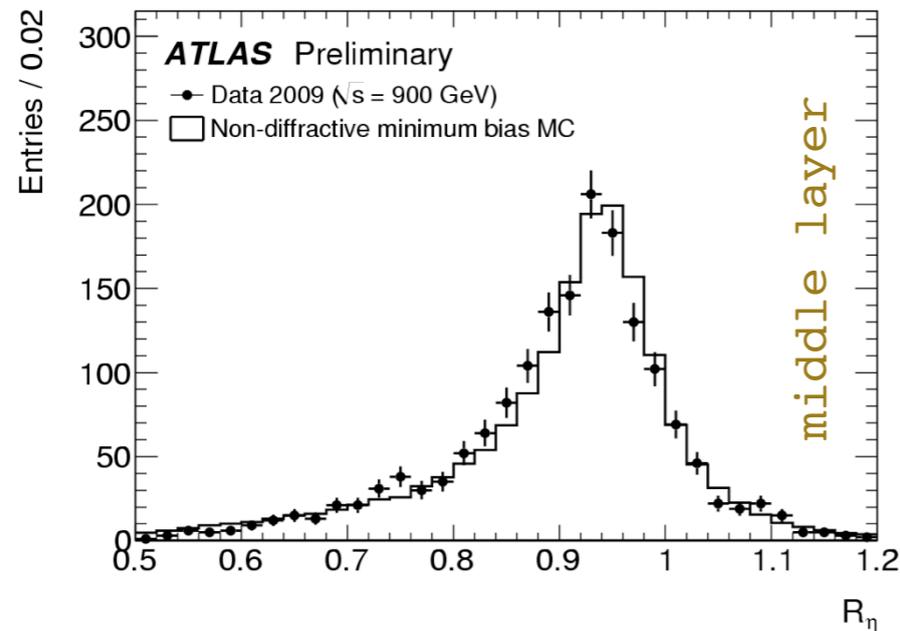
- tre livelli di selezione: "loose", "medium", "tight"
- selezione fatta sulle variabili:
 - calorimetriche - forma della shower:
sfruttando la segmentazione del calorimetro sia longitudinale
che trasversale nei vari strati
 - traccia: tra gli altri TRT - PID



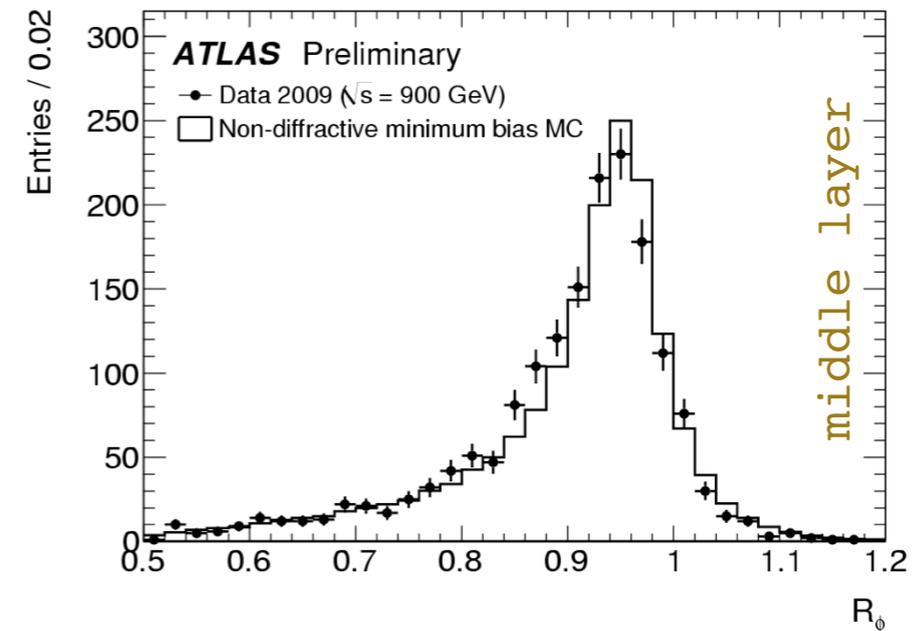
elettroni/fotoni

esempi di variabili usate nell'identificazione

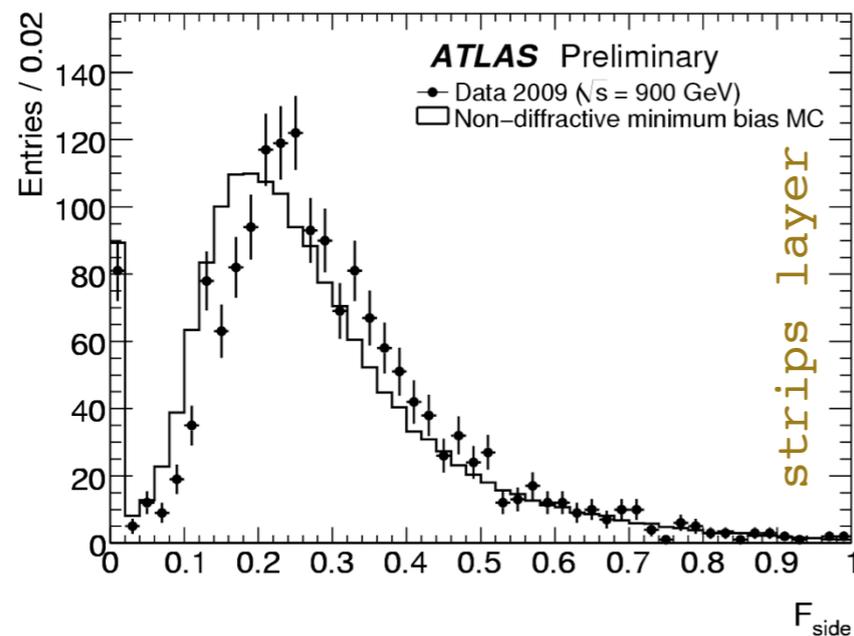
rapporto energia nella finestra 3x7/7x7



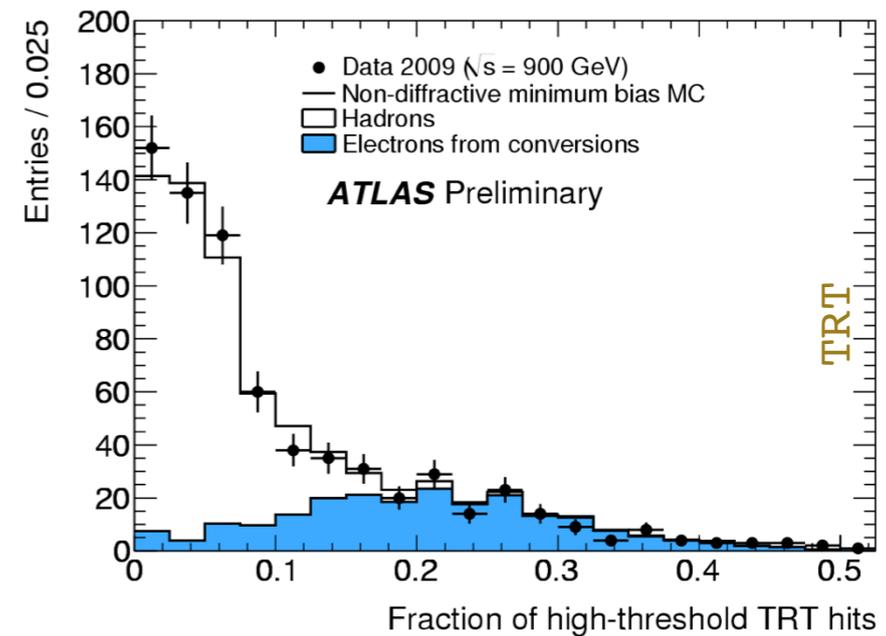
rapporto energia nella finestra 3x3/3x7



frazione di energia fuori dal core di 3 strips ma dentro una finestra di 7



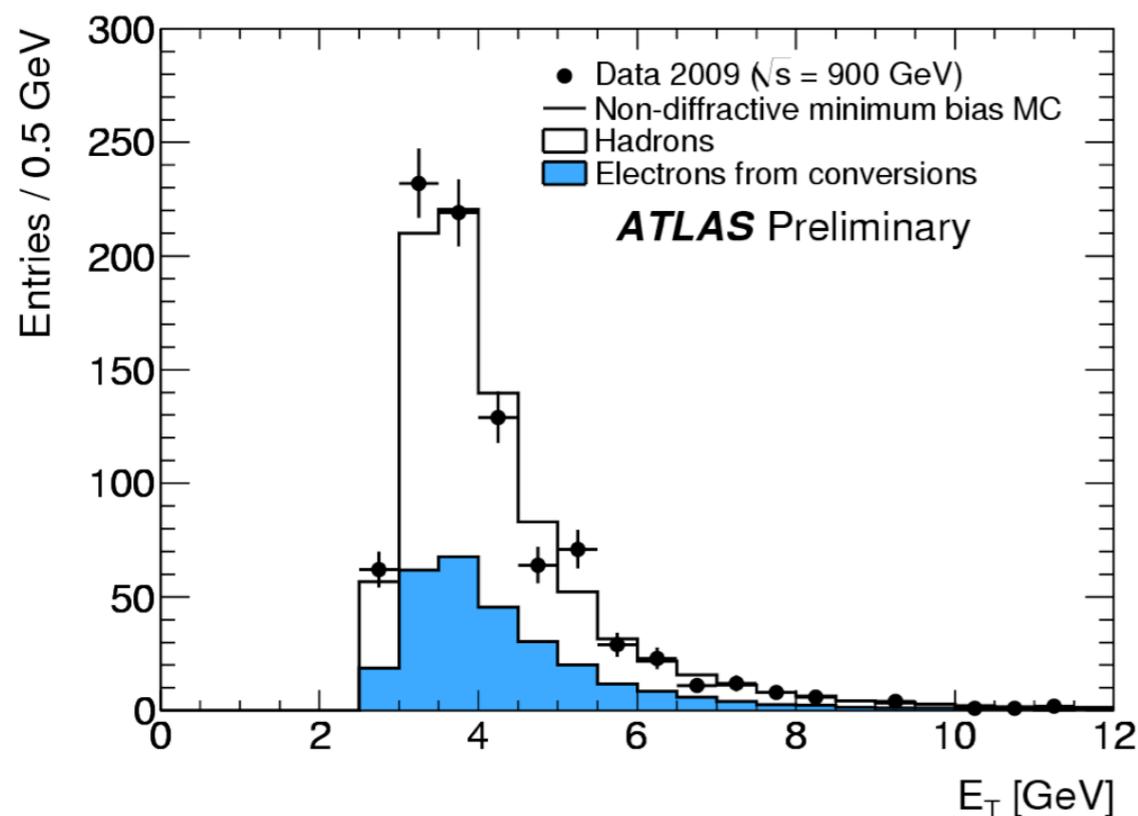
frazione di hit soglia alta sul totale



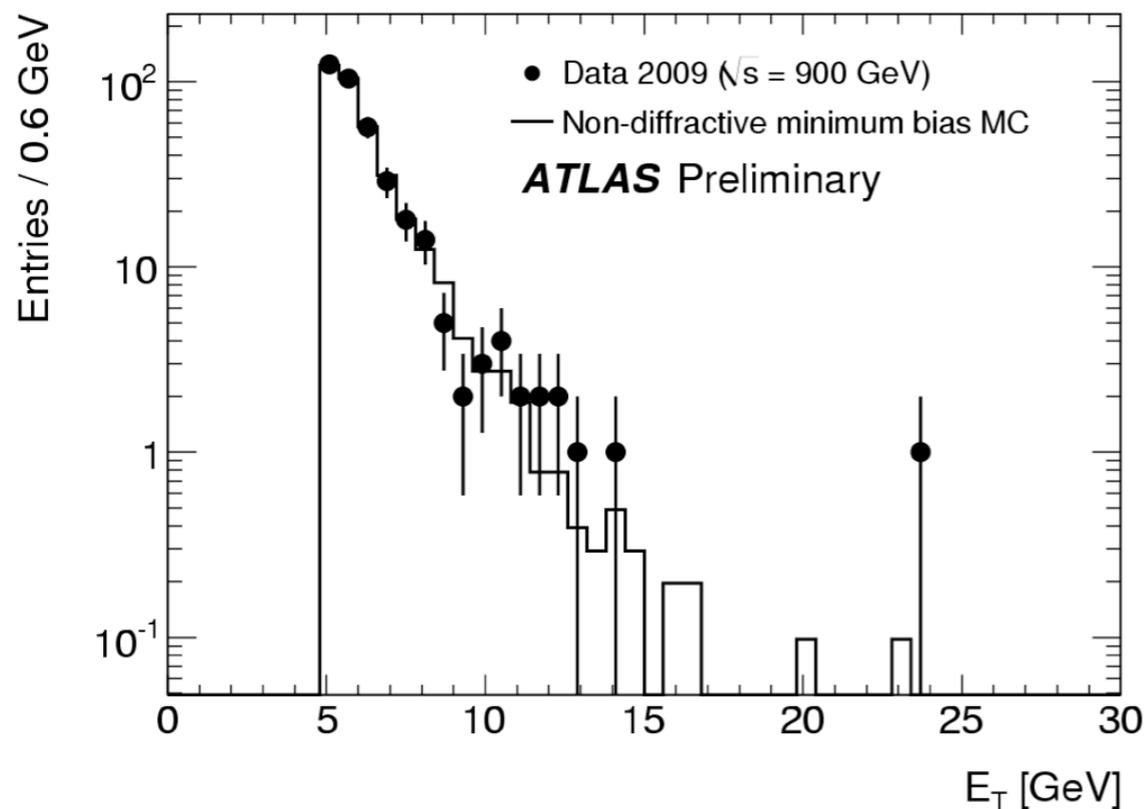
E' cominciato lo studio dettagliato degli effetti fini tipo cross talk

elettroni/fotoni

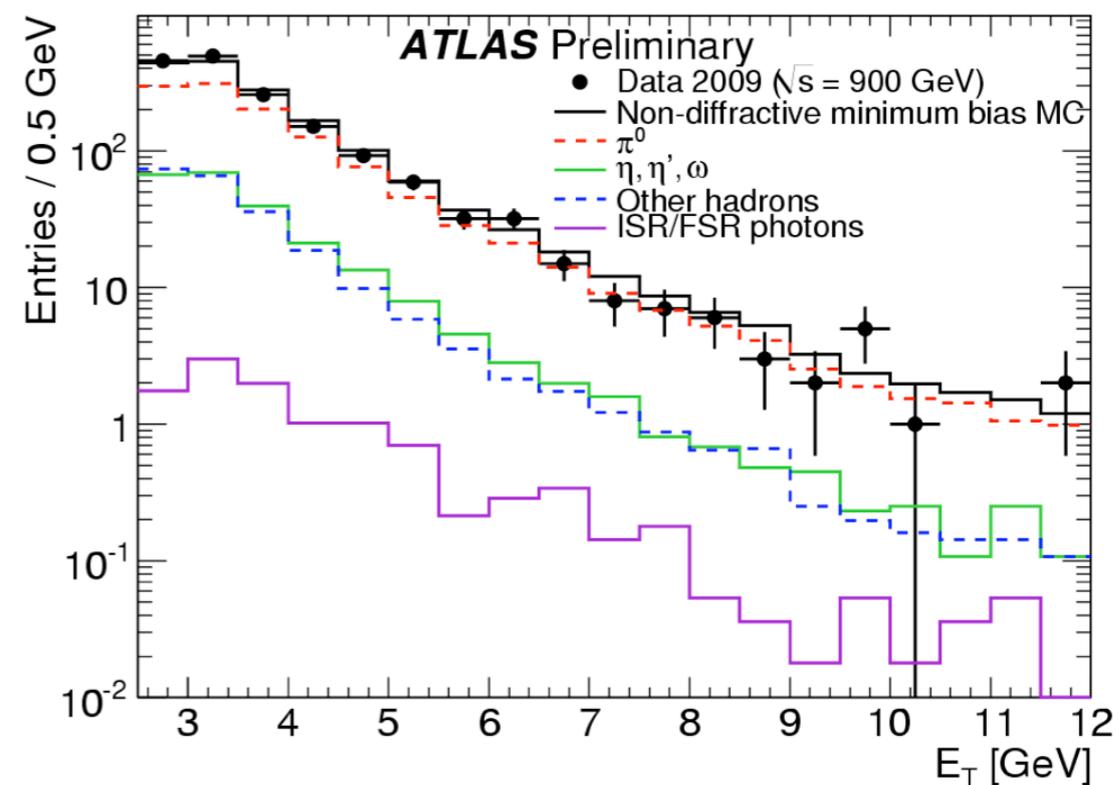
elettroni



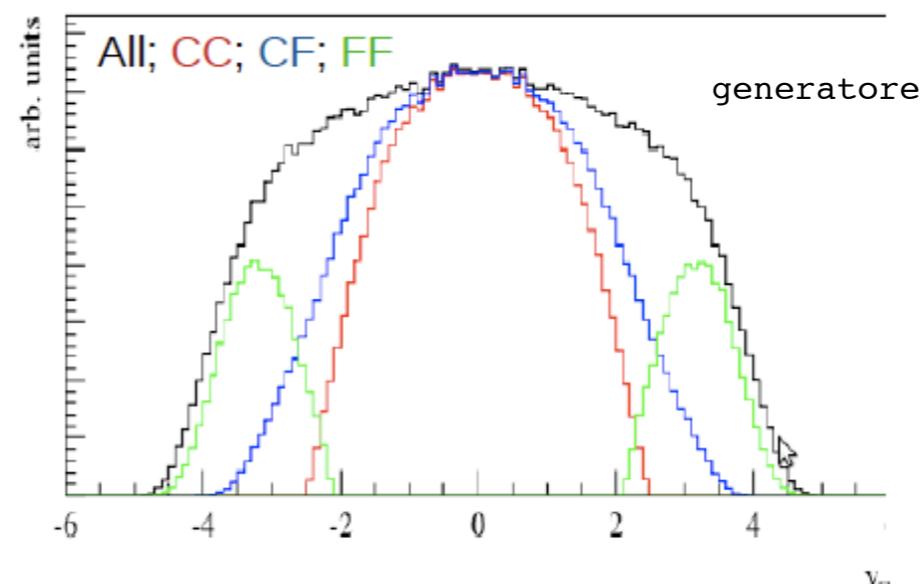
forward



fotoni

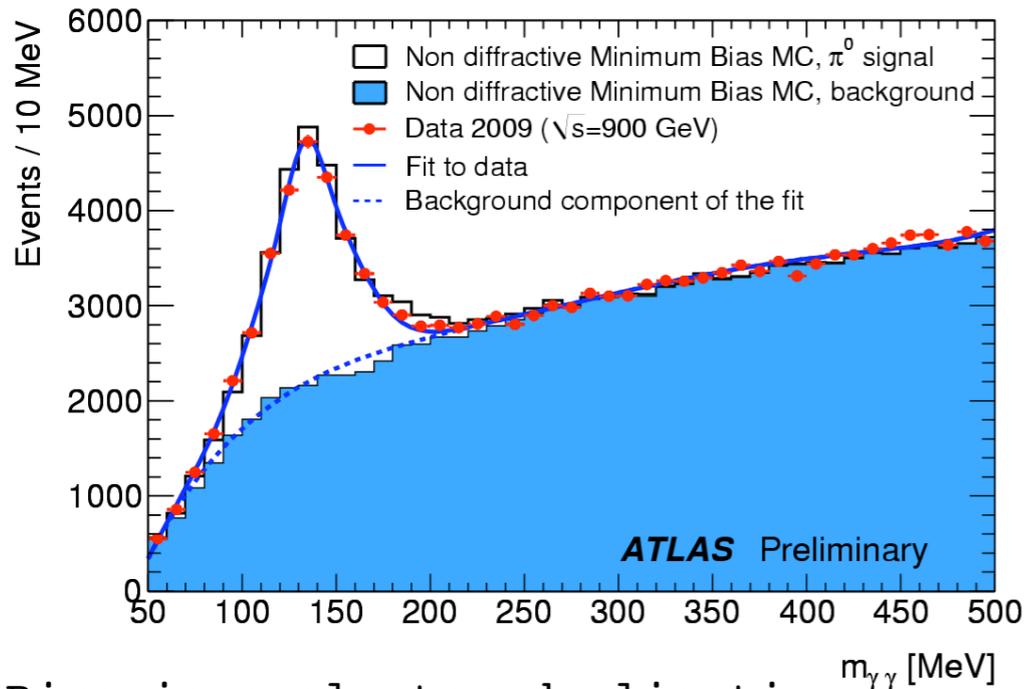


La regione $|\eta| > 2.5$ non è coperta dal tracciatore e quindi non c'è distinzione tra elettroni e fotoni. L'utilizzo di elettroni forward aumenta di molto l'accettanza per la Z

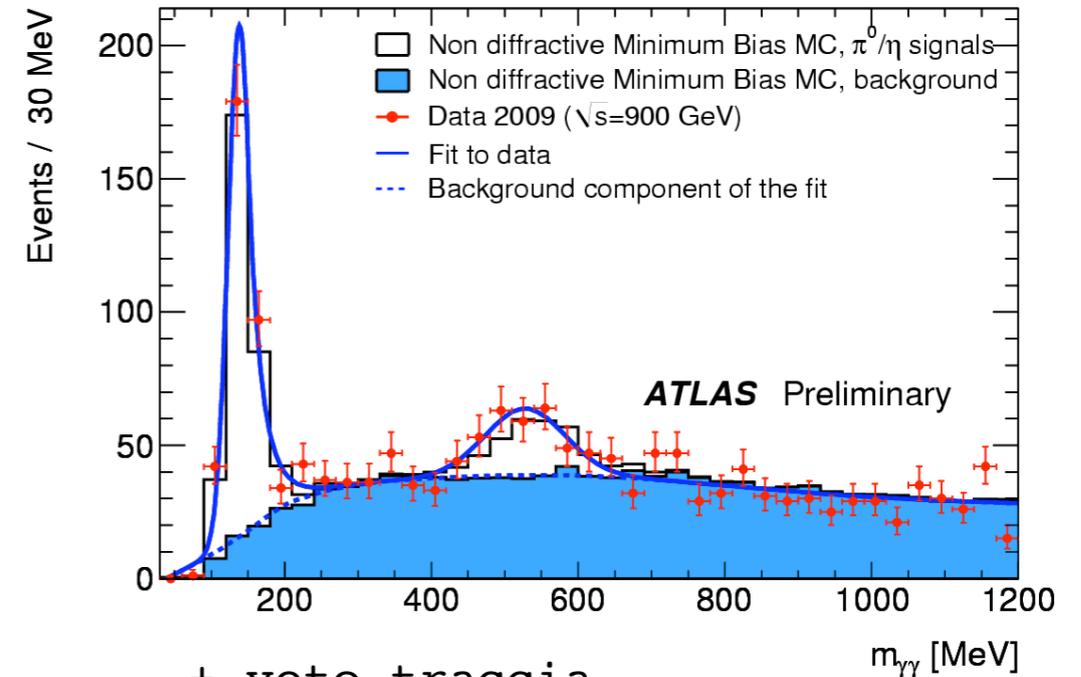
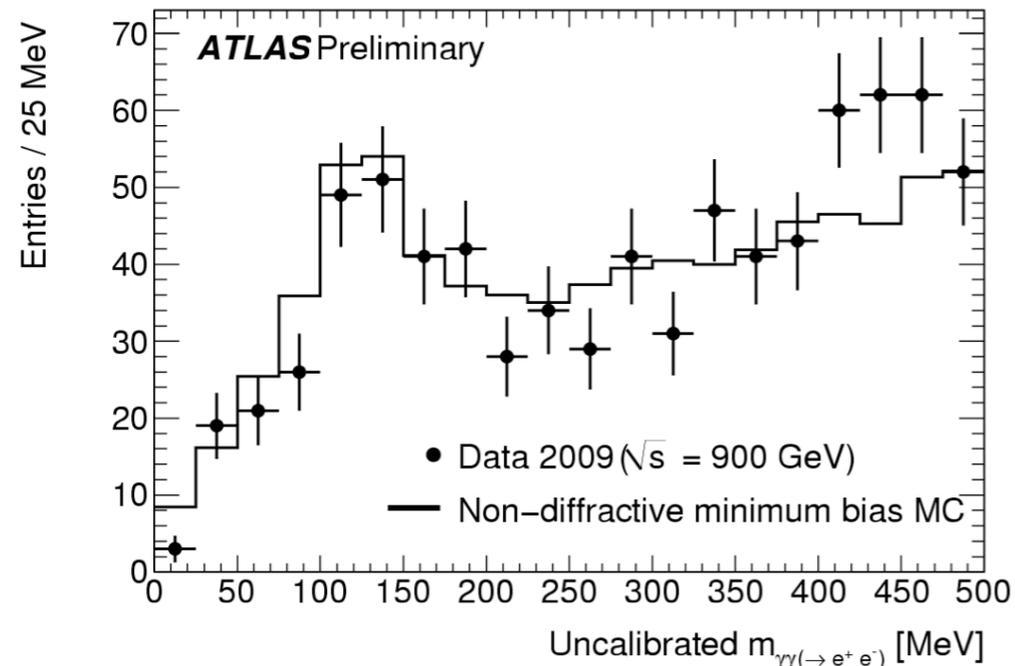


elettroni/fotoni

Cluster di dimensione fissa ($\Delta\eta \times \Delta\varphi = 0.075 \times 0.125$) taggati da un EMtopocluster (seed a 4σ sopra il noise e aggiunge le celle adiacenti sopra 2σ e poi quelle ancora adiacenti a 0σ) calibrati entro 2%.



Rimozione cluster duplicati
 $ET(\text{cluster}) > 400$ MeV
 $E1 / (E1 + E2 + E3) > 10\%$



+ veto traccia
 $ET(\text{cluster}) > 800$ MeV
 $pT(\text{coppia}) > 2200$ MeV

Tracciatore + calorimetro

Ricostruzione delle coppie con un fotone convertito e uno non convertito

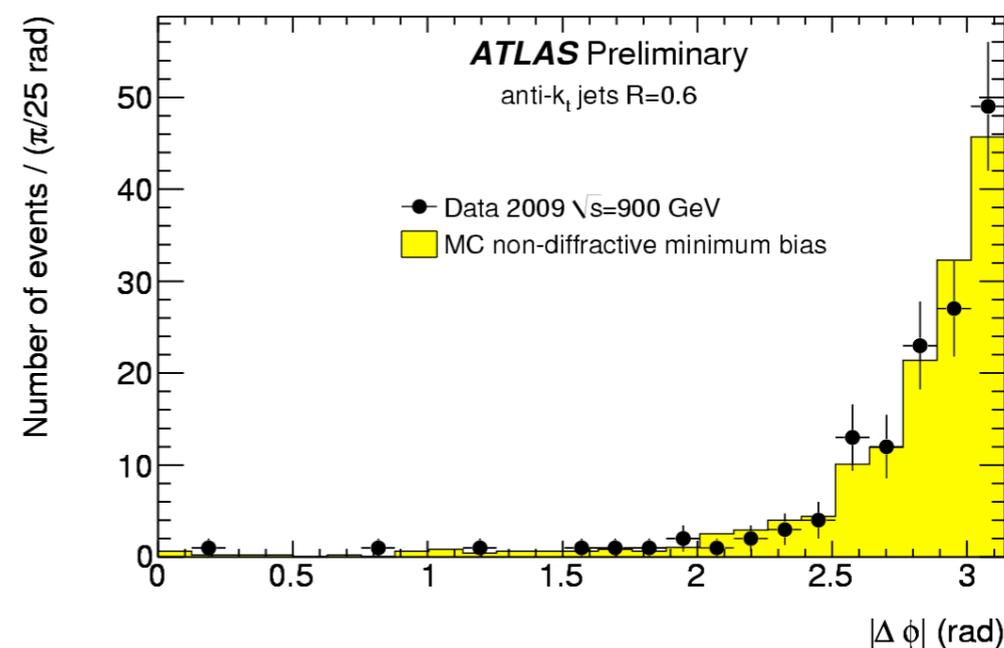
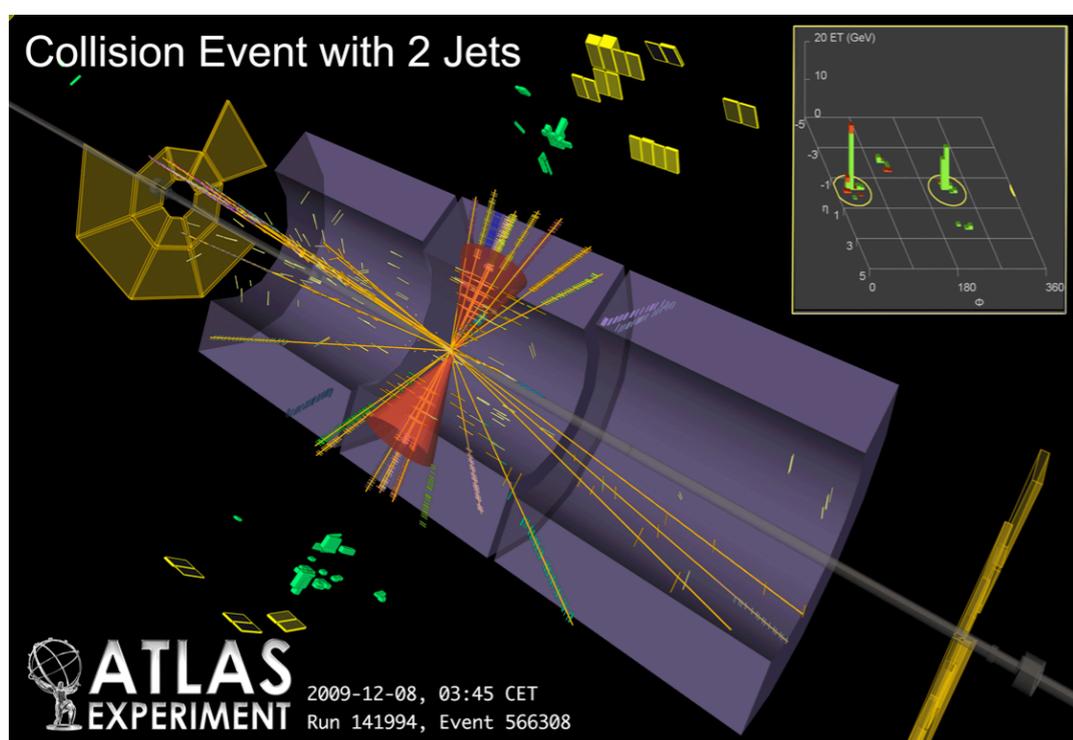
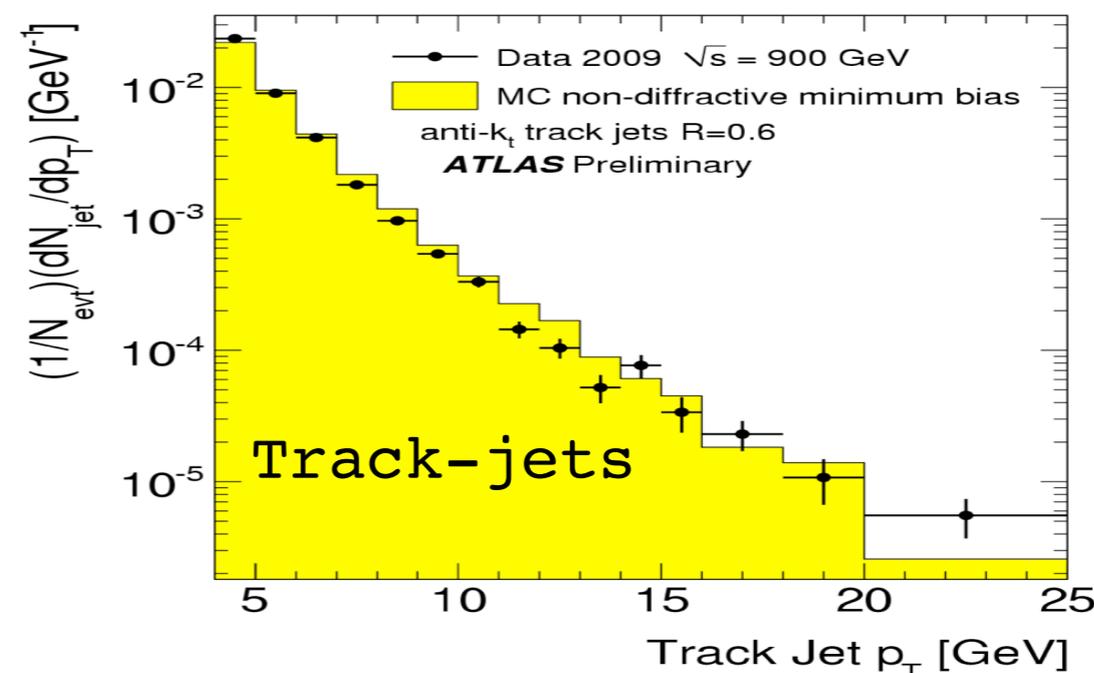
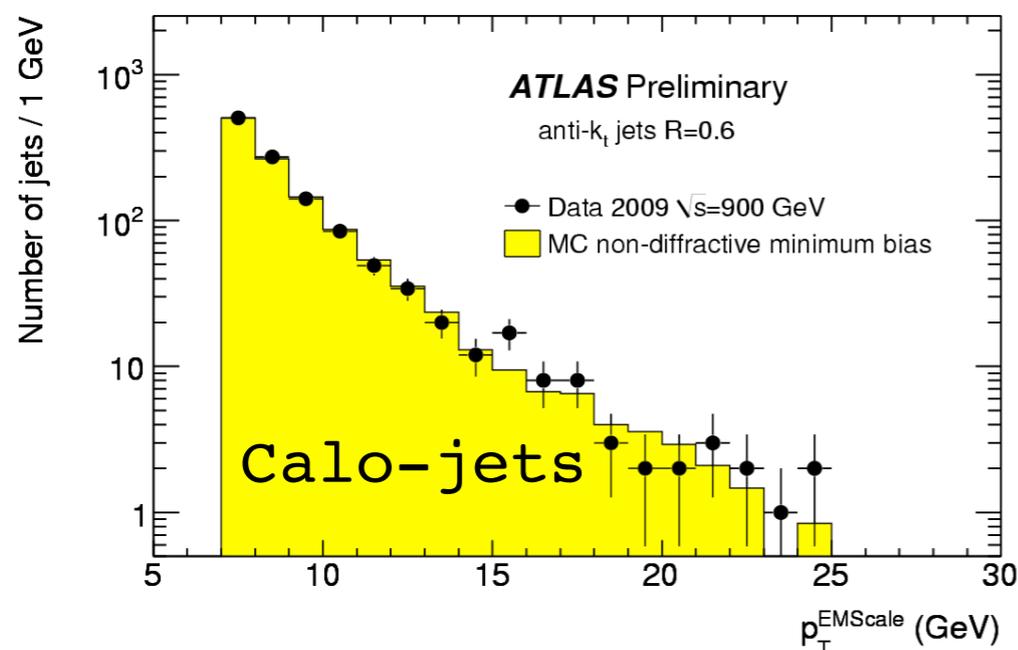
EMtopocluster ($430\text{-}\sigma$ noise)
 $ET(\text{cluster}) > 300$ MeV
 $pT(\text{coppia}) > 1900$ MeV

jets

anti-Kt R = 0.6

Jet ricostruiti con l'agoritmo anti-kt R=0.6

Track-jets complementari ai calo-jets perche' indipendenti dalla calibrazione del calorimetro.



ricostruzione dei jet e'
ben simulata, inclusa $\Delta\phi$

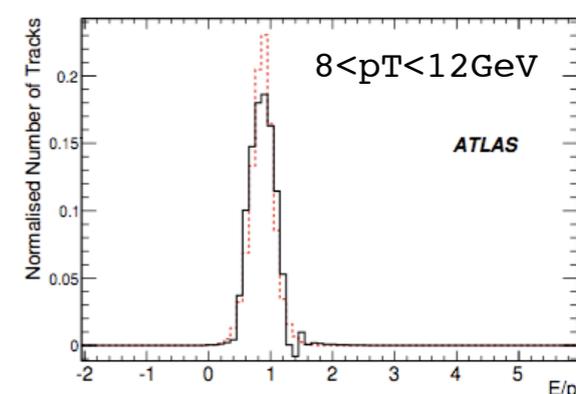
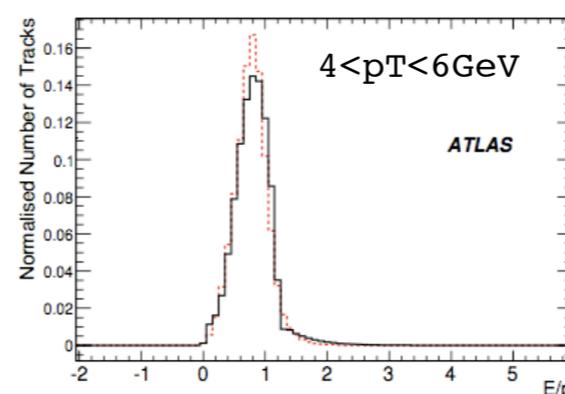
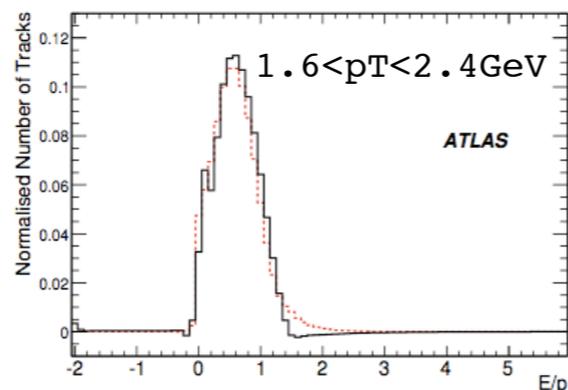
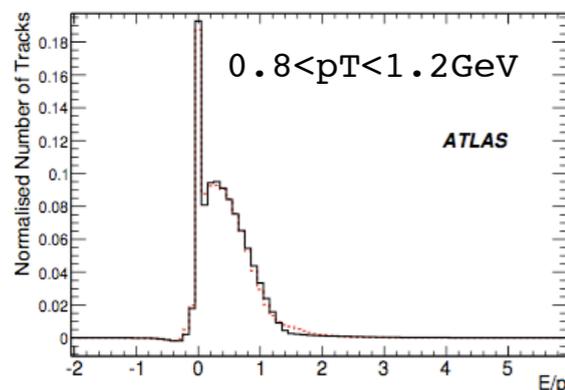
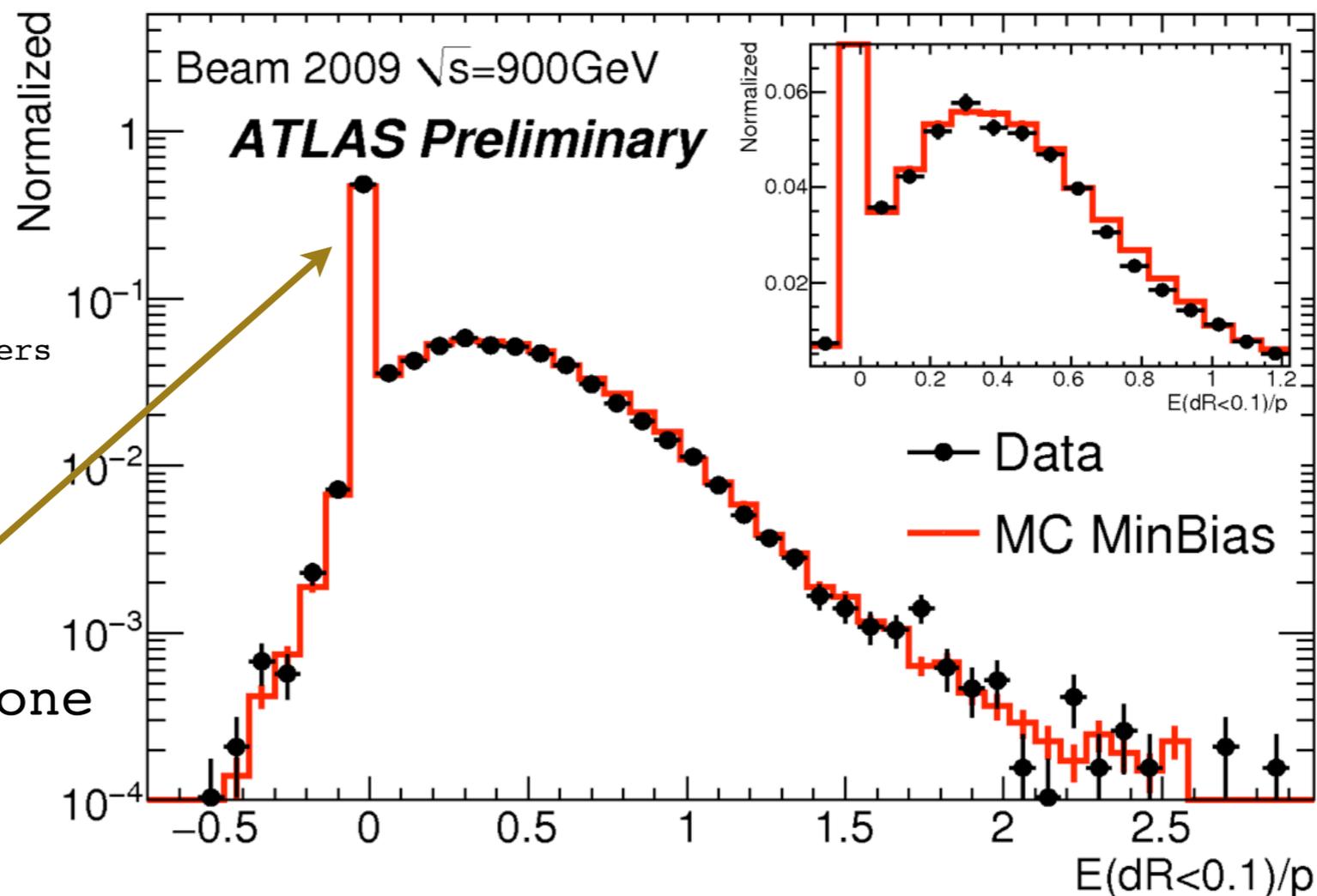
jets

selezione di tracce isolate:

- nessuna traccia in $\Delta R < 0.4$
- $p_T > 0.5$ GeV
- $|\eta| < 0.8$
- topoclusters

topoclusters come gli EMtopoclusters ma includono anche il calorimetro adronico

effetto di diffusione

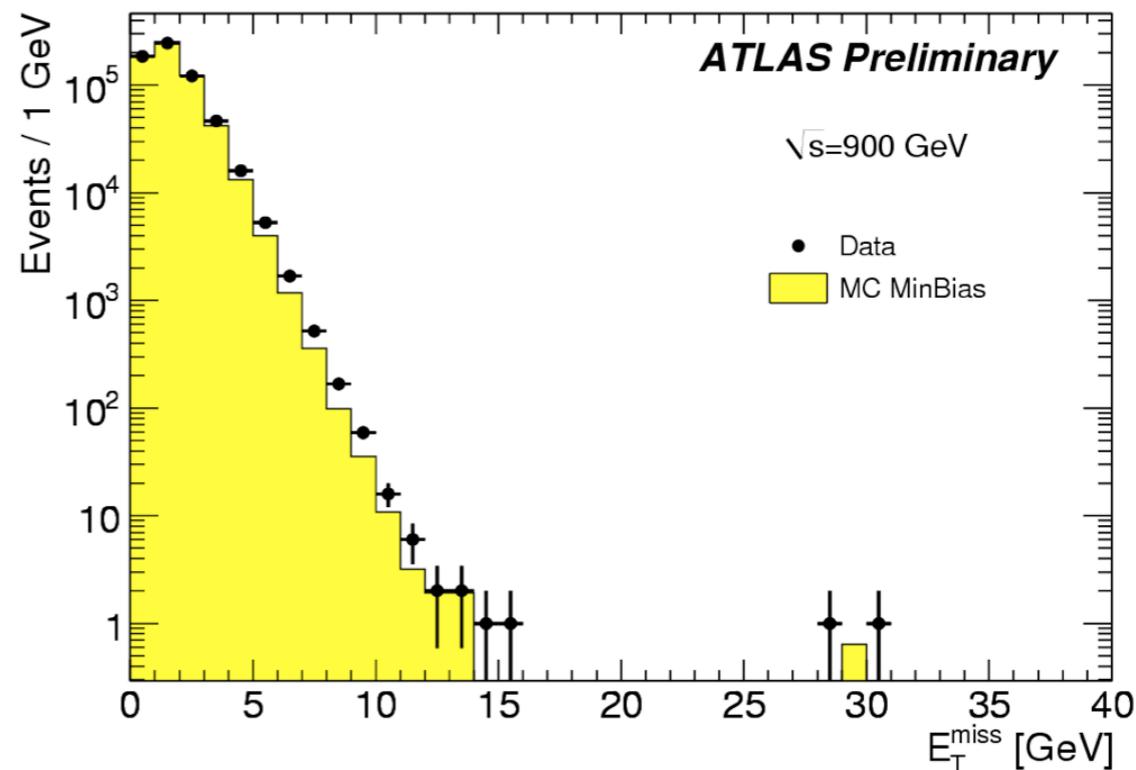


missing E_T

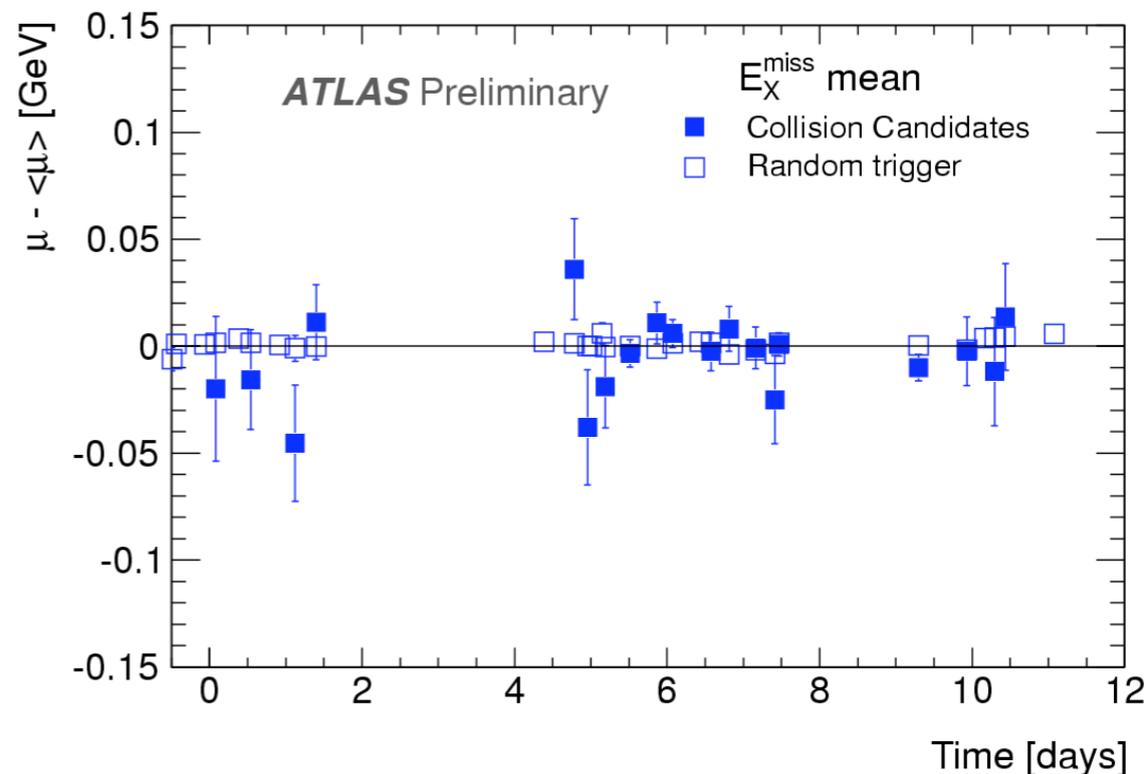
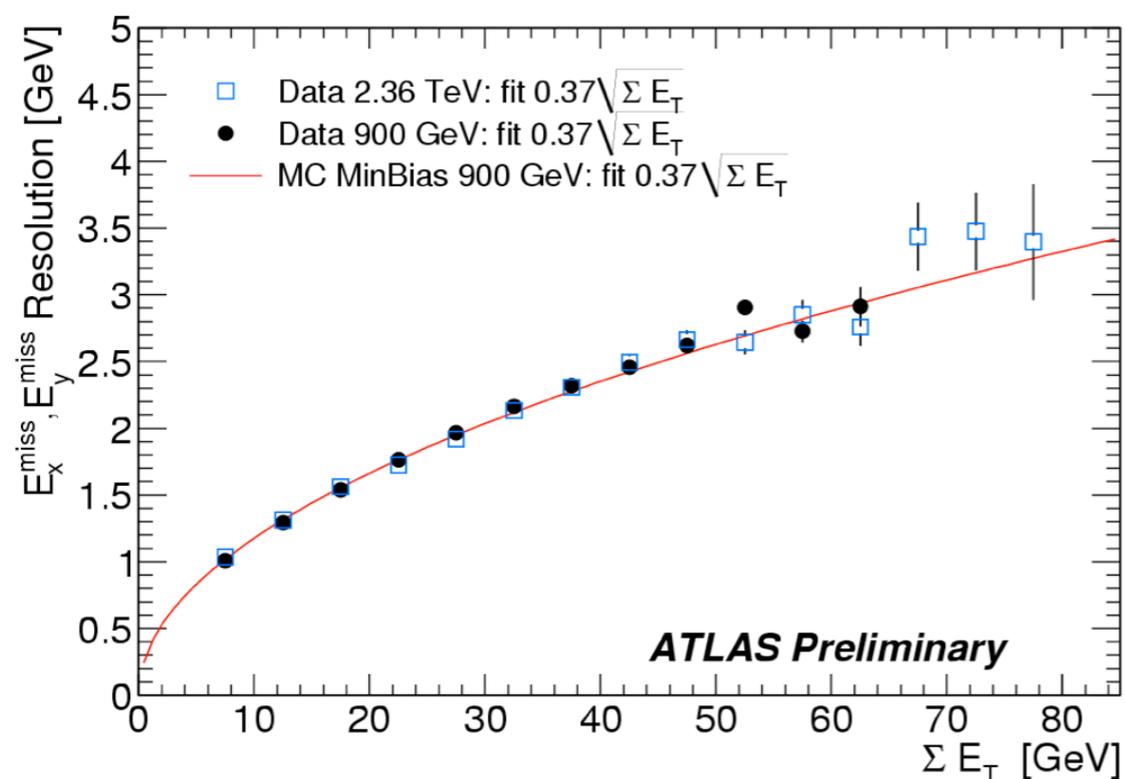
Primi studi di missing ET con eventi minbias

topoclusters:

- e.m. scale
- $|\eta| < 4.9$



Assumo $E_{T\text{miss}}(\text{minbias}) = 0$

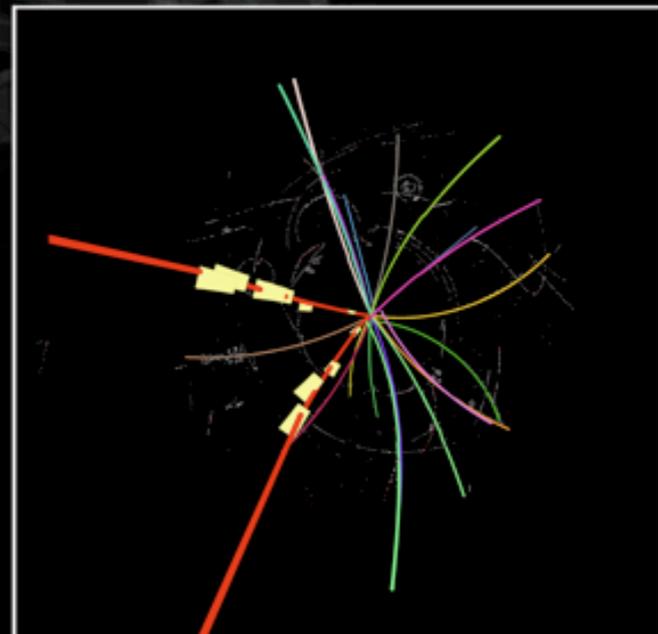
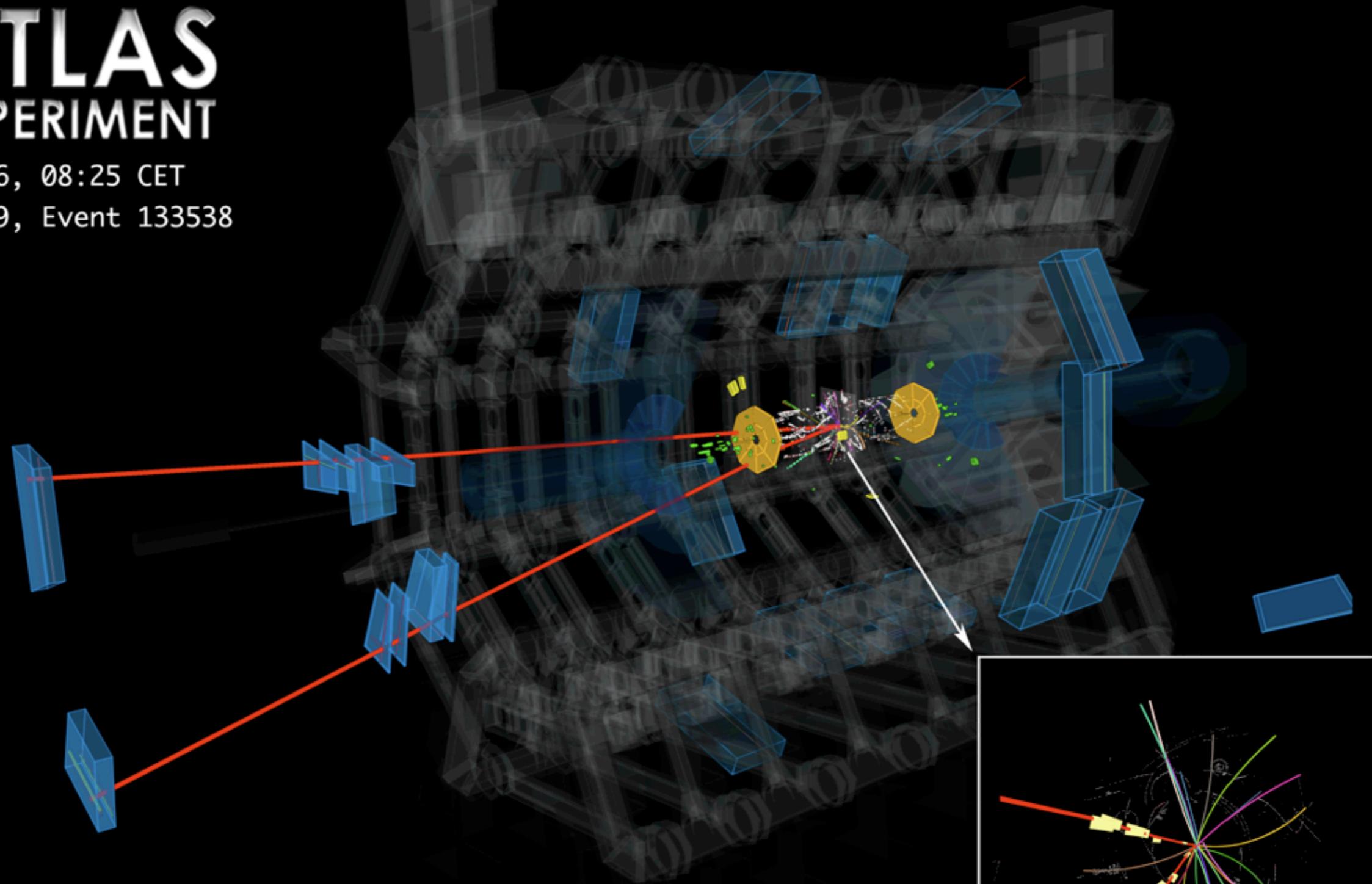


Media (e dispersion) stabili nel tempo

 **ATLAS**
EXPERIMENT

2009-12-06, 08:25 CET

Run 141749, Event 133538



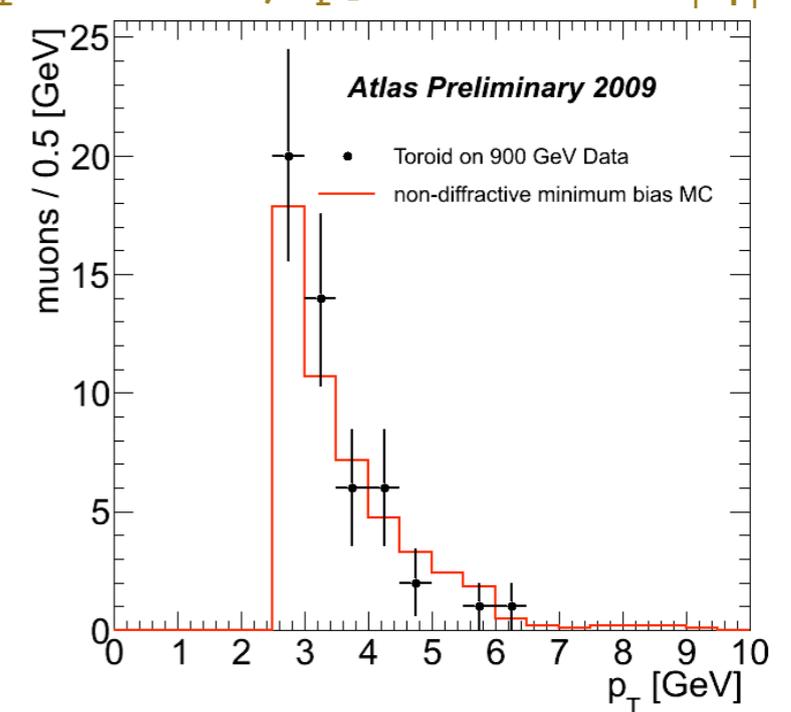
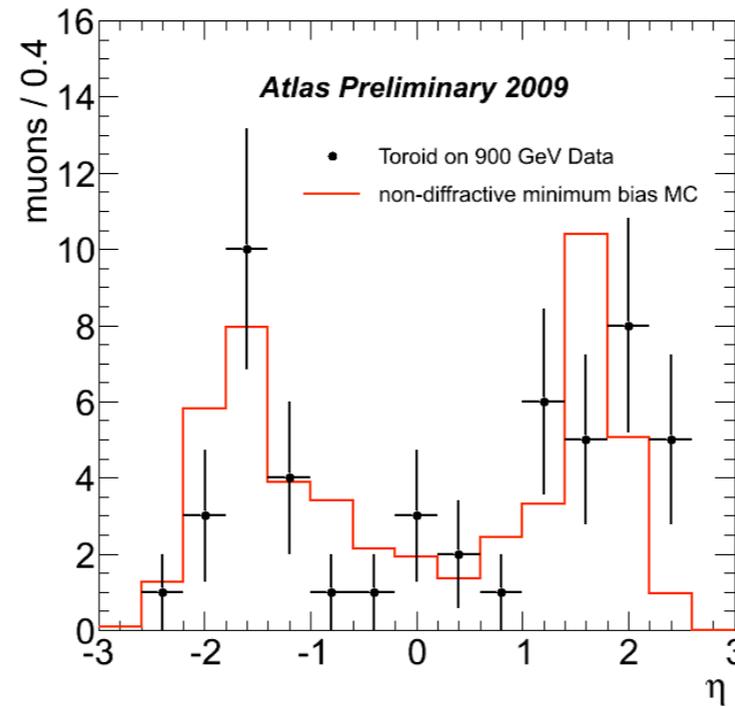
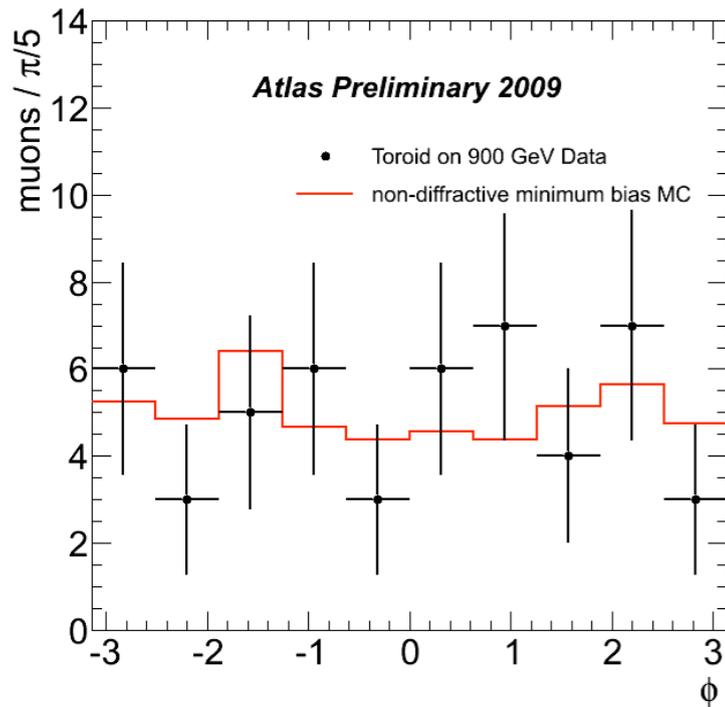
Collision Event with 2 Muon Candidates

<http://atlas.web.cern.ch/Atlas/public/EVTDISPLAY/events.html>

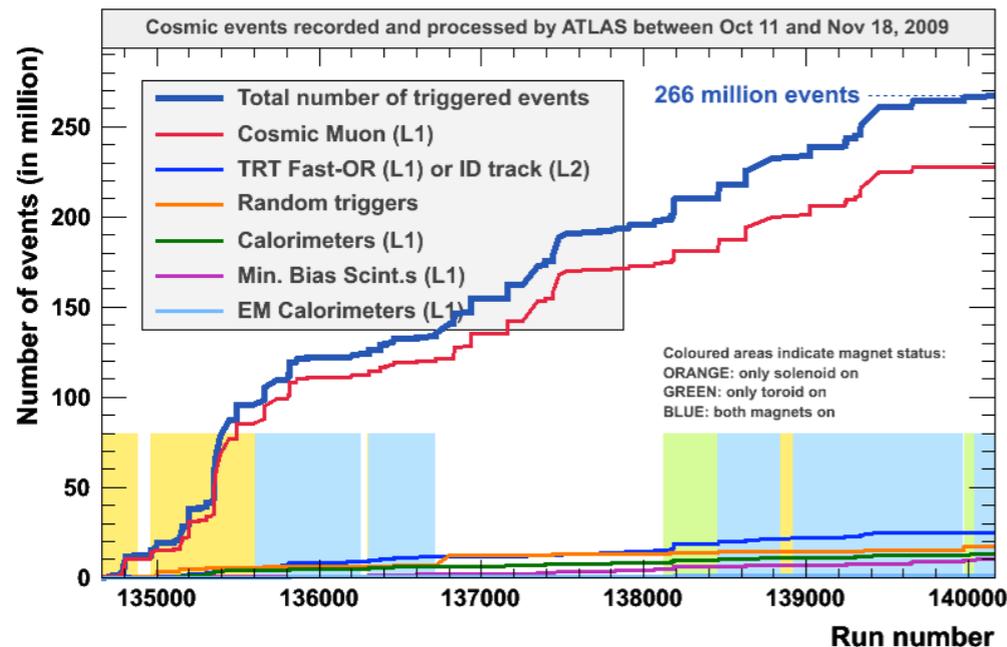
spettrometro a μ

Nelle collisioni a 900 GeV la statistica e' limitata: 50 candidati.

Selezione: $p > 4$ GeV, $p_T > 2.5$ GeV $|\eta| < 2.5$

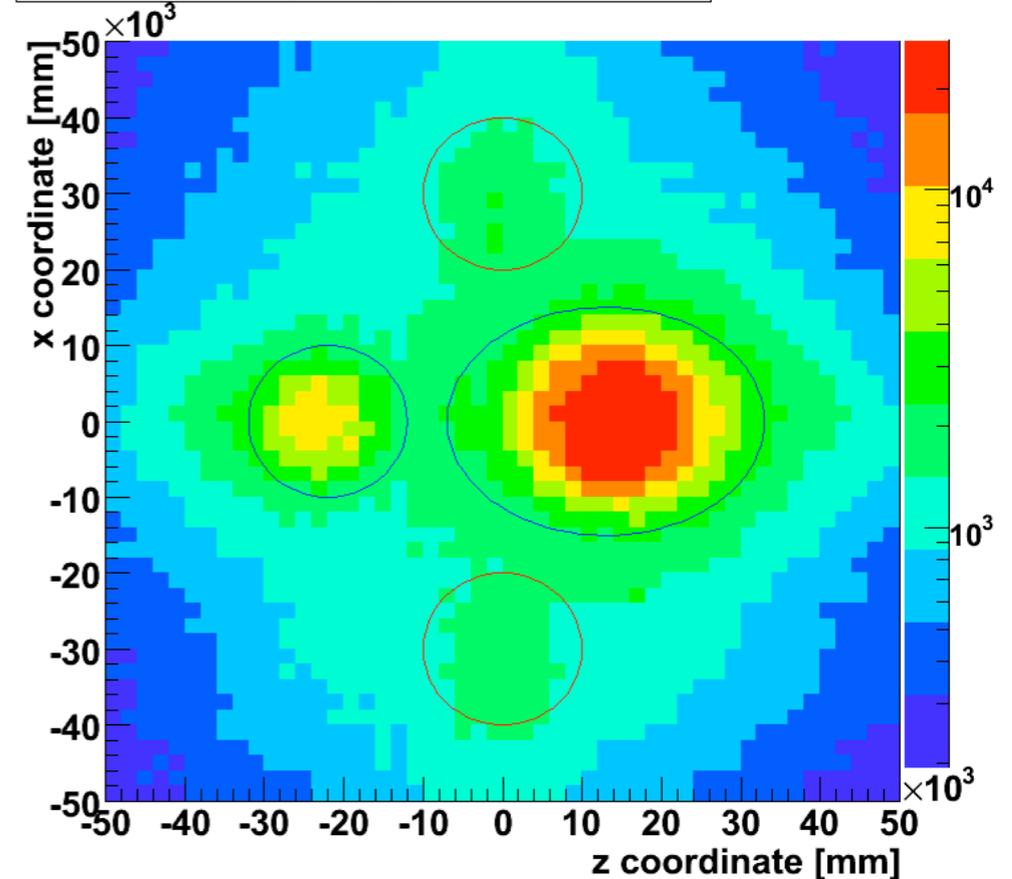


Moltissimi studi fatti sui cosmici.
Statistica ~300 milioni eventi



RPC track impact point on surface

Entries 6616665



conclusioni

Le performance di ATLAS (tracciatore, calorimetria e spettrometro a μ) sono state testate con i primi eventi a 900 GeV ($\sim 9\mu\text{b}^{-1}$) minimum bias

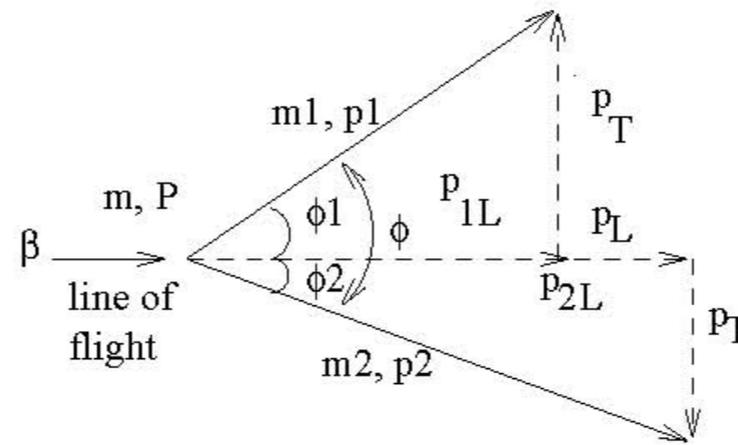
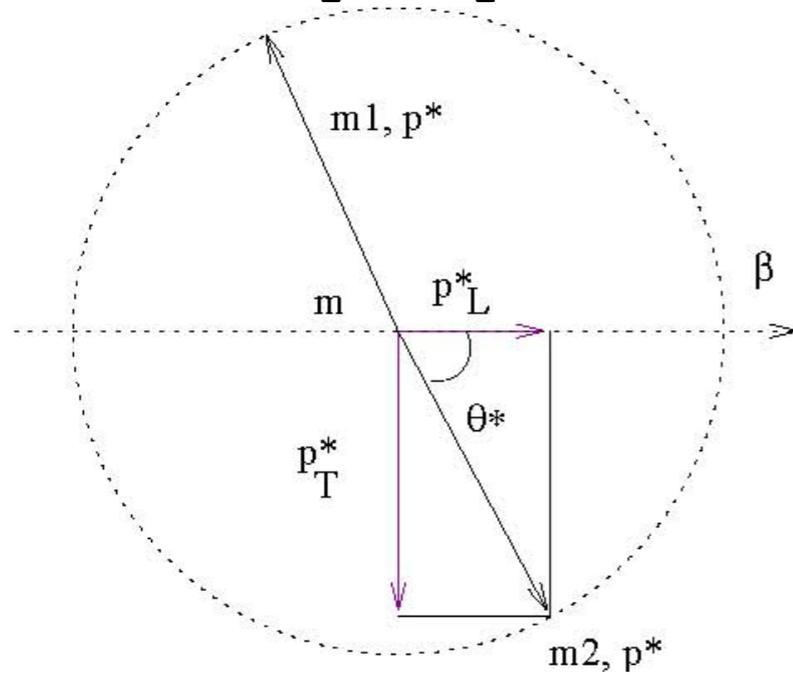
I primi risultati sono ottimi e la simulazione del detector e' gia' molto accurata !

Adesso comincia fisica ad alto pT !

backups

armenteros-podolanski

(1953) Podolanski e Armenteros hanno costruito un metodo per analizzare la dinamica dei decadimenti a due corpi per cercare nuove particelle neutre instabili in termini delle quantità misurate: p_1, p_2 .



$$\vec{P} = \vec{p}_1 + \vec{p}_2$$

$$p_L = p_{1L} + p_{2L} = p_1 \cos \phi_1 + p_2 \cos \phi_2$$

$$p_T = p_1 \sin \phi_1 = p_2 \sin \phi_2 = p_1 p_2 \sin \phi / P$$

$$\varepsilon = \frac{2p_T}{P} = \frac{2 \sin \phi_1 \sin \phi_2}{\sin \phi}$$

$$\alpha = \frac{(p_{1L} - p_{2L})}{(p_{1L} + p_{2L})}$$

p_T e' indipendente da β .

$$\alpha = \alpha_0 + f(p^*, \cos \theta^*)$$

$$\alpha_0 = \frac{m_1^2 - m_2^2}{m^2}$$

$$p_L^* = \frac{(\alpha - \bar{\alpha})}{(2/\beta m)} \quad p^{*2} = p_L^{*2} + p_T^{*2}$$

$$\frac{(\alpha - \bar{\alpha})^2}{(2p^*/\beta m)^2} + \frac{p_T^2}{p^{*2}} = 1$$

$$\frac{(\alpha - \bar{\alpha})^2}{\bar{\varepsilon}^2 + (m\bar{\varepsilon}/P)^2} + \frac{\varepsilon^2}{(m\bar{\varepsilon}/P)^2} = 1$$

Nel piano α - p_T o α - ε , i punti corrispondenti ad un dato tipo di decadimento giacciono su una famiglia di ellissi i cui parametri sono determinati dalla massa della particella neutra e dalla velocità dei prodotti di decadimento.

anti- k_T

E' un caso particolare della classe dei sequential recombination algorithms

Si definisce una distanza:

$$d_{ij} = \min(k_{ti}^{2p}, k_{tj}^{2p}) \frac{\Delta_{ij}^2}{R^2}$$

$$d_{iB} = k_{ti}^{2p}, \quad \Delta_{ij}^2 = (y_i - y_j)^2 + (\phi_i - \phi_j)^2$$

Dove: i, j sono particelle/pseudojets; d_{ij} e' la distanza tra i e j ; d_{iB} e' la distanza tra i e il fascio.

Clustering: identificata la minore distanza tra due entita' (i, j) se questa e' del tipo d_{ij} si combinano le due in una nuova entita; se invece e' del tipo d_{iB} i viene promosso a jet e tolto dalla lista delle entita'.

La definizione di distanza e' generale:

$p=1$ e' lo standard algoritmo k_t

$p>1$ ha proprieta' simili a $p=1$

$p=0$ e' l'algoritmo di Cambridge/Aachen

$p=-1$ e' l'algoritmo anti- k_t

$p<0$ ha proprieta' simili all' anti- k_t

Proprieta':

infrared safe (particelle di basso p_T non devono influenzare il numero di jet)

collinear safe (il jet deve essere ricostruito anche in caso di particelle collineari)

confini dei jet sono solidi rispetto alla radiazione soft

identificazione e/gamma

Type	Description	Name
Loose electron and photon cuts		
Acceptance of the detector	$ \eta < 2.47$ for electrons, $ \eta < 2.37$ for photons ($1.37 < \eta < 1.52$ excluded)	-
Hadronic leakage	Ratio of E_T in the 1st sampling of the hadronic calorimeter to E_T of the EM cluster (used over the range $ \eta < 0.8$ and $ \eta > 1.37$)	R_{had1}
	Ratio of E_T in the hadronic calorimeter to E_T of the EM cluster (used over the range $ \eta > 0.8$ and $ \eta < 1.37$)	R_{had}
Middle layer of the EM calorimeter	Ratio in η of cell energies in 3×7 versus 7×7 cells.	R_η
	Lateral width of the shower	w_2
Medium electron cuts (in addition to the loose cuts)		
Strip layer of the EM calorimeter	Total lateral shower width (20 strips)	w_{tot}
	Ratio of the energy difference between the largest and second largest energy deposits over the sum of these energies	E_{ratio}
Track quality	Number of hits in the pixel detector (at least one)	-
	Number of hits in the pixels and SCT (at least seven)	-
	Transverse impact parameter (<5 mm)	d_0
Track matching	$\Delta\eta$ between the cluster and the track in the strip layer of the EM calorimeter	$\Delta\eta_1$
Tight electron cuts (in addition to the medium electron cuts)		
B-layer	Number of hits in the B-layer (at least one)	
Track matching	$\Delta\phi$ between the cluster and the track in the middle layer of the EM calorimeter	$\Delta\phi_2$
	Ratio of the cluster energy to the track momentum	E/p
TRT	Total number of hits in the TRT (used over the acceptance of the TRT, $ \eta < 2.0$)	-
	Ratio of the number of high-threshold hits to the total number of TRT hits (used over the acceptance of the TRT, $ \eta < 2.0$)	-
Tight photon cuts (in addition to the loose cuts, applied with stricter thresholds)		
Middle layer of the EM calorimeter	Ratio in ϕ of cell energies in 3×3 and 3×7 cells	R_ϕ
Strip layer of the EM calorimeter	Shower width for three strips around maximum strip	w_{s3}
	Total lateral shower width	w_{tot}
	Fraction of energy outside core of three central strips but within seven strips	F_{side}
	Difference between the energy of the strip with the second largest energy deposit and the energy of the strip with the smallest energy deposit between the two leading strips	ΔE
	Ratio of the energy difference associated with the largest and second largest energy deposits over the sum of these energies	E_{ratio}