Identified particle production in inelastic pp events with the ATLAS detector

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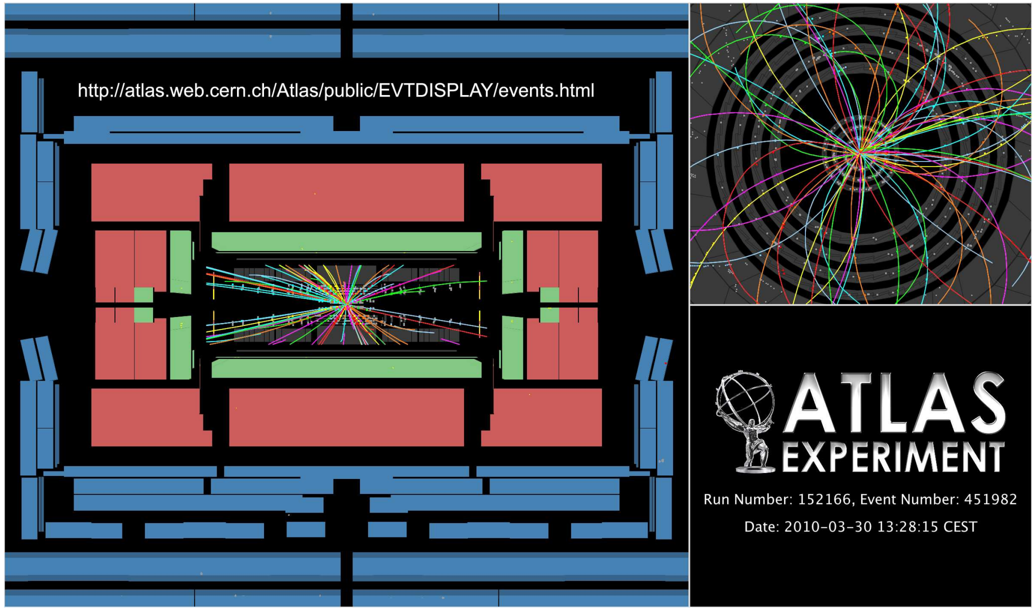
On behalf of the ATLAS Collaboration

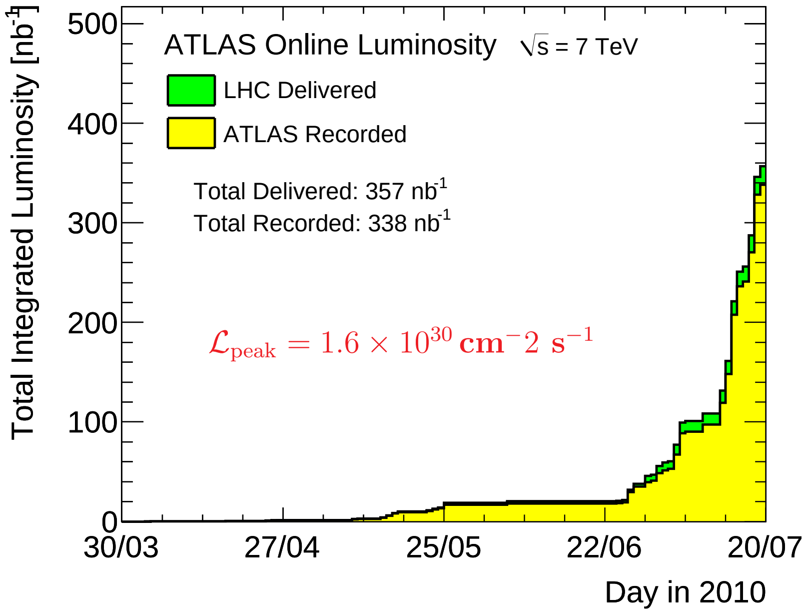
ICHEP 2010, Paris, July 22-28, 2010

O U T L I N E : https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CONFNOTES/

- Introduction & Motivation
- $\phi(1020)$ production at $900\,$GeV — ATLAS-CONF-2010-023 (included in arXiv:1005.5254, subm. to JINST)
- K_s^0 and Λ^0 production at $7\,$TeV — ATLAS-CONF-2010-033
- $K^{*\pm}$, $\Xi^{\mp}$ and $\Omega^{\mp}$ production at $7\,$TeV — ATLAS-CONF-2010-032
- $D^{*\pm}$, $D^{\pm}$ and $D_s^{\pm}$ production at $7\,$TeV — ATLAS-CONF-2010-034
- Summary & Outlook

Introduction & Motivation





ATLAS @ LHC is a discovery machine ... and Soft Physics first !

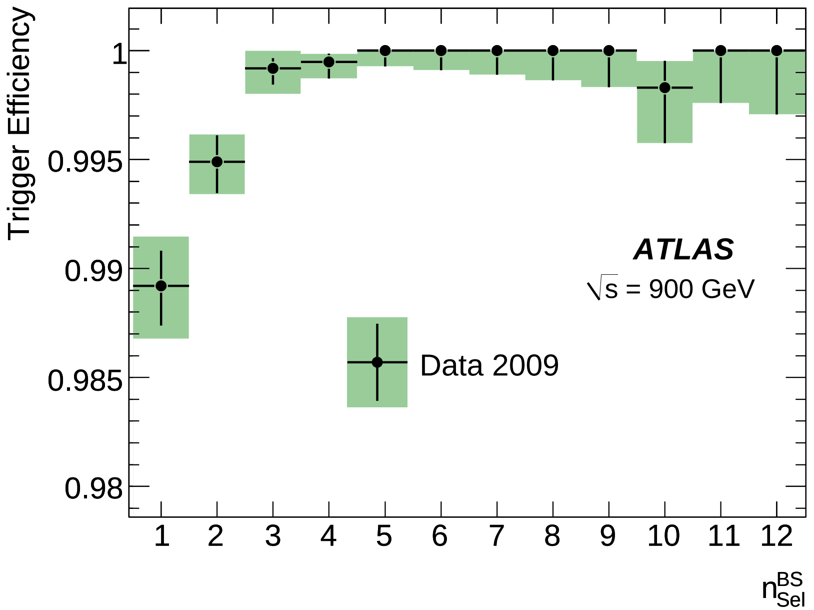
Important to study identified particle production

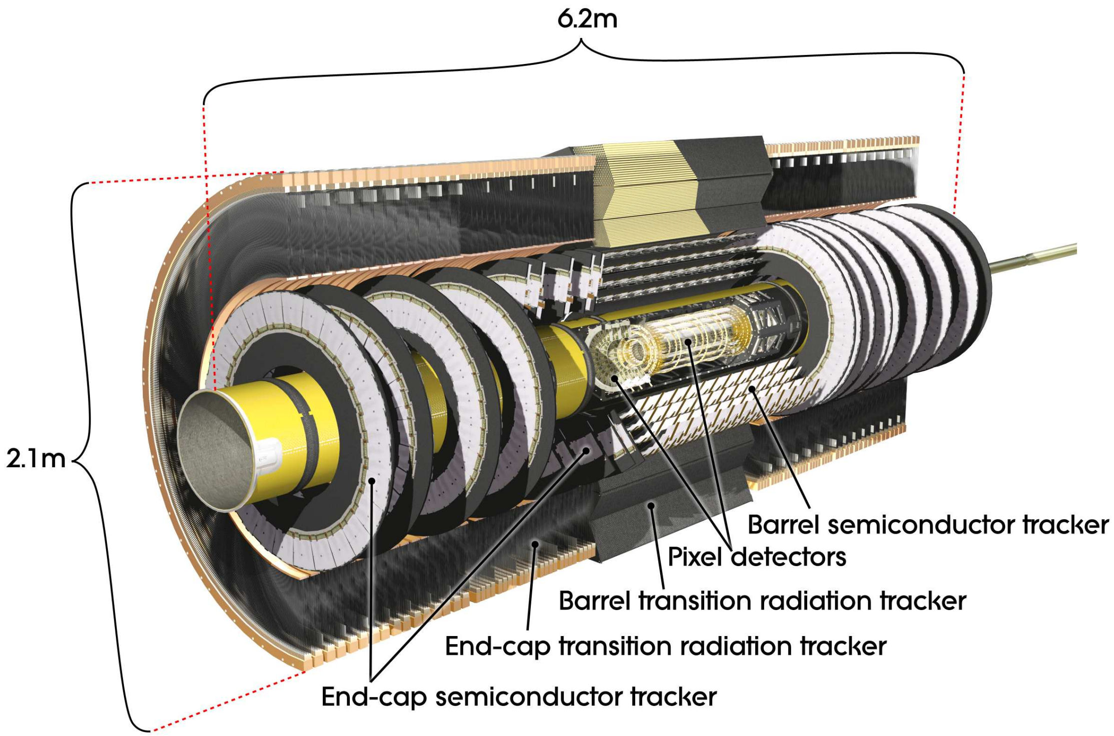
- to tune modelling of backgrounds to high-p_T processes
- to compare production in pp and HI collisions
- to evaluate and calibrate tracking performance

We present in this talk

- production of strange mesons and baryons
- production of charmed mesons (see ATLAS talks in track 6 for results on J/ψ)

Data taking and analysis





trigger: at least one hit above threshold in the Minimum-Bias Trigger Scintillators at each end of the detector

tracks with at least 2-5 hits in Pixel+SCT and $p_T > 100\,\mathrm{MeV}$ $(|\eta| \lesssim 2.5)$

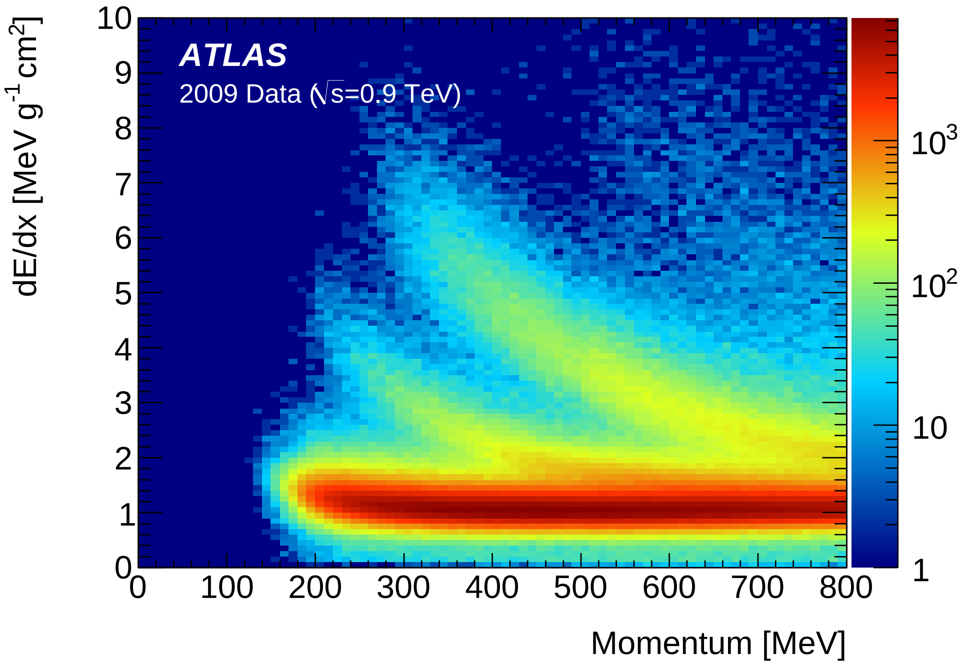
primary and secondary vertices reconstruction $\Longrightarrow$ resonances

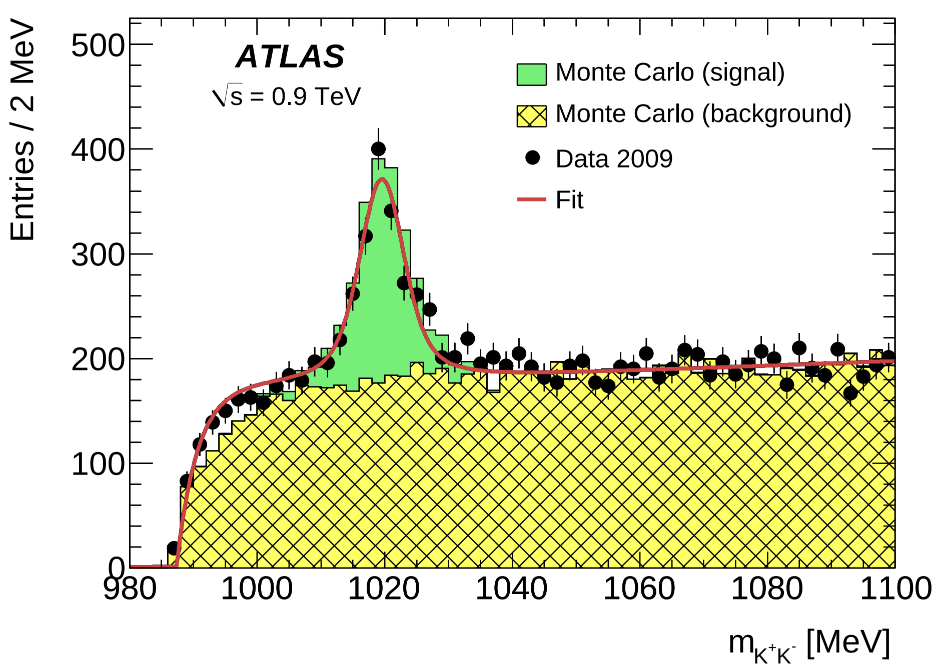
results are compared with the inelastic minimum-bias PYTHIA MC using ATLAS MC09 tune (ATLAS-PHYS-PUB-2010-002) to Tevatron data and ATLAS Geant4 simulation (arXiv:1005.4568, subm. to EPJC)

$\phi(1020) \rightarrow K^+K^-$ in $900\,$GeV data $\quad \mathcal{L}_{int} \sim 10\mu\mathbf{b}^{-1}$

two track from primary vertex with $p_T < 0.8\,$GeV each

dE/dx from Pixel detector: $f_{pion,\ kaon,\ proton}$ **- likelihood functions from the bands fit by a Bethe-Bloch-like eq.**





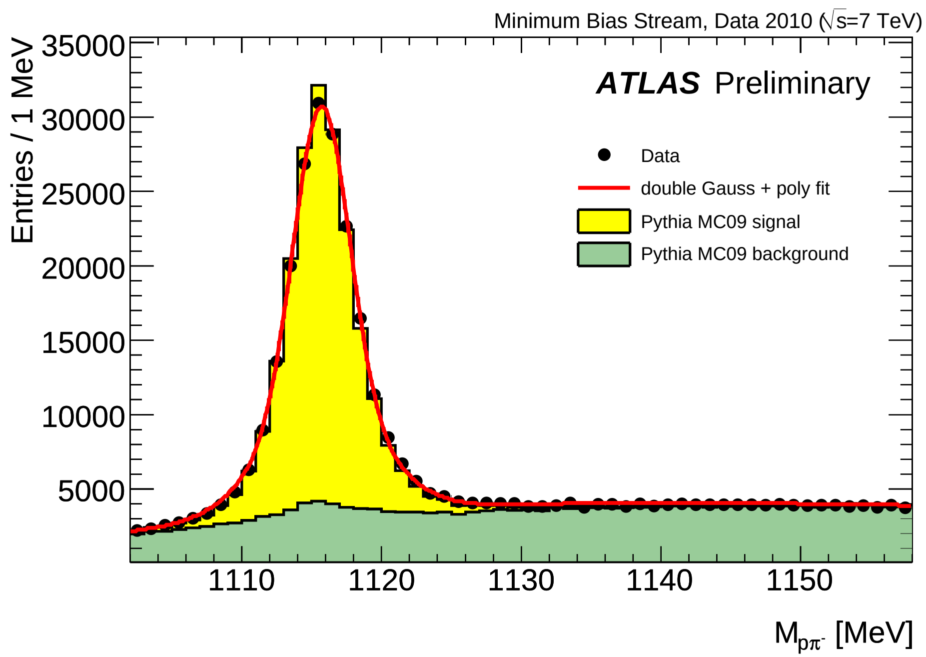
$r_{kaon} \equiv \frac{f_{kaon}}{f_{pion}+f_{proton}} > 1.2$ **for each track**

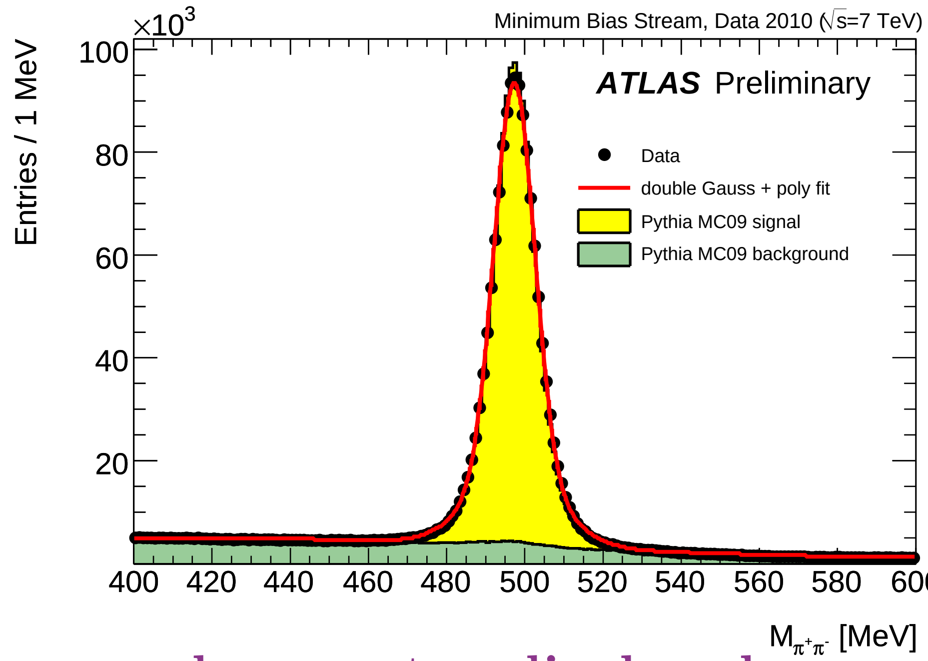
MC signal and background separately normalised to data

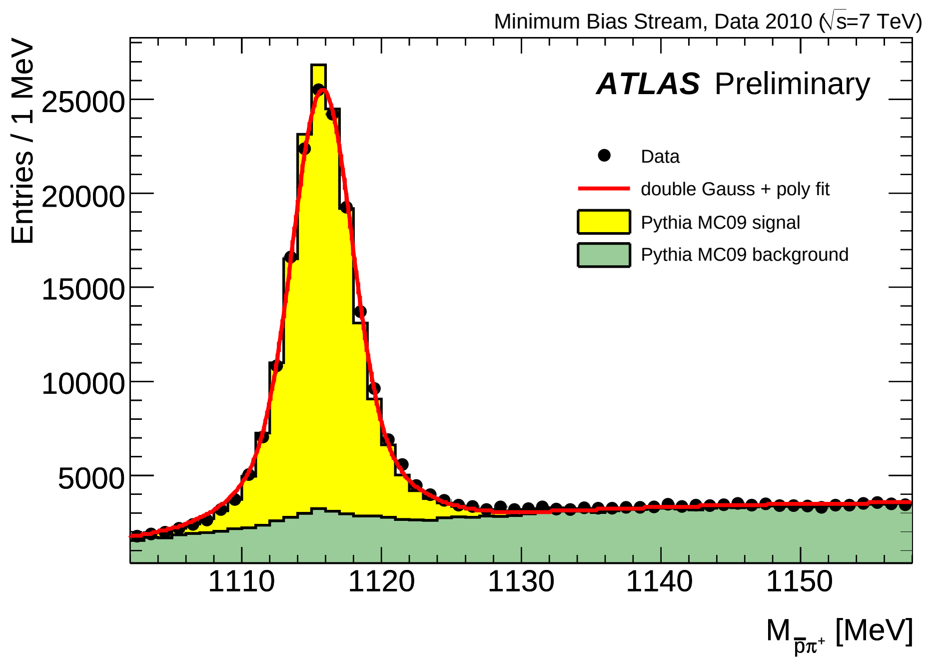
Fitted mass and experimental resolution agree with those from MC

Fitted mass ($1019.5 \pm 0.3\,$MeV) in excellent agreement with PDG($1019.46\,$MeV)

$K^0_S \to \pi^+\pi^-$ and $\Lambda^0 \to p\pi^-$ (+ c.c.) at 7 TeV $\mathcal{L}_{int} \sim 190\mu\mathbf{b}^{-1}$







secondary vertex displaced from primary vertex

K^0_S : $L_{XY} > 0.4\,\mathbf{cm}$, $\cos\theta > 0.999$

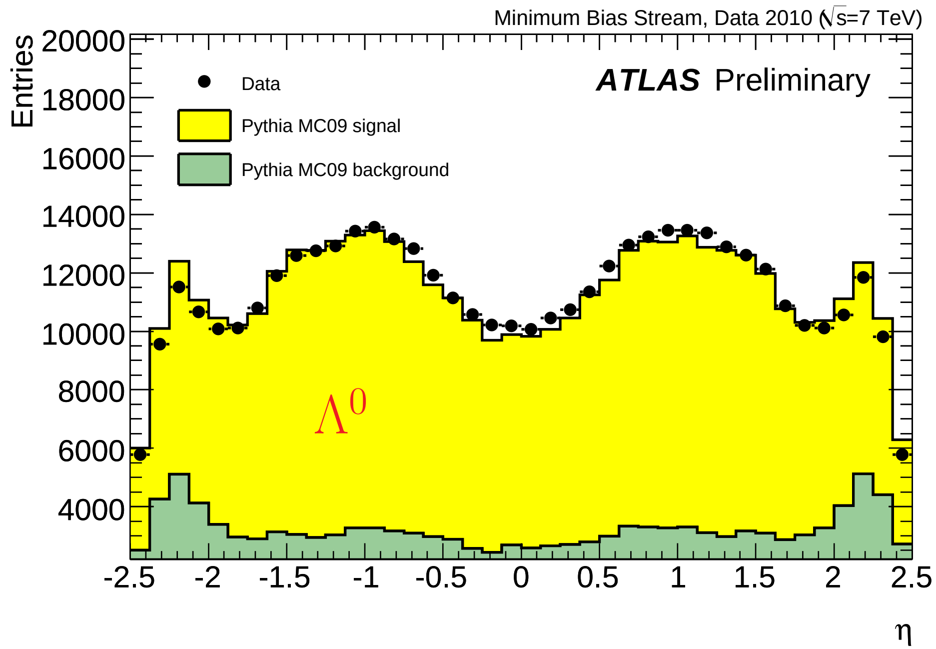
$\Lambda^0/\bar{\Lambda}^0$: $L_{XY} > 3\,\mathbf{cm}$, $\cos\theta > 0.9998$

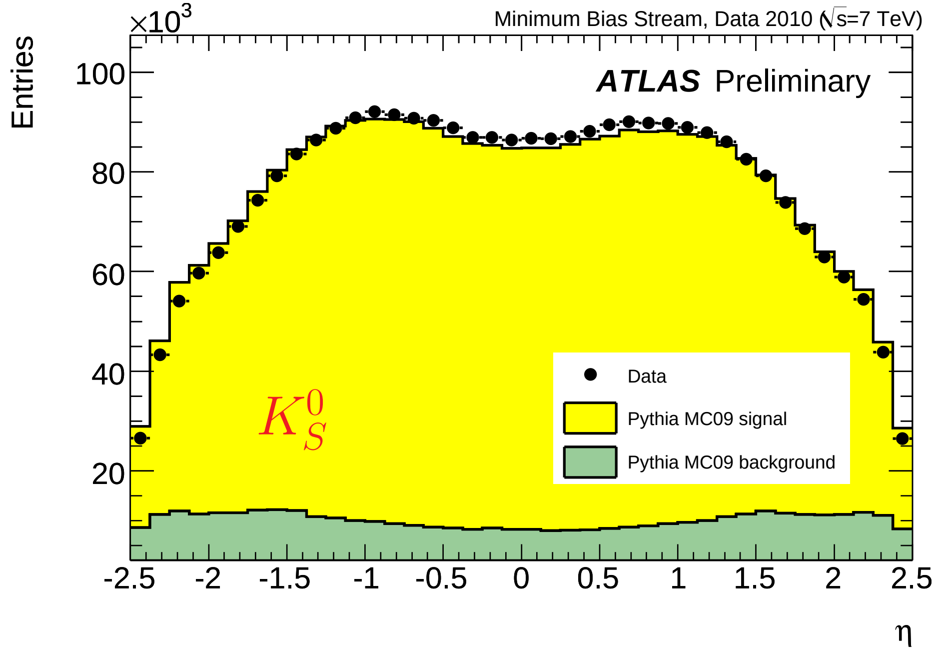
(θ **is** $\angle$ **between** $\vec{p}_{XY}(K^0_S/\Lambda^0/\bar{\Lambda}^0)$ **and** $\vec{s}_{XY}(PV - SV)$)

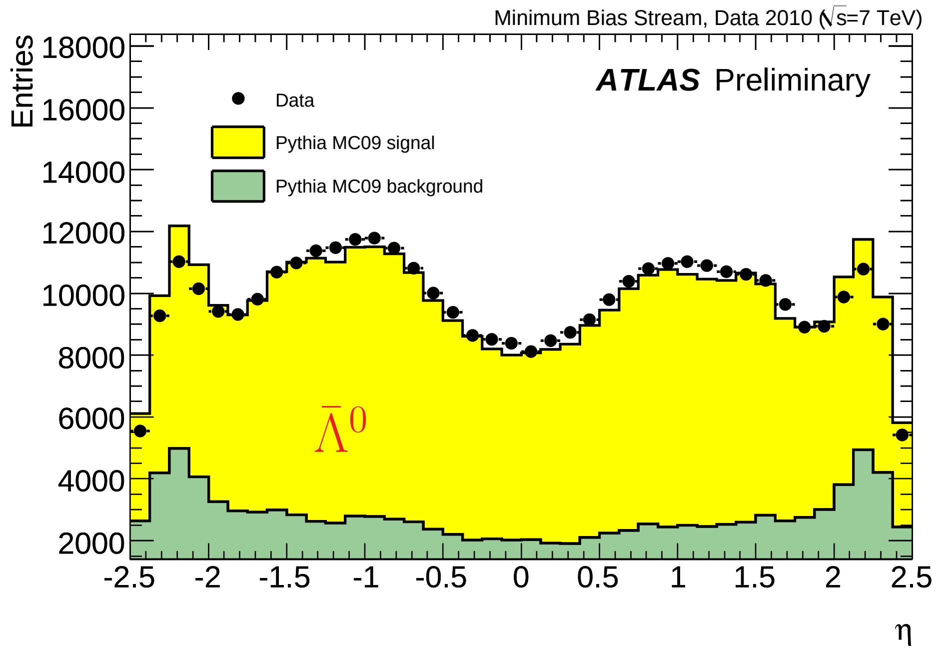
MC signal and background separately normalised to data

Fitted masses and widths consistent with MC and PDG mass values

η spectra for $K_S^0 \to \pi^+\pi^-$ and $\Lambda^0 \to p\pi^-$ (+ c.c.) candidates







Candidates:

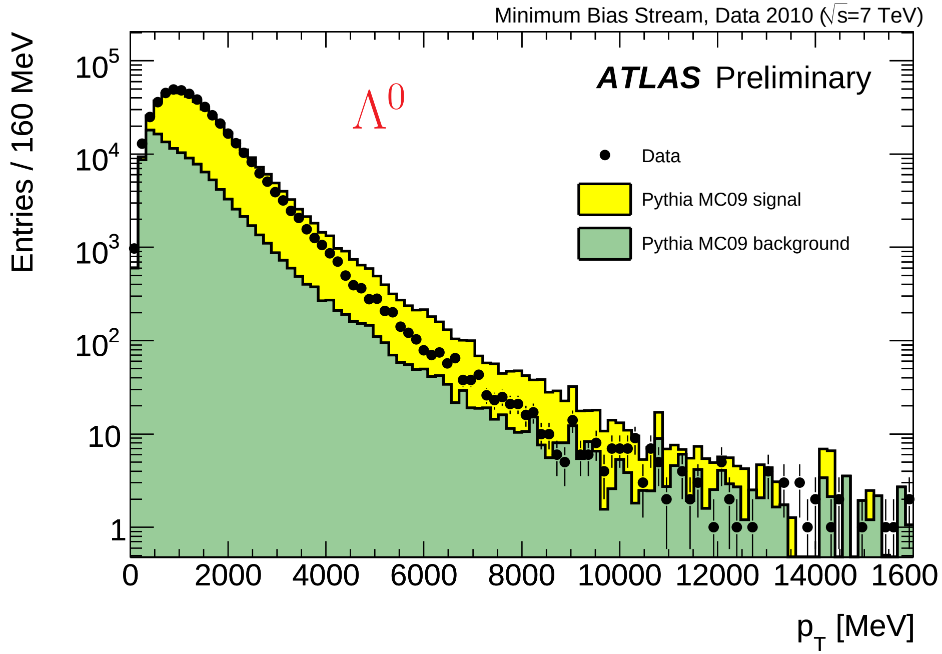
$|M_{\pi^+\pi^-} - M(K_S^0)_{\text{PDG}}| < 20\,\textbf{MeV}$

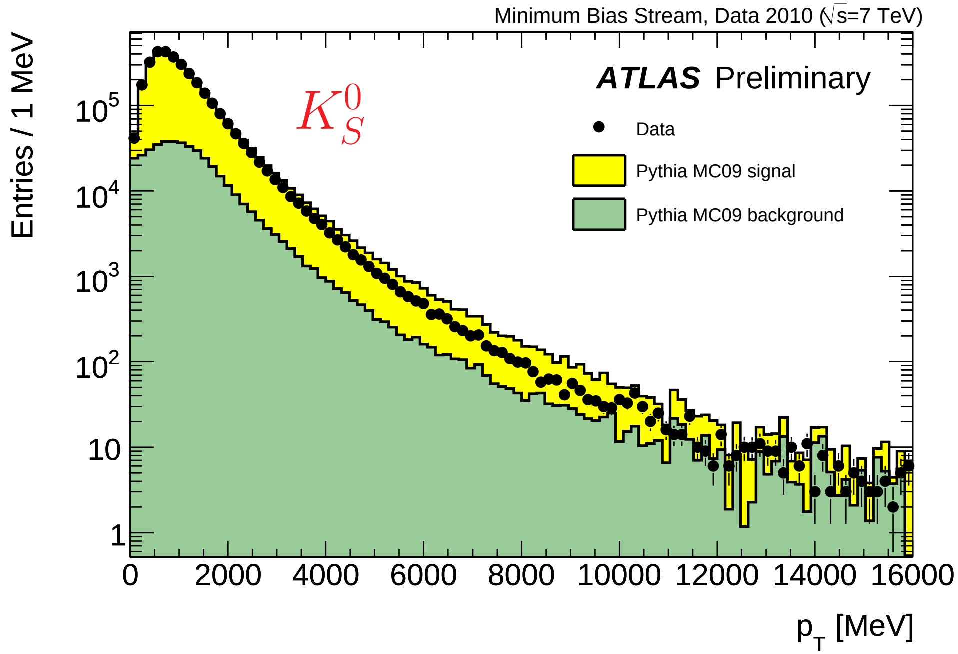
$|M_{p\pi^-/\bar{p}\pi^+} - M(\Lambda^0)_{\text{PDG}}| < 7\,\textbf{MeV}$

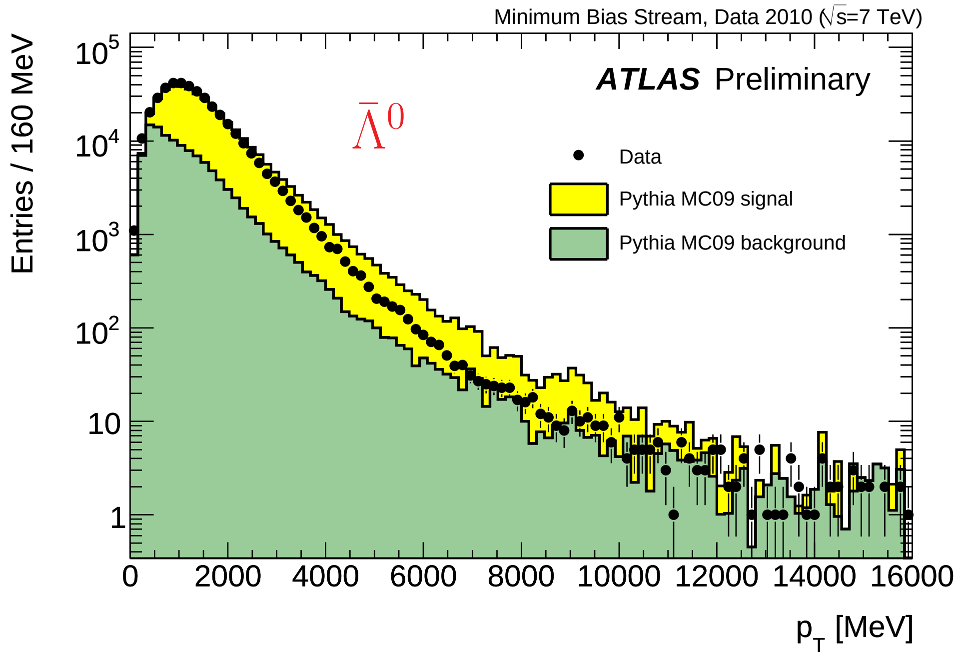
MC consistent with data within 10%

no corrections for detector effects yet

p_T spectra for $K^0_S \to \pi^+\pi^-$ and $\Lambda^0 \to p\pi^-$ (+ c.c.) candidates







Candidates:

$|M_{\pi^+\pi^-} - M(K^0_S)_{\mathrm{PDG}}| < 20\,\mathbf{MeV}$

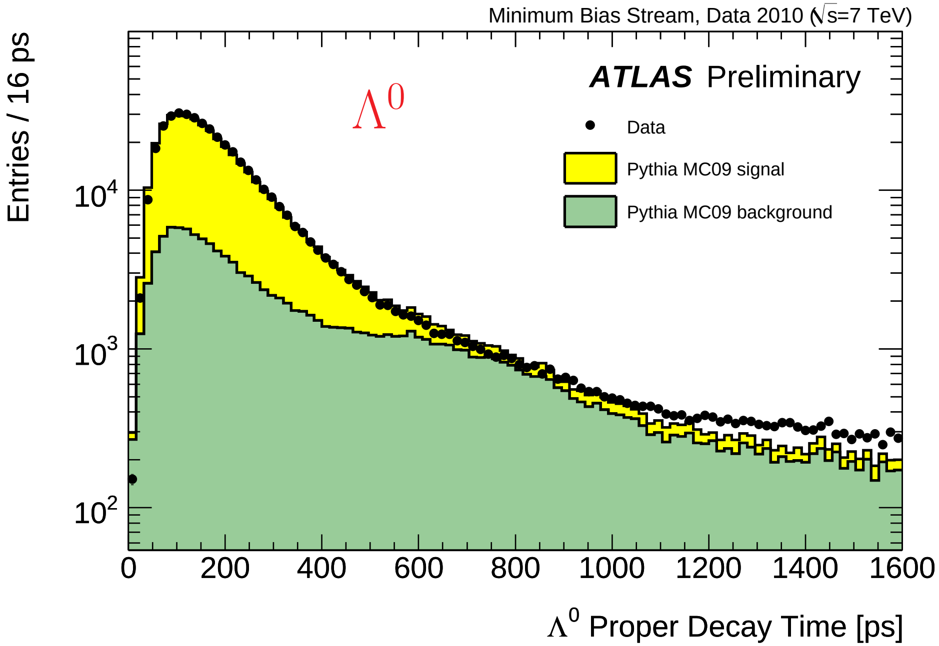
$|M_{p\pi^-/\bar{p}\pi^+} - M(\Lambda^0)_{\mathrm{PDG}}| < 7\,\mathbf{MeV}$

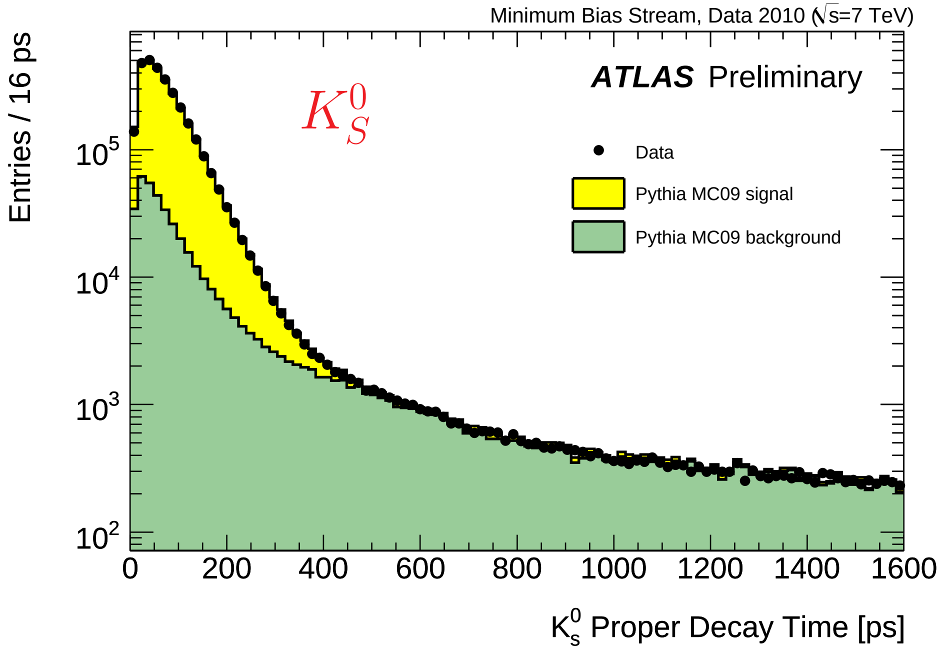
MC is harder in p_T

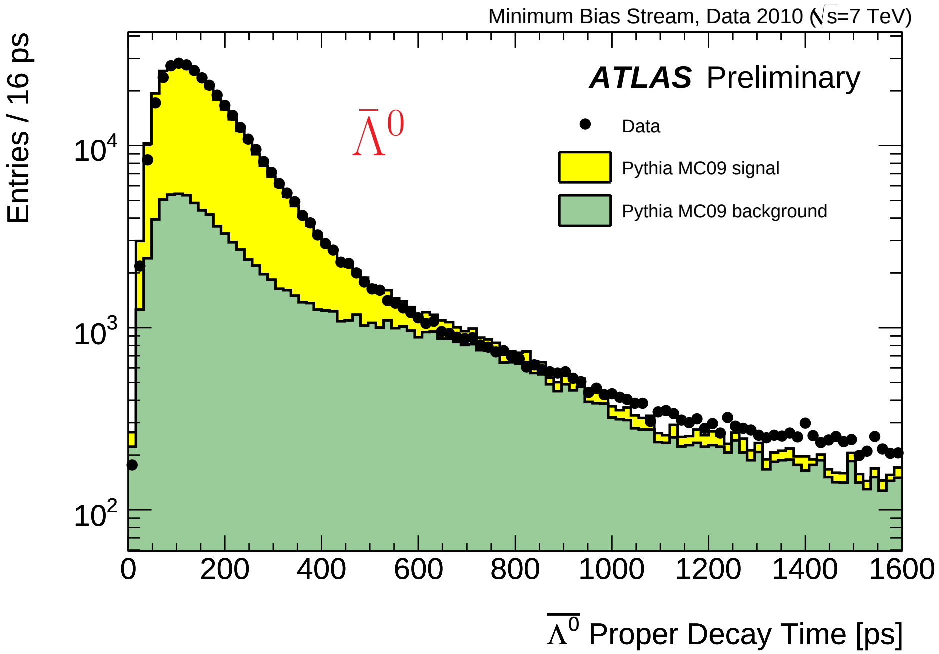
discrepancy is smaller for K^0_S

no corrections for detector effects yet

Proper decay time for K_S^0, Λ^0 and $\bar{\Lambda}^0$ candidates







Candidates:

$|M_{\pi^+\pi^-} - M(K_S^0)_{\mathrm{PDG}}| < 20\,\mathbf{MeV}$

$|M_{p\pi^-/\bar{p}\pi^+} - M(\Lambda^0)_{\mathrm{PDG}}| < 7\,\mathbf{MeV}$

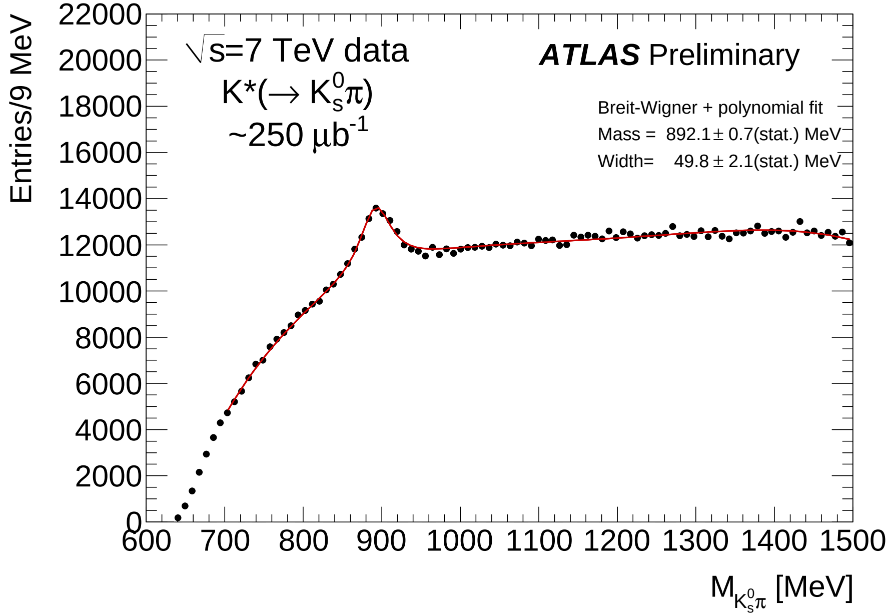
MC is in good agreement for K_S^0

agreement is worse for $\Lambda^0/\bar{\Lambda}^0$

in the background-dominated region

no corrections for detector effects yet

$K^{*+} \to K^0_s \pi^+$, $\Xi^- \to \Lambda^0 \pi^-$ and $\Omega^- \to \Lambda^0 K^-$ (+ c.c.) at 7 TeV



cascades: secondary and tertiary vertexes displaced from primary vertex

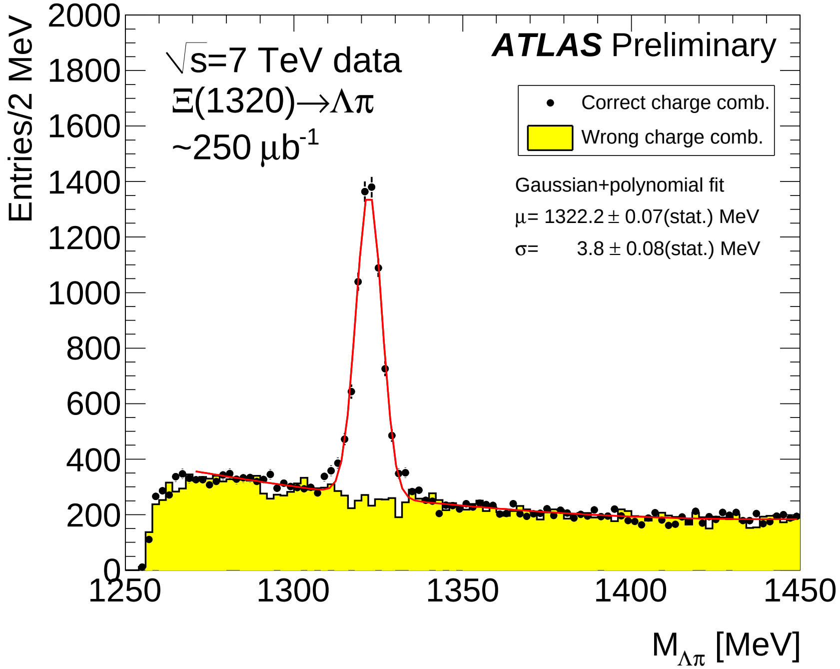
$K^{*\pm}$: $L_{XY} < 0.8$ **cm**, $p_T(K^{*\pm}) > 1.5$ **GeV**

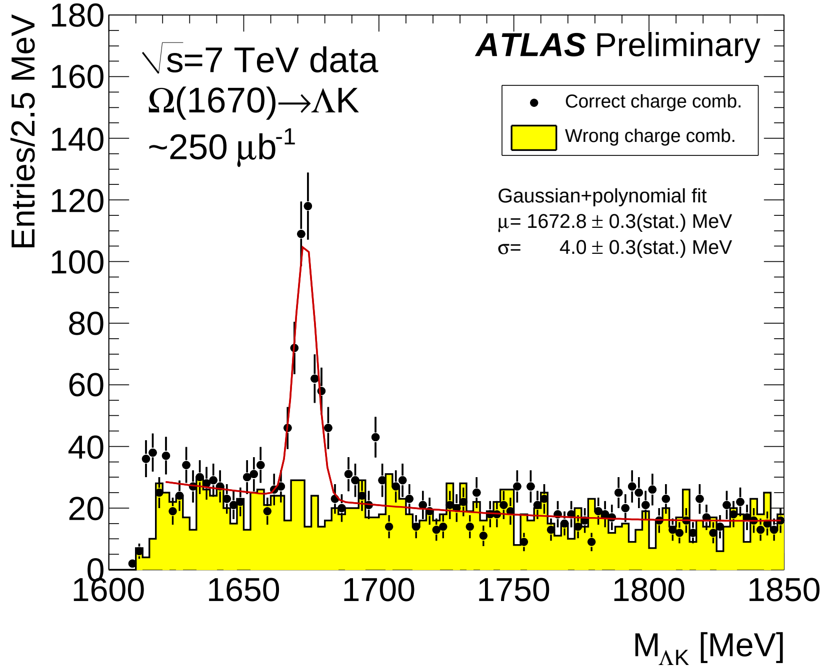
$\Xi^{\mp}$: $L_{XY} > 0.4$ **cm**

$\Omega^{\mp}$: $L_{XY} > 0.6$ **cm**, $p_T(\Omega^{\mp}) > 1.5$ **GeV**

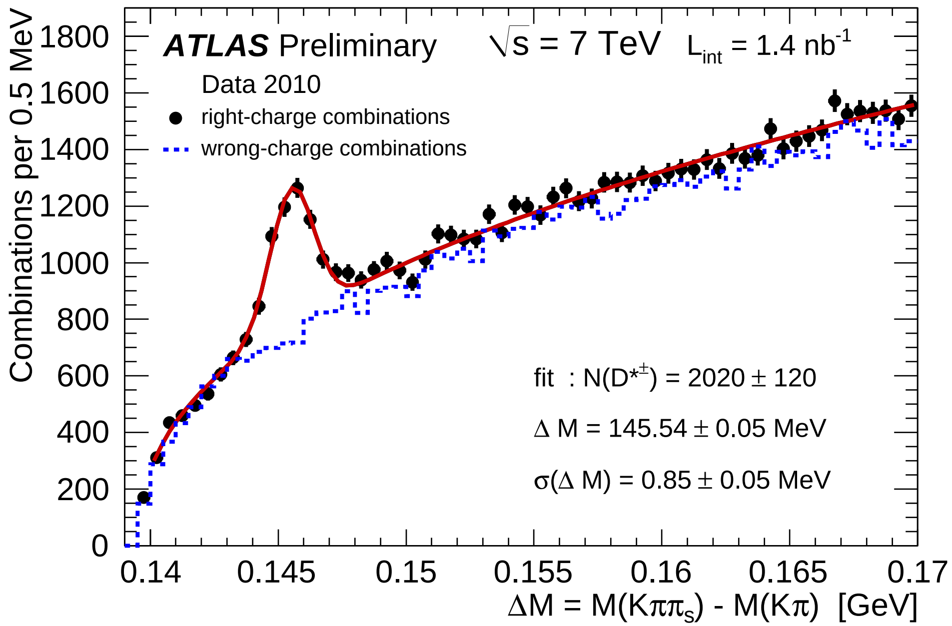
wrong charges for $\Xi^{\mp}$ and $\Omega^{\mp}$ describe backgr.

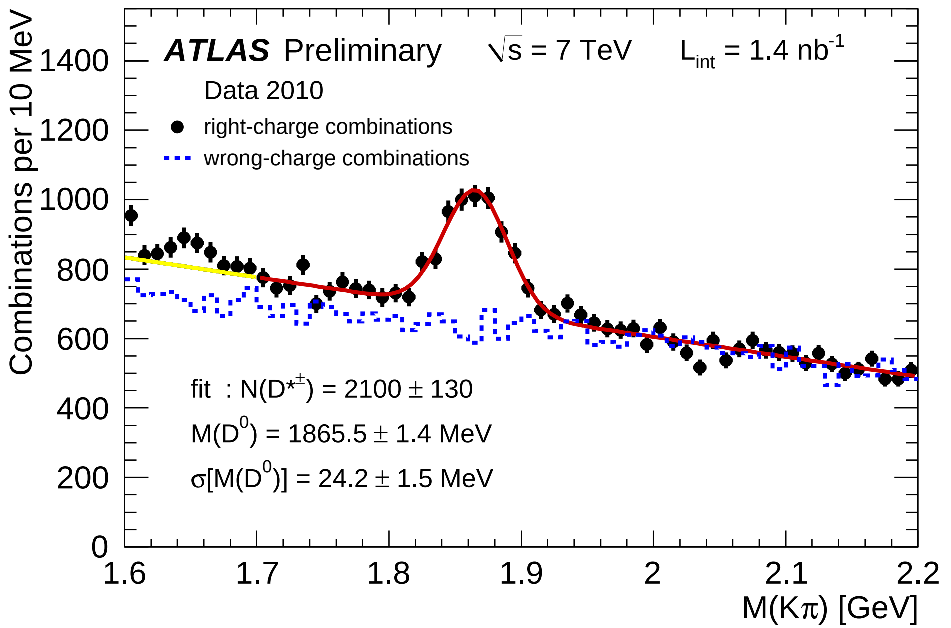
Fitted masses and $K^{*\pm}$ natural width agree with PDG values





$D^{*+} \rightarrow D^0 \pi_s^+ \rightarrow (K^- \pi^+) \pi_s^+$ (+ c.c.) reconstruction





Kinematic range:

$p_T(D^{*\pm}) > 3.5\,\mathbf{GeV},\ |\eta(D^{*\pm})| < 2.1$

$p_T(D^{*\pm})/\sum E_T > 0.02 \quad \Longleftarrow$ **hard fragmentation**

$L_{XY}(D^0) > 0 \quad \Longleftarrow c\tau(D^0) = 123\,\mu\mathrm{m}$

$p_T(K,\pi) > 1\,\mathbf{GeV},\ p_T(\pi_s) > 0.25\,\mathbf{GeV}$

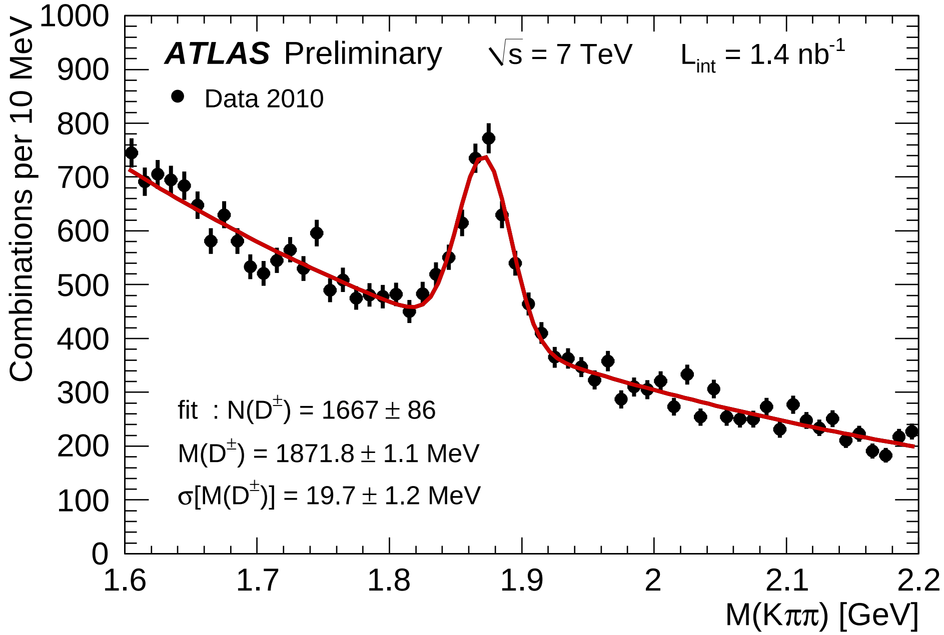
$\Longleftarrow 1.83 < M(K\pi) < 1.90\,\mathbf{GeV}$

Wrong-charge combinations: $(K^+\pi^+)\pi_s^-$ **(+ c.c.)**

$\Longleftarrow 144 < M(K\pi\pi) - M(K\pi) < 147\,\mathbf{MeV}$

Fitted masses and widths consistent with MC and PDG mass values

$D^+ \rightarrow K^- \pi^+ \pi^+$ reconstruction



Kinematic range:

$p_T(D^\pm) > 3.5\,\textbf{GeV},\ |\eta(D^\pm)| < 2.1$

$p_T(D^\pm)/\sum E_T > 0.02 \quad \Longleftarrow$ **hard fragmentation**

$L_{XY}(D^\pm) > 1.3\,\textbf{cm} \quad \Longleftarrow c\tau(D^+) = 312\,\mu\text{m}$

$p_T(K) > 1\,\textbf{GeV}$

$p_T(\pi_{1,2}) > 0.8\,\textbf{GeV},\ p_T(\pi^{max}_{1,2}) > 1\,\textbf{GeV}$

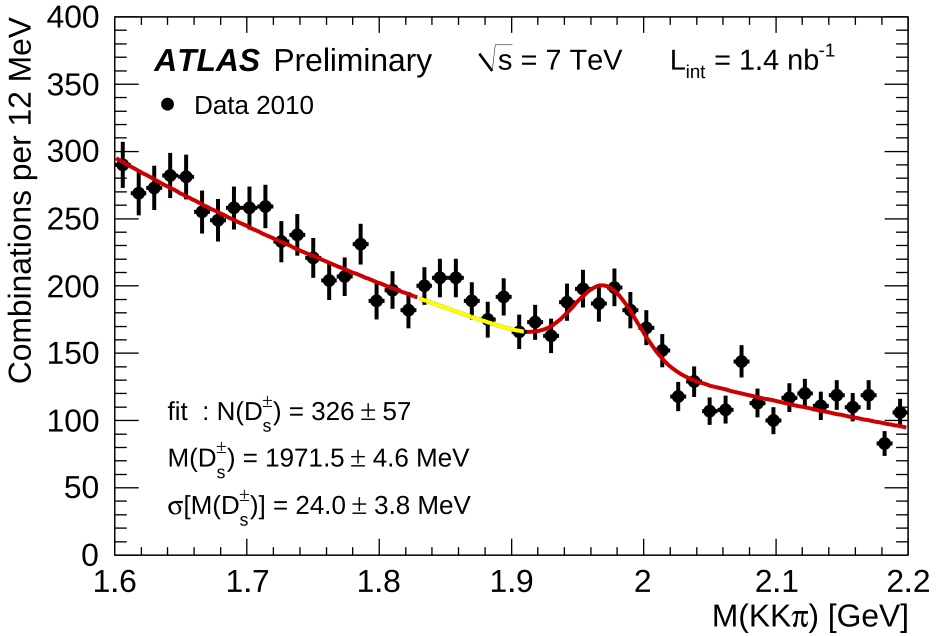
suppression of $D^{*\pm}$ **and** $D_s^+ \rightarrow \phi\,\pi^+ \rightarrow (K^-\,K^+)\,\pi^+$ **(+c.c.) reflections:**

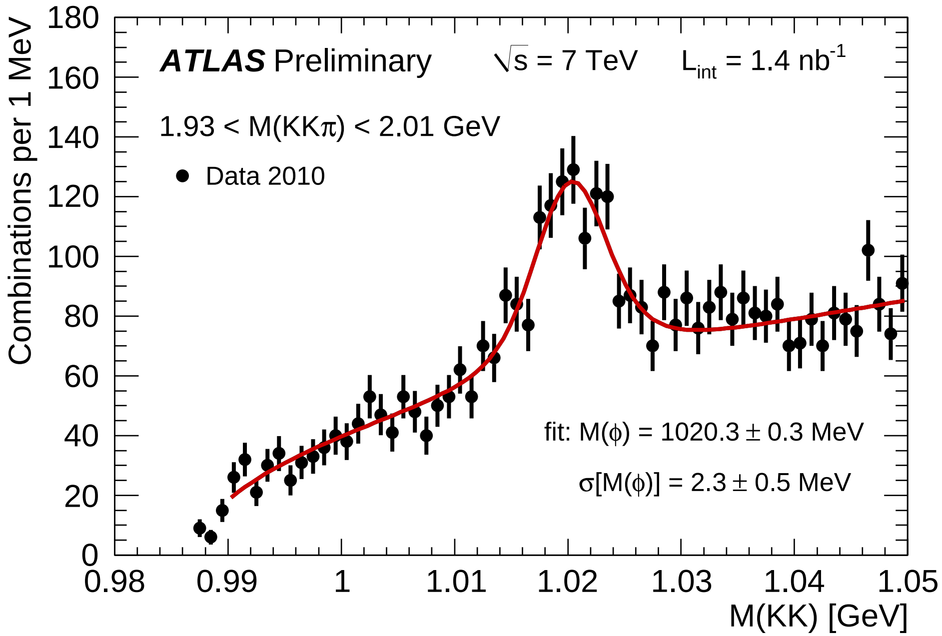
remove $\Delta M_{1,2} < 150\,\textbf{MeV}$ **and** $|M(K^\pm,\text{"}K^\mp\text{"}) - M(\phi)_{\text{PDG}}| < 8\,\textbf{MeV}$

$\cos\theta^*(K) > -0.8$ **(angle between** $\vec{p}(K)$ **in** $D^\pm$ **rest frame and** $\vec{p}(D^\pm)$ **in the lab)**

Fitted mass and width consistent
with MC and PDG mass value

$D_s^+ \rightarrow \phi\,\pi^+ \rightarrow (K^-\,K^+)\,\pi^+$ reconstruction





Kinematic range:

$p_T(D_s^\pm) > 3.5$ **GeV**, $|\eta(D_s^\pm)| < 2.1$

$p_T(D_s^\pm)/\sum E_T > 0.04$ $\Longleftarrow$ **hard fragmentation**

$L_{XY}(D_s^\pm) > 0.4$ **cm** $\Longleftarrow$ $c\tau(D_s^+) = 150\,\mu$m

$p_T(K_{1,2}) > 0.7$ **GeV**, $p_T(\pi) > 0.8$ **GeV**

$\Longleftarrow$ $|M(KK) - M(\phi)_{\mathrm{PDG}}| < 6$ **MeV**

$\cos\theta^*(\pi) < 0.4$
($\angle$ between $\vec{p}(\pi)$ in $D_s^\pm$ r.f. and $\vec{p}(D_s^\pm)$ in the lab)

$|\cos\theta'(K)|^3 > 0.2$
($\angle$ between $\vec{p}(K)$ and $\vec{p}(\pi)$ in K^+K^- r.f.)

$\Longleftarrow$ $1.83 < M(KK\pi) < 1.91$ **GeV**

Fitted masses and widths consistent with MC and PDG mass values

Summary & Outlook

Sizable samples of strange mesons and baryons (up-to $\Omega^- \equiv sss$)
and charmed mesons
have been identified with very first ATLAS data

$K_s^0/\Lambda^0/\bar{\Lambda}^0$ reconstructed kinematic distributions are in reasonable agreement with the ATLAS MC09 PYTHIA tune

... and there is a room for agreement improvement
distributions and ratios corrected for detector effects soon

$D^{*\pm}$, $D^{\pm}$ and $D_s^{\pm}$ mesons have been reconstructed
in common kinematic range $p_T > 3.5\,\mathrm{GeV}$, $|\eta| < 2.1$

charm production cross sections soon

Fitted masses and widths of the strange and charmed resonances are in agreement with the MC and PDG values

dE/dx identification, secondary vertexing and cascade vertexing have been validated

High performance of the ATLAS tracking confirmed

Backup: Tracking Performance