$B_s(5366)$ studies in ATLAS

V.Nikolaenko   IHEP Protvino

Layout

- B_s properties
- B_s->J/ψ signal without lifetime cut
- Other ATLAS studies
- Conclusions

B_s

- m(B_s) = 5366.3±0.6 MeV;
- τ=1.472±0.026 psec;
- Even/Odd ΔΓ/Γ=0.092±0.030;
- BR ratios:
- → D_s^- — anything (93 ± 25) %
- → $D_{s1}(2536)^-$BR(D(2536)→D(2536)->$D^{*-}K^0$)   (0.24 ± 0.07) %
- → D_s^- lν anything   7.0   ± 2.4 %
- → $D_s^- \pi^+$ 0.32 ± 0.05
- → $D_s^-(\pi^+\pi^+\pi^-)$ 0.84 ± 0.33
- → $D_s^{-+} K^{++}$ 0.030 ± 0.007
- → $D_s^+ D_s^-$ 1.04   ± 0.35
- → $D_s^{*+} D^{*-}$ 4.0   ± 1.5

B$_s$ cont.

- →J/ψ φ   0.13   ± 0.04 %
- →ψ(2s)φ   0.068   ± 0.027 %
- →φφ   0.0014 ± 0.0008 %
- →π$^+$K$^-$ 0.00049± 0.00010%
- →K$^+$K$^-$ 0.0033 ± 0.0009 %
- →φY   0.0057 ± 0.0022 %
- The last CDF results: see hep-ex 1011.2506 Nov 2010
- LUMI 5.0 1/fb
- → 6 000 B$_s$->J/ψφ events

B$_s$(5366) without lifetime cut

- Used almost full data sample in Muons (or MuonsWithBeam) stream aquired in 2010

-B$_s$(5366) is registered in (J/ψ φ) mode, with J/ψ->μ$^+$μ$^-$ and φ->K$^+$K$^-$ (without kaon identification)

ATLAS Data

- Used D3PD produced by SM group (stream Muons or Muons_with_beam), full dataset starting from period D6; excluded runs 166925, 166094, 167963

- Requested primary vertex (at least 3 tracks)

- Requested two Staco muons of opposite sigh, with >0 hits in Pixel and >5 hits in SCT,

- Cosmics suppression: requested impact parameters for muons |d0_wrtPrv|<2.0 and |Z0_wrtPrv*sin(θ)|<2.0 mm;

- Requested at least one Staco Muon with Pt>5.0 GeV;

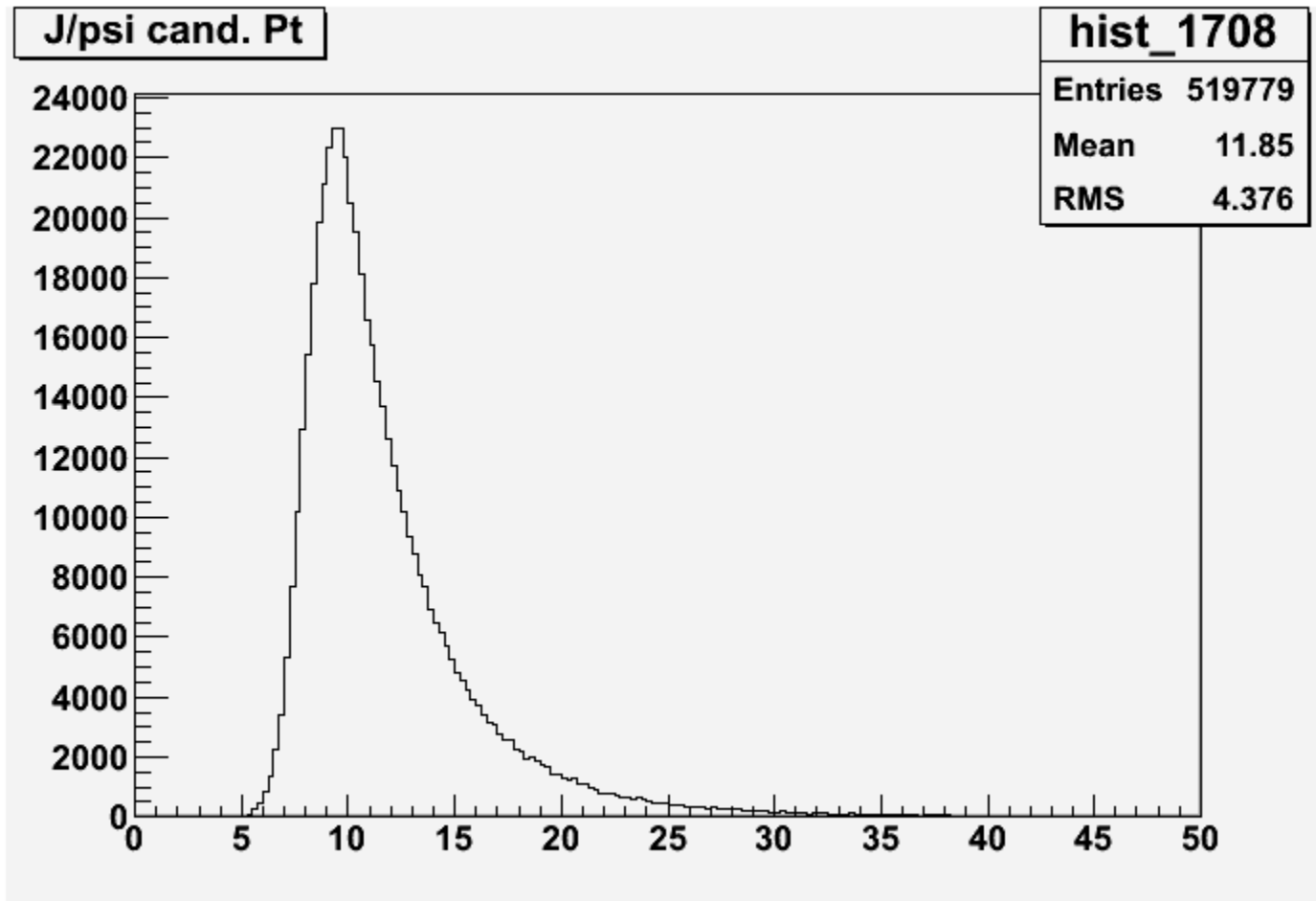# Charged tracks selection

- Requested loose cuts on impact parameters with respect to reconstructed primary vertex: |d0_wrtPV|<2.0 and |Z0_wrtPV sin(θ)|<2.0;

- Excluded muons (if both ϕ and θ angles of track are within one degree interval from muon angles)

- Tracks are taken with kaon mass

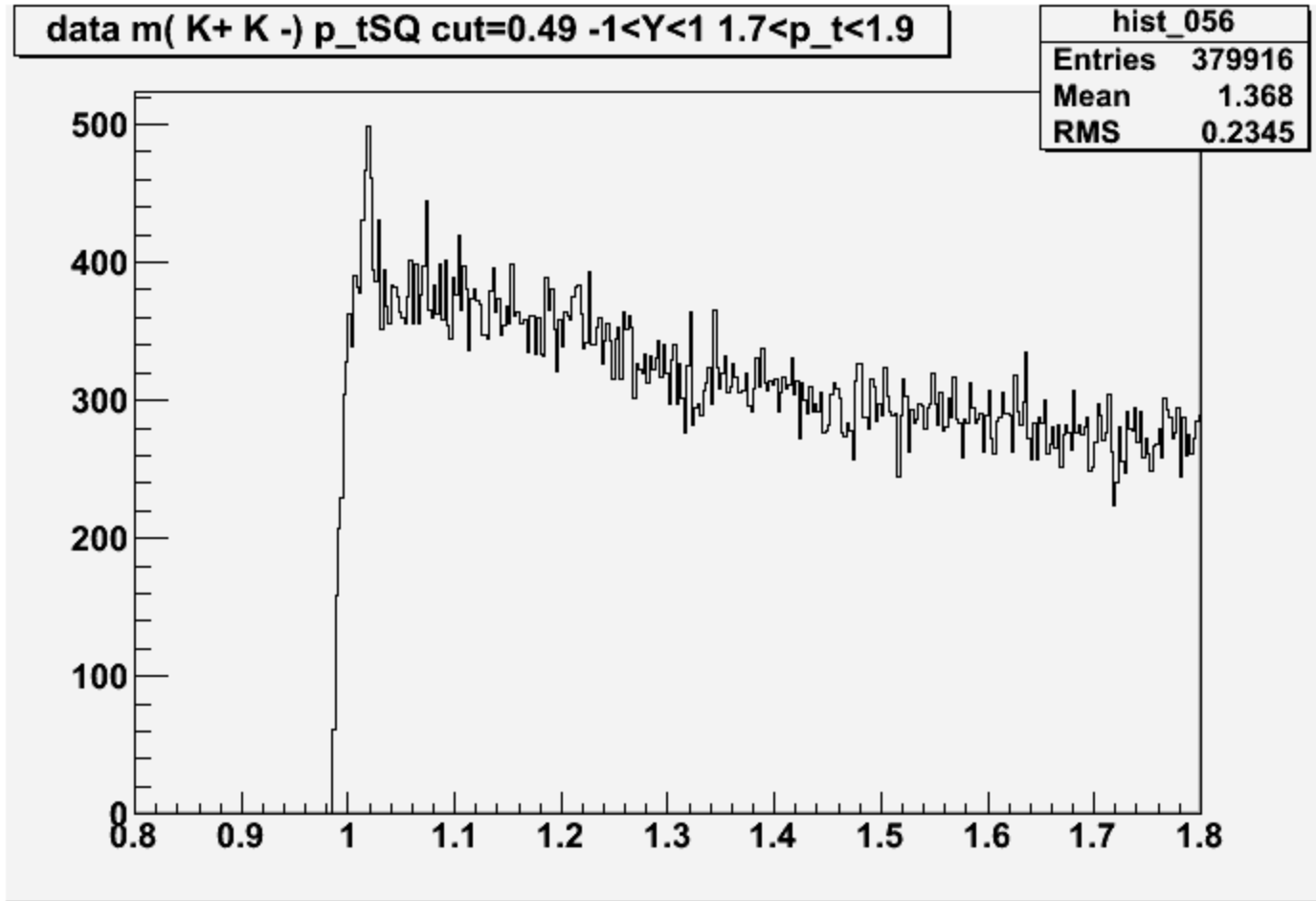- The ϕ-meson signal region chosen as 1.011<m($K^+ K^-$)<1.025 GeV

J/ψ signal
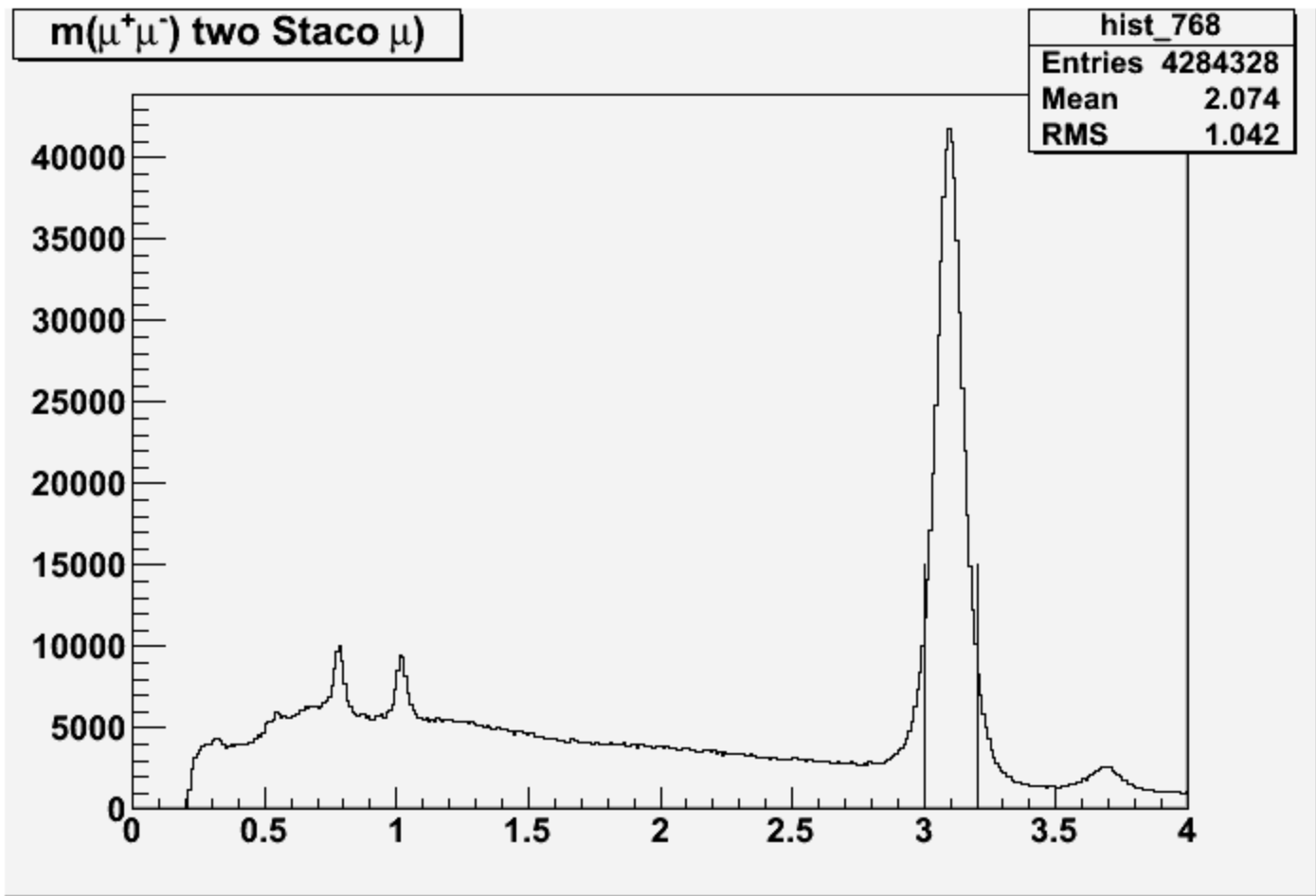
Pt of J/ψ

φ(1020) signal at high Pt

This signal from MinBias run 152345 at 1.7<Pt<1.9 GeV – shown for illustration

Selection requirements

-3.0< m(mu+mu-)<3.2 GeV (J/ψ selection) at |Y| < 0.75 ,

-2.95 < m < 3.25 at 0.75 < |Y|<1.50 ;

-2.90 < m < 3.30 at 1.50 < |Y| < 2.00;

-2.85 < m < 3.35 at 2.00 < |Y| < 2.40;

- Combinations of charged track pairs of opposite sign taken, with kaon mass, 1.011 <m(K+K-) < 1.025 GeV (ϕ- selection);

- No kaon identification requested;

- Taken J/ψ and ϕ longitudinal momenta projections to the B_s direction, then calculated the difference/sum ratio R=(p_l(J/ψ)-p_l(ϕ))/(p_l(J/ψ)+p_l(ϕ)); requested R<0.6 – i.e. this cut suppresses the low-pt track-combinations;

- - there is a linear function of COS(angle) between B_s and J/ψ momentum vectors in the B_s rest frame;
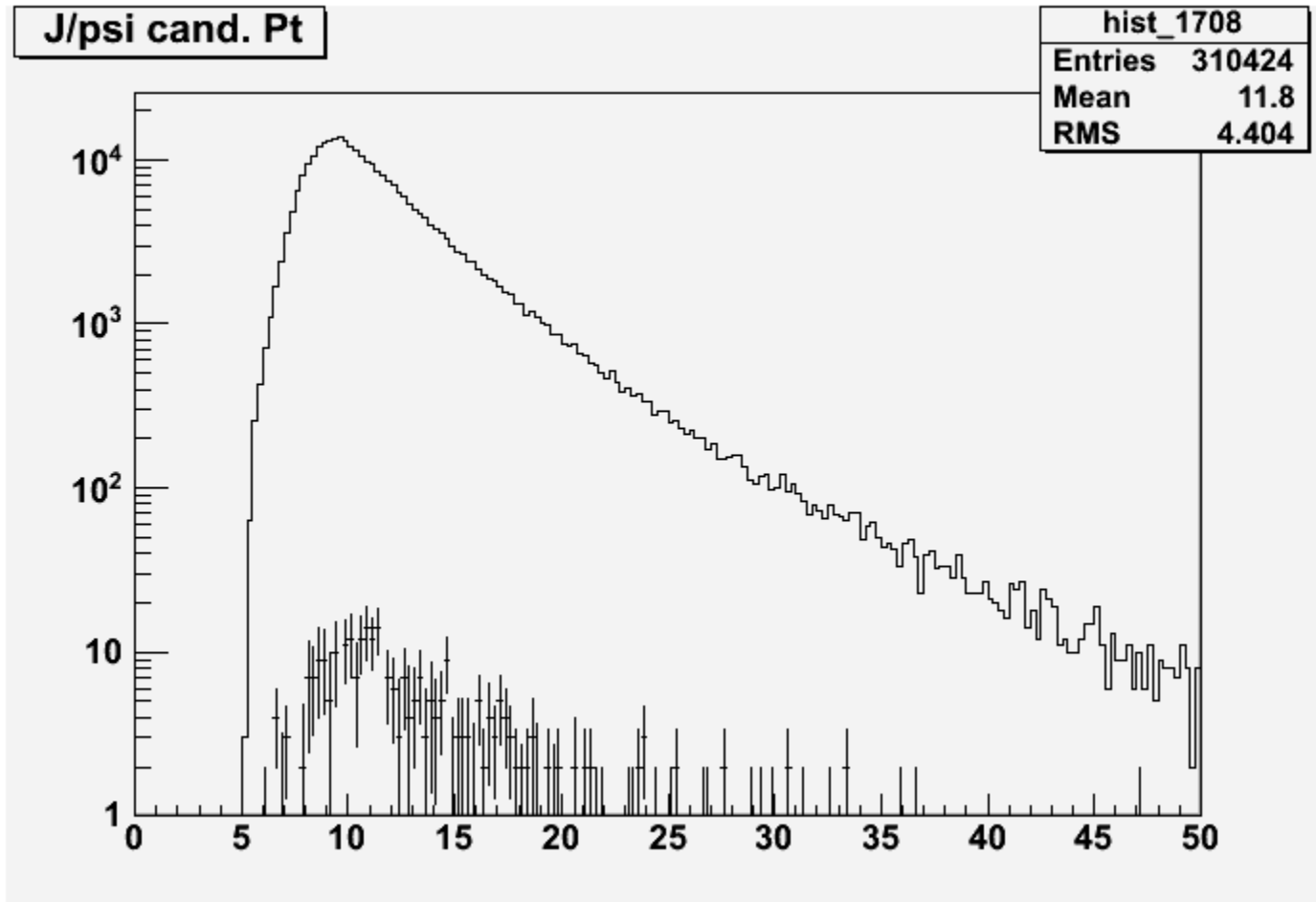
- No lifetime requirements;

# B$_s$ signal in m($\mu^+\mu^-K^+K^-$) - m($\mu^+\mu^-$) spectrum
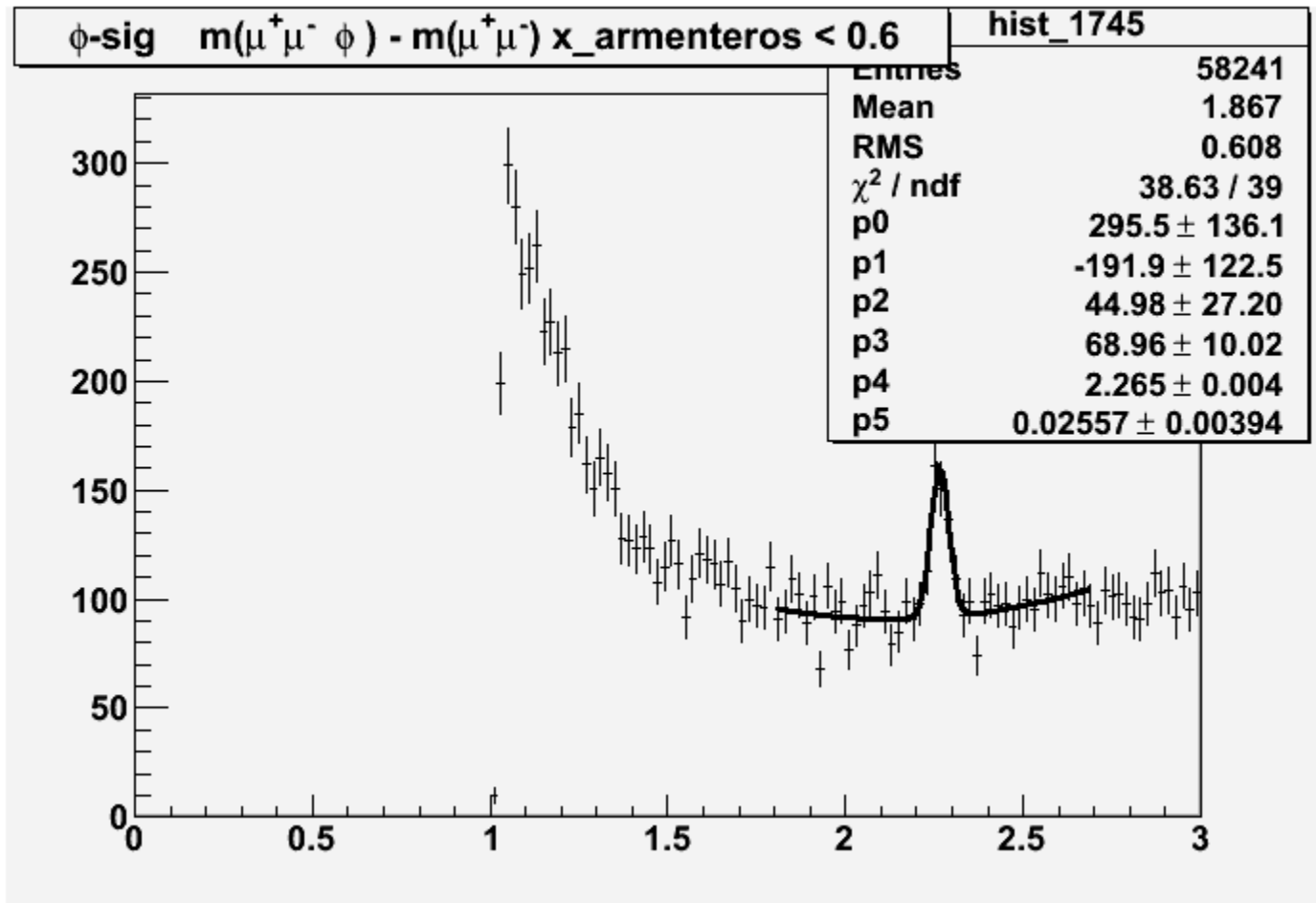
Fit result

- Fit by pol2(BG) + gaussian(signal)
- Signal norm.= 70.25 ± 10.69;
- Signal mean=   2.266± 0.004;
- Gaussian σ =   0.02557±0.00394;
- Expected mass diff. 5.366-3.097 = 2.269 GeV; observed signal max. is 3 MeV lower than expected – i.e. it is consistent with PDG;
- Number of events 215±33;

# Pt of B$_s$ (signal-BG, 60% stat.) compared with Pt of J/ψ

Pt of J/ψ off B$_s$ decay (signal-BG, 60% stat.) compared with total Pt of J/ψ
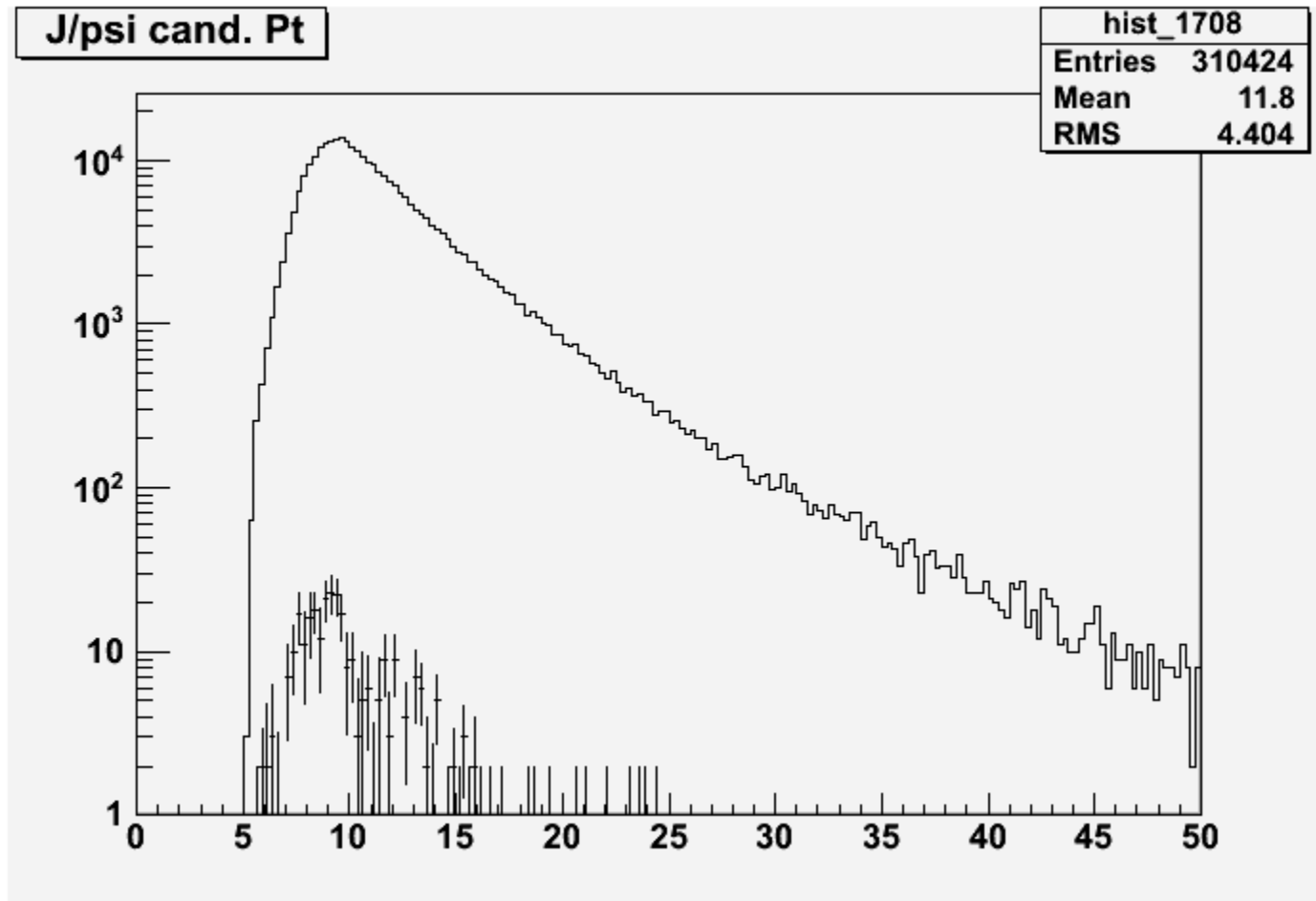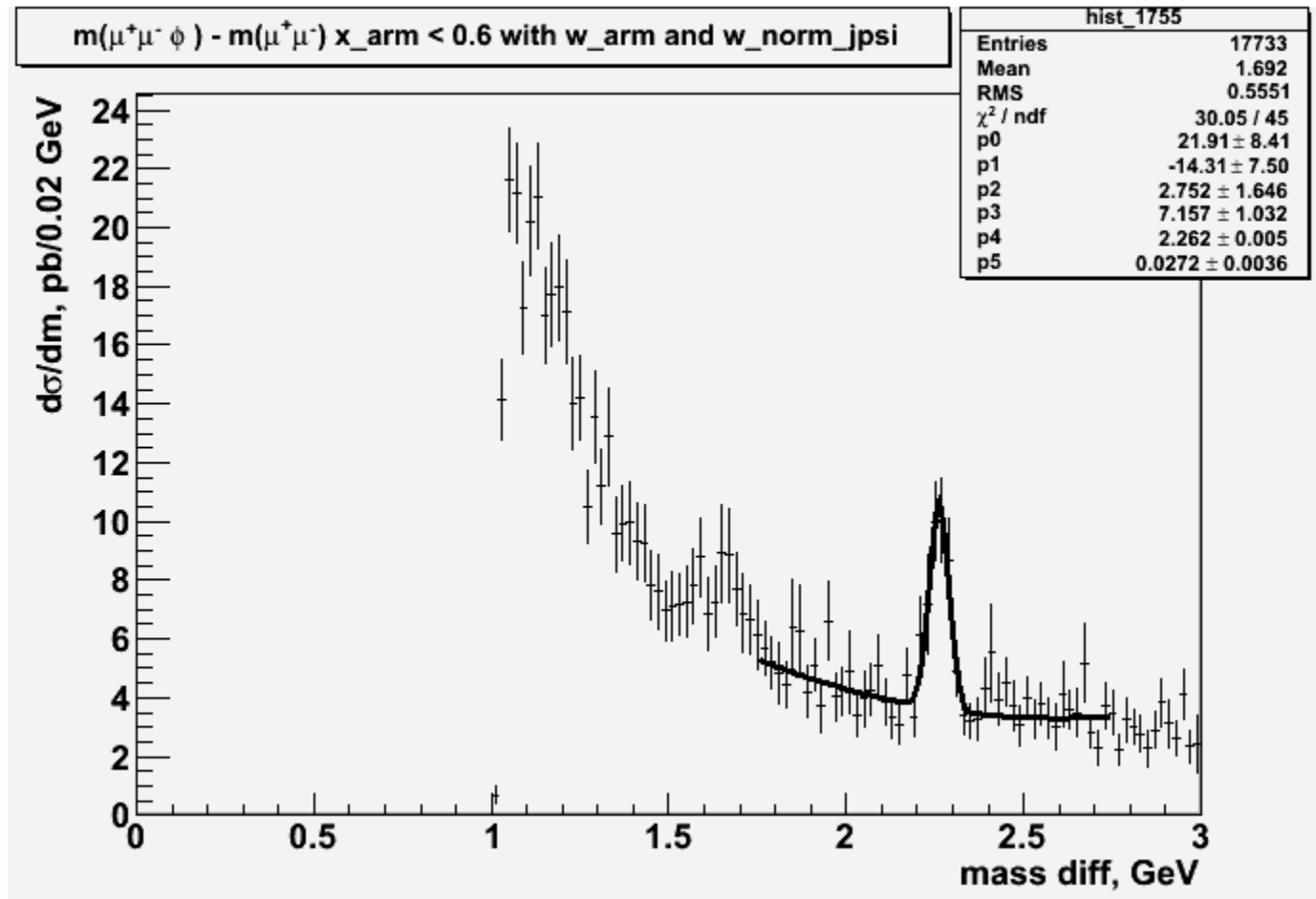
To cross section

- Estimation of B_s cross section at high Pt(B_s) seems to be possible; selected region at Pt>12 GeV and |Y|<2.0;

- Normalization can be done to J/ψ cross section which is measured in ATLAS (see ATL-COM-PHYS-2010-1035) and using number of J/ψ events with current selection requirements; for this purpose the |Y|-interval of J/ψ is subdivided in four bins (0.0:0.75:1.50:2.00:2.40) and each Pt interval is subdivided in 20 bins from 5.5 to 70 GeV;

- Number of J/ψ events in cells is determined from the fit of mass spectra;

- Cut of x-Armenteros is taken into account assuming flat distribution - i.e. S-wave only in B_s decay;

dσ/dt of J/ψ at 0.75<|Y|<1.50
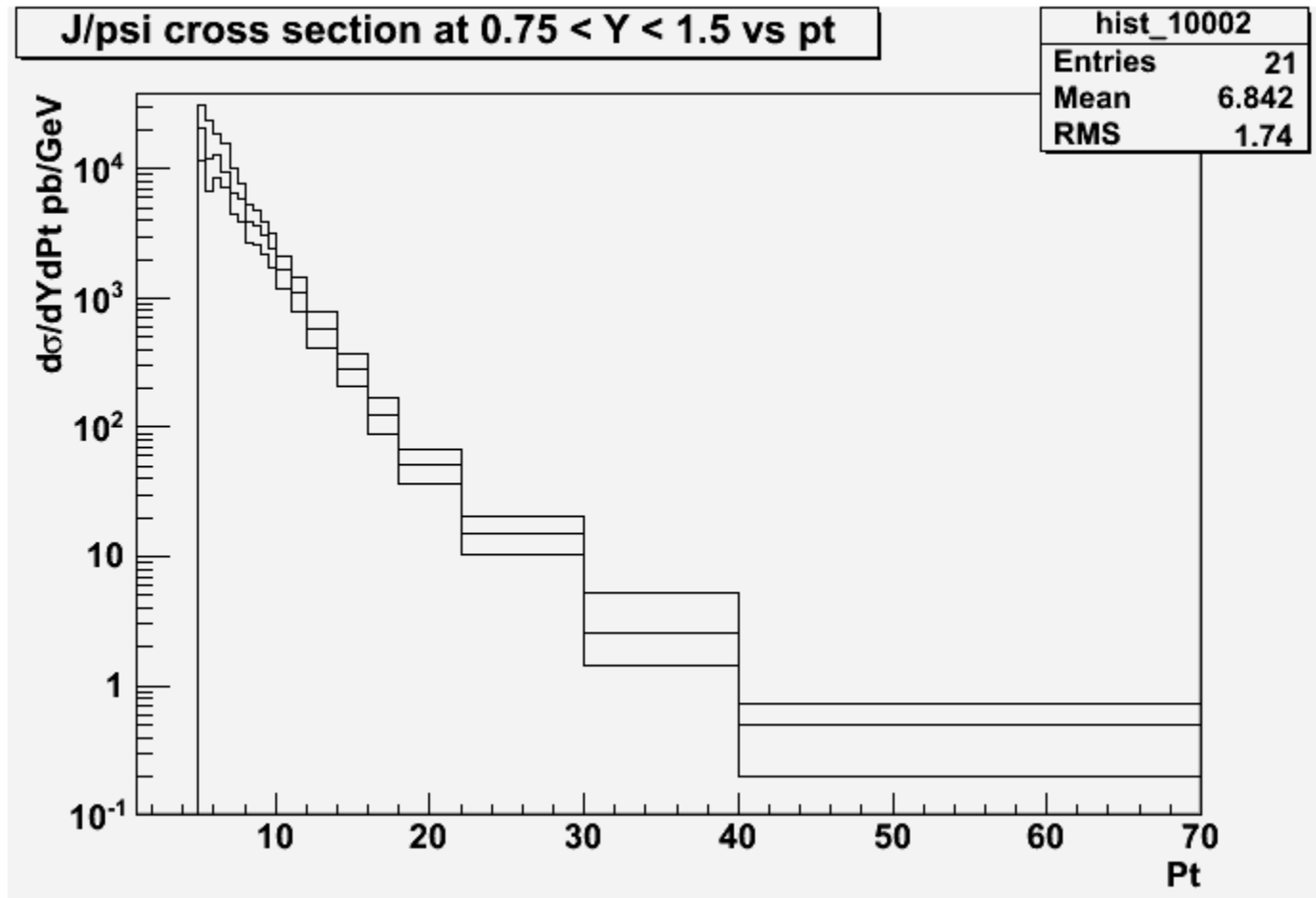
Shown central values and one-σ deviations with statistical, systematic and theory errors added in quadrature

Fit of weighted distribution

Very preliminary cross section

- At Pt(B_s) > 12 GeV and | Y(B_s) | < 2.0, the product $\sigma \cdot BR(B_s) \cdot BR(J/\psi) \cdot BR(\phi) \cdot \varepsilon(\phi) = 24 \pm 4(\text{stat}) \pm 8(\text{syst})$ picobarn;
- To do:
- Apply the recent update of J/ψ differential cross section measurements;
- Look for angular distributions and estimate contribution from P-wave in B_s->J/$\psi\phi$ decay;
- Estimate efficiency of ϕ detection and look for other possible inefficiencies;
- Look for possible optimisation of cuts.

Studies with vertex refit

- This is the main stream in B_s studies in ATLAS;
- Decay channel to (J/ψ φ) used;
- Combined muons used, Pt > 4 GeV;
- Apart from combined muons, also "tagged" muons used (with lower Pt);
- Vertex fit for combinations of muons with pairs of other charged tracks tried; satisfactory combinations written to Ntuples;
- A cut on kaon Pt is applied, say 1000 or 800 MeV;
- A model of "time of flight" for BG events is constructed; then fits tried, with a signal – single or double exponential plus BG;
- A lifetime cut may be applied;
- Fitted number of events is close to 300 - it is lower in comparison with CMS;
- Stability of B_s lifetime measurement is under investigation.

Conclusions

- B_s signal in (J/ψ ϕ) mode at high Pt without lifetime cut is observed

- Number of observed events N_{exp} = 215±33

- Observed signal is concentrated at Pt>10 GeV and Pt-spectrum of J/ψ from B_s decay is softer than the total J/ψ spectrum

- The first very preliminary estimation of B_s cross section at high Pt, Pt>12 GeV is obtained, with normalization to differential J/ψ cross section obtained by Onia group. More efforts needed for getting reliable result.