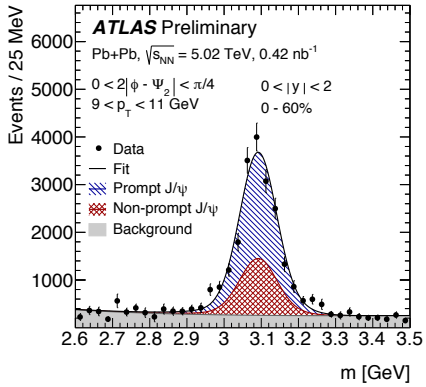
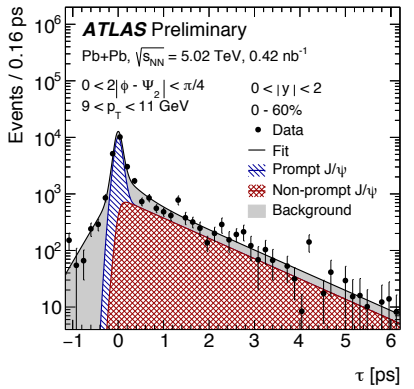
Prompt and Non-prompt J/ψ Elliptic Flow in Pb+Pb Collisions at 5.02 TeV with the ATLAS Detector

Jorge López for the ATLAS Collaboration

Universidad Técnica Federico Santa María, Valparaíso, Chile

The elliptic flow of prompt and non-prompt J/ψ was measured in Pb+Pb collisions at 5.02 TeV with an integrated luminosity of 0.42/nb with the ATLAS detector. The prompt and non-prompt signals are separated using a two-dimensional simultaneous fit of the invariant mass and pseudo-proper time in the dimuon decay channel. The measurement is performed in the kinematic range $9 < p_T < 30$ GeV, $|y| < 2$ and 0 - 60% collision centrality. Elliptic flow is evaluated with respect to the event plane. It is observed that prompt and non-prompt J/ψ mesons have non-zero elliptic flow. Prompt J/ψ v_2 decreases as a function of p_T, while non-prompt J/ψ v_2 appears to be essentially constant over the studied kinematical region. There is no observed dependence on rapidity or centrality.





Methods

J/ψ is studied in the dimuon decay channel. Muons are selected with $p_T > 4$ GeV and $|y| < 2.4$. Dimuon pairs are required to have opposite sign, pair $p_T > 9$ GeV, $|y| < 2$ and $2.6 < m < 3.5$ GeV. Prompt and non-prompt signals are separated using the pseudo-proper decay time.

Yields are extracted using a 2D fit to the invariant mass and pseudo-proper decay time distribution, corrected for acceptance and muon trigger and reconstruction efficiencies, using a Probability Distribution Function (PDF), where the terms are defined in the table below.

$$\mathrm{PDF}(m,\tau) = \sum_{i=1}^{5} N_i f_i(m) \cdot h_i(\tau) \otimes g(\tau)$$

The elliptic flow coefficient (v_2) is extracted from simultaneous chi-square fit to the prompt and non-prompt azimuthal distributions accounting the correlations between both yields.

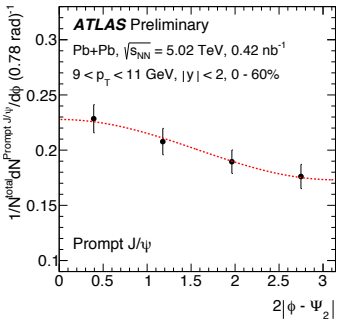
$$\chi^2(\boldsymbol{\theta}) = (\boldsymbol{y} - \boldsymbol{\mu}(\boldsymbol{\theta}))^T V^{-1} (\boldsymbol{y} - \boldsymbol{\mu}(\boldsymbol{\theta}))$$

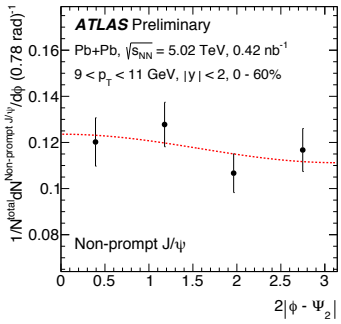
$$\frac{\mathrm{d}N}{\mathrm{d}\phi} = N_0(1 + 2v_2 \cos[2(\phi - \Psi_2)])$$

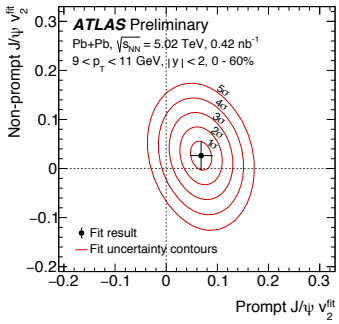
The fitted value of v_2^{fit} is correct to account for the event-plane resolution, $v_2 = v_2^{\mathrm{fit}}/R$ (see below).

i	Type	Source	$f_i(m)$	$h_i(\tau)$
1	Signal	Prompt	$\omega_i \mathrm{CB}_1(m) + (1-\omega_i)\mathrm{G}_1(m)$	$\delta(\tau)$
2	Signal	Non-prompt	$\omega_i \mathrm{CB}_1(m) + (1-\omega_i)\mathrm{G}_1(m)$	$\mathrm{E}_1(\tau)$
3	Background	Prompt	$\mathrm{E}_2(m)$	$\delta(\tau)$
4	Background	Non-prompt	$\mathrm{E}_3(m)$	$\mathrm{E}_4(\tau)$
5	Background	Non-prompt	$\mathrm{E}_5(m)$	$\mathrm{E}_6(\lvert\tau\rvert)$

Centrality	$\mathcal{R}$	$\langle N_{\mathrm{part}} \rangle$
0 − 20%	0.759 ± 0.011	311.4 ± 2.6
20 − 40%	0.871 ± 0.004	160.3 ± 2.7
40 − 60%	0.766 ± 0.006	70.5 ± 2.2
0 − 60%	0.794 ± 0.032	135.6 ± 2



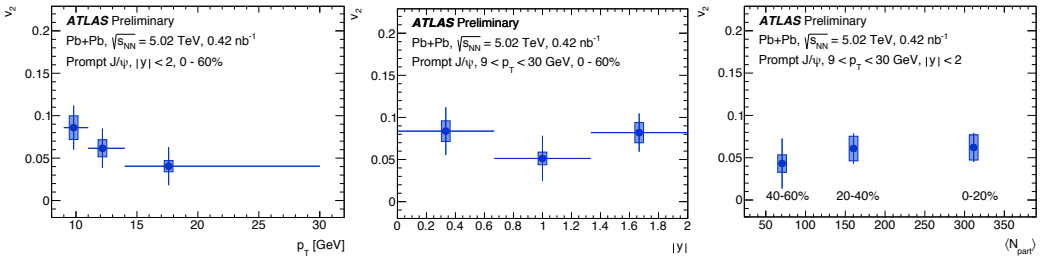


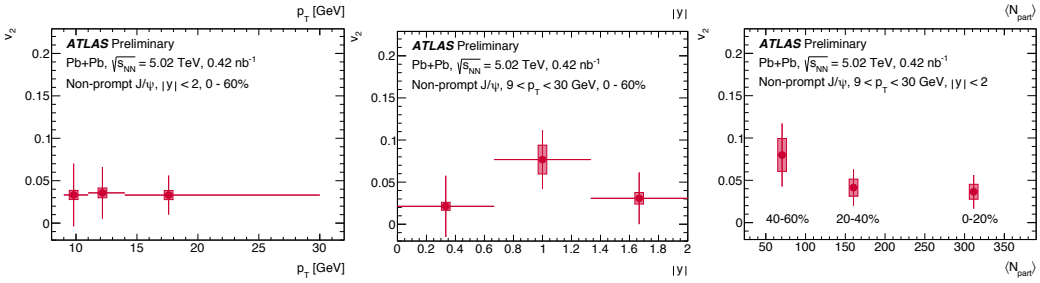


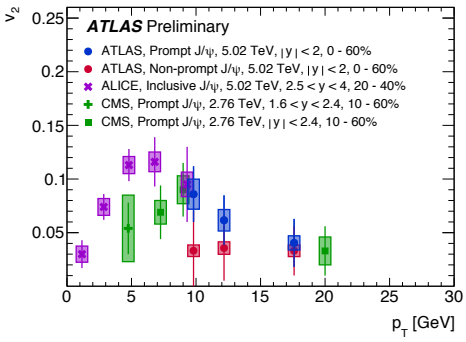
Results

A significant flow signal is observed for prompt J/ψ, which decreases with increasing p_T with a statistical significance of about 2σ. At high p_T both prompt and non-prompt J/ψ v_2 are the same within the uncertainties. This suggests a similar v_2 origin for both charm and bottom quarks at sufficient high p_T. Neither mode shows significant rapidity or centrality dependence. The presented measurement complements recent observations of a similar suppression pattern for both prompt and non-prompt J/ψ as a function of centrality and different p_T behavior measured by ATLAS [1].

[1] *(To appear online).*







The ATLAS Detector

The ATLAS experiment at the LHC is a multi-purpose particle detector with a forward-backward symmetric cylindrical geometry and has nearly full coverage in solid angle. It consists of an inner tracking detector surrounded by a thin superconducting solenoid, electromagnetic and hadronic calorimeters, and a muon spectrometer incorporating three large superconducting toroid magnets.