Non-Prompt J/psi Analysis

PbPb @ 5.02 TeV

Himanshu Sharma

Apr 14th, 2020

IFJ - ALICE Meetings

Activites:

- **Status of ReducedTree Production for LHC18q period**

- **Progress on Fitting for Non-prompt Fraction**

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Reduced trees for LHC18q

Status of ReducedTree Production :

- LegoTrain finished for LHC18q reduced trees (136 runs - Central-barrel-Tracking)
- Output trees were collected from Stage-2 (Total stages 4, fails at stage-3)
- Copied the Trees to GSI run-wise using alien.py
- Avg parallel speed of Copying = 350 MBytes/Sec

Statistics

LHC18q	Total # of Runs	Total # of Trees	Size	Time taken to Copy
On Grid	136	2484	3.8T	-
Copied to GSI	123	2428	3.6T	~3 H

Filtering for Jpsi :

- Expected to start today and filter max. possible runs ASAP (scripts are ready!).

Activites:

- Status of ReducedTree Production for LHC18q period

- **Progress on Fitting for Non-prompt Fraction**

Procedure

- Basic Idea to maximize

$$lnL = \sum_{i=1}^{N} lnF(x^i, m^i_{e^+e^-}) \qquad (1)$$

- X = pseudo-proper decay length
- m=invariant mass reconstructed from pairs
- Observing either signal or bkg J/psi
-

$F(x^i, m^i_{e^+e^-}) \rightarrow$ Likelihood Function
$\rightarrow$ Probability of observing a J/Ψ, given x^i and $m^i_{e^+e^-}$
$\sum \rightarrow$ Sum over all the J/ψ candidates

- Unbinned 2-dim likelihood fit function

$$F(x, m_{e^-e^+}) = \underbrace{f_{sig}.F_{sig}(x)}_{F_{sig} = f'_B.F_B(x) + (1-f'_B).F_{Prompt}(x)}.M_{sig}(m_{e^+e^-}) + (1 - f_{sig}).F_{bkg}(x).M_{bkg}(m_{e^+e^-})$$

X-distribution for Prompt-Jpsi

- Function to Fit :

$$F(x, m_{e^-e^+}) = f_{sig}.\left[f'_B.F_B(x) + (1-f'_B).F_{Prompt}(x)\right].M_{sig}(m_{e^+e^-}) + (1 - f_{sig}).F_{bkg}(x).M_{bkg}(m_{e^+e^-})$$

f'_B & $f_{sig}(= \frac{S}{(S+B)})$ are free parameters.

All the PDFs are defined in the Ana-note.

Fitting Templates

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According to the previous slide (last bullet)

- **We need 5 templates PDFs for the 2-dim (m_{ee}, x) fitting of the Likelihood function.**

  - $M_{sig}(m_{ee})$: template for Invariant Mass of J/Ψ-Signal (taken from MC)

  - $M_{bkg}(m_{ee})$: template for Inv. Mass Combinatorial Background.

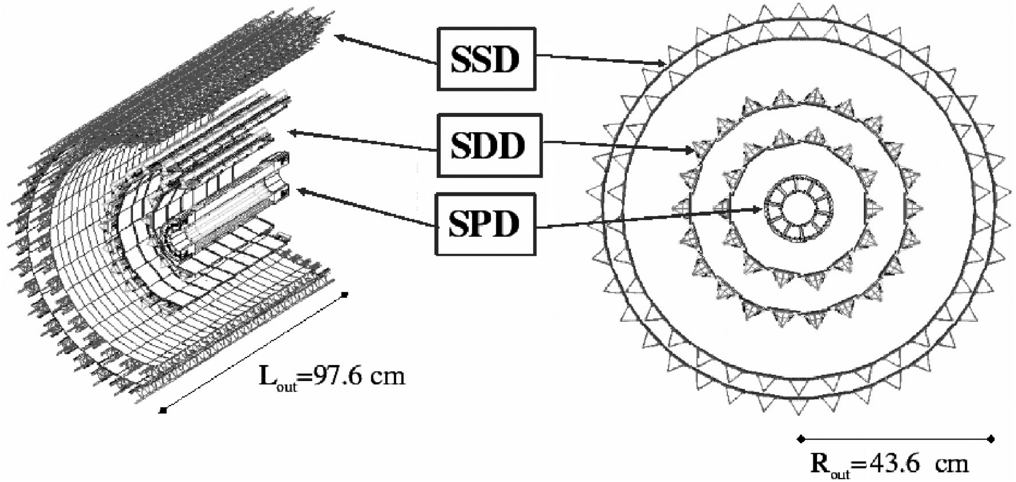
  - R(x) : Resolution function – depends on p_T, Hits on SPD's I^{st} layer (taken from MC)
  ~ $F_{Prompt}(x)$

  - $F_B(x)$: template for Non-prompt J/Ψ (from MC)

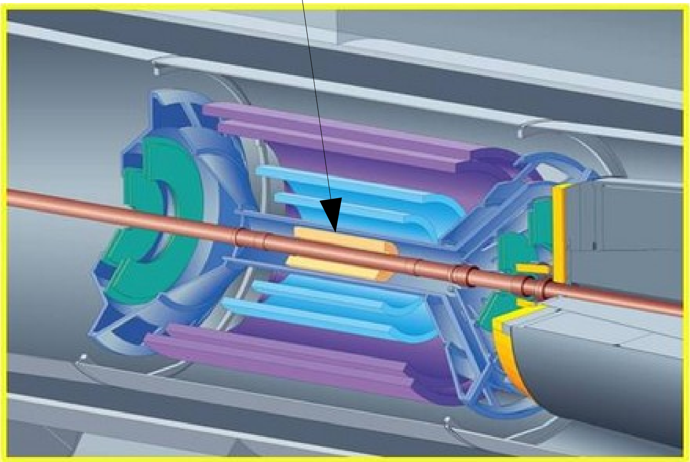
  - $F_{bkg}(x)$: template for fitting x-Background (not sure now!)

The Likelihood fitting classes are given in $AliPhysics/PWGDQ/dielectron/BtoJPSI
I took some functions from there for fitting our distributions one-by-one.

SPD-type of J/Ψ



SPD (Silicon Pixel Detector)



ITS-ALICE

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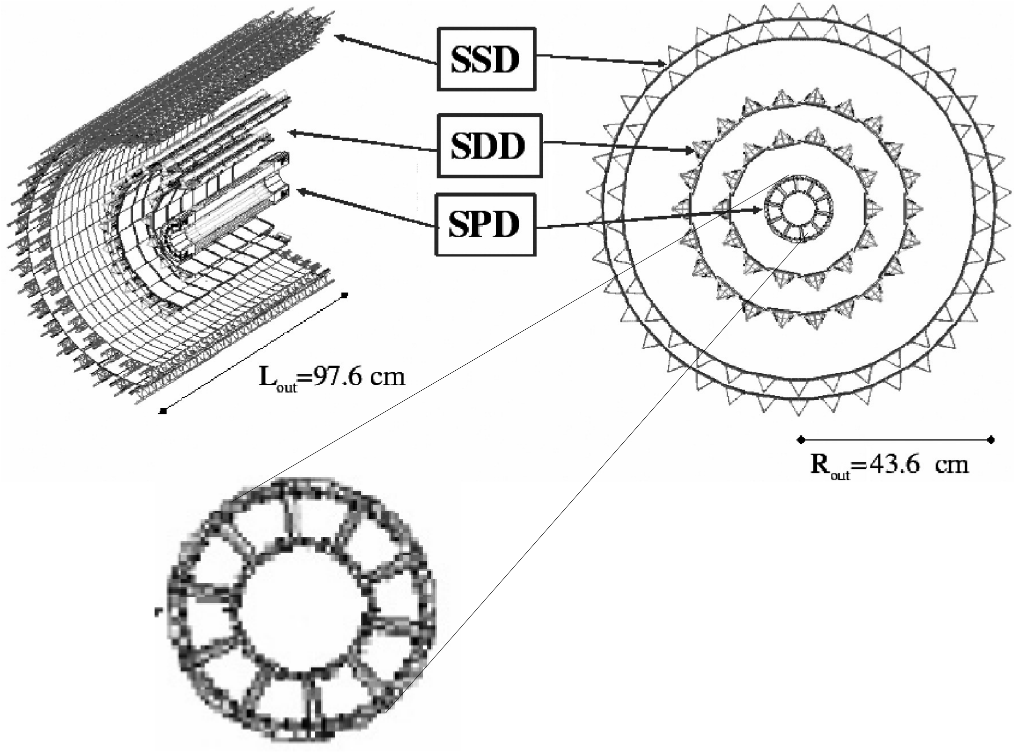

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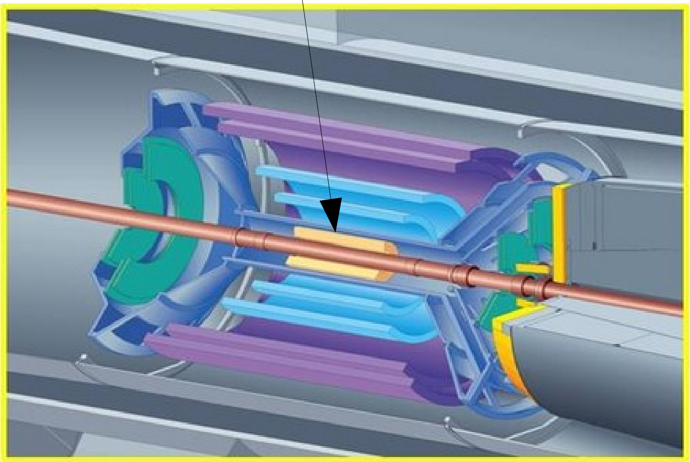

ITS-ALICE

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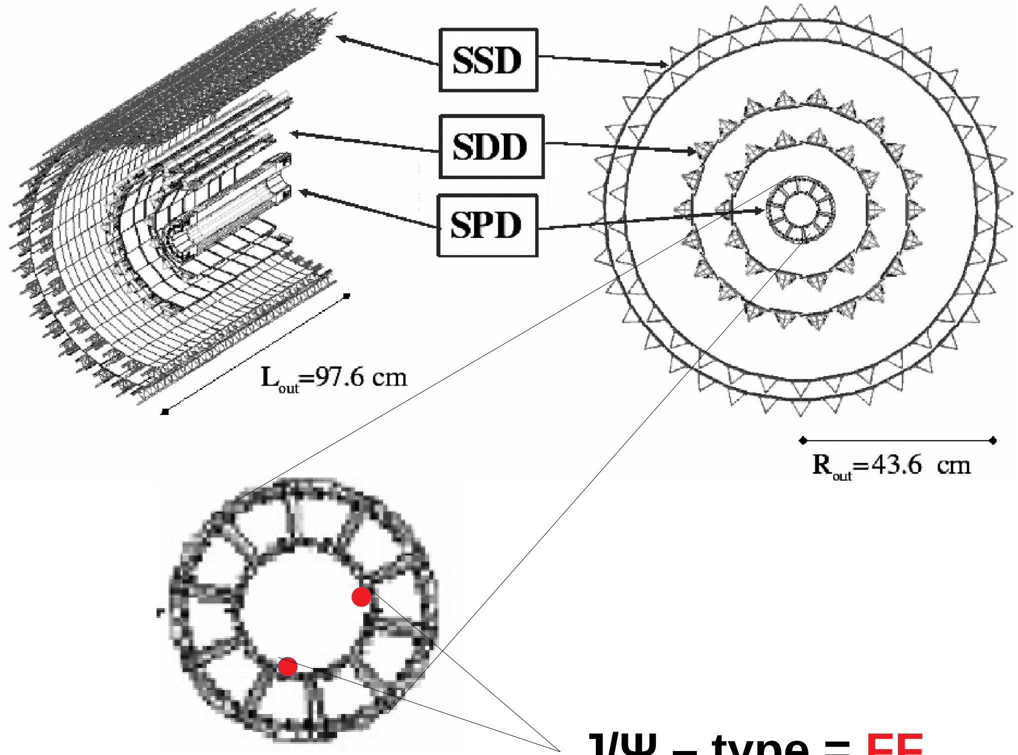
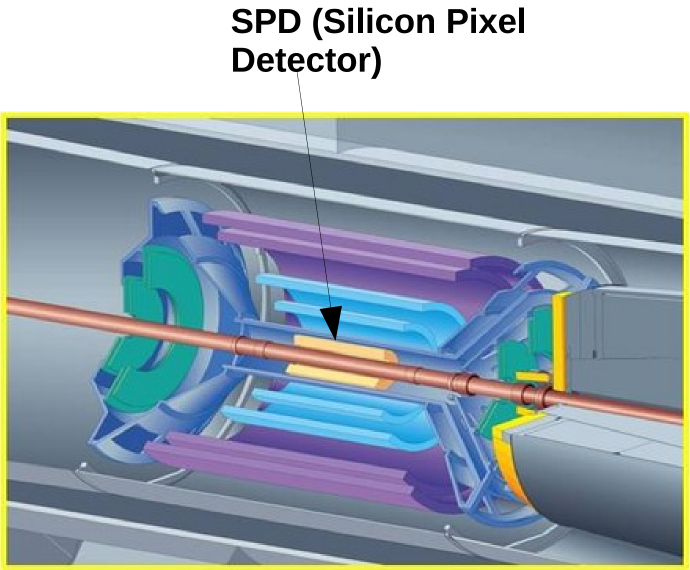


J/Ψ – type = FF



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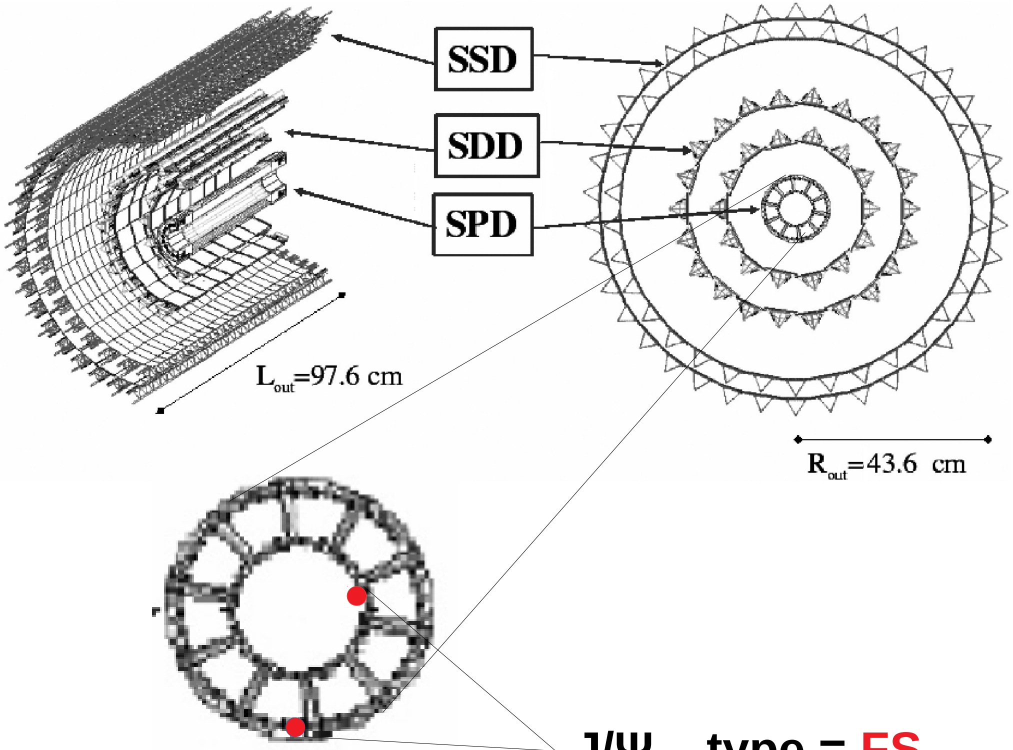
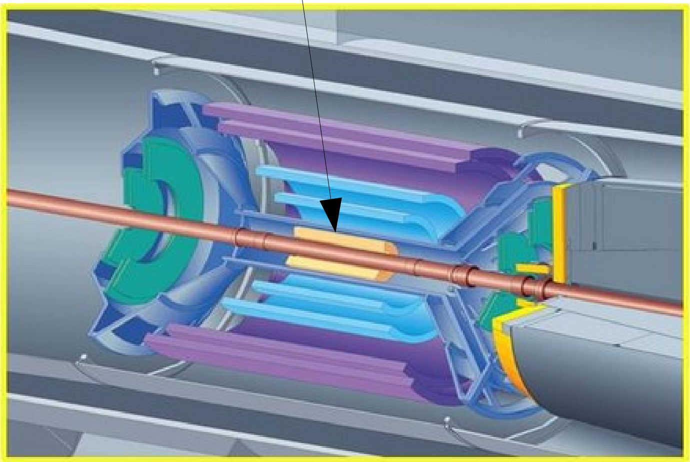
SPD-type of J/Ψ



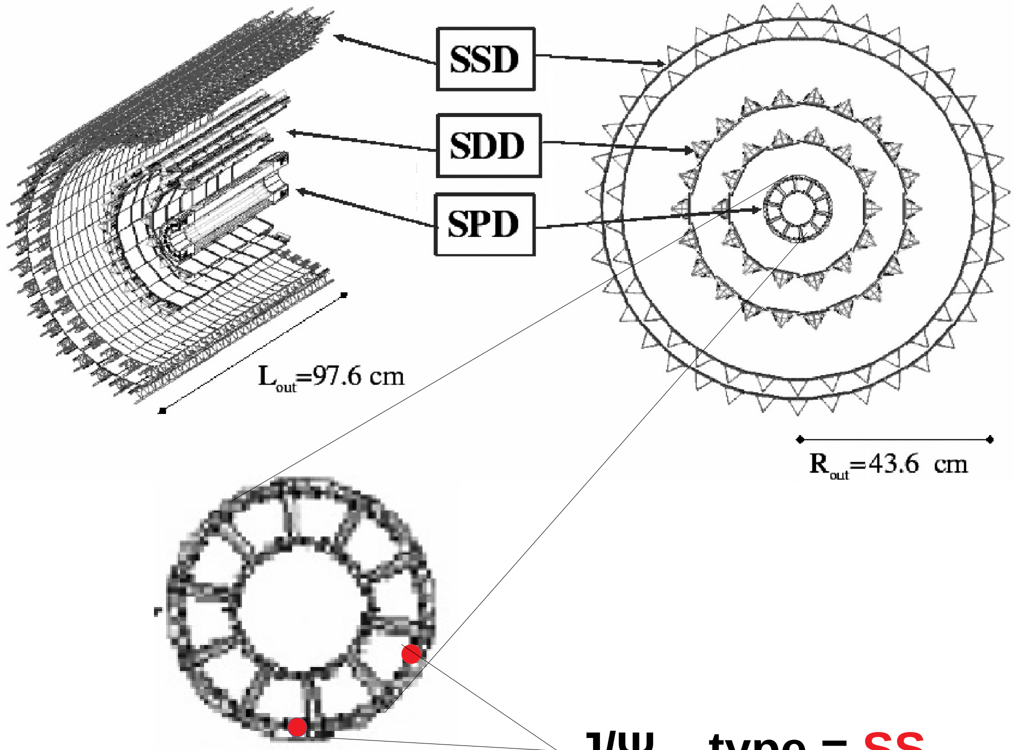
J/Ψ – type = FS

SPD (Silicon Pixel Detector)



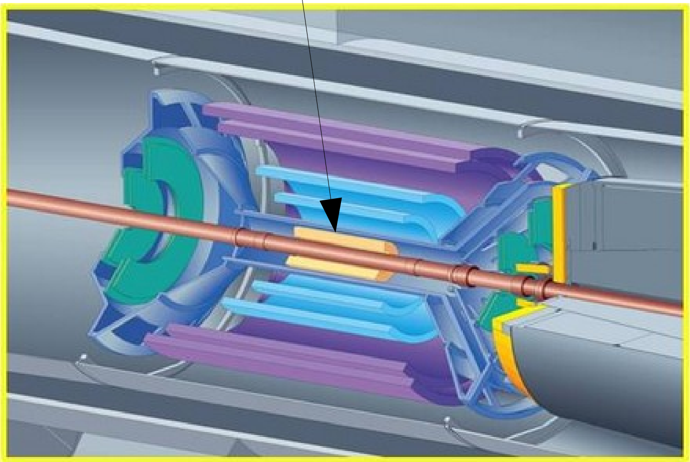
ITS-ALICE

SPD-type of J/Ψ



J/Ψ – type = SS

SPD (Silicon Pixel Detector)



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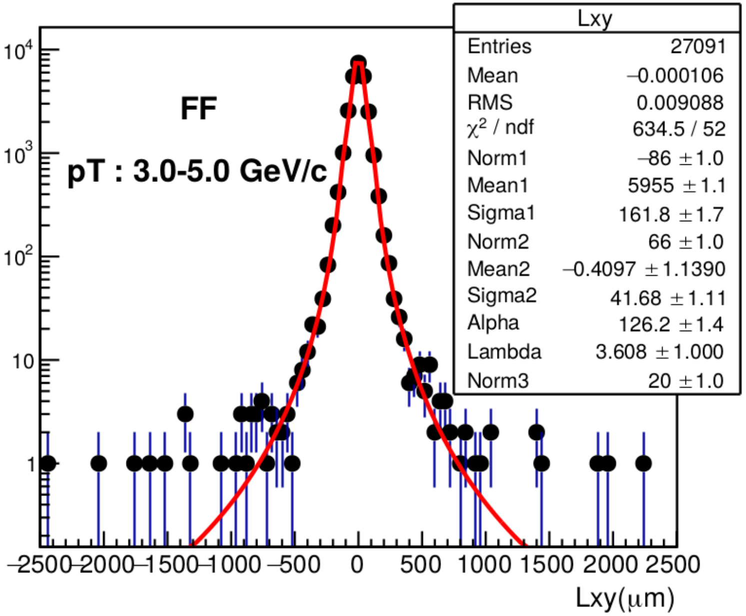
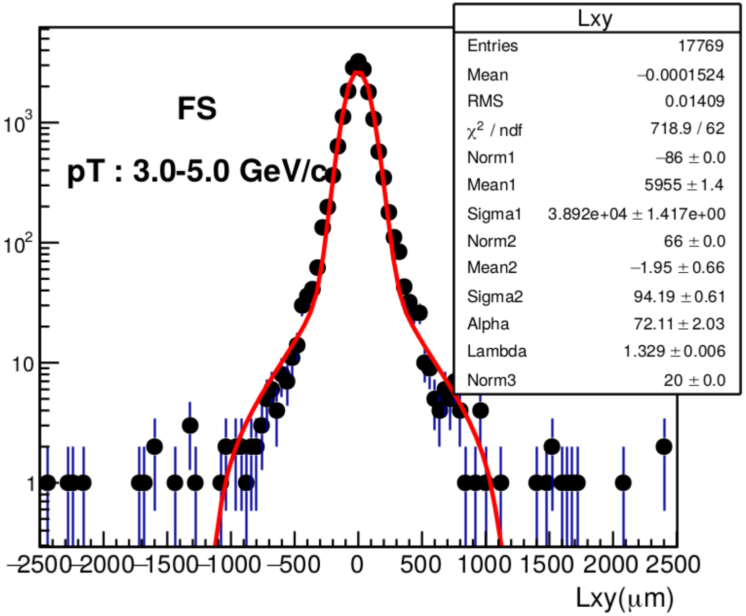
Resolution function fitting for Lxy (Single distribution):

$$x = \frac{c \cdot L_{xy} \cdot m_{J/\psi}}{p_T^{J/\psi}}$$

$$L_{xy} = \vec{L} \cdot \vec{p}_T^{J/\psi} / p_T^{J/\psi}$$





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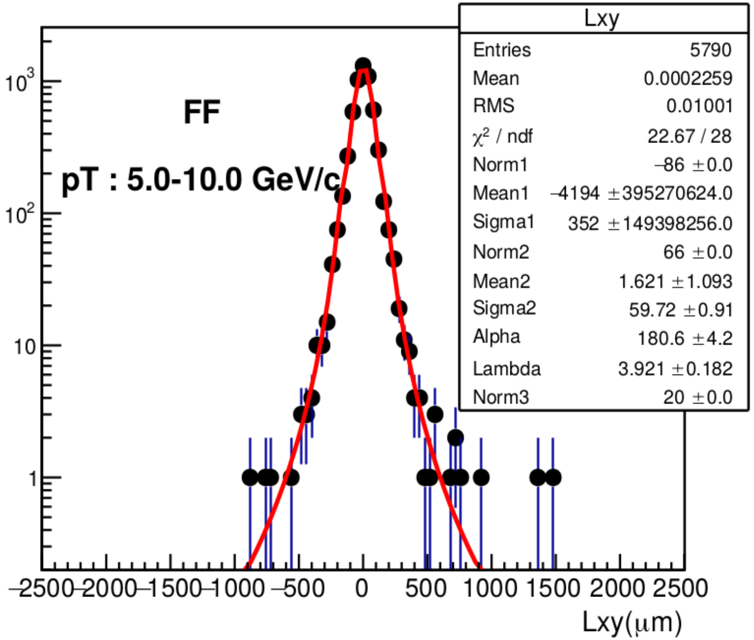

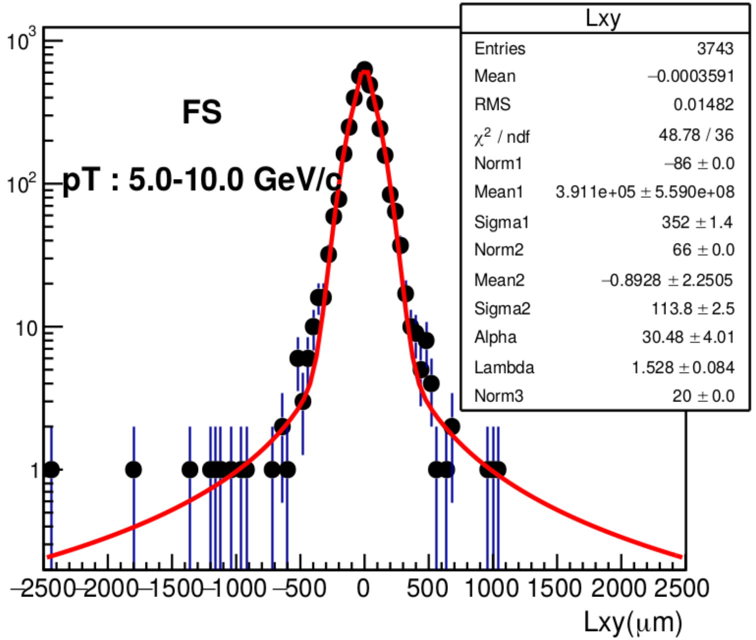

Next Steps:

- Fitting Using the ‘BtoJPSI’ functionality in AliPhysics
  - for M and Psproper-decay-length

Back-Up

SnapShot of copying progress using alien.py

```
jobID: 19/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 32.95 MiB/s MESSAGE: [SUCCESS]
jobID: 20/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 55.78 MiB/s MESSAGE: [SUCCESS]
jobID: 14/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 38.45 MiB/s MESSAGE: [SUCCESS]
jobID: 6/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 42.65 MiB/s MESSAGE: [SUCCESS]
jobID: 16/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 40.26 MiB/s MESSAGE: [SUCCESS]
jobID: 22/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 44.06 MiB/s MESSAGE: [SUCCESS]
jobID: 24/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 40.35 MiB/s MESSAGE: [SUCCESS]
jobID: 13/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 33.06 MiB/s MESSAGE: [SUCCESS]
jobID: 8/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 40.21 MiB/s MESSAGE: [SUCCESS]
jobID: 2/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 39.00 MiB/s MESSAGE: [SUCCESS]
jobID: 26/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 18.08 MiB/s MESSAGE: [SUCCESS]
jobID: 11/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 35.79 MiB/s MESSAGE: [SUCCESS]
jobID: 1/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 27.63 MiB/s MESSAGE: [SUCCESS]
jobID: 17/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 32.07 MiB/s MESSAGE: [SUCCESS]
jobID: 10/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 31.33 MiB/s MESSAGE: [SUCCESS]
jobID: 12/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 32.31 MiB/s MESSAGE: [SUCCESS]
jobID: 25/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 27.33 MiB/s MESSAGE: [SUCCESS]
jobID: 23/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 28.94 MiB/s MESSAGE: [SUCCESS]
jobID: 18/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 21.37 MiB/s MESSAGE: [SUCCESS]
jobID: 21/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 22.60 MiB/s MESSAGE: [SUCCESS]
jobID: 5/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 23.74 MiB/s MESSAGE: [SUCCESS]
jobID: 15/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 16.25 MiB/s MESSAGE: [SUCCESS]
jobID: 3/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 17.54 MiB/s MESSAGE: [SUCCESS]
jobID: 4/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 17.68 MiB/s MESSAGE: [SUCCESS]
jobID: 9/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 18.97 MiB/s MESSAGE: [SUCCESS]
jobID: 7/26 >>> ERRNO/CODE/XRDSTAT 0/0/0 >>> STATUS OK >>> SPEED 21.17 MiB/s MESSAGE: [SUCCESS]
```

Resolution Function R(x):

$$R(x) = w_1 \cdot G_1(x;\mu_1,\sigma_1) + w_2 \cdot G_2(x;\mu_2,\sigma_2) + w_3 \cdot f(x;\alpha,\lambda)\ ,$$

where the two functions G_1 and G_2 are gaussian functions:

$$G(x;\mu,\sigma) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

while the symmetric power law term has the stepwise form:

$$f(x;\alpha,\lambda) = \begin{cases} \frac{\lambda-1}{2\alpha\lambda} & |x| < \alpha \\ \frac{\lambda-1}{2\alpha\lambda}\alpha|x|^{-\lambda} & |x| > \alpha \end{cases}$$

M_{Sig} (m_{ee}) : Crystal-ball function

$$f(m^{e^+e^-};\alpha,n,\bar{m},\sigma,N) = N \cdot \begin{cases} \exp\left(-\frac{(m^{e^+e^-}-\bar{m})^2}{2\sigma^2}\right) & \text{for } \frac{m^{e^+e^-}-\bar{m}}{\sigma} > -\alpha \\ A \cdot \left(B - \frac{m^{e^+e^-}-\bar{m}}{\sigma}\right)^{-n} & \text{for } \frac{m^{e^+e^-}-\bar{m}}{\sigma} \leqslant -\alpha \end{cases}$$

and where the coefficients are:

$$A = \left(\frac{n}{|\alpha|}\right)^n \cdot \exp\left(-\frac{|\alpha|^2}{2}\right) \qquad B = \frac{n}{|\alpha|} - |\alpha| \ .$$

M_{Bkg} (m_{ee}) : Exponential function

$$M_{Bkg}(m_{e^+e^-};\lambda,A) = A \cdot e^{-\frac{(m^{e^+e^-})}{\lambda}} + B\ ,$$

A & Lambda are free parameters

M_{Bkg} (m_{ee}) : Exponential function

$$F_{B\,[p_T,type]}(x) = \chi_B(x') \otimes R_{[p_T,type]}(x)$$

PsProper-decay disttribution from for
Non-prompt Jpsi MC-reconstructed

Resolution
Function