Run 15 pp J/ψ Multiplicity Analysis

PHENIX HI PWG Meeting

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02/17/2022

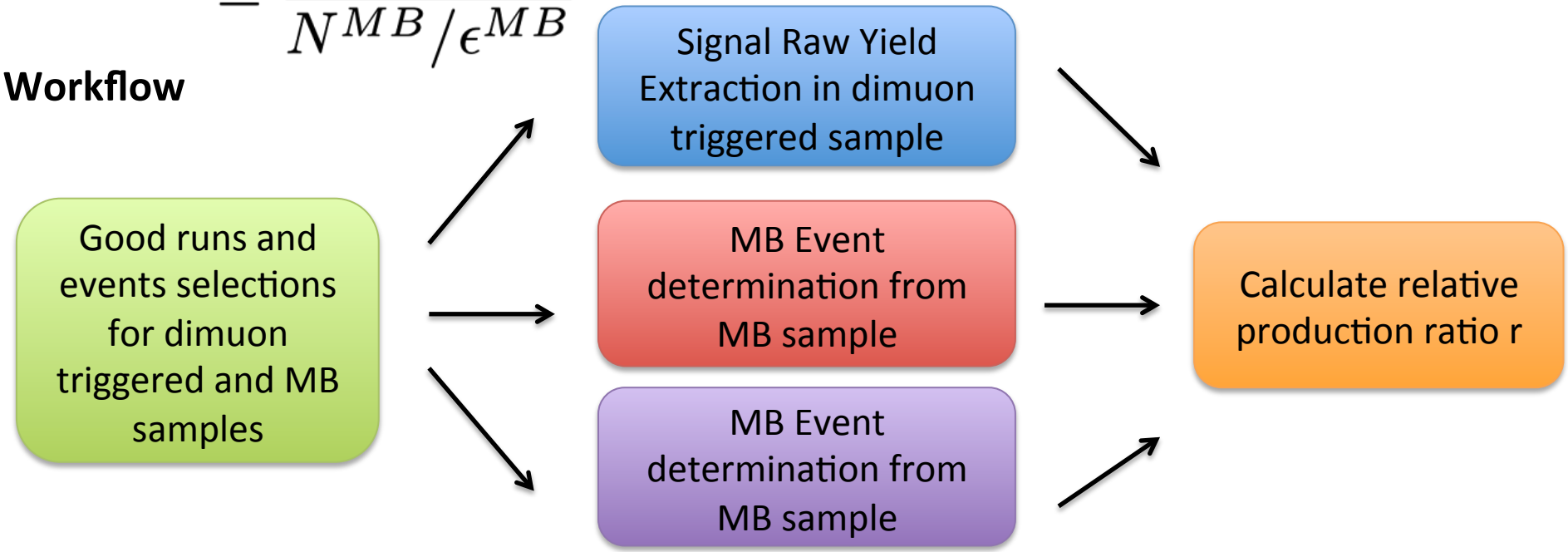
Overview

Motivation

- Fully reconstruct J/ using the PHENIX north and south FVTX detectors
- Study J/ψ production in small systems from a quantity measurement

$$R(N^{ch}) = \frac{d\sigma^{J/\psi}(N^{ch})}{d\sigma^{MB}(N^{ch})} = \frac{N^{J/\psi}/\epsilon^{J/\psi}}{N^{MB}/\epsilon^{MB}} \qquad r = \frac{N^{J/\psi}/\epsilon^{J/\psi}/ < \sigma^{J/\psi} >}{N^{MB}/\epsilon^{MB}/ < \sigma^{MB} >}$$

Workflow



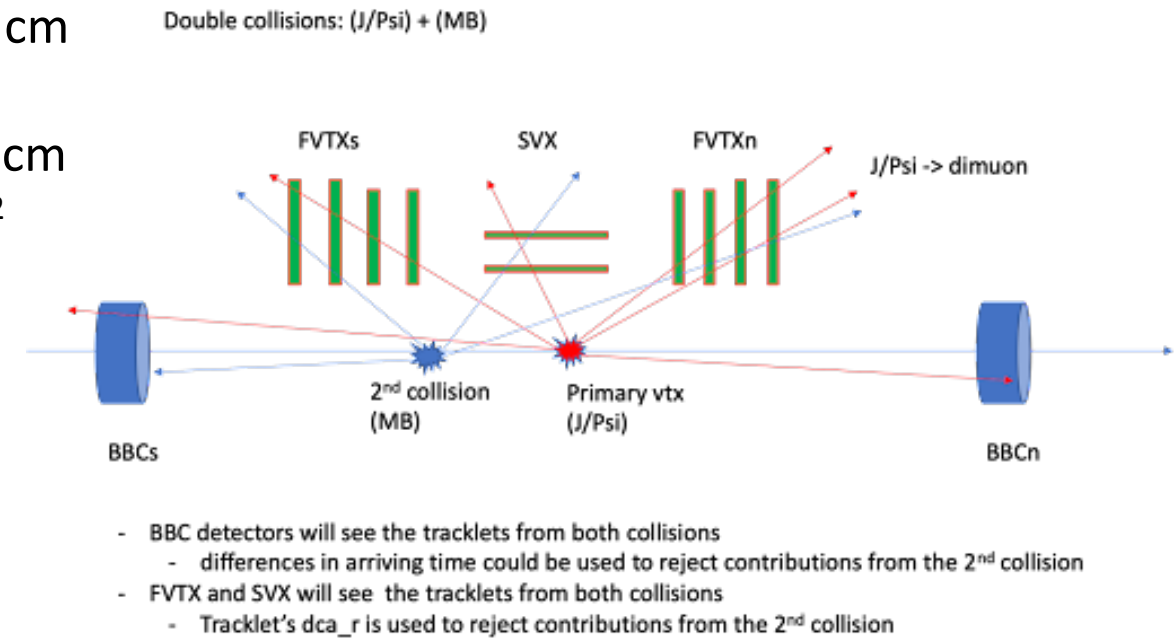
Analysis Selections

Run Selections

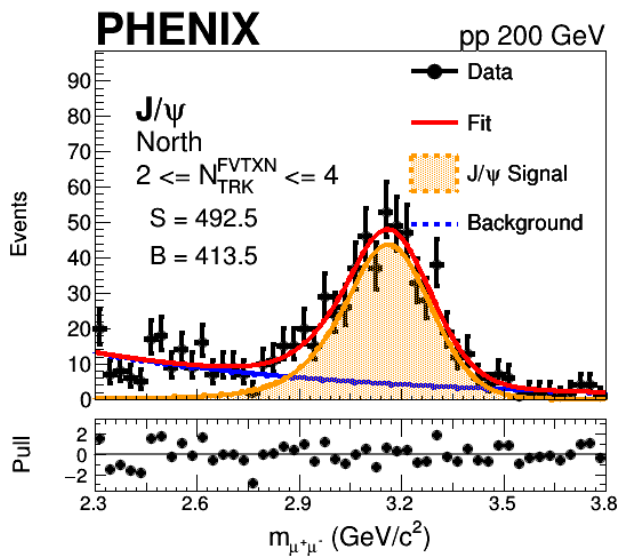
- Make sure the MB and dimuon trigger samples have the same good runs for FVTX South and North
- Number of good runs: South = 552 and North = 527

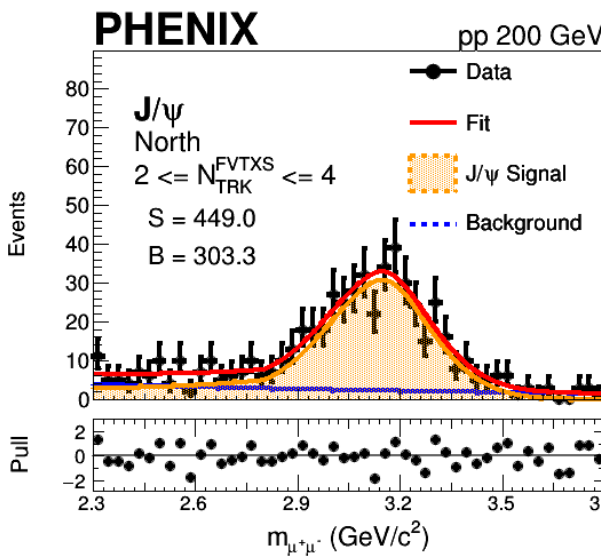
Event Selections

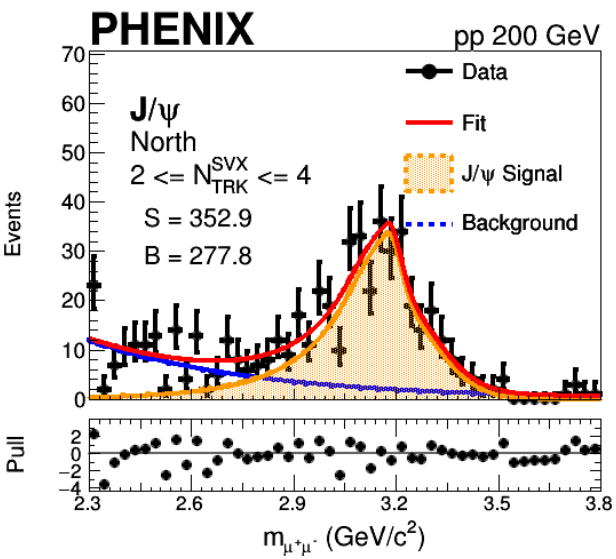
- |Primary vertex z| < 10 cm
- |Primary vertex z Error| < 0.2 cm
- |BBC z| < 20 cm
- |Primary vertex z - BBC z| < 5 cm
- 2.5 GeV/c^2 < $m_{\mu\mu}$ < 3.7 GeV/c^2
- FVTX χ^2 cut < 20
- FVTX DCA cut < 0.2 cm
- 1 < FVTX |η| < 3
- SVX DCA cut < 0.1 cm
- SVX |η| < 1.5



J/ψ Invariant Mass Fit – FVTX North

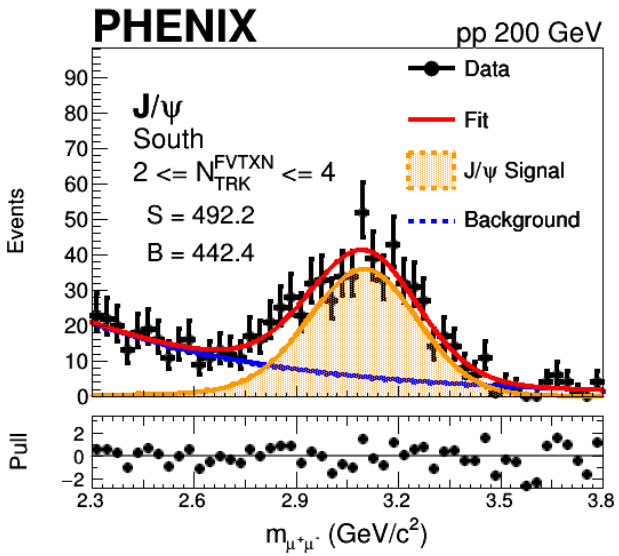


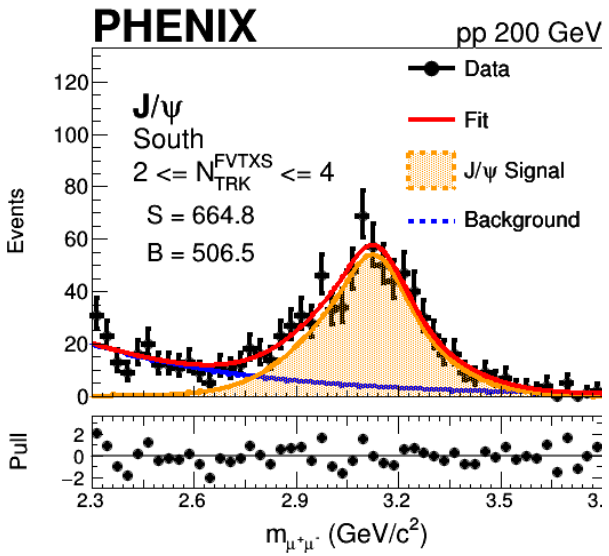


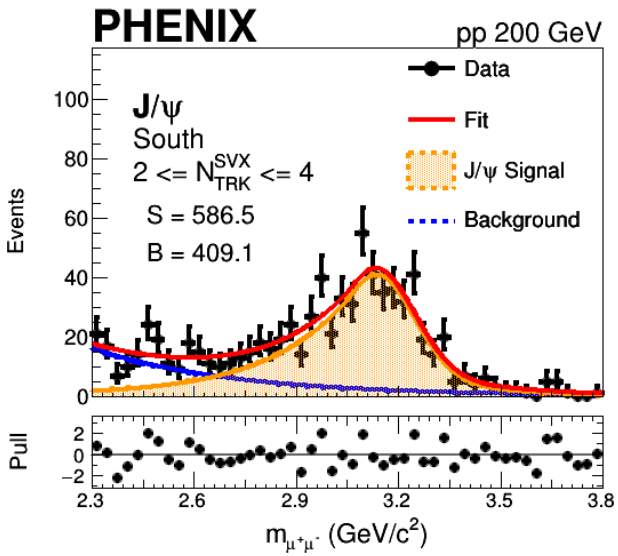


- Unbinned roofit to extract the signal yield
- Signal fit function is double crystal ball
- Switch the background fit function to exponential decay
- The fit performance looks great
- The SVX has smaller number of tracks in general

J/ψ Invariant Mass Fit – FVTX South







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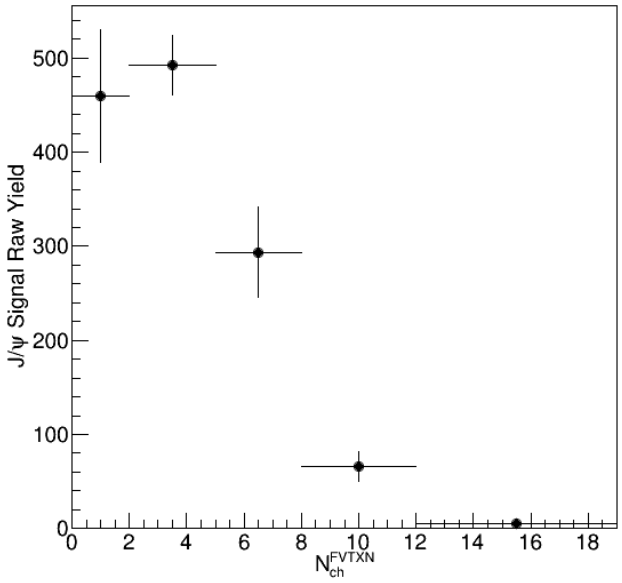
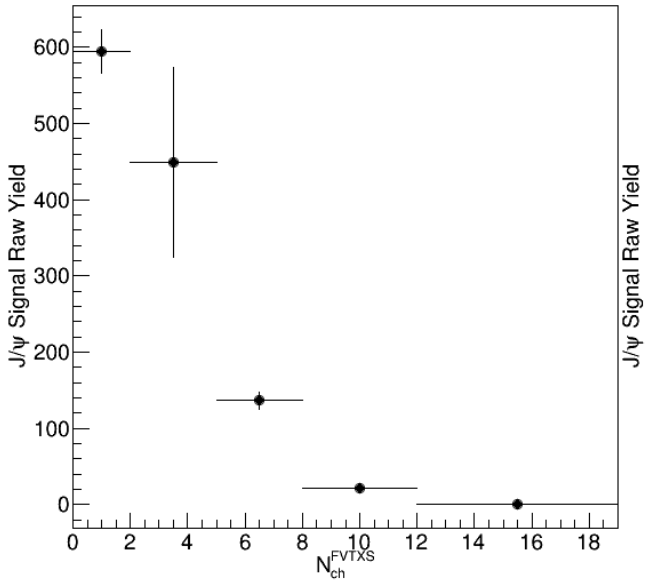
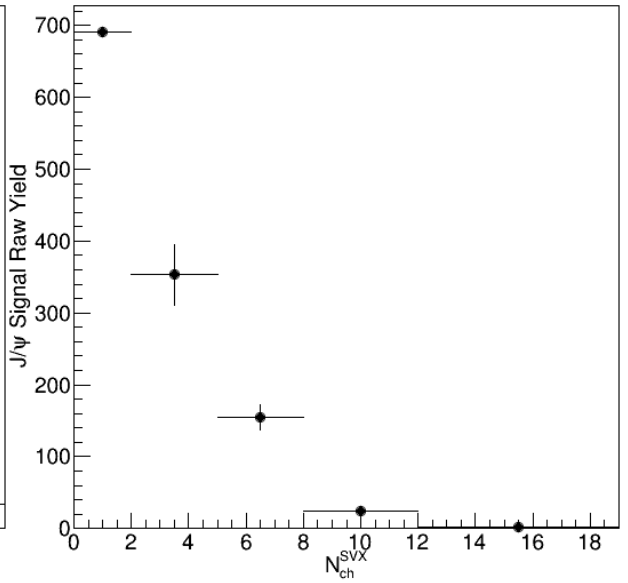
J/ψ Invariant Mass Fit – FVTX North

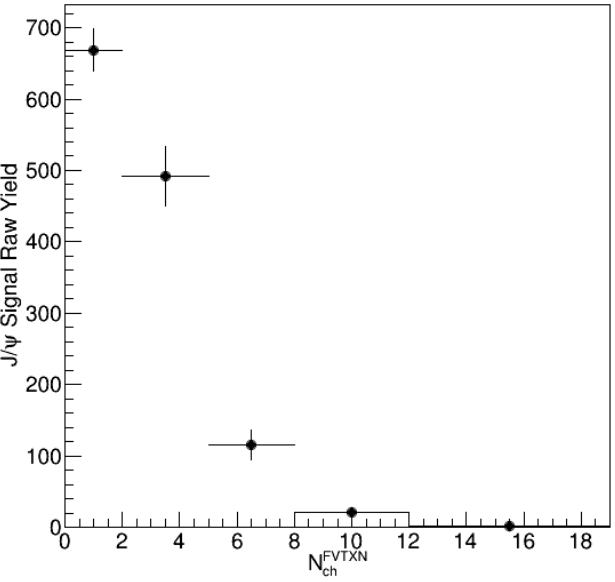


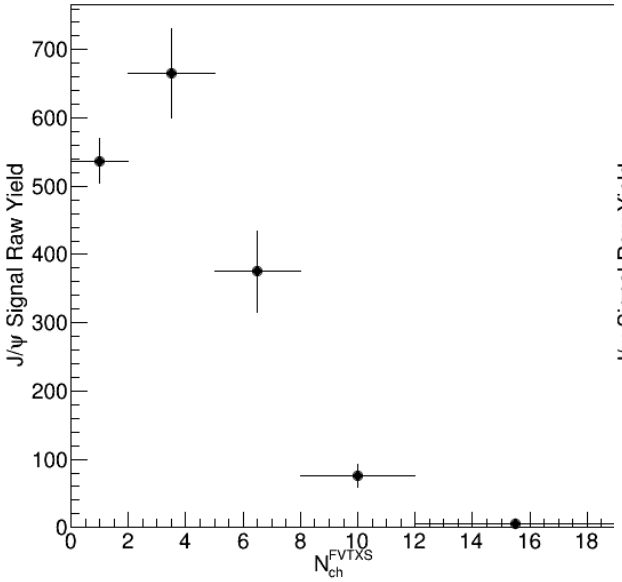


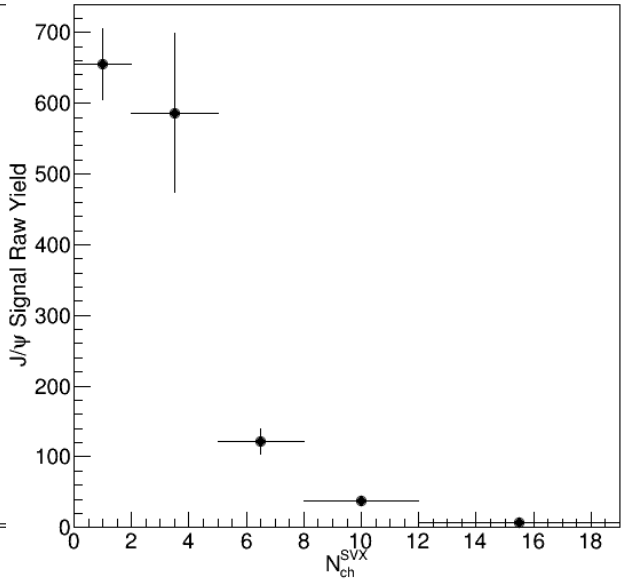


- The raw yield at highest p_T is very small due to the poor statistics
- The SVX has smaller number of tracks in general

J/ψ Invariant Mass Fit – FVTX South







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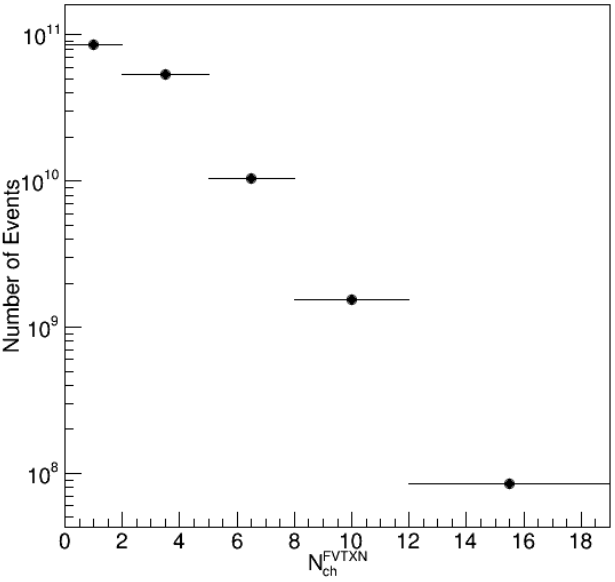
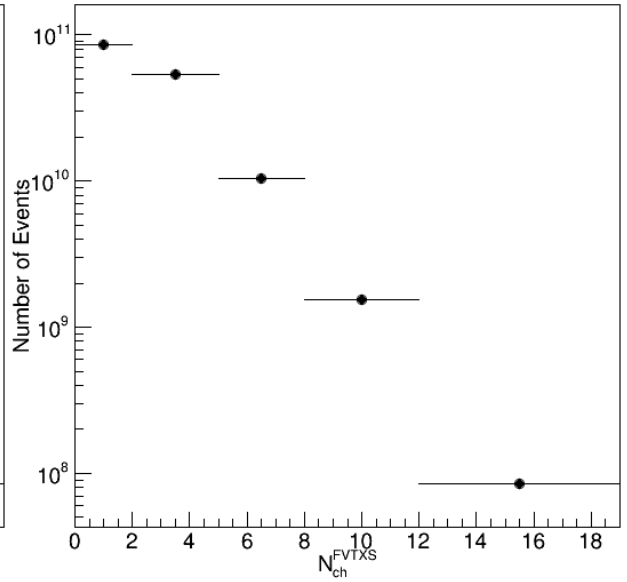
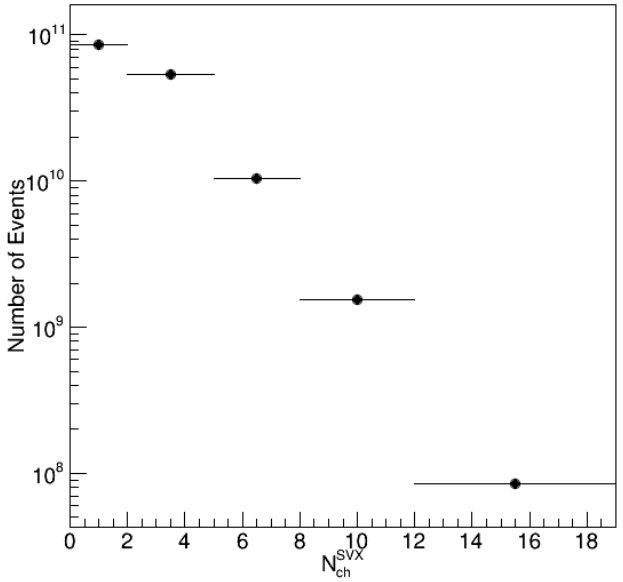
MB Event Multiplicity Distribution – FVTX North

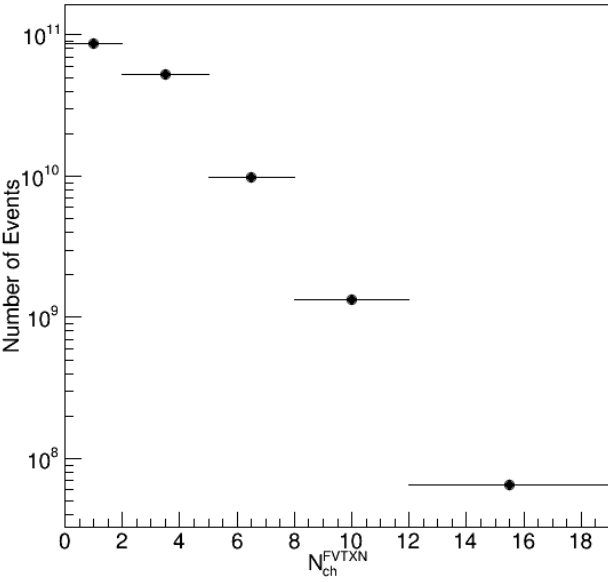


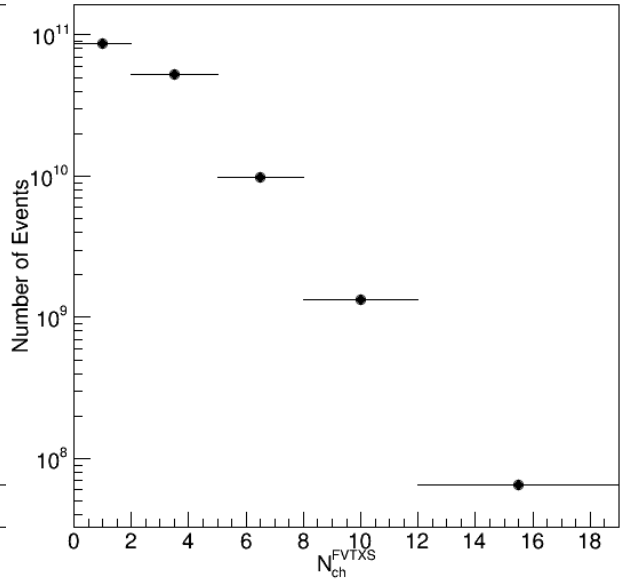


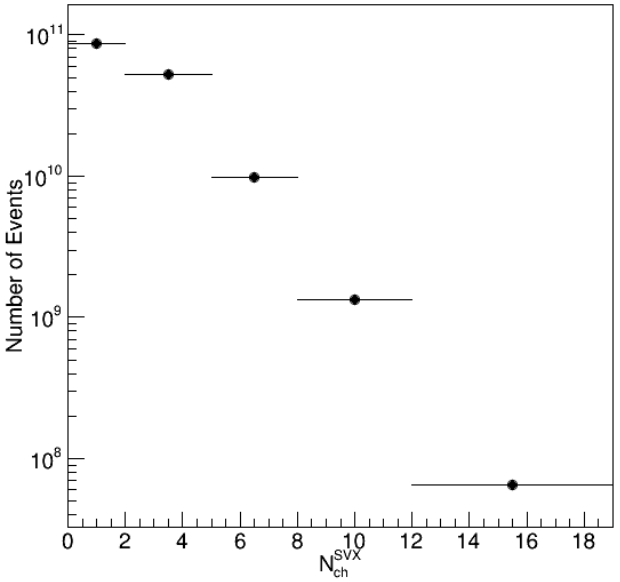


- Obtain the MB event multiplicity distribution by scaling the prescale factor + 1 for each run and add up all the runs
- Use as a normalization factor for the signal raw yield of J/ψ in each multiplicity bin

MB Event Multiplicity Distribution – FVTX South

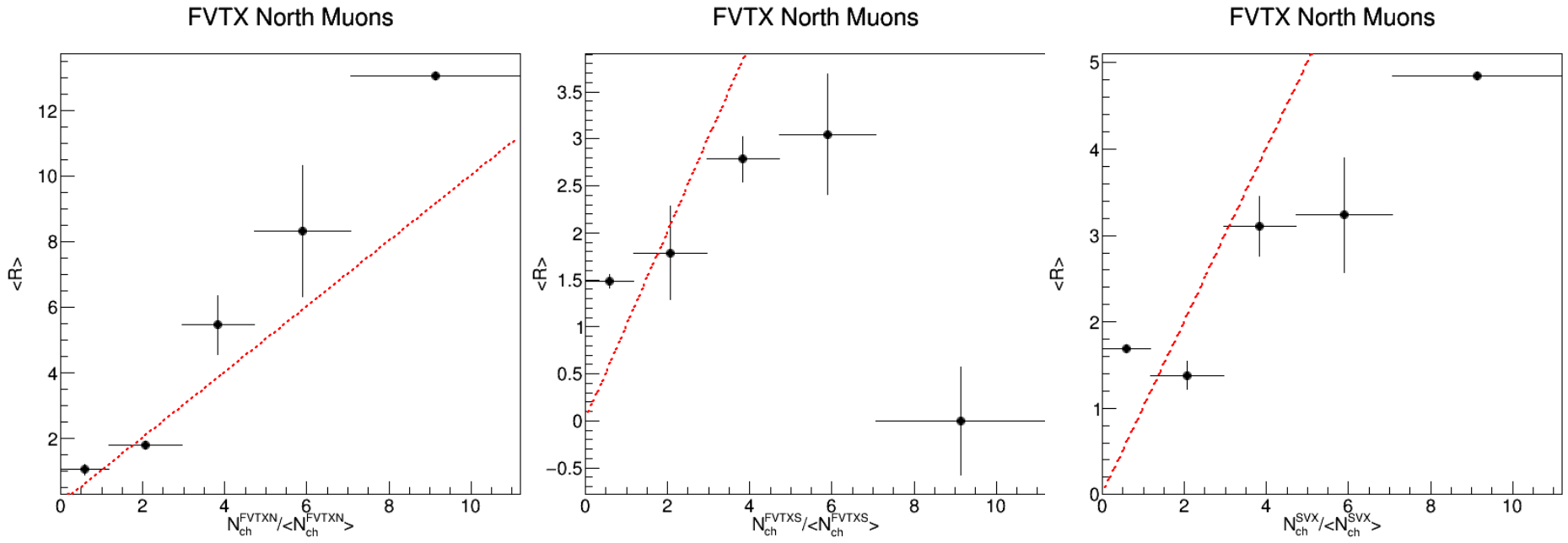






- Obtain the MB event multiplicity distribution by scaling the prescale factor + 1 for each run and add up all the runs
- Use as a normalization factor for the signal raw yield of J/ψ in each multiplicity bin

<R> vs $N_{ch}/\langle N_{ch}\rangle$ for FVTX North

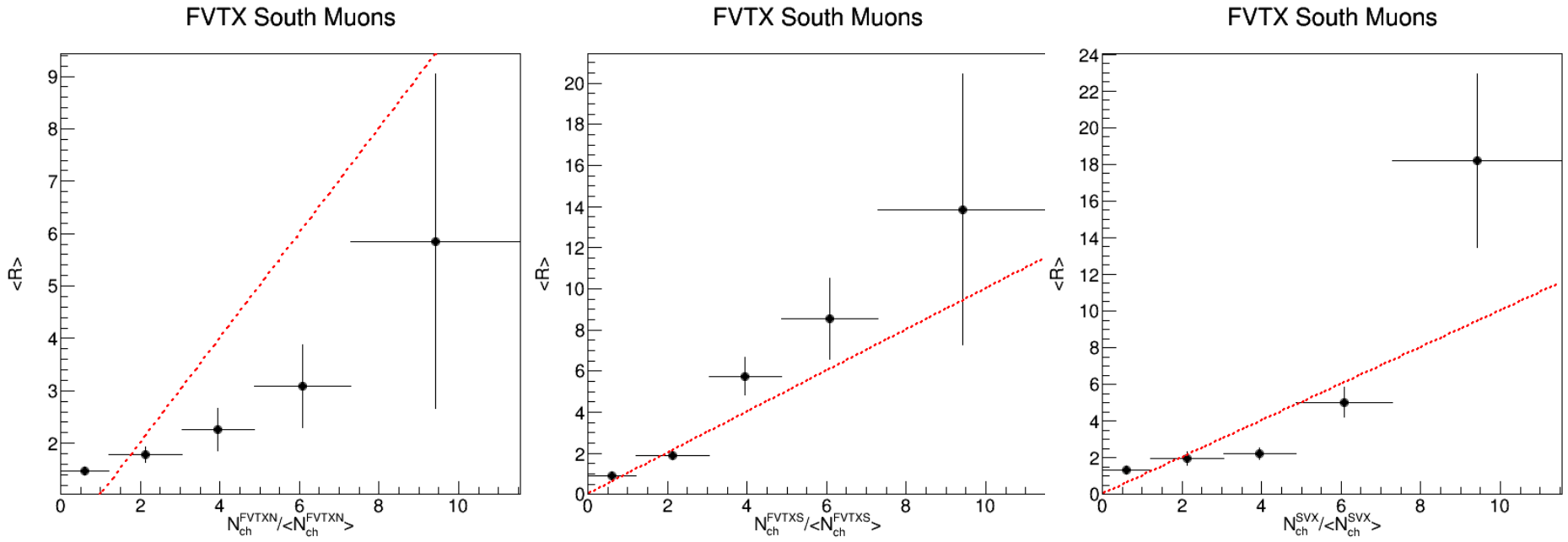


- Here <R> is defined as:

$$\langle R\rangle = (N^{J/\psi}/N^{MB})/(\langle N^{J/\psi}\rangle/\langle N^{MB}\rangle)$$

- The X axis is the normalized quantity: $N_{ch}/\langle N_{ch}\rangle$
- <R> is not yet corrected by the MB trigger bias ratio
- The highest multiplicity bin might be problematic due to the poor statistics

<R> vs $N_{ch}/\langle N_{ch}\rangle$ for FVTX South



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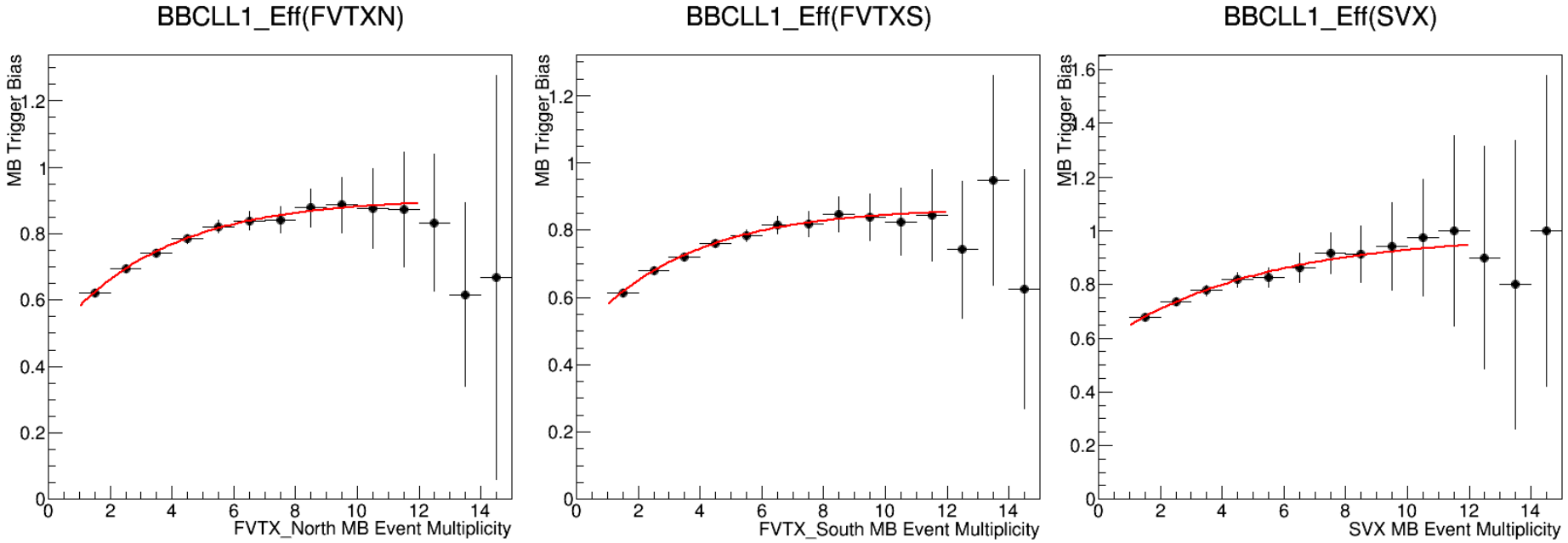
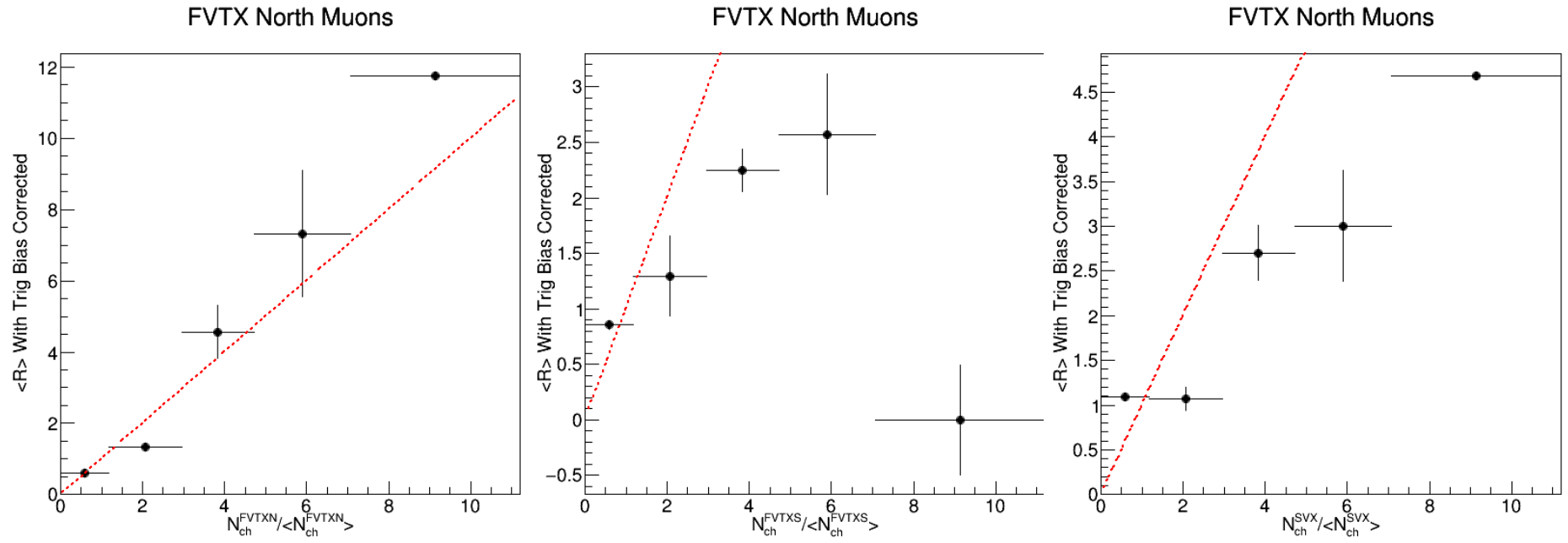
MB Trigger Bias Correction



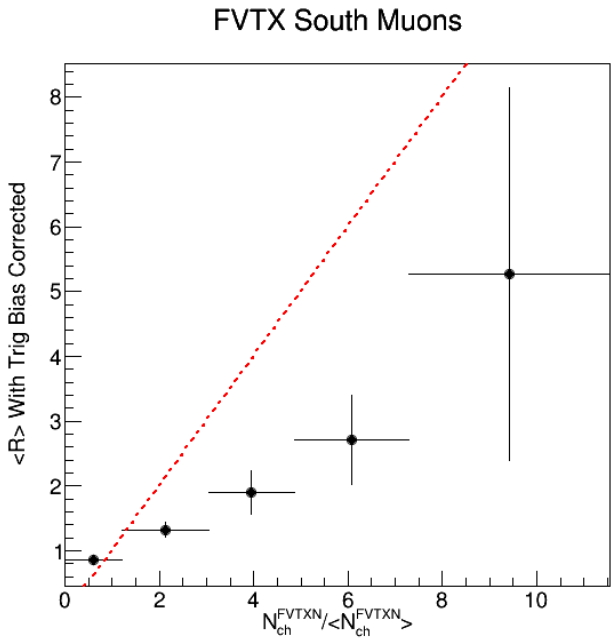
- Correct the MB trigger efficiency bias to take the MB trigger efficiency as a function of multiplicity into account
- Fit the the MB trigger efficiency bias with a function: $y = [0] + [1]\, e^{-[2] \times to}$ extrapolate the efficiency as a function of multiplicity at low and high multiplicity region
- The fits all look good for FVTXN, FVXTS, and SVX
- Evaluate the MB trigger efficiency bias for the corresponding multiplicity in the bin center to obtain the correction factor to multiply for each bin

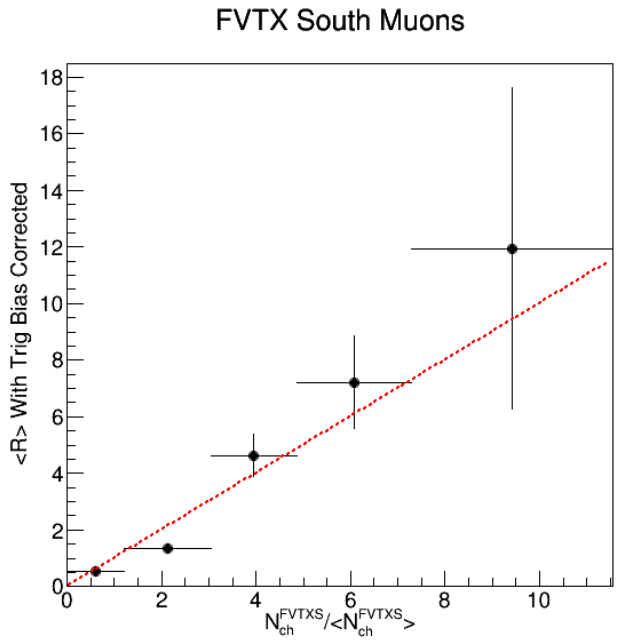
Final Results for FVTX North

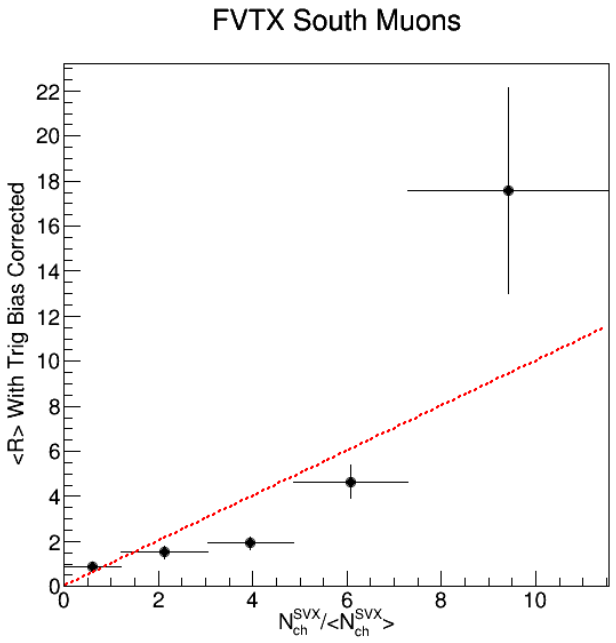


- Multiply the fitted trigger bias ratio function to obtain the final results
- The FVTX North tracks with FVTX North J/ψ generally is consistent with y = x at low multiplicity but above y = x at high event multiplicity
- The FVTX South tracks with FVTX North J/ψ generally is consistent with y = x at low multiplicity but is below y = x at high event multiplicity
- Double check the statistical uncertainties to make sure they are correct

Final Results South FVTX







- Multiply the fitted trigger bias ratio function to obtain the final results
- The FVTX North tracks with FVTX South J/ψ generally is consistent with y = x at low multiplicity but is below y = x at high event multiplicity
- The FVTX South tracks with FVTX South J/ψ generally is consistent with y = x at low multiplicity but above y = x at high event multiplicity
- Double check the statistical uncertainties to make sure they are correct

Summary and To Do List

- We have quickly produce the preliminary results of J/ψ production ratio as a function of event multiplicity
- We compare our results for North and South J/ψ with different event multiplicity definition: FVTXN, FVTXS, and SVX
- We compare our results with y = x and cross check the N_{coll} - like scaling for J/ψ in pp collision in the point of view of partons and found that the enhancement for same direction and suppression for opposite directions
- Finish the systematic uncertainties studies for pp and complete the same analysis studies for pA to study modification of J/ψ production due to the nuclear matter effect in small systems
- Complete the analysis notes and aim at presenting the results in QM 2022