

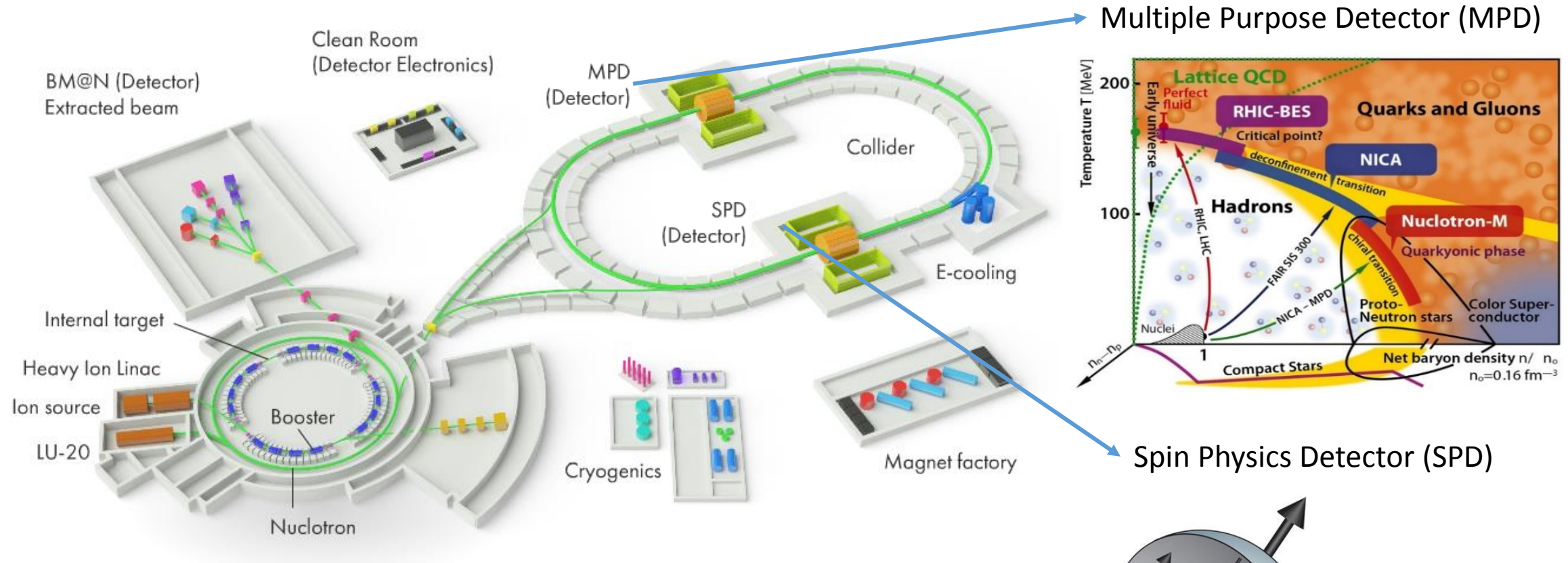
# Monte Carlo simulation of the Spin Physics Detector response for $J/\psi$ production studies

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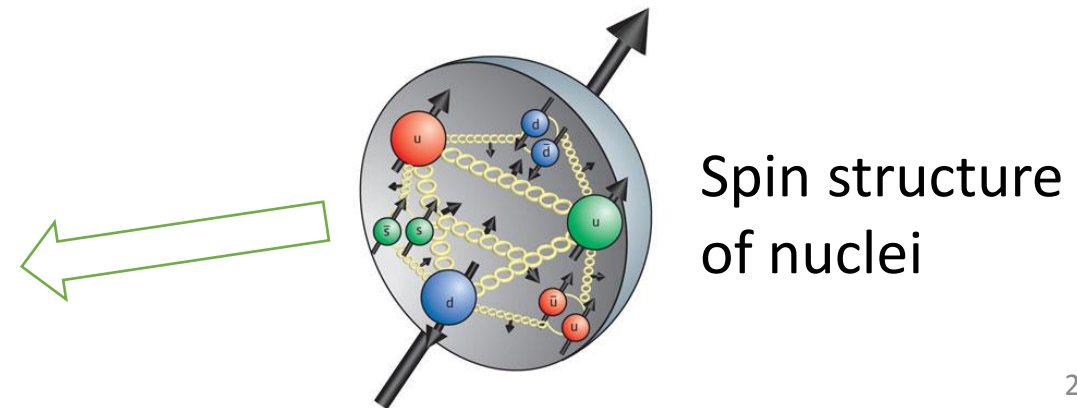
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Igor Denisenko, Dzhelapov Laboratory of Nuclear Problems

# SPD in the NICA project



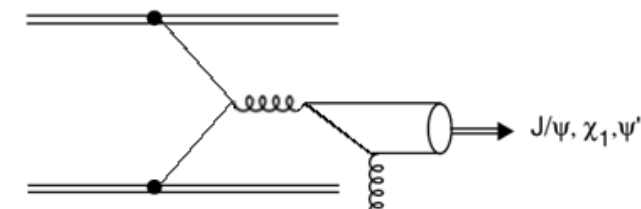
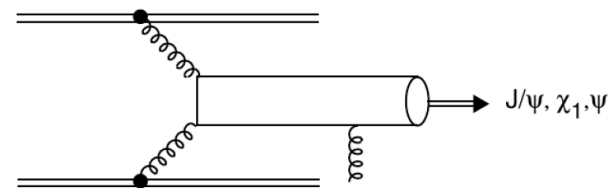
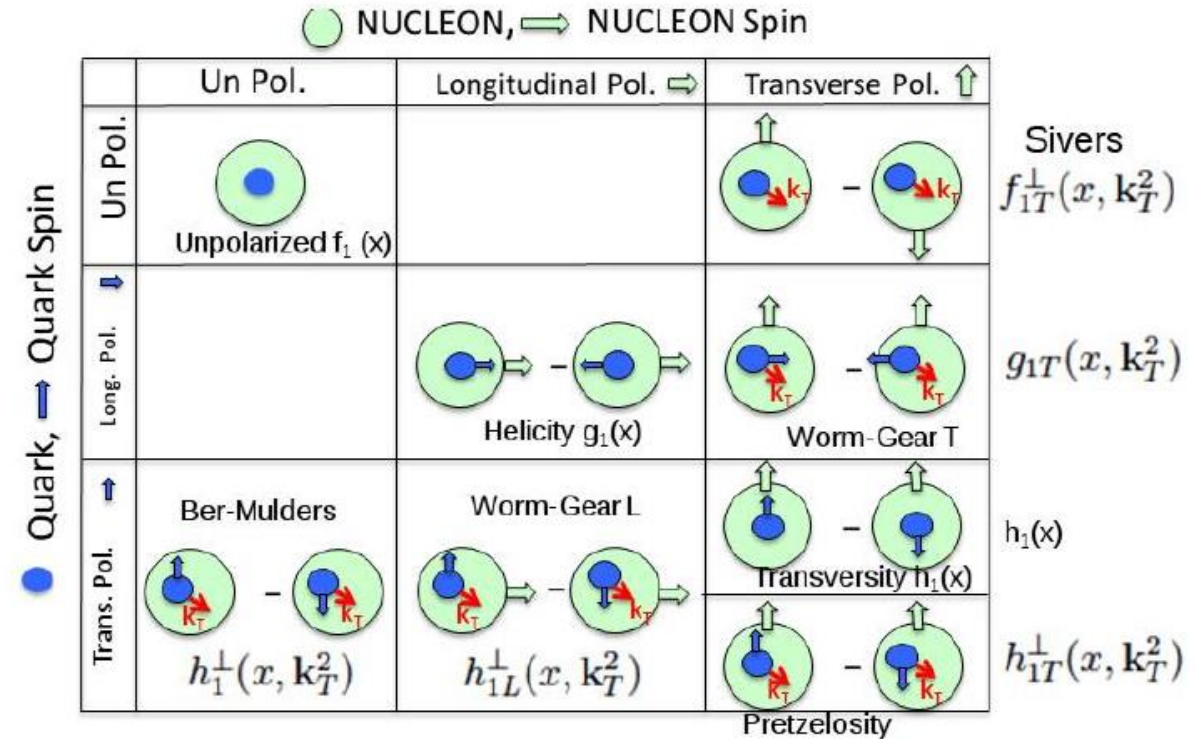
Studies of a great variety of spin and polarization dependent effects in polarized pp and dd collisions at  $\sqrt{s} < 27\text{GeV}$ .



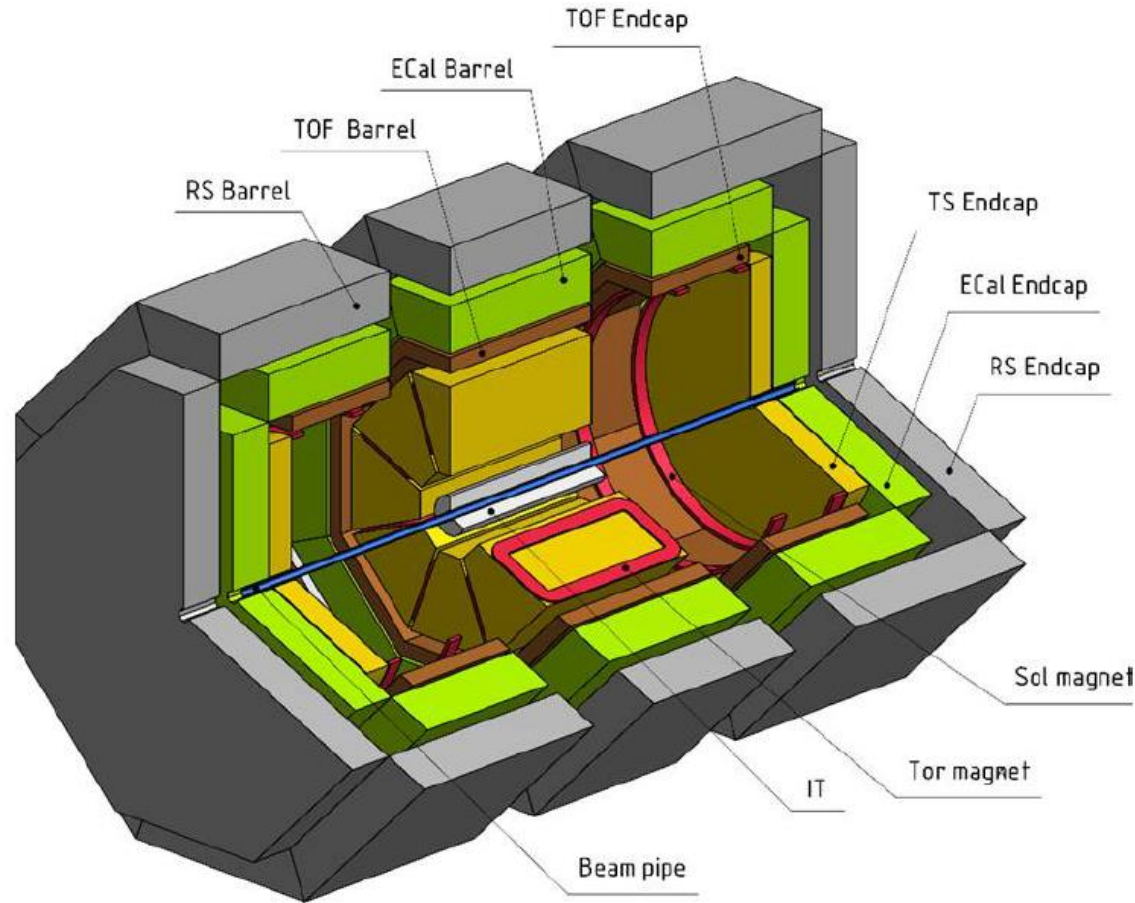
# SPD Physics Program

## Access to spin dependent processes

- Drell-Yan.
- Prompt photon production.
- Charmonia production.
- Sensitive to gluon content of colliding hadrons.
- Challenge and an important test for our understanding of QCD.
- Its comprehension would allow the separation of quark-antiquark annihilation and gluon-gluon fusion contributions.



# SPD hybrid configuration

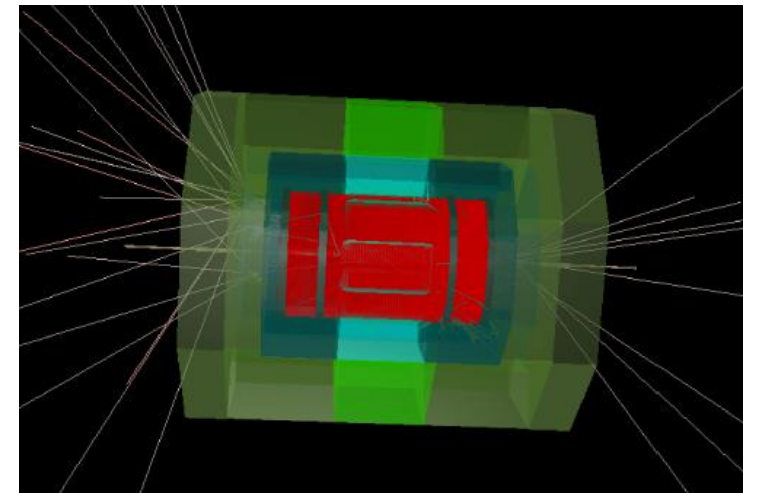


## Tasks:

- Relative contribution of  $q\bar{q}$  annihilation in the SPD energy range.
- Studies of the acceptance dependence on  $J/\psi$  polarization.

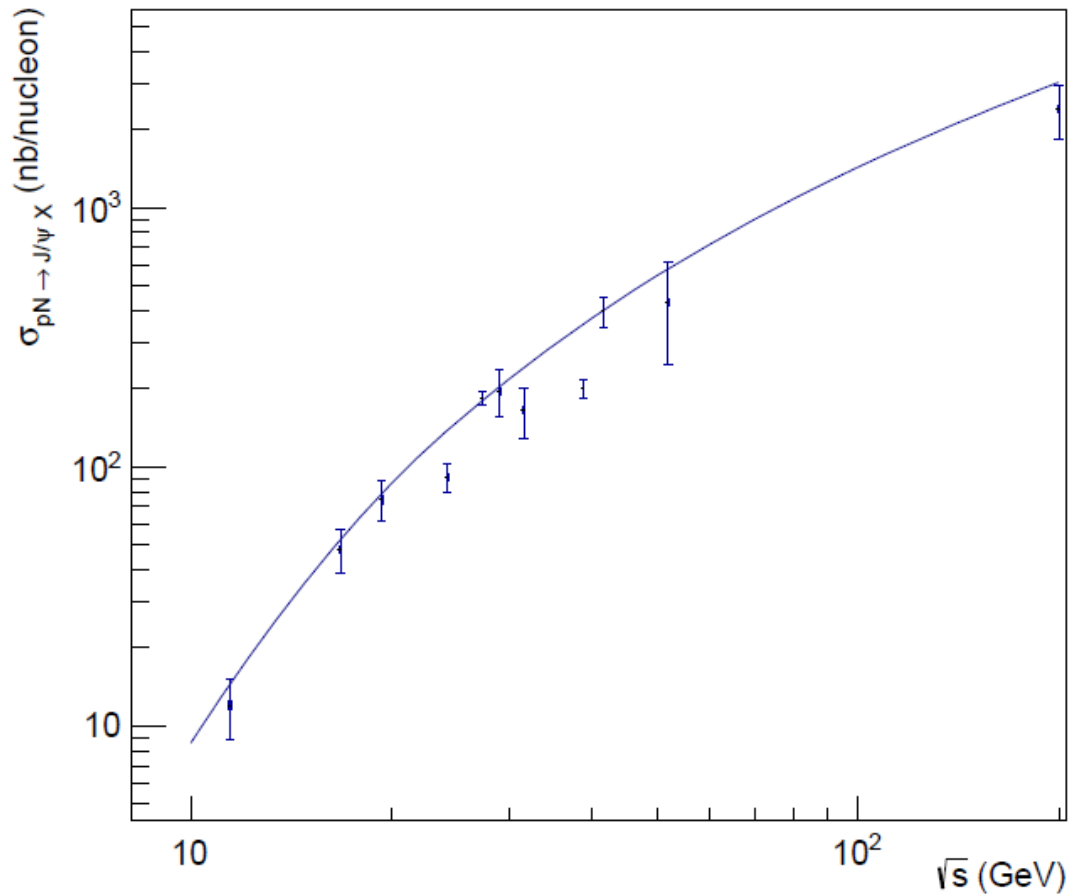
## SPDRoot:

- Based on the FairRoot.
- ROOT geometry.
- Transportation of secondary particles through material of the setup and simulation of detector response is provided by GEANT4 code.
- Pythia6 and Pythia8 as well as specialized generators can be used for simulation of primary nucleon-nucleon collision.

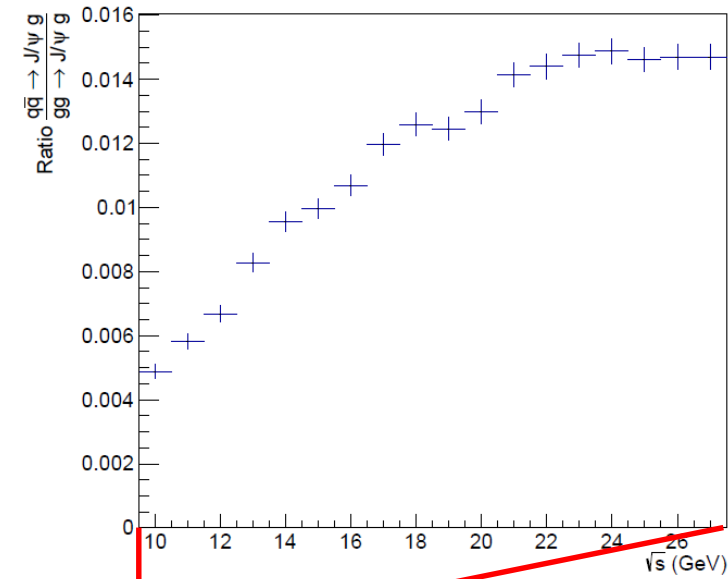


# Relative contribution of $q\bar{q}$ annihilation

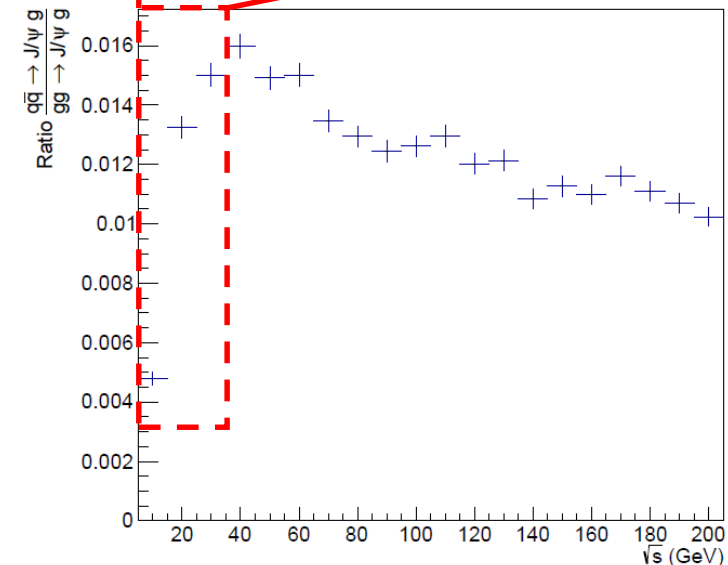
Experiment vs. Pythia8 simulation



- Tuning of Pythia8 parameters.
- Direct production of  $J/\psi$  is 60%.



$q\bar{q}$  influence decreases for low energies but the  $q\bar{q}$  annihilation contribution increases

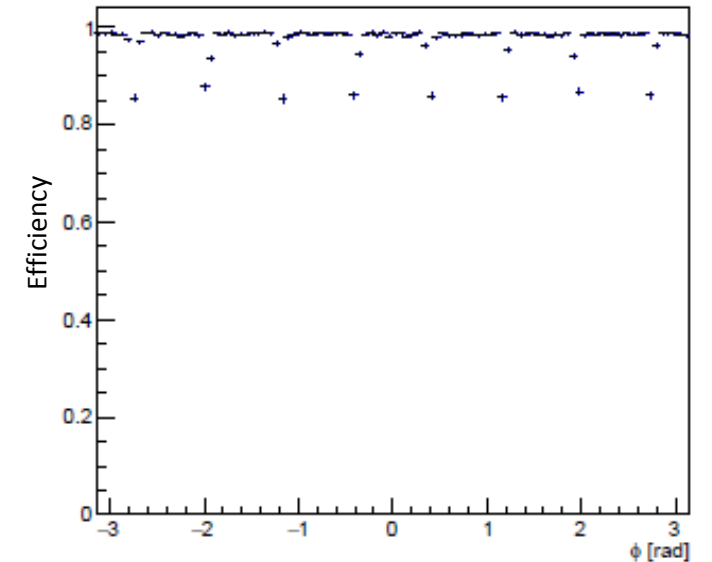
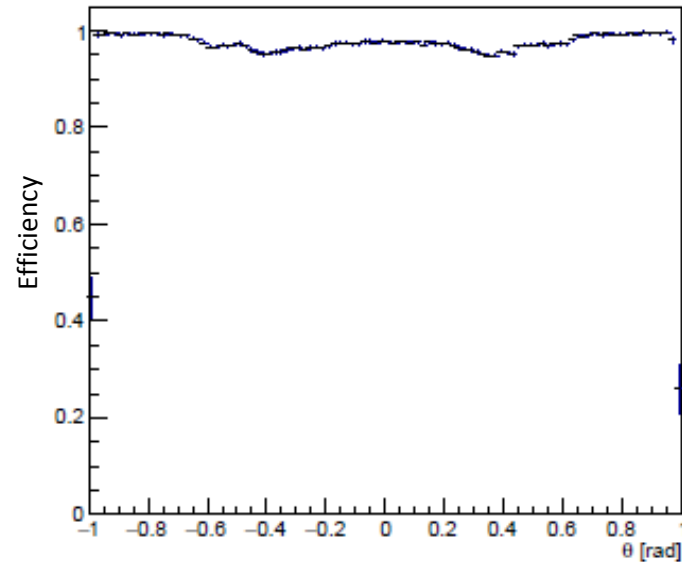
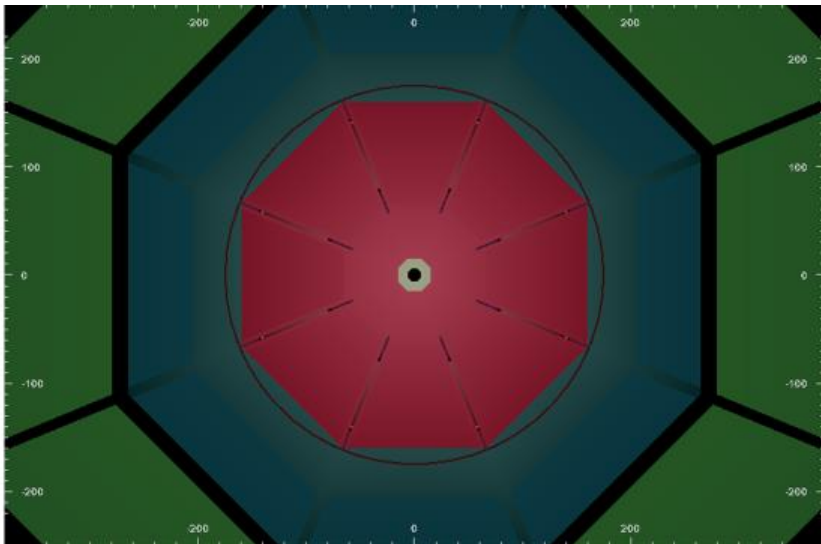
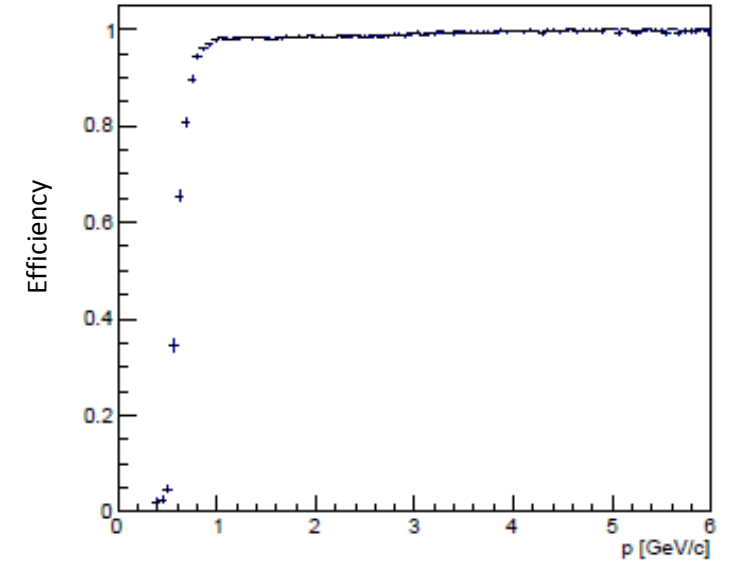
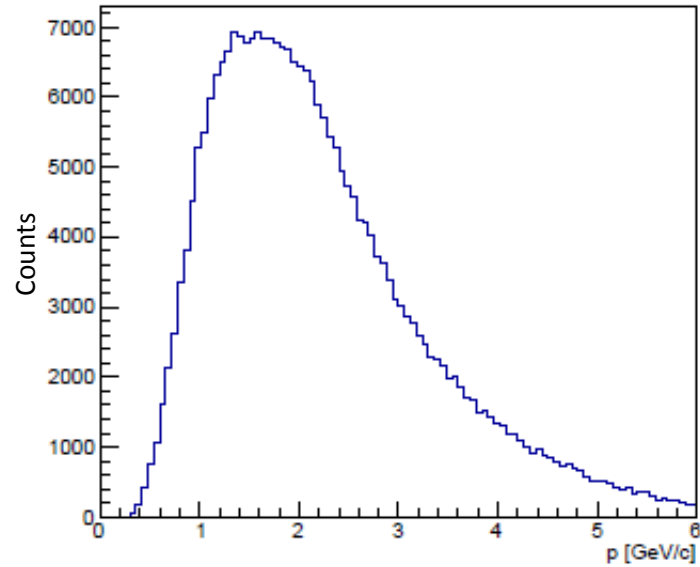
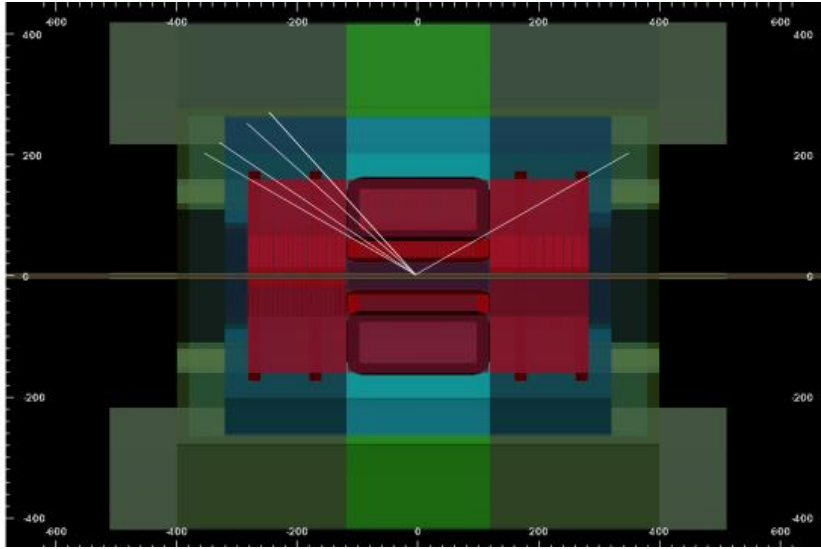


Pythia8 treatment for low energies needs further studies

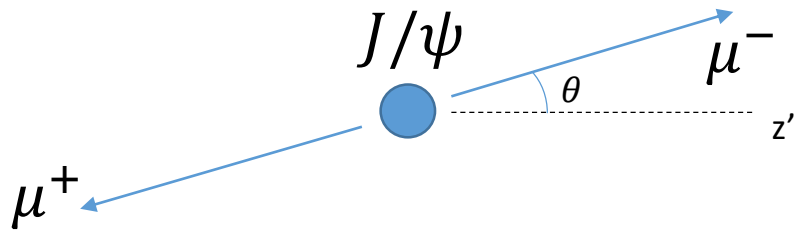


# SPD acceptance

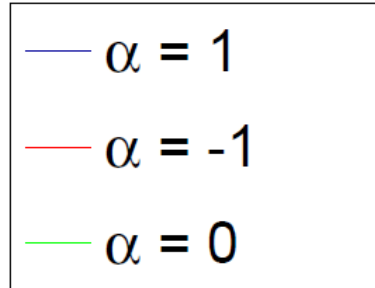
$J/\psi \rightarrow \mu^- \mu^+$  Muon detection done in the range system



# Influence of $J/\psi$ polarization in selection efficiency



$$\frac{dN}{d(\cos \theta)} = 1 + \alpha \cos^2 \theta$$

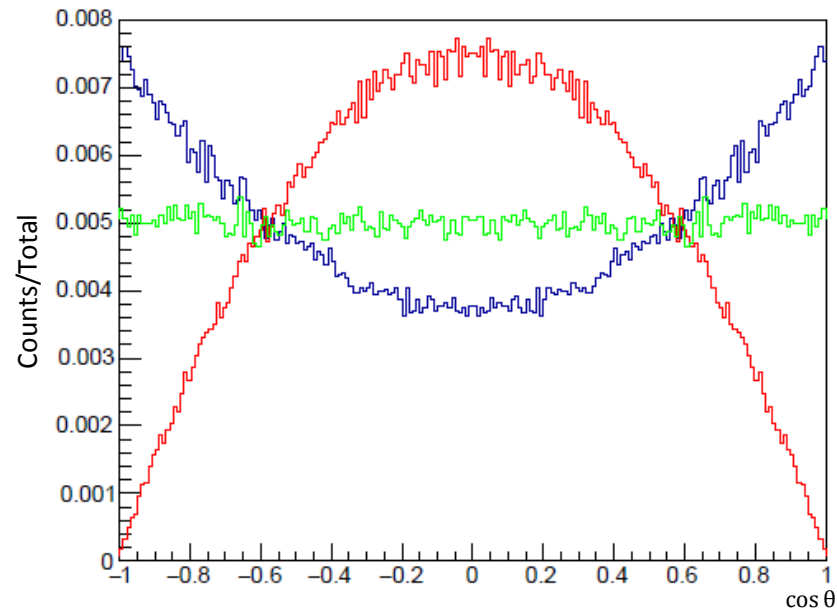


$$\alpha = -1 \rightarrow e_{-1} = (96.0 \pm 0.1)\%$$

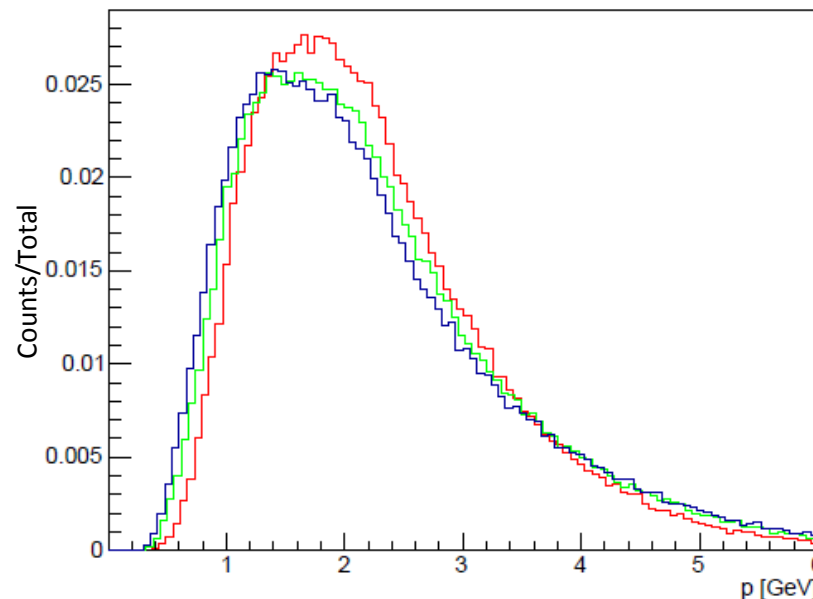
$$\alpha = 0 \rightarrow e_0 = (94.7 \pm 0.1)\%$$

$$\alpha = 1 \rightarrow e_1 = (94.0 \pm 0.1)\%$$

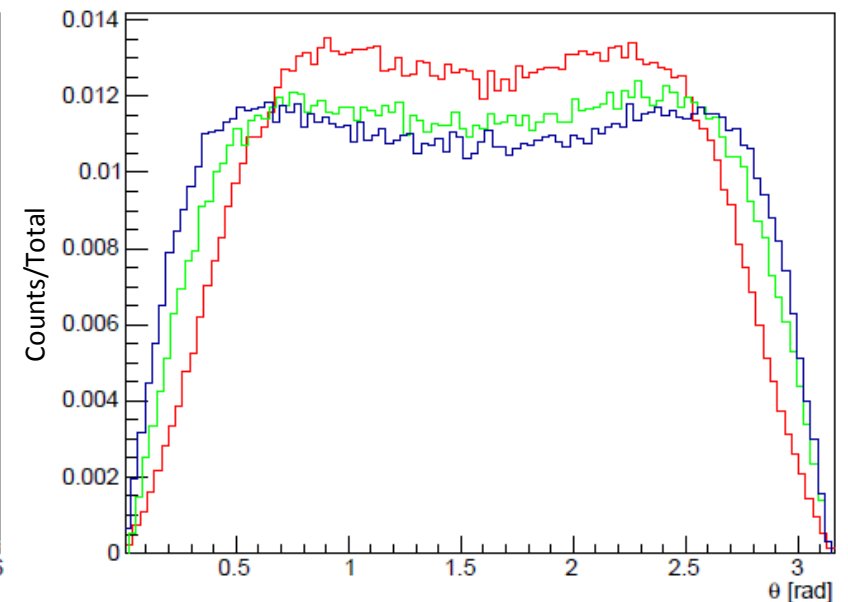
Muon  $\cos\theta$  distribution in  $J/\psi$  frame



Muon momentum distribution



Muon  $\theta$  distribution



# Summary

- Pythia8 tuned and validated for the total  $J/\psi$  cross section.
- Decreasing of CMS energy will not significantly increase contribution of the  $q\bar{q}$  annihilation process.
- $J/\psi$  polarization notably affects kinematic distributions for muons.
- Acceptance variation of 2%.
- Results will be used for the update of the conceptual design of the SPD.



Thank you!