Simulation of pp interactions at the HJet polarimeter at RHIC

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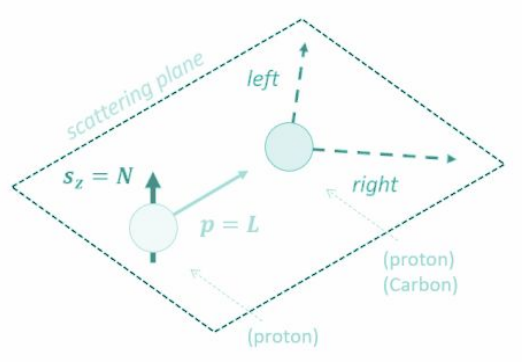
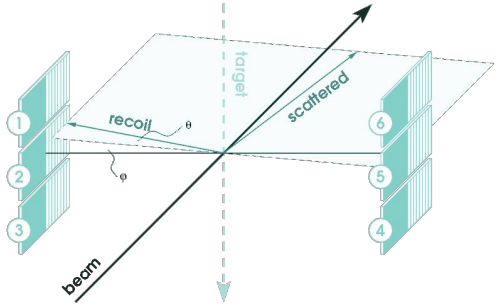
2021/05/05

Hadron polarimetry method and data



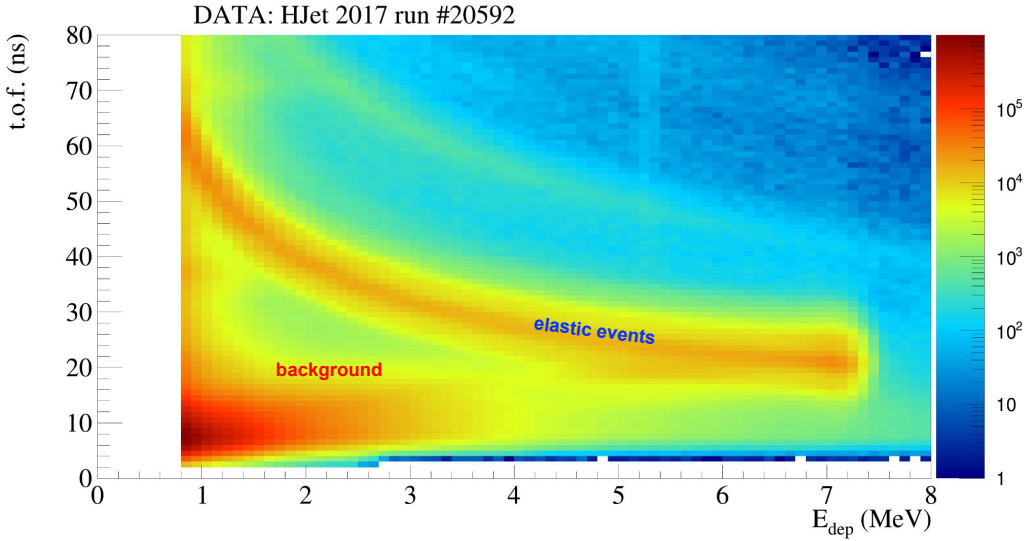


Basis:

Elastic scattering in CNI-region

-> left-right asymmetry of recoil particles: $\epsilon = \frac{N_L - N_R}{N_L + N_R}$

Asymmetry and polarization are related through **analyzing power**: $\epsilon = A_N P$



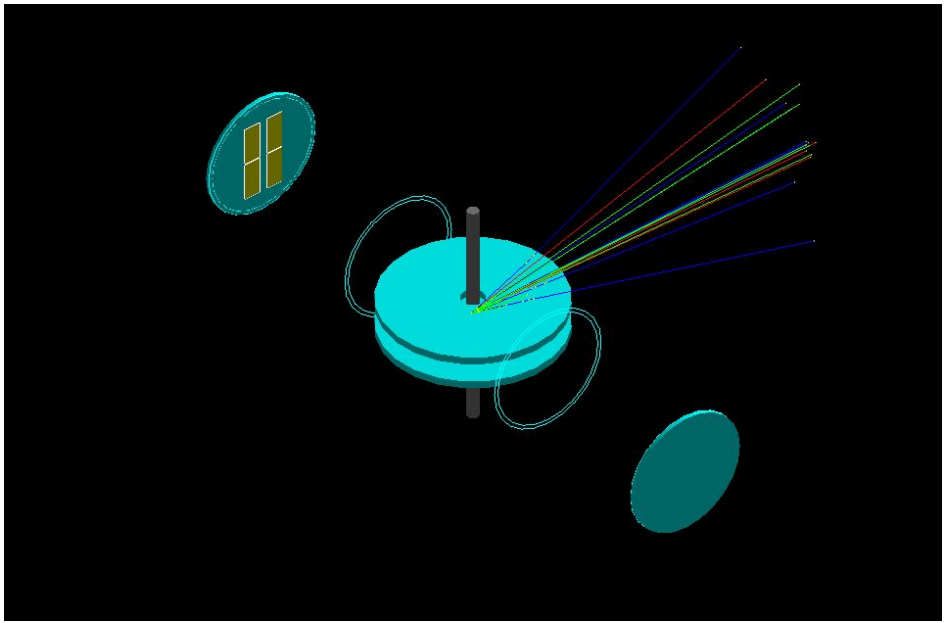
Simulation

Event generator: Pythia 6, “minimum bias” process mix

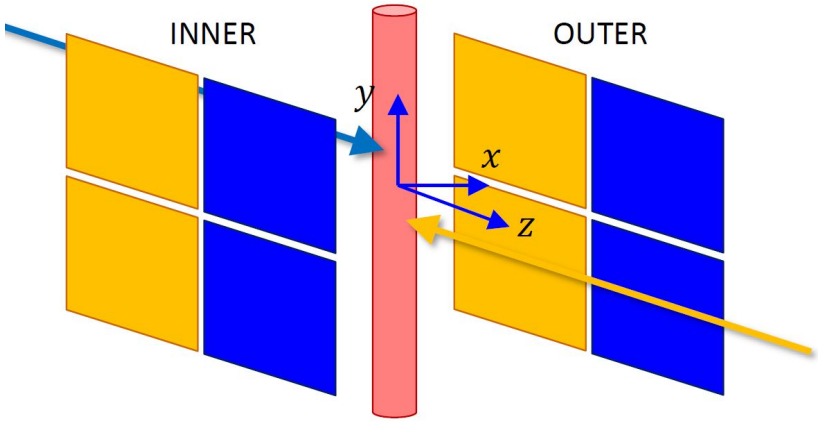
$11 : f_i f_j \to f_i f_j$
$12 : f_i f_i \to f_k f_k$
$13 : f_i \bar{f}_i \to f_k \bar{f}_k$
$28 : f_i g \to f_i g$
$53 : gg \to f_k \bar{f}_k$
$68 : gg \to gg$
$91 :$ elastic scattering
$92 :$ single scattering $(AB \to XB)$
$93 :$ single scattering $(AB \to XA)$
$94 :$ double diffraction
$95 :$ low $p_\perp$ production

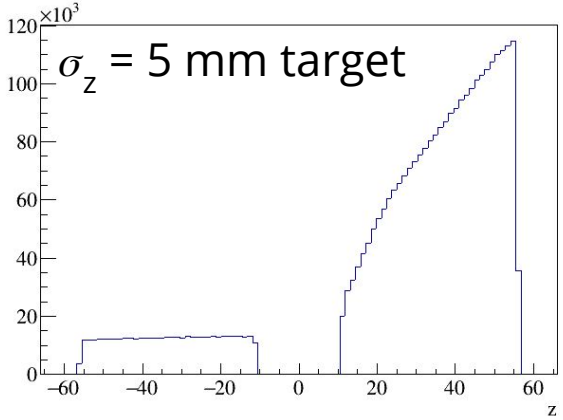
E_{beam} = 255 GeV

Passage through matter: Geant 4 (HJetSim, by Oleg Eyser)



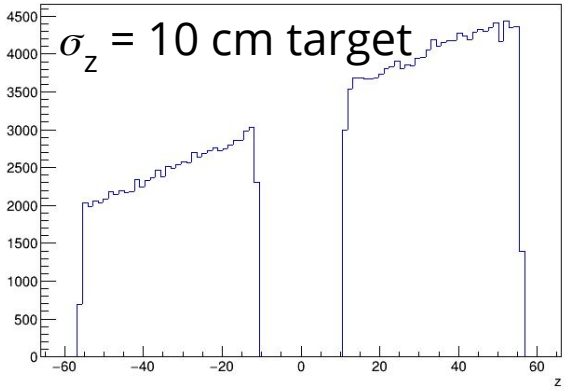
Z hit distribution

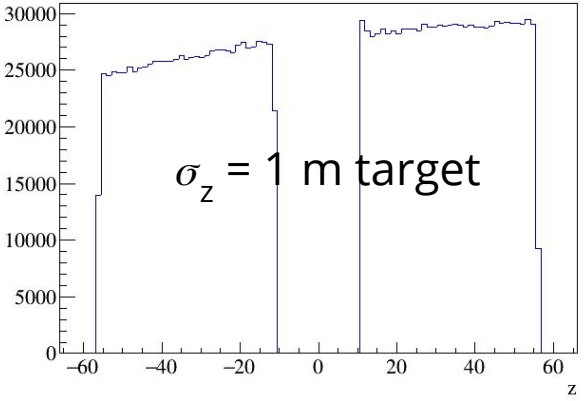




For the blue beam:

- z>0 strips include hits from elastic process
- z<0 strips don't include hits from elastic process





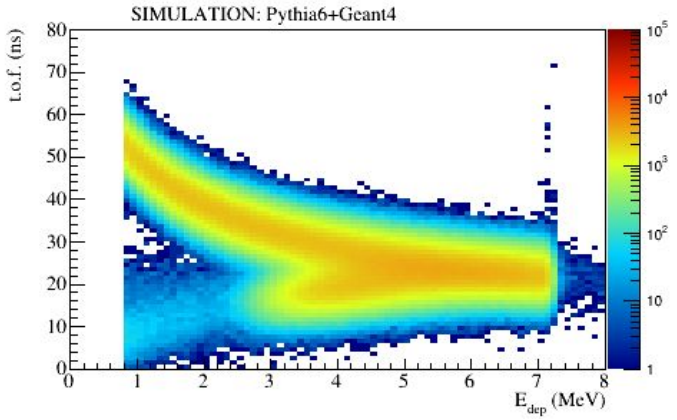
PID

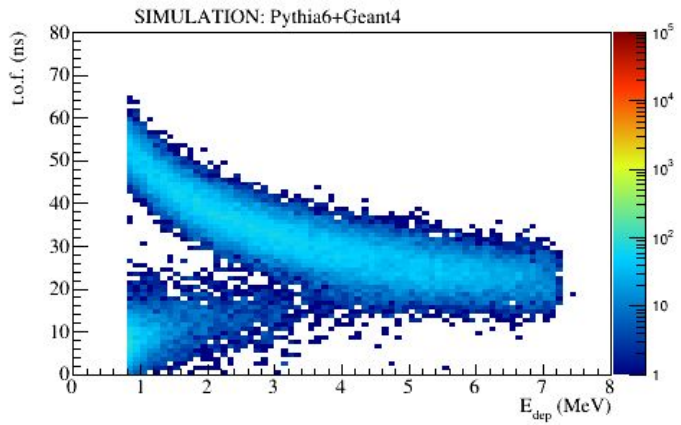
σ_z = 5 mm target

PROTONS

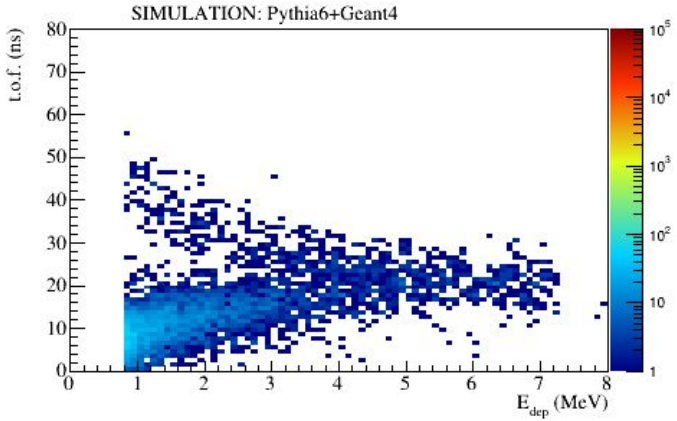
PIONS

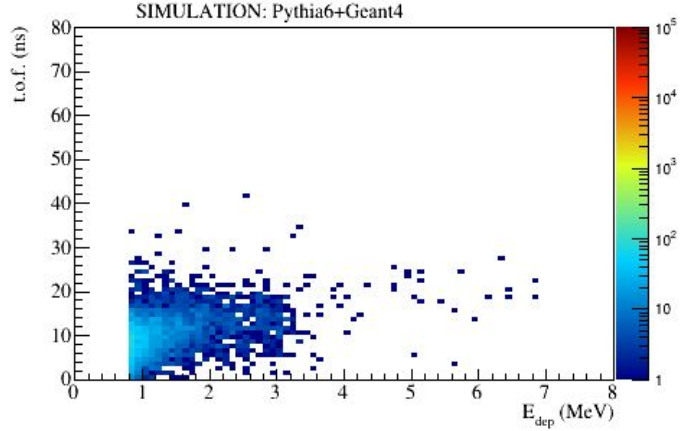
Z>0





Z<0





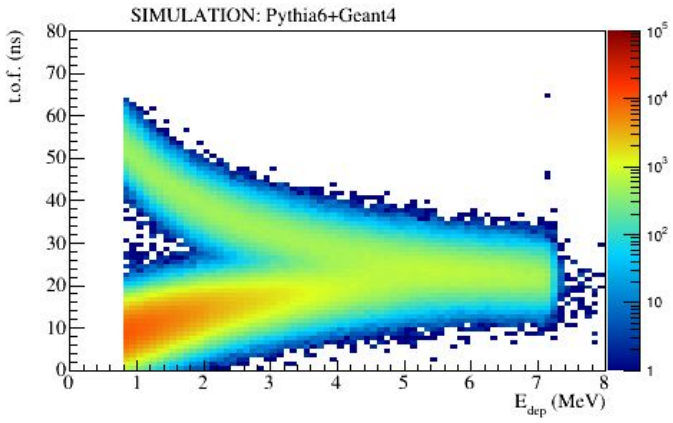
PID

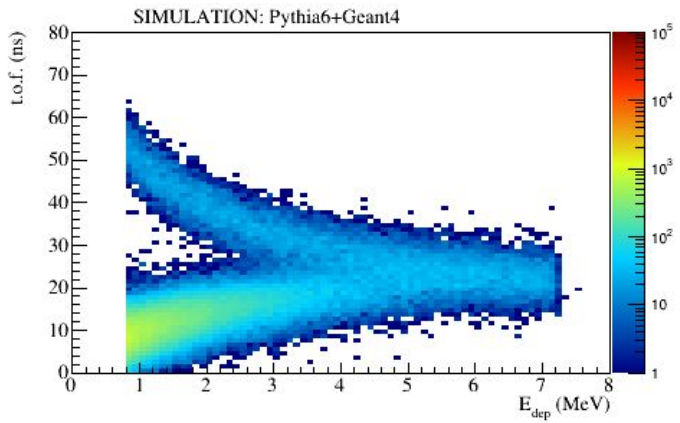
σ_z = 10 cm target

PROTONS

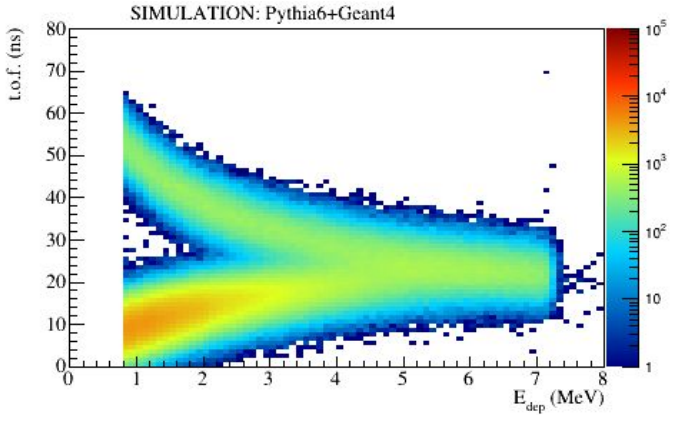
PIONS

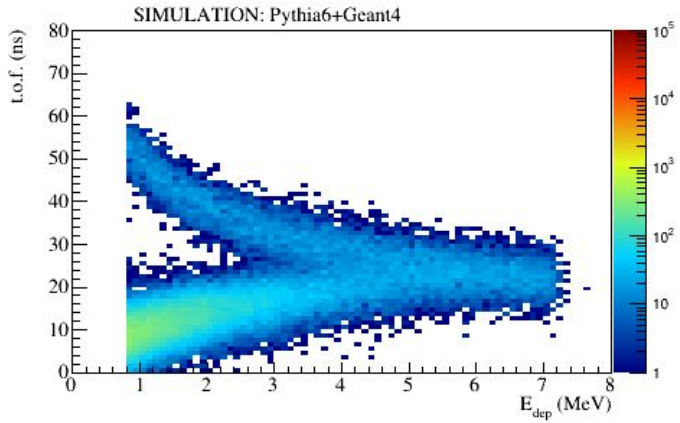
Z>0





Z<0





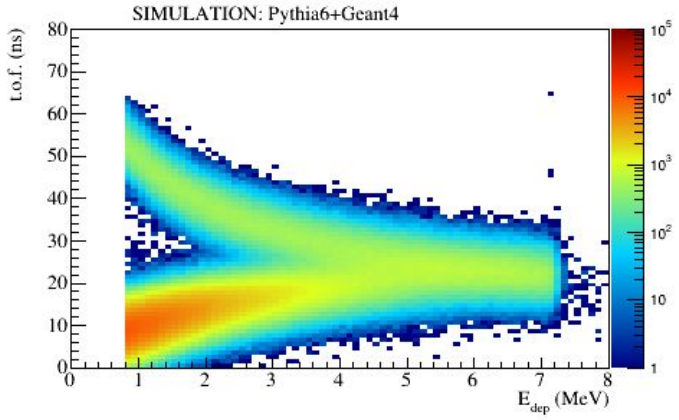
PID

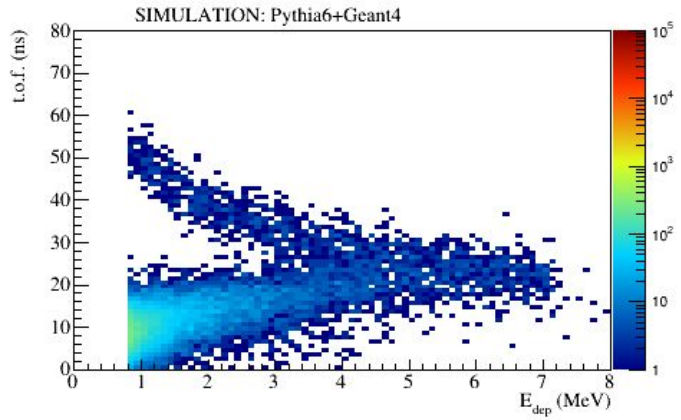
σ_z = 1 m target

PROTONS

PIONS

Z>0





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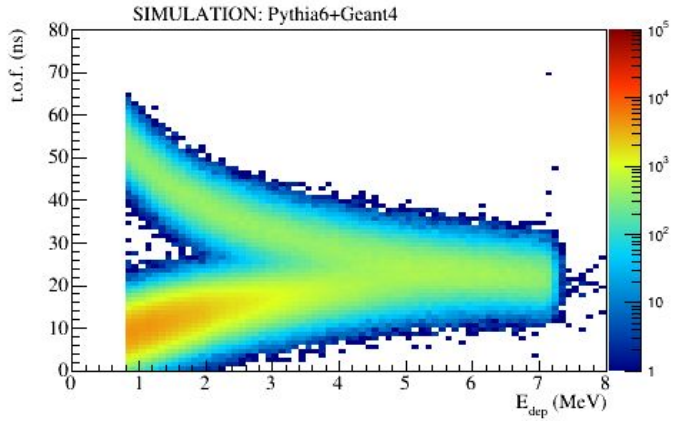
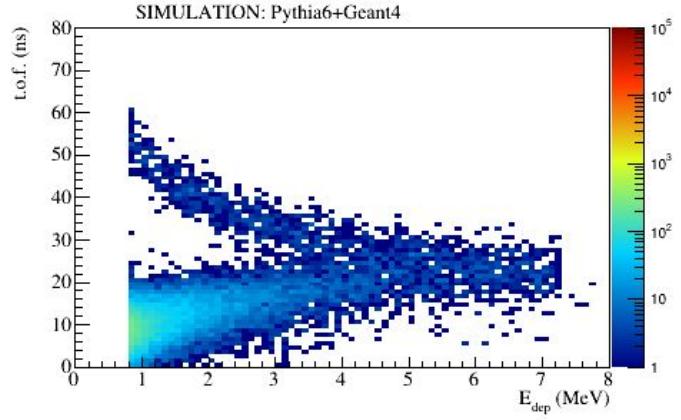
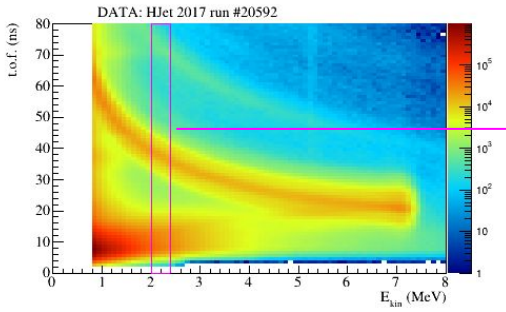


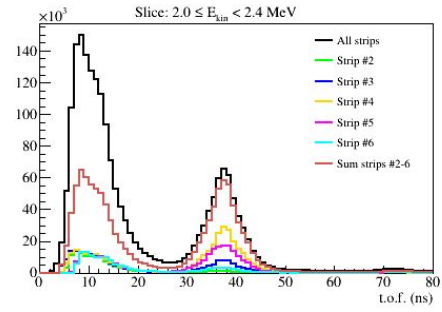


Data vs simulation

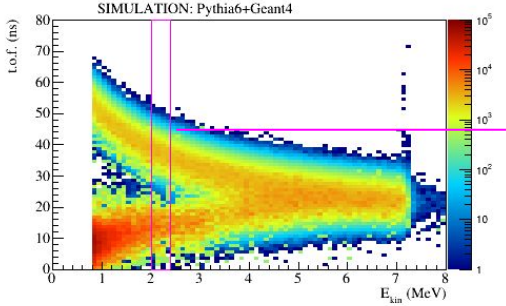
1Bevents, σ_z = 5mm target,
background (z<0)
multiplicative factor 400

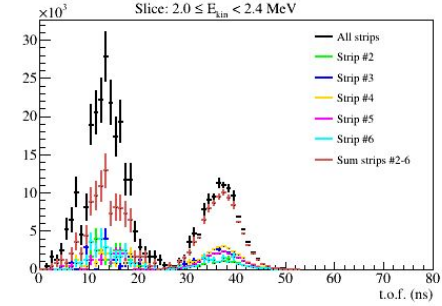
DATA: t.o.f. vs E_{dep}



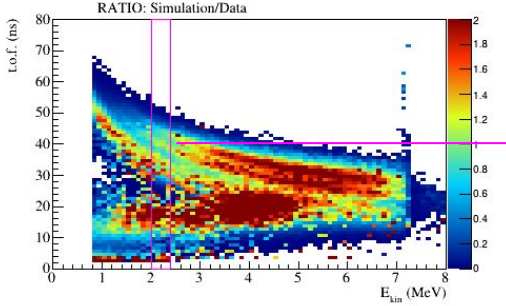


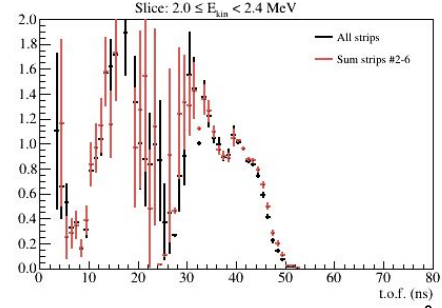
SIMULATION: t.o.f. vs E_{dep}





RATIO (SIMULATION/DATA): t.o.f. vs E_{dep}





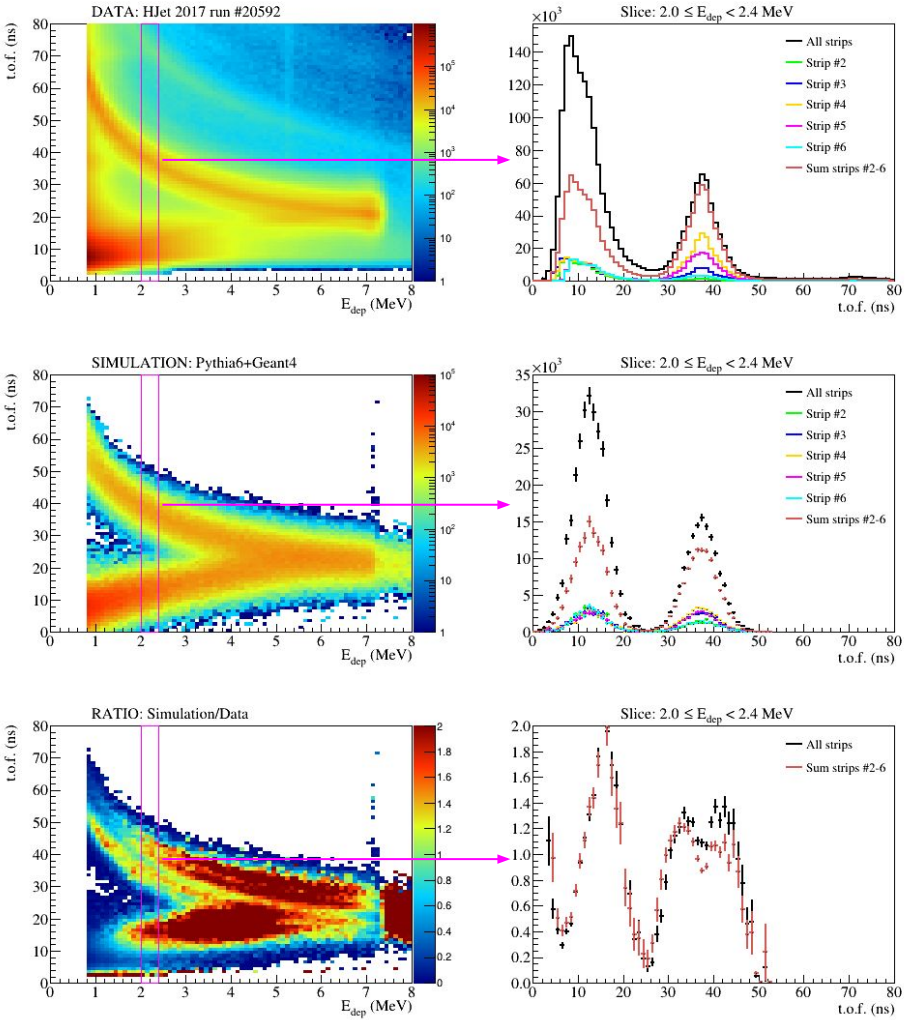
Data vs simulation

DATA: t.o.f. vs E_{dep}

1Bevents, σ_z = 5 mm target,
100Mevents σ_z = 10 cm target,
100Mevents σ_z = 1 m target,
background (z<0)
multiplicative factor 45

SIMULATION: t.o.f. vs E_{dep}

RATIO (SIMULATION/DATA): t.o.f. vs E_{dep}



Summary and outlook

A reasonable description of the HJet data was achieved using Pythia 6 and Geant 4 / HJetSim, namely:

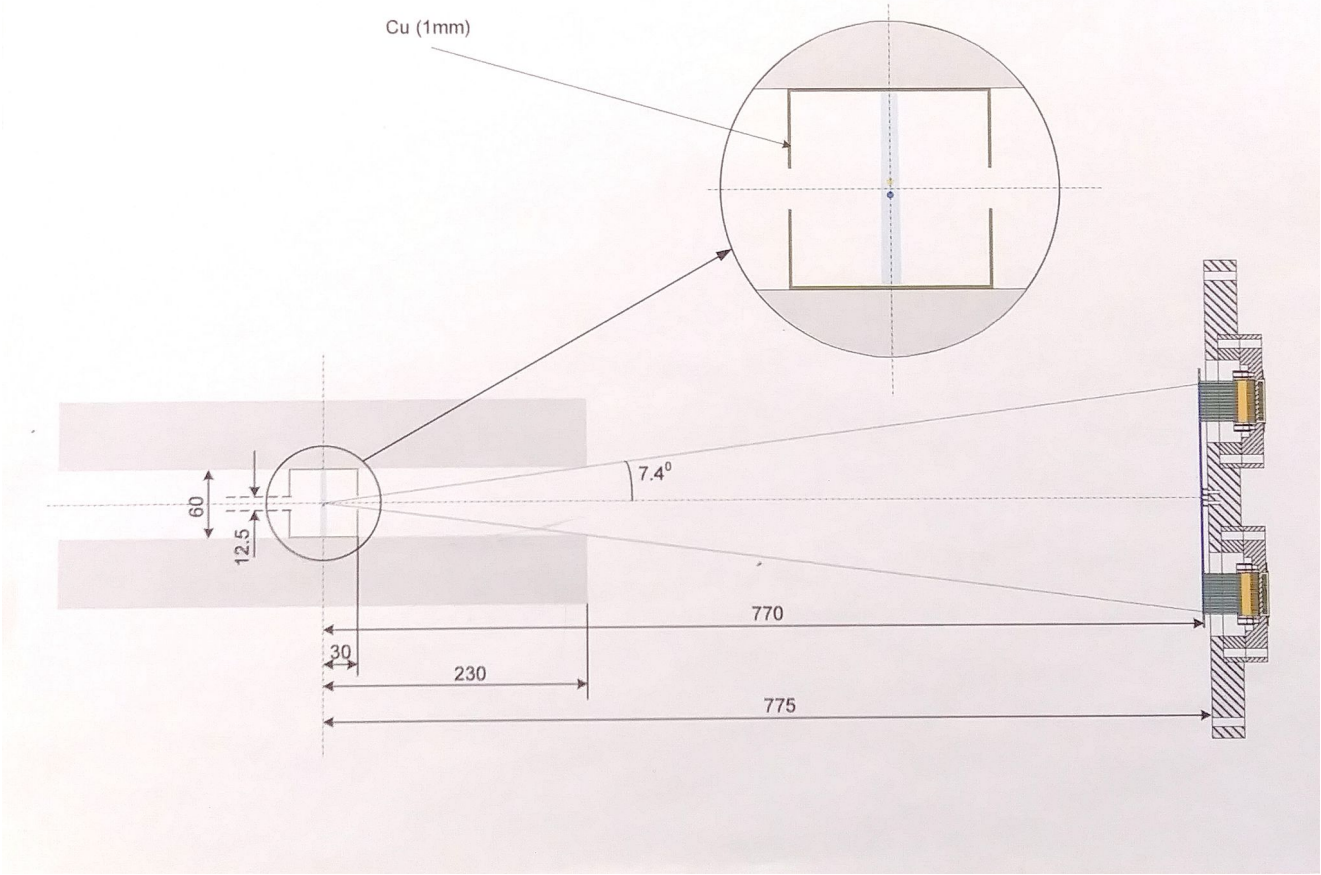
- Composition of the background (including punch-through particles) to elastic events
- Extended targets allow to emulate molecular hydrogen
- Dead layer allows to reproduce the cutoff in the tof vs E_{dep} plot at E_{dep}~7 MeV
- Delta(tof) ~ 1 ns allows to get an almost symmetric ration for the signal peak

Next steps:

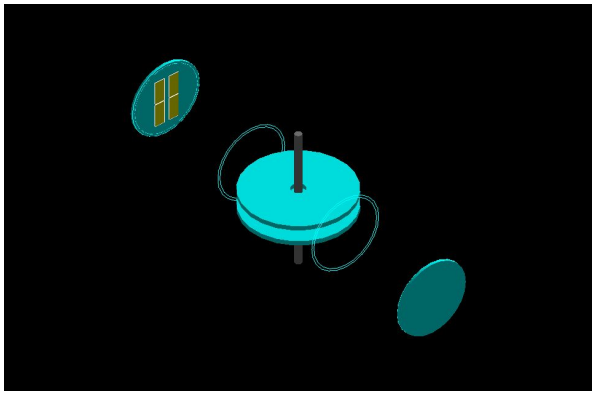
- Second layer of silicon
- pC polarimeter

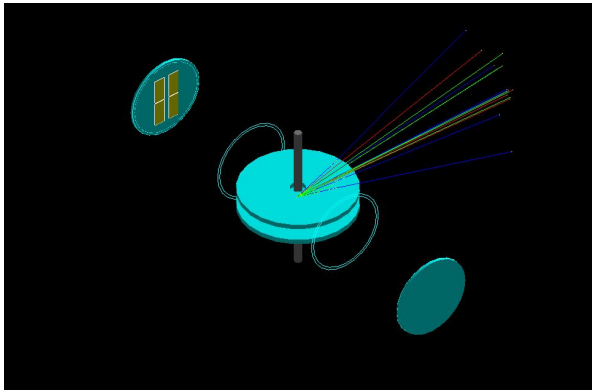
Backup

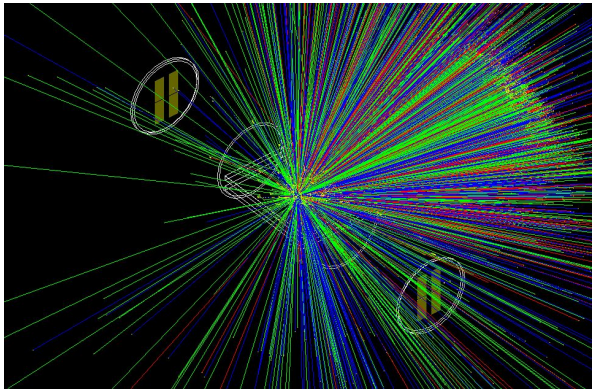
Side view and dimensions of the H-jet beam setup



HJet description visualization







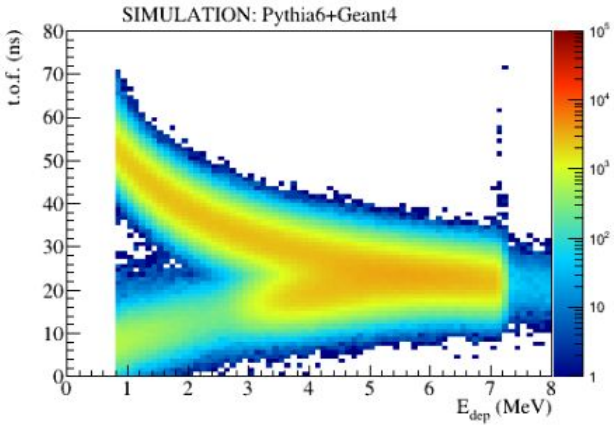
PID

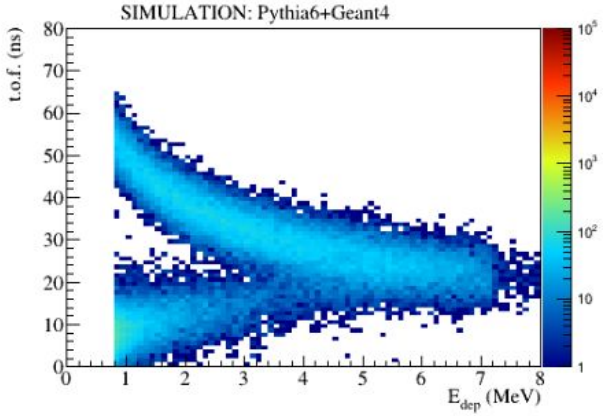
MIX:
σ_z = 0.5 mm +
σ_z = 10 cm + σ_z
= 1 m

PROTONS

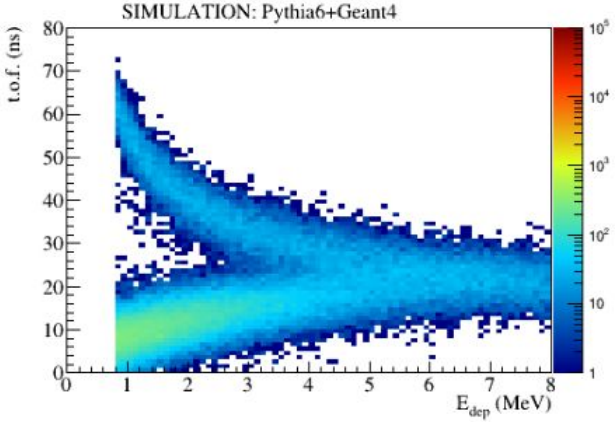
PIONS

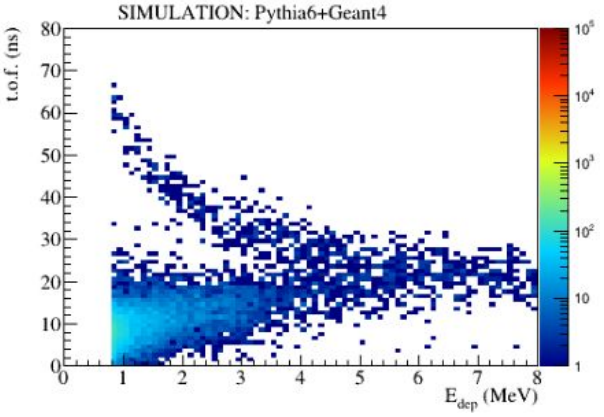
Z>0



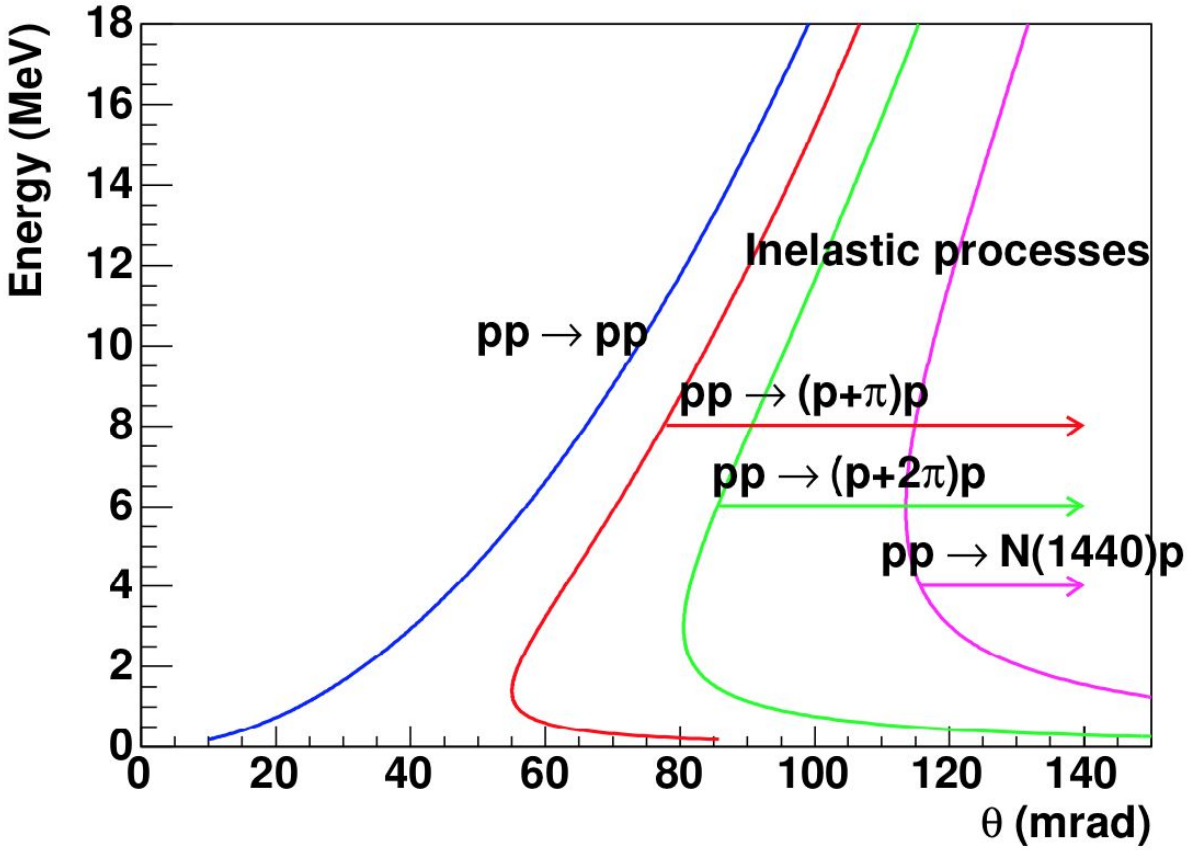


Z<0





Kinematics


Energy (MeV)
18
16
14
12
10
8
6
4
2
0
0
20
40
60
80
100
120
140
θ (mrad)
Inelastic processes
pp → pp
pp → (p+π)p
pp → (p+2π)p
pp → N(1440)p