Update on NDE in PCAL/ECAL

$$e\,p \longrightarrow e'\pi^{+}(n)$$

RGA-Data

Fall 2018:

1- inbending data at 10.6 GeV , 169 runs, torus-1

The data used in this presentation correspond to RGA inbending pass1:

/cache/clas12/rg-a/production/recon/fall2018/torus-1/pass1/v0/dst/train/skim7/

"coatjava": "/group/clas12/packages/clara/4.3.12_6.5.3//plugins/clas12",

2- outbending data at 10.6 GeV ,171 runs, torus+1

The data used in this presentation correspond to RGA outbending pass1

/volatile/clas12/rg-a/production/recon/fall2018/torus+1/pass1/v1/dst/train/ skim7/)

coatjava":/group/clas12/packages/clara/4.3.12_6.5.6//plugins/clas1

Spring 2019:

1- inbending data at 10.2 GeV 113 runs

The data used in this presentation correspond to RGA inbending pass1:

/lustre19/expphy/volatile/clas12/rg-a/production/recon/spring2019/torus-1/pass1/v0/dst/train/skim7

coatjava": "/group/clas12/packages/clara/4.3.12_6.5.6.2//plugins/clas12"

Extracting Neutron Detection Efficiency

Determine the neutron detection efficiency (NDE) by using: $e\,p \rightarrow e'\,\pi^{+}(n)$

1. Select $e'\,\pi^{+}$ final state with no other charged particles $p(e, e'\,\pi^{+})X_n$.
2. Assume the missing particle is a neutron, calculate the missing momentum of the neutron and its trajectory through CLAS12 from the $e'\,\pi^{+}$ vertex
3. Check if the neutron's path intersects with the front face of PCAL/ECAL.

Yes → count as expected neutron
NO → skip the event

4. Loop over neutral PCAL/ECAL hits:
   - ✓ Get intersection of ray with the PCAL/ECAL face by drawing a line from the e′ π^{+} vertex to the actual neutral PCAL/ECAL hit.
   - ✓ Calculate ΔR for each actual neutral PCAL/ECAL hits, which is the distance between the intersection of the PCAL/ECAL hit and the intersection of the expected neutron trajectory.
   - ✓ Select hit with the smallest ΔR.
5. Applied some kinematics cuts to identify neutrons.

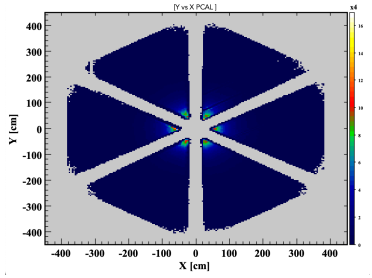
$$\mathbf{NDE} = \frac{N_{detected\ (n)}}{N_{expected\ (n)}}$$

Particle Identification

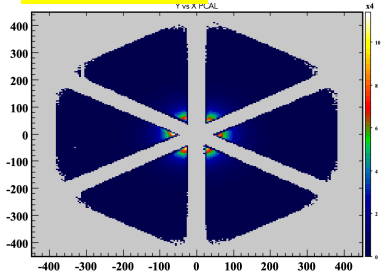
Cuts are applied to clean up the electron

- **Electromagnetic Calorimeter fiducial cut**

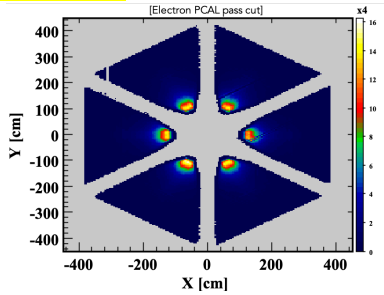
Spring Data



inb Fall Data

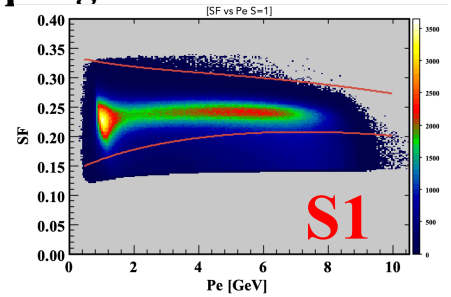


outb Fall Data

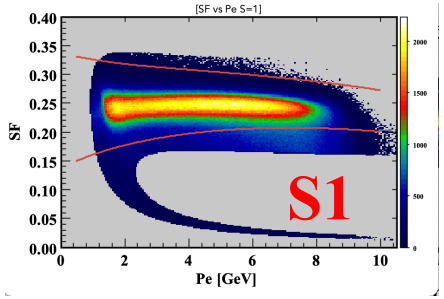


- **3 Sigma Sampling fraction cut**

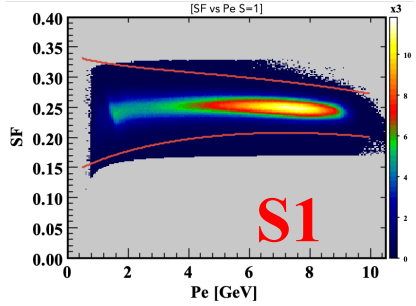
Spring Data



inb Fall Data

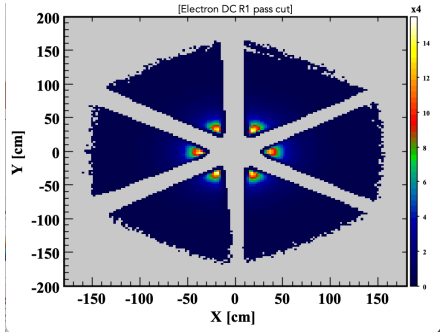


outb Fall Data



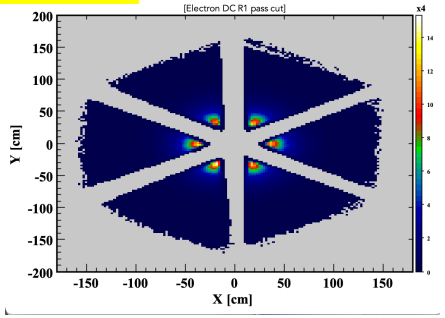
- **Drift chamber region 1,2,3 fiducial cut**

Spring Data

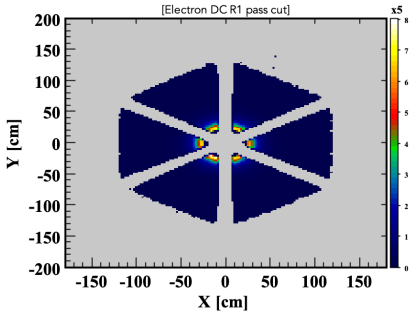


DC region 1

inb Fall Data



outb Fall Data



- **z-vertex position cut**

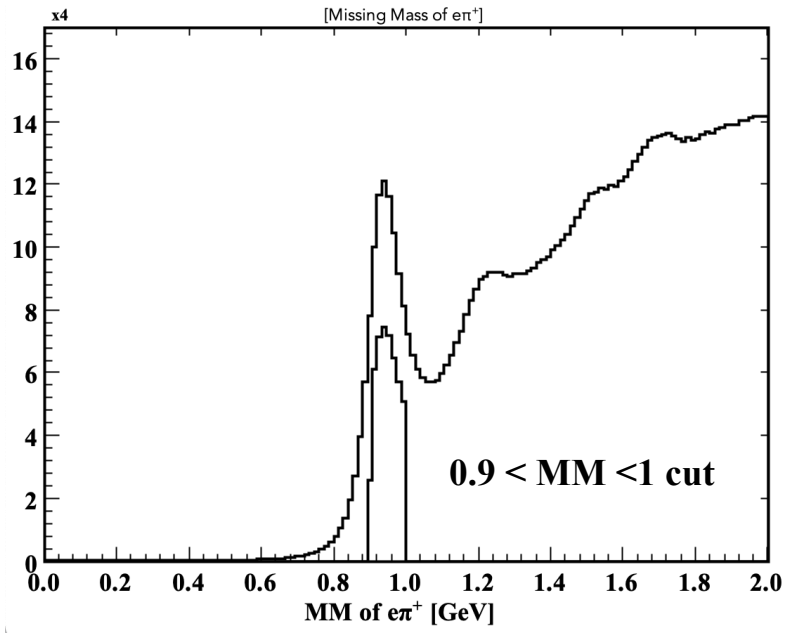
π^+ Identification

Cuts are applied to clean up the π^+ sample:

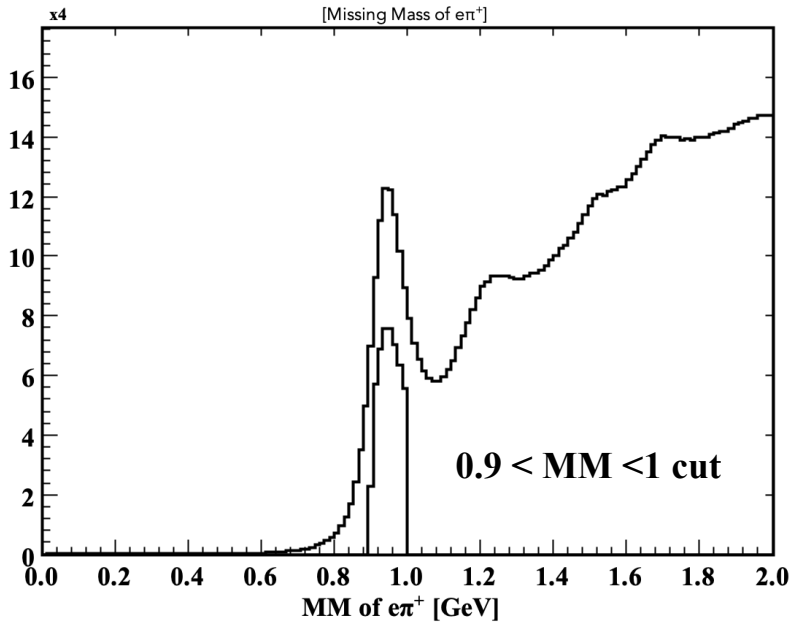
- Δv_z position cut $-20 \leq \Delta v_z \leq 20$
- Drift chamber region 1,2,3 fiducial cut
- χ^2 cut
- Δt cut $\Delta t = t_{start} - \left[t_{FTOF} - \frac{path}{\beta}\right]$ $-0.5 \leq \Delta t \leq 0.5$ cuts
- $\Delta\beta$ cut $\Delta\beta = \left[\left(\frac{path}{(T_{\pi+(SC)} - T_{start}).c}\right) - \left(\frac{p}{\sqrt{p^2 + M_\pi^2}}\right)\right]$ $-0.02 \leq \Delta\beta \leq 0.02$ cuts

Missing Mass epipX$_n$

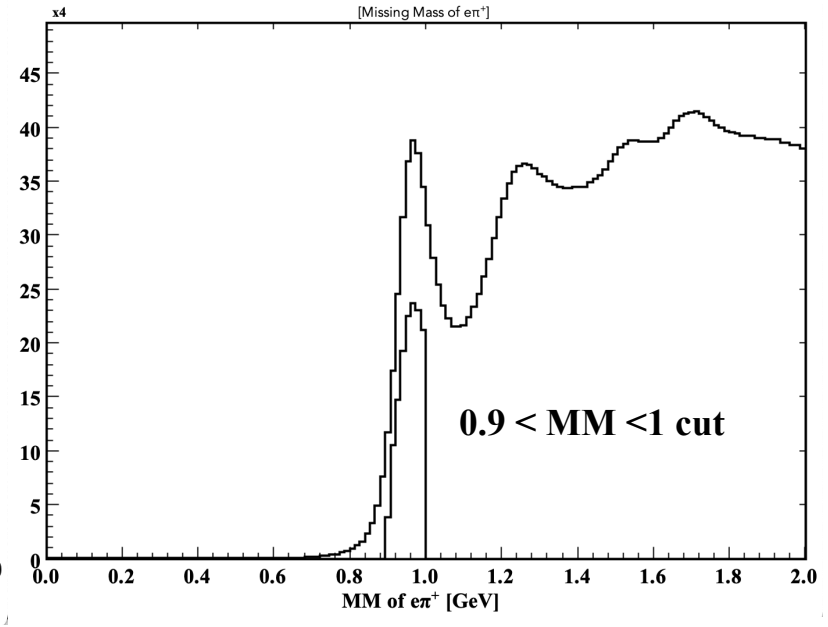
inb_Spring Data at 10.2 GeV

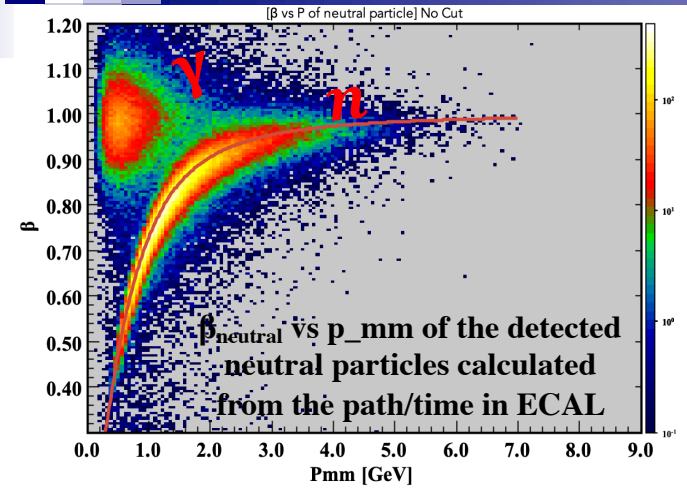


inb_Fall Data at 10.6 GeV

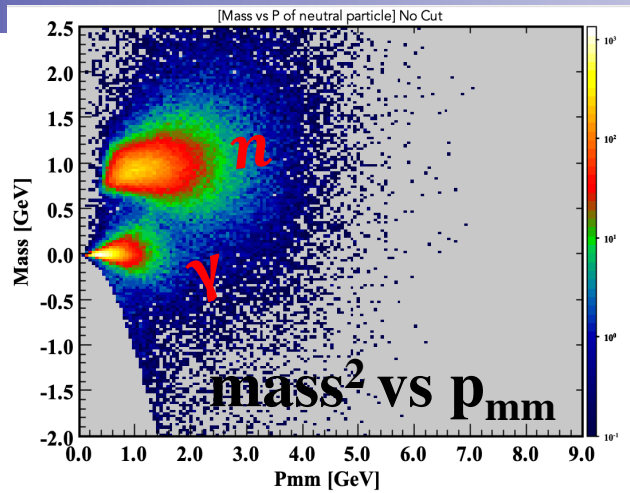


outb_Fall Data at 10.6 GeV



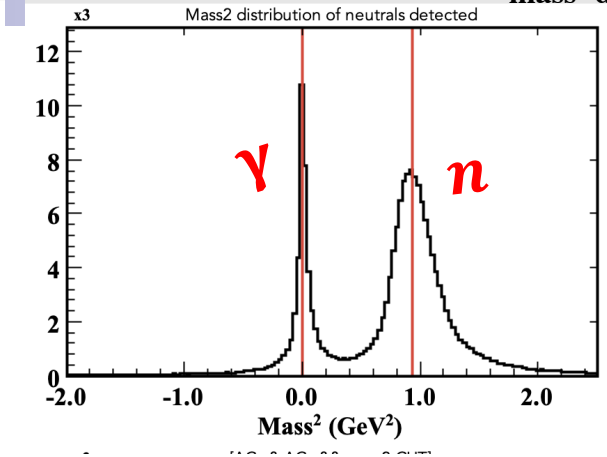


$\beta_{neutral}$ vs p_mm of the detected neutral particles calculated from the path/time in ECAL

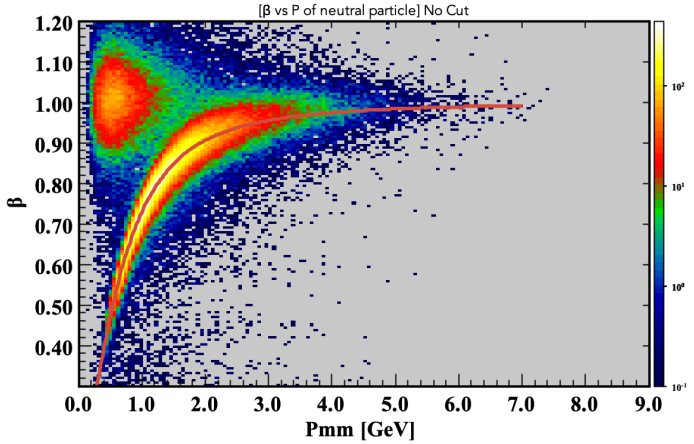


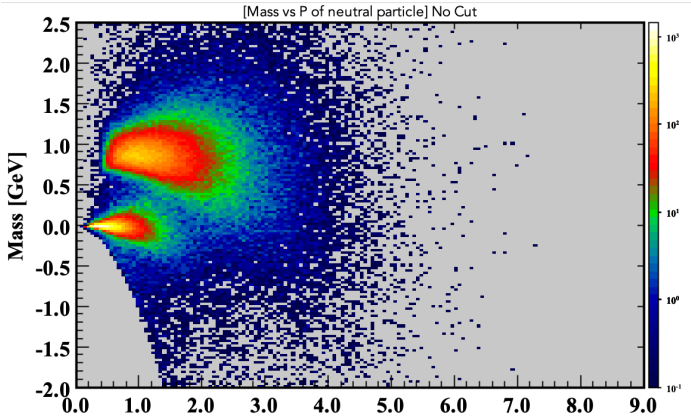
$mass^2$ vs p_{mm}

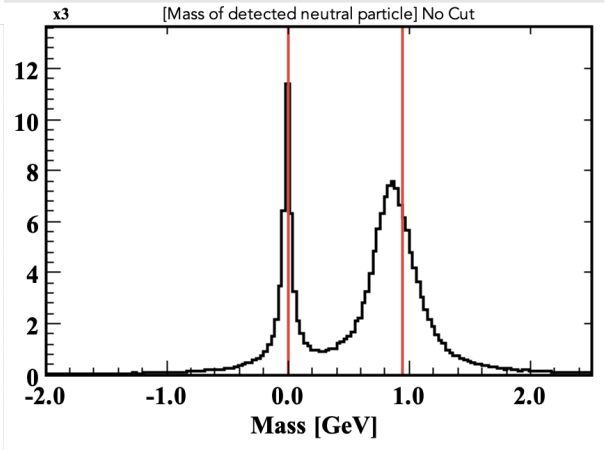
$mass^2$ distribution of the detected neutral particles



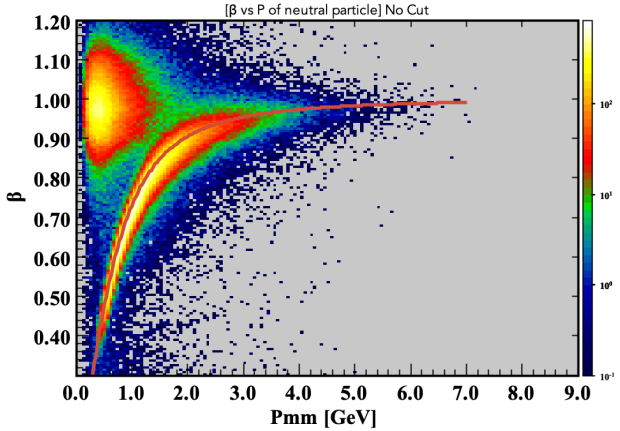
inb_Spring Data at 10.2 GeV

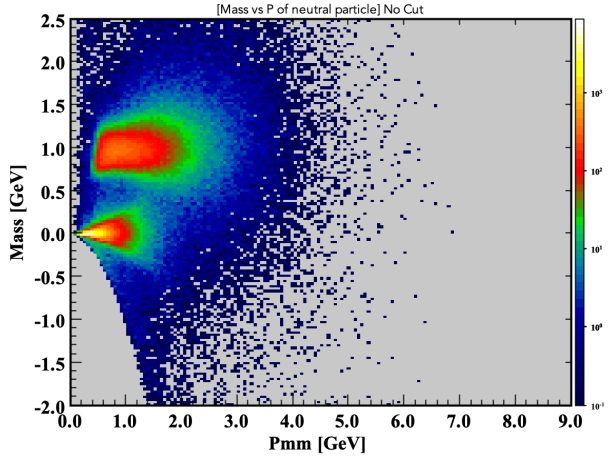


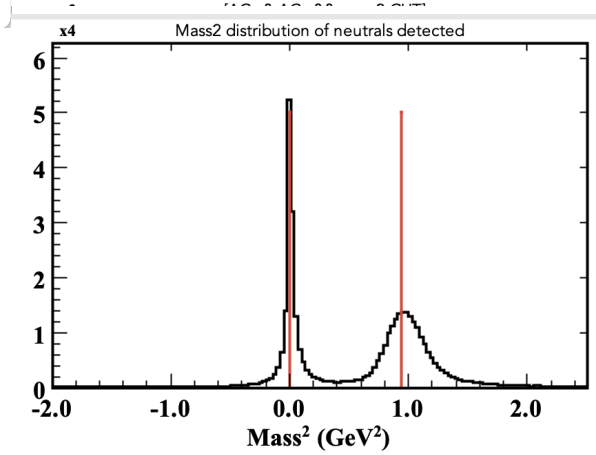




inb_Fall Data at 10.6 GeV

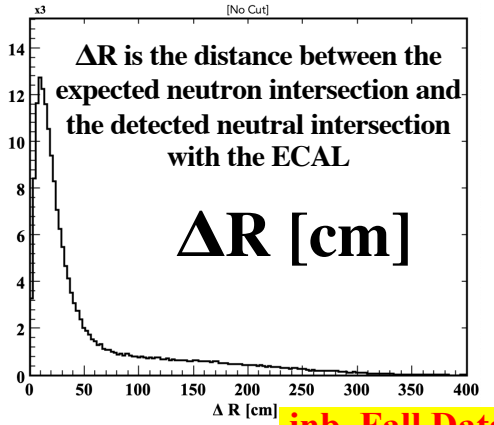




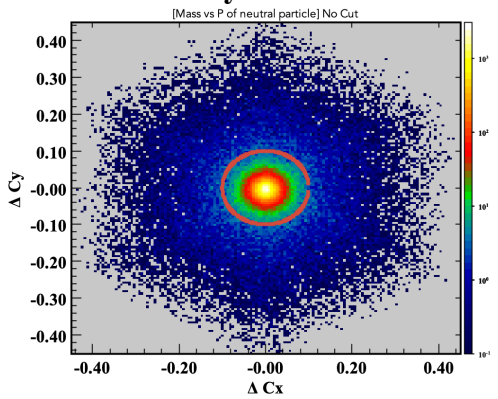


outb_Fall Data at 10.6 GeV

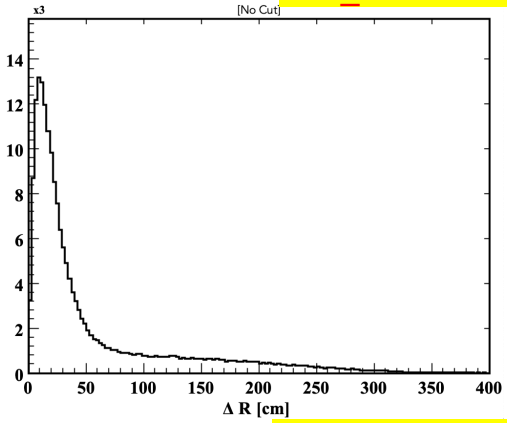
inb_Spring Data at 10.2 GeV

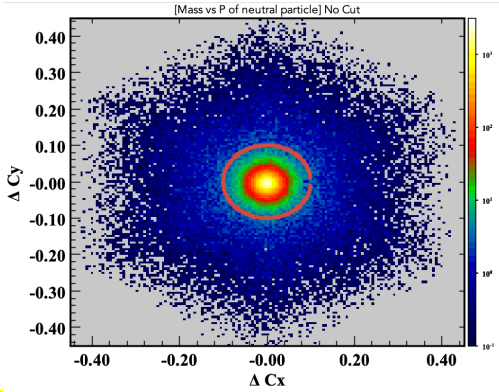


ΔC_y vs ΔC_x

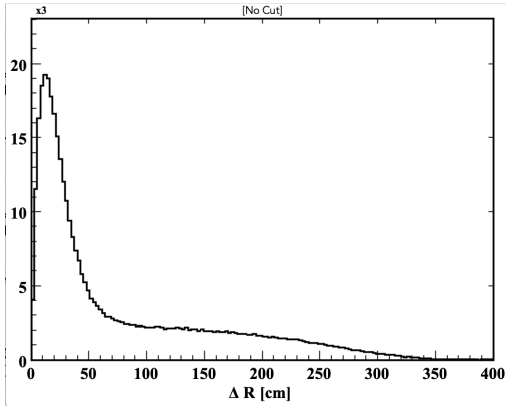


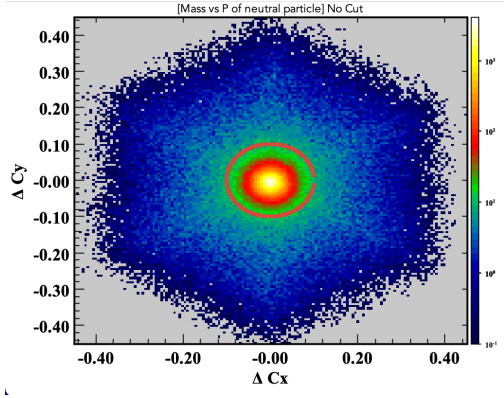
inb_Fall Data at 10.6 GeV



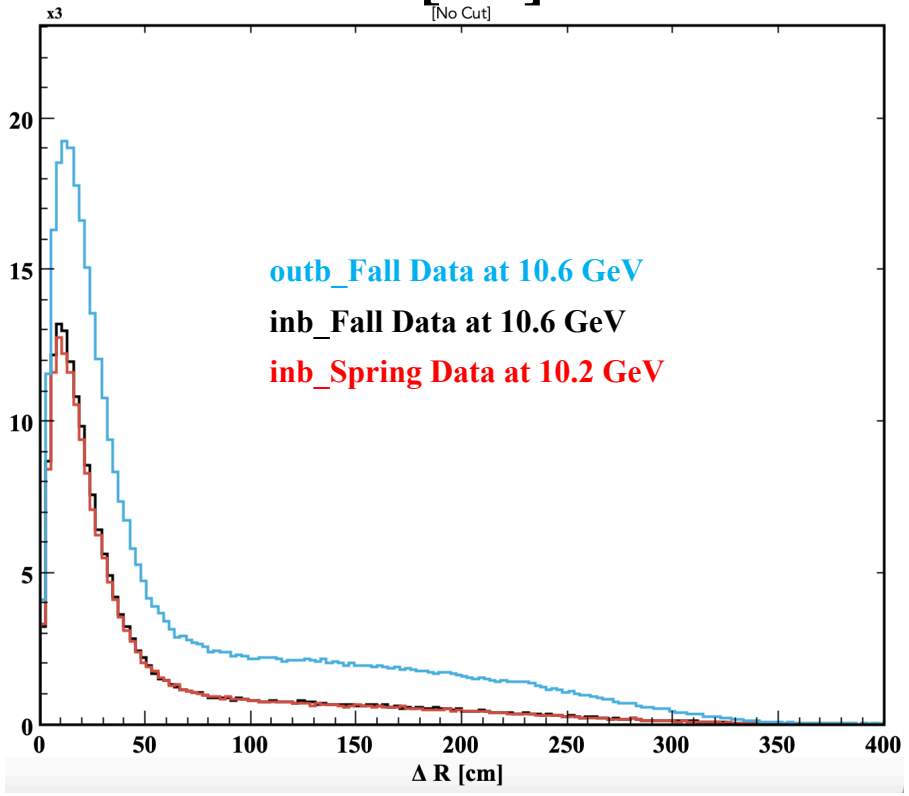


outb_Fall Data at 10.6 GeV





ΔR [cm]



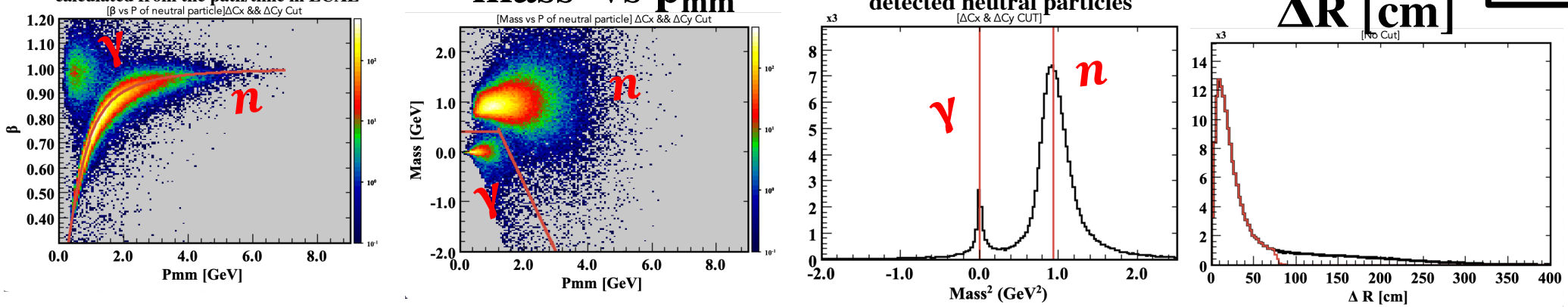
Apply cut: $\sqrt{\Delta C_x^2 + \Delta C_y^2} < 0.1$

$\beta_{neutral}$ vs p_mm of the detected neutral particles calculated from the path/time in ECAL

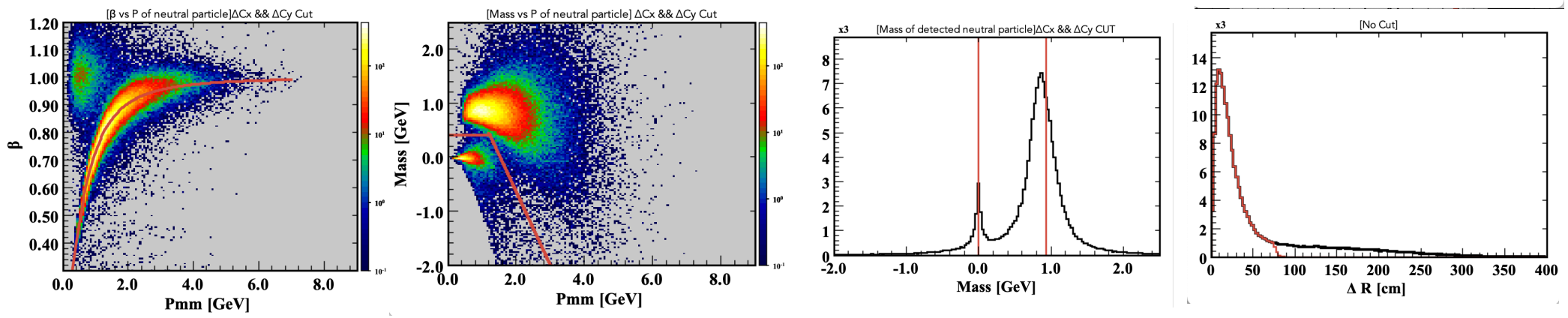
mass^2 vs p_{mm}

mass^2 distribution of the detected neutral particles

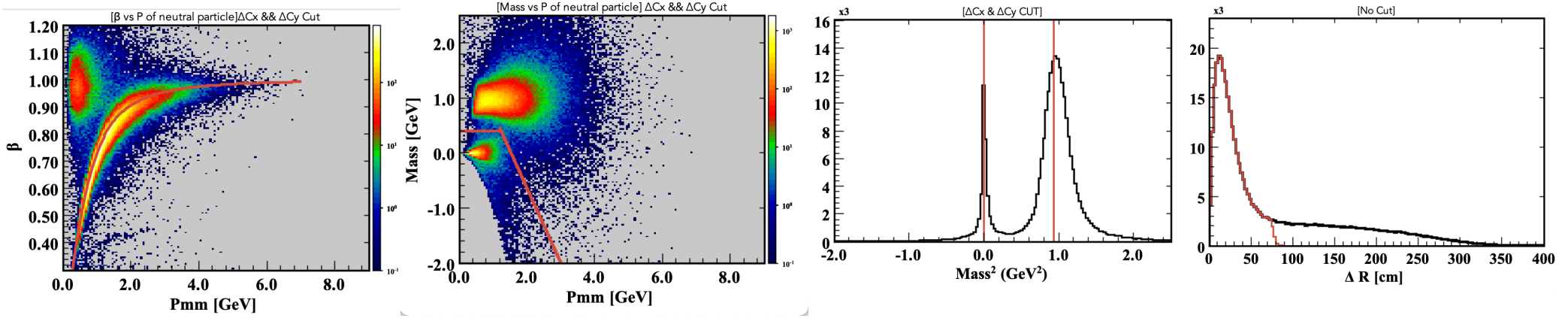
ΔR [cm]



inb_Spring Data at 10.2 GeV



inb_Fall Data at 10.6 GeV



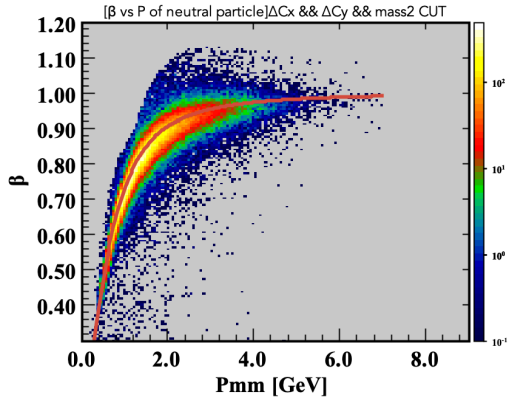
outb_Fall Data at 10.6 GeV

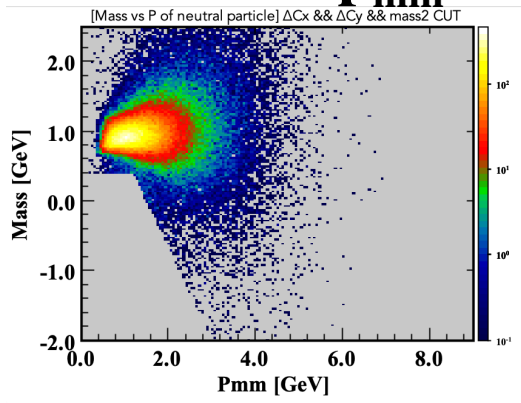
$\beta_{neutral}$ vs p_mm of the detected neutral particles calculated from the path/time in ECAL

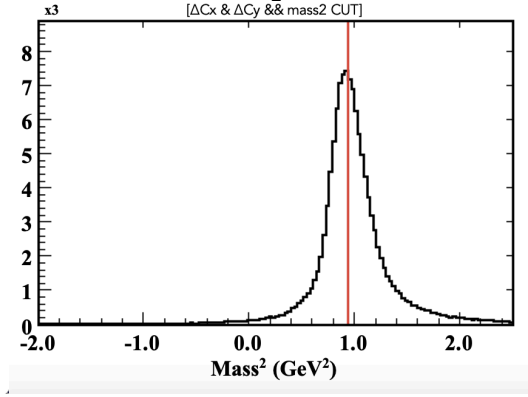
mass^2 vs p_{mm}

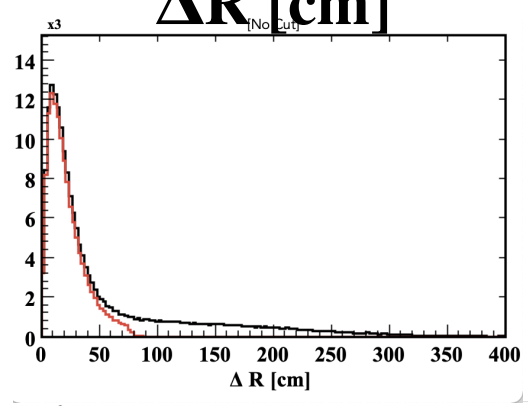
mass^2 distribution of the detected neutron particles

ΔR [cm]

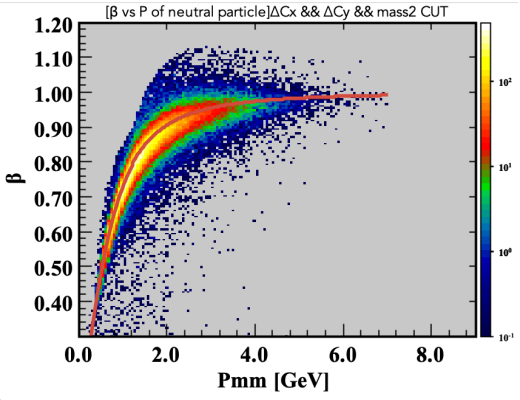


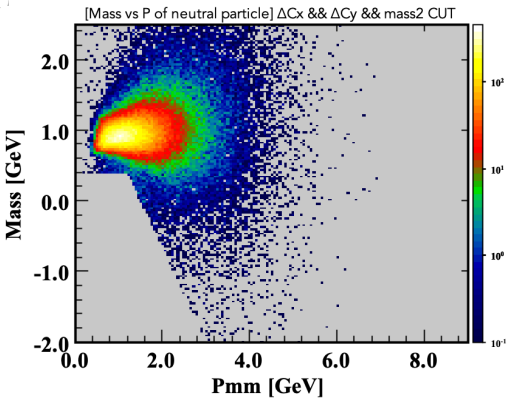


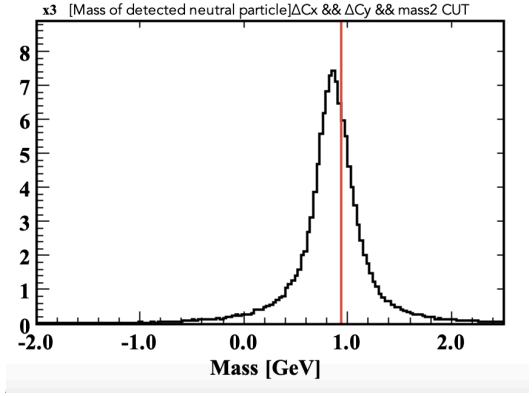


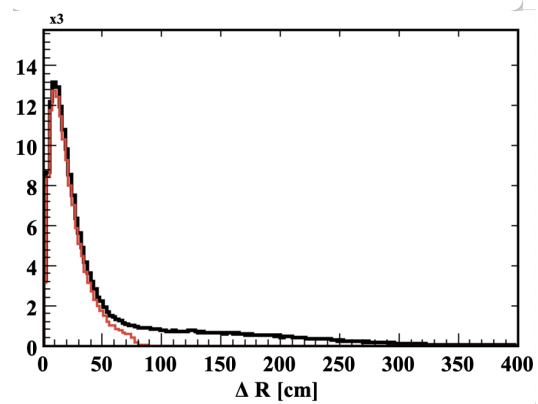


inb_Spring Data at 10.2 GeV

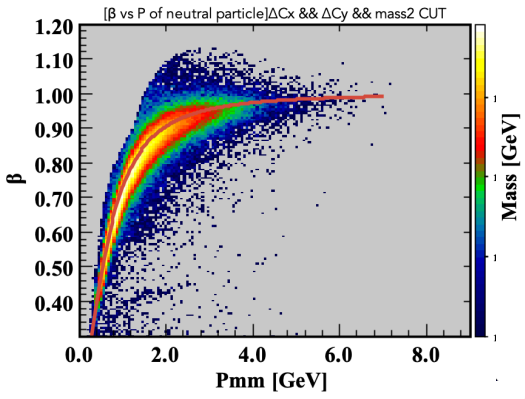


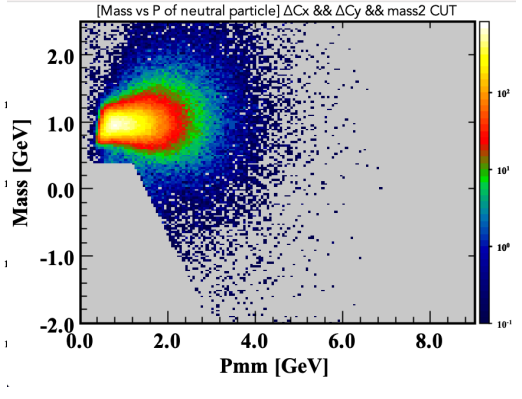


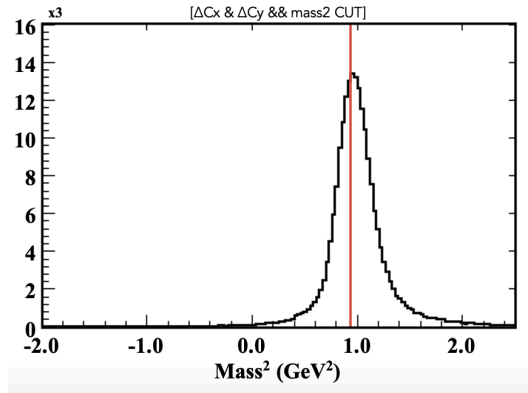


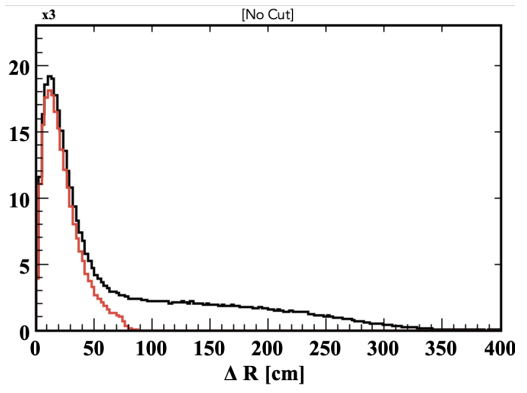


inb_Fall Data at 10.6 GeV





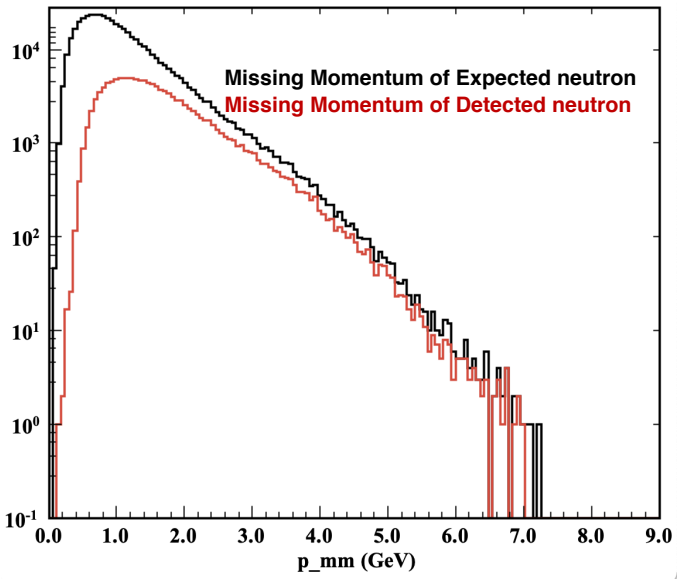




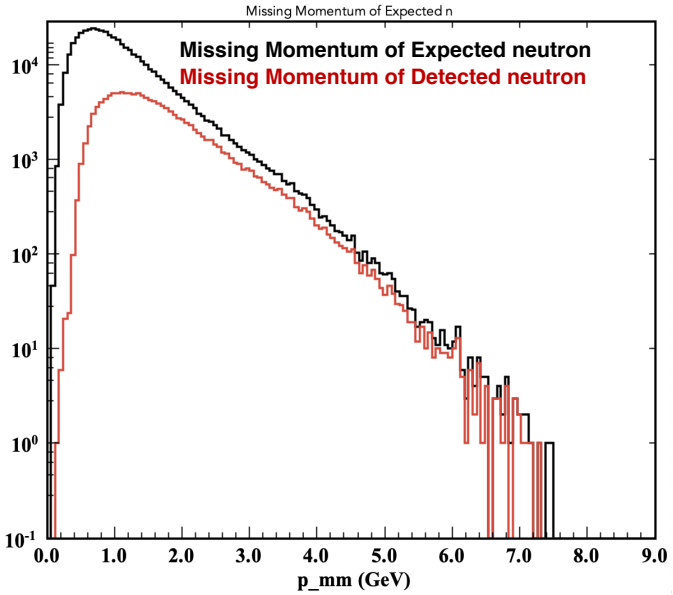
outb_Fall Data at 10.6 GeV

Missing Momentum of expected and detected neutron

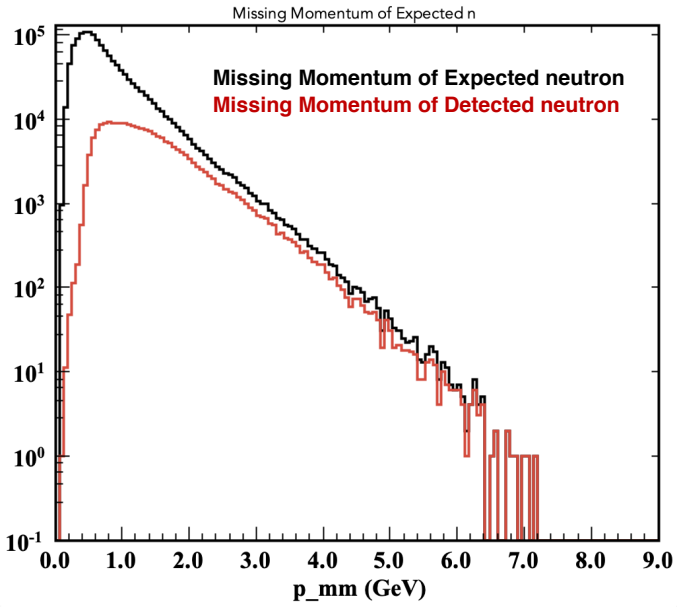
inb_Spring Data at 10.2 GeV



inb_Fall Data at 10.6 GeV



outb_Fall Data at 10.6 GeV



Results of NDE