SoLID SIDIS-NH_3 Studies

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The purpose of the studies

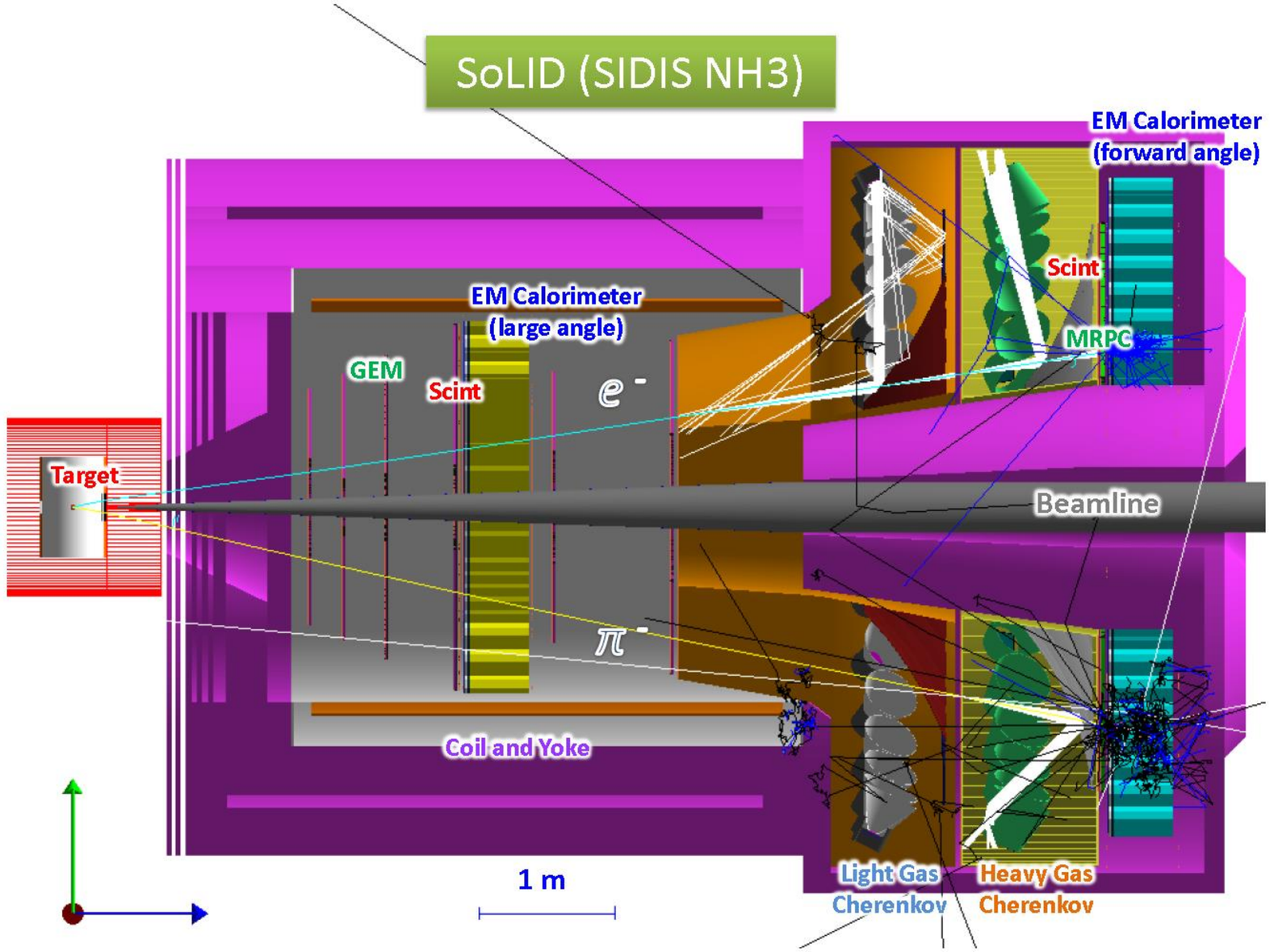
- In SoLID SIDIS-proton experiment we will be measuring SSA/DSA in SIDIS using transversely polarized NH_3 target
- Due to the large magnetic field in the transverse direction, there will be a different kind of background compared to that of the low field He^3 experiment
- As a result, a very high rate of charged particles will be localized in a quite narrow region of the acceptance. We refer to this strong, specific type of background as sheet-of-flame
- In order to avoid any damage to the apparatus, the detector and sub-detector sectors in the direct line-of sight of any sheet-of-flame plane should be shielded and/or turned off during the NH_3 experiment
- We use the eDIS generator and full Geant4 simulations for the trigger, background and acceptance studies (which includes the sheet-of-flame as well)
- We look at particle hit rate, which is based upon the material budget in the target

SoLID-SIDIS Experimental overview

$$e + p \rightarrow e' + \pi^{+/-} + X$$

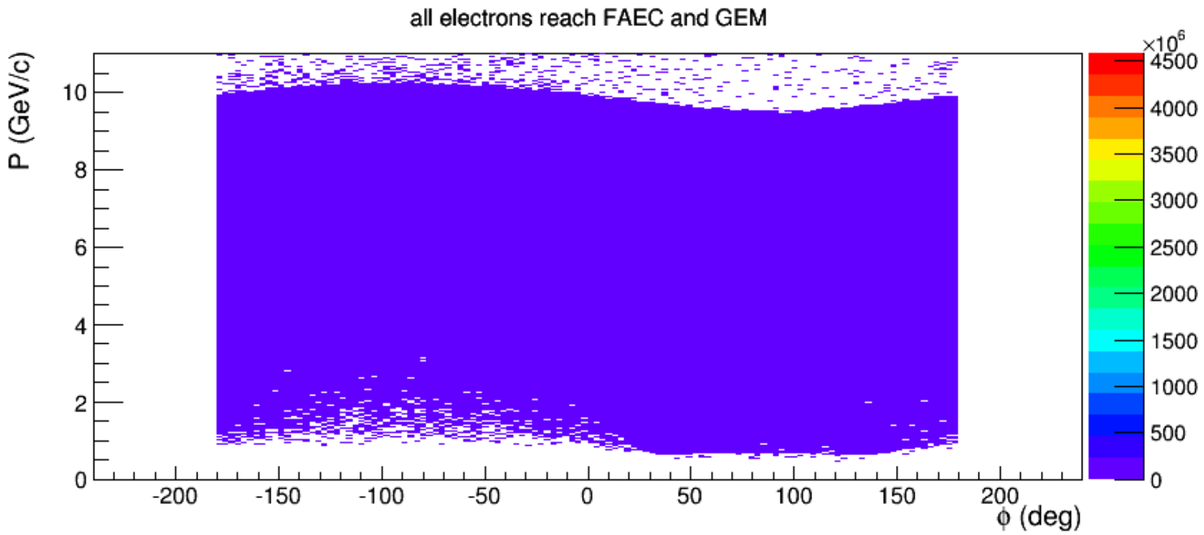
- The NH_3 target polarization is required to be higher than 70% with the spin flip in every few hours.
- Two Beam energies: 11 GeV and 8.8 GeV

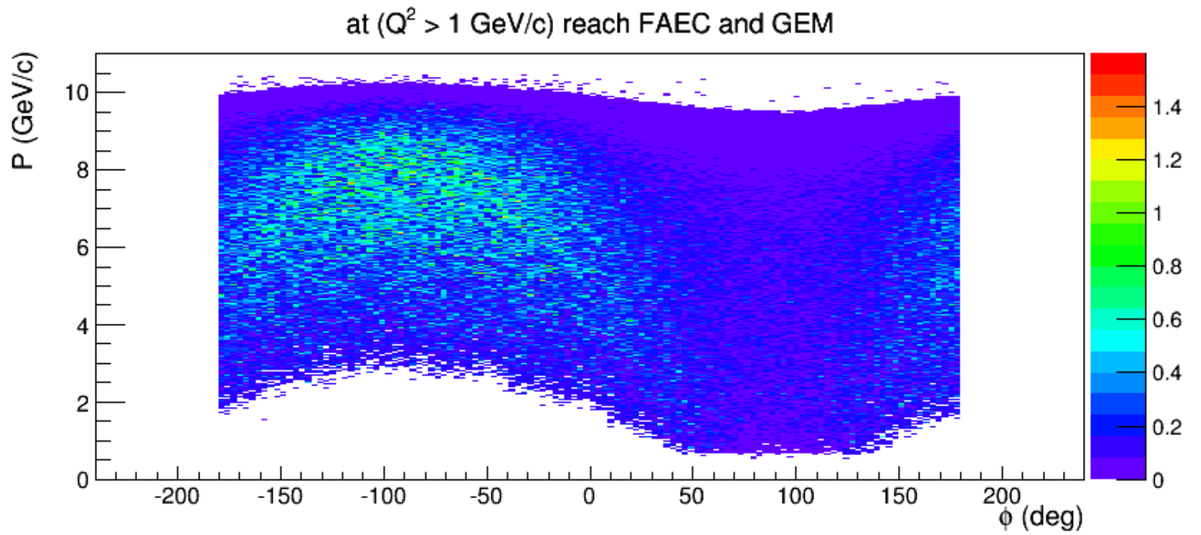
- Total luminosity
  $5.95 \cdot 10^{35}\ cm^{-2}\ s$
- Beam current: 100nA
- The beam goes through 5T target magnetic field
- Density of the NH_3 target
  $0.819\ g\ cm^{-3}$
- NH_3 target thickness
  2.826 cm

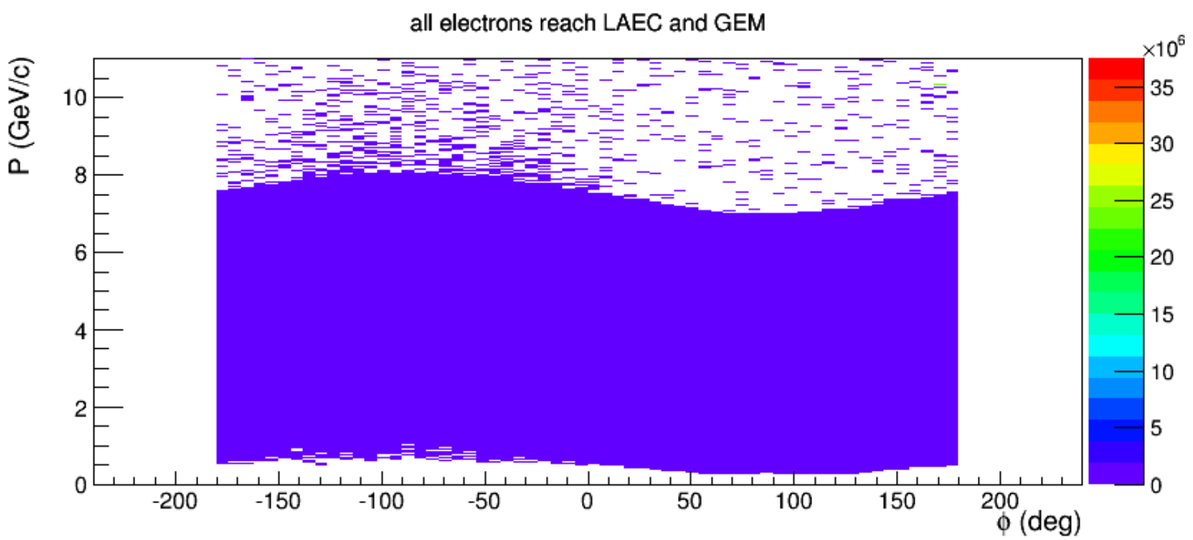


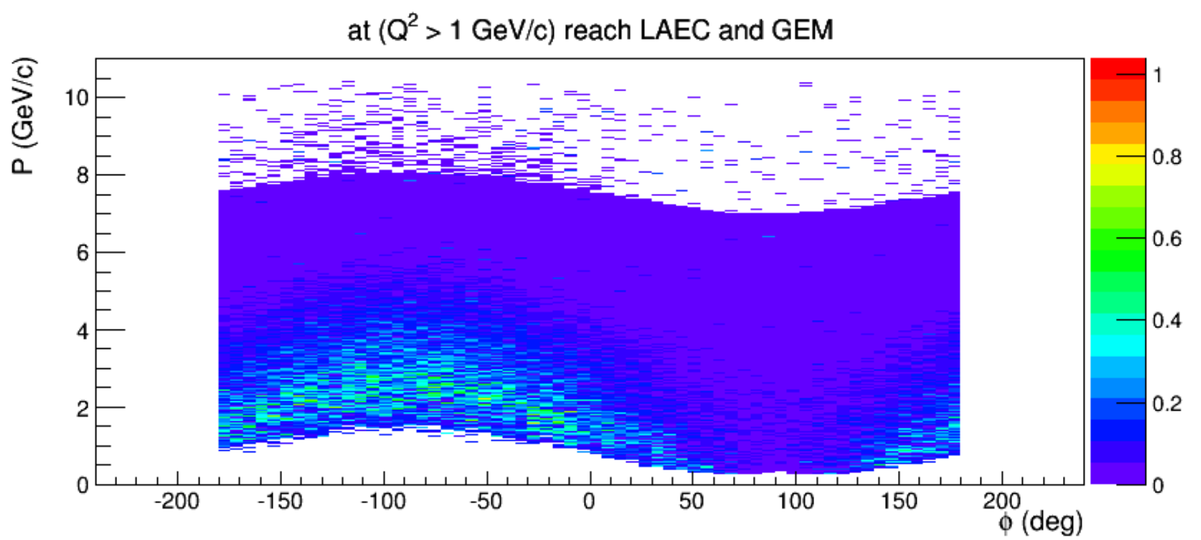
Electron momentum – azimuthal angle plots

- Let's now look at the momentum P (in GeV/c) of electrons (reaching FAEC, LAEC and GEM) vs. the ϕ angle
- In the right plots, $Q^2 > 1$ (GeV/c)^2 cuts are also implemented for these sub-detectors



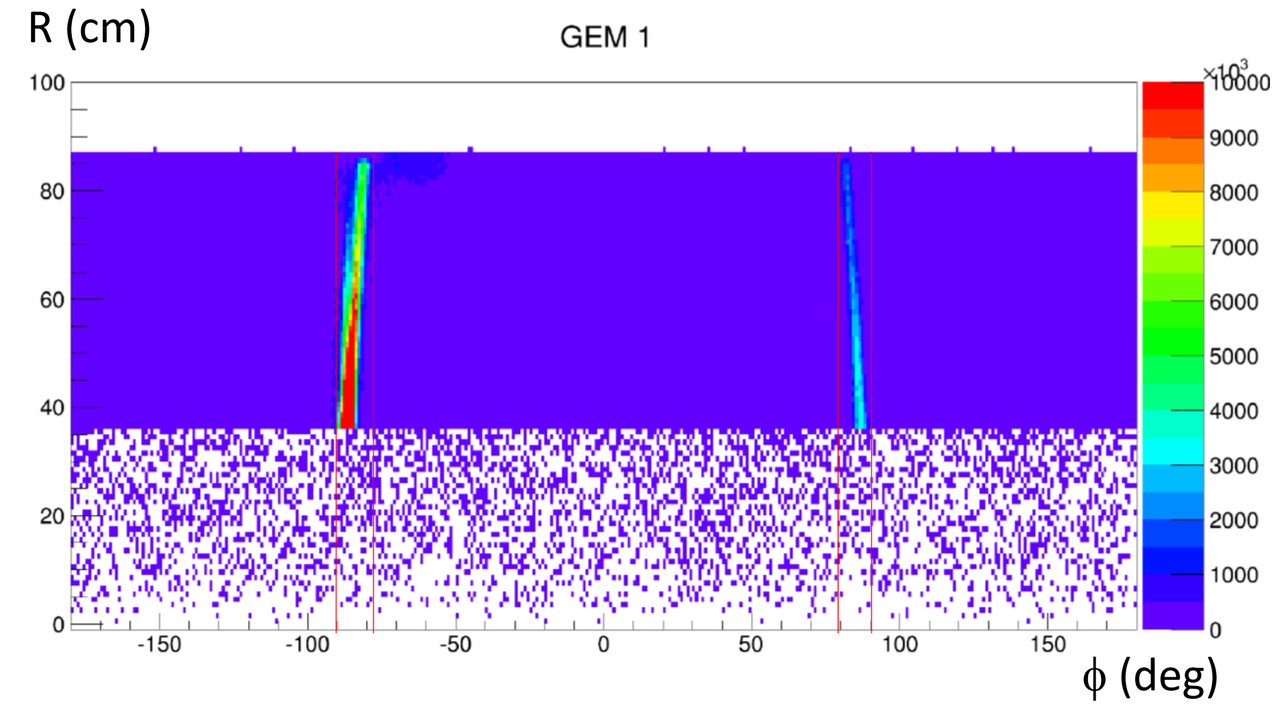


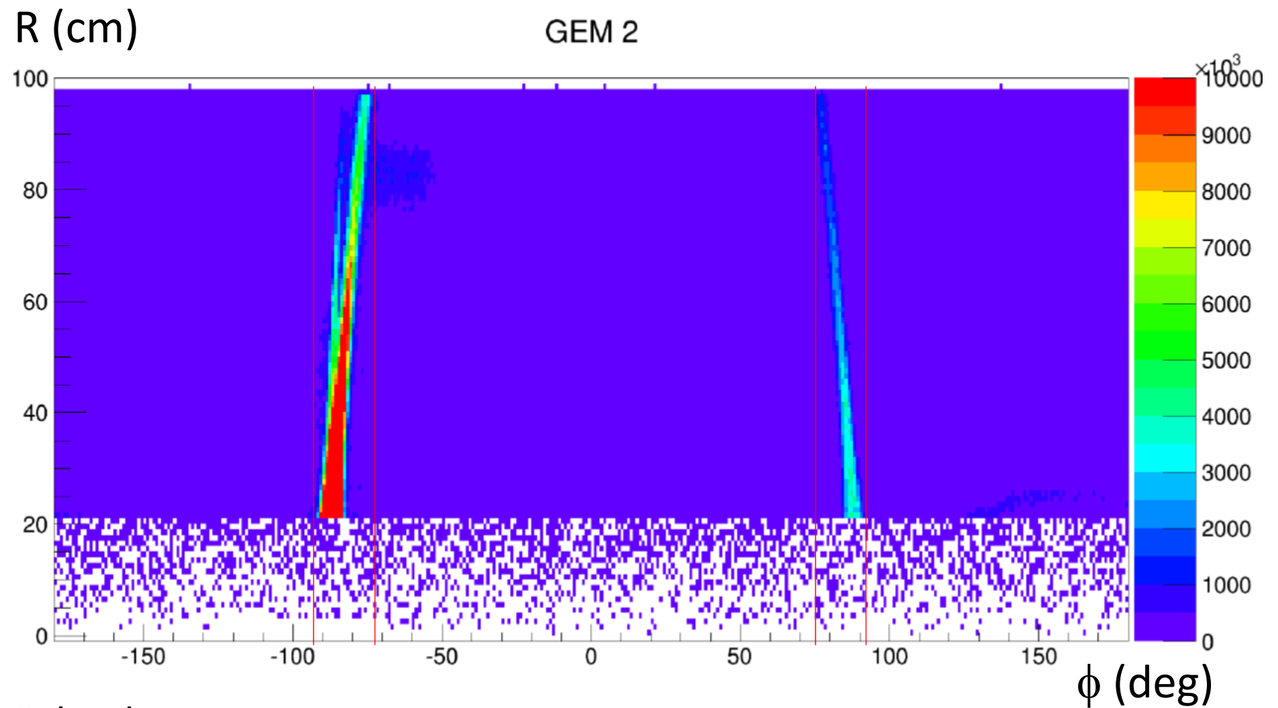


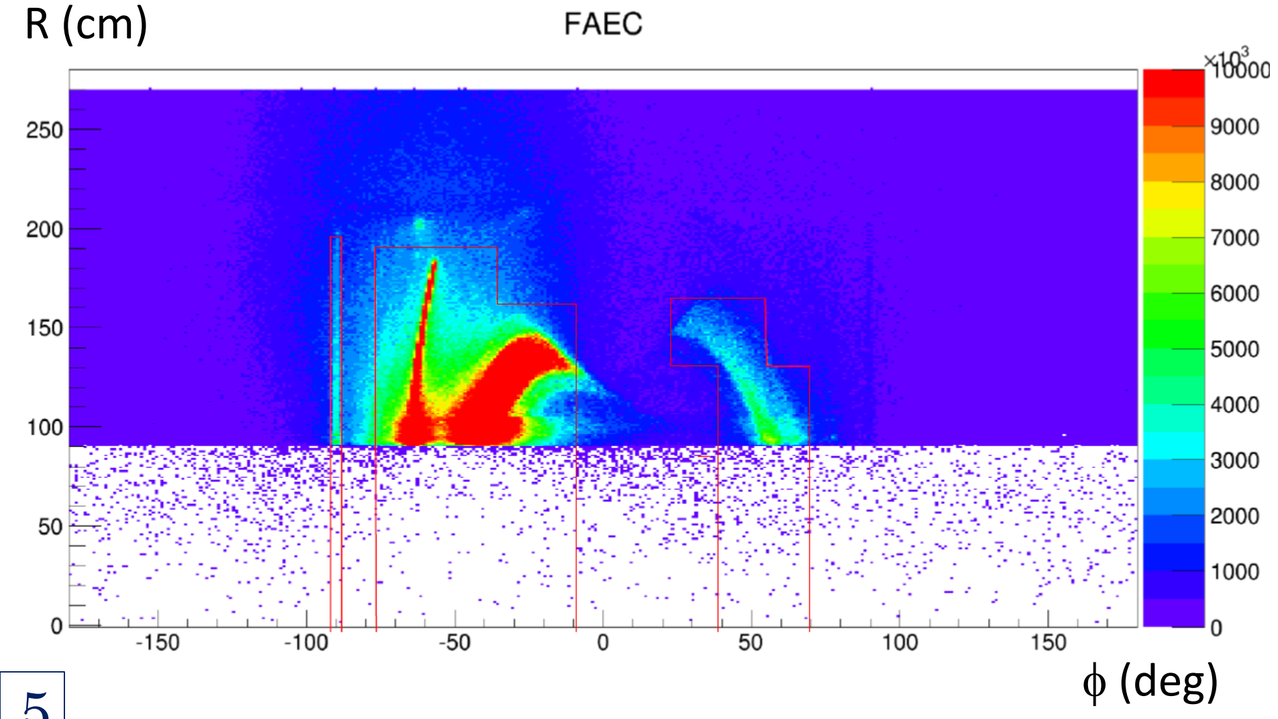


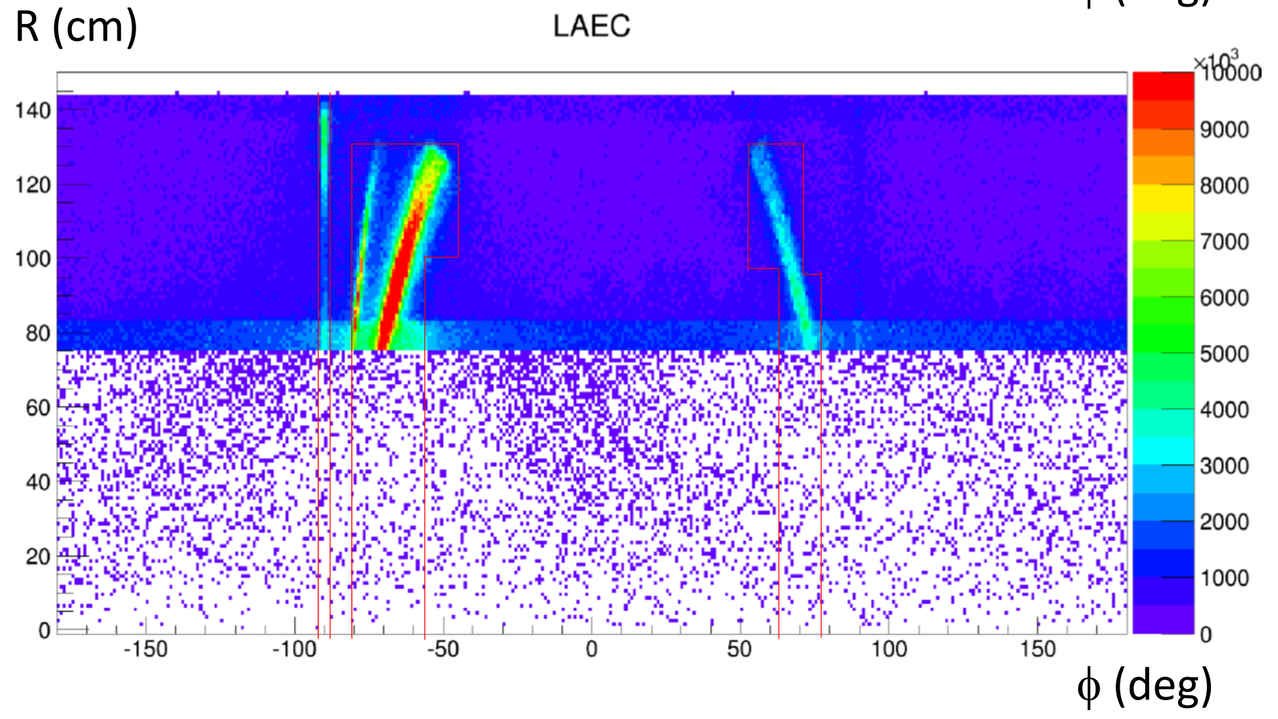
Some sheet-of-flame cuts used in the analysis

- Here we show a few examples of the current sheet-of-flame cuts that we use in the analysis (see Backups for more examples)



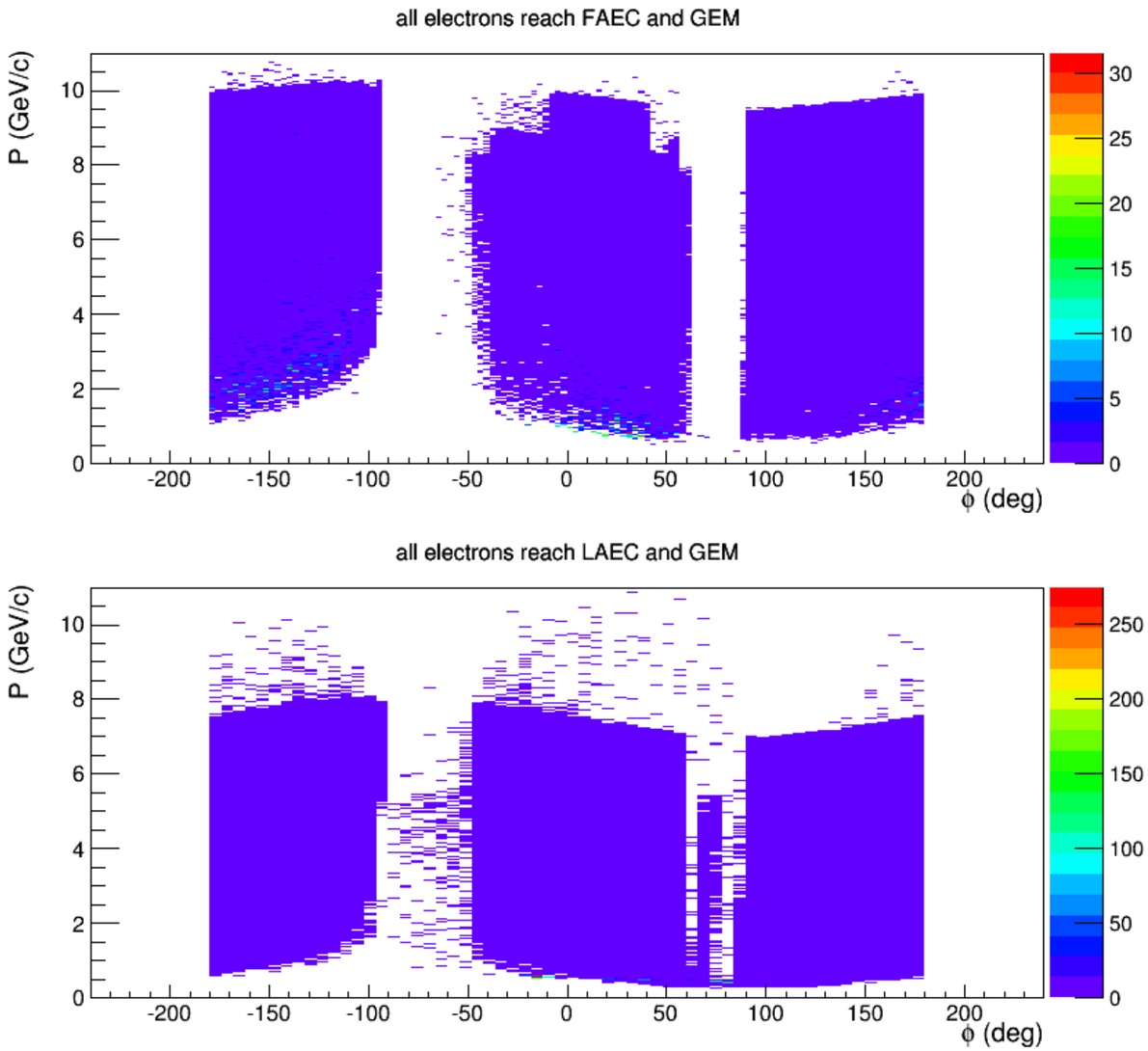


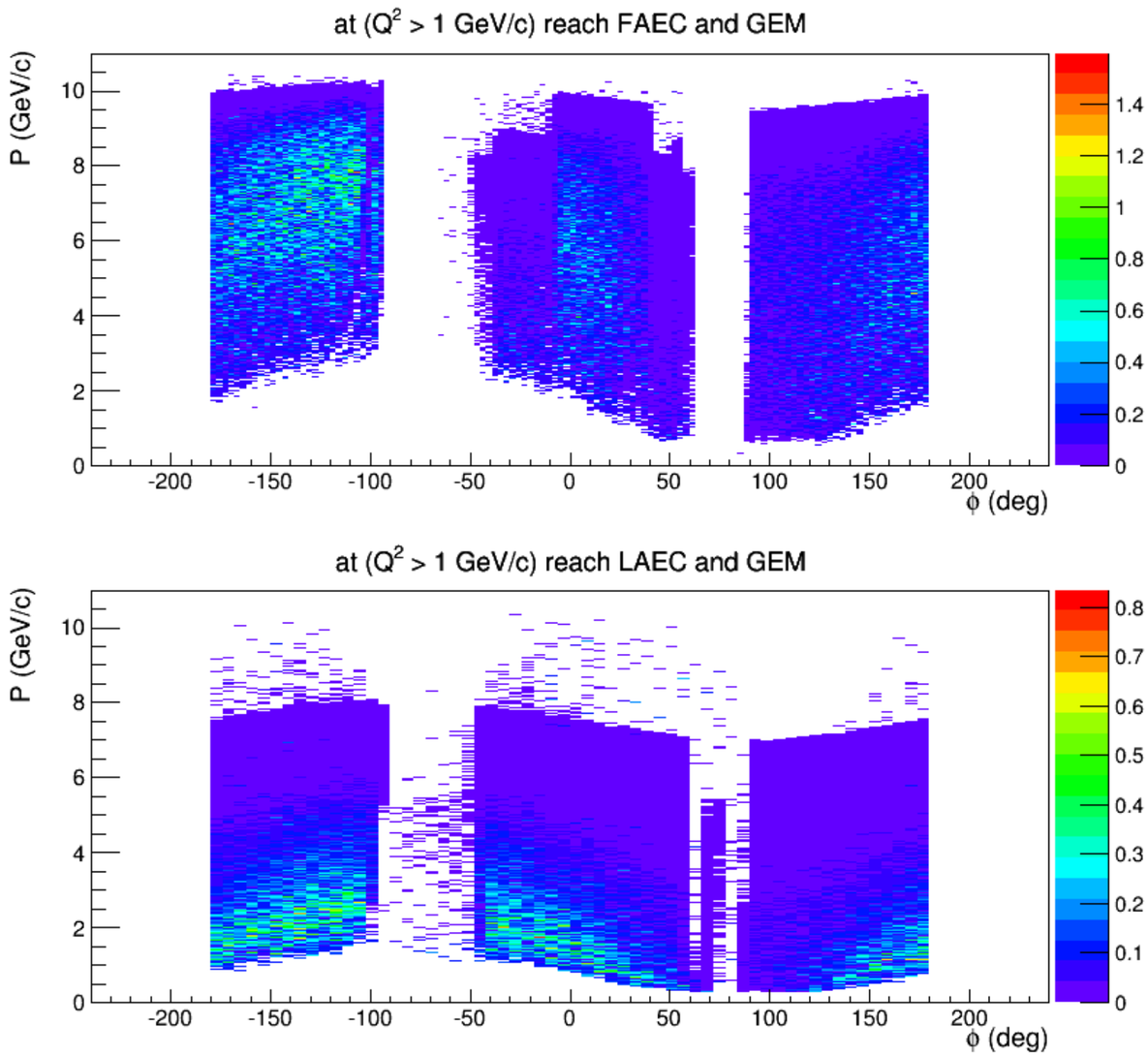




Electron momentum – angle plots with sheet-of-flame cuts

- Again we show the momentum P of electrons (reaching FAEC, LAEC and GEM) vs. the ϕ angle, after all sheet-of-flame cuts are implemented
- In the right plots, $Q^2 > 1$ (GeV/c)^2 cuts are also implemented for these sub-detectors





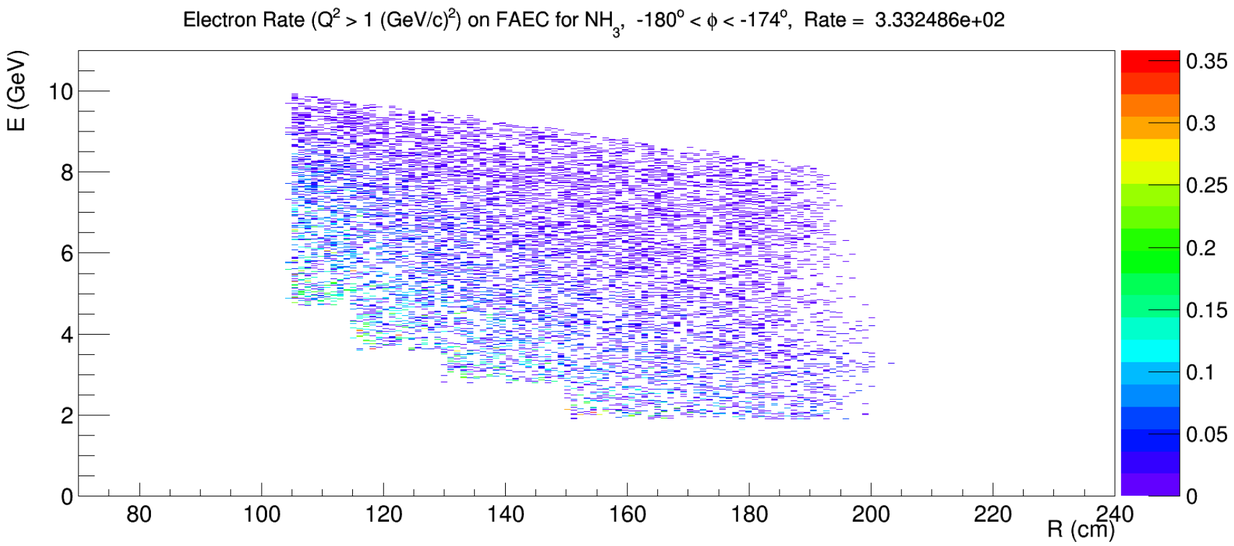
- Now let us look at the eDIS rates (slide 6th) for cases when various sheet-of-flame cuts are implemented, corresponding to different subsystems
- The sheet-of-flame cuts are used for GEM 1, GEM 2, GEM 3, GEM 4, GEM 5, GEM 6, LGC, HGC, FASPD, LASPD, FAEC, LAEC

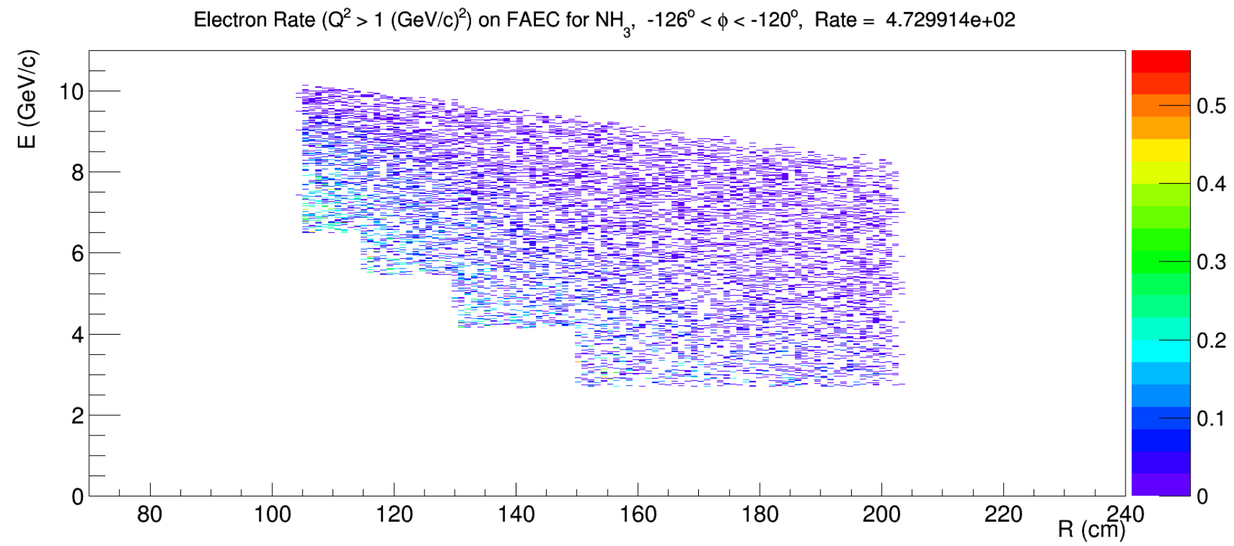
for NH_3 Rates in kHz	All electrons reach FAEC and GEM	All electrons reach LAEC and GEM	Q^2 >1 GeV/c electrons reach FAEC and GEM	Q^2 >1 GeV/c electrons reach LAEC and GEM
No sheet-of-flame cuts implemented	4889221	67722	17.12	2.83
Sheet-of- flame cuts for all subsystems	19.47	6.4	10.02	2.06
Sheet-of- flame cuts only for all GEMs	30.88	8.24	12.41	2.19
Sheet-of- flame cuts for all subsystems except for all GEMs	28.42	614	11	2.21

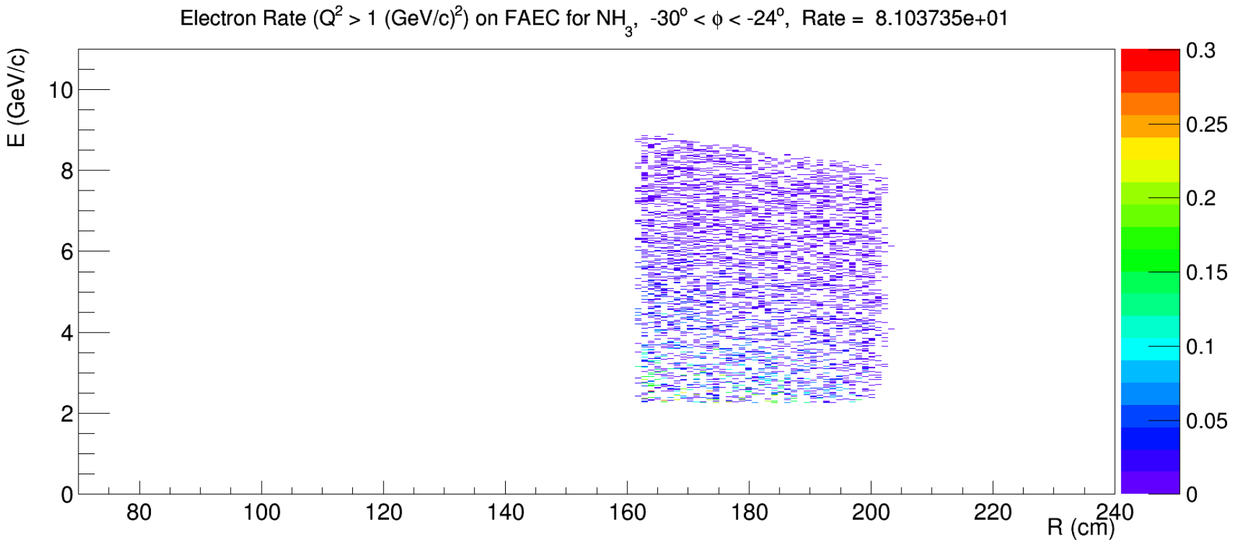
PRELIMINARY

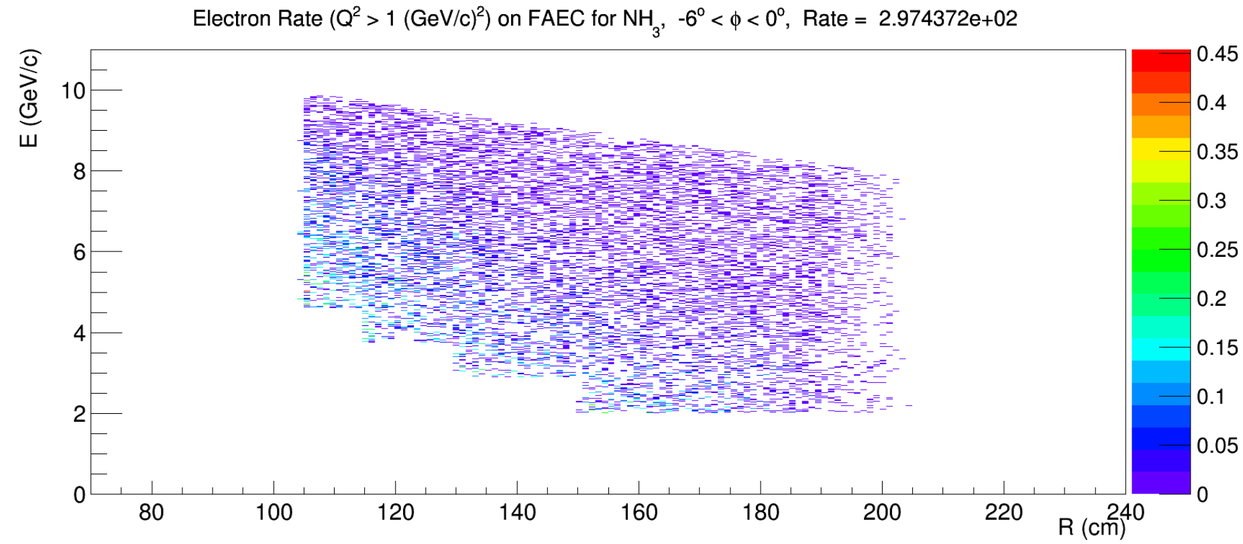
Electron energy – radius plots for FAEC

- Plots for the Energy (in GeV) of electrons vs. the radius R (in cm) on FAEC
- We find the $Q^2 = 1\ (GeV/c)^2$ lines and implement them as step functions in $\phi = 6°$ bins from -180° to 180°. In this and next slides we show the results in eight ϕ bins









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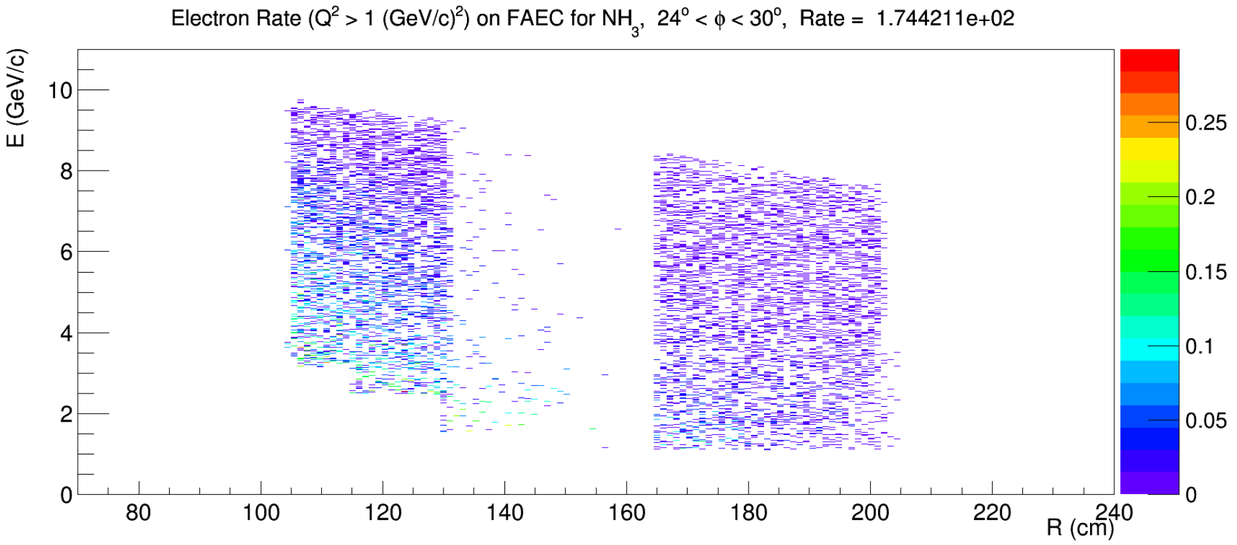
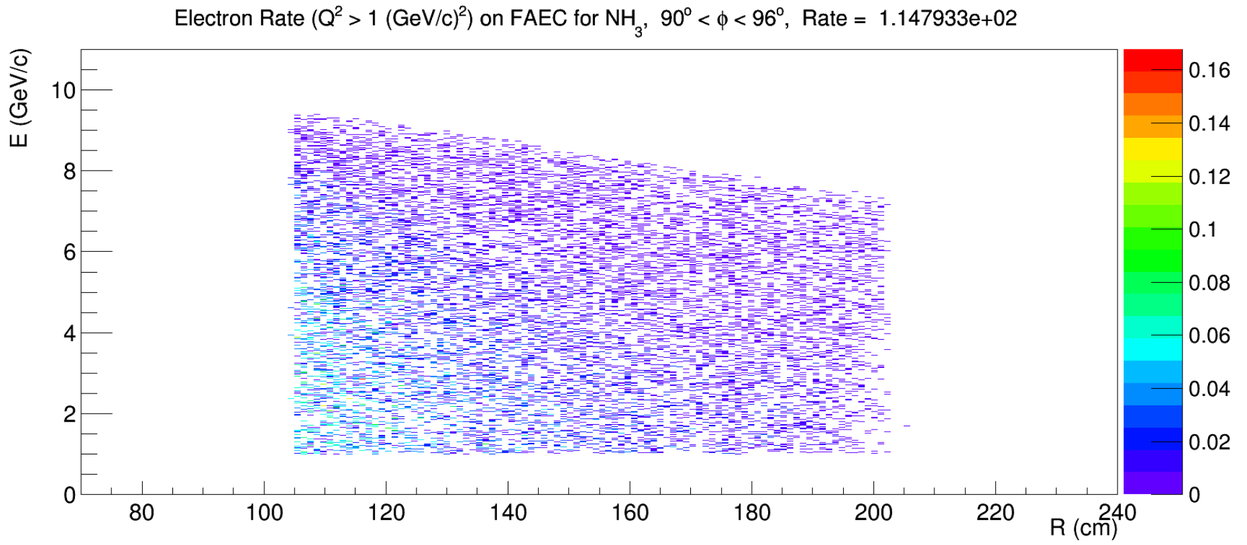
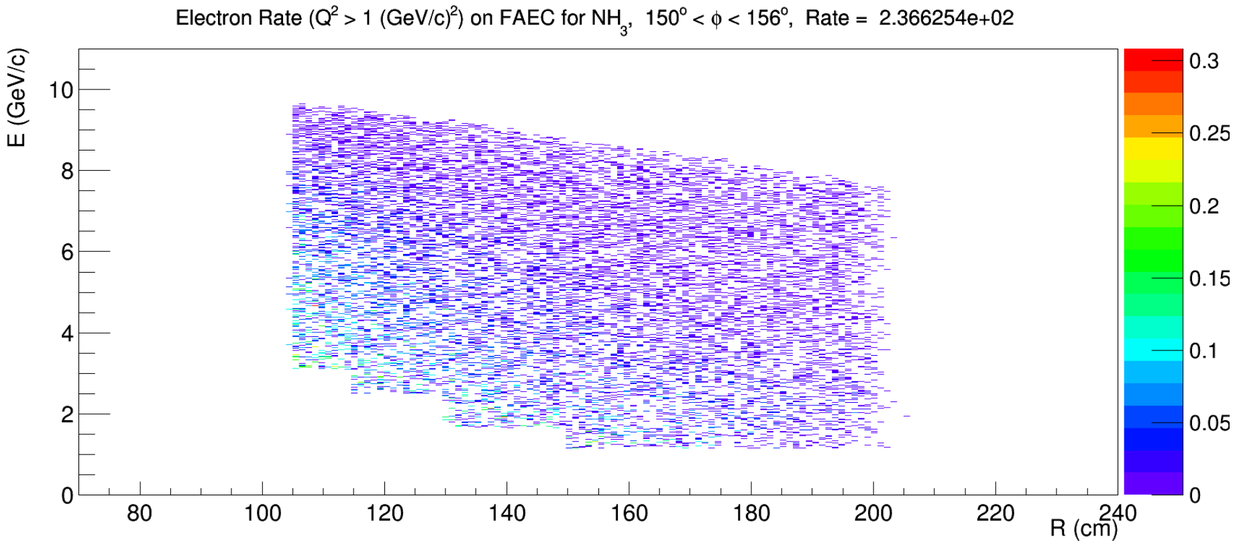
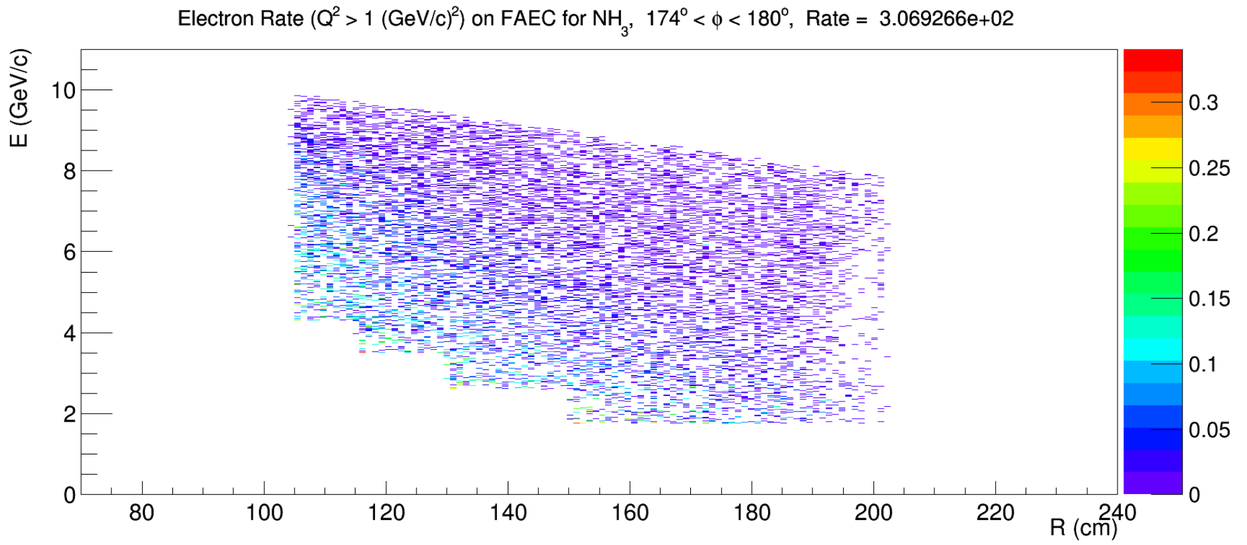
- We find the $Q^2 = 1\ (GeV/c)^2$ lines and implement them as step functions in $\phi = 6°$ bins from -180° to 180°. Totally there are sixty ϕ bins









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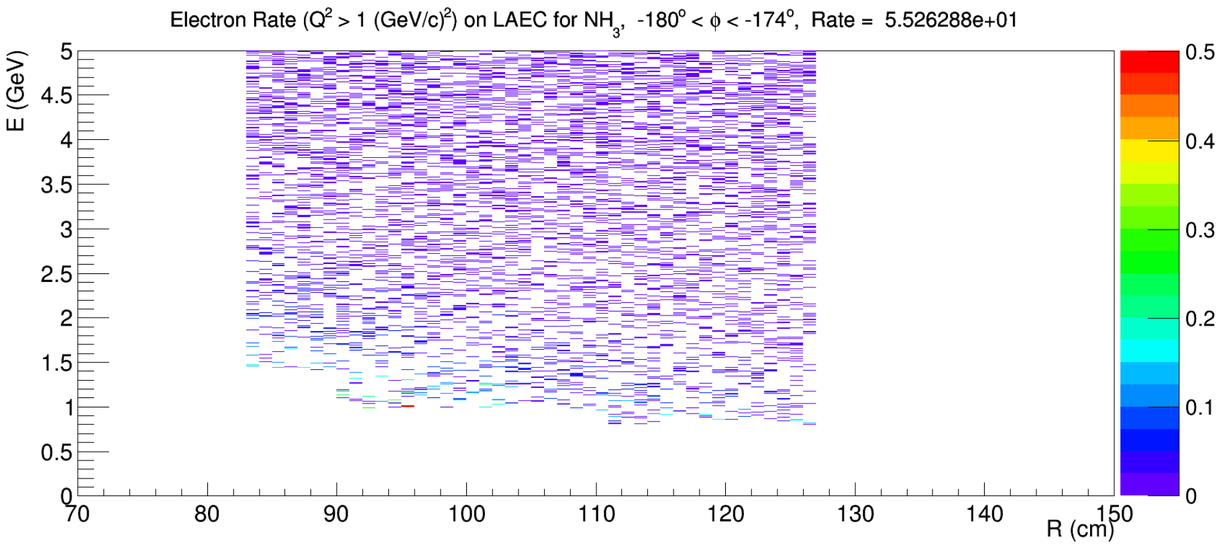

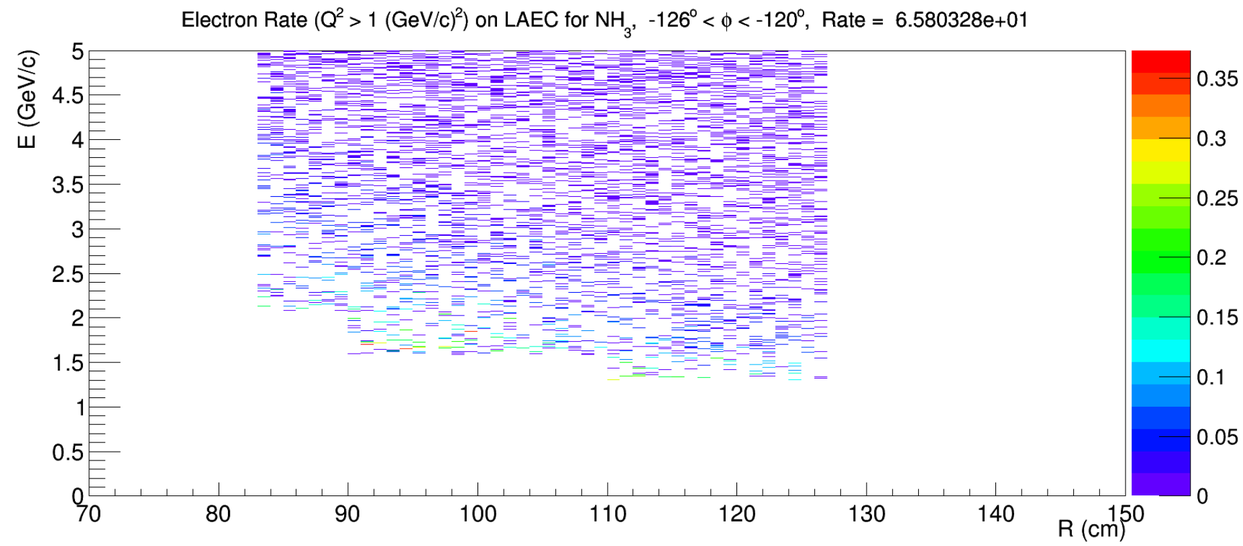

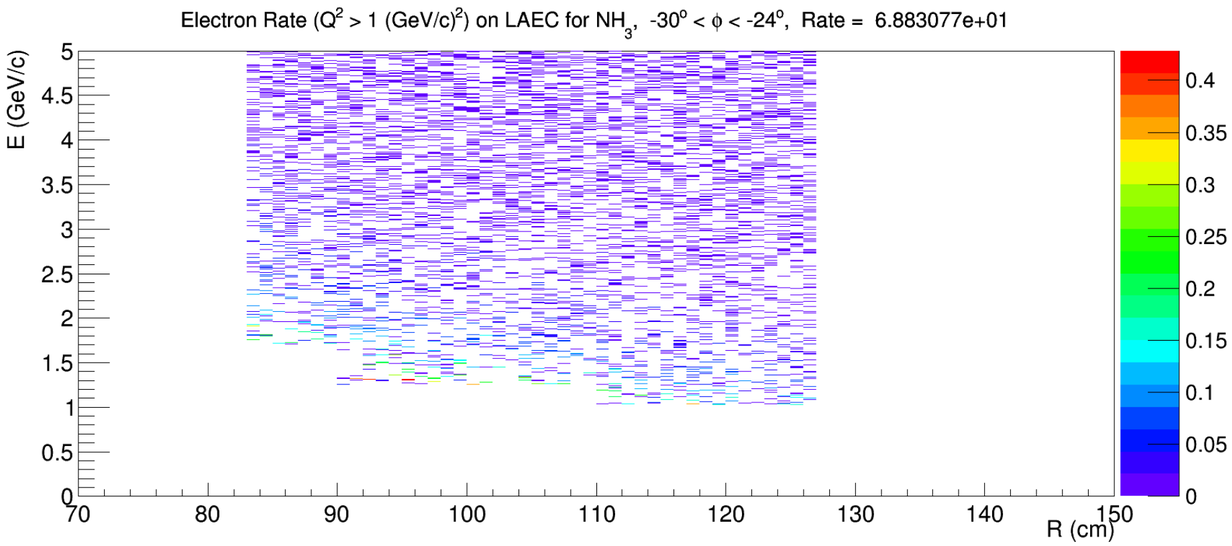

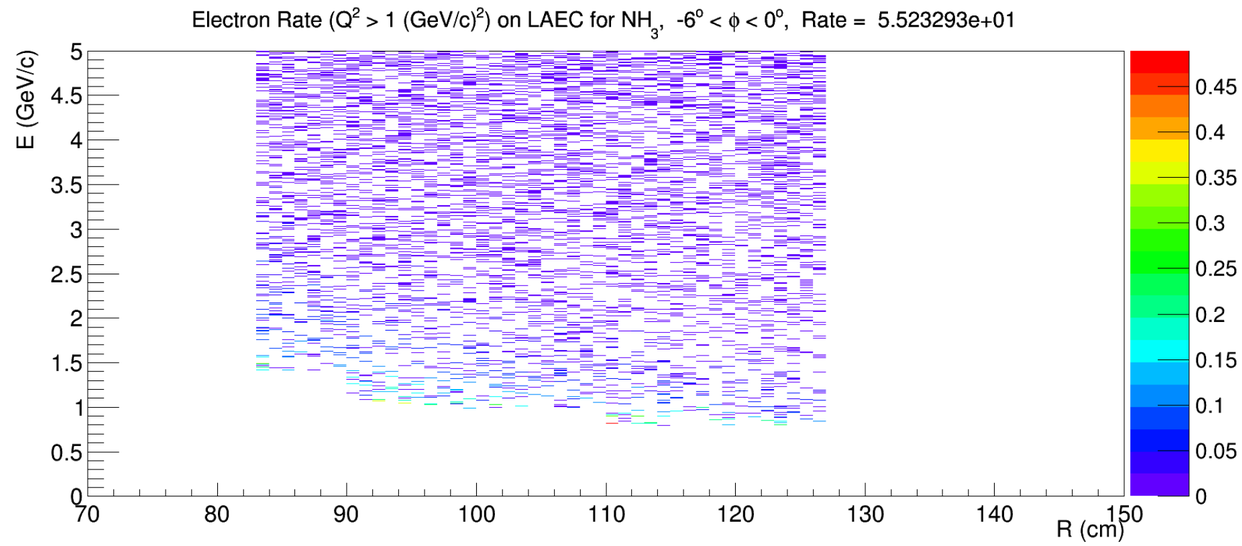

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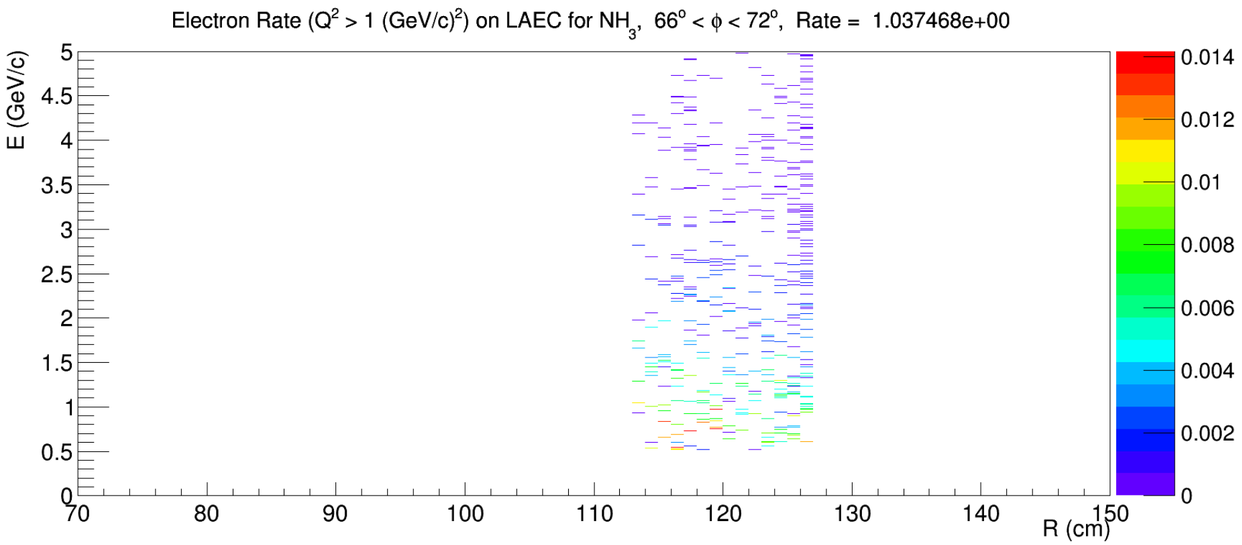
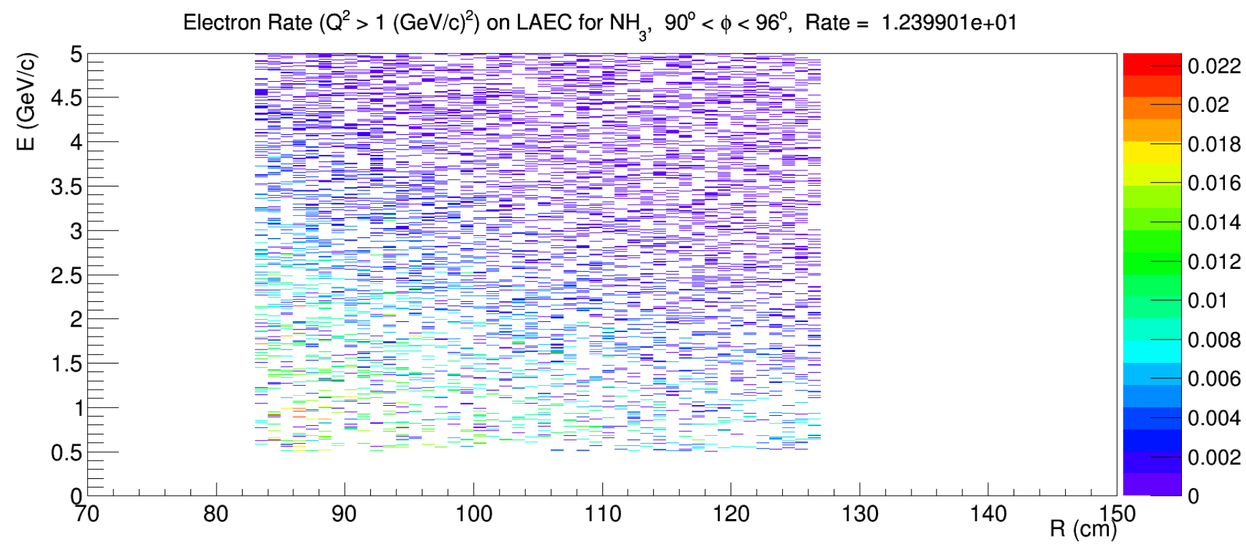
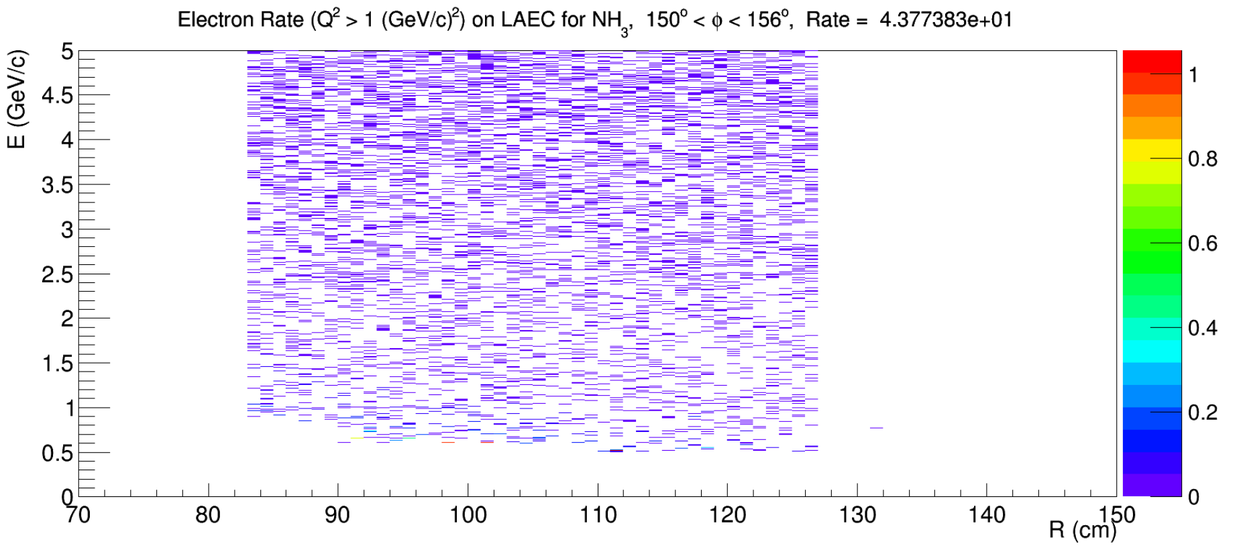
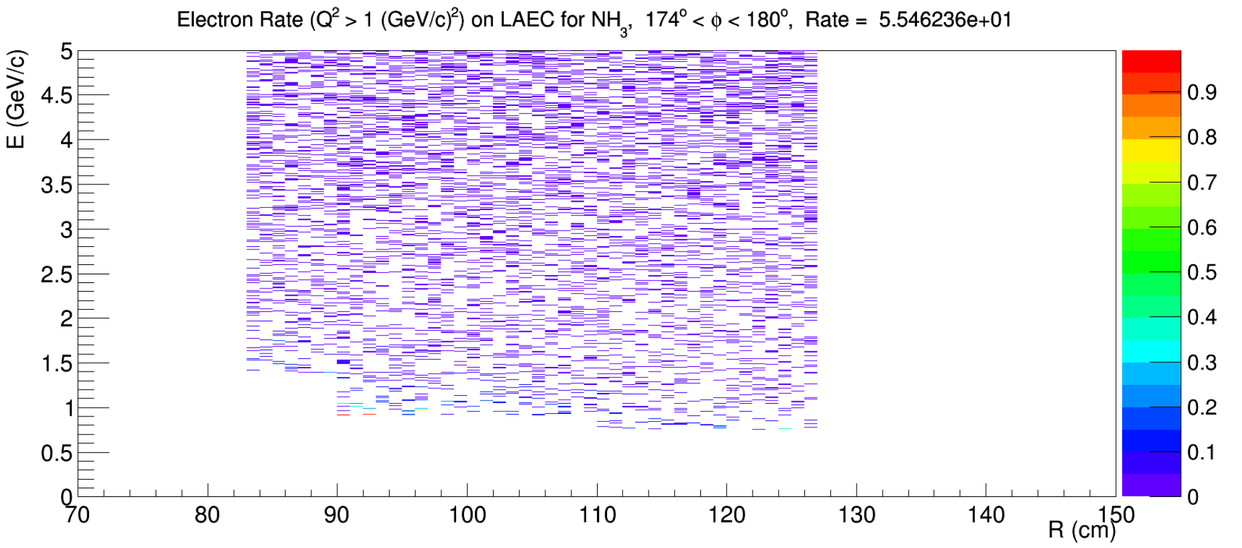


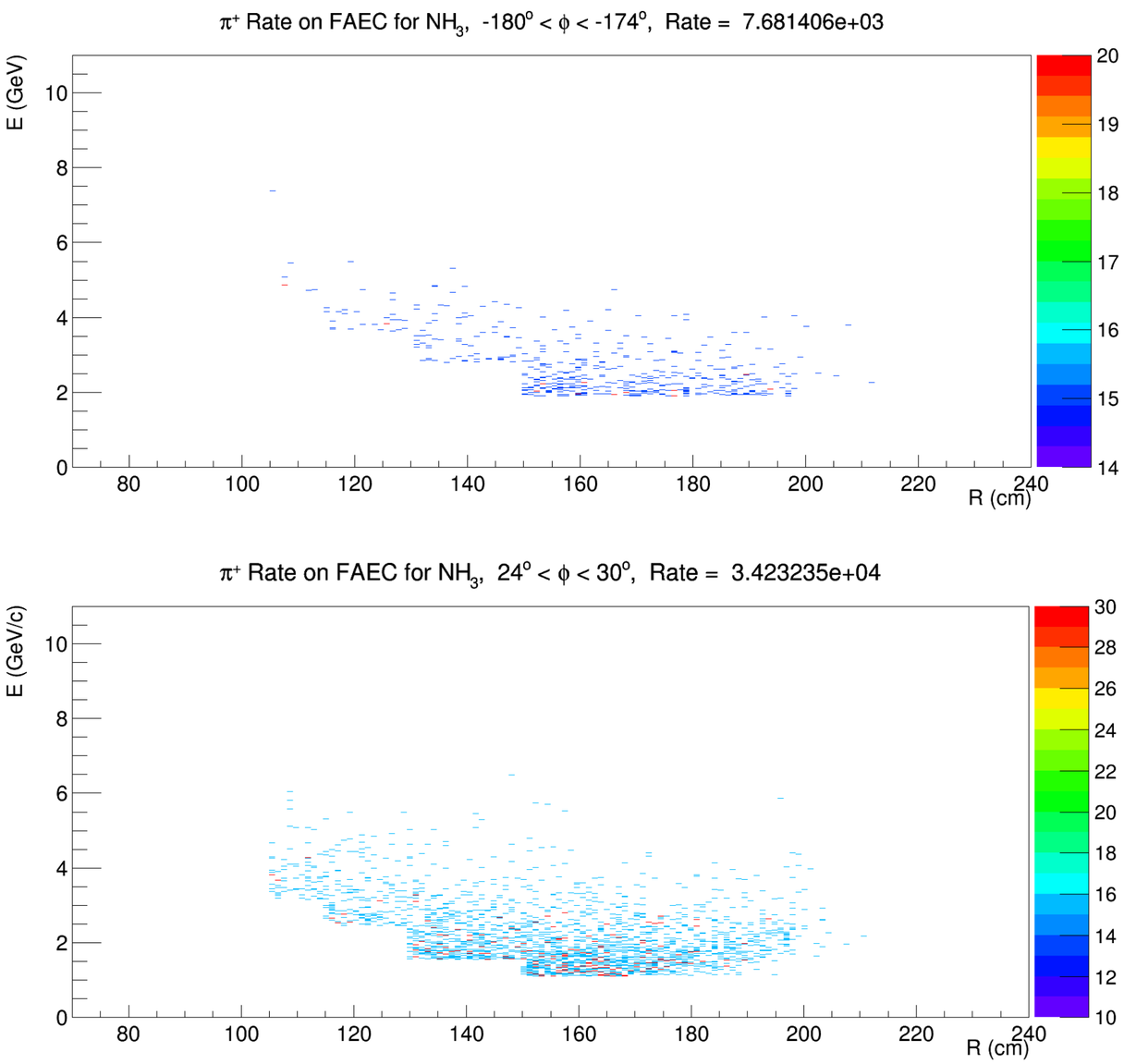


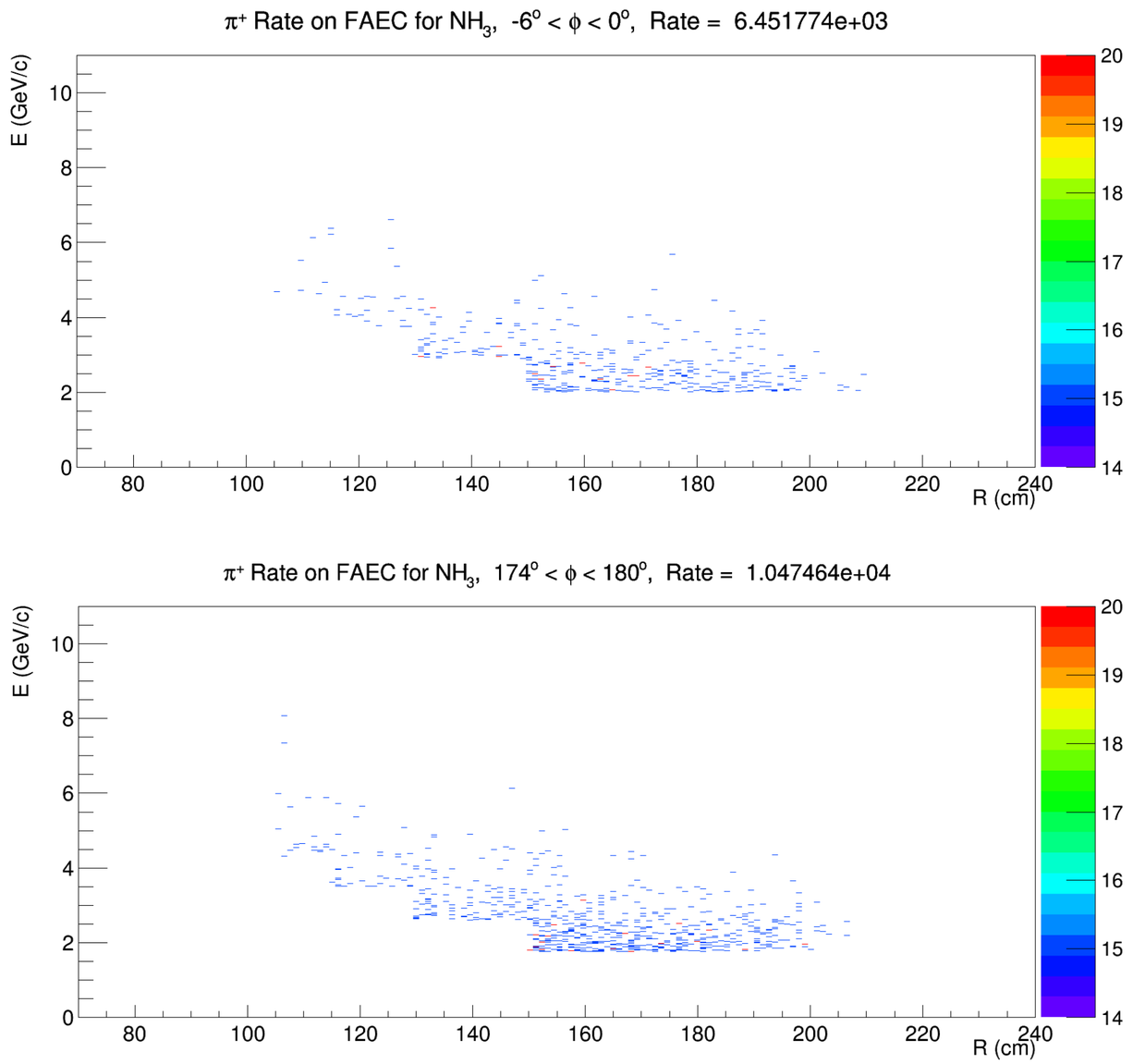




π^+ energy – radius plots for FAEC

- Some plots for the Energy (in GeV) of π^+ vs. the radius R (in cm) on FAEC
- The previously shown electron trigger cuts are implemented in similar ϕ bins from -180° to 180°. Here are only four examples





π^+ energy – radius plots for LAEC

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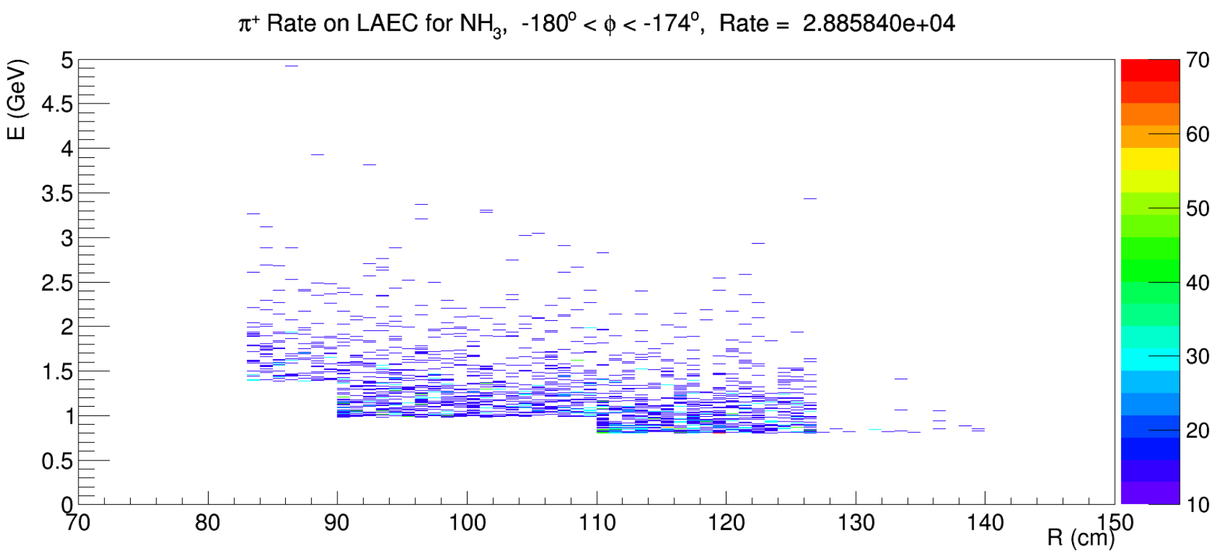
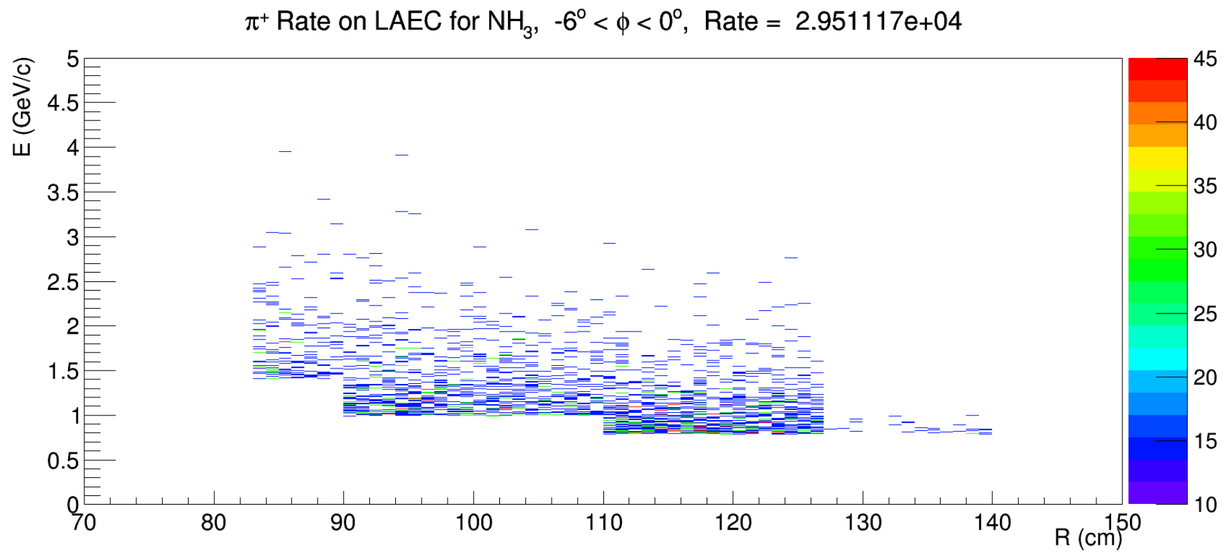
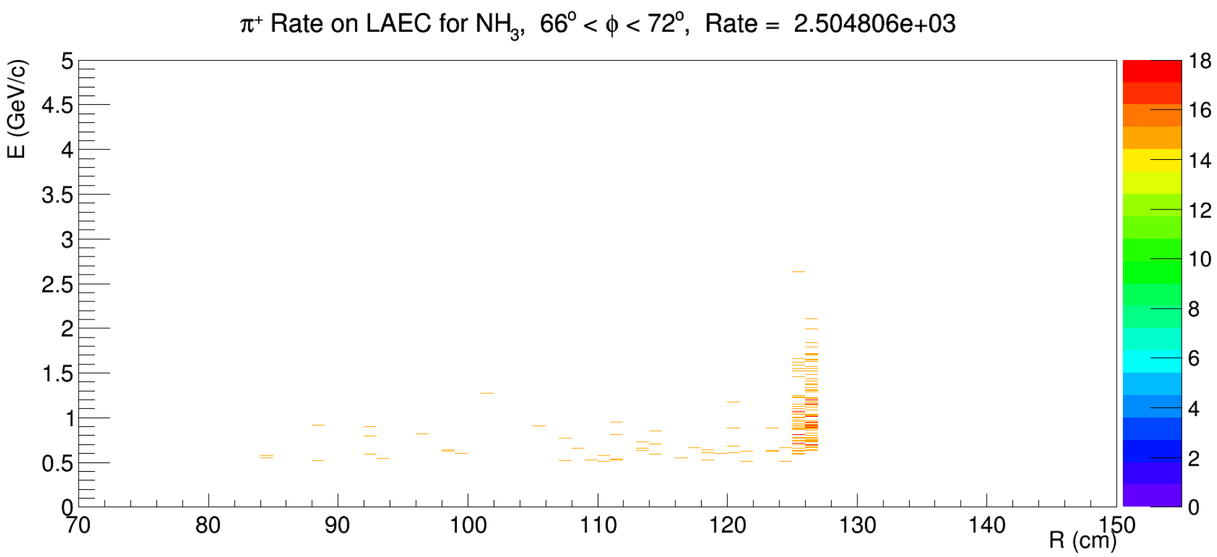
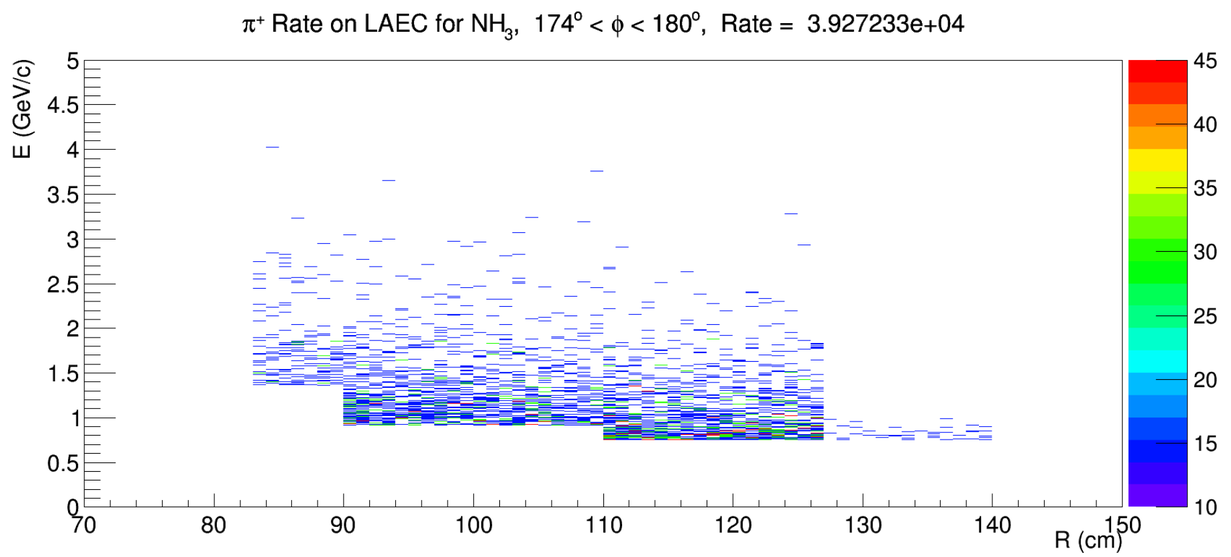








Total particle rates for FAEC and LAEC *PRELIMINARY*

- Here we show the total hit rates for FAEC and LAEC

for NH_3 Rates in kHz	Total Rate	for NH_3 Rates in kHz	Total Rate
Electrons at FAEC with trigger cut	11.25	Electrons at LAEC with trigger cut	2.41
Electrons at FAEC without trigger cut	19.47	Electrons at LAEC without trigger cut	6.43
π^+ at FAEC with trigger cut	679.1	π^+ at LAEC with trigger cut	1.31e+03
π^+ at FAEC without trigger cut	2.24e+03	π^+ at LAEC without trigger cut	4.44e+03
π^- at FAEC with trigger cut	447.1	π^- at LAEC with trigger cut	1.42e+03
π^- at FAEC without trigger cut	1.81e+03	π^- at LAEC without trigger cut	3.72e+03
Photon (electron) rate from π^0 separated at FAEC with trigger cut	7.17e+03 (2.05e+03)	Photon (electron) rate from π^0 separated at LAEC with trigger cut	721.9 (33.8)
Photon (electron) rate from π^0 separated at FAEC without trigger cut	39.31e+03 (40.14e+3)	Photon (electron) rate from π^0 separated at LAEC without trigger cut	51.43e+03 (60.03e+03)

Next steps

- In the next steps for the electron trigger rate, we will apply EC trigger response correctly for electron and pion instead of the simple cut, and we should also add LGC into the trigger.

- We will see whether the trigger satisfies the requirement of < 100 kHz trigger rate.

- Depending on the outcome we maybe need to make a coincidence trigger of electron and hadron

- Also, the NH_3 acceptance will be re-made, based upon which one may re-address some of the physics plots obtained from the proton target and shown in the SoLID PreCDR report

Backups

Some details on the slides 8th and 9th for FAEC

for NH_3 Rates in kHz	$-180° < \phi < -174°$	$-30° < \phi < -24°$	$90° < \phi < 96°$	$174° < \phi < 180°$
Electrons at FAEC with trigger cut	0.33	0.081	0.11	0.31
π^+ at FAEC with trigger cut	7.68	0.36	0.91	10.47
π^+ at FAEC without trigger cut	64.08	28.89	1.05	59.95
π^- at FAEC with trigger cut	7.03	1.27	13.19	8.79
π^- at FAEC without trigger cut	50.72	5.13	23.98	54.01

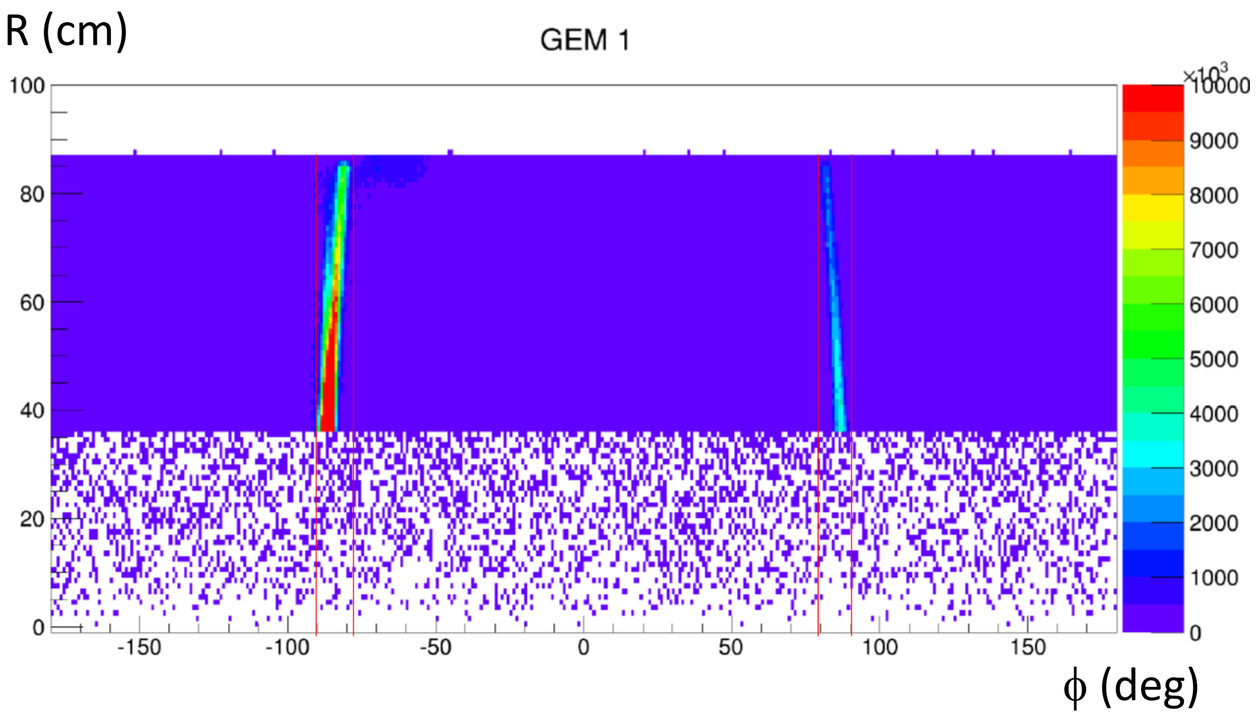
PRELIMINARY

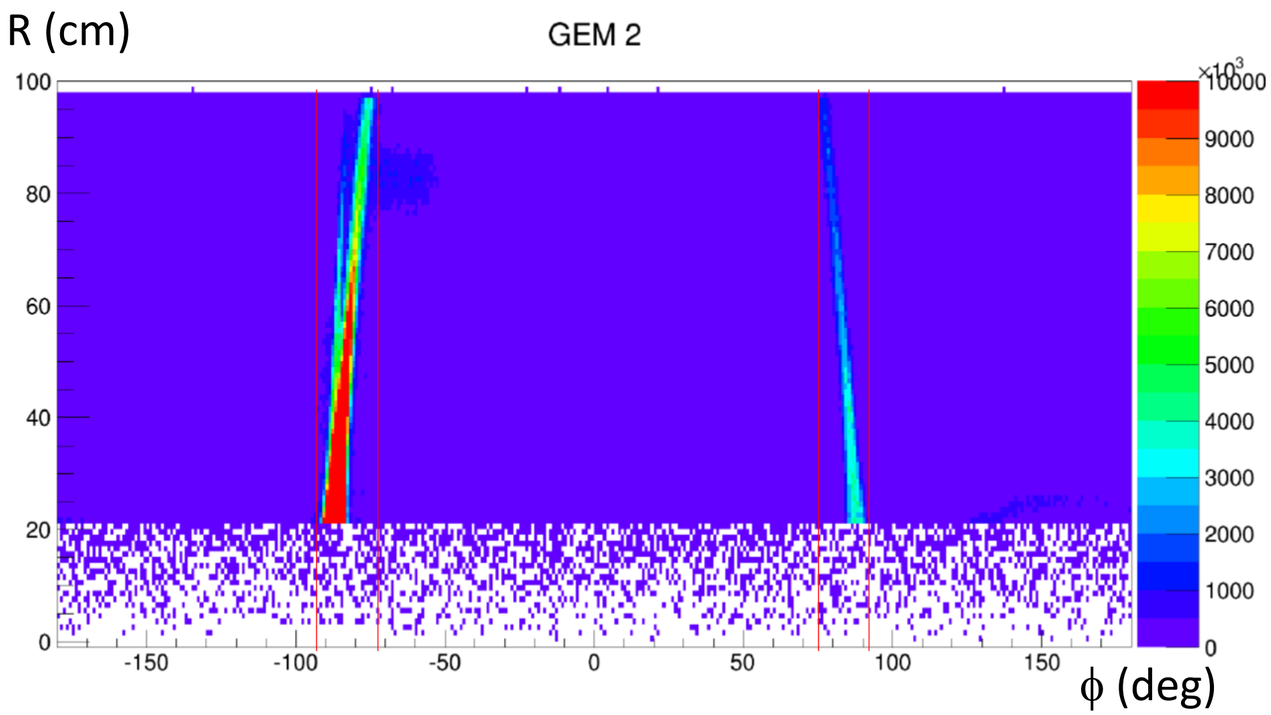
Some details on the slides 10th and 11th for LAEC

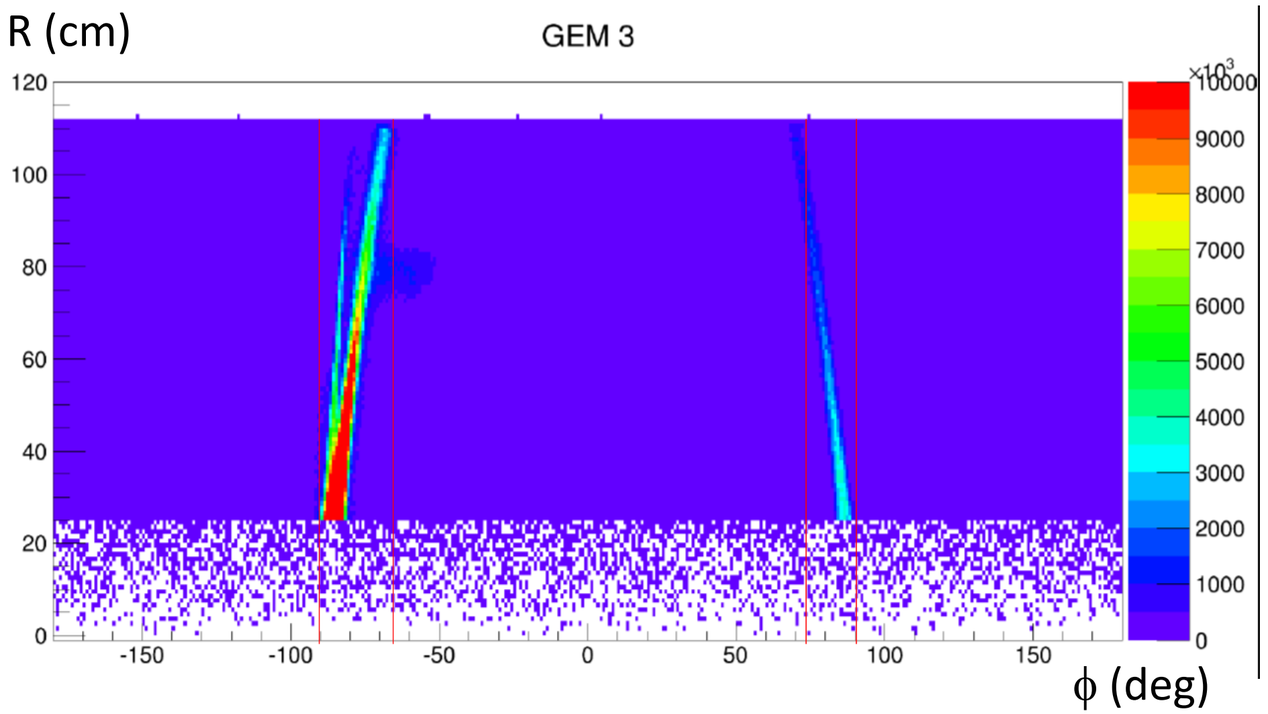
for NH_3 Rates in kHz	$-180° < \phi < -174°$	$-30° < \phi < -24°$	$90° < \phi < 96°$	$174° < \phi < 180°$
Electrons at LAEC with trigger cut	0.055	0.069	0.012	0.055
π^+ at LAEC with trigger cut	28.86	7.64	0.56	39.27
π^+ at LAEC without trigger cut	102.42	126.56	0.96	100.3
π^- at LAEC with trigger cut	30.37	21.77	16.16	31.53
π^- at LAEC without trigger cut	87.21	66.58	31.26	87.4

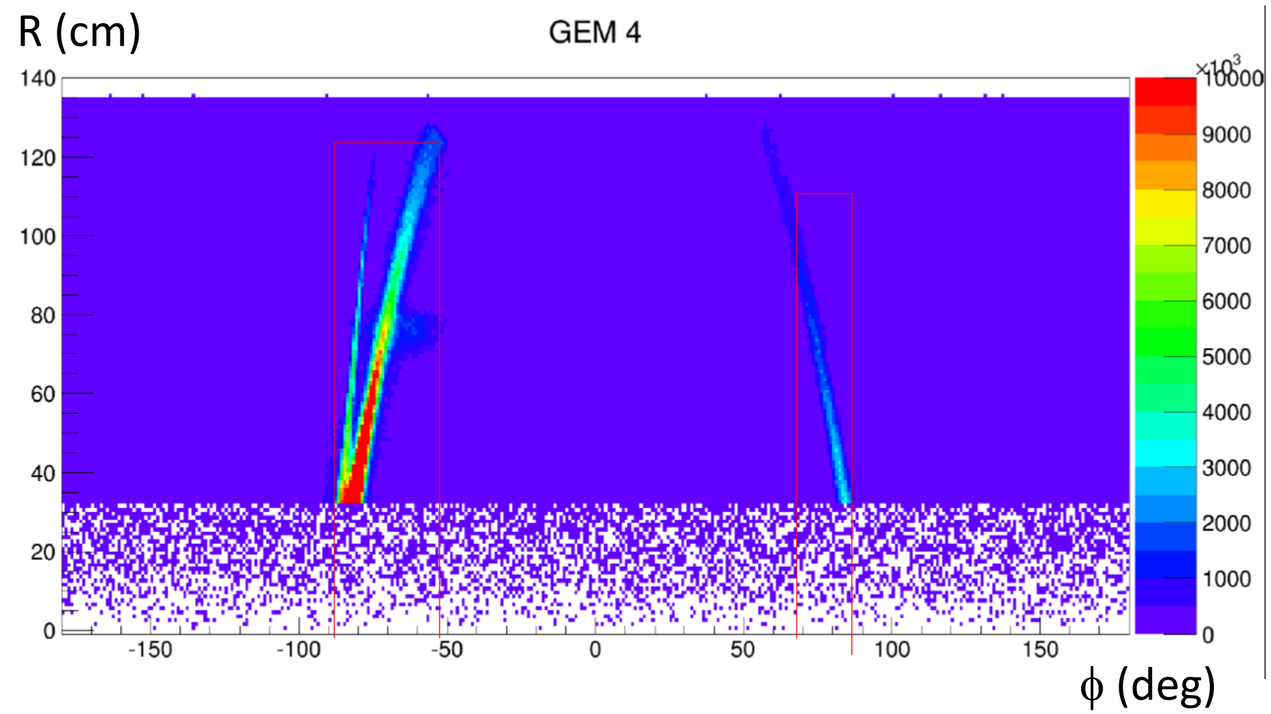
PRELIMINARY

Redesigned sheet-of-flame cuts currently used









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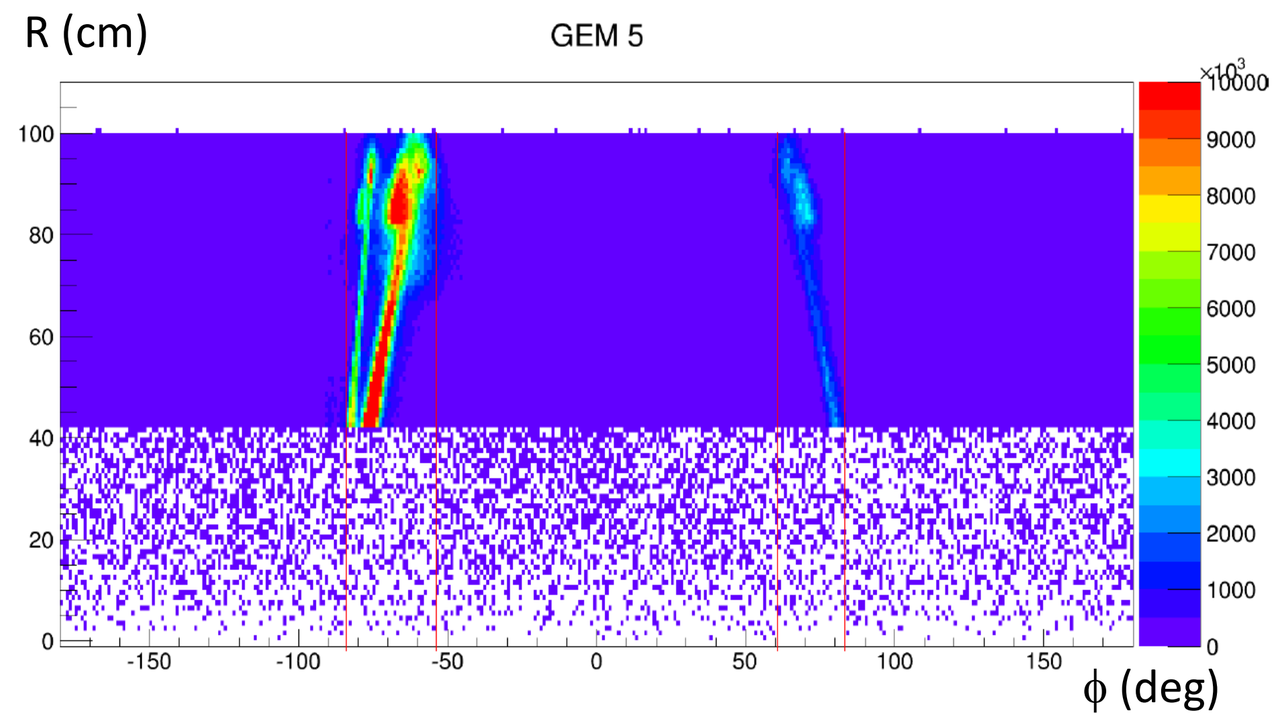

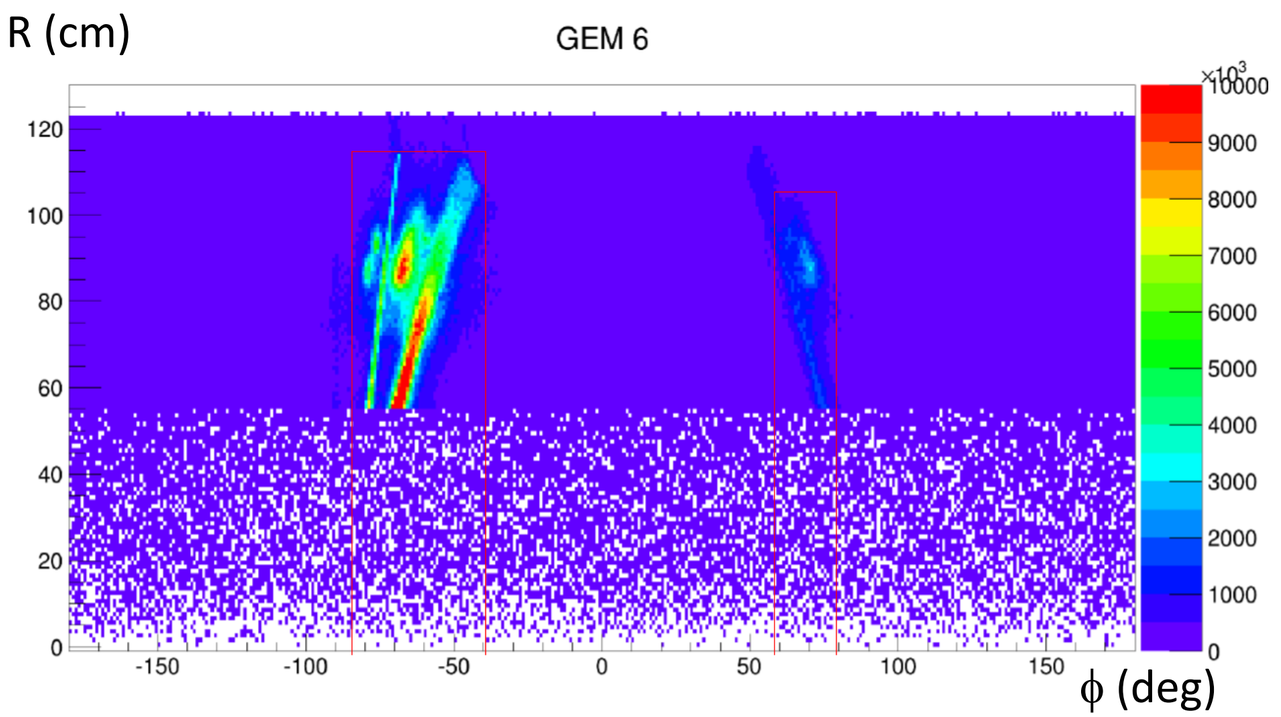

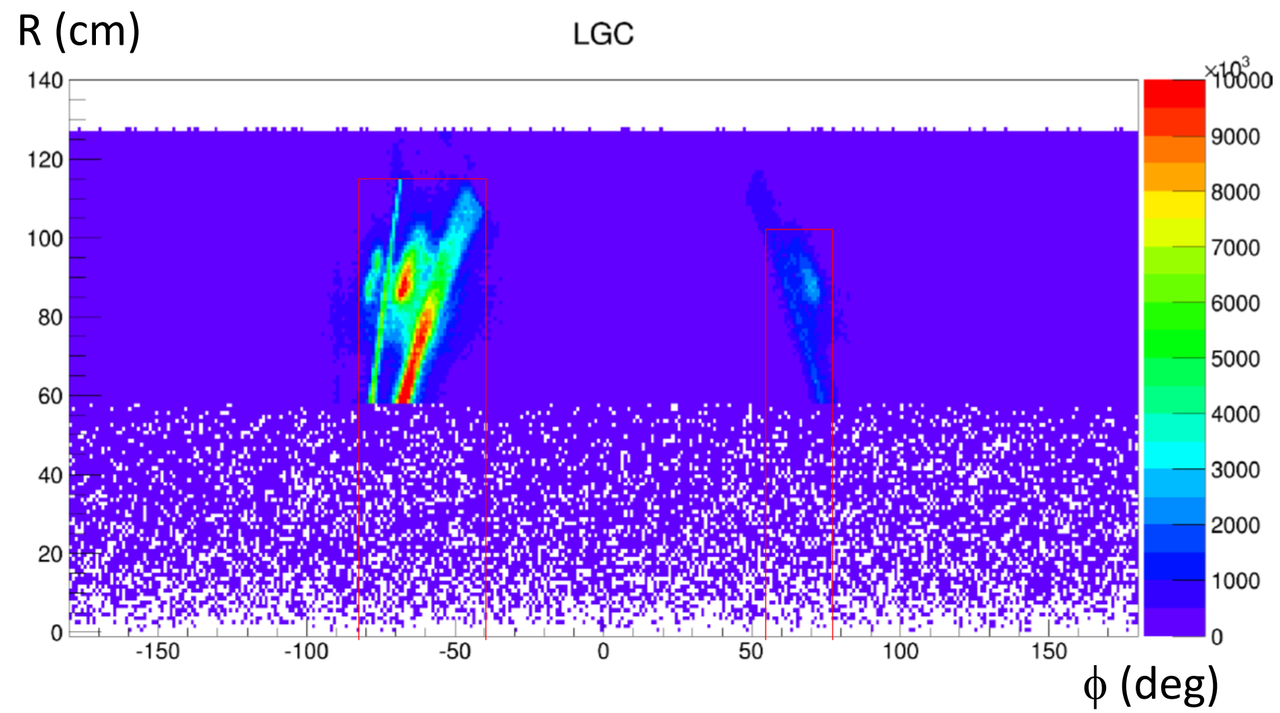

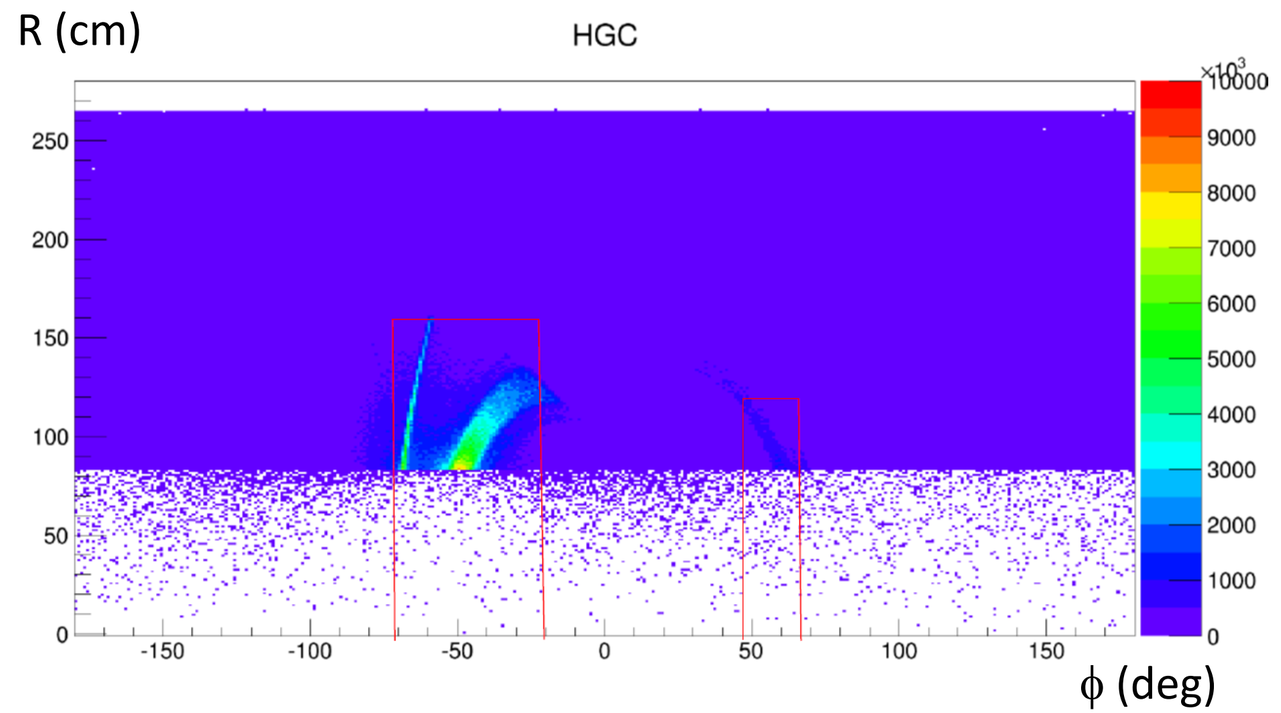

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