SCE Time Dependence Study using Beam Electrons/Protons

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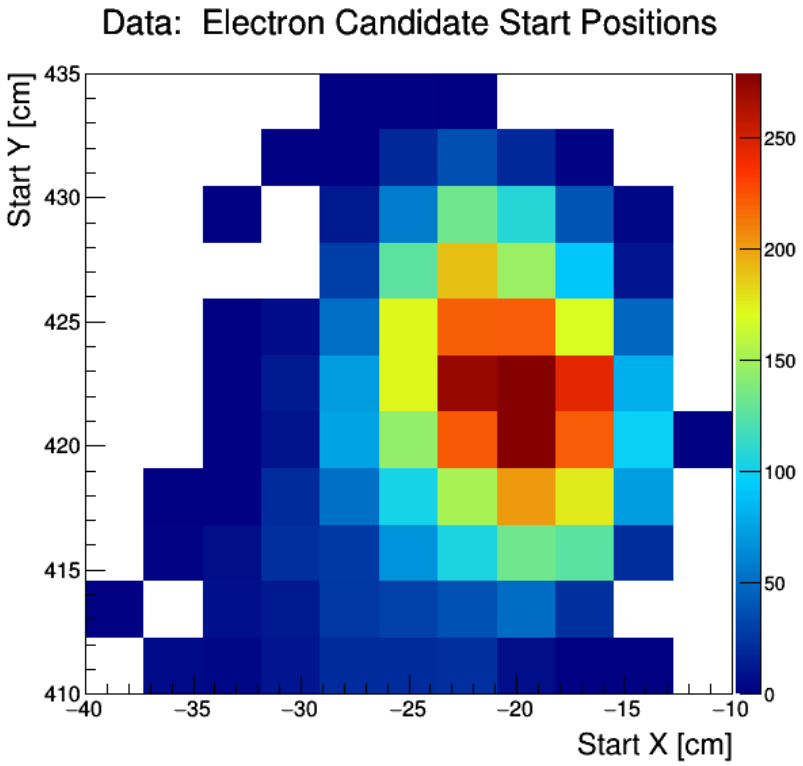
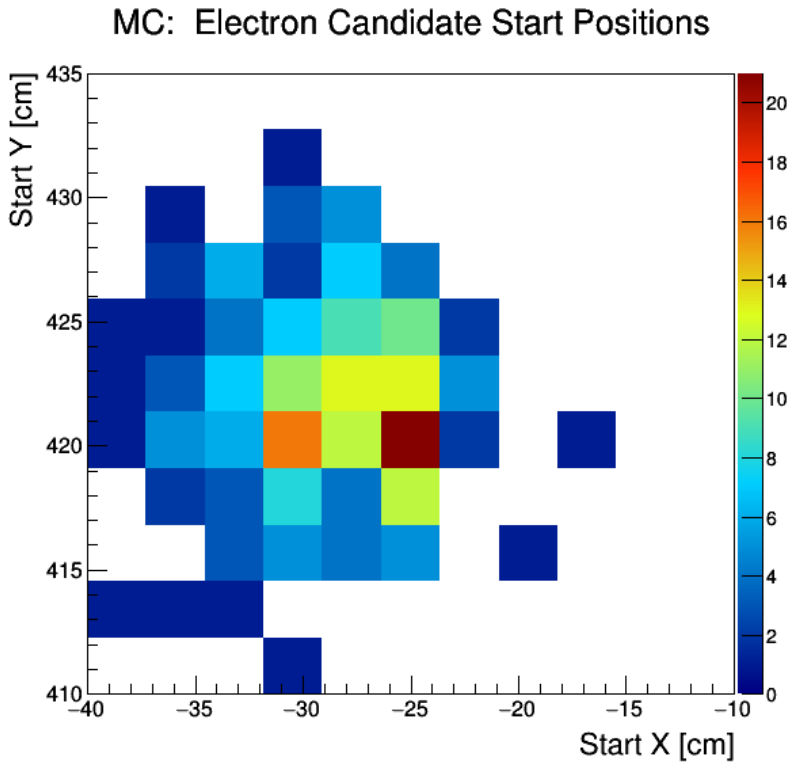
Introduction

- Aaron presented a study of beam electrons (e^+) in the Thursday ProtoDUNE Analysis meeting
  - See slides **here**
- This is a useful sample for detector calibration – can use to probe **time dependence of SCE**
  - Look at width of ΔZ distribution in data, compare to MC
  - Broadening in MC due only to reconstruction effects
  - Broadening in data due to reconstruction and SCE
  - Also study ΔZ bias/resolution in X-Y plane
- Aaron also provided sample of protons – repeat study
- This study is to be complemented with cosmics-based time dependence study (Francesca)
  - Cosmics-based study opens up other parts of TPC

Electrons

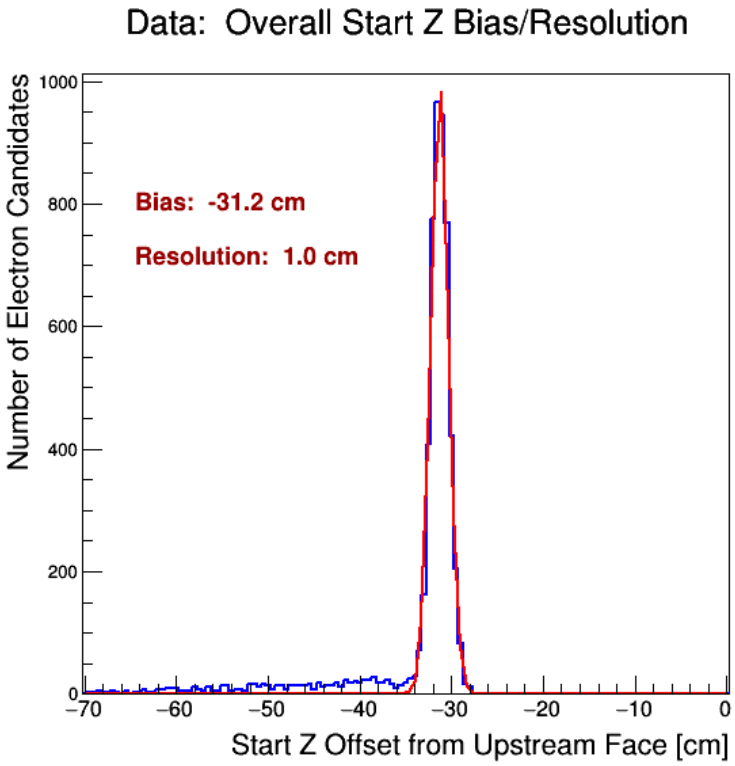
Samples/Coverage

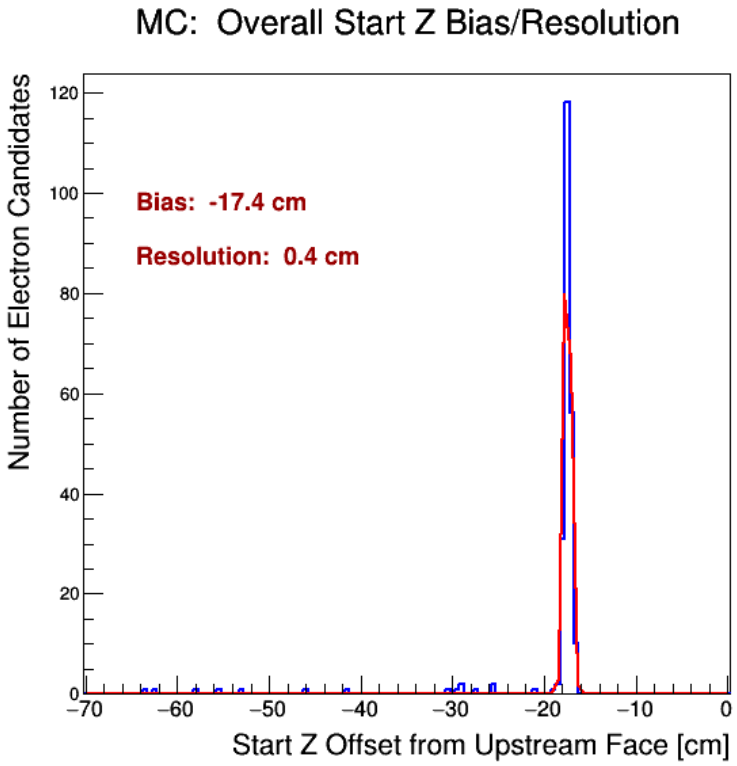




- Data: Run 5809
  - Number of e^+ candidates: **5930**
- MC: 1 GeV e^+ beam MC
  - Number of e^+ candidates: **240** (can we get more?)

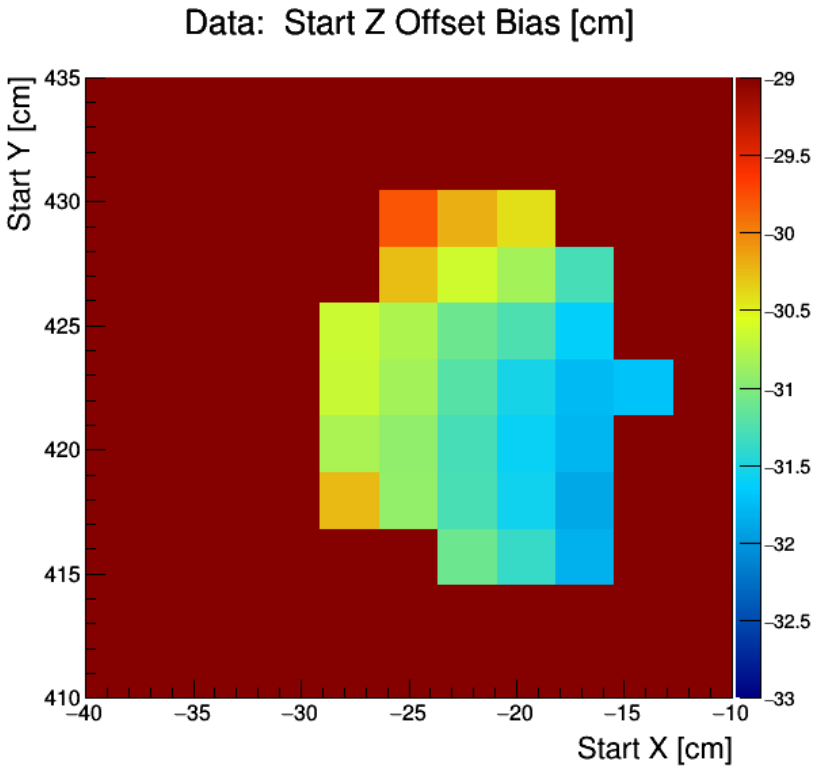
Gaussian Fits

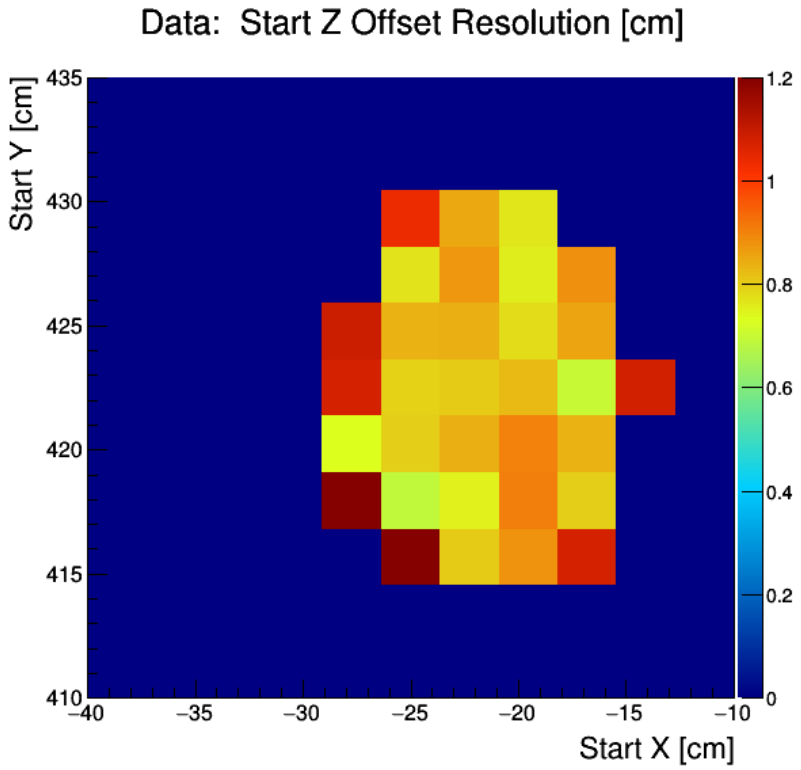




- Look at total Z offset distribution (all e^+ candidates)
  - Data: -31.2 ± 1.0 cm
  - MC: -17.4 ± 0.4 cm
- Implies SCE time dependence ~ 1 cm (**3%** effect)

Bias/Resolution in Data

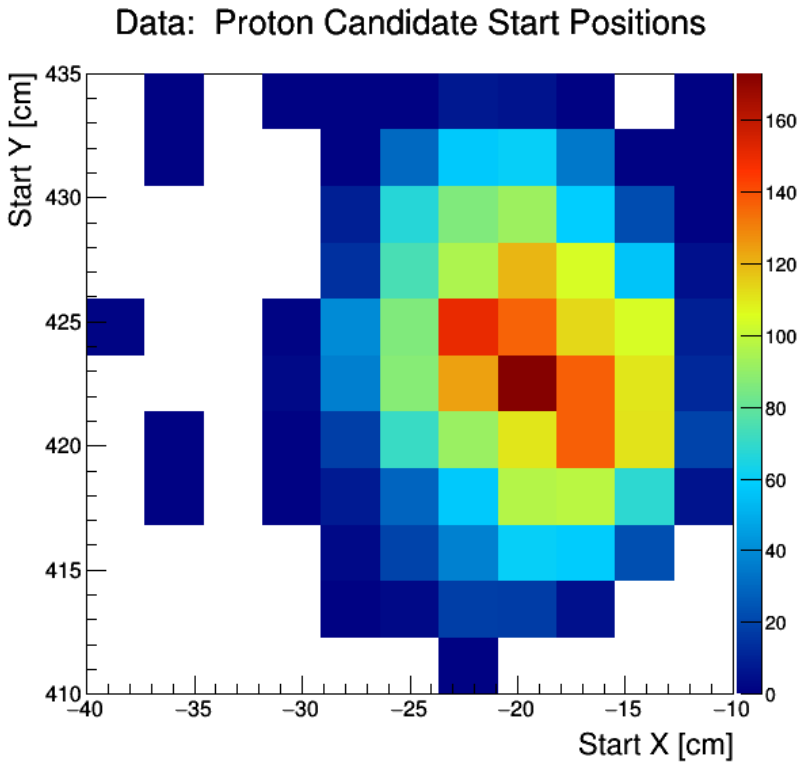




- Study dependence of bias/resolution in X-Y plane
  - Fit to Gaussian only if > 40 candidates in bin, **data only**
- See expected variation in X-Y plane for bias (SCE worse near cathode), relatively constant resolution

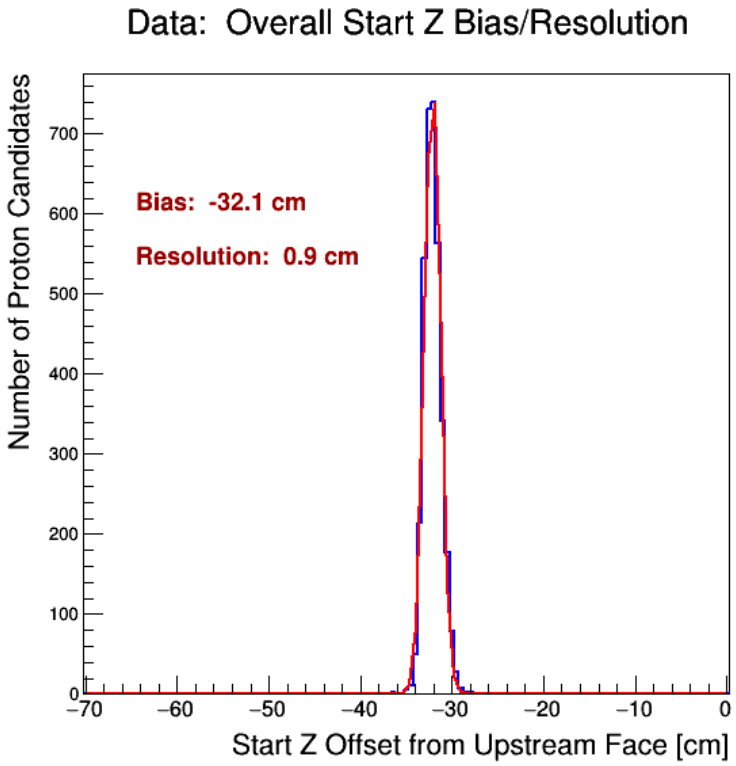
Protons

Sample/Coverage



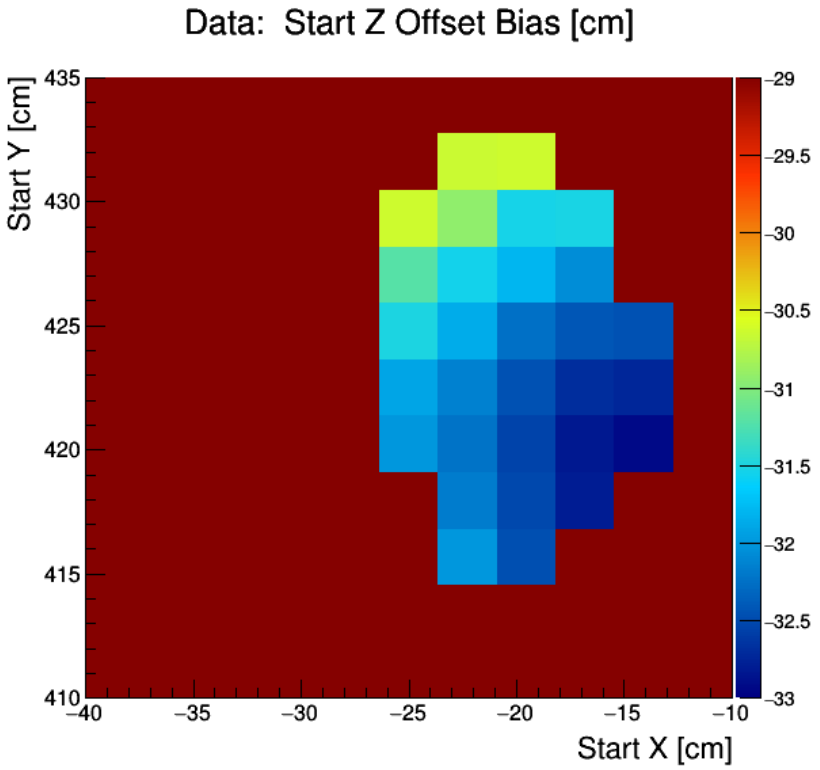
- Data: Run 5387
  - Number of p candidates: **3542**
- **No MC** sample provided for this run
  - Can be produced, of course…

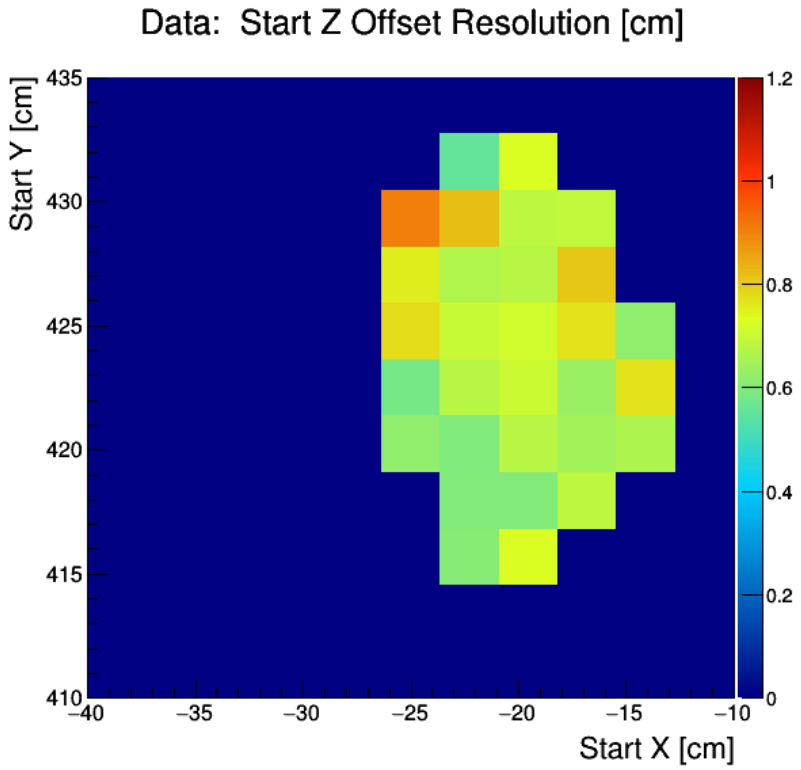
Gaussian Fit



- Look at total Z offset distribution (all p candidates)
  - Data: -32.1 ± 0.9 cm
- Similar resolution as for electrons sample, but bias is different by **~1 cm** (-32.1 cm vs. -31.2 cm)

Bias/Resolution in Data





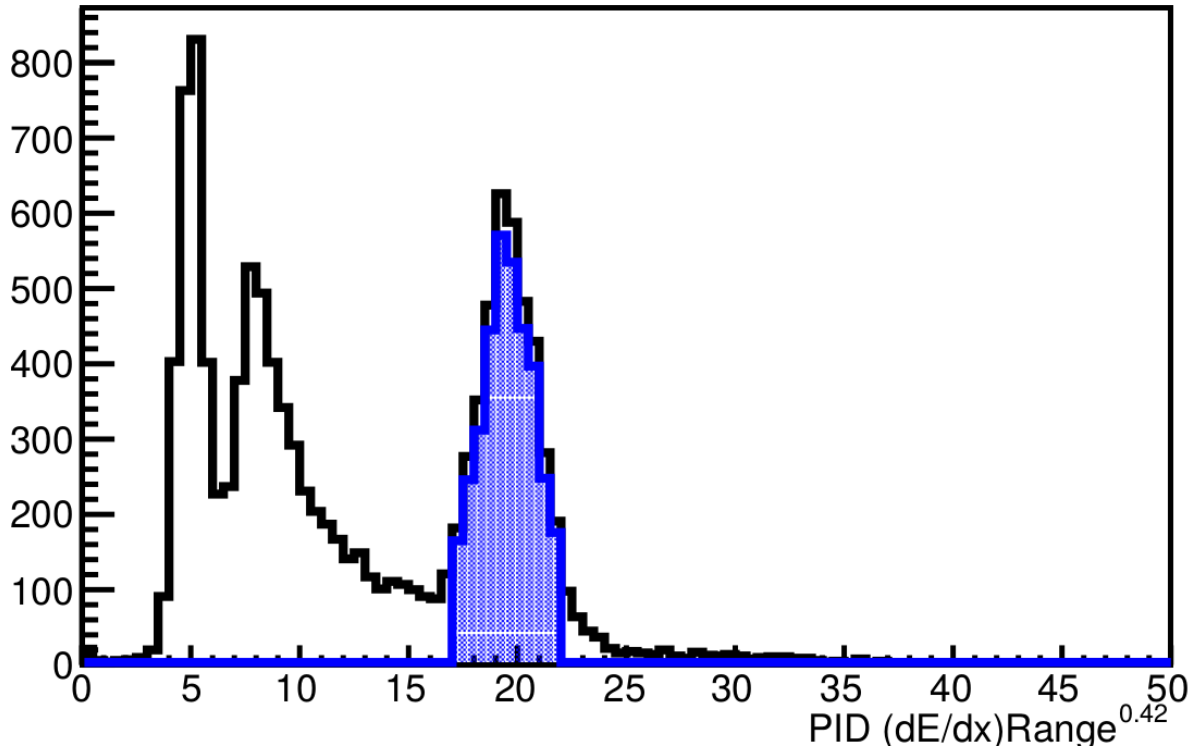
- Study dependence of bias/resolution in X-Y plane
  - Fit to Gaussian only if > 40 candidates in bin
- Similar conclusions as for case of electrons (expected distributions), though bias is worse by **~1 cm**

Conclusions/Discussion

- Using beam electrons/protons samples prepared by Aaron, studied SCE time dependence
  - Can only study SCE where beam enters upstream TPC face with this analysis
- Appears to be ~**1 cm** variation in SCE over time
  - Roughly **3%** of total SCE spatial distortion (~ 30 cm)
  - Reconstruction resolution of roughly 0.4 cm (~ 1 wire)
- Similar effect observed at MicroBooNE (roughly 5% variation in SCE over time)
- Need to study SCE time dependence over entire TPC
  - Cosmics-based analysis by Francesca – O(hours)
  - ^{39}Ar-based analysis by Alex Flesher – O(minutes)

BACKUP SLIDES

Proton Selection



- Aaron uses PID cut to select proton candidates (see above plot)