A preliminary look at HV-CMOS eTCT data after p-irradiation

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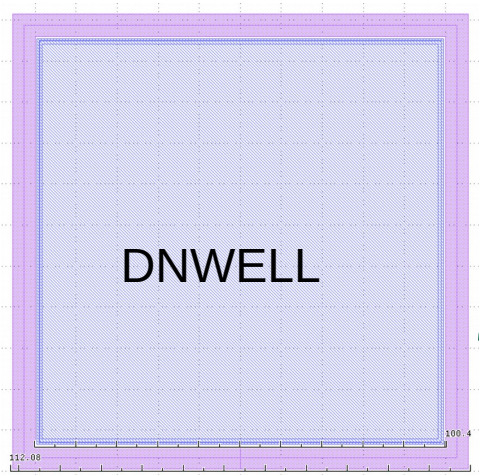
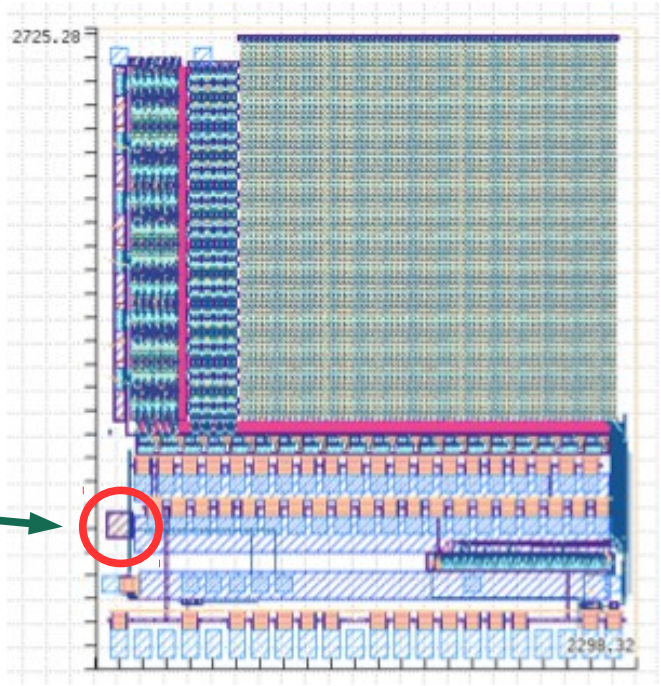
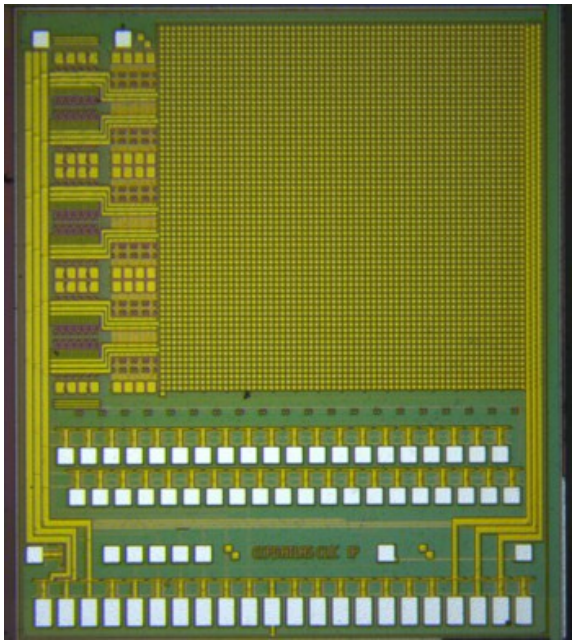
Samples

- Up to now: measurements on AMS H18 HV2FEI4 v3
  - one dedicated passive 100 x 100 µm diode accessible
    - no neighbours, so beware of edge effects, HV supply via p-"guard ring"
- Irradiation at CERN PS (Irrad 1) without biasing
  - fluences of 2.3, 6 and 11.1e15 p/cm^2 (i.e. 1.42, 3.72 and 6.9e15 neq/cm^2 have been reached)
- Very recent measurements in TCT+ setup by Christian Gallrapp

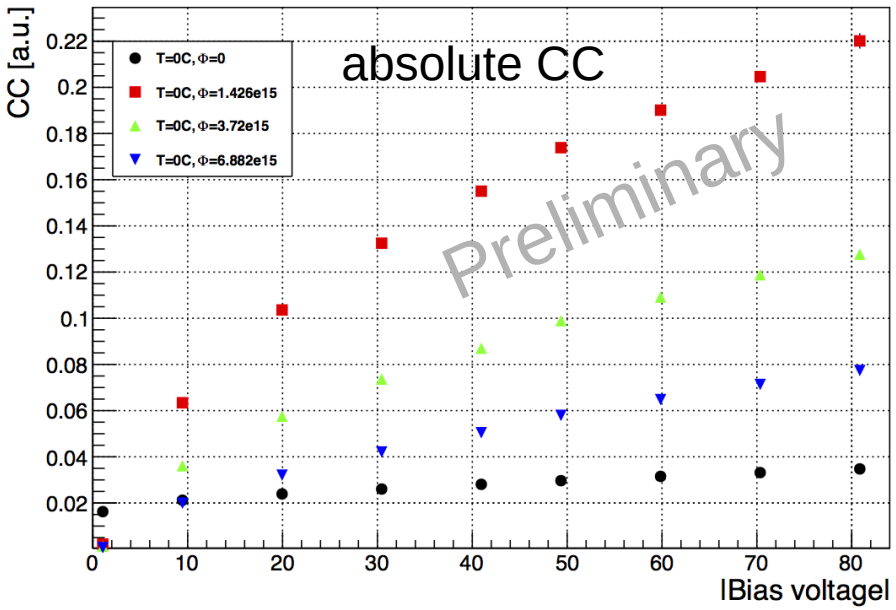


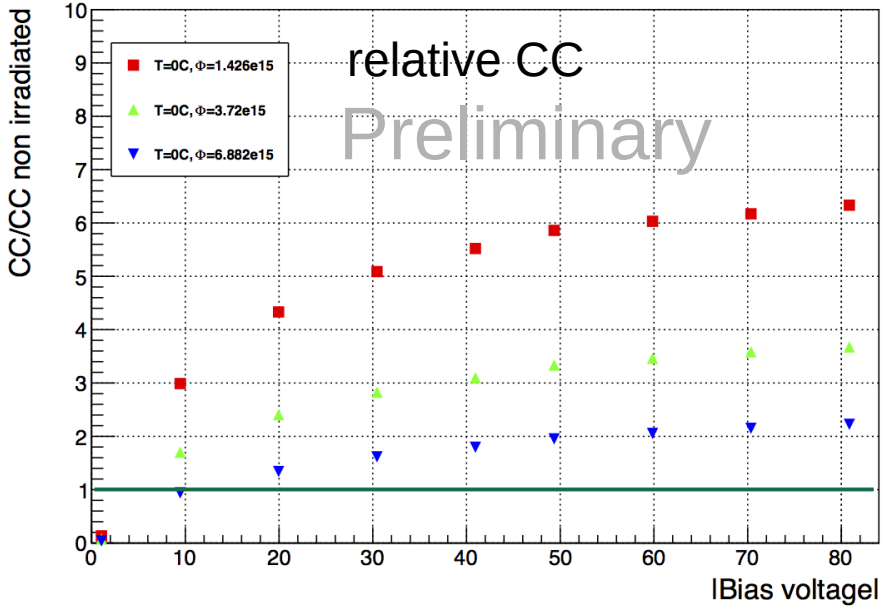




A first look at the data

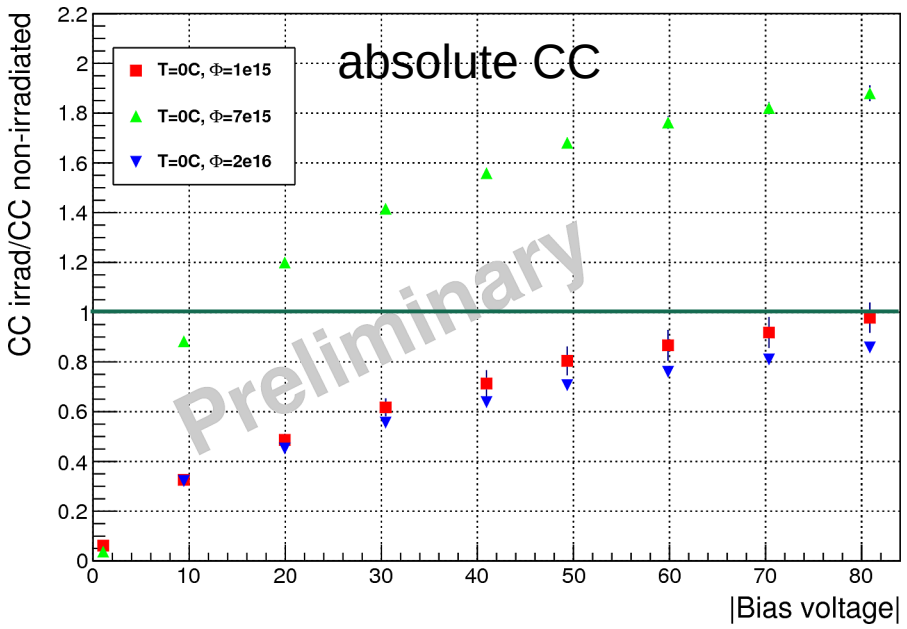
- p-irradiated samples at 0 degrees C
- largest charge collection (by far!) after 1.42e15 neq/cm^2
  - relative CC larger than 6 (!) at 80V
  - for lower fluences: 3.6 (3.7e15 neq/cm^2) and 2.2 (6.9e15 neq/cm^2)
- always more collected charge than before irradiation
  - but no diffusion, rel. CC > 1 already after a few V

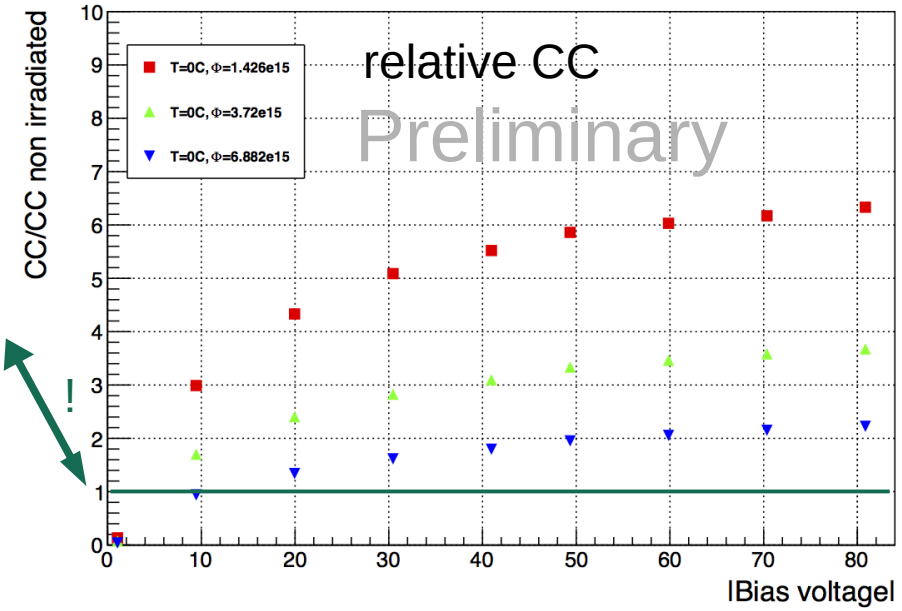




Direct comparison to neutron data

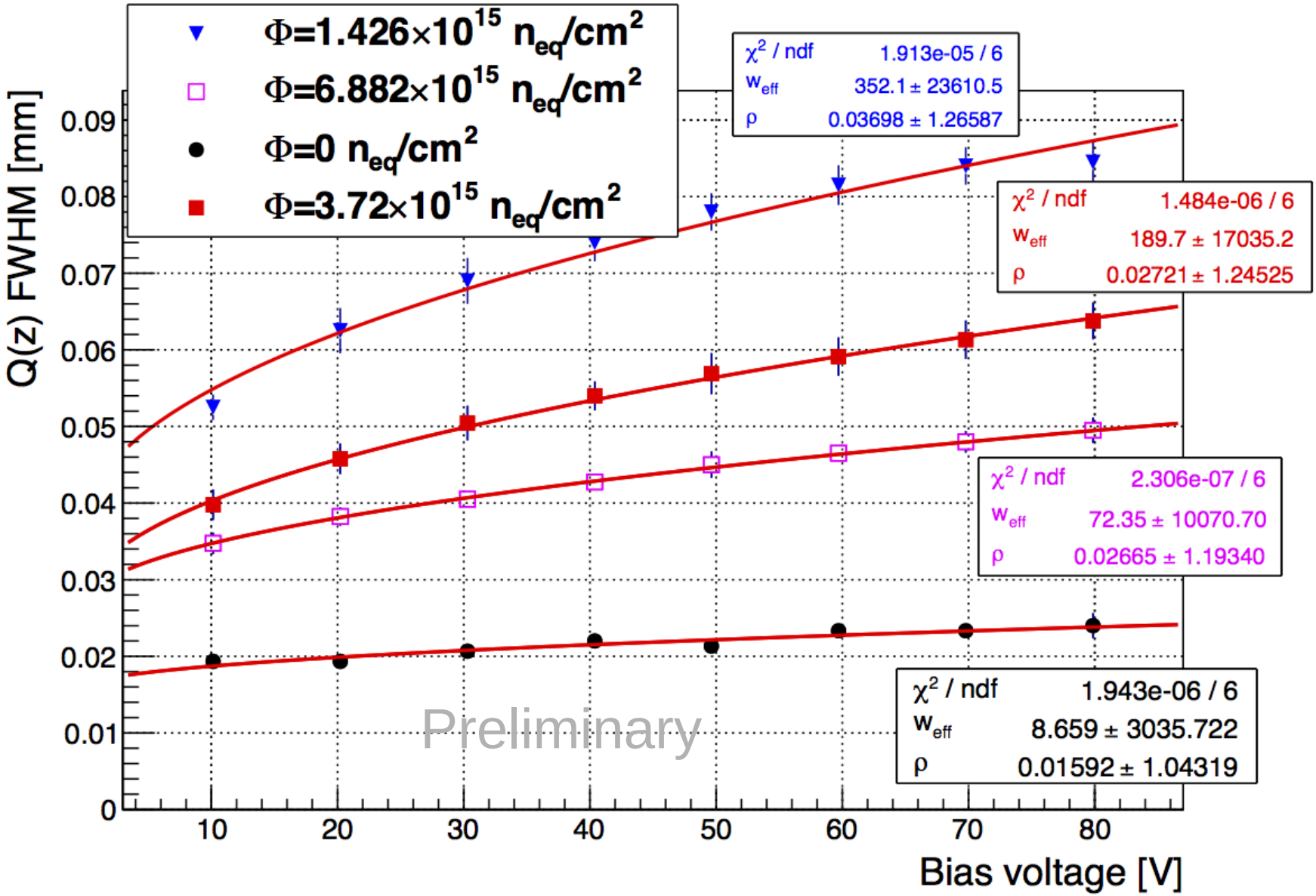
- direct comparison to n-irradiated data: relative CC
  - comparable after 7e15 neq/cm2: 1.9 (n) vs. 2.2 (p) at 80V
  - insane discrepancy (factor 6) between 1e15 (n) and 1.42e15 (p) neq/cm^2
    - however, large jump in charge collection from some 10^{14} to $1e^{15}$ neq/cm^2 also seen by JSI Ljubljana, but only factor 2 or so





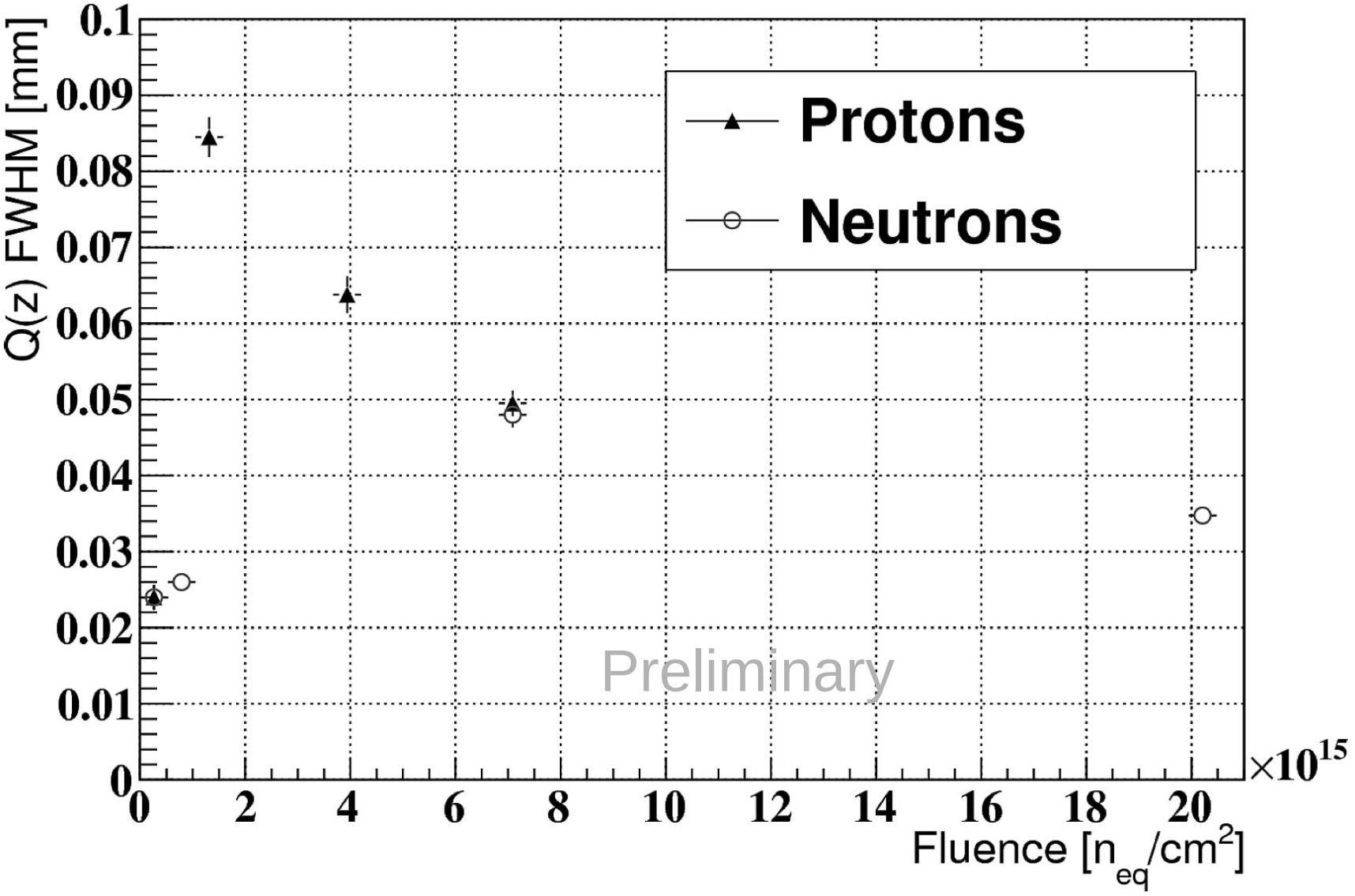
Extracted depths of charge-collection zones

- difficult for shallow depletion depths



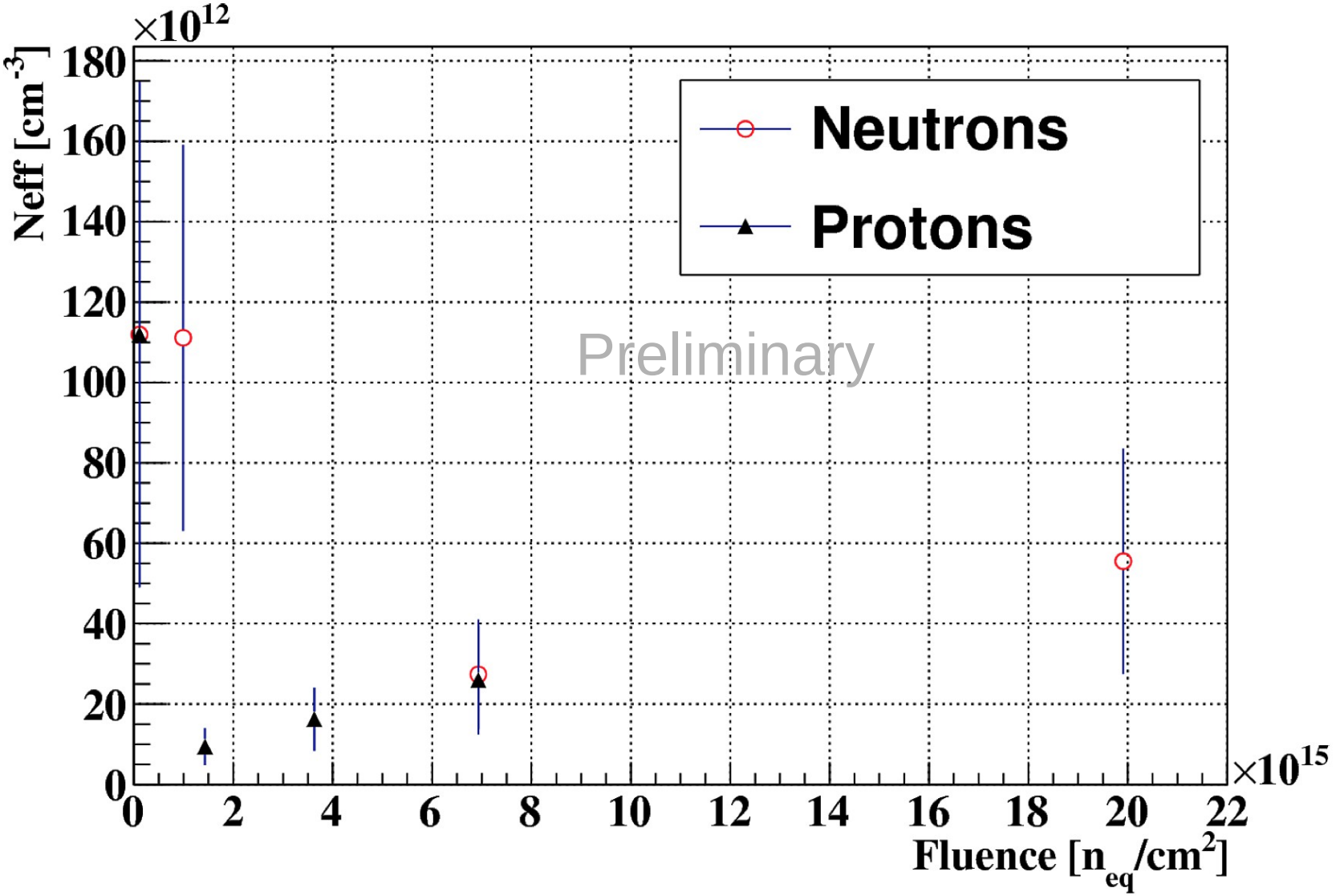
Direct comparison with neutrons

- Depletion width (FWHM) at 80V vs. Fluence



Direct comparison with neutrons

- $N_{effective}$ vs. Fluence
  - caveat: 10 Ohm*cm should be 1300e12/cm^3 before irradiation!



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(Preliminary) Conclusions

- Samples irradiated with high-energetic protons exhibit consistent behaviour after 7e15 neq/cm^2 (hightest fluence reached at CERN PS)
- Observation of huge increase in depletion depth for lower fluences, collected charge up to 6 times the value before irradiation
  - migh be consistent with larger (complete?) acceptor removal from charged hadron irradiation compared to neutron irraidation
- Possible inconsistency at lowest investigated fluences (1.42e15 (p) vs. 1e15 (n) neq/cm^2)
  - however, deficit in collected charge was measured by JSI Ljubljana for fluences below 1e15 neq/cm2
  - hypothesis: loss of diffusion due to trapping, acceptor removal not yet compensating by increasing depletion zone
    - higher initial bulk resistivity should help
- More data needed at lower fluences to clarify picture
- (AMS) samples with higher initial bulk resistivity will become available towards the end of the year