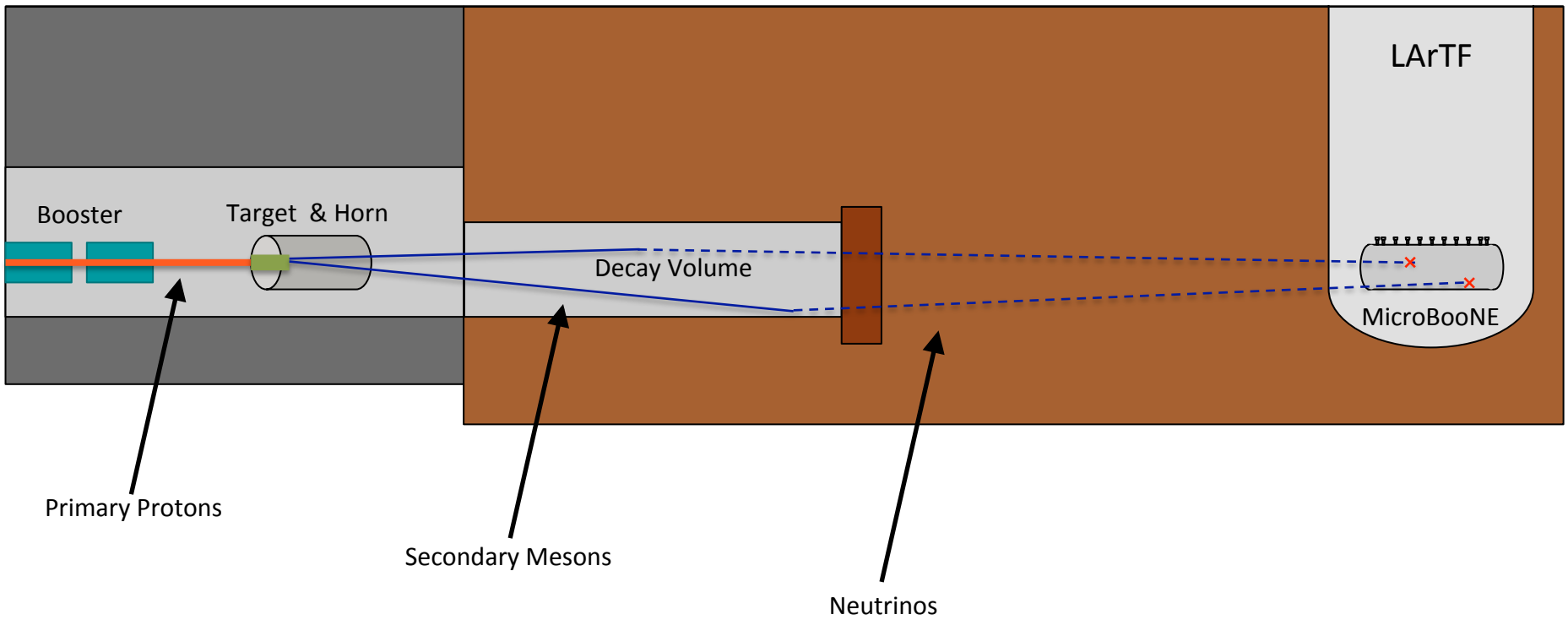
Neutron Measurements at SciBooNE with MITPC

MicroBooNE Collaboration Meeting

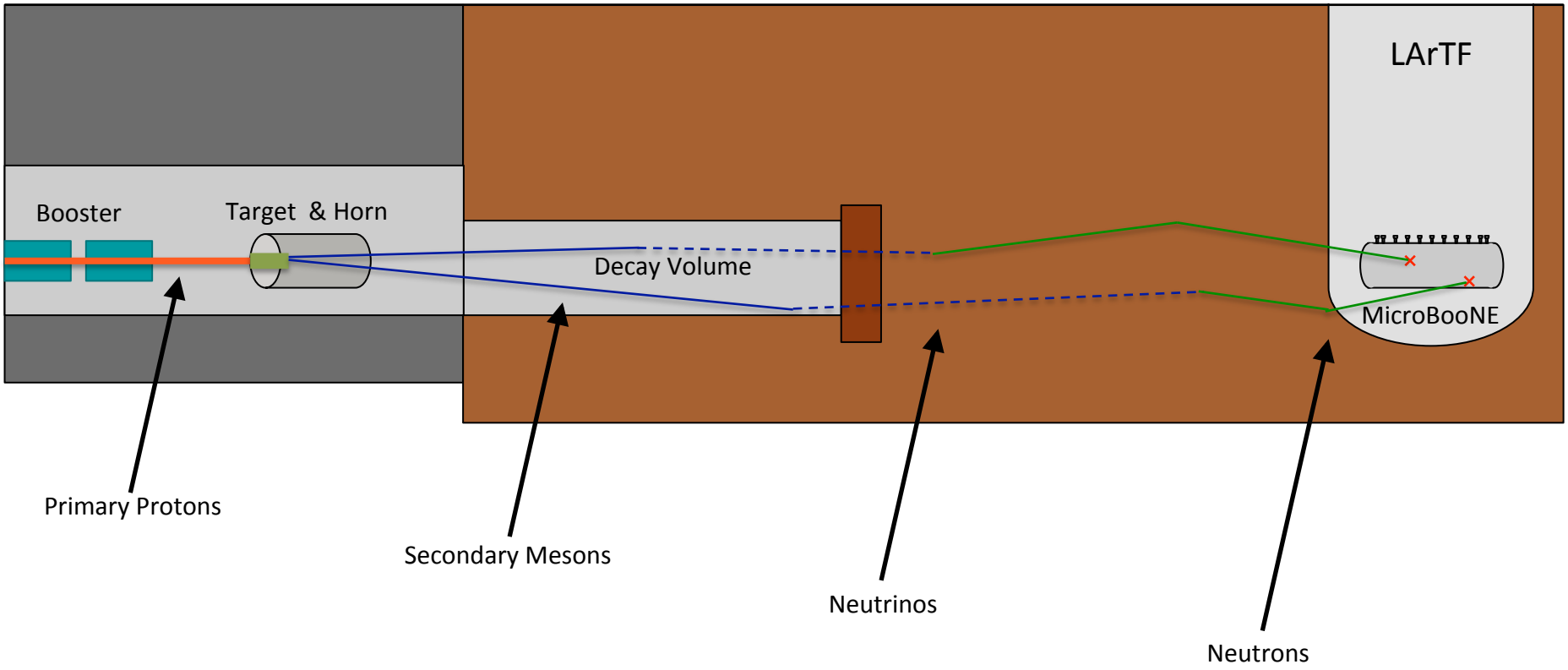
Marjon Moulai, MIT

July 29, 2015

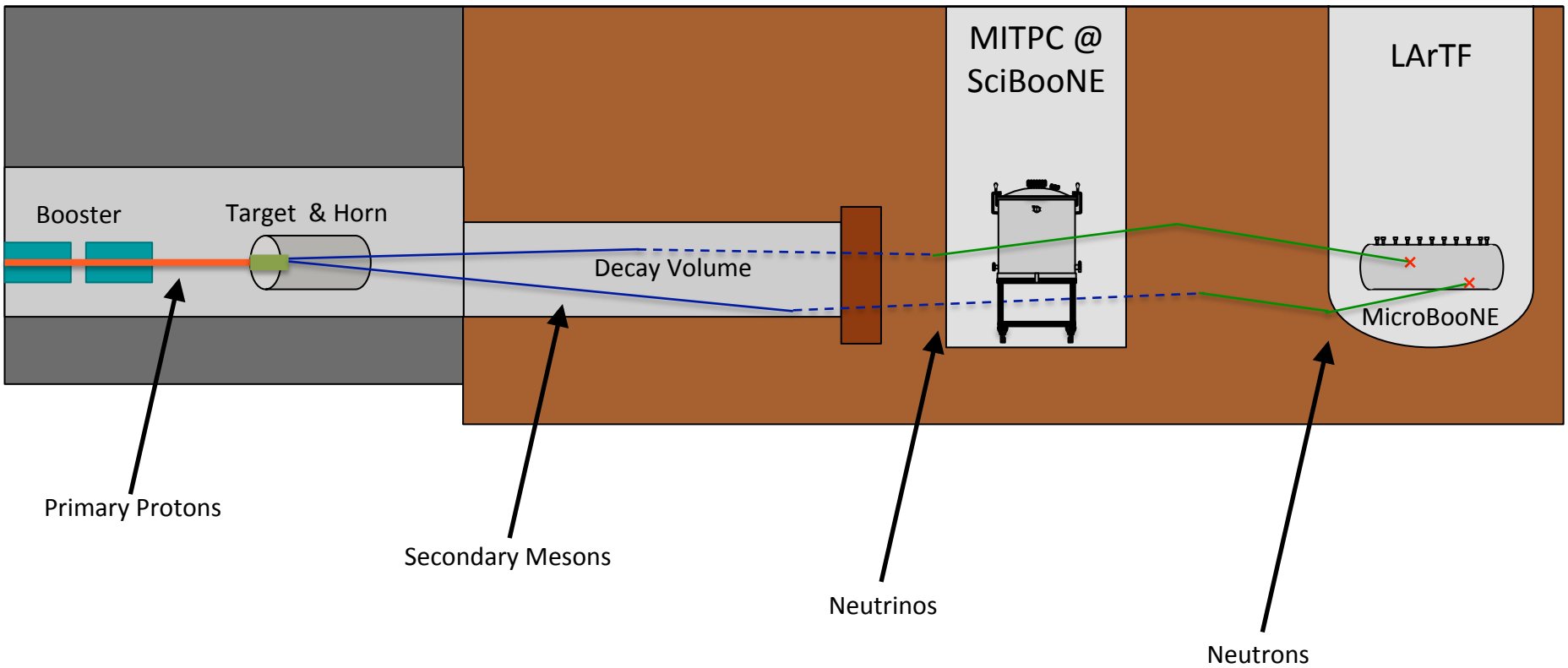
Booster Neutrino Beamline



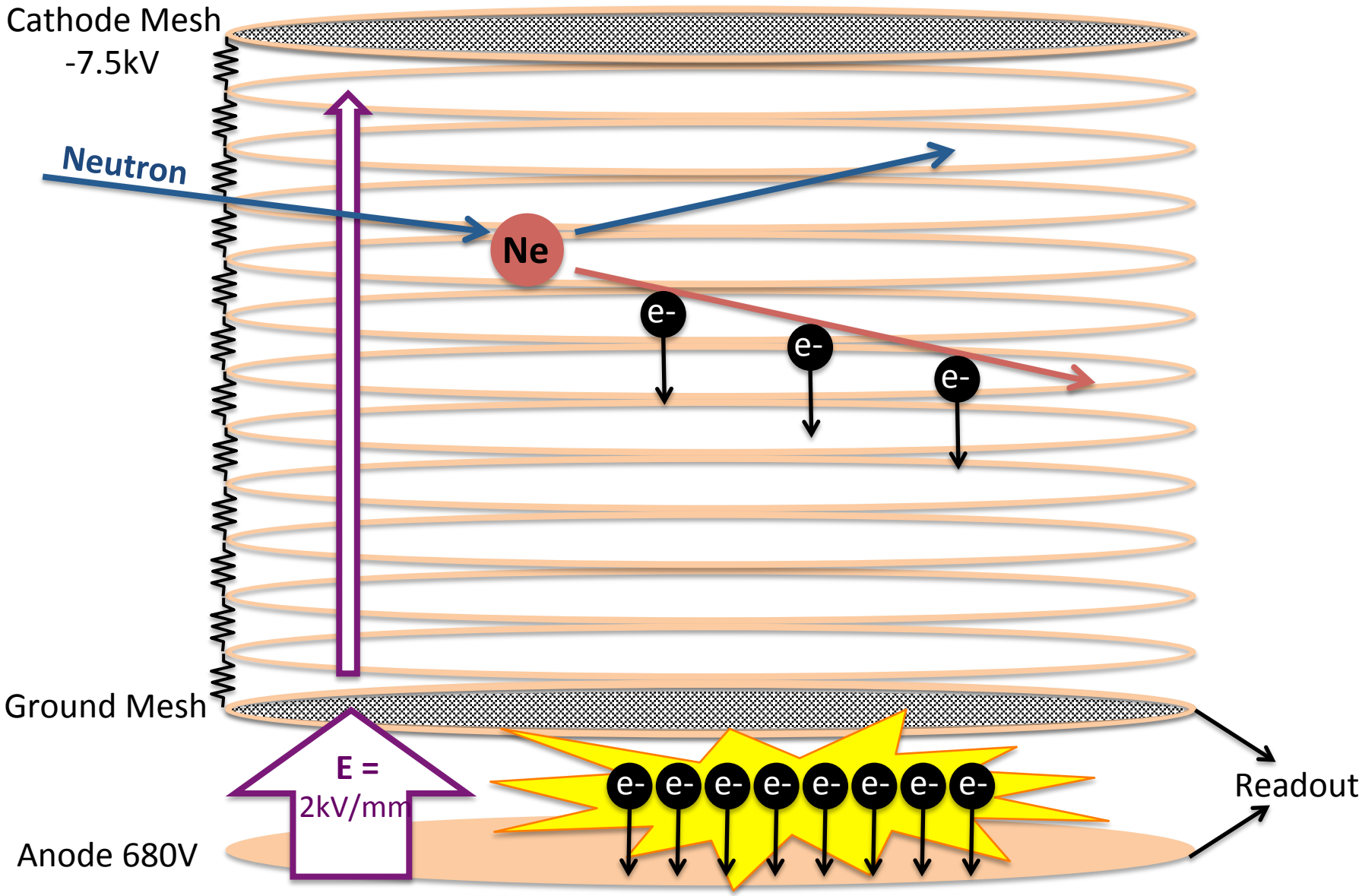
Booster Neutrino Beamline



Booster Neutrino Beamline

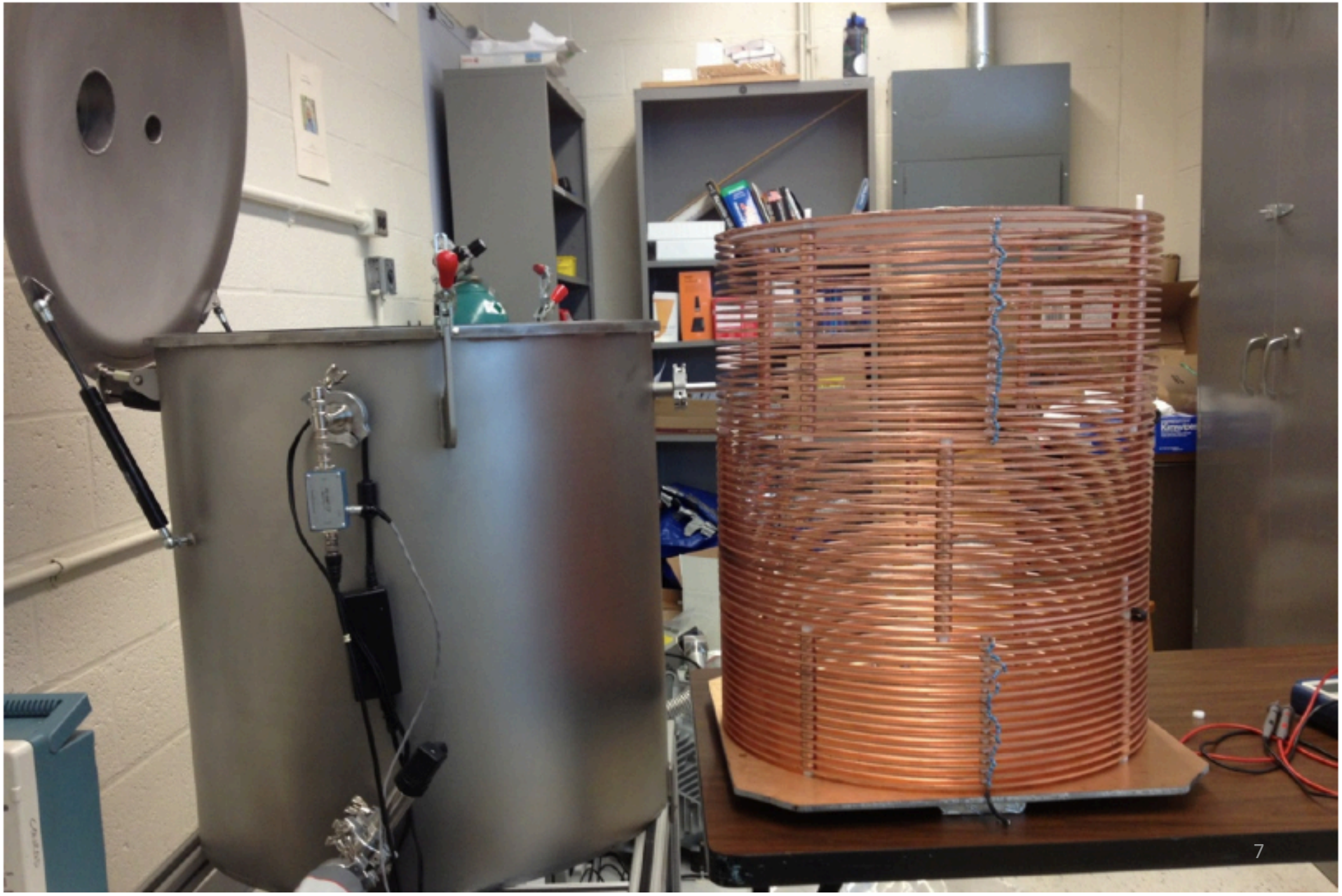


87.5% Ne + 12.5% CF_4 @ 600 Torr

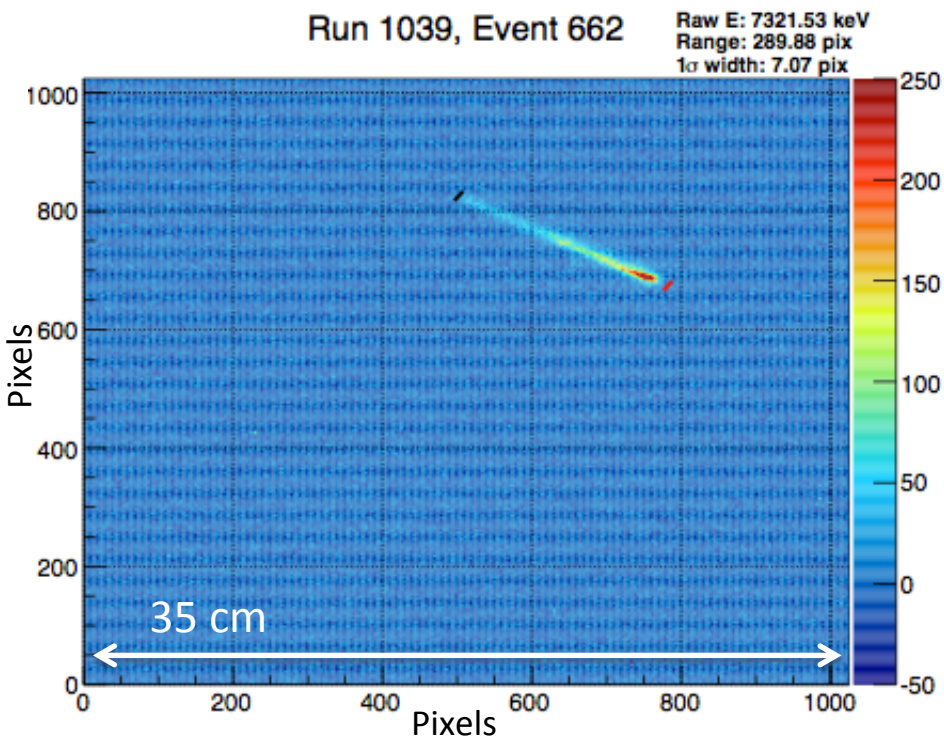


Paper coming out on use of neon in a TPC very soon!

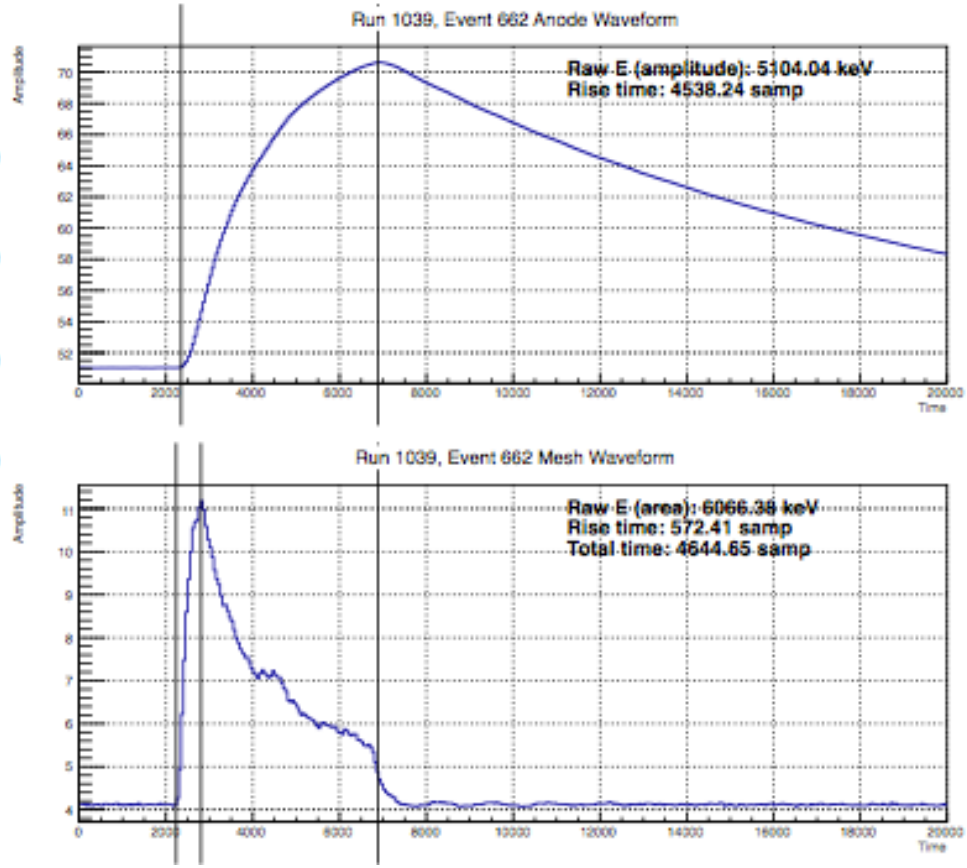
MITPC field cage outside of chamber



Event readout of an alpha

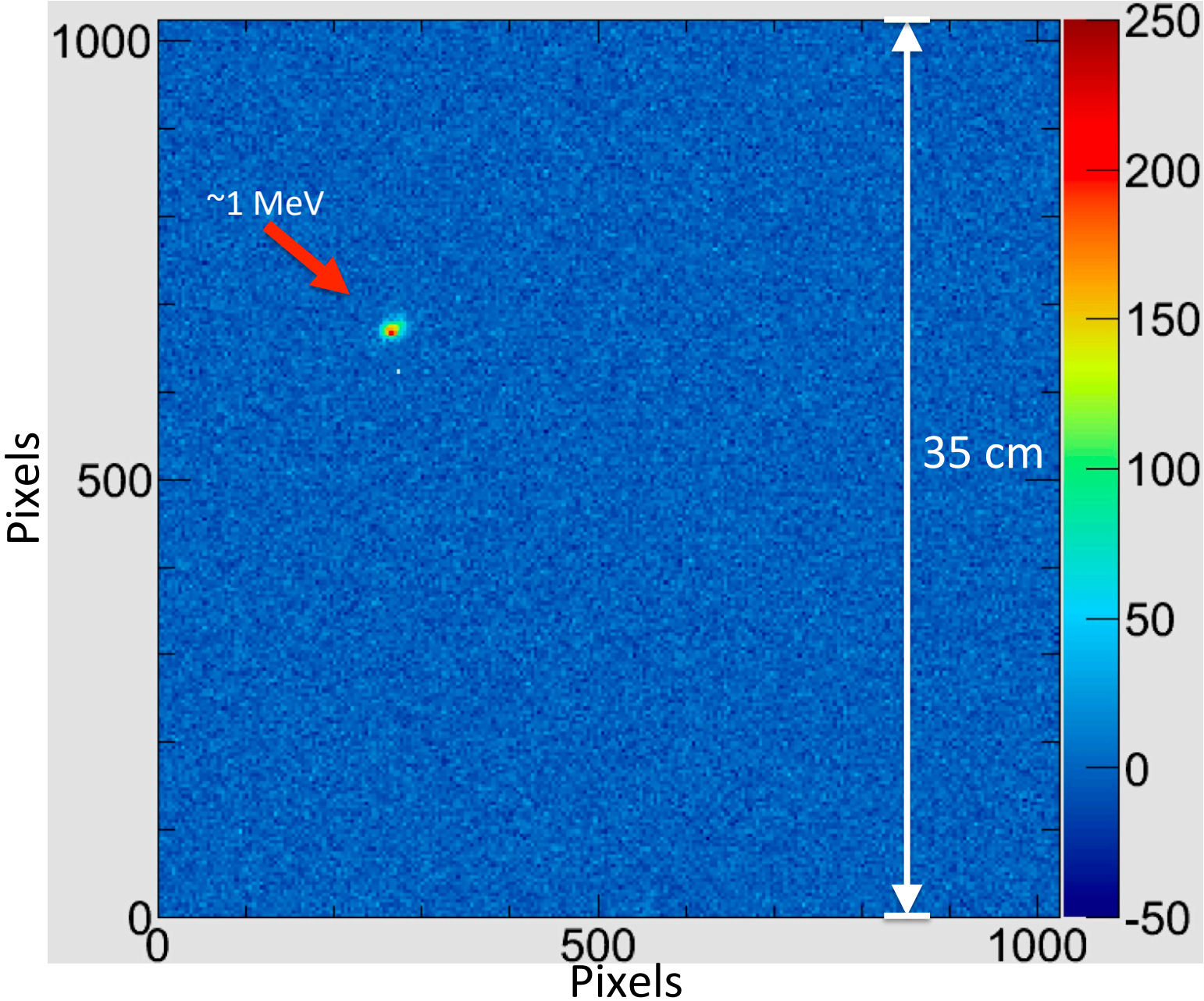


CCD readout

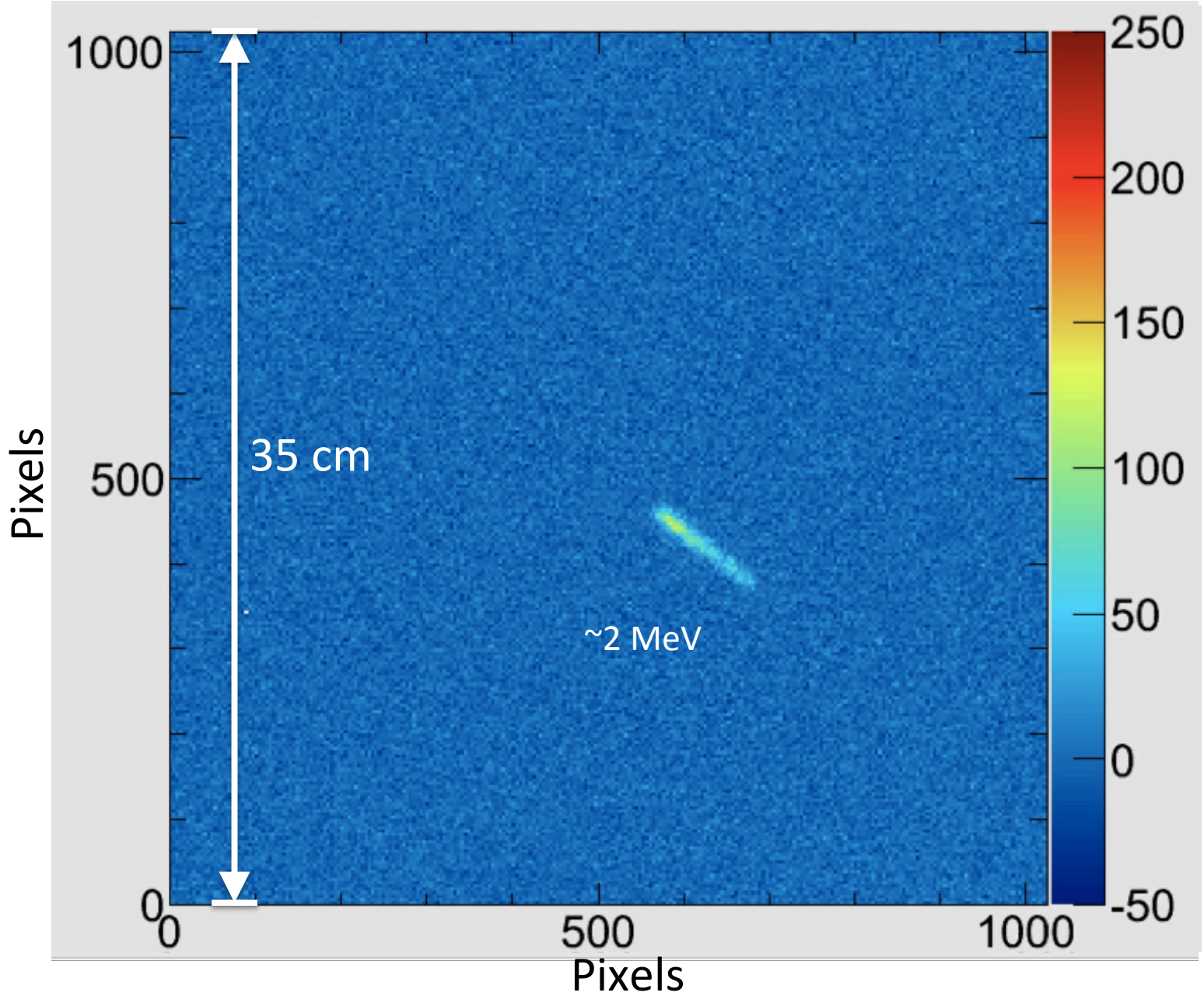


Waveform readouts: anode (top); mesh (bottom)

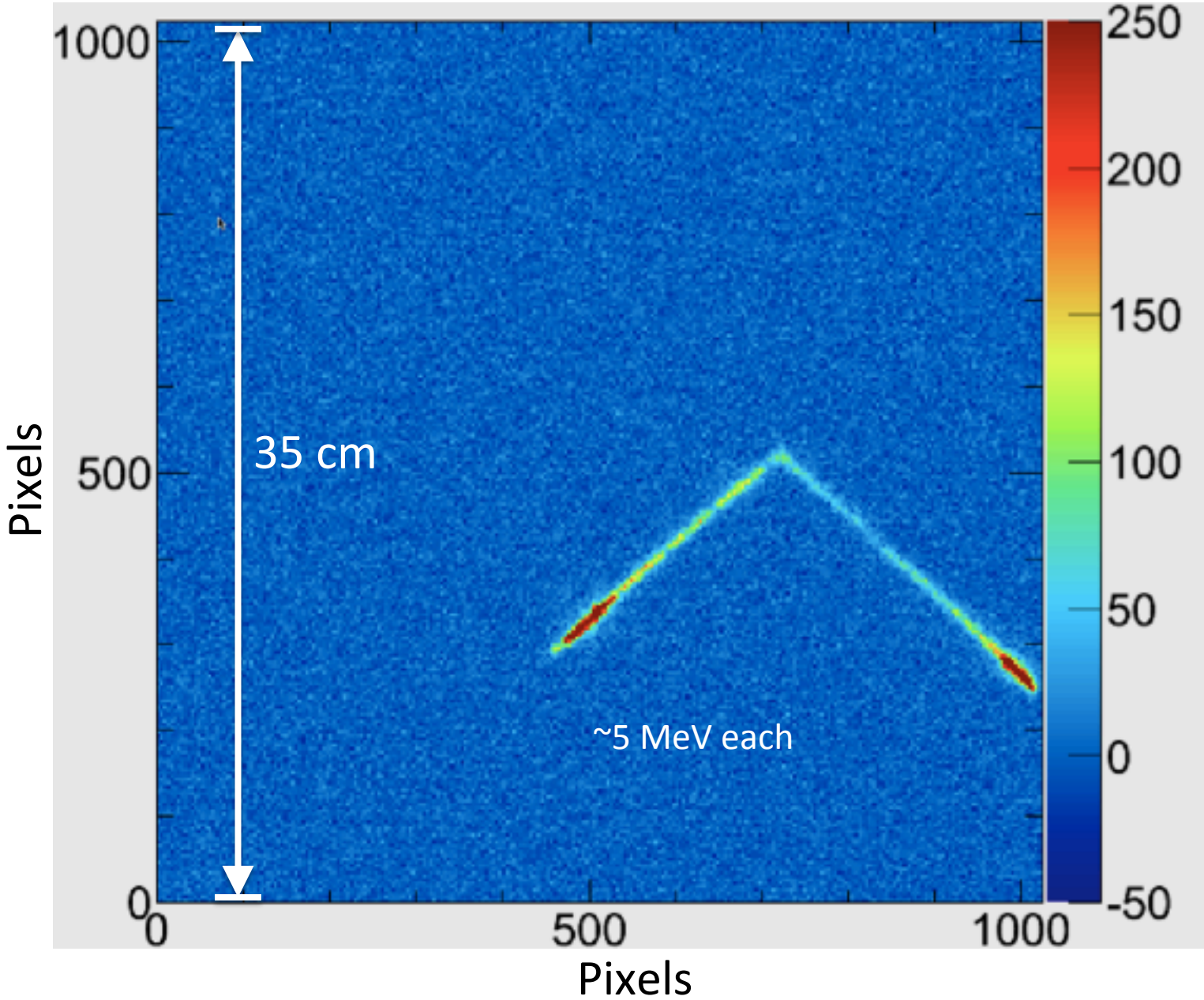
Neutron-Induced Nuclear Recoil



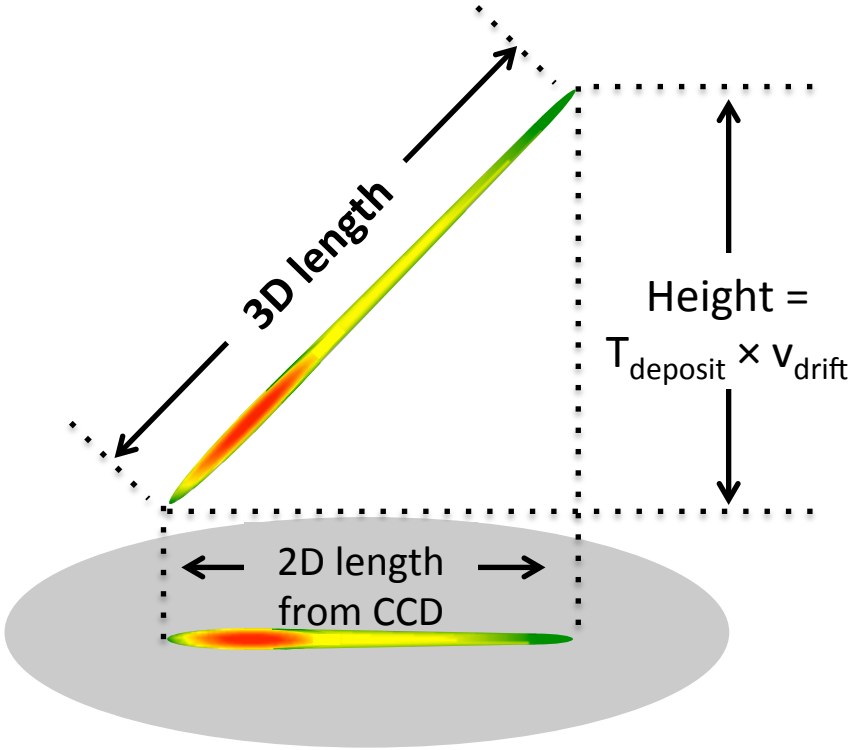
Neutron-Induced Nuclear Recoil

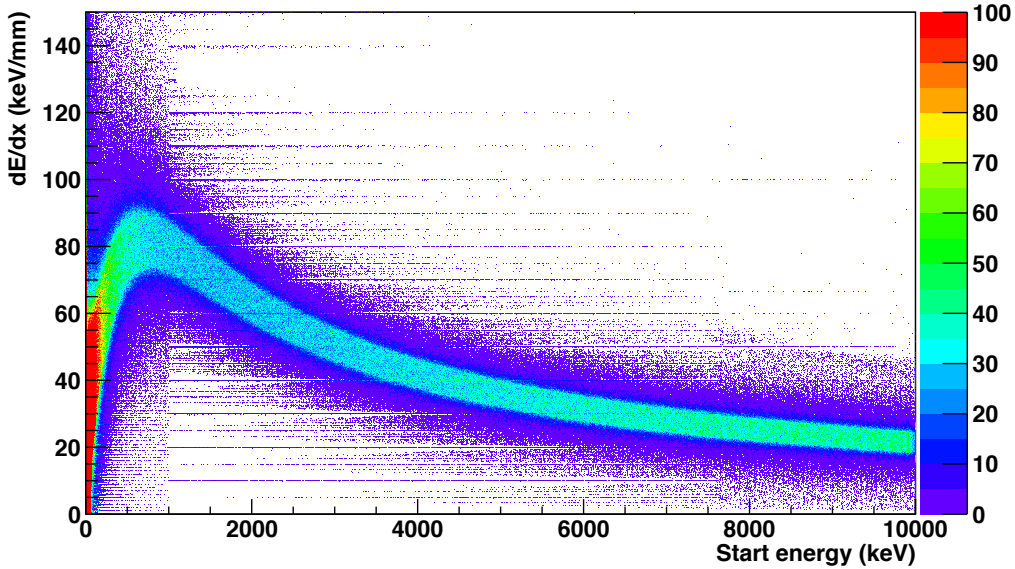


$$^{220}\mathrm{Rn} \rightarrow {}^{216}\mathrm{Po} \rightarrow {}^{212}\mathrm{Pb}$$

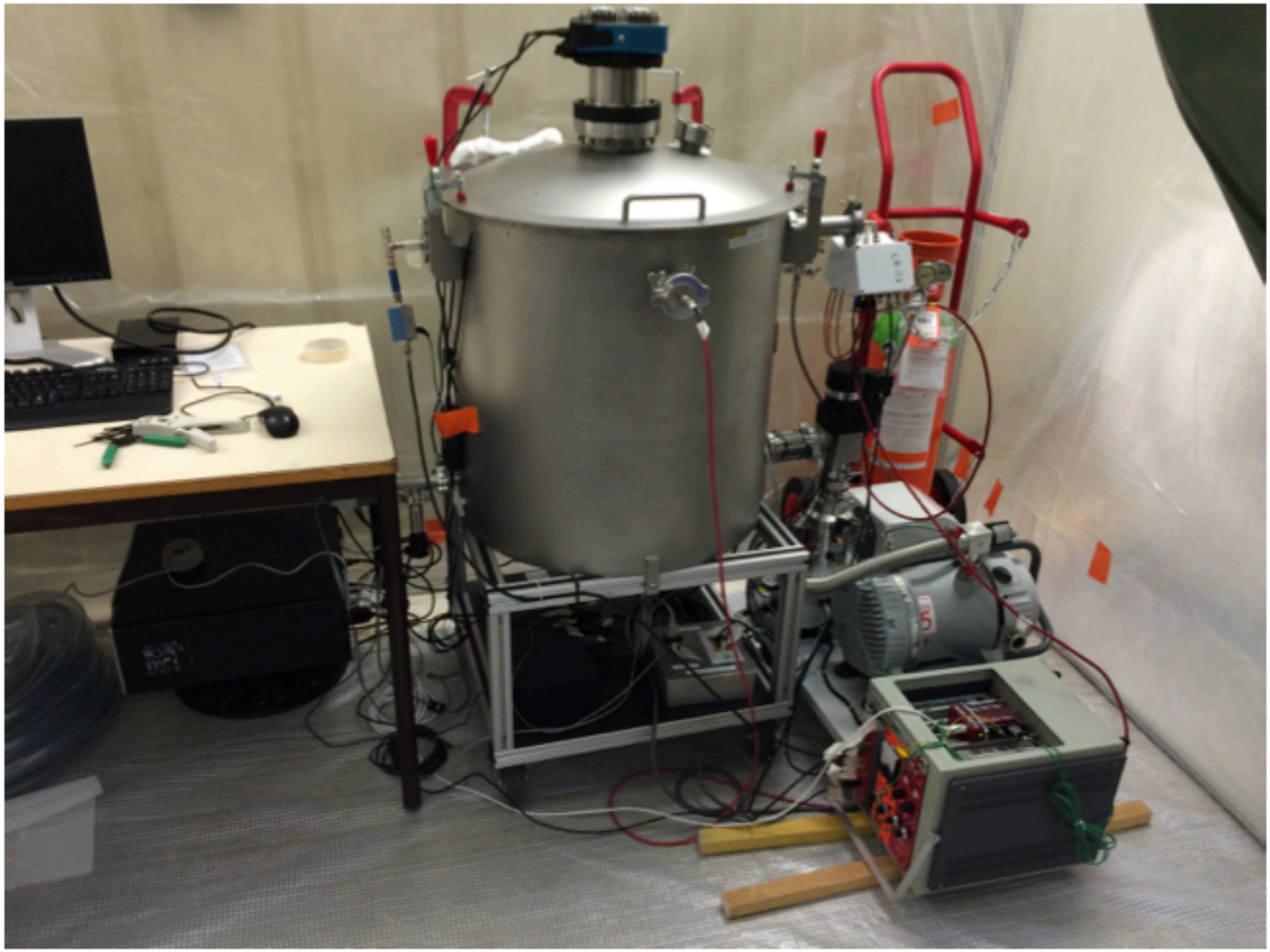


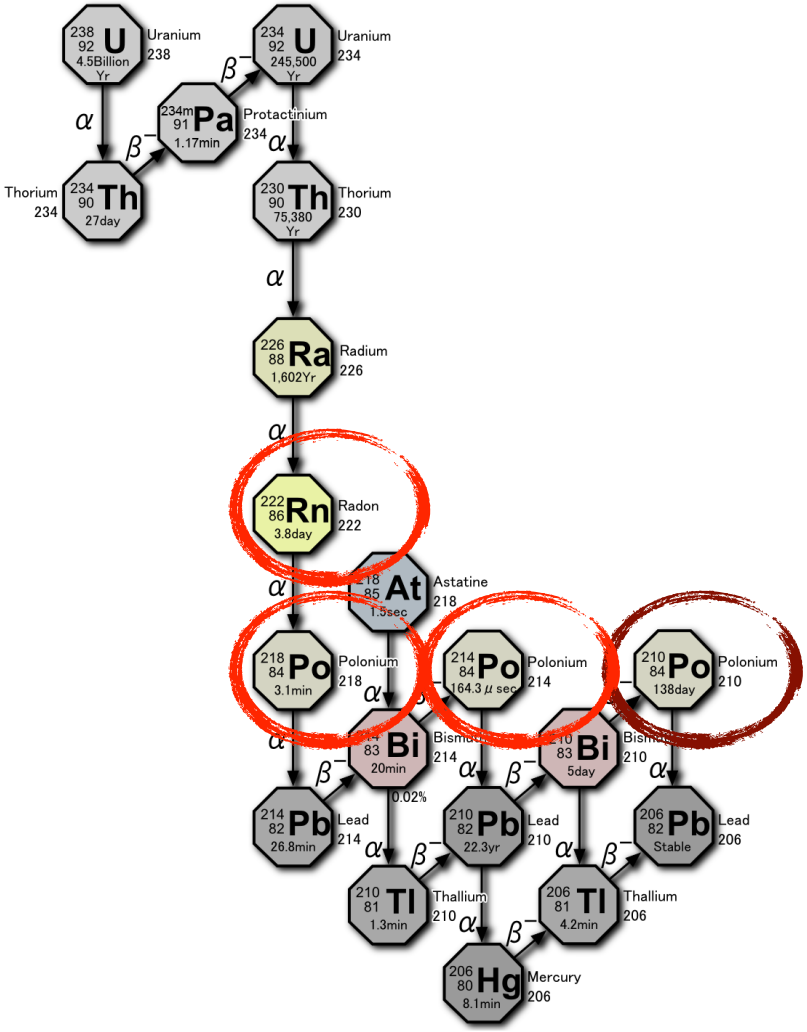
Energy reconstruction from 3D length, SRIM

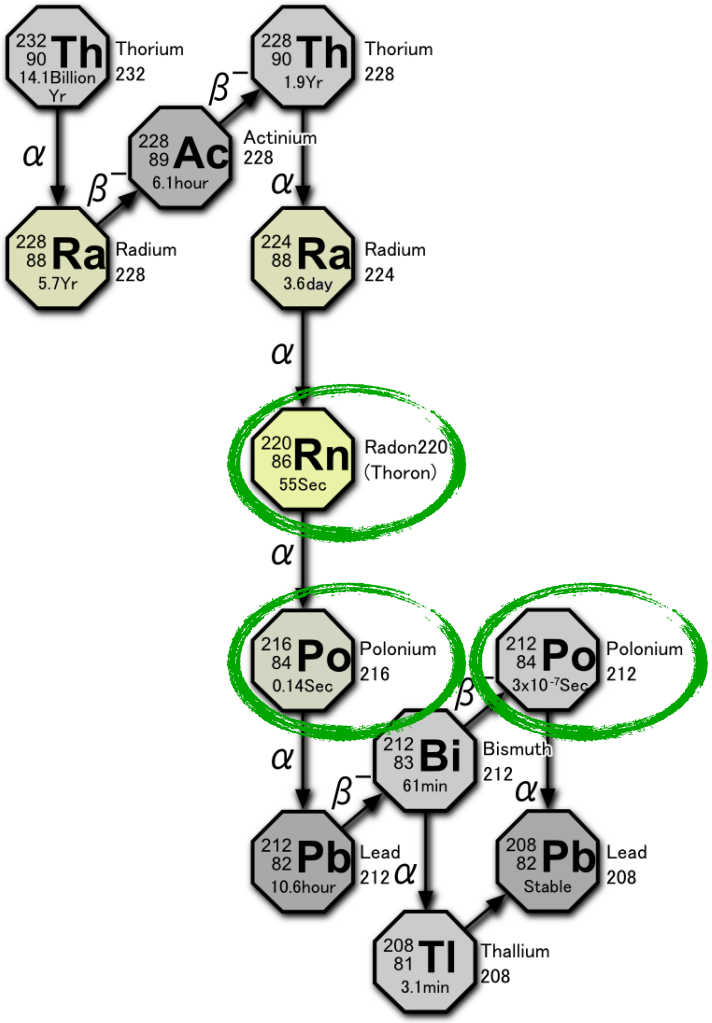




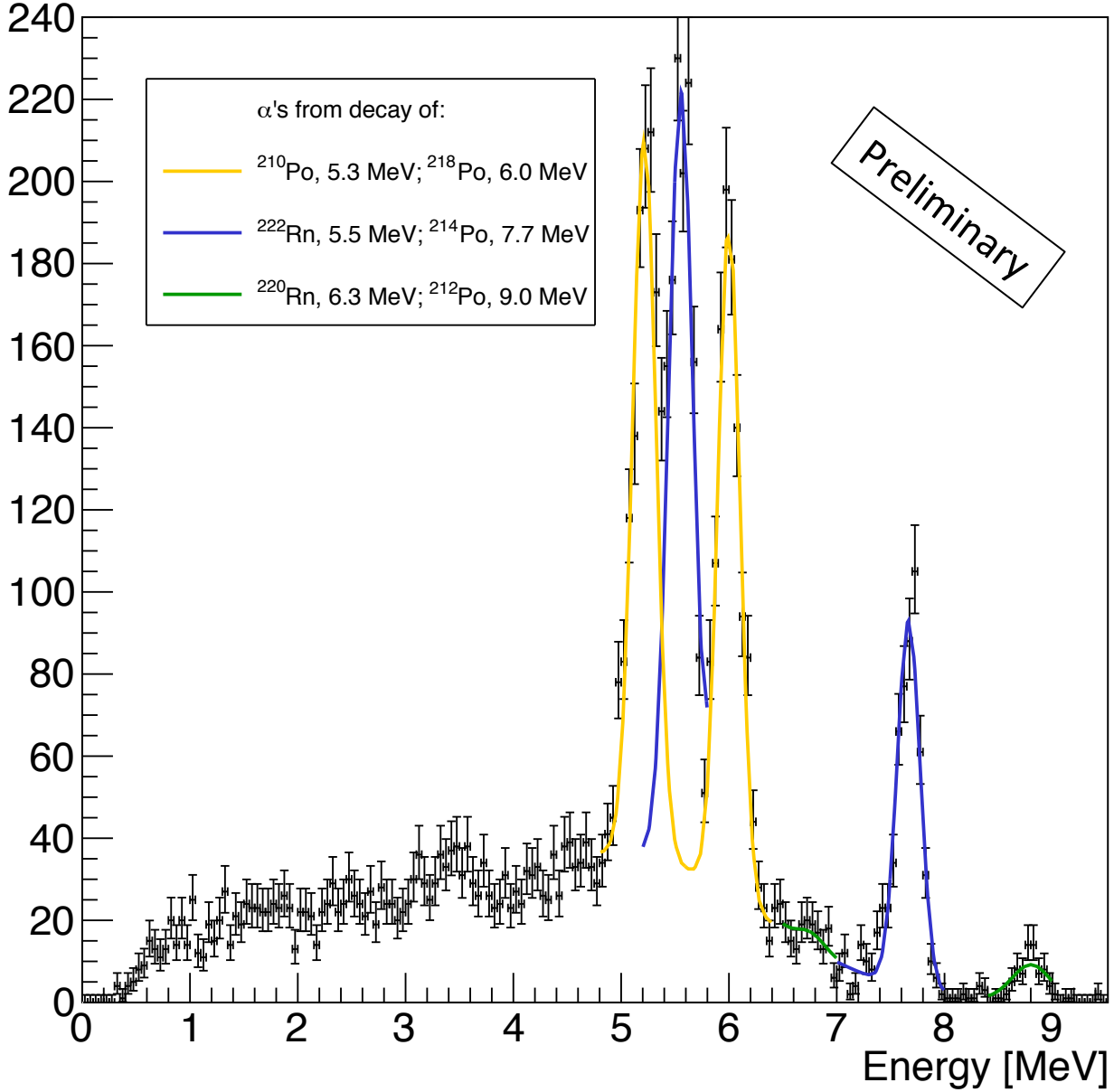
DCTPC at Double Chooz



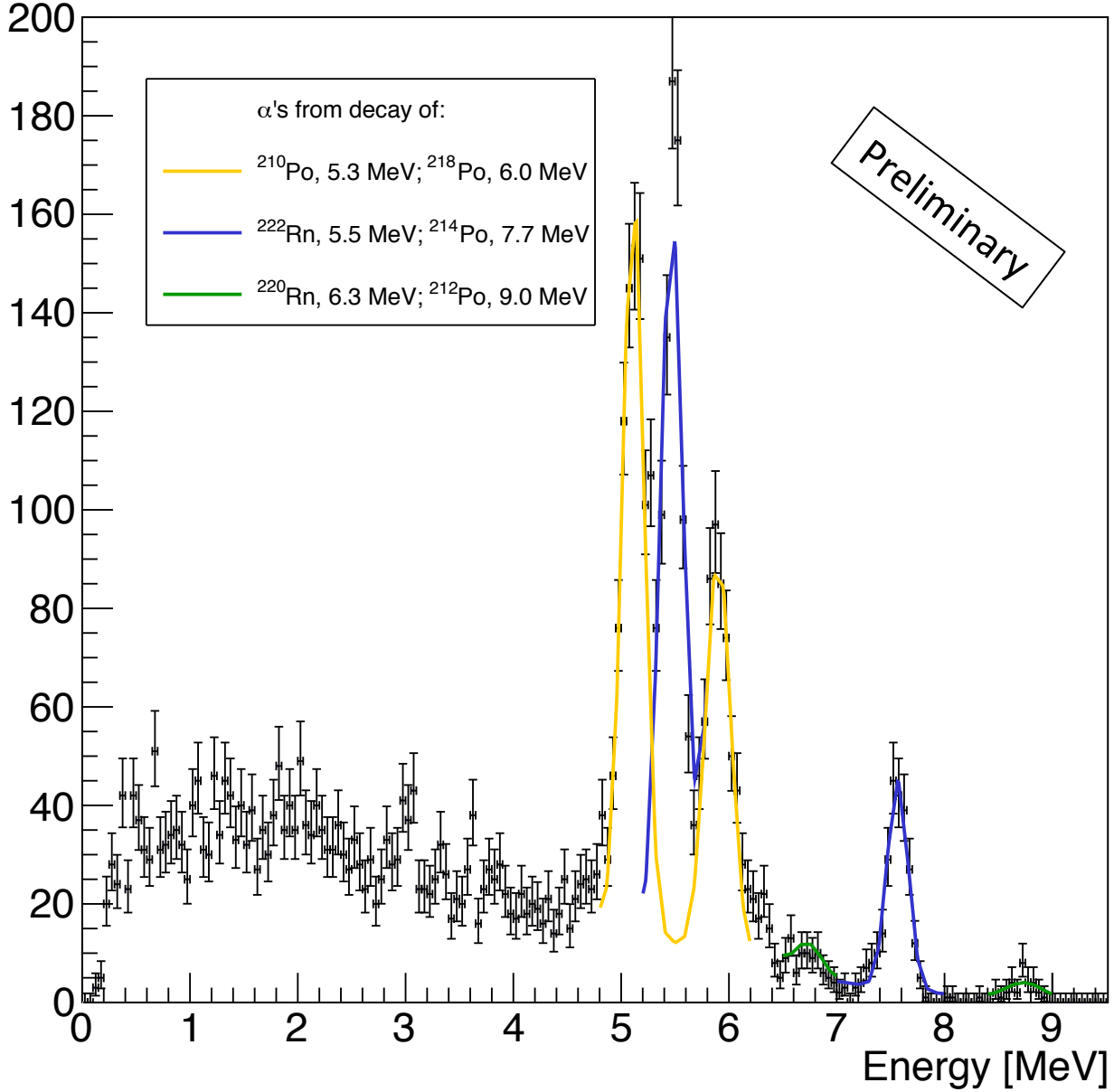

238 92 U 4.5Billion Yr
Uranium 238
234 92 U 245,500 Yr
Uranium 234
234m 91 Pa 1.17min
Protactinium 234
234 90 Th 27day
Thorium 234
230 90 Th 75,380 Yr
Thorium 230
226 88 Ra 1,602Yr
Radium 226
222 86 Rn 3.8day
Radon 222
218 85 At 1.5sec
Astatine 218
218 84 Po 3.1min
Polonium 218
214 84 Po 164.3 μ sec
Polonium 214
210 84 Po 138day
Polonium 210
214 83 Bi 20min
Bismuth 214
210 83 Bi 5day
Bismuth 210
0.02%
214 82 Pb 26.8min
Lead 214
210 82 Pb 22.3yr
Lead 210
206 82 Pb Stable
Lead 206
210 81 Tl 1.3min
Thallium 210
206 81 Tl 4.2min
Thallium 206
206 80 Hg 8.1min
Mercury 206


232 90 Th 14.1Billion Yr
Thorium 232
228 90 Th 1.9Yr
Thorium 228
228 89 Ac 6.1hour
Actinium 228
228 88 Ra 5.7Yr
Radium 228
224 88 Ra 3.6day
Radium 224
220 86 Rn 55Sec
Radon220 (Thoron)
216 84 Po 0.14Sec
Polonium 216
212 84 Po 3x10-7Sec
Polonium 212
212 83 Bi 61min
Bismuth 212
212 82 Pb 10.6hour
Lead 212
208 82 Pb Stable
Lead 208
208 81 Tl 3.1min
Thallium 208

60 L, Double Chooz near hall, 7 months



40 L, Double Chooz far hall, 6 months



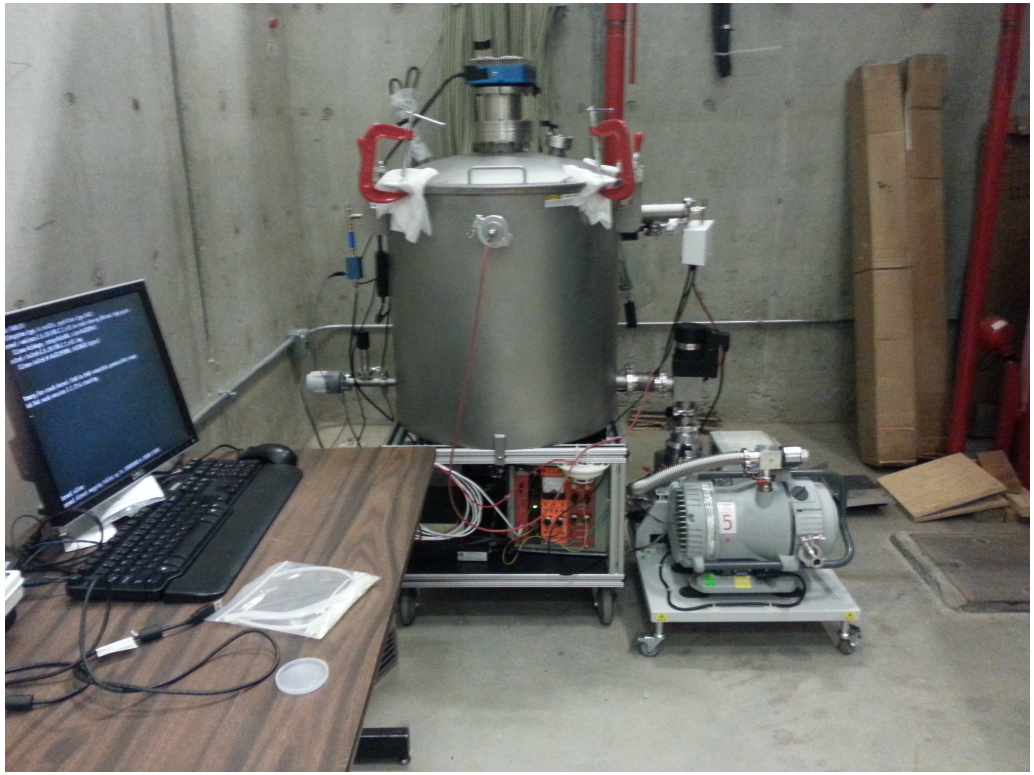
Paper coming out on DCTPC run at Double Chooz

Neutron measurement at SciBooNE hall

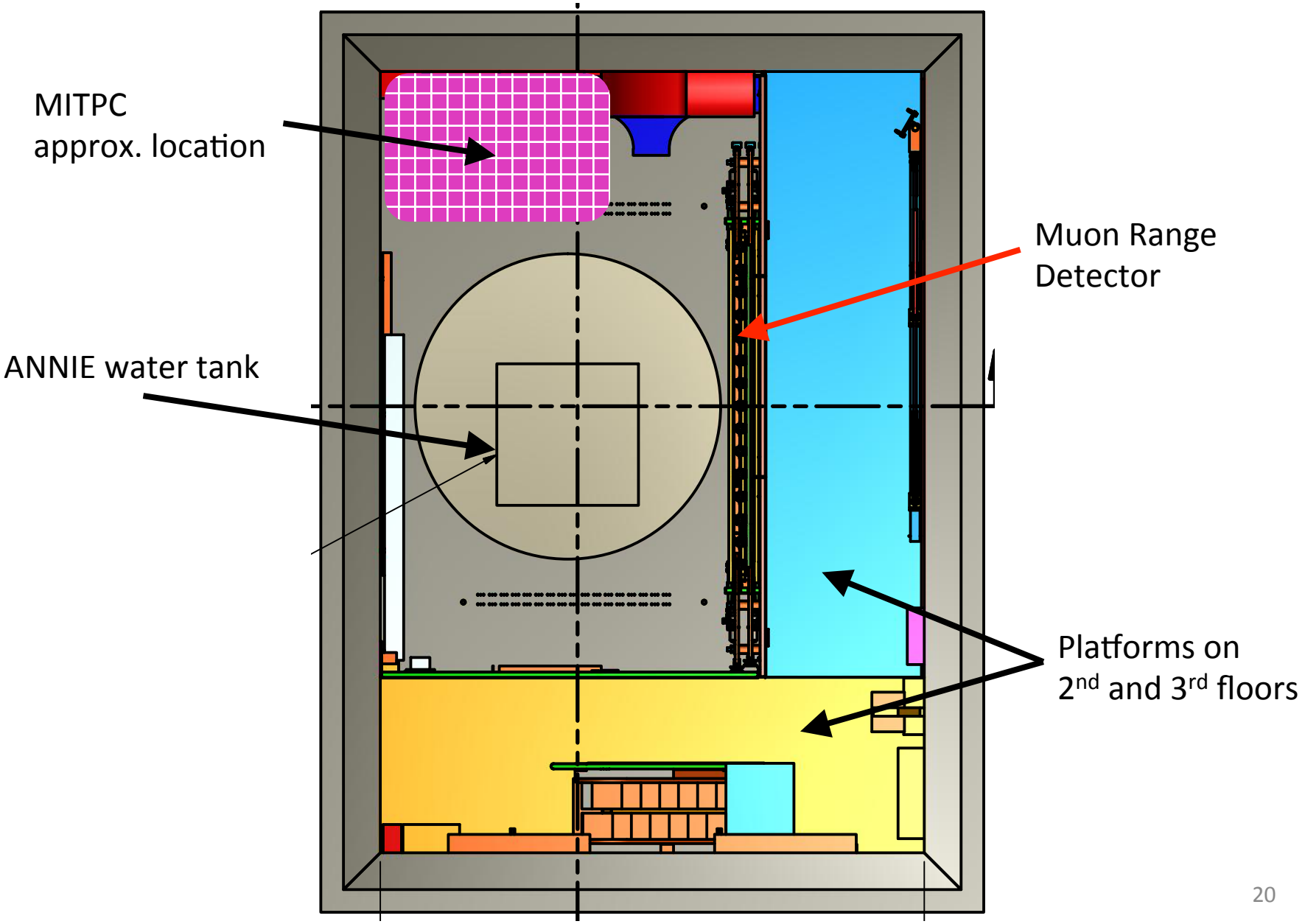
- Tune Monte Carlo prediction for neutron background
- MicroBooNE:
  - Neutral current elastic
  - Strange quark contribution to nuclear spin
  - Neutron ID
  - Supernova neutrinos
  - ^{39}Ar
  - Nuclear de-excitation gammas
- SBND
- ANNIE

Neutron measurements at SciBooNE hall

- Ready for BNB turn-on
- Sensitivity:
  - over 100 MeV recoils
- 300-500 neutrino-induced neutrons over 6.6 x 10^{20} POT
- Other neutrons:
  - Skyshine
  - Cosmogenic/radiogenic
- Run for 3 years



Bird's eye-view of SciBooNE hall



Takeaway

- MITPC is a directional fast neutron detector
- Successful DCTPC runs at Double Chooz
- Measure fast neutrons in the SciBooNE enclosure
  - Start when BNB turns on
  - Run for three years
- Papers coming out on neon studies, DCTPC

Thank you!