A Sort-of Tissue Equivalent Proportional Counter (STEPC) for Space Radiation Dosimetry Applications

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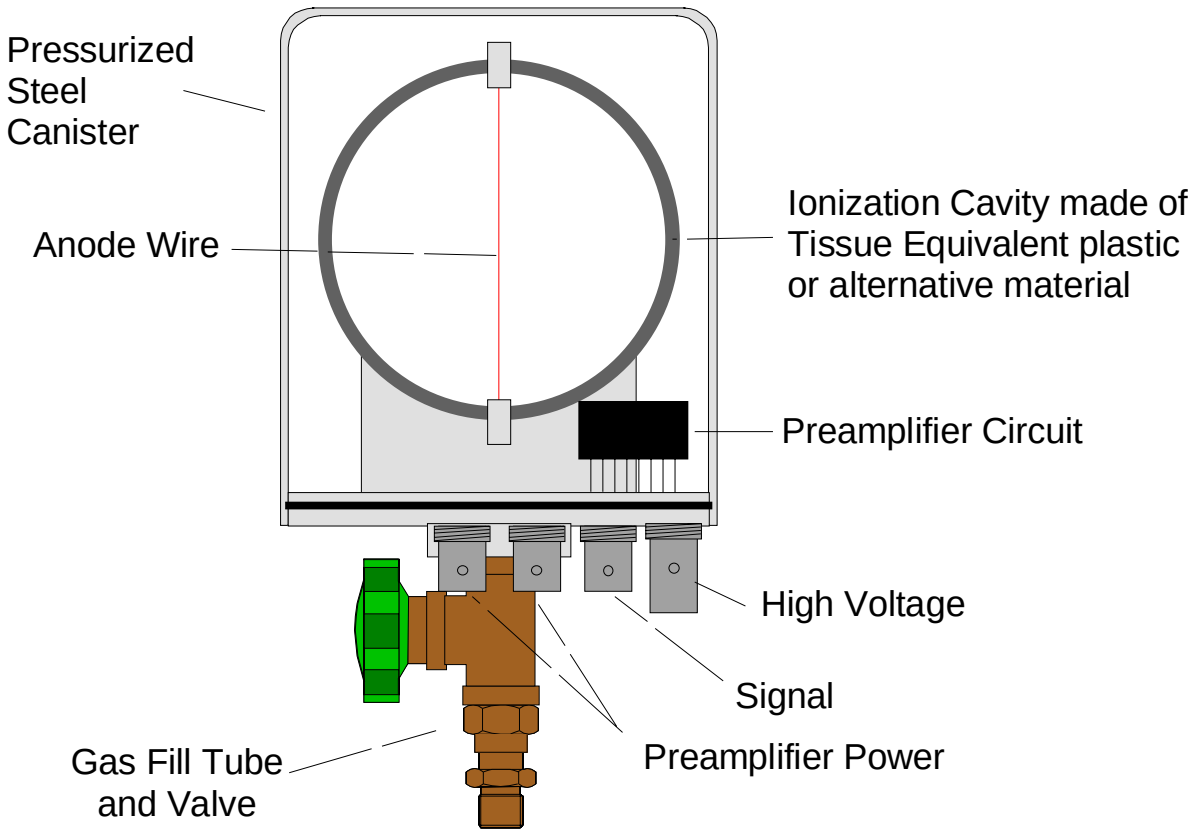
Research Objectives

- Evolutionary approach to TE ionization chamber and proportional counter design, fabrication, and testing;
- Common 2” ϕ spherical chamber design;
- Alternative TE plastics;
- Alternative anode wire, field tube, and grid wire configurations;
- Alternatives in fill gas composition and pressure;
- Alternative detector/spectrometer electronics;
- Testing of instruments on near-space Balloon flights.

Design of Prototype STEPC



STEPC Prototype Features

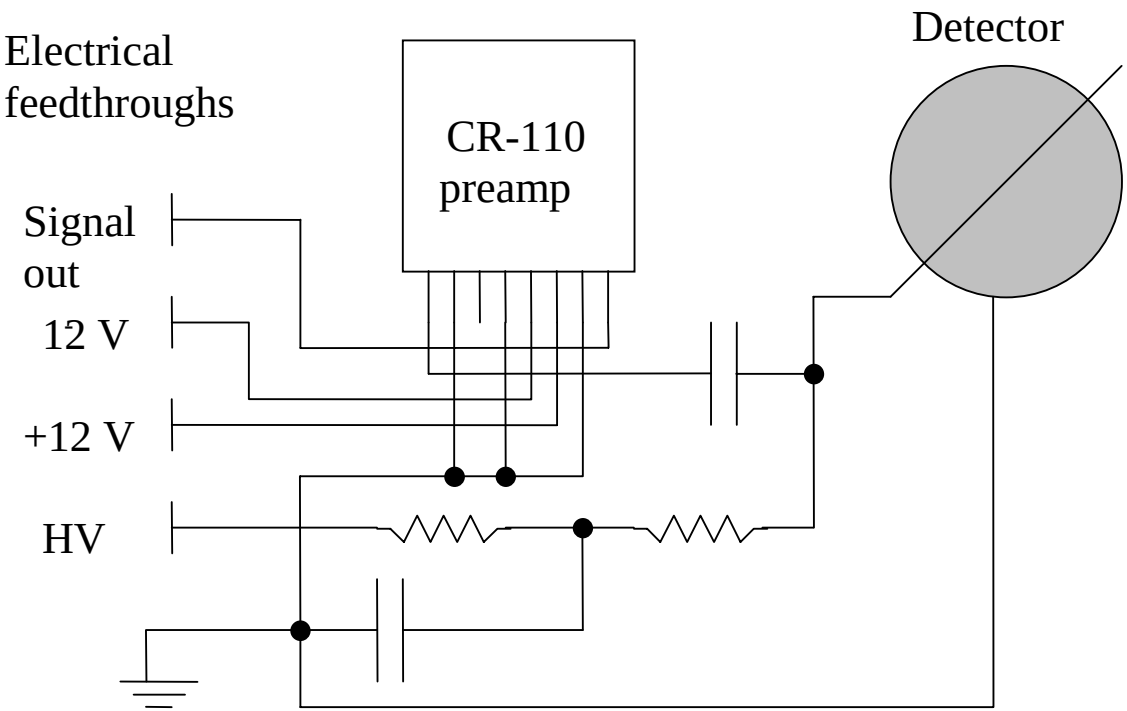
Similar in design to FarWest LET-SW2 2” single wire counter, but includes:

- built in preamplifier (Cremat CR-110).
- double O-ring resealable container,
- removable ^{241}Am check source.

Currently five versions of STEPC:

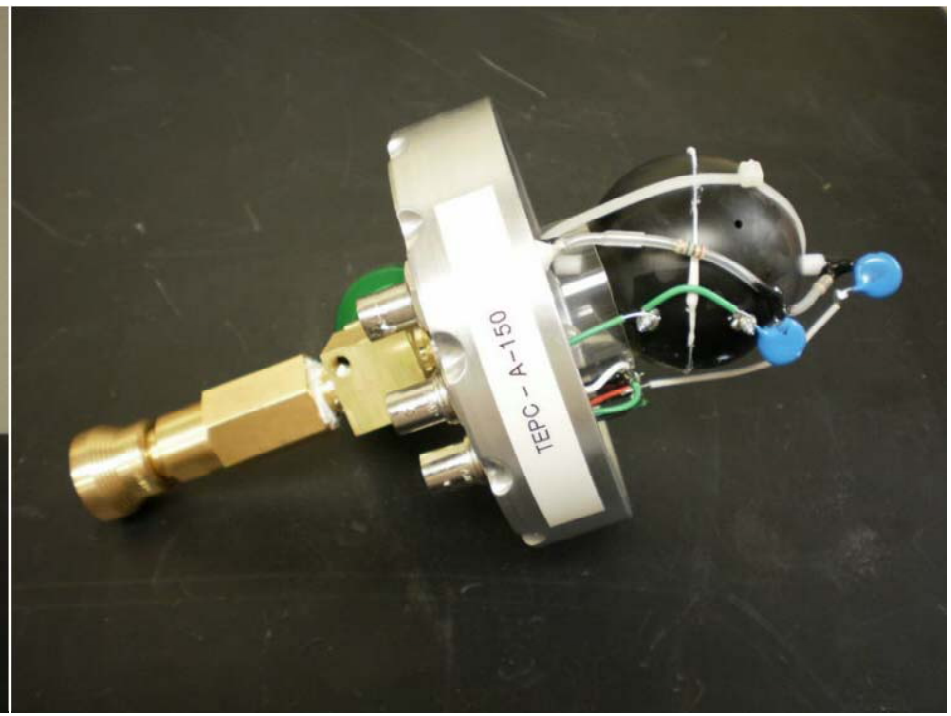
- A-150 Tissue Equivalent Plastic,
- Nylon,
- Acrylic,
- Polyethylene,
- Polystyrene.

STEPC Prototype Circuitry



STEPC Prototype

Detector in a can



STEPC's guts

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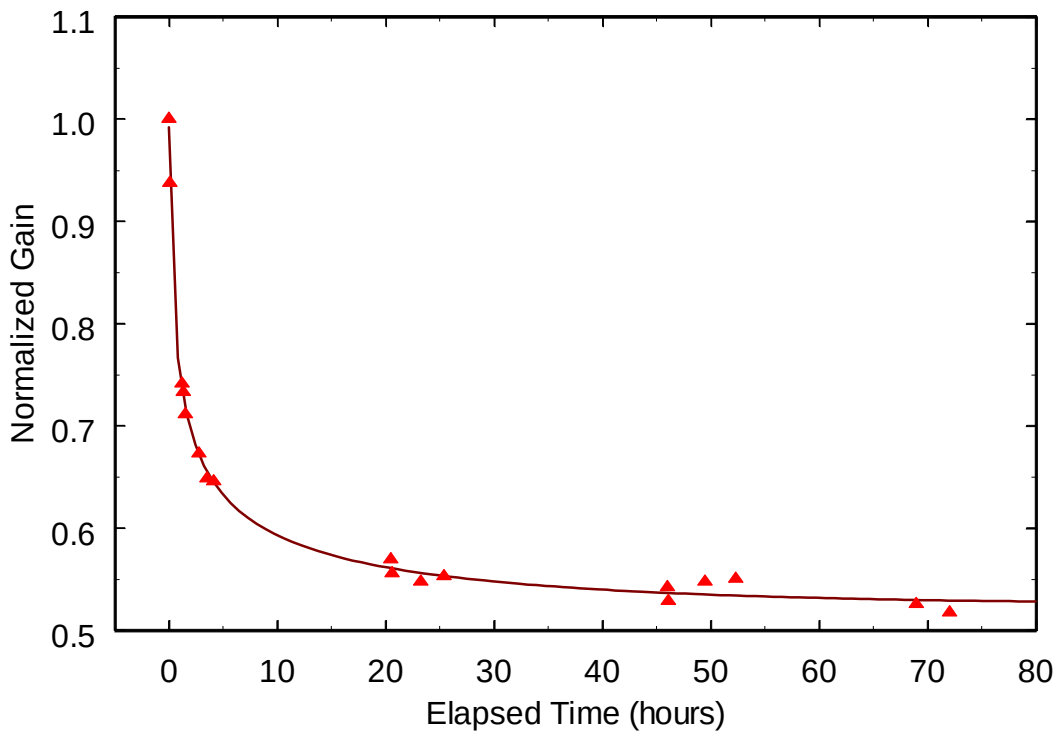
Stabilization of gas gain as a function of time since STEPC gas fill



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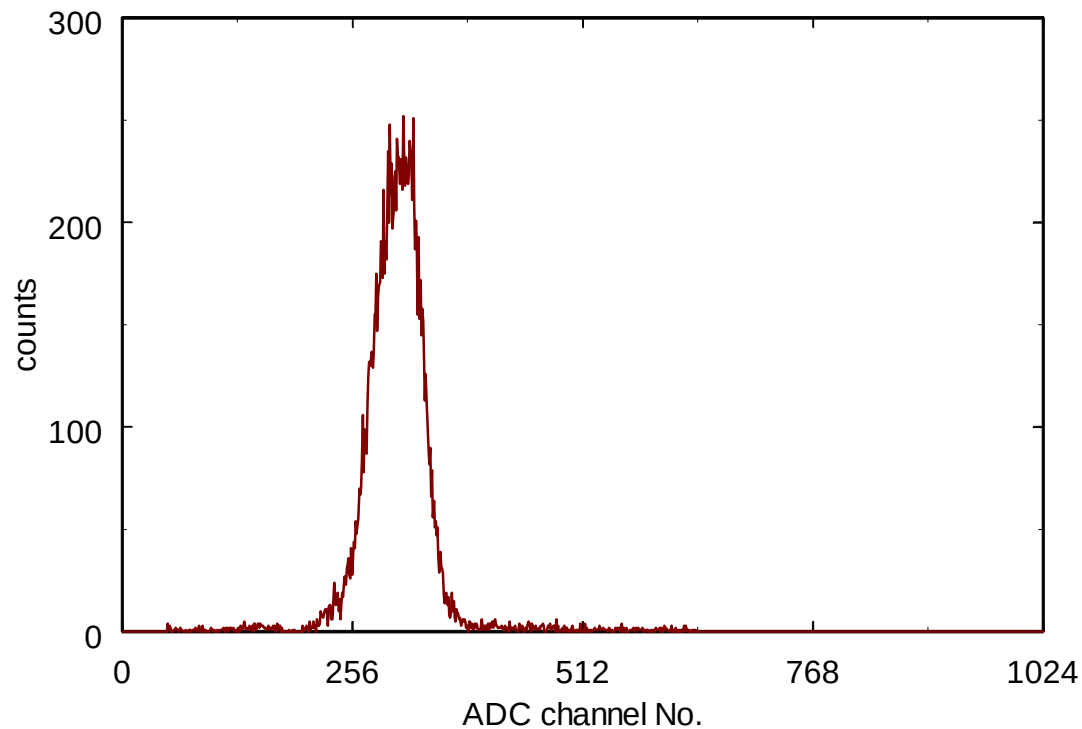
Uncalibrated Lineal Energy spectrum from 5.49/5.44 MeV ^{241}Am α-particles measured in A-150 STEPC operating at 1400 V and 173 Torr.



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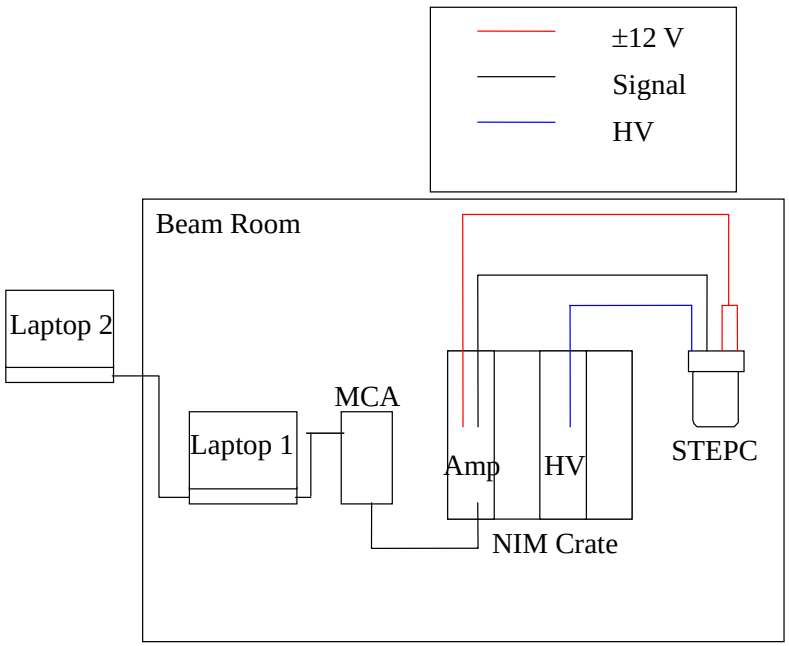
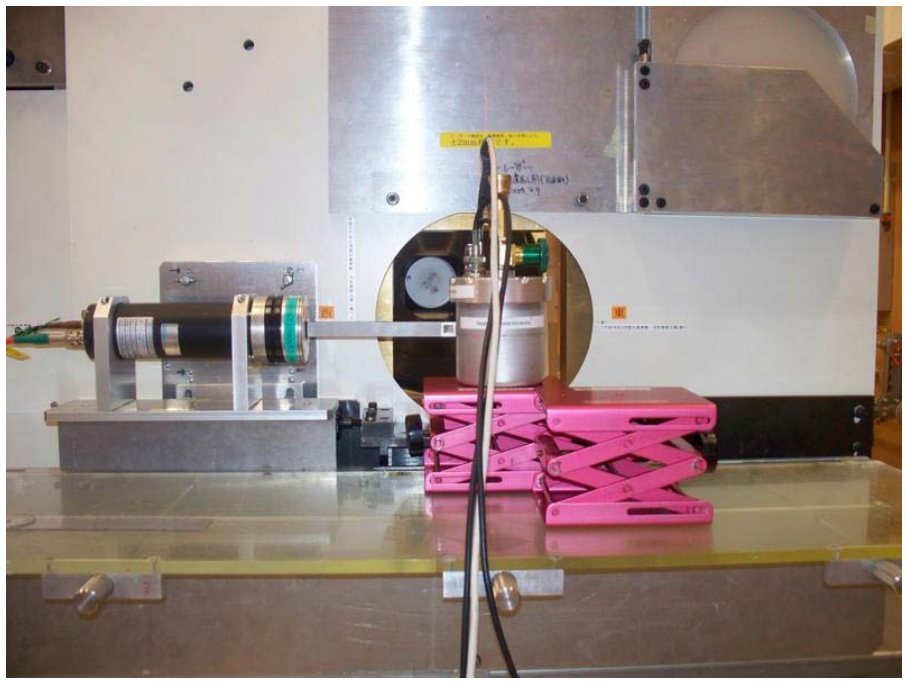
Initial testing at HIMAC with 150 MeV/amu ^{4}He and 500 MeV/amu ^{56}Fe beams





- BIO Room using 10 cm diameter beam
- scintillator to monitor beam flux

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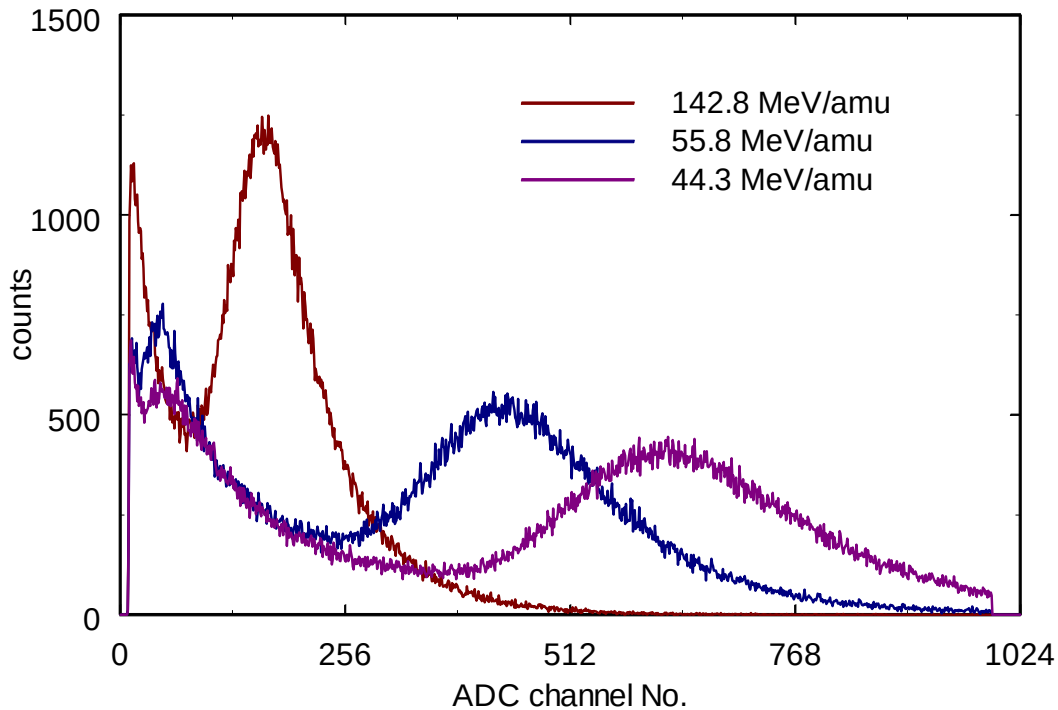
Uncalibrated lineal energy (y) spectra measured by the Nylon STEPC during exposures to bare and range modulated ^{4}He beams at HIMAC.



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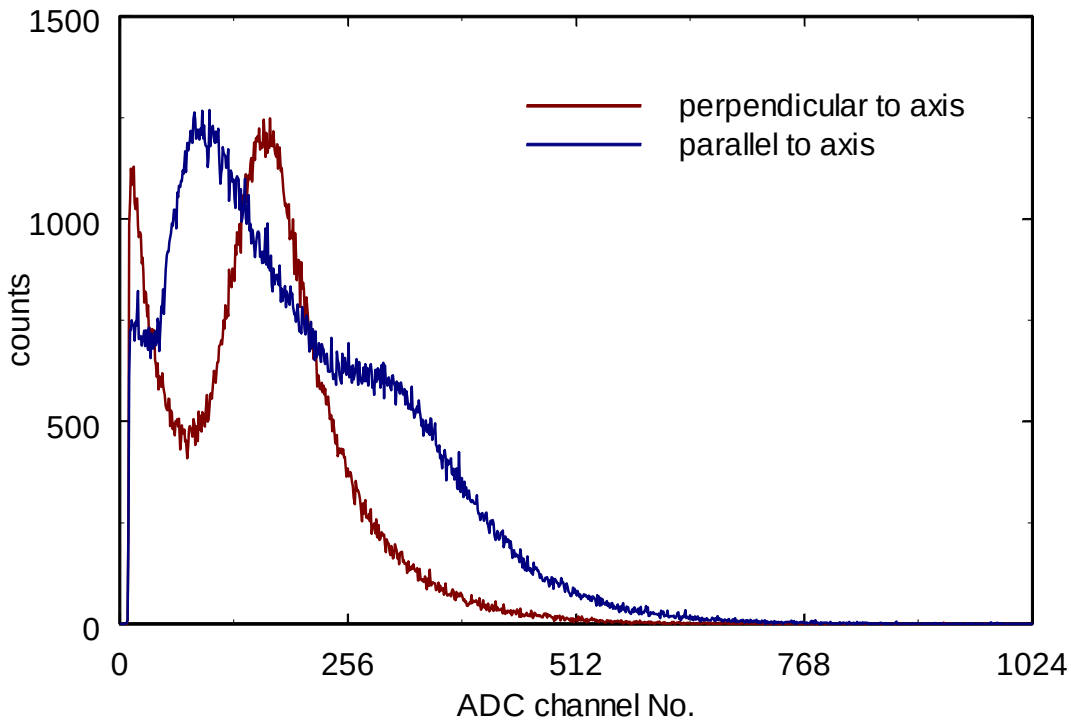
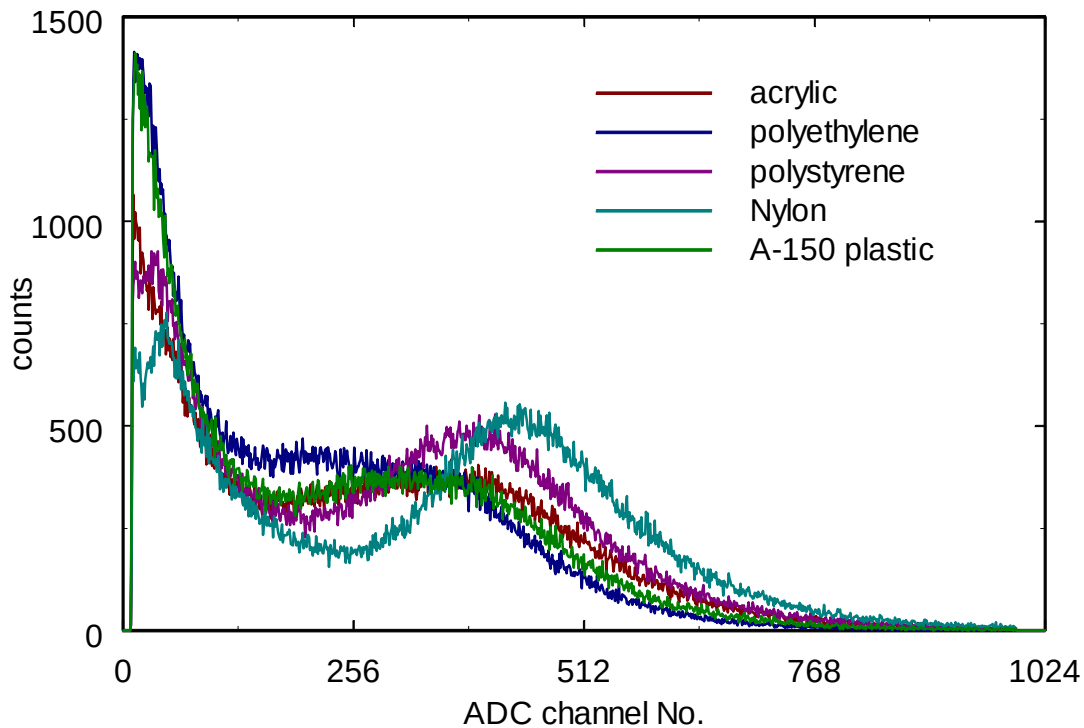
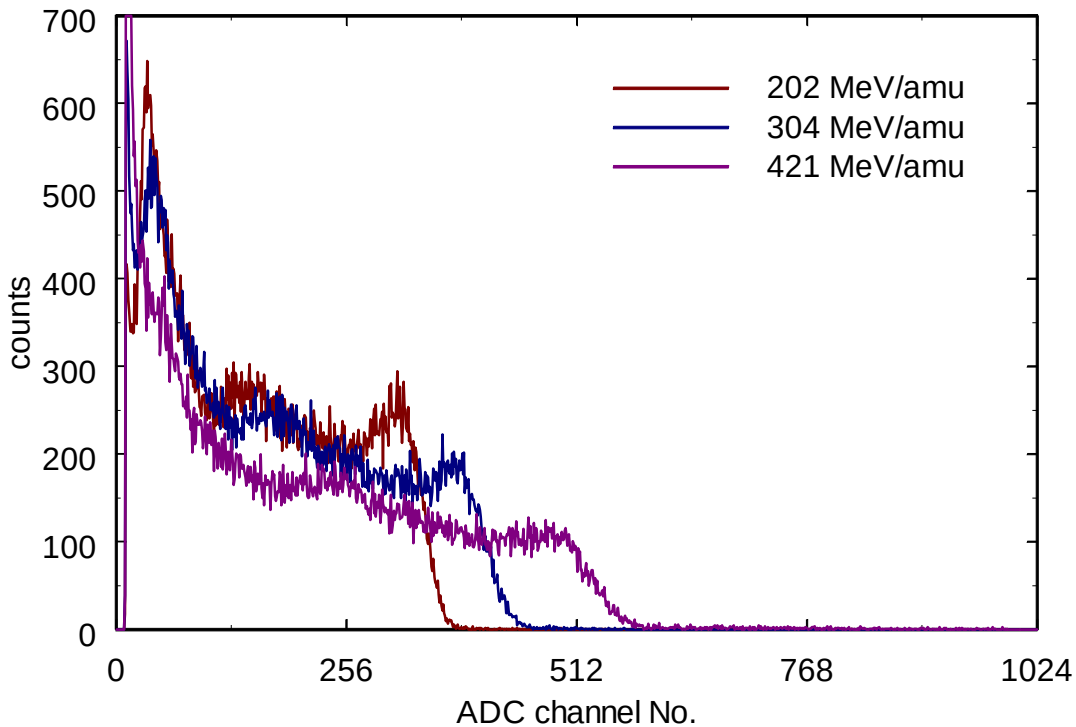
Uncalibrated lineal energy (y) spectra measured by the Nylon STEPC during exposures to the ^{4}He beams at orientations perpendicular to and parallel to the axis of container



Uncalibrated lineal energy (y) spectra measured by the five STEPC detectors during exposures to the ^{4}He beam behind 12 cm of absorber.

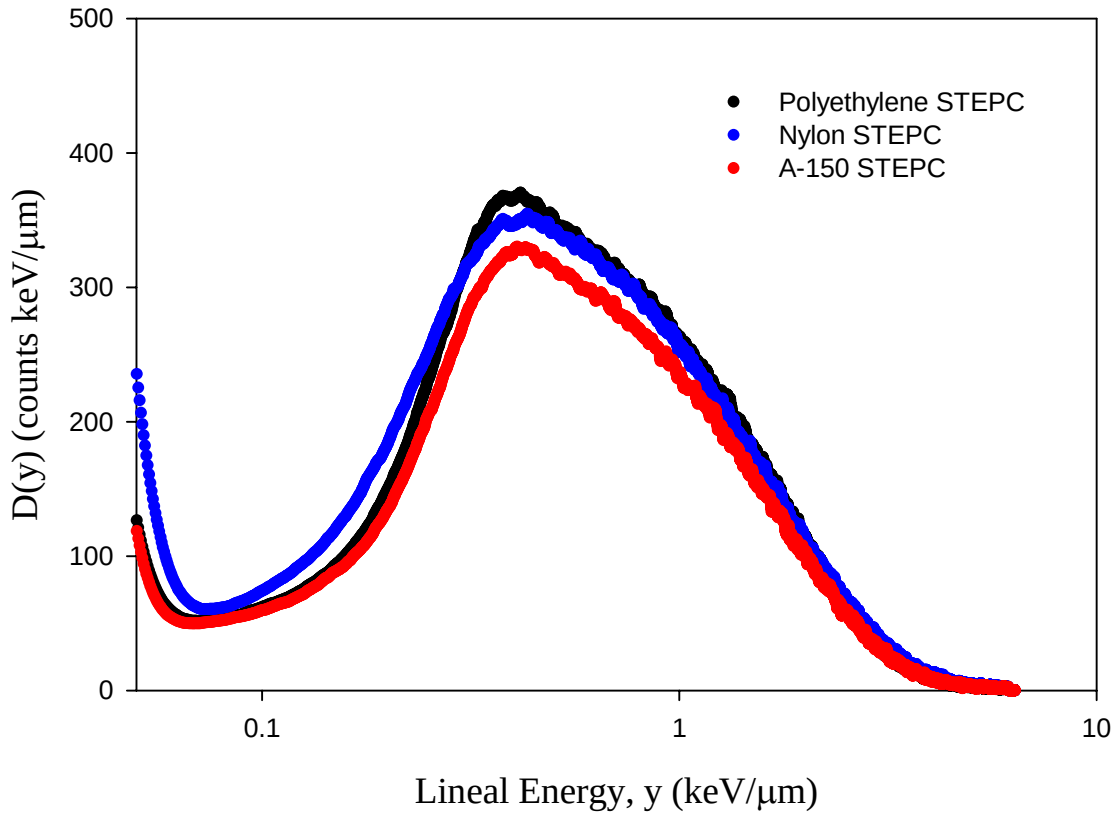


Uncalibrated lineal energy (y) spectra measured by the polystyrene STEPC in the HIMAC ^{56}Fe beam behind 0.0, 3.0, and 5.0 cm water equivalent absorber.



STEPC Characterization at the ProCure Proton Treatment Center in Oklahoma City, USA

Dose Distributions as a function of Lineal Energy for 87 MeV Protons at ProCure using multiple STEPCs



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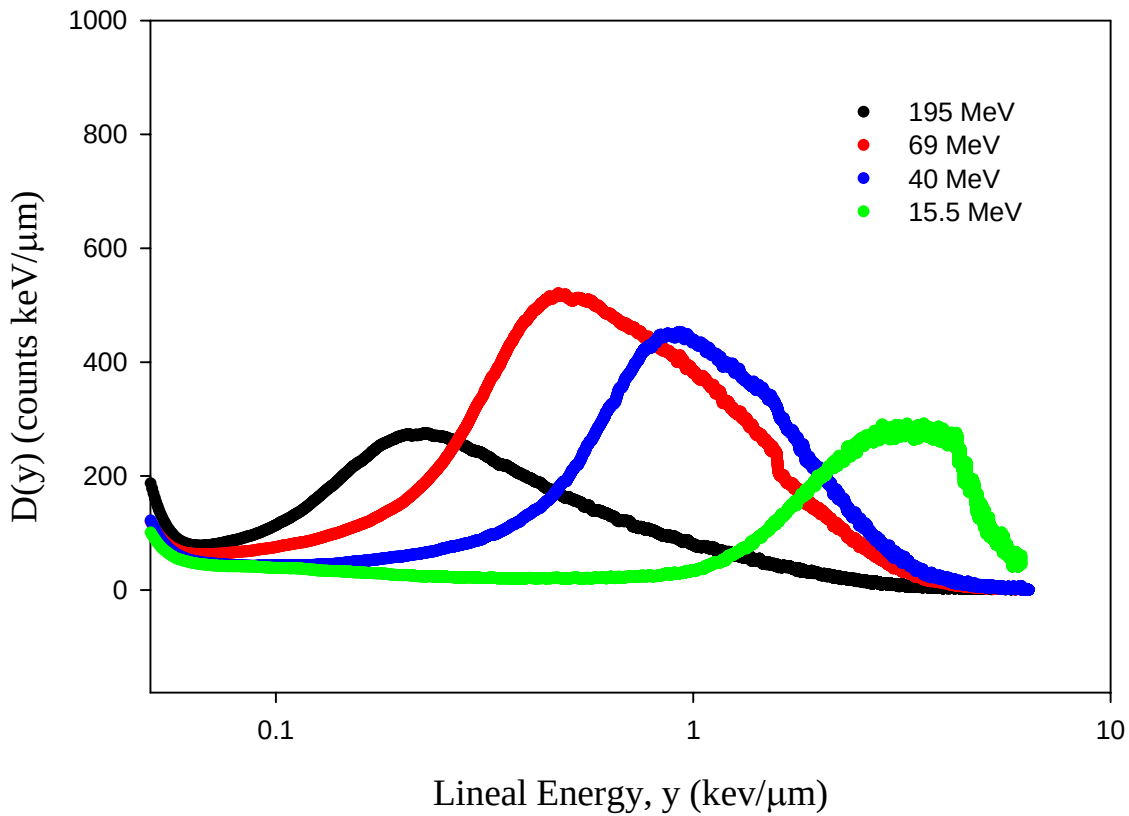
Dose Distributions as a function of Lineal Energy for Protons at ProCure with the A-150 STEPC



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Portable, Autonomous STEPC for high altitude balloon testing

- Integrated into STEPC Container
  - Ionization Cavity √
  - Preamplifier: Cremat CR-110 √
  - Amplifier: Cremat CR-200 or Amptek
  - Spectrometer/ADC: Bridgeport Instruments Emorpho, XIA μDXP, Amptek DP4
  - High voltage power supply: EMCO or similar DC/DC converter
- External to STEPC Container
  - Microcontroller/Datalogger
  - Battery-based power supply

Conclusions

- Prototype STEPCs have been designed, fabricated and our now being characterized and calibrated.
- Currently comparing STEPCs with ionization cavities made of different materials to assess effect of composition on detector response.
- Currently designing amplifier, spectrometer, and HVPS that will fit in container with existing ionization cavity and preamp.
- Portable, autonmous STEPC, including power supply and data logging computer will be tested on a high altitude balloon mission in early 2011 (we hope).