Liquid Krypton Gamma Detector & Neutron Imaging

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Liquid Krypton (LKr) Gamma Ray Detector

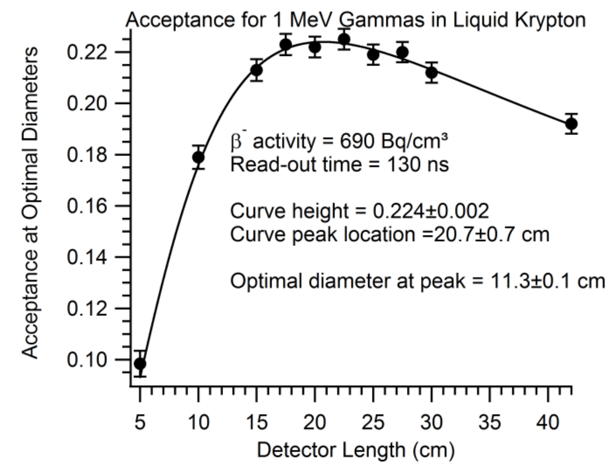
- Objective
  - Gamma energy less than 12 MeV
  - Rapid decision-making
  - Minimal integration (pulse) time
- Application
  - Spectral analysis for isotope identification
  - Rapidly scan cargo for IEDs and nuclear materials

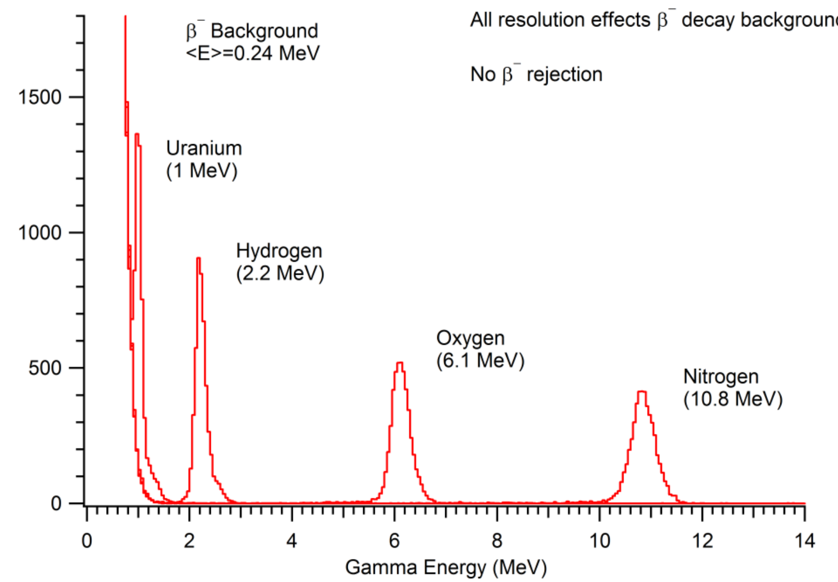
Gamma Ray Scintillation Detector

- Radioactive source decays and emits a photon
- Photon interacts with the matter to produce electrons
  - Photoelectric effect, Compton Scattering & pair production
- Electrons collect in photomultiplier tube (PMT)
- Current/voltage pulse height proportional to initial electron and gamma energy

LKr Scintillation Detector Design

- ^{85}Kr Beta Decays
- Optimal Dimensions
- Xenon Doping
  - Reduces scintillation pulse decay time
  - Increases energy resolution

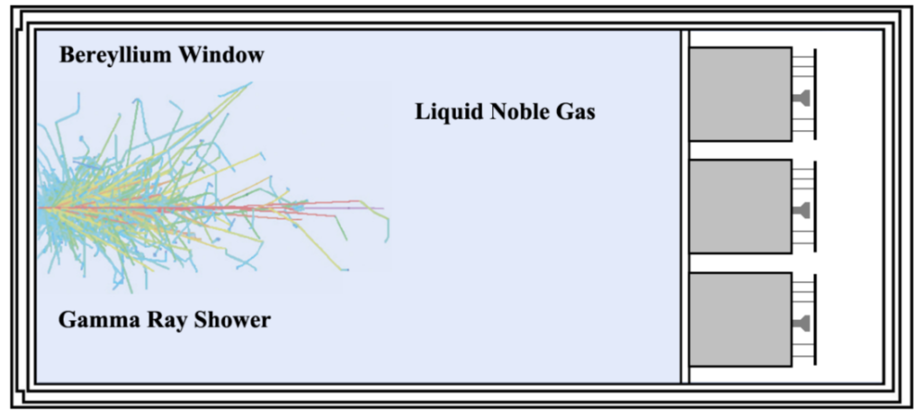




Simulated gamma spectrums for LKr Detector

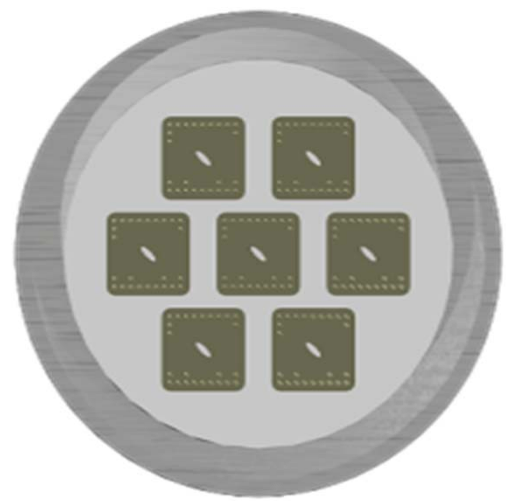
LKr Detector

Outside vacuum chamber



Side cross section view of LKr detector with gamma ray shower and small PMTs

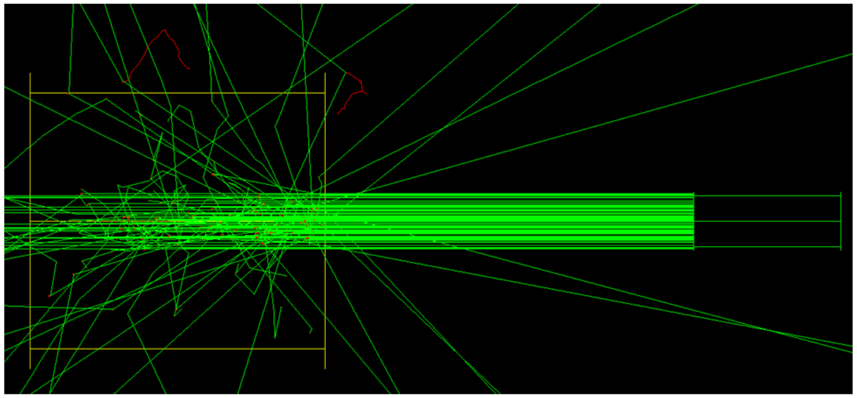
Side view cross section



Back cross section

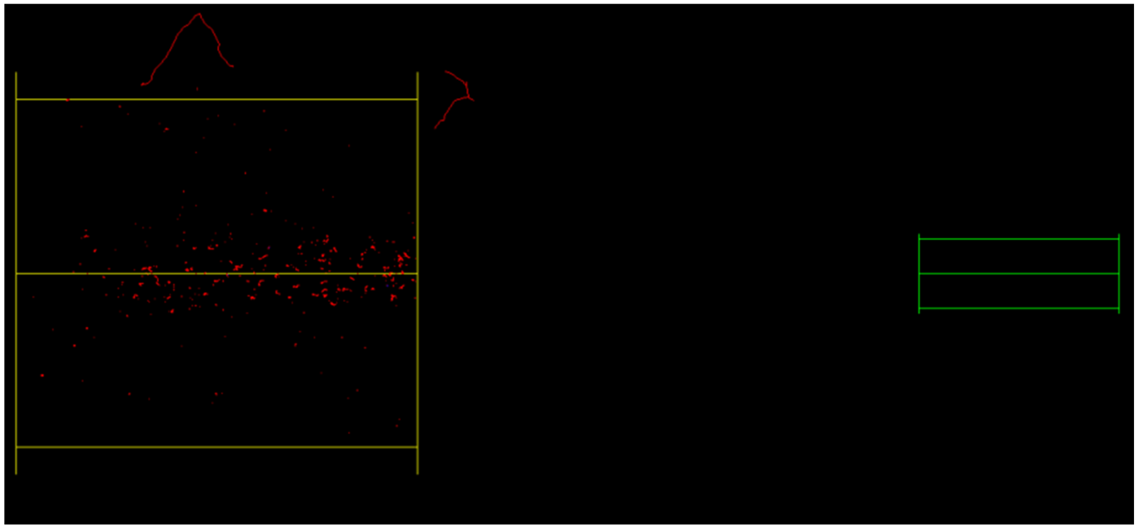
SoftWare for Optimization of Radiation Detectors (SWORD)

SWORD Events



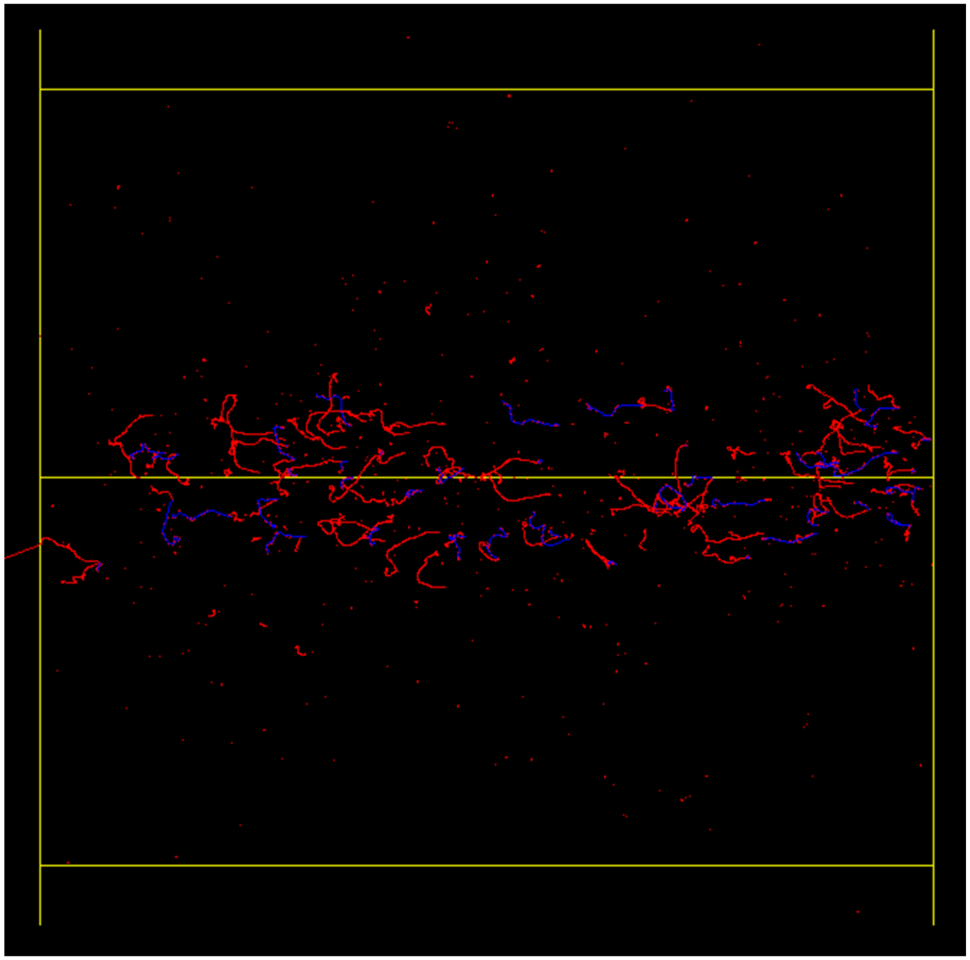
2.22MeV Photon Beam - No filter

- CAD-like interface
- Monte-Carlo simulation using GEANT 4 simulation engine from CERN



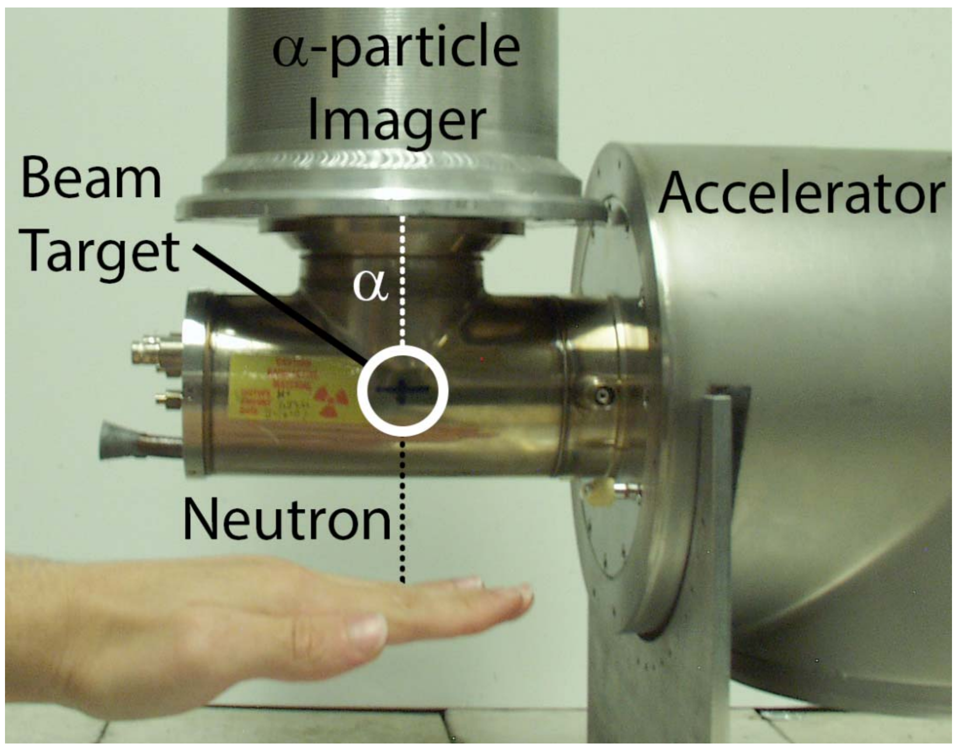
2.22MeV Photon Beam - Nonzero charges

10.8 MeV Photon Beam



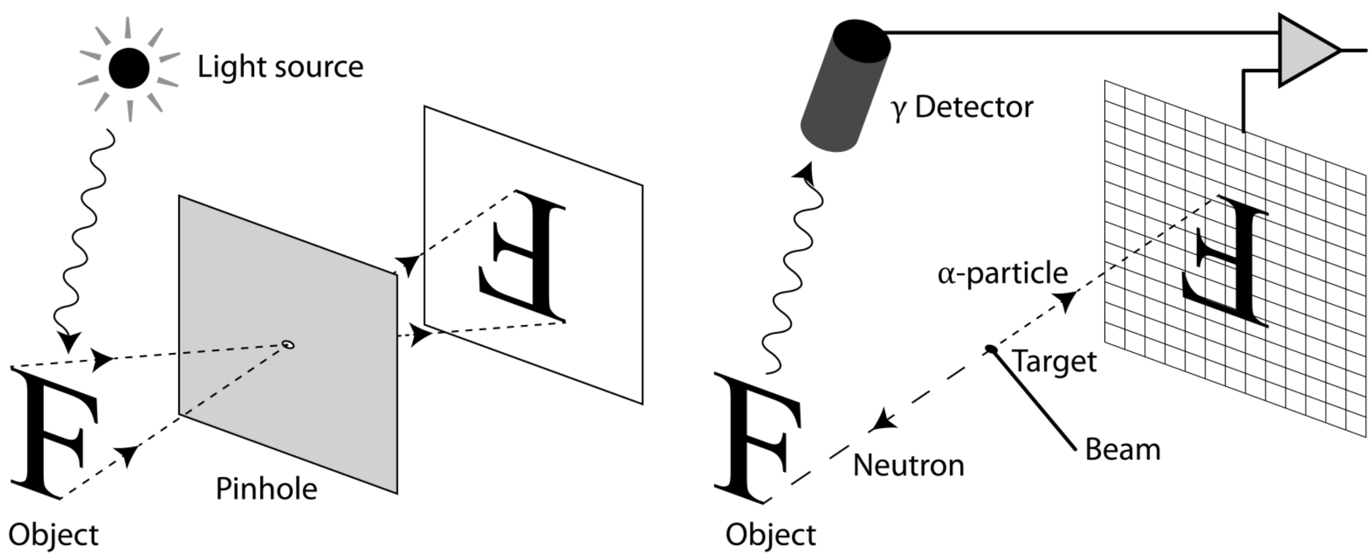
Neutron Imaging

- Associated Particle Imaging (API) technique
  - Deuterium-Tritium nuclear reaction

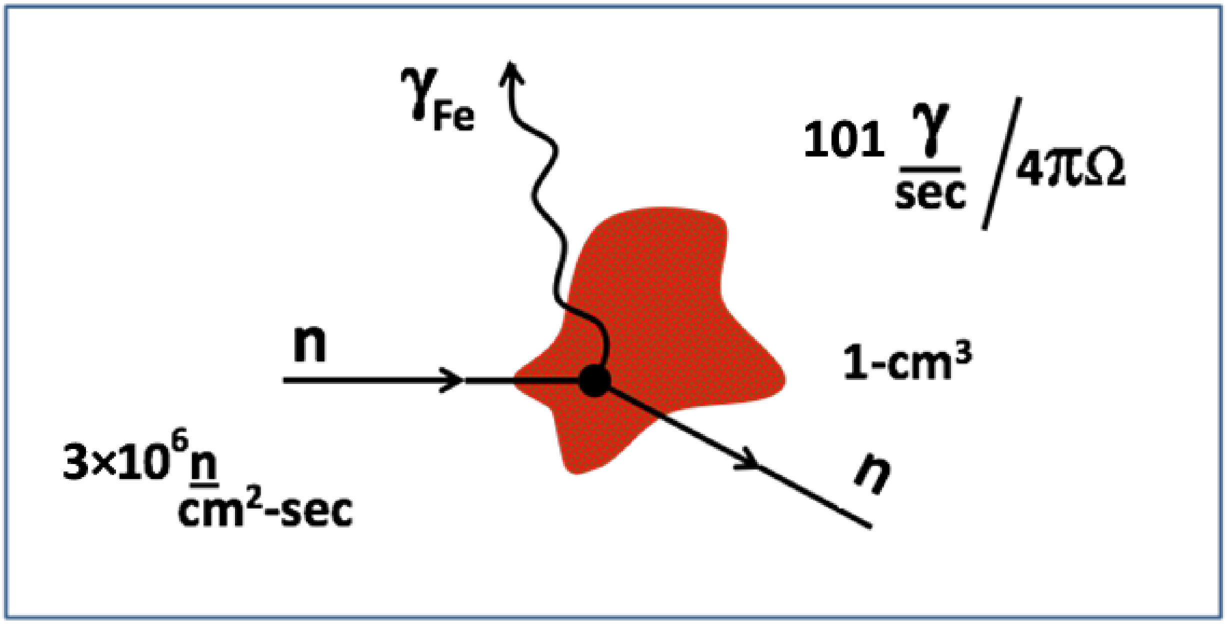


Neutron Imaging

- α particle hits position-sensitive detector
  - Direction and time of neutron emission
- Neutron interacts with target material
  - Produces gamma ray



Medical Application



Dose in rem:

$H=1.6.10^{-5}\ \frac{n}{r^2}$ $\left\{\begin{matrix} \text{n – neutrons/sec} \\ \text{r - cm} \end{matrix}\right\}$ $\sigma_{Fe} \sim 3.1$ barns

5rem Max $\Rightarrow$ 30 sec exposure