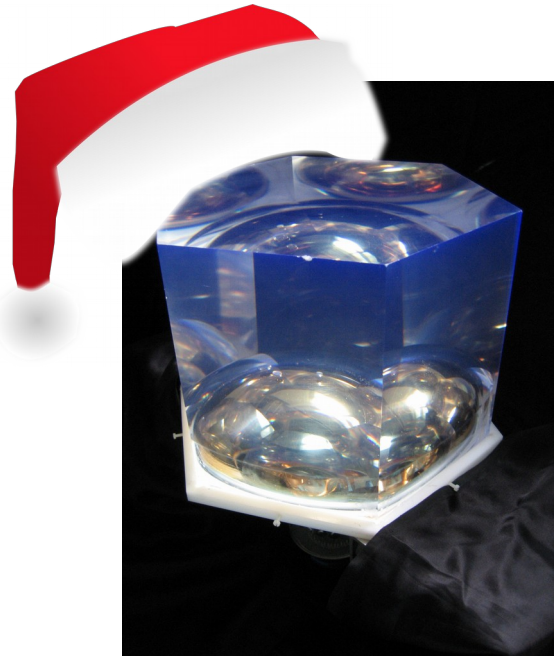
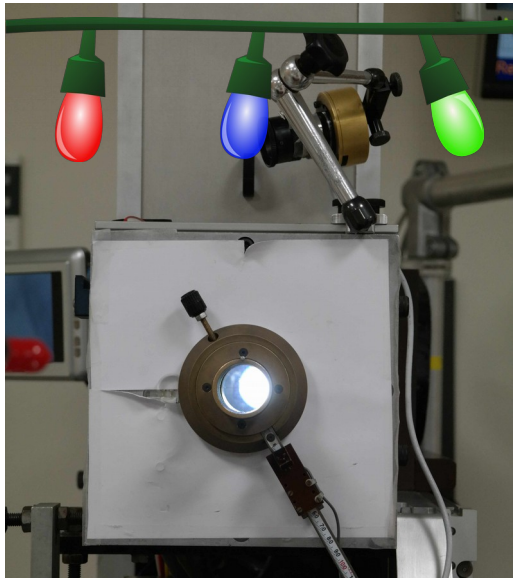
Proton Therapy Calorimetry





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UCL Christmas Meeting 19/12/2016

Proton Therapy

- Idea: Use radiation therapy to treat cancer
- Why proton therapy is useful

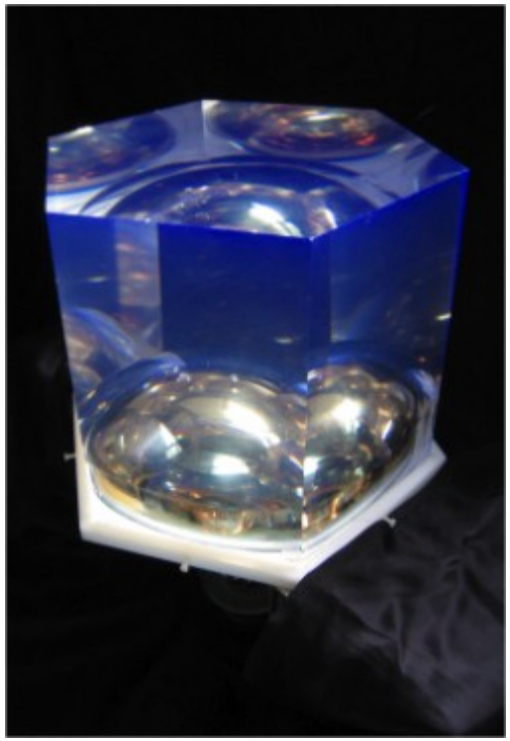
  Protons stop!

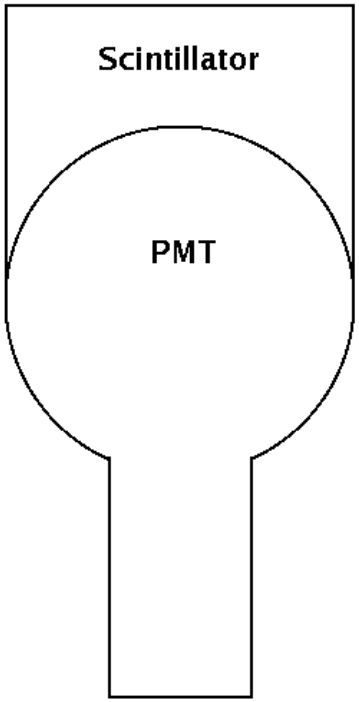
  ⇨ More precise contouring possible (than with X-rays)
  Less side effects
  Important for tumours near critical organs and young patients

- What we do to improve it
  - Two projects based on SuperNEMO calorimeter developed at UCL
    - **Fast calorimeter** for Proton CT: Improve treatment planning by reducing conversion errors
    - **Segmented calorimeter** for beam quality assurance

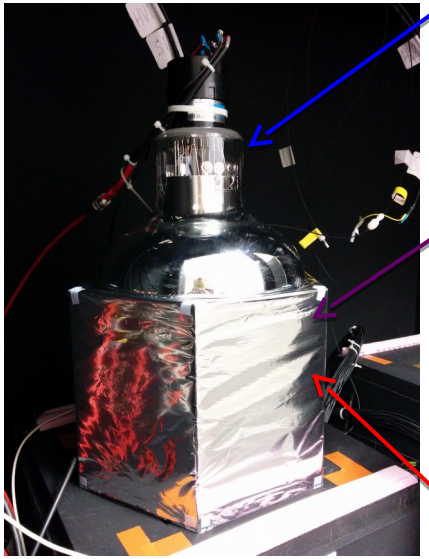
SuperNEMO Calorimeter

- SuperNEMO experiment trying to measure neutrinoless double beta decay: very precise measurements of electron/positron energy.
- SuperNEMO calorimeter consists of 550 Optical Modules (wrapped scintillator block + PMT):
- Energy resolution $\frac{7.5\,\%}{\sqrt{E}(MeV)}$
- Does it the trick for protons?





Fast calorimeter: Patient 1



R5912-MOD Hamamatsu 8" PMT

EJ-200 hexagonal PVT block:

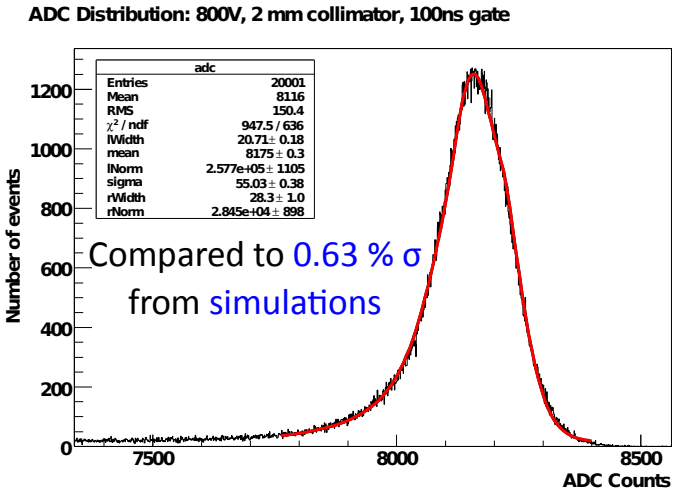
276 mm diameter
193 mm deep, minimum thickness between PMT and scintillator: 100 mm

Wrapping:

Sides: 75 µm of PTFE (Teflon) ribbon
Sides and entrance face: 12 µm of Mylar

Results:

- Energy resolution: 0.67 ± 0.11 % σ



- Good linearity!
- BUT good resolution for low rates only. Go smaller to improve timing and make nozzle-mounted design.

Patient 2

2” Hamamatsu R13089-100-11 **PMT** with negative HV active divider base

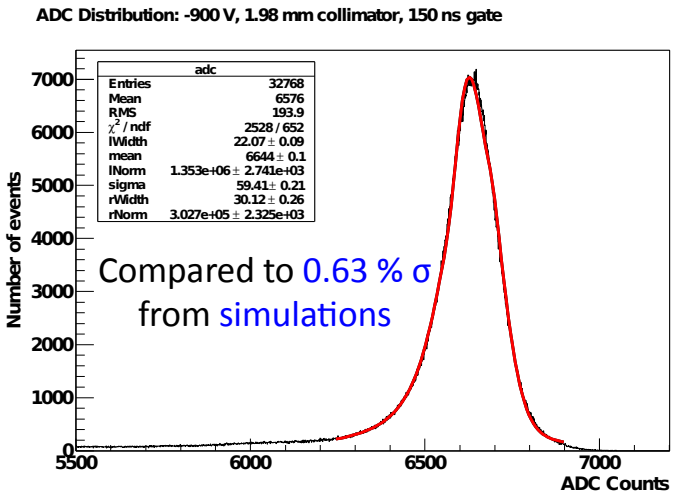
3 cm x 3 cm x 5 cm cuboid ENVINET/NUVIA **PS** standard **scintillator**

Wrapping:

Sides: 75 µm of PTFE (Teflon) ribbon
Sides and entrance face: 12 µm of Mylar

Results:

- Energy resolution: 0.89 ± 0.11 % σ



- Good linearity!
- Reaching rates of up to 250 kHz!
- We suspect a potential problem with the PMT base – next try to use one with no active components.

Patient 3

2” Hamamatsu R13089-100-11 **PMT** with negative HV UCL soldered base with no active components

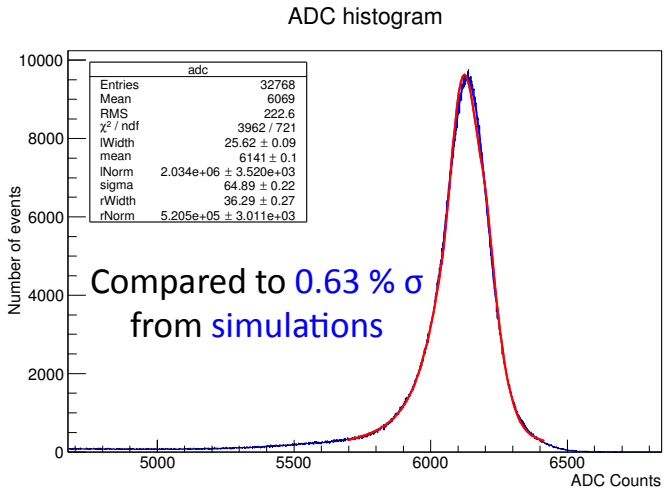
3 cm x 3 cm x 5 cm cuboid ENVINET/NUVIA **PS** standard **scintillator**

Wrapping:

Sides: 75 µm of PTFE (Teflon) ribbon
Sides and entrance face: 12 µm of Mylar

Results:

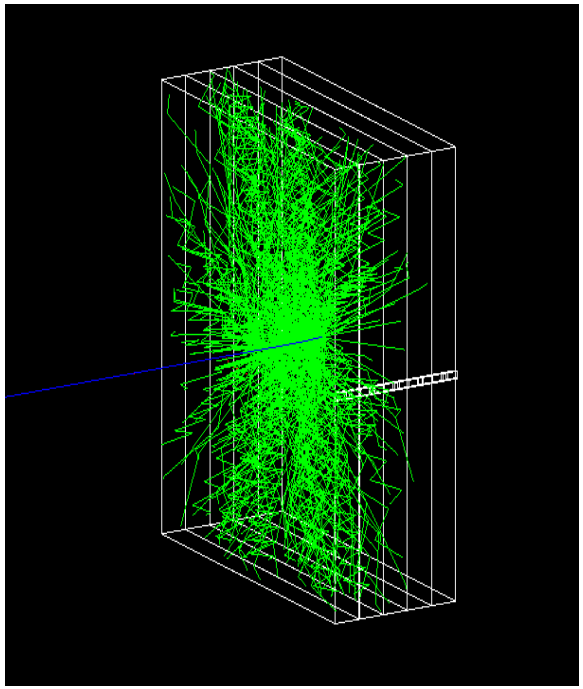
- Energy resolution: 1.06 ± 0.11 % σ

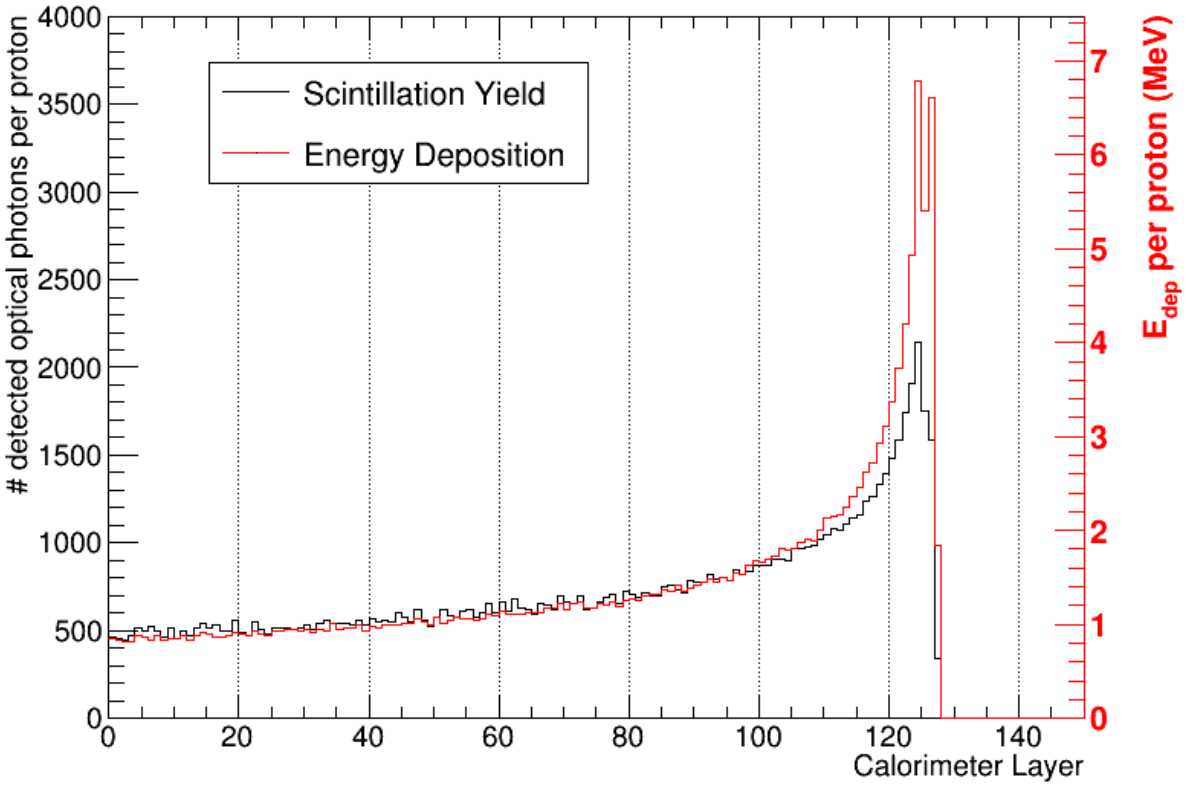


- Analysis ongoing

Segmented Calorimeter

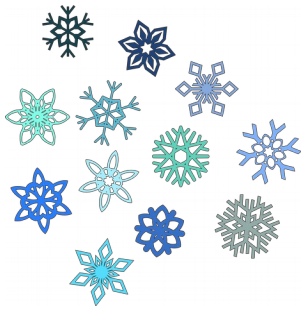
- Other project: Cut calorimeter crystal in segments
- Readout per segment ⇨ determine proton energy from curve shape
- Difficulty: Quenching of scintillator at high dE/dx





Outlook

- Development towards fast calorimeter for proton CT (last Clatterbridge data analysis ongoing)
- Segmented calorimeter: Currently at simulation stage



Thank you and
Merry Christmas!