Self-Gated Monitoring System

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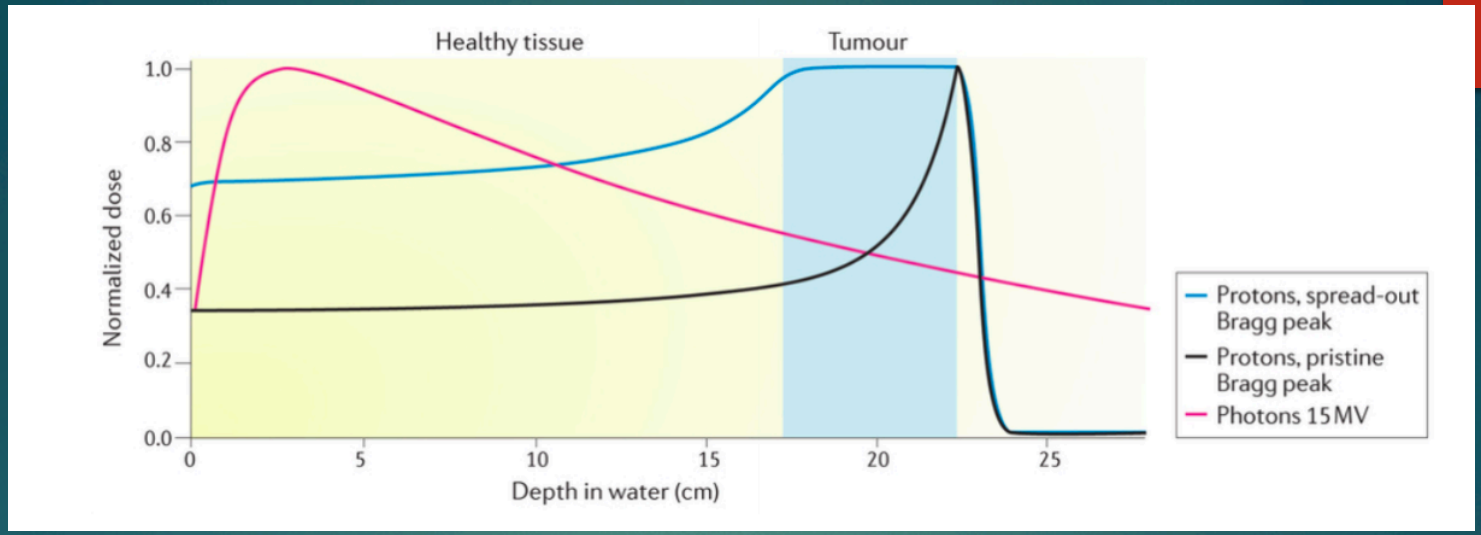
Outline

- Introduction
- Purpose
- Materials and Methods

Introduction

- Proton Therapy offers the potential for excellent dose conformity
- The dose distribution of proton beam has a very sharp fall-off at its distal edge
- Range uncertainties occur due to uncertainties in dose prediction, in patient positioning and organ motion during the treatment.
- Over or under dose
- Margins are defined
- Dose is deposited into healthy tissue



Schematic illustration of the dose deposition between photon beam and proton beam

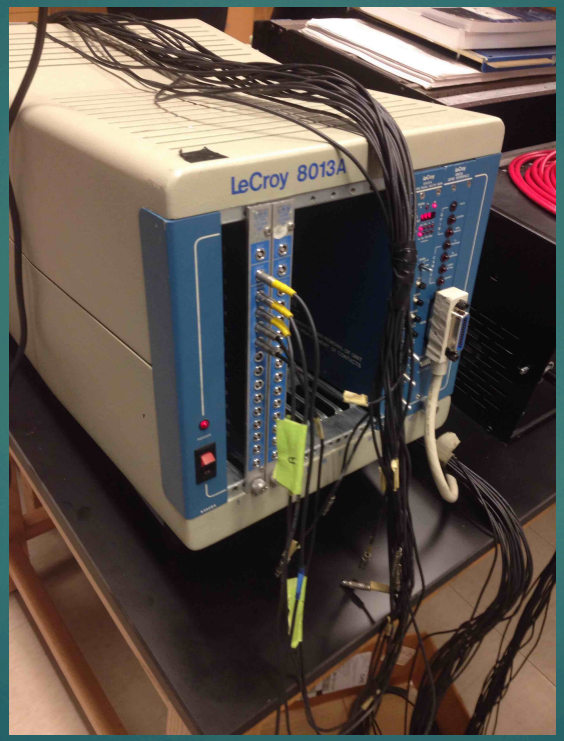
Purpose

- Minimize the dose that is deposited in the health tissue(Lung)
- Build two arrays from thin scintillating fibers placed outside the water phantom
- To detect secondary particles due to proton beam
- Correlate the secondary flux with actual dose deposited inside the lung tumor
- Develop a tracking algorithm to extract the motion and 2D profile of tumor in real time.
- Develop Topas(Geant4 based toolkit)simulation to optimize the detector geometry and reconstruct the dose and location of the tumor

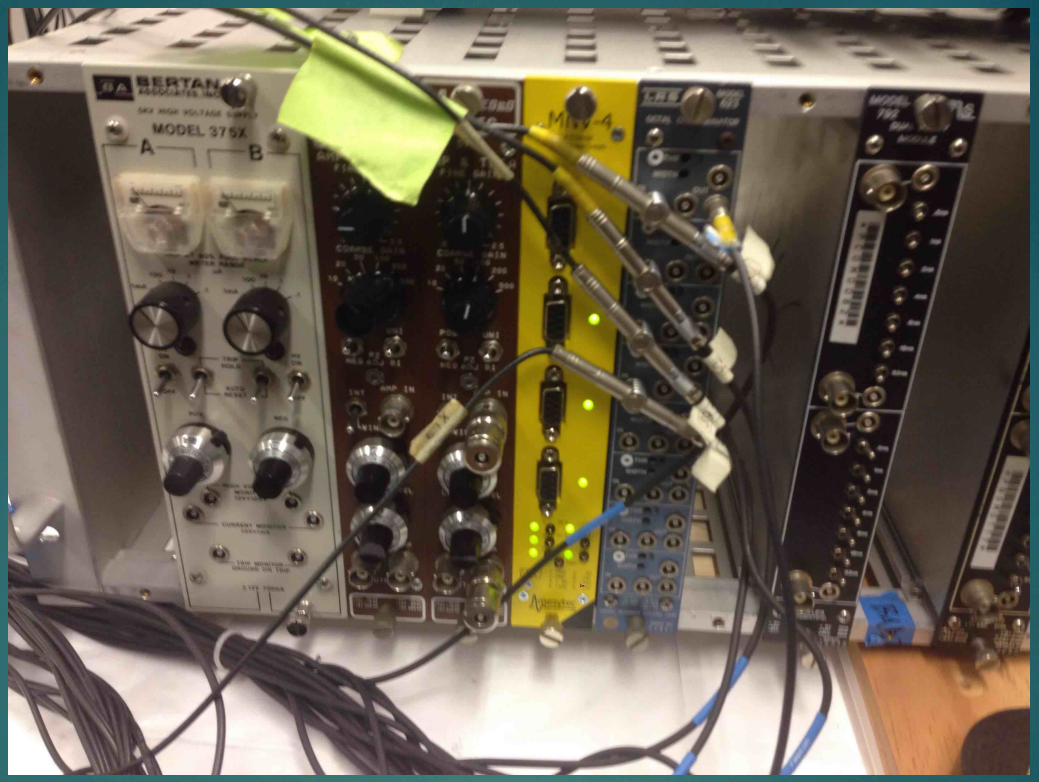
Materials

- 1.Data Acquisition Components
- Windows PC
- Data Acquisition Software(Developed)
- PCI-GPIB Card
- Lecroy 8901A Gpib interface
- Lecroy 2249A Analog Digital converter
- Lecroy 8013A Main Frame
- Nim Crate with Discriminator and Delay Module
- Scintillating Fibers (3x3 mm)
- Hamamatsu 16 channel PMT
- 2.Topas Simulation
- 3.Custom 3D motion simulator

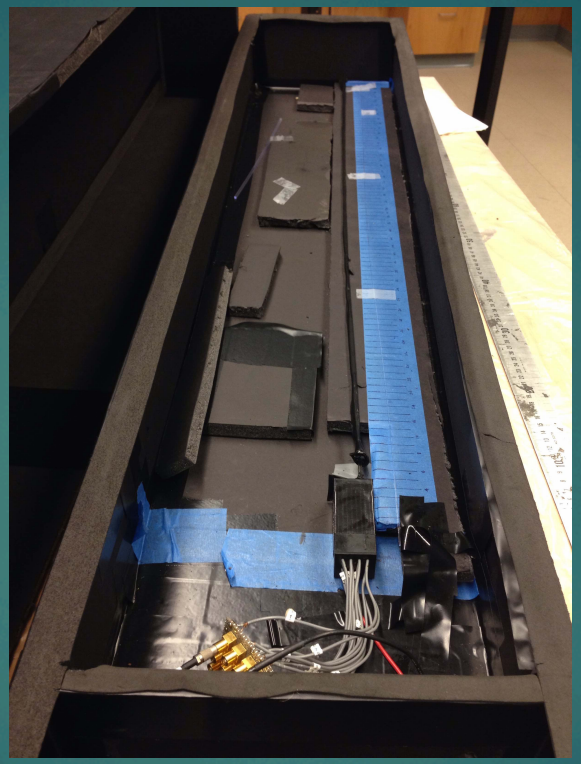
Data Acquisiotion



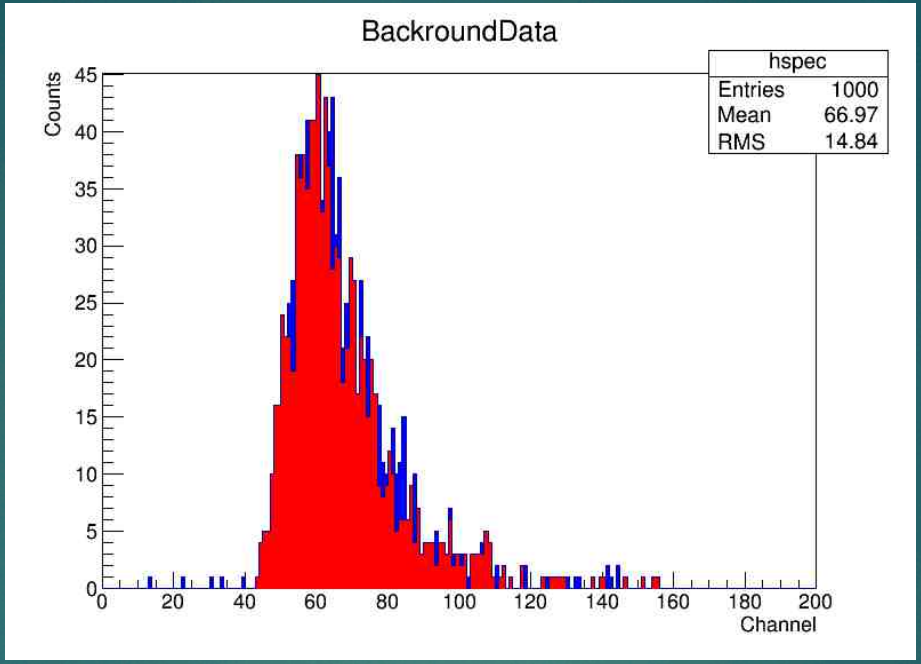
Lecroy 8013A Main Frame with 2249A ADCs



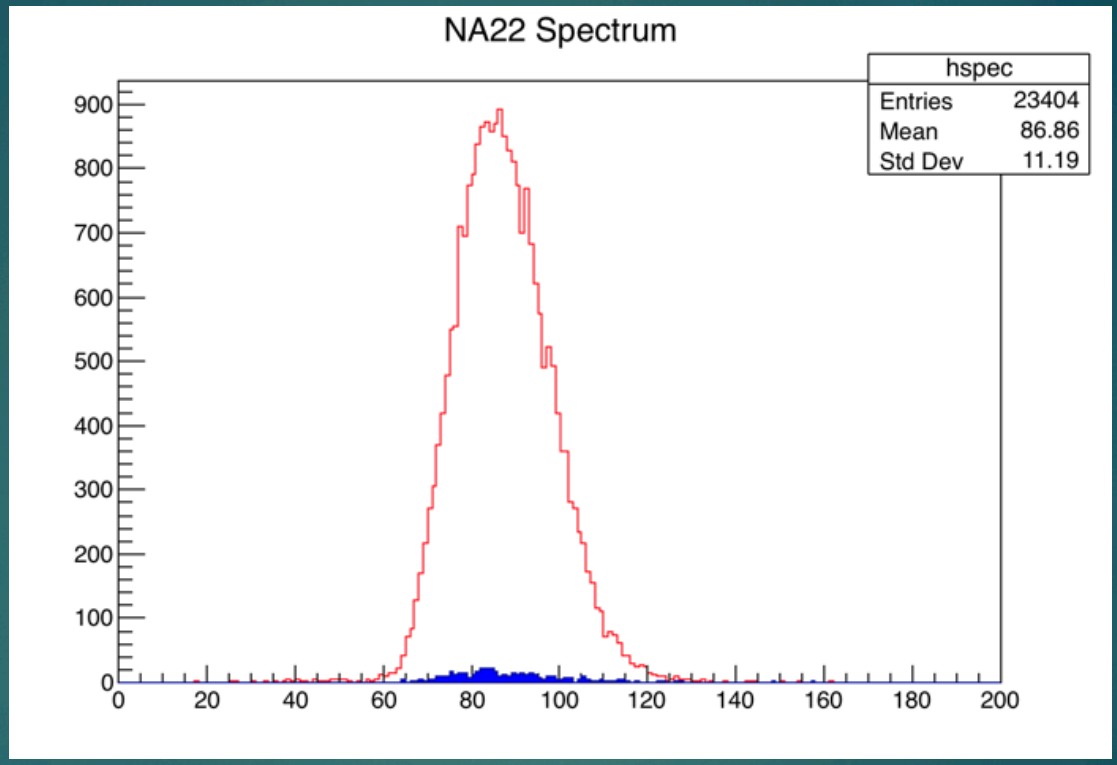
Nim Crate



Black Box with PMAT and Fibers connected



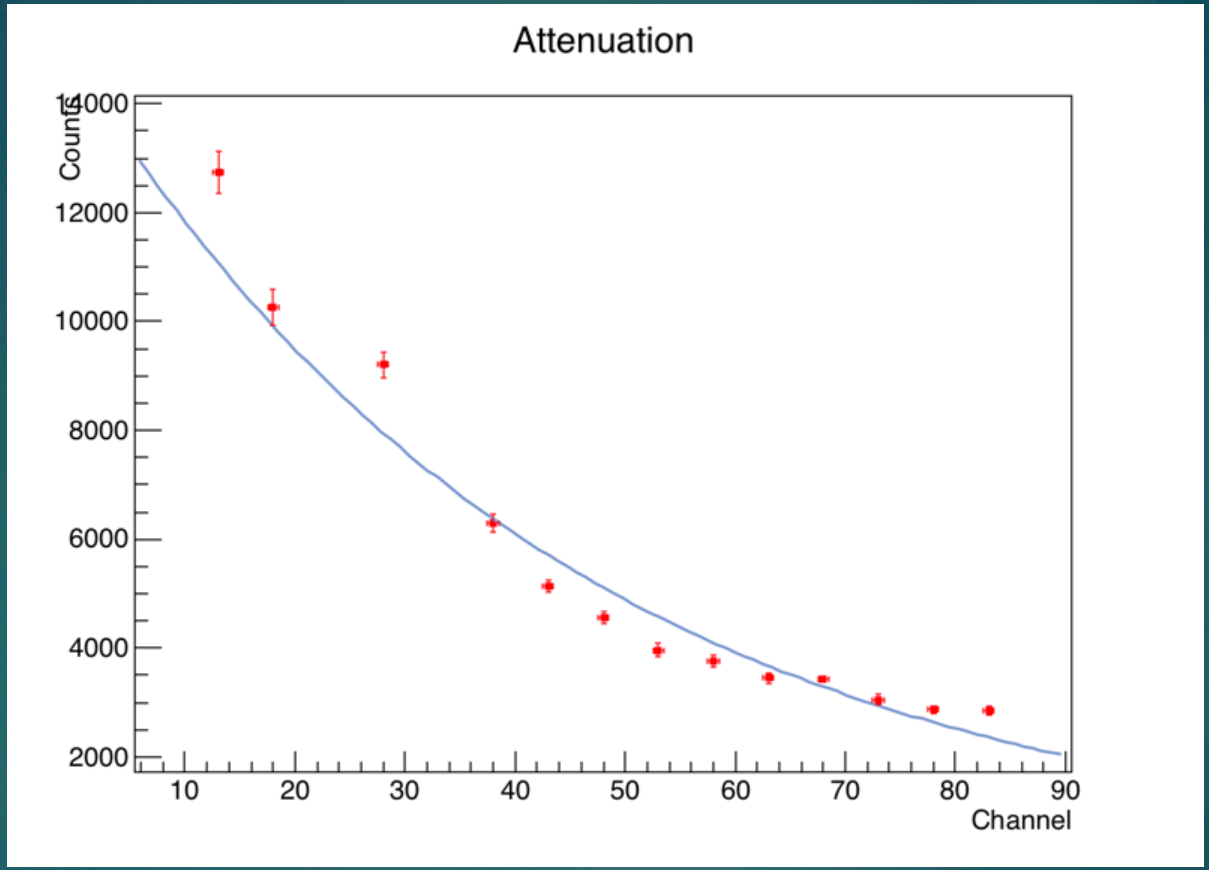
Background data comparison. Light on(red), light off(blue).

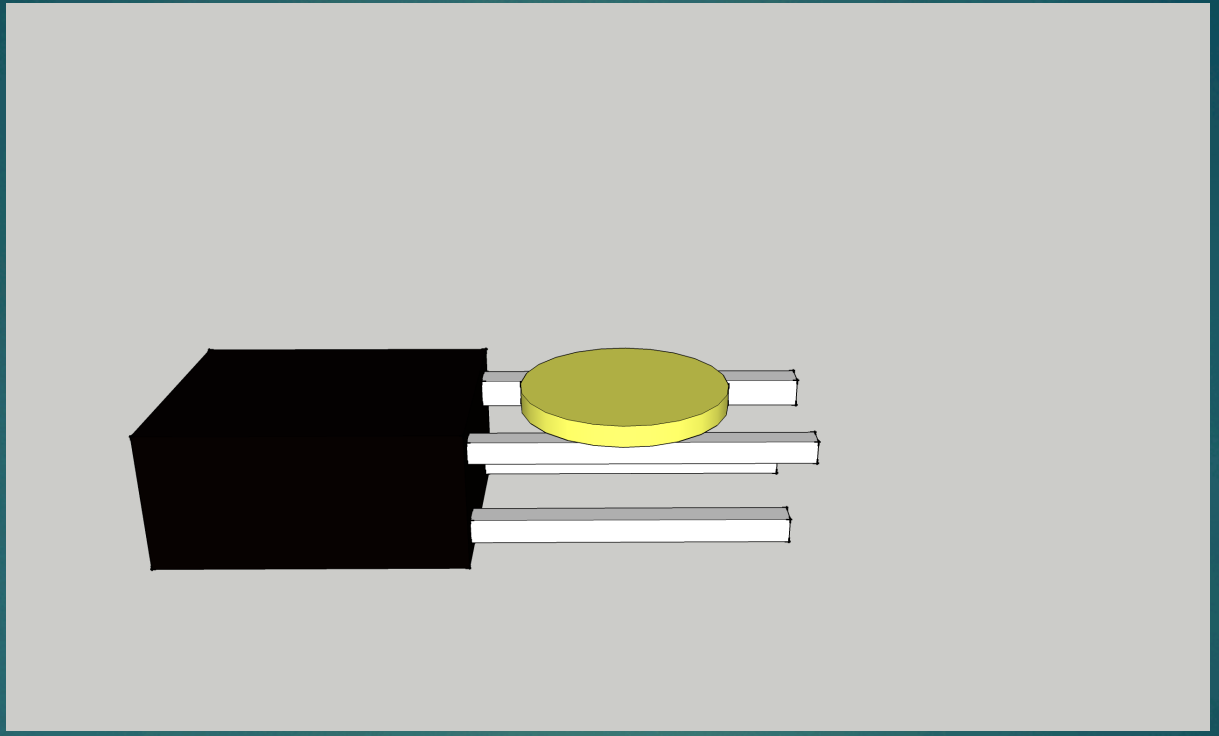


Background(blue) vs ^{22}Na spectrum(red).

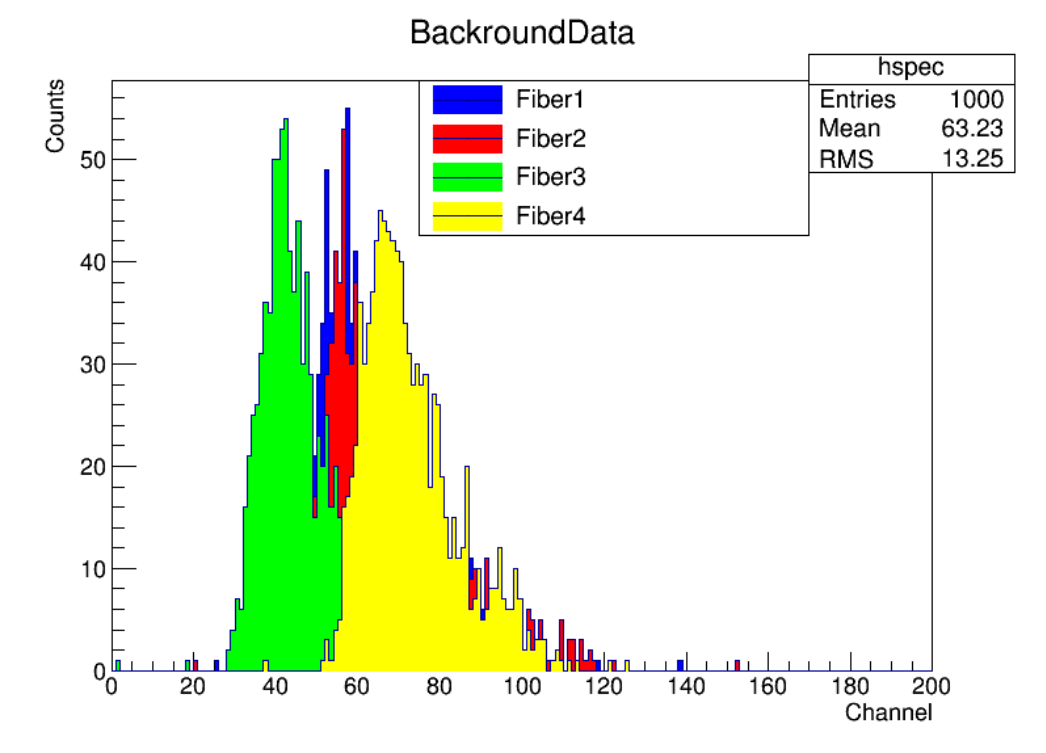
Attenuation of Scintilatting Fiber

- Na-22 source was put on the fiber while taking the data.
- Each measurement was taken moving source 5 cm away from the PMT.
- Each time 1500 data point was taken
- First 3 minutes in this data point of each measurement was used


Attenuation
Counts
14000
12000
10000
8000
6000
4000
2000
10
20
30
40
50
60
70
80
90
Channel



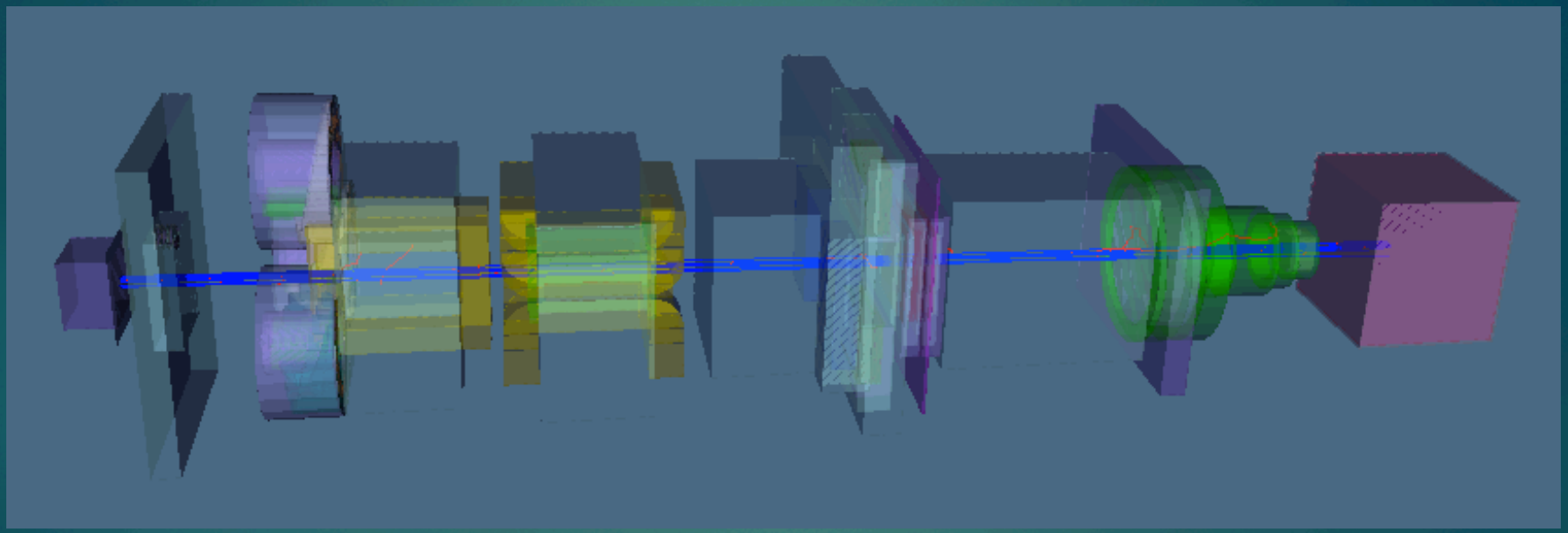
Schematic diagram of of PMT, fibers and Na22 radioactive source(yellow)



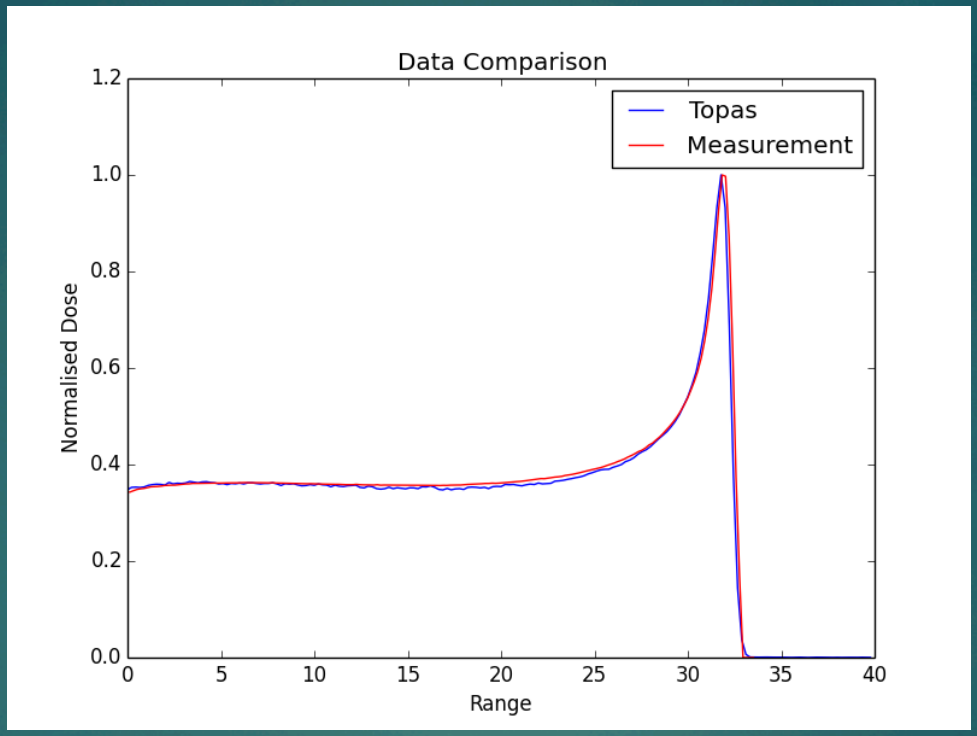
^{22}Na spectrum of four fibres attached to the PMT

TOPAS

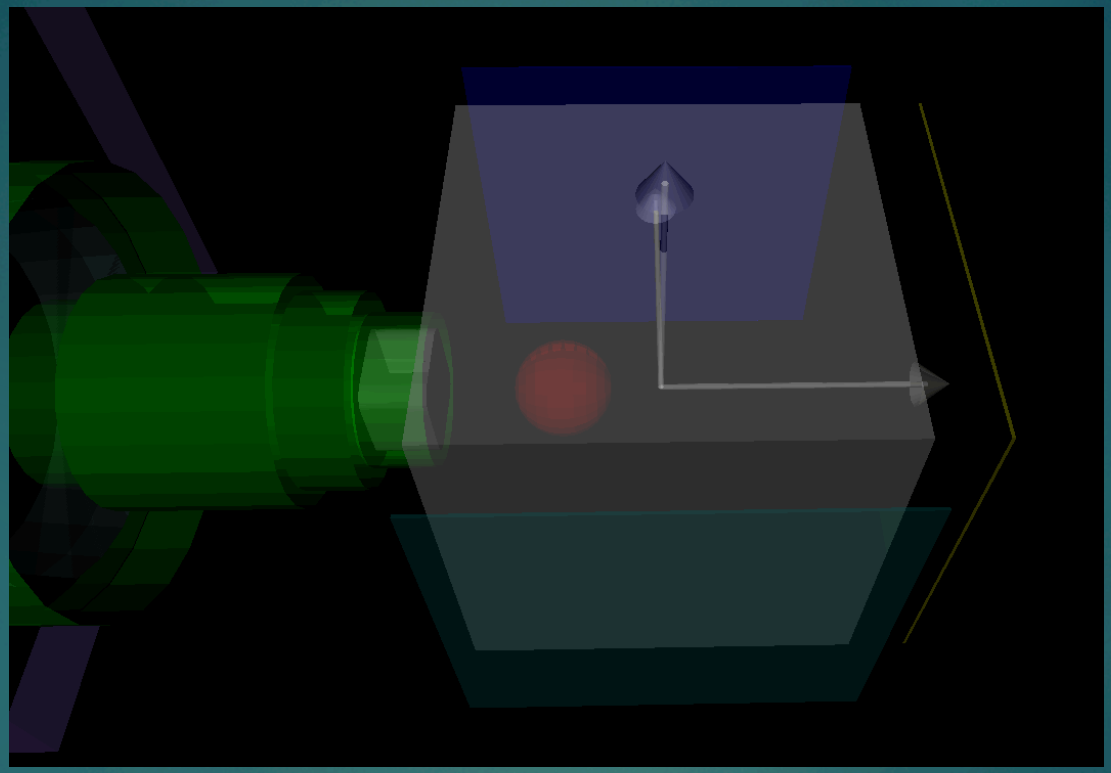
- Topas is a Geant4 based simulation tool for particle simulation which uses the Monte Carlo algorithm
- particularly important for proton therapy, in particle transport
- it can model full nozzle setup that includes rotation wheels, ion chambers, snouts, jaws for scanning mode and scattering mode
- It makes Monte Carlo simulation more readily available for researchers and clinicians
- Easy To use



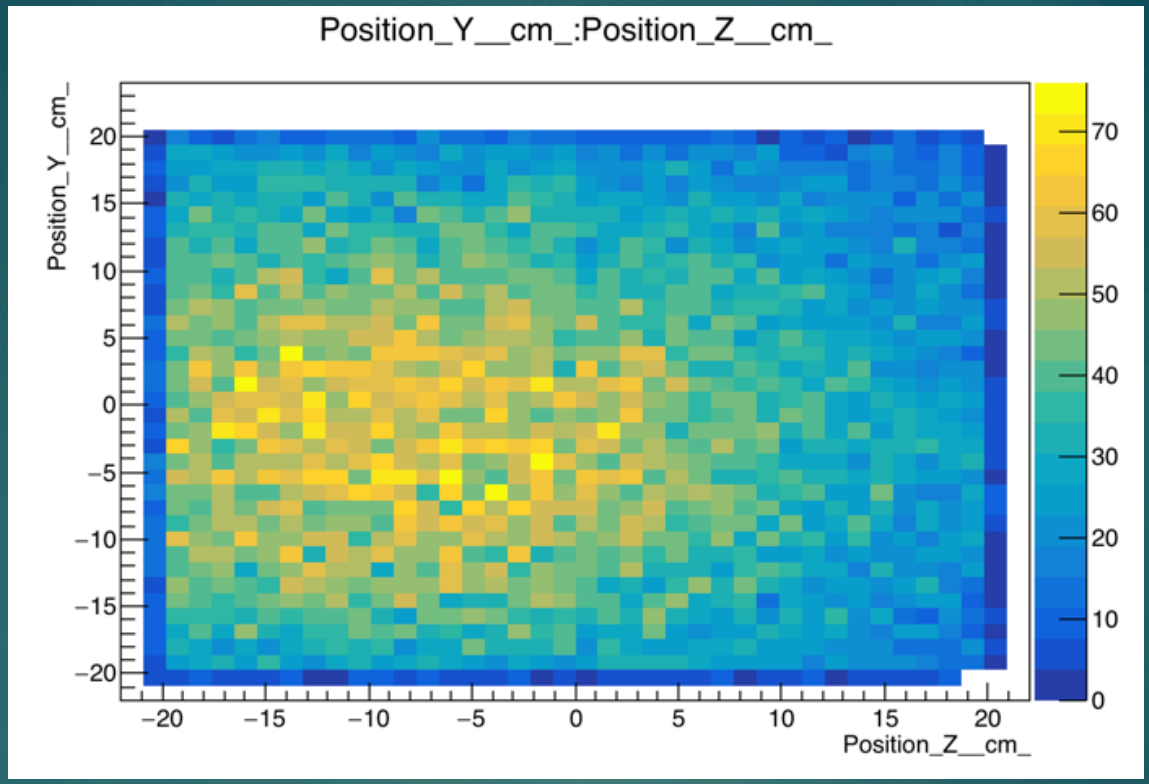
Full setup simulation of IBA for scattering proton beam



230 MeV proton beam range in water



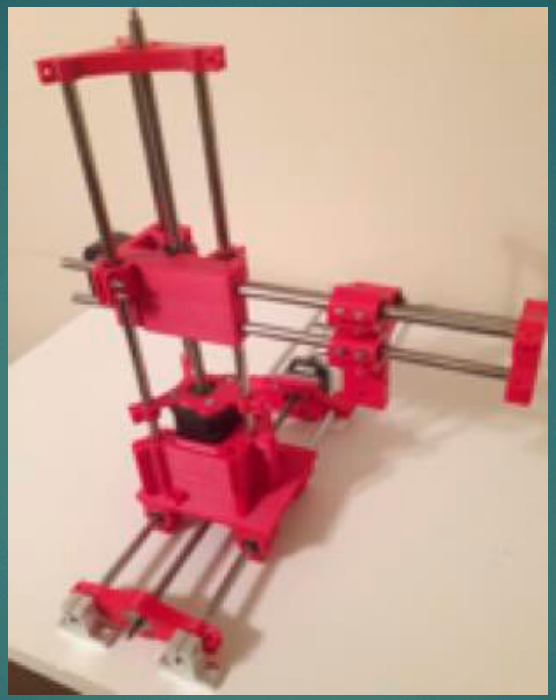
Topas simulation of the detection system



Particle flux on ZY plane(Green dedector)

3D Custom Phantom

- A custom 3D motion simulator was designed to simulate the organ motion in water phantom
- Google SketchUp 3D modeling software
- Da Vinci 3D printer
- Arduino mega micro controller to control the stepper motors



THANK YOU