Recap of Consultation Meetings and some simulations

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18th September 2025

LhARA Collaboration Meeting 8

Consultation Meeting

- As part of PA1 WP5 held 3 user consultation meetings
  - Online (Ruth hosted, stage 1)
  - Birmingham (Tony hosted, stage 1)
  - Liverpool (Narender/Milaan hosted, stage 2)
- Aim to draw a list of requirements for the facility in order to allow a wide range of users to optimise their work
- Main focus Stage 1 in-vivo but also Stage 2 in-vitro and companion animals

Consultation Meetings Conclusions

Conclusions

C1: The case for a change to the present baseline beam-delivery concept for the low and high energy *in-vitro* end stations and the *in-vivo* end station is not compelling and therefore the present baseline should be retained.

C2: A specification of 5% as the upper limit on the accuracy of the integrated dose measurement and its repeatability is sufficient for the dose-measurement uncertainty not to dominate the error budget of biological experiments.

C3: Any setup and end-station must be **"Simple, Robust, Reproducible, and Cheap"**.

C4: For the rest of the consultation process, the Stage 1 in-vitro experiments will assume the use of standard plastic cell dishes.

C5: An X-ray source to be included in the facility to allow control sample and low LET comparisons to be made with cultures in both the stage 1 and stage 2 *in-vitro* end-stations

C6: Integration of cell transport into the end-stations, and environmental stabilisation needs to be in the order of minutes to ensure cell viability.

C7: Temperature and oxygen stability must be maintained and monitored and be set for user requirements.

C8: The experimental complications arising from using a low-energy proton beam must be considered carefully and a Geant4 simulation has been developed to extract kinetic Energy, LET, profiles etc.

Consultation Meetings Conclusions

Conclusions

C9: Animal house on site is essential for animal work as it is a ”One-way trip” for animals involved in experiments.

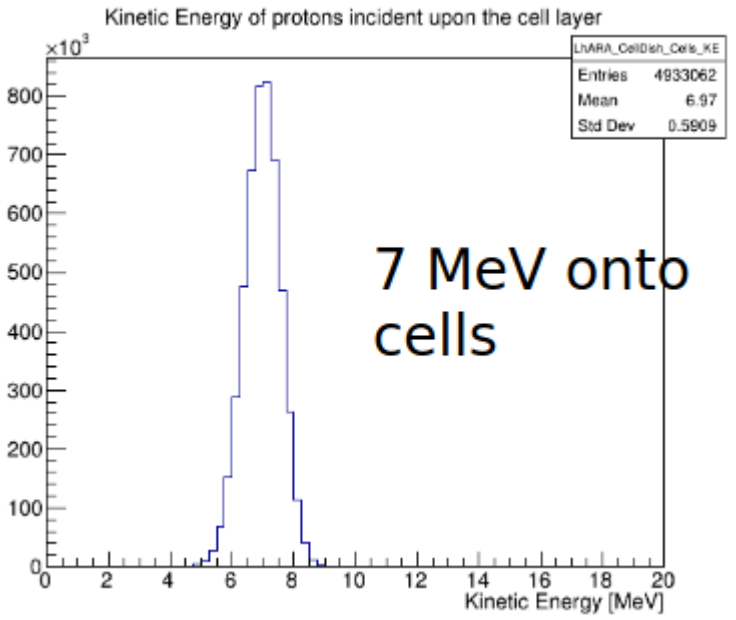
C10: Support will be required from external experts regarding the regulations for animal work. Development of the specification of the *in-vitro* end station and its operation should include careful consideration of the range of animals required. Mary Lyons have been involved thus far.

C11: Real time imaging will be required in the end-station room for animal work, alignment, reproducability e.g cone-beam CT.

Pre-CDR Geometry

Simulation setup to closely match that of the Pre-CDR.

* **25um Ti vacuum window**
* **100um end-station plastic window**
* **250um plastic beam monitor**
* **5mm air gap**
* **1.3 mm cell dish base**
* **30um cells**
* **2mm water (or Marcus chamber for dose)**



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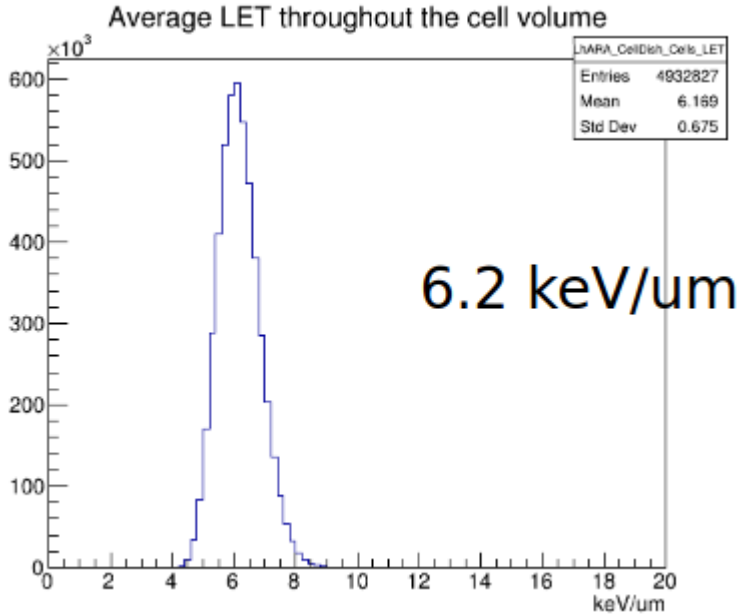

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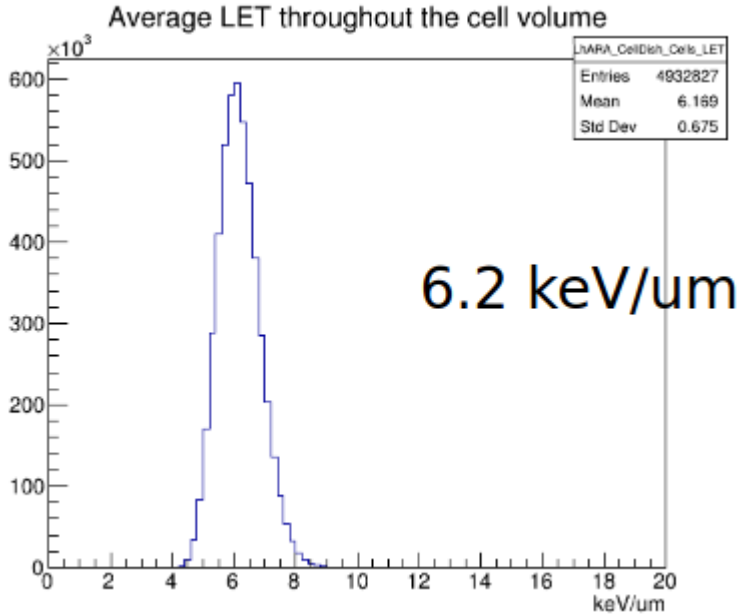

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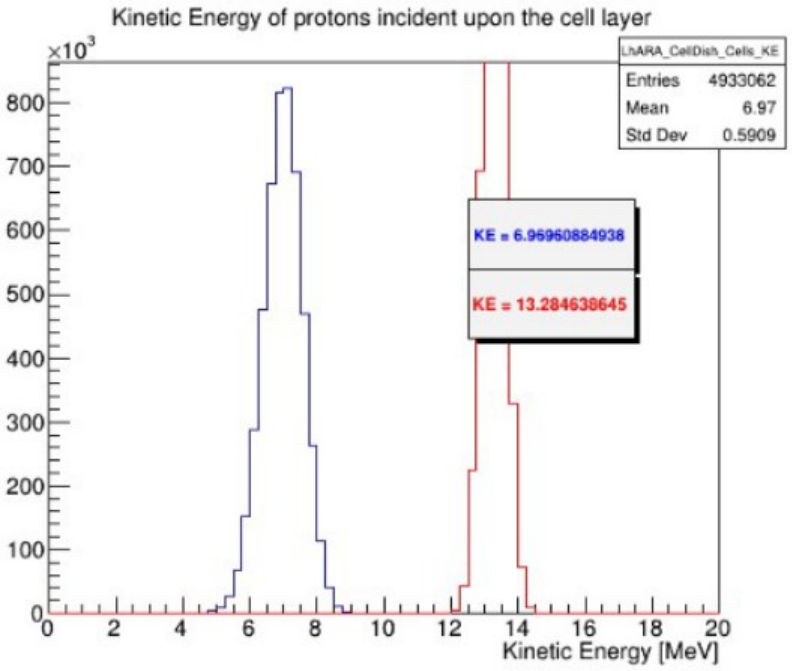
* 2.5 um Mylar **dish base**
* **30um cells**
* **2mm water (or Marcus chamber for dose)**

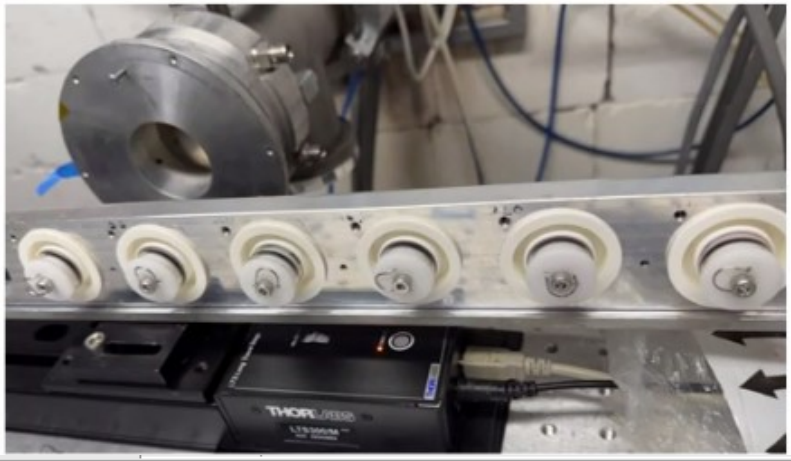


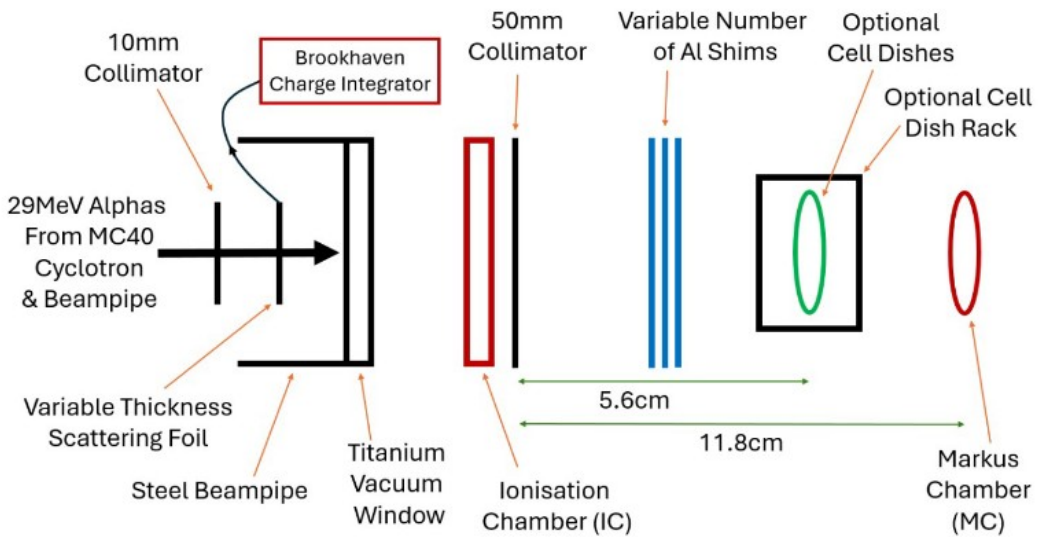
HeLa

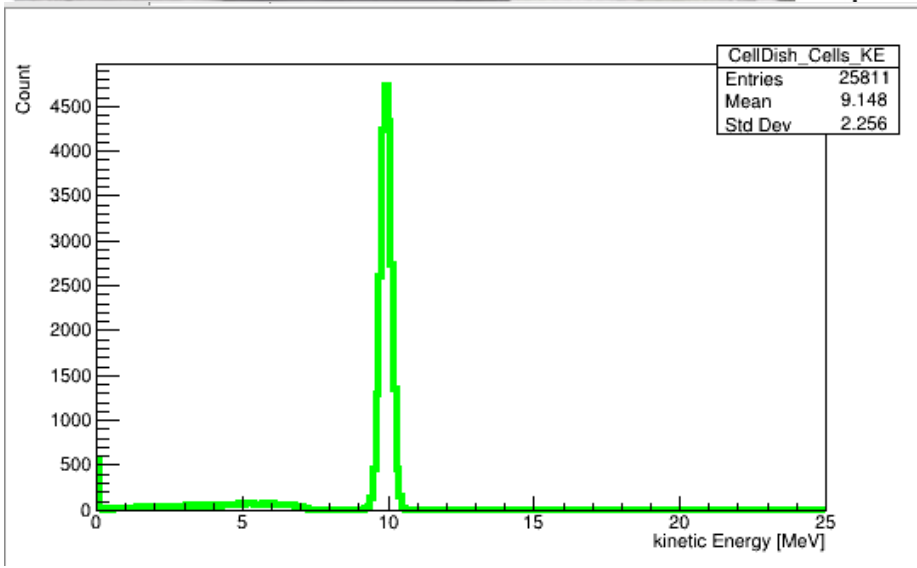
Radiobiology Preparations 2 – **Protons (14 vs 28 MeV)**

Pre-plating protocol:

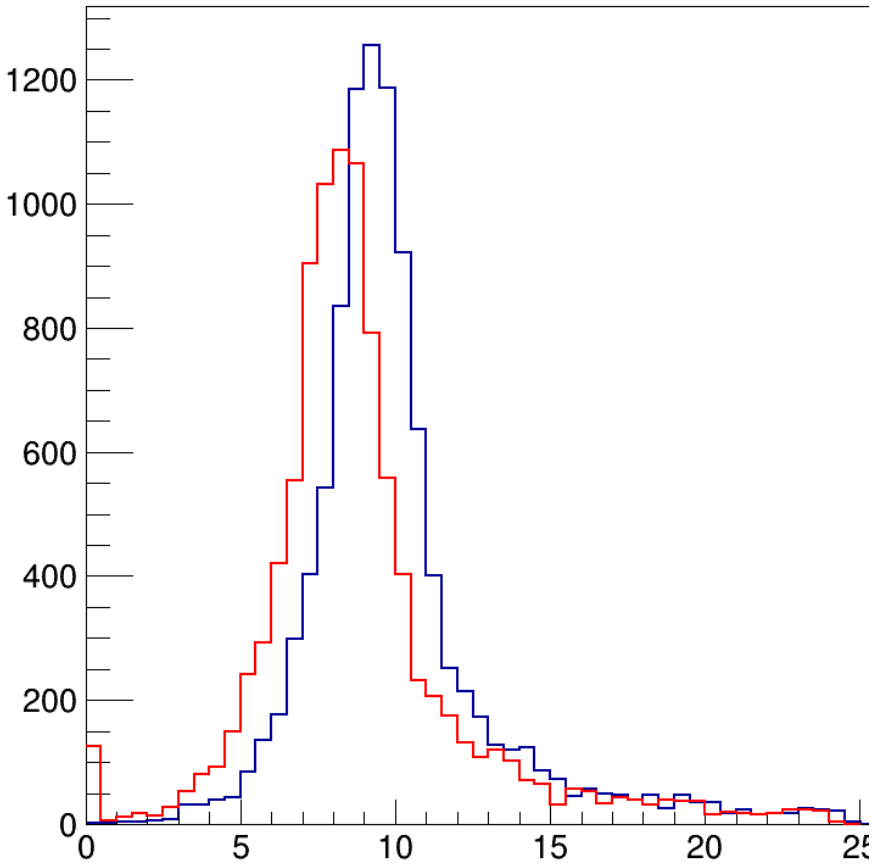
1. Seed single cells on mylar the day before (PM)
2. Remove media and Irradiate single cells vertically
3. Change media
4. Grow colonies for 7-14 days
5. Stain and count



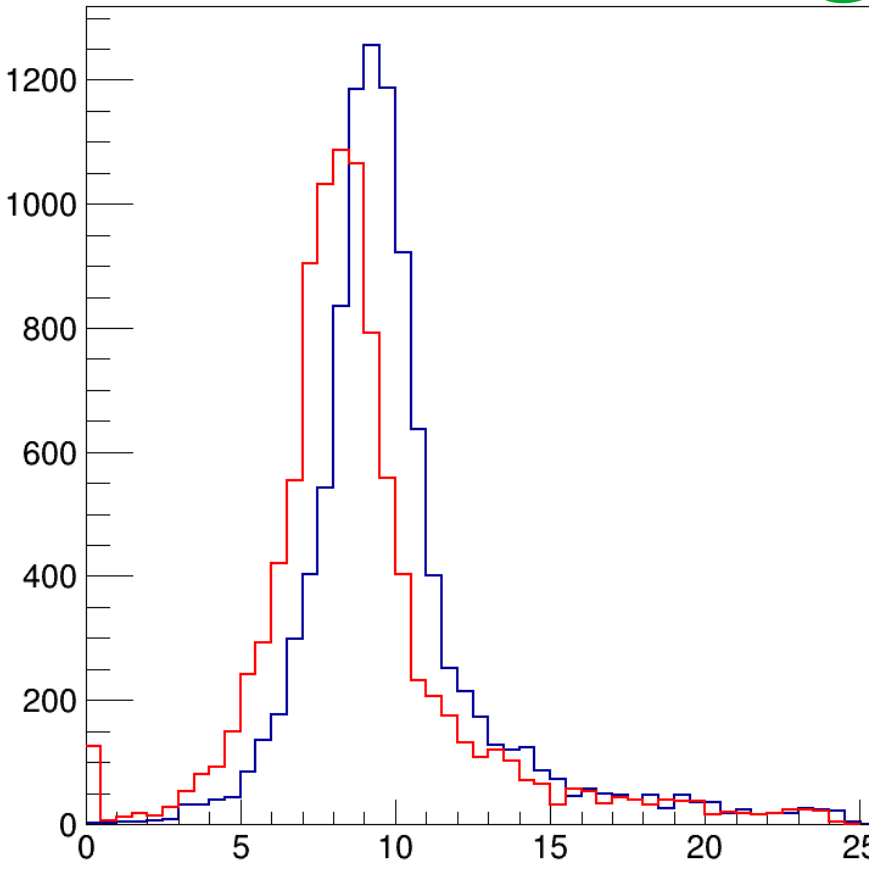


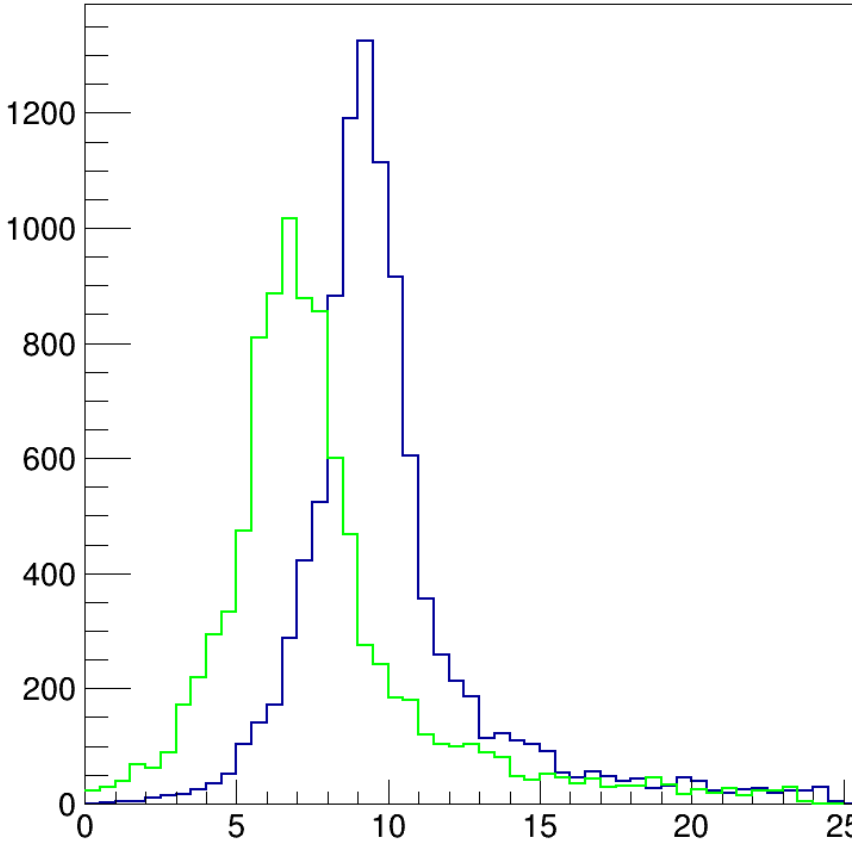


SCAPA, 2.5um Mylar

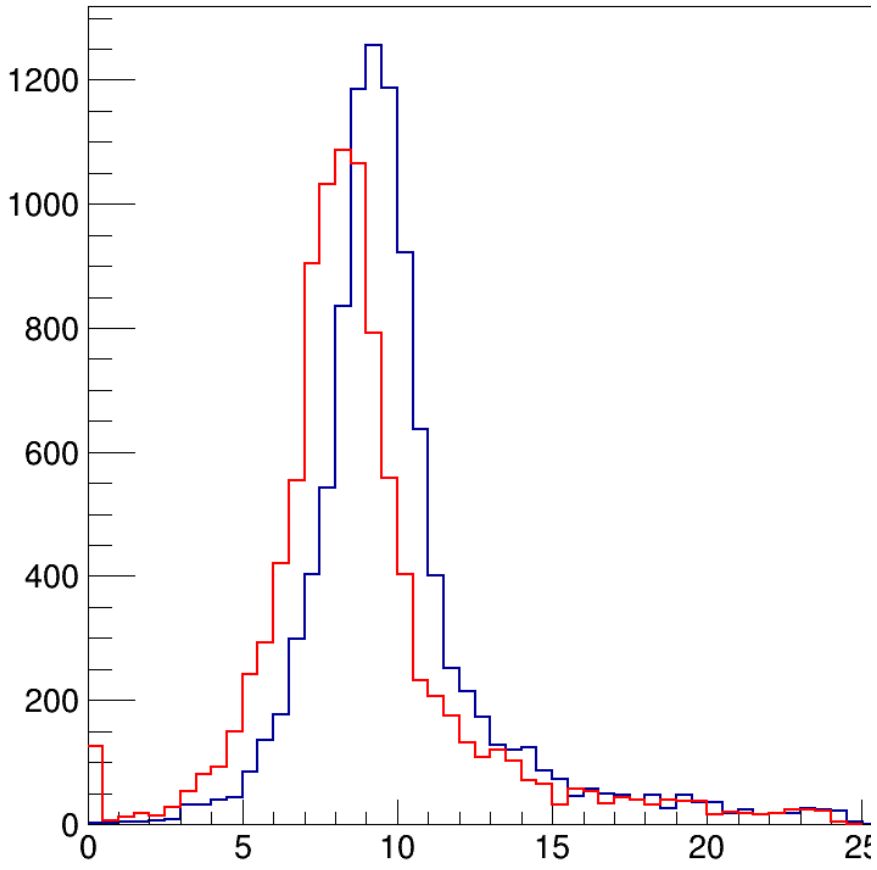


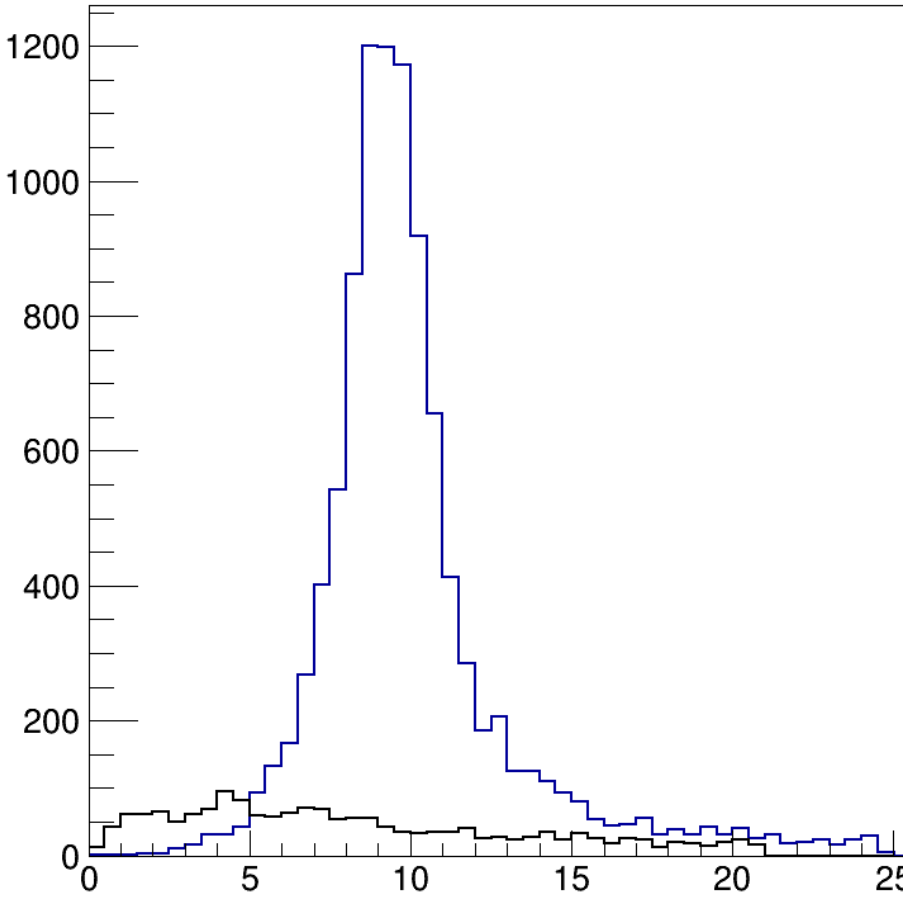
SCAPA, 2.5um Mylar (+) 130um Glass



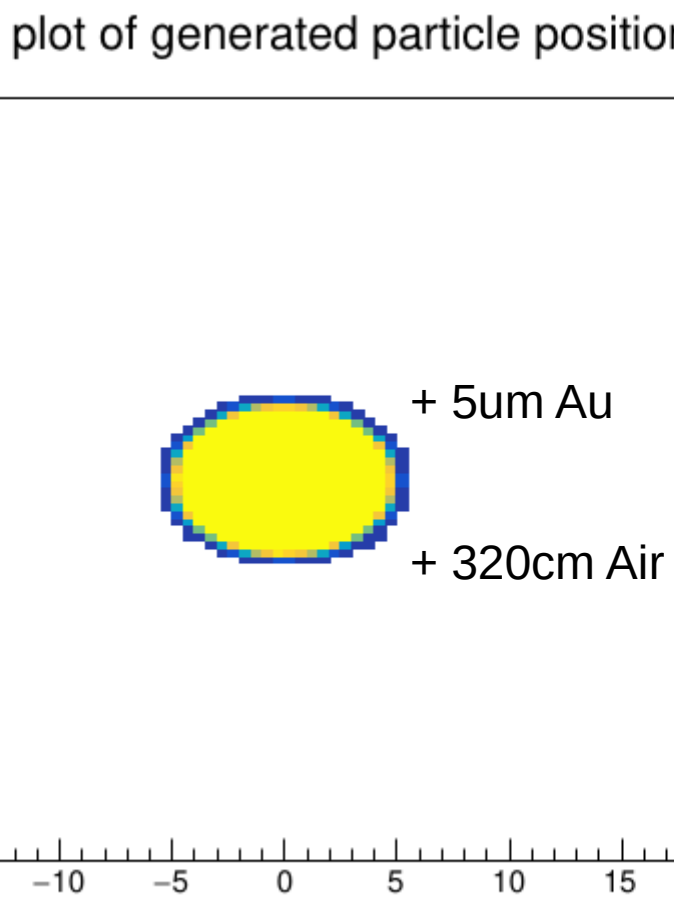


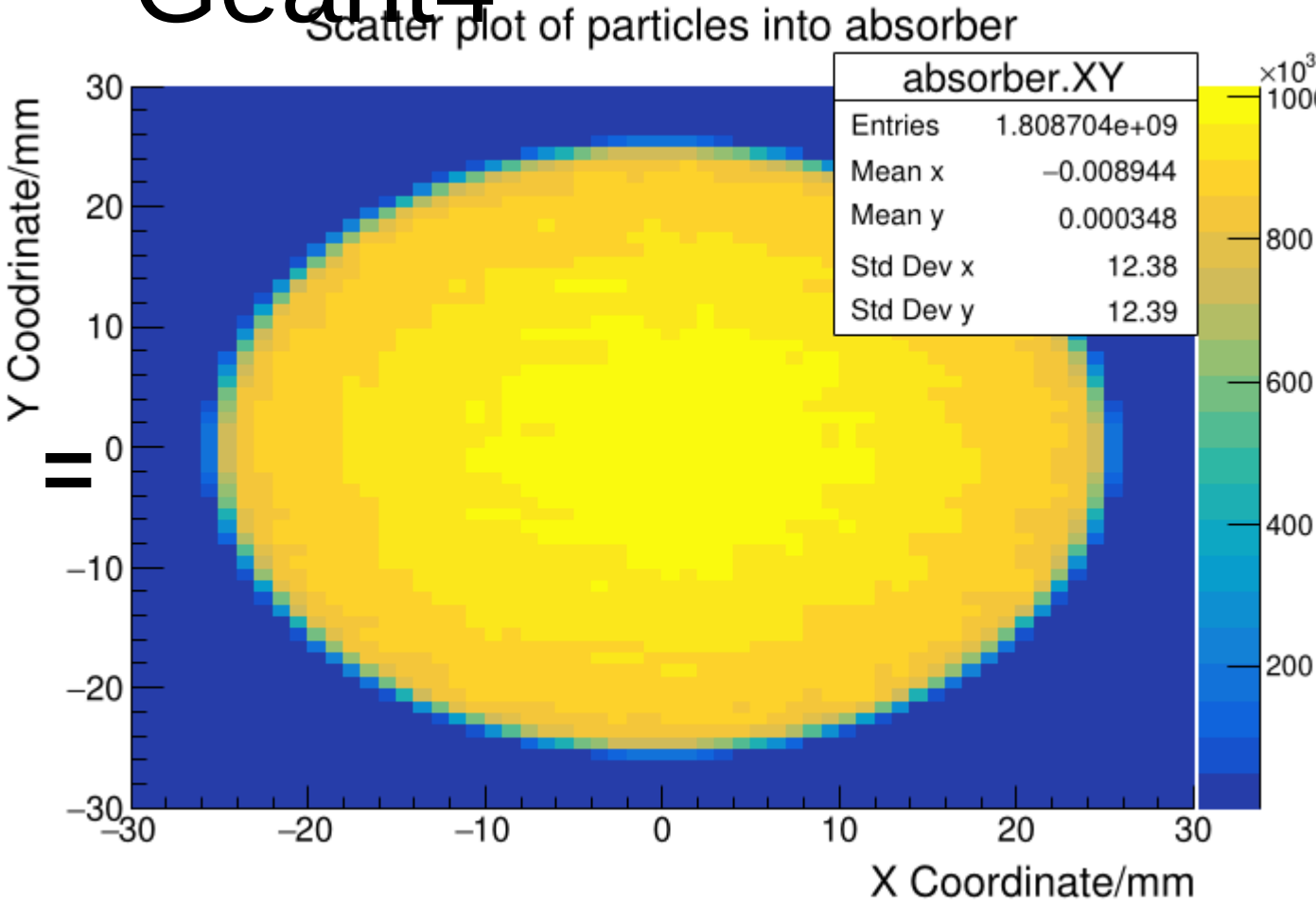
SCAPA, 1.2mm Polystyrene

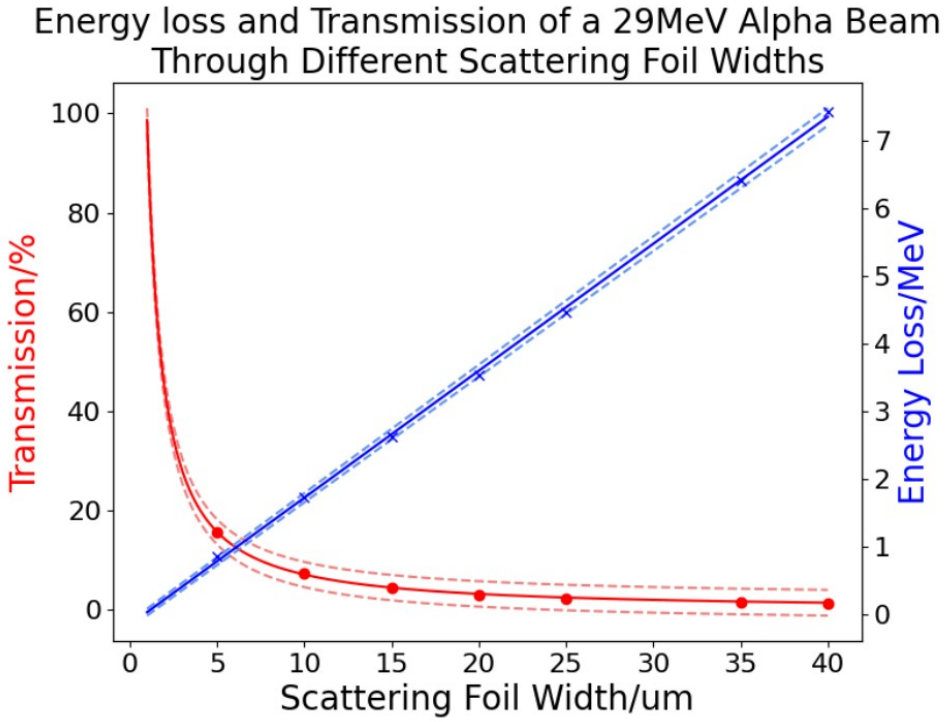


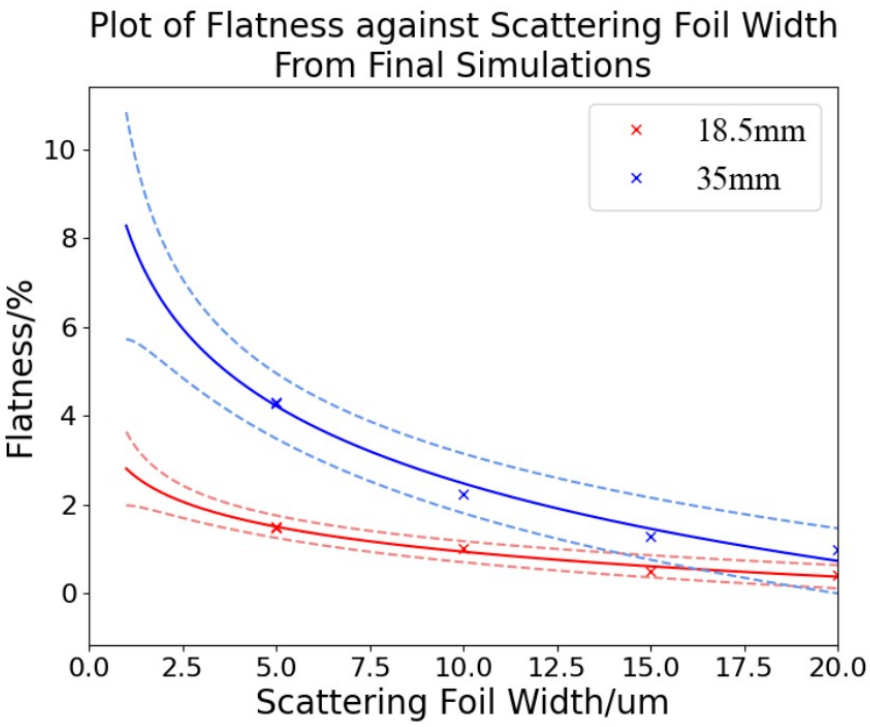


Scattering Foil – 28 MeV alpha Geant4

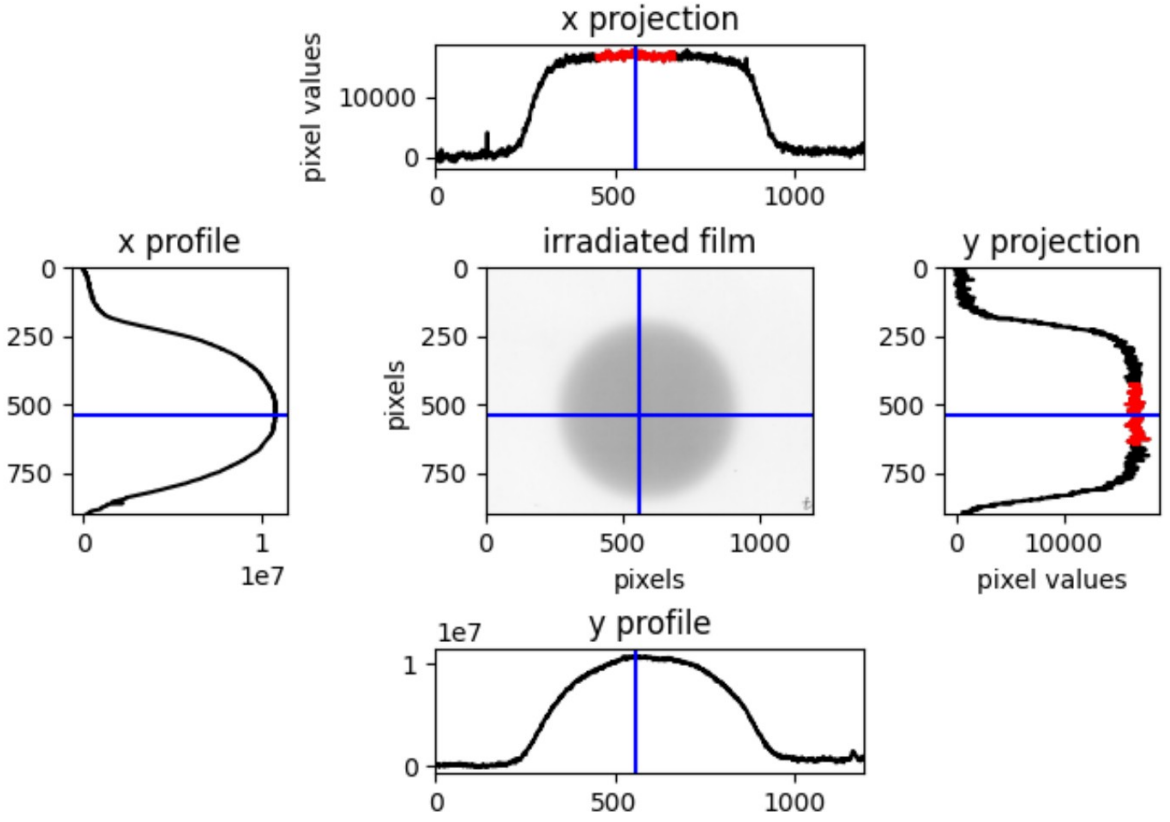





Energy loss and Transmission of a 29MeV Alpha Beam
Through Different Scattering Foil Widths
Transmission/%
Energy Loss/MeV
Scattering Foil Width/um
0
5
10
15
20
25
30
35
40
0
20
40
60
80
100
0
1
2
3
4
5
6
7


Plot of Flatness against Scattering Foil Width
From Final Simulations
18.5mm
35mm
Flatness/%
Scattering Foil Width/um
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
0
2
4
6
8
10

Scattering Foil – 28 MeV alpha data



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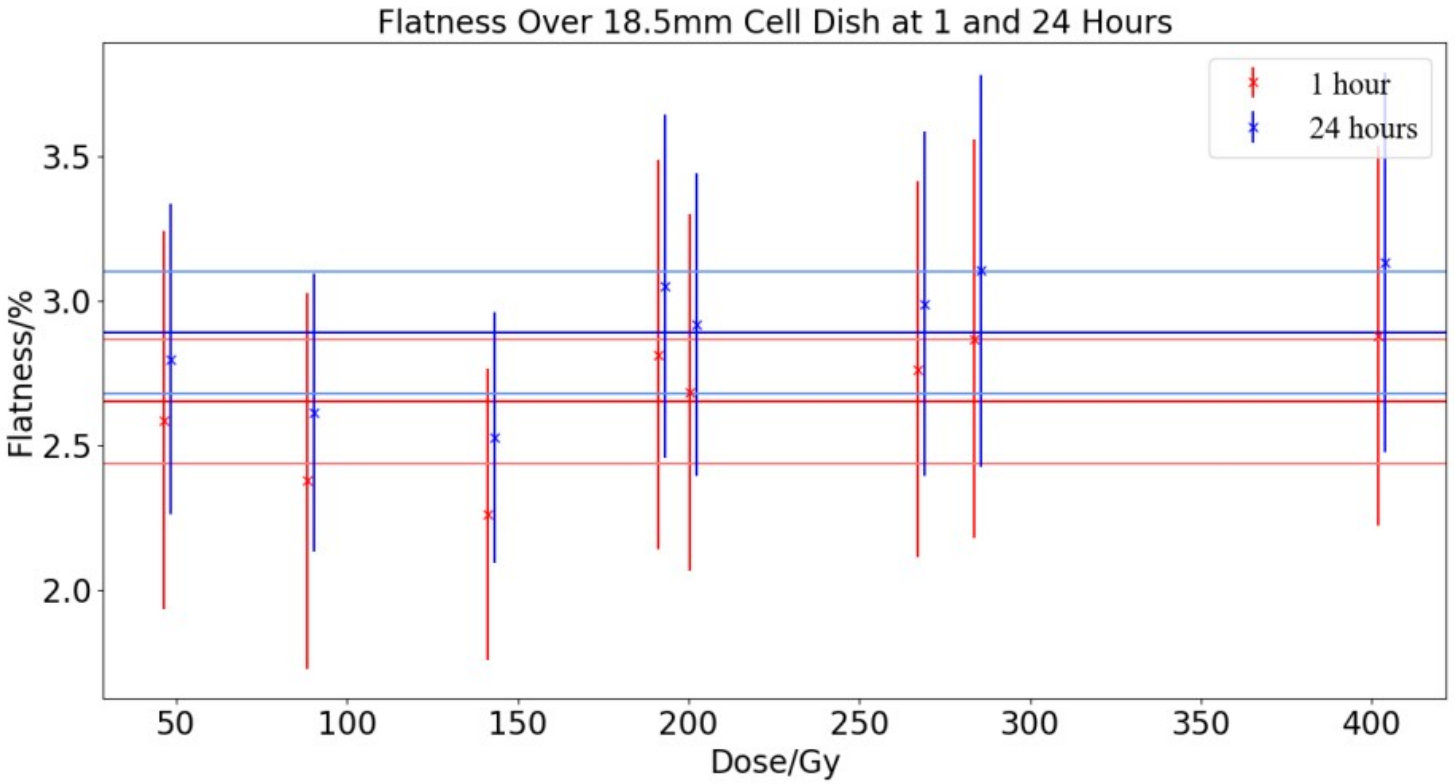

Figure 4.6: Flatness measured over $18.5mm$ at 1 and 24 hours for each film