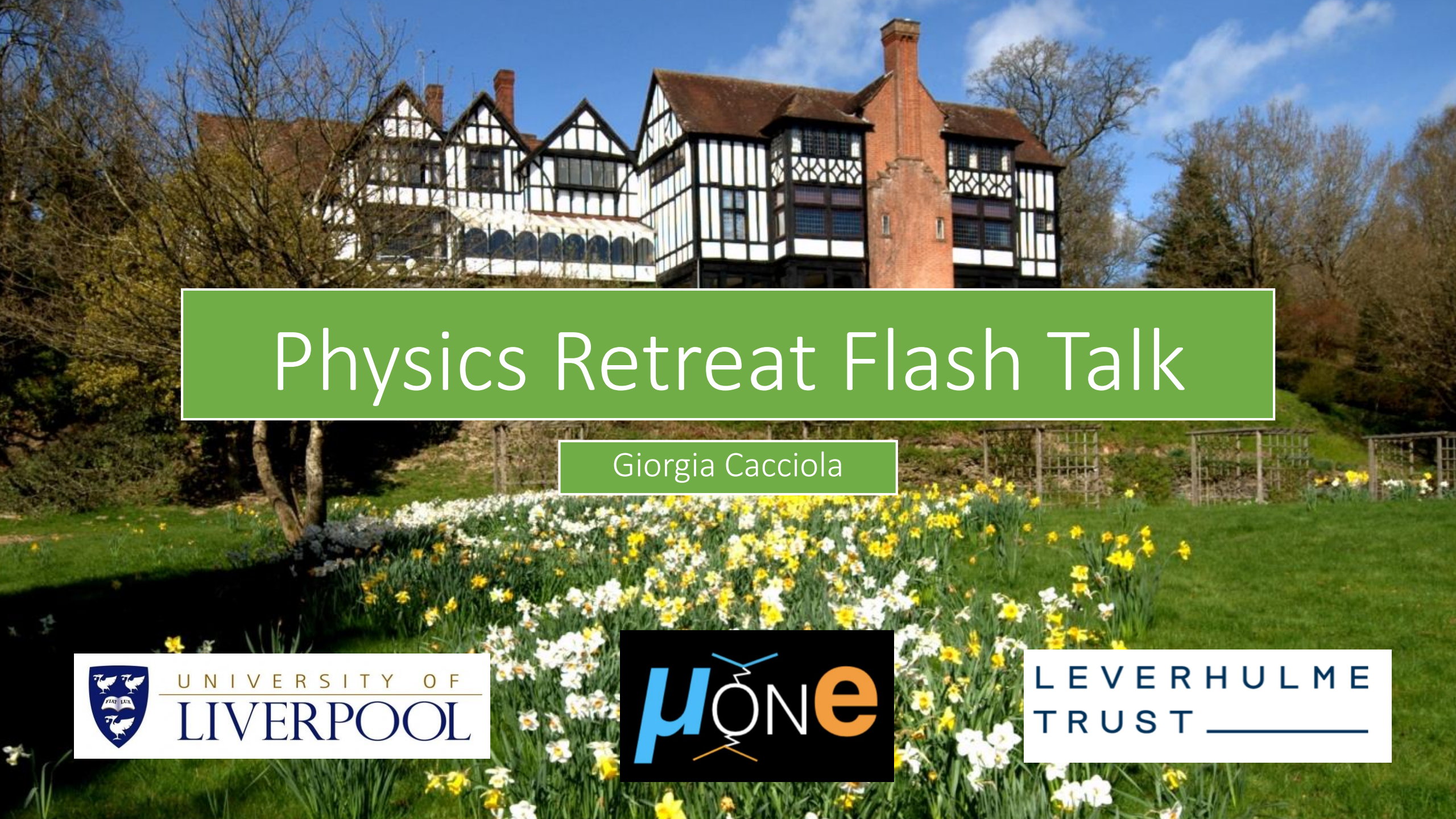


Physics Retreat Flash Talk

Giorgia Cacciola

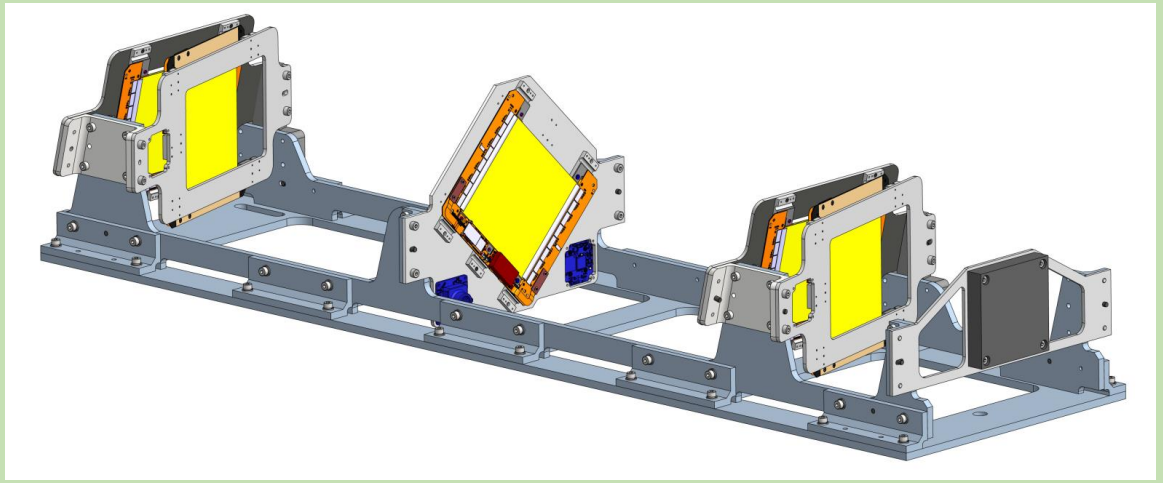
UNIVERSITY OF LIVERPOOL

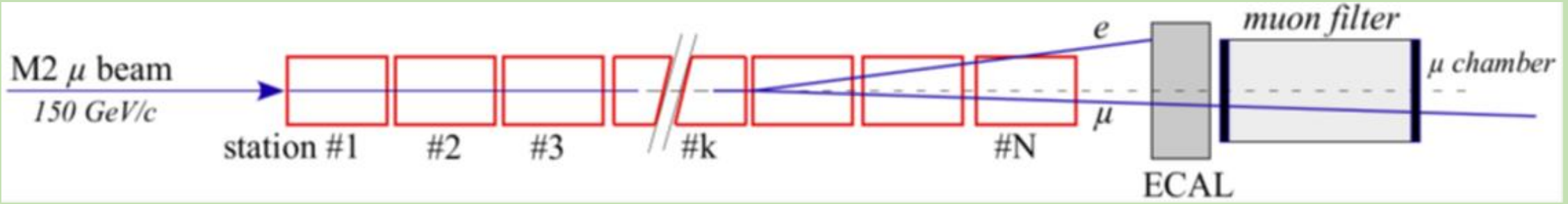
μONE

LEVERHULME TRUST

MUonE

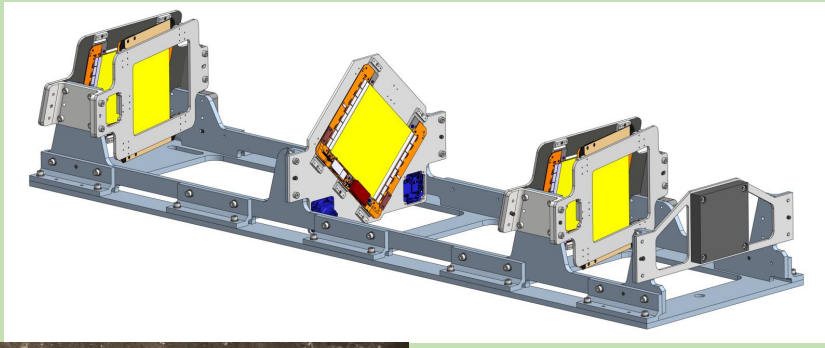
- MUonE will take place at the M2 beamline at CERN
- It is a modular experiment made up of repeating 1m long station . Each with its own target and tracking system.
- The station is made up of 6 2S modules which have been developed for the CMS phase 2 upgrade .
- Before the stations there will also be a beam momentum spectrometer (BMS) and afterwards a muon filter and calorimeter for PID.

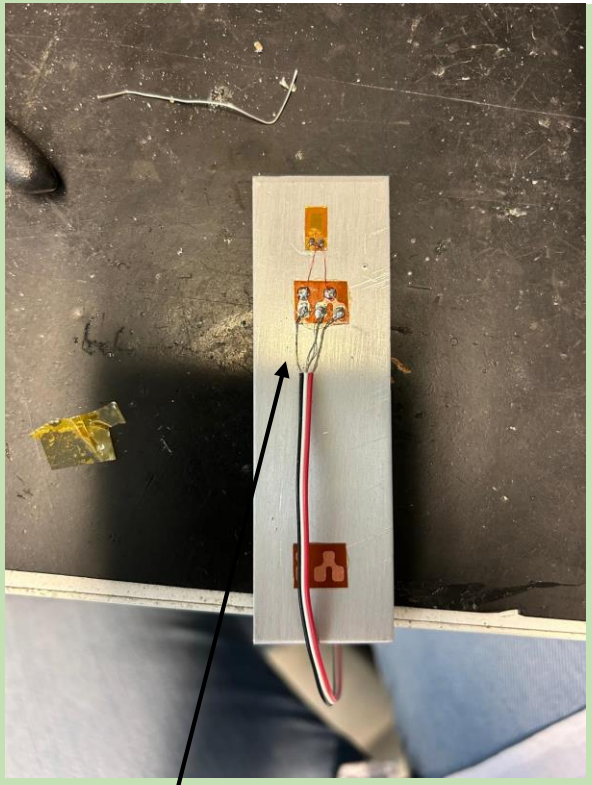




Hardware Studies

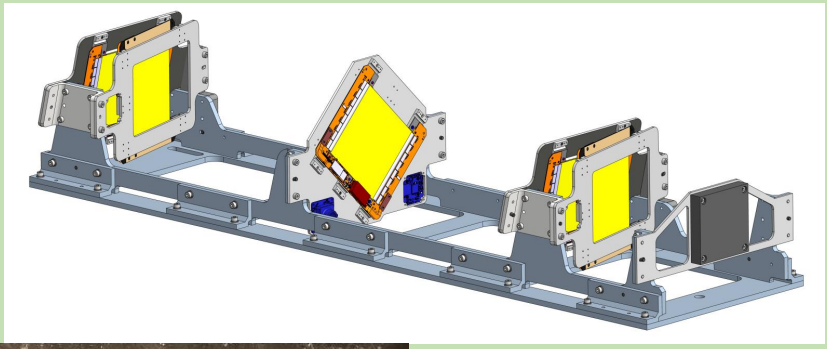
- Current support structure is made from Invar which is a material that is composed of Iron and Nickel . Invar is expensive, heavy and difficult to machine
- So we looked at Carbon Fibre …
- The first try wasn't so successful as the standard carbon fibre frames showed bending in the structure after being subjected to different temperatures.
- So we tried a different carbon fibre, this is called M55J and is Carbon Fibre combined with cyanate ester
  This gave better results and so this material was used for the support structure of the BMS





I learnt how to solder !

Hardware Studies



- Current su… Invar which is a mater… nd Nickel . Invar is ex… machine
- So we lool…
- The first tr… standard carbon fib… the structure … rent temperatu…
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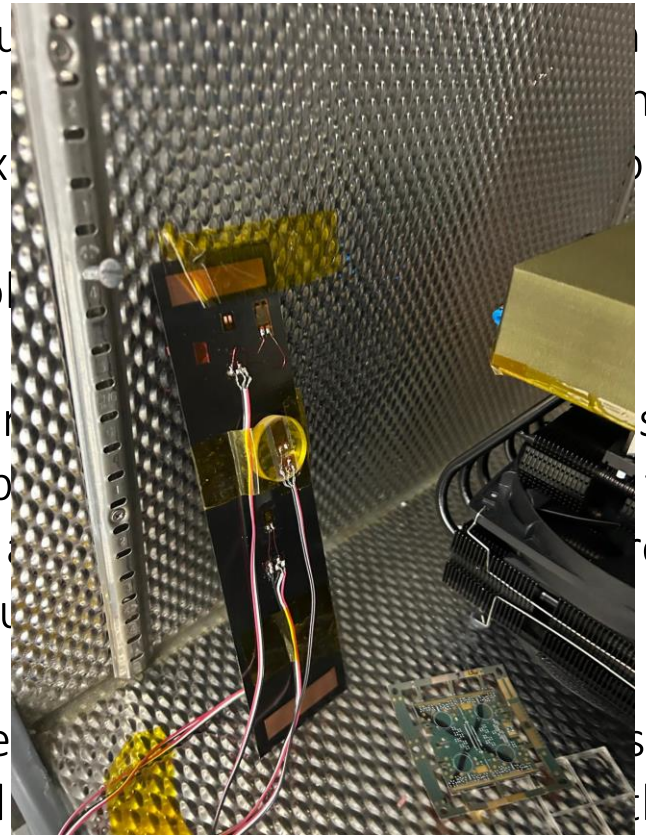
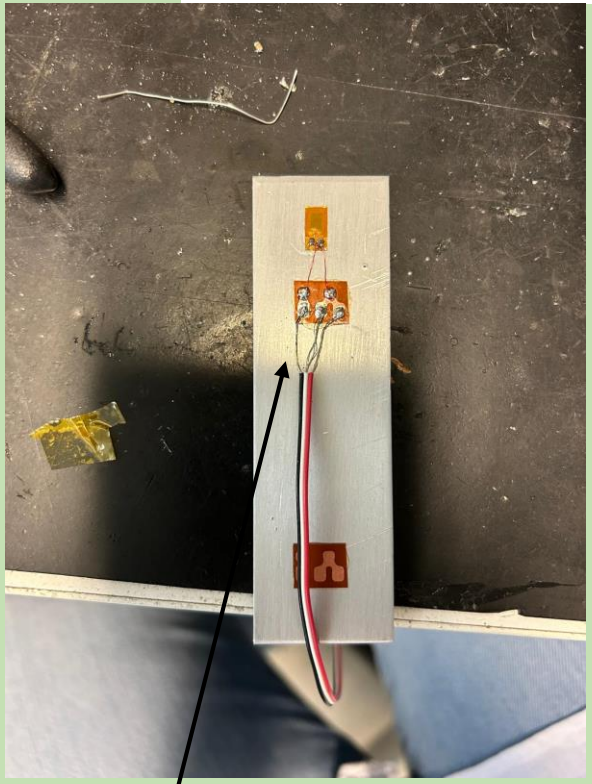


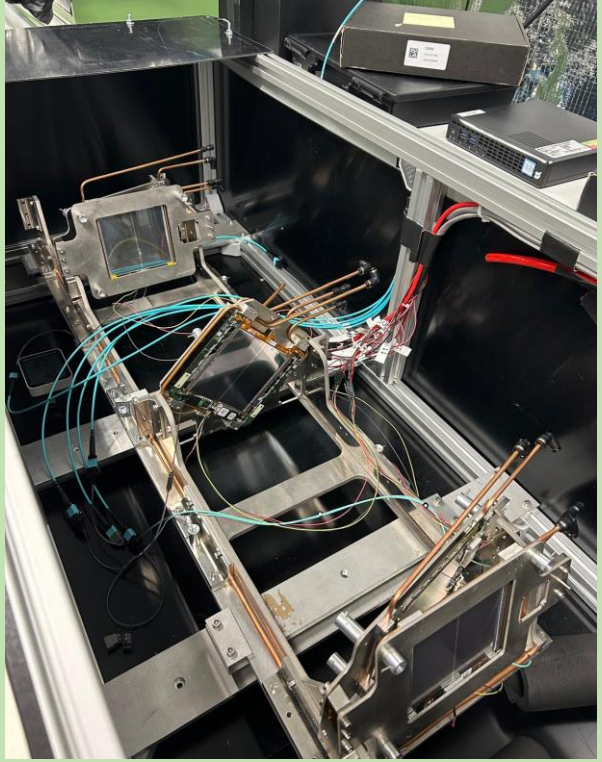


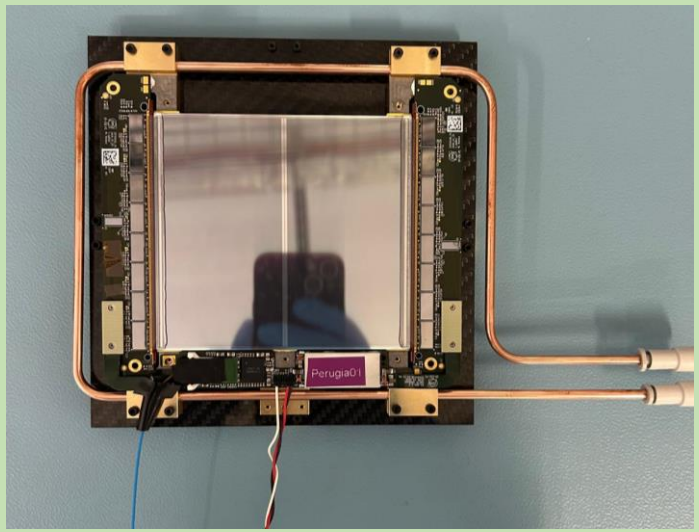
I learnt how to solder !

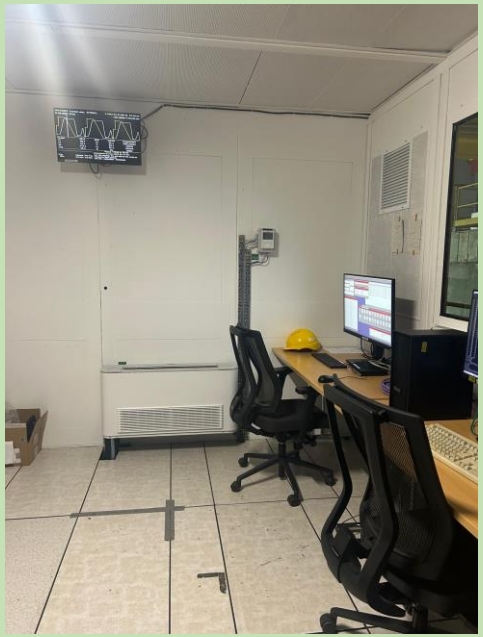
- BMS station made up of carbon fibre support structure at CERN for the test run !

2025 Test Run

- In March I went to CERN to work on the testing of the 2S modules in preparation for the start of the test run
- During this time I learnt how to mount modules and helped run tests on the modules once mounted
- Also did some shifts whilst I was at CERN







Geant4 Simulation Work

- There are differences between MC and data
- Modifying the geant4 simulation of 2S modules to improve the Data – MC comparison

-> Implementation of delta rays

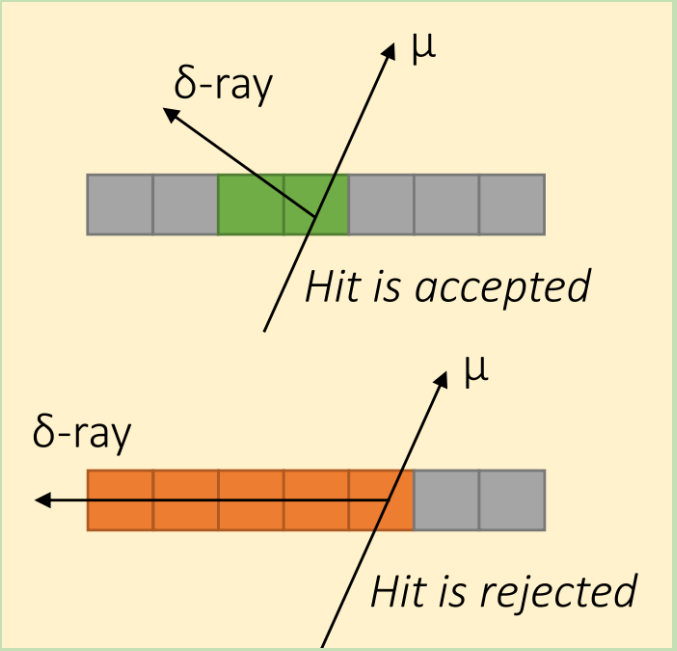
->Increasing the sampling throughout the silicon

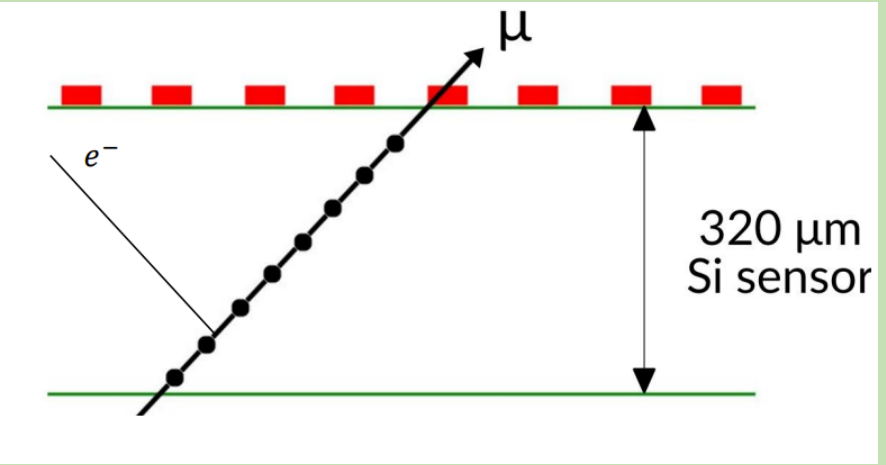
->Changing the active thickness

->Adding timing effects

Implementation of delta rays

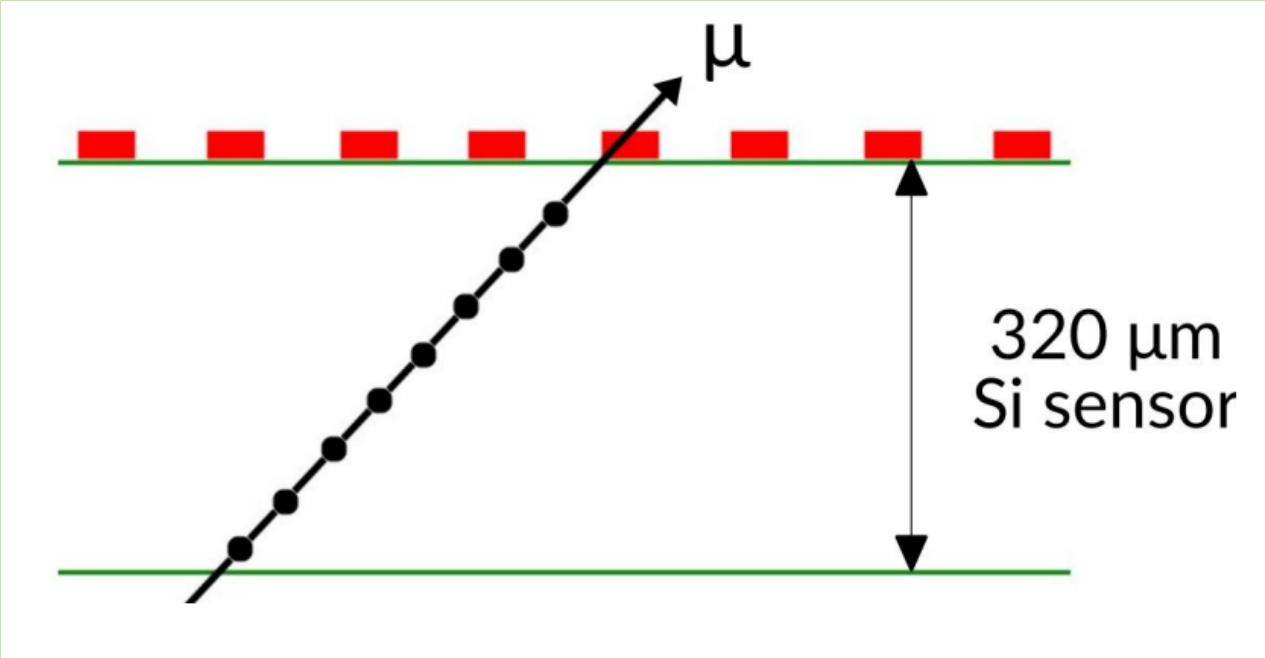
- We expect delta rays to travel in the silicon and be emitted at large angles
- Currently there is a range cut in the simulation of 9.7 MeV
  -> which means that particles that have a lower energy than this will not be generated
- This was lowered to 31.7 keV to include the low energy particles that were not being generated





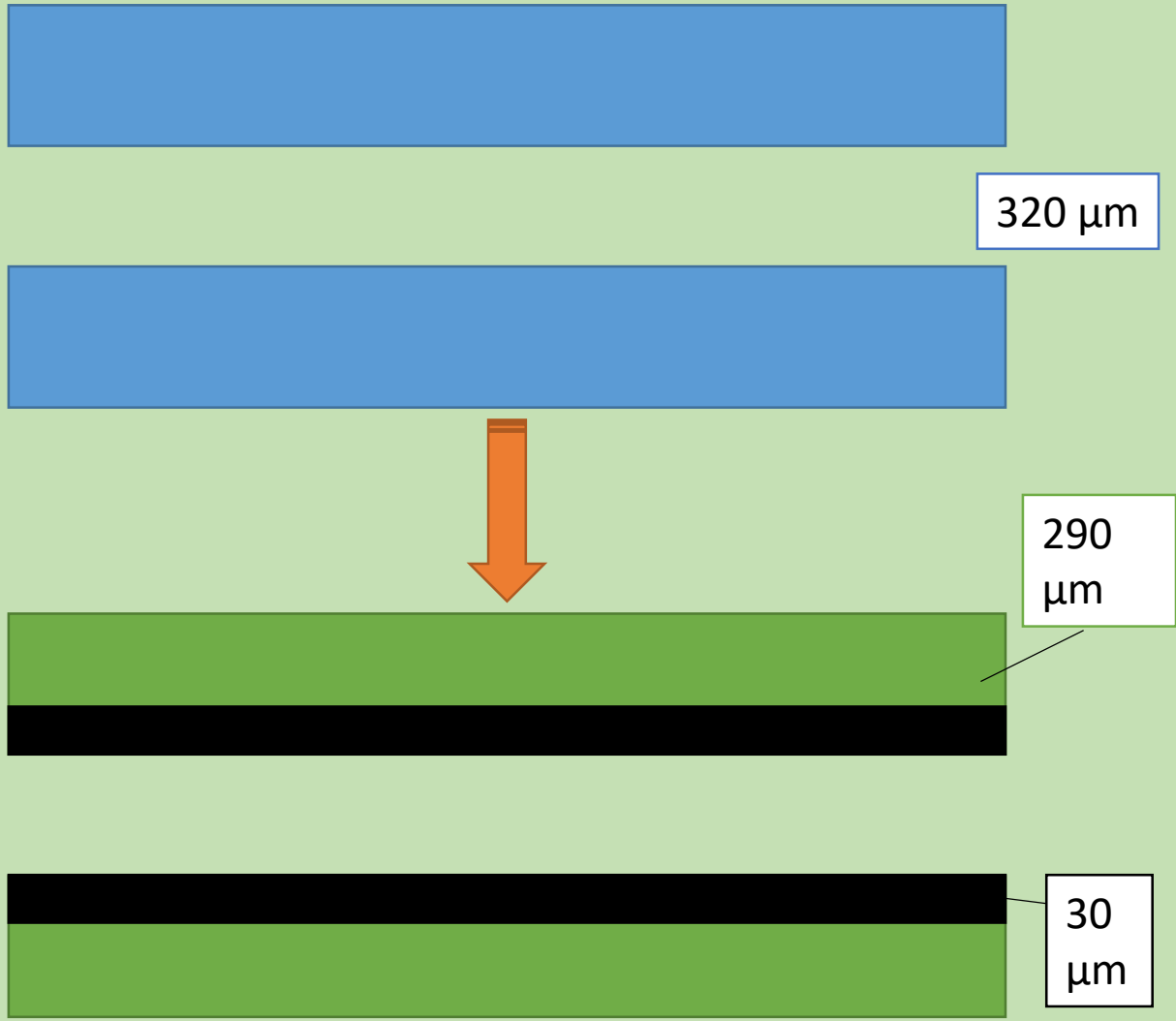
Increasing the sampling throughout the silicon

- Currently FairMUonE only saves the entering and exiting positions of the particle through the silicon and then divides evenly in the digitization
- By adding more steps throughout the silicon sensor this increases our sampling and we will be more precise with having the landau fluctuations over smaller paths



Changing the active thickness

- There was a study done by CMS where they evaluated what active thickness would be best for the phase 2 upgrade → they found the best option was 290um of active thickness and 30 um inactive.
- To implement this , the way the tracker points are saved was changed.



Adding timing effects

- Currently in FairMUonE the 2S modules are perfectly synchronised and particles are in time with the DAQ clock
- To change this two offsets were added

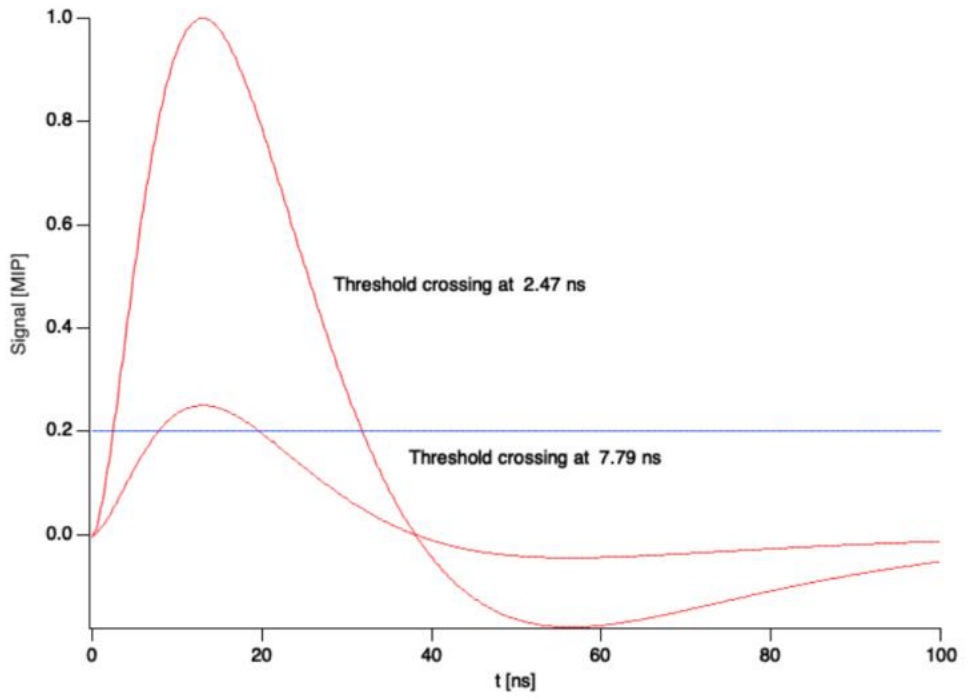
1. We expect muons to be uniformly distributed over a clock cycle, so an offset was added to every hit in an event so that a random time of arrival with respect to the DAQ clock is implemented.
2. The second offset was added to change the synchronisation of the 2S modules, the gaussian offset is applied to each module which is kept for the whole simulation.

CBC Pulse shape

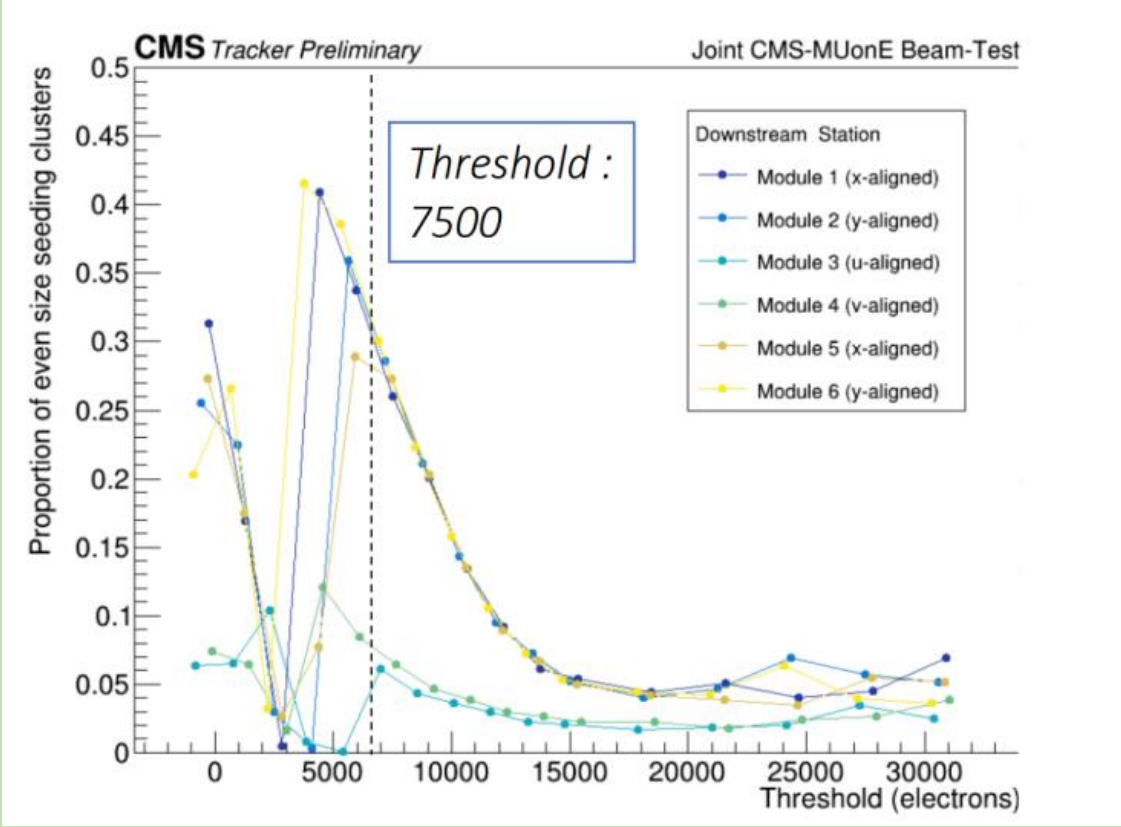
- In previous implementation we just look at if the signal is larger than the threshold
- The time when a signal is over the threshold depends on the charge of the signal

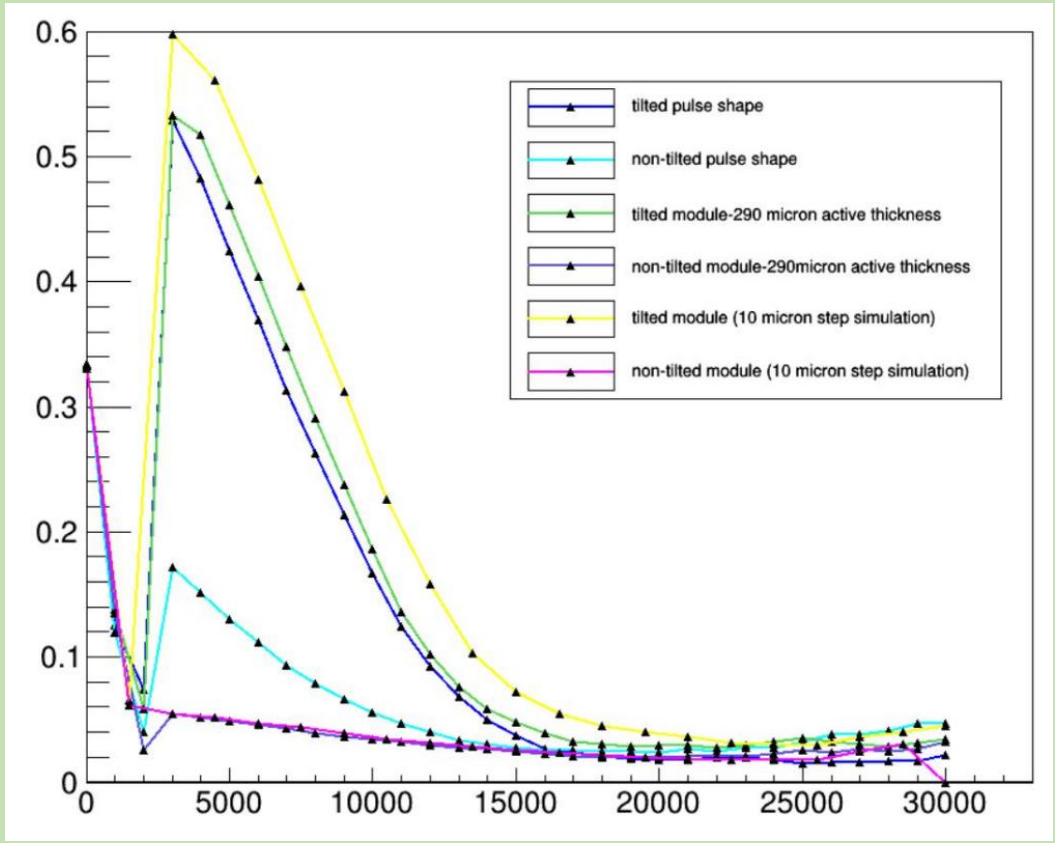
- By adding in the pulse shape function into the digitization we calculate the time it takes for a particle to surpass the stripThreshold

$$f(t) = Ae^{-at} + Be^{-bt} + Ce^{-ct} + De^{-dt}$$



Does any of this help ?





- This Simulation work is close to a point where it can be merged onto FairMUonE as to have these improvements available for others in MUonE – I will be working on finalising this in the coming weeks

Thank you for Listening !