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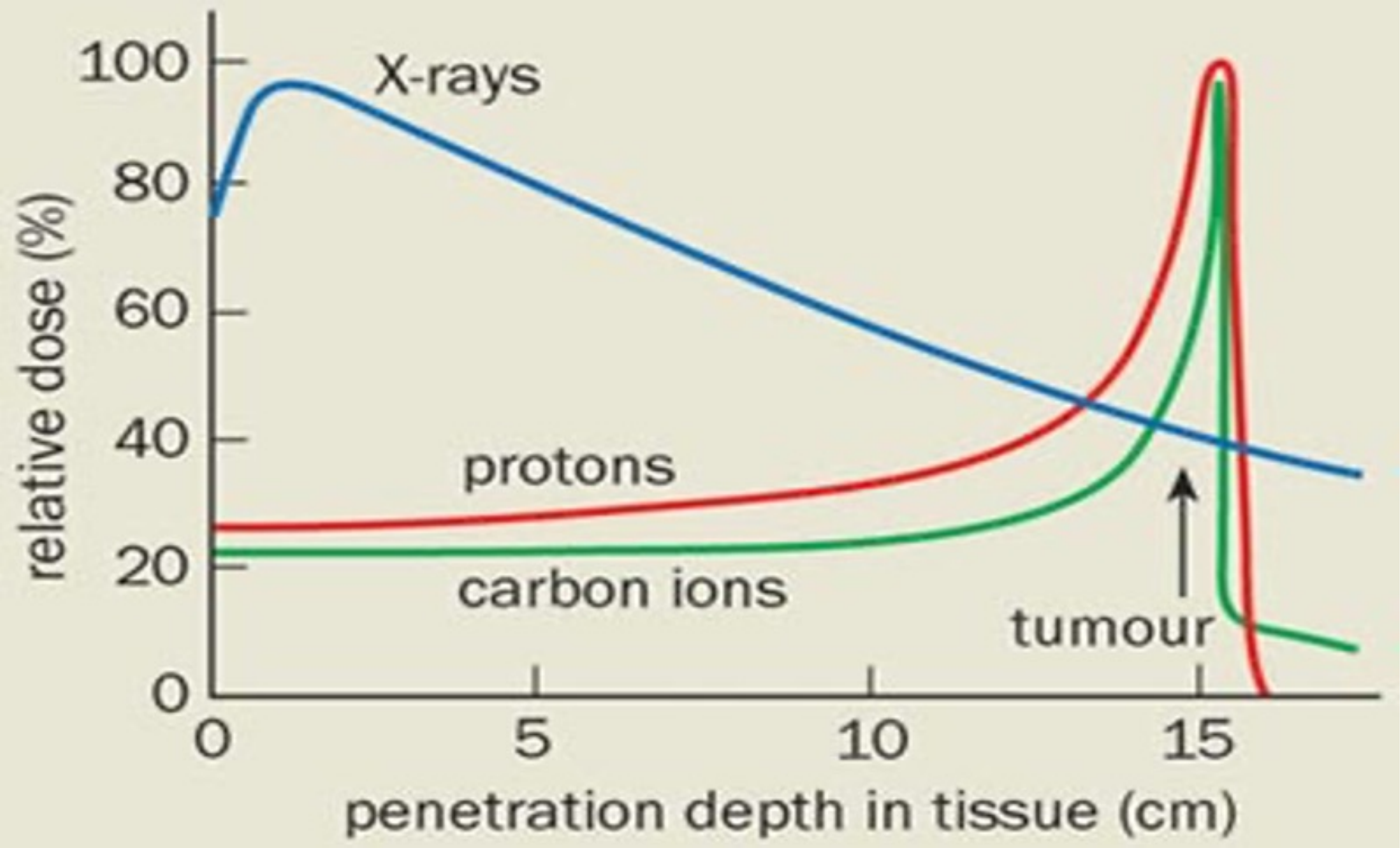
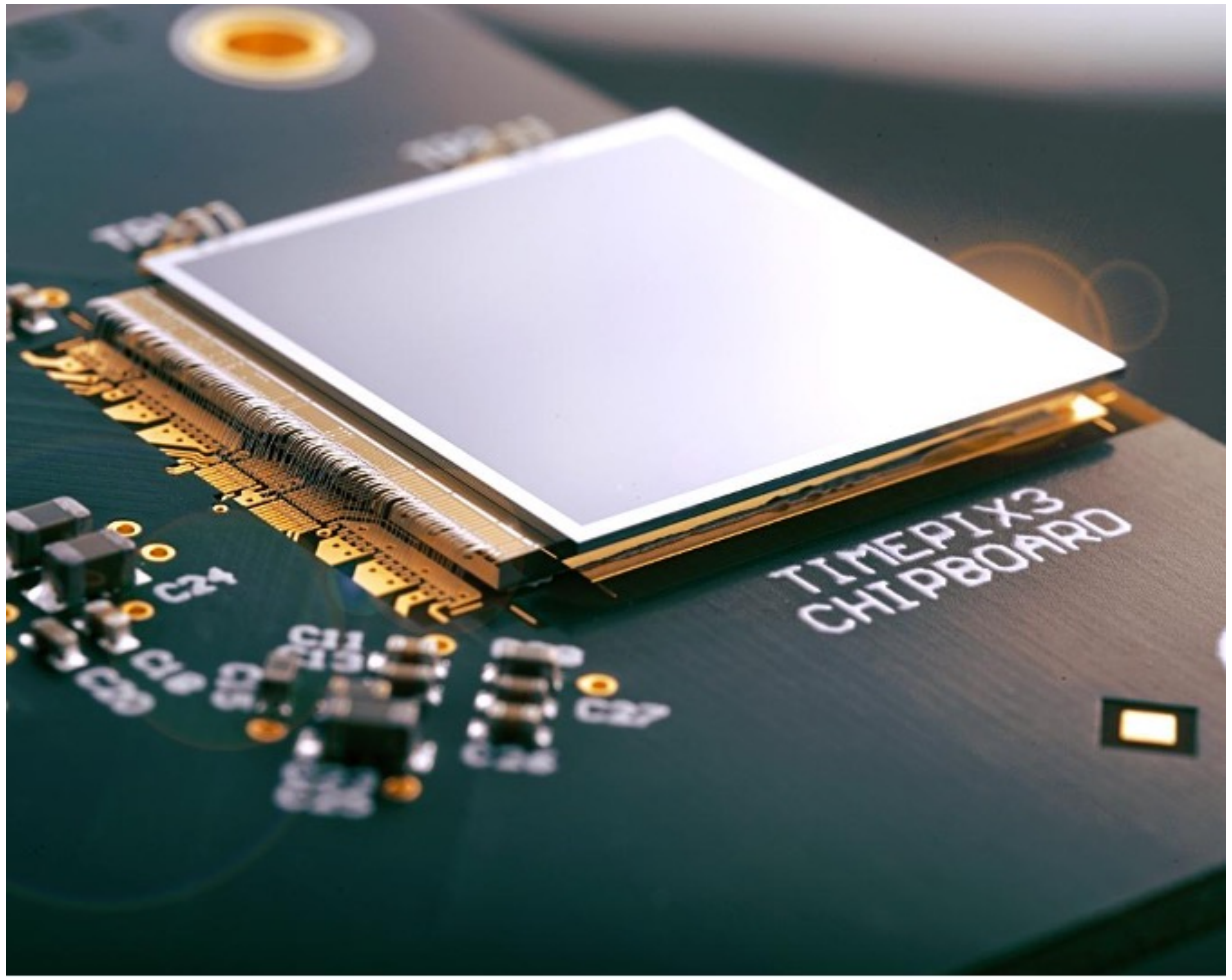
Range verification in particle therapy using silicon pixel detectors and TOPAS Monte Carlo software





Supervisors: Dr.Jonathan Taylor and Prof Gianluigi Casse

Razan Alshamrani

Hyper-Kamiokande

Naomi Foster

- Supervised by Neil McCauley and Sam Jenkins

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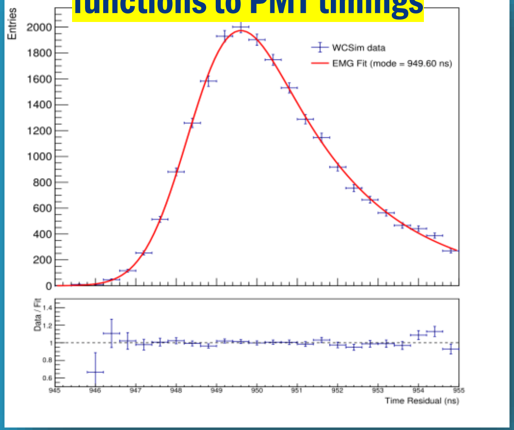
Hyper-Kamiokande (HK), under construction in Japan, is a next-generation water Cherenkov detector with a 250-kiloton volume and over 20,000 PMTs—eight times the fiducial volume of Super-Kamiokande. It will study CP violation using accelerator neutrinos from J-PARC and probe the neutrino mass hierarchy. My work focuses on developing the light injection system to monitor and calibrate, water optical properties and PMT response, and on contributing to building graph neural network-based reconstruction tool to enable faster, more accurate event reconstruction ahead of HK's 2028 start.

Fitting far too many different functions to PMT timings



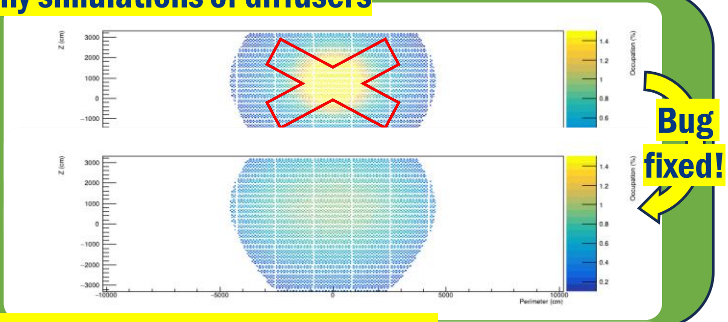
Key to calibrating against PMT timing response differences is accurately characterising the arrival time of Cherenkov photons.

An exponentially modified Gaussian (EMG) function was found to be the most robust fit across varying statistics, with the mode of the distribution serving as the characteristic arrival time.

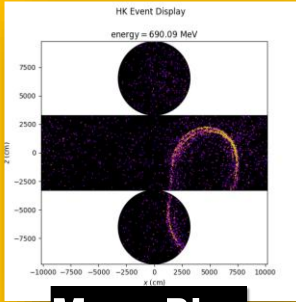
Running far too many simulations of diffusers

Light injection using the diffuser enables calibrating out timing differences of PMTs.

Accurate simulation of the diffuser profile is crucial; efforts were made to incorporate a more realistic photon distribution based on data from the actual diffusers to be used in HK.



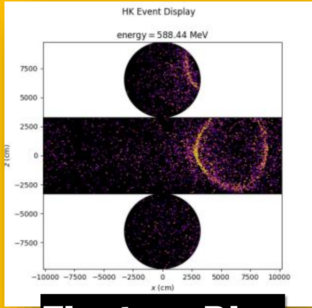
Venturing into ML based neutrino event reconstruction



Training data is generated from simulations of electron- and muon-like events to train a simple classifier using the CAVERNS GNN model.

Further work will link the effectiveness of this event reconstruction method to systematics controlled by the light injection system.

Simulating actual particles and not just laser light

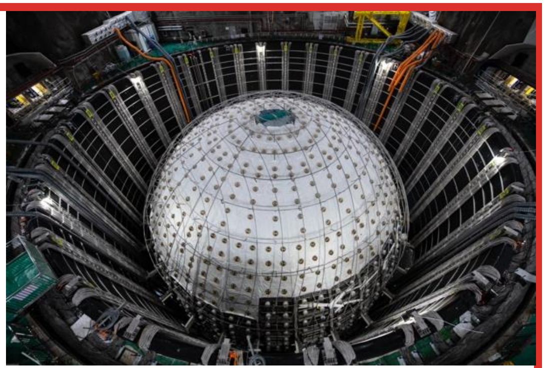


Machine Learning Algorithms for Neutrino Event Reconstruction in JUNO

Liam Jones

Supervisors: ***Prof. Costas Andreopoulos*** *& Prof. Xianguo Lu*

JUNO

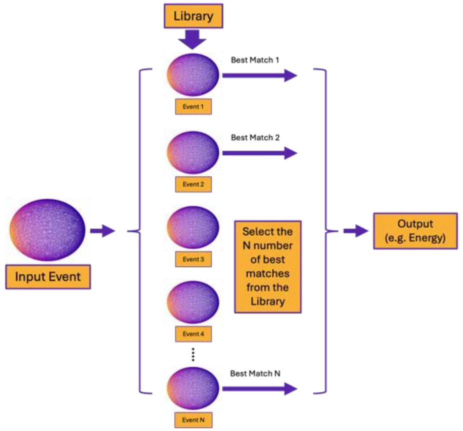


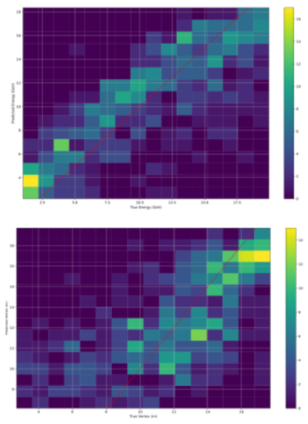
JUNO aims to resolve the Neutrino Mass Ordering (NMO) within the next **6 years of data taking.**

- JUNO detector: **20 kton** liquid scintillator — largest of its kind
- **~78%** photocathode coverage, excellent energy resolution and background rejection
- Filling cycle nearing completion, stable data taking starts in August
- Broad physics programme: reactor, atmospheric, solar, supernova, and geo-neutrinos + BSM searches
- Atmospheric neutrinos enable independent measurement of NMO & θ_{23} octant

Current Work

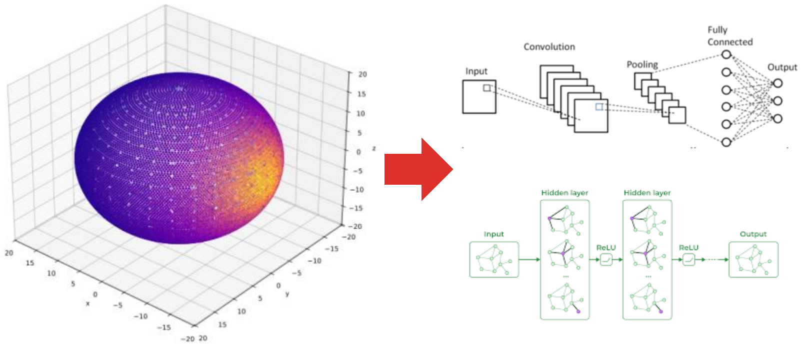
- Building a Library Event Matching Algorithm
  - Useful for classification and reconstruction as well as benchmarking other Machine Learning algorithms
- Reconstruction of Energy, Vertex and Direction of atmospheric neutrinos





Future Work

- Full classification and reconstruction chain with an emphasis on atmospheric neutrinos (GeV scale)
- Investigate and apply Deep Learning Architectures (CNN/GNN) to JUNO data
- Apply to real data taken at JUNO

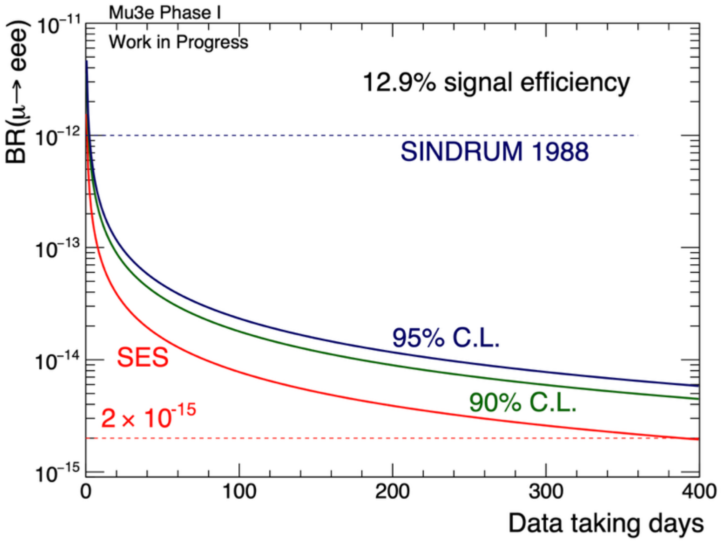


High Volume Data Processing in Real-Time Infrastructures for the Mu3e Experiment

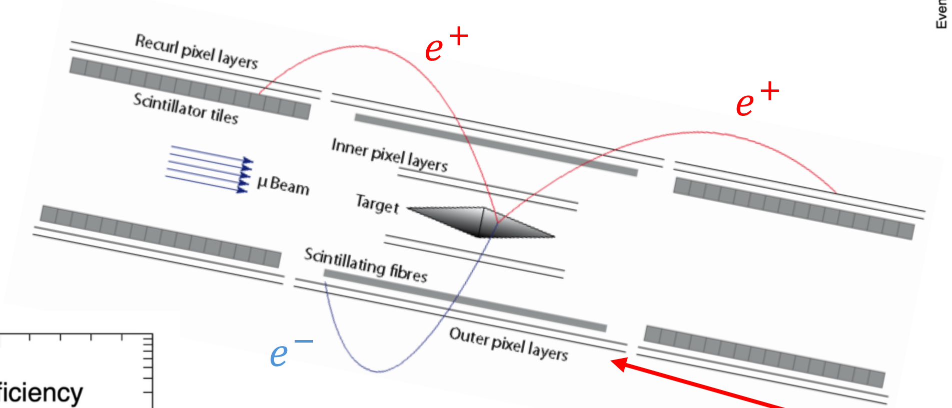
Supervised by: Dr. Nikolaos Rompotis & Prof. Joost Vossebeld

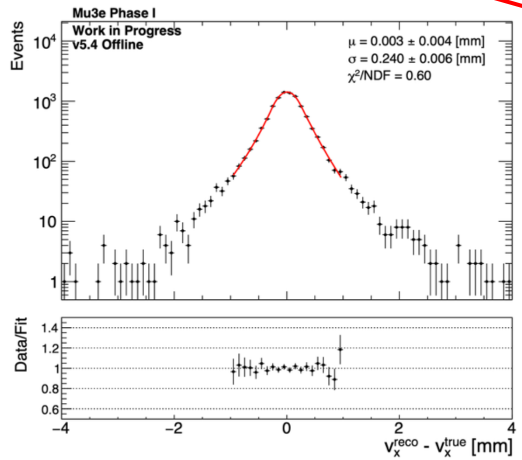
The Mu3e Experiment

- Aim to observe the **Charged Lepton Flavour Violating** decay $\mu^+ \rightarrow e^+e^+e^-$
- SM BR $\approx \mathcal{O}(10^{-54})$ – any observation of the decay is unequivocal evidence for new physics.



Excellent momentum, vertex, and timing resolution is required at Mu3e, to separate signal from background.

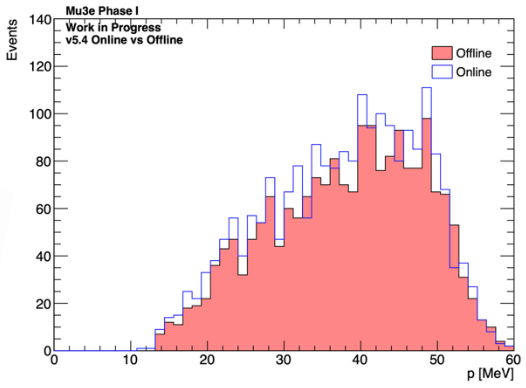


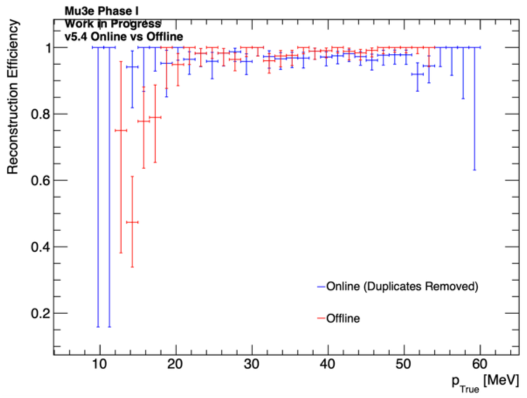


Liverpool involvement!

GPU Reconstruction

- Reconstruction of short tracks performed on a GPU at Mu3e!





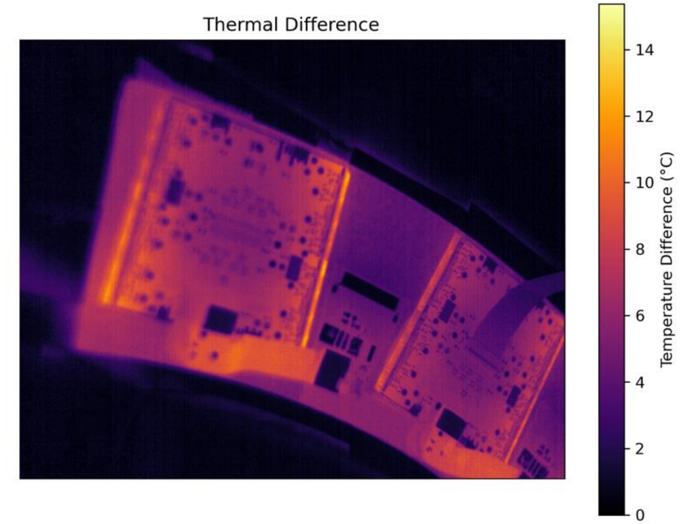
Future Work

- Analyse the Michel spectrum using a two-layer detector configuration.
- Initially with only MC studies ahead of the upcoming beam time in June/July this year!
- Continue QC tests on chips for outer pixel detectors in the lab.

Stephen Randles
Supervisors: Andy Mehta, Helen Hayward and Monica D'Onofrio

HEP 1 min presentation
22/05/25

ATLAS ITk Upgrade

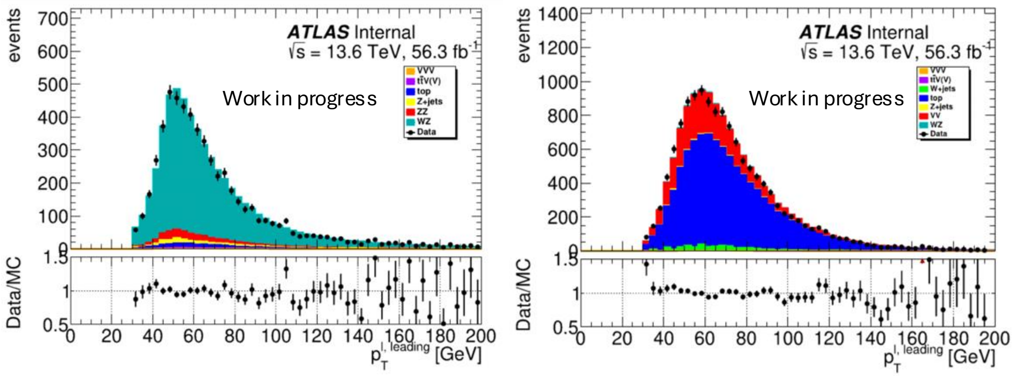


ATLAS Qualification task

Investigated thermal properties of prototype pixel modules

Working on thermal cycling a prototype Pixel Outer End Cap half-ring

ATLAS Run2+Run3 Highmass Higgs search

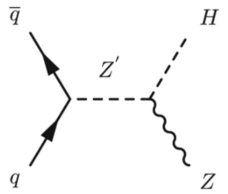


Looking for a heavy resonance decaying to two Z bosons then to $4l$ or $2l2v$

Working on Control Regions for the $2l2v$ to normalise large background processes

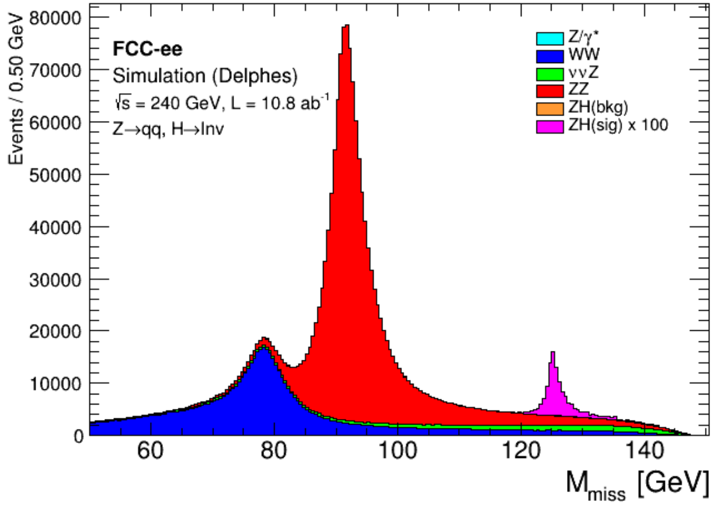
Working on fitting the control regions and signal regions for the $2l2v$

ATLAS Run3 Higgs to Invisible search



Coming soon....

FCC-ee Higgs to Invisible



Found the potential of observing invisible Higgs boson decays at FCC-ee

Higgs to dark matter can be excluded with 95% confidence if Branching fraction is greater than 0.052%

Development of Fast Timing Silicon Detectors

Archie Hanlon
Supervisors: Dr Eva Vilella-Figueras
Dr Nicola Massari, Professor Gianluigi Casse

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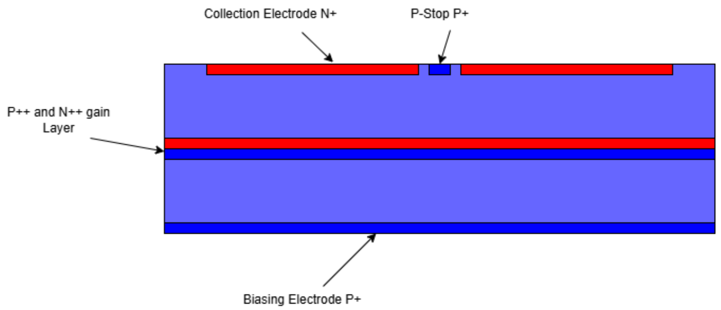
LIV.INNO

Overview

Development of a monolithic LGAD, Cactus-GL by incorporating a gain layer into existing HV-CMOS technology

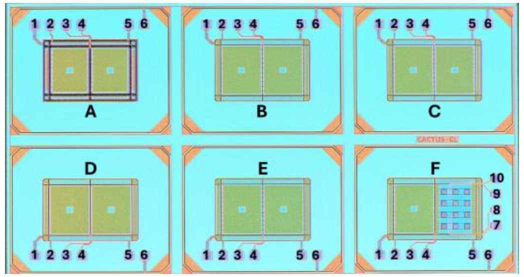


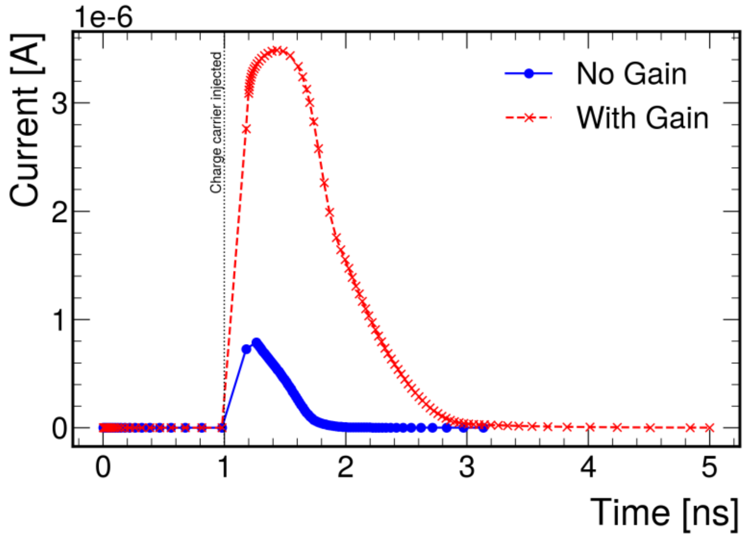
Future Work

Increase speed of TCAD simulations using machine learning methods
Investigate the effects of radiation damage on gain layer sensors

Simulation Work

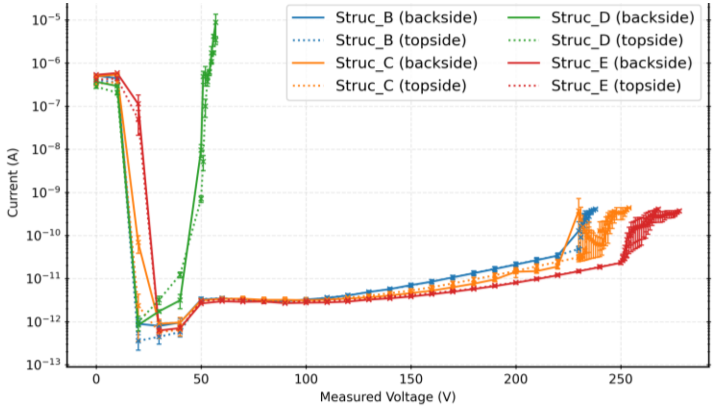
Replicated TCAD simulations used to design the Cactus-GL chip, gain layer observed to create electron avalanche and improve SNR





Chip Characterisation

Taking I-V measurements of the fabricated Cactus-GL chip. Initial confirmation of a functional gain layer, with further testing to come.



Search for LLPs with Tracks at FASER

Pawan

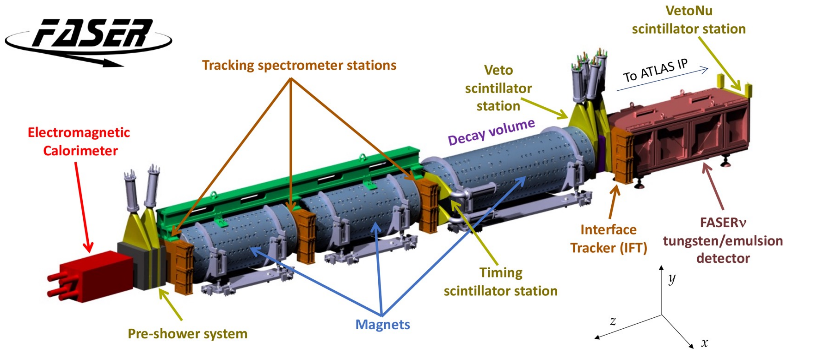
Supervisors: Prof. Carl Gwilliam, Dr. Monika Wielers, Prof. Monica D'Onofrio

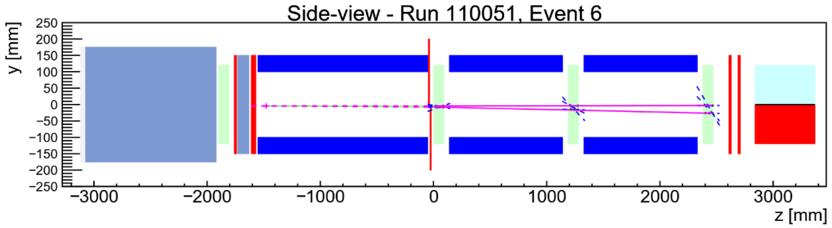
FASER Experiment

- FASER is located 480m downstream of ATLAS IP. Shielded by 100m of rock and concrete.
- Particles that make to FASER are muons, neutrinos new Long-Lived Particles (e.g. Dark Photon/Higgs).
- LLP decays can be detected at FASER by the tracking spectrometer or EM Calorimeter.

pp → LLP + X,   LLP travels ~ 480 m

LLP → ee, μμ, ππ, γγ



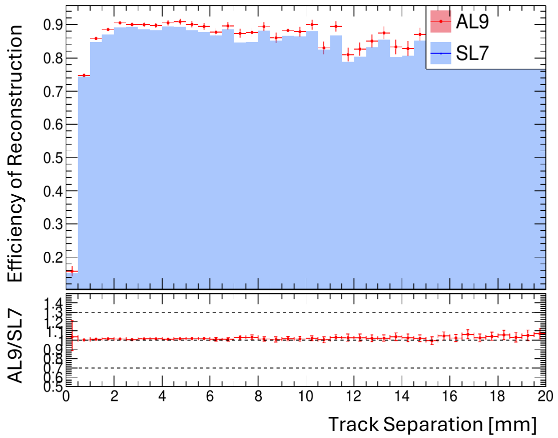


Event Display of FASER's canonical target signature of Dark Photon Decaying into a pair of electrons

Dark Photon Analysis

- World-leading constraints on Dark-Photon parameter space using 2022 data alone (27 fb^{-1})
- Data collected in 2023-2024 -- 7-fold increase in Luminosity (190 fb^{-1})
- **NEW DECAY CHANNELS UNLOCKED !**
- Sensitivity to new models – Dark Higgs, UpPhilic

Preparation for New Analyses

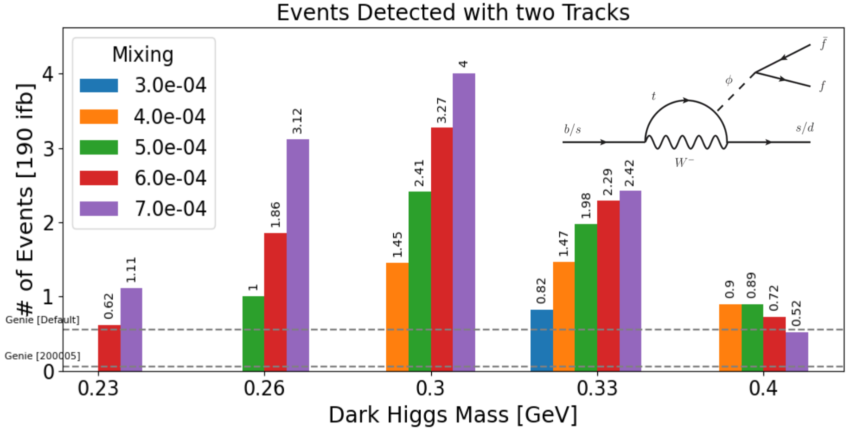


Study of Track-Reconstruction Performance with new software release

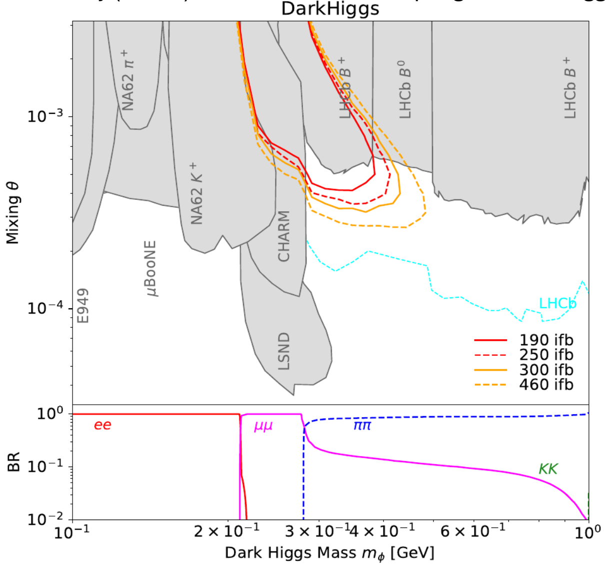
Future Work

- New analyses with μμ and ππ decay channels
- Generate New Monte-Carlo Samples for UpPhilic...
- Develop selection strategy for muonic and pionic final states – distinguish from neutrino background

Preliminary Dark Higgs Analysis



Number of Events (above) passing the Analysis Cutflow and Projected Sensitivity (below) for various mass-couplings of Dark Higgs



Data-Simulation Comparisons in Heavy-Ion Collisions

Matthew Ockleton

Supervised by: Dr. Jaime Norman & Prof. Marielle Chartier

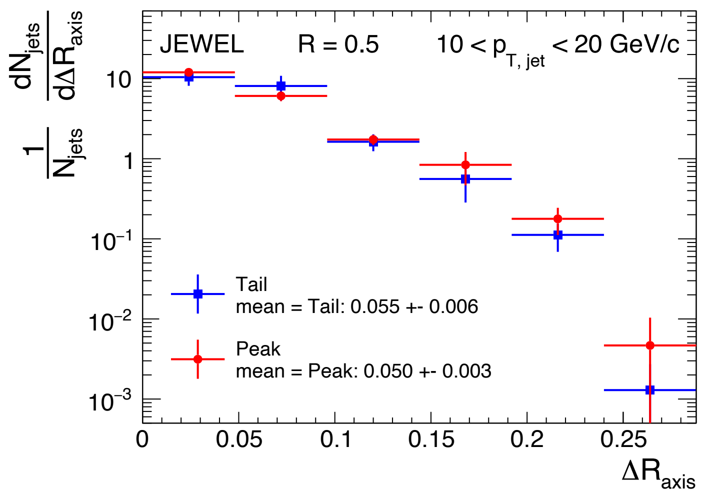
Model Studies w/ JEWEL

Background

- Simulates particle-jet modification due to QGP
- Replicates recent ALICE measurement

My work

- Finalised studies from Masters project
- Presented results to ALICE Jet Substructure working group
- Motivates Danny's work (see talk Friday)



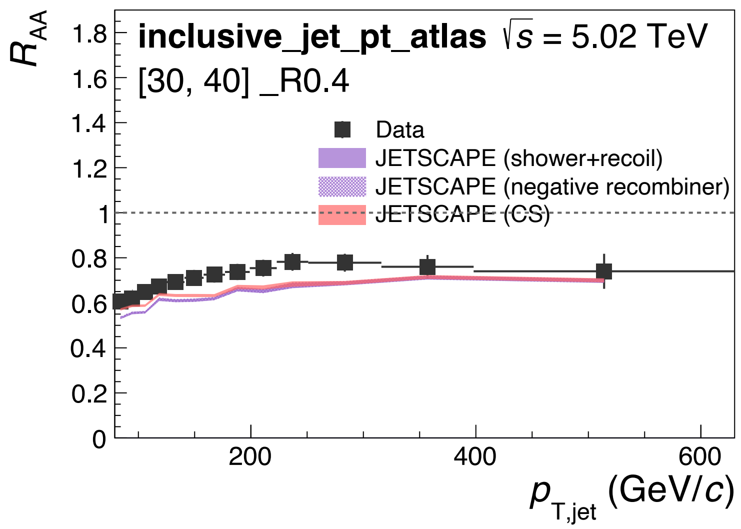
Bayesian Analyses w/ JETSCAPE

Background

- Heavy-ion collision event generator and statistical framework
- Constrains properties that aren't directly measurable via Bayesian inference

My work

- Setup framework on UK HPC system
- Developing framework to investigate 'bulk' QGP properties with jet measurements



Jet Measurements w/ ALICE

Background

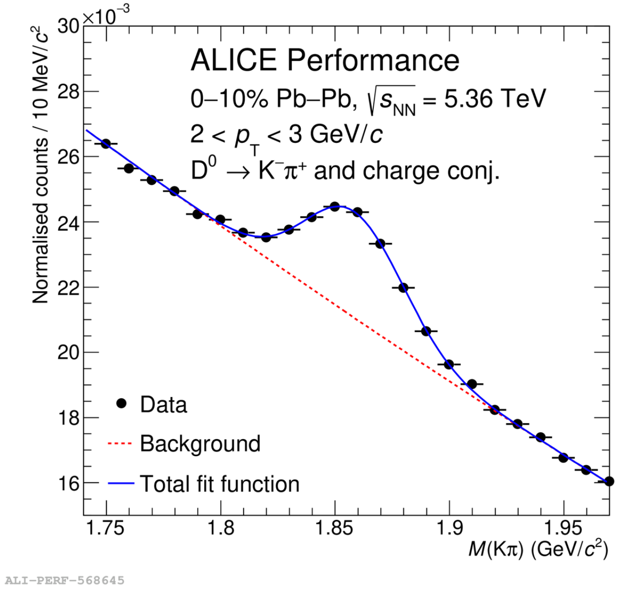
- A Large Ion Collider Experiment at CERN

My work

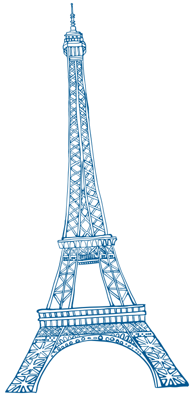
- Learning ALICE O^2 analysis framework

Future work

- Analysis task: measuring charmed jet signals using ML classification algorithms
- Service task

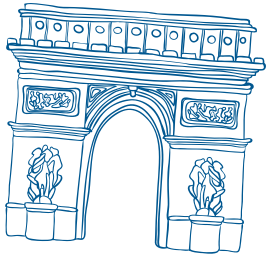


About Me



- **Mingyu Zhang(Britta), China**
- **Personality:** ENFP – Curious, energetic, people-oriented
- **Hobbies:** Travelling ✈️, exploring cultures 🌍

- **Background**
  Physics,LuDong University, China
  PhD student @ University of Liverpool (LIV.INNO CDT)
- **Project**
  Fast readout for Ultra-Dense pixel arrays
  → Developing faster, sharper silicon sensors for particle physics

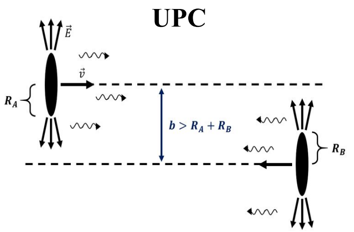


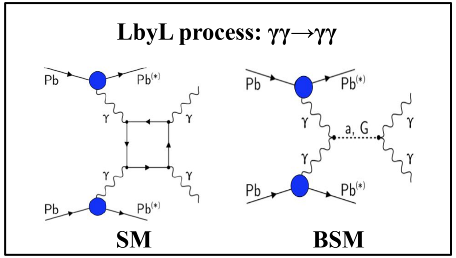
Searches for Axions in Ultra-Peripheral heavy-ion Collisions.

Name: Shirsendu Roy

Supervisors: Dr. Nikolaos Rompotis, Prof. Monica D'Onofrio

★ **Thesis Topic:** Study of light-by-light (LbyL) ultra-peripheral lead-lead collisions at the ATLAS detector, with a focus on searching for new physics, particularly axion-like particles (ALPs) and gravitons**.**

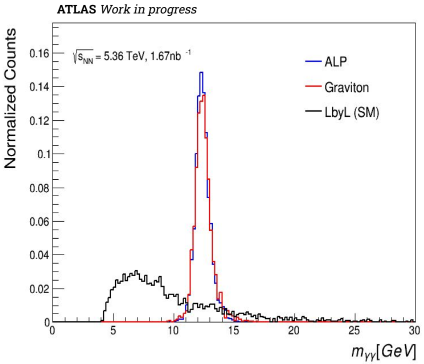


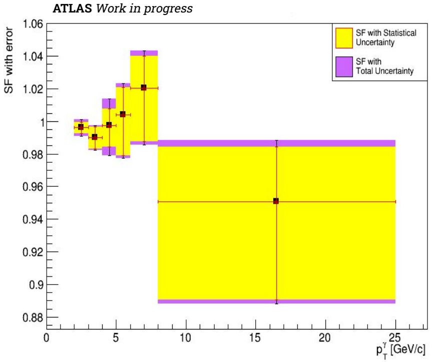


Current Work:

★ Development and validation of photon identification approaches based on Machine-Learning (ML) techniques.

★ Photon Identification efficiency corrections from data.





The parameterization is performed in two dimensions (p_T, η).

Future Work:

★ Analysis in progress: Search for ALPs and Gravitons upto 100 GeV mass in UPCs with ATLAS Run-3 data.

★ Contribution to ATLAS Inner Tracker (ITk).