MANCHESTER 1824

The University of Manchester

Research Software Engineer / Physicist position in the REALDARK project

TOBIAS FITSCHEN AND SUKANYA SINHA

PI: CATERINA DOGLIONI - UNIVERSITY OF MANCHESTER

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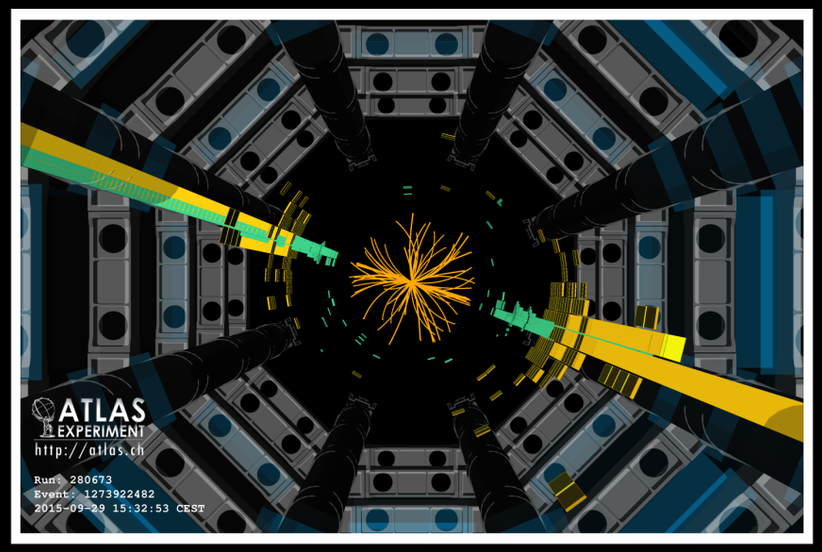
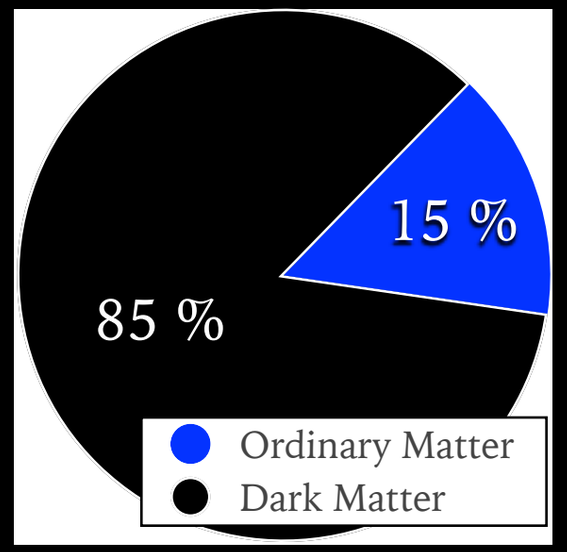
European Research Council

Established by the European Commission

Introduction to the group activities



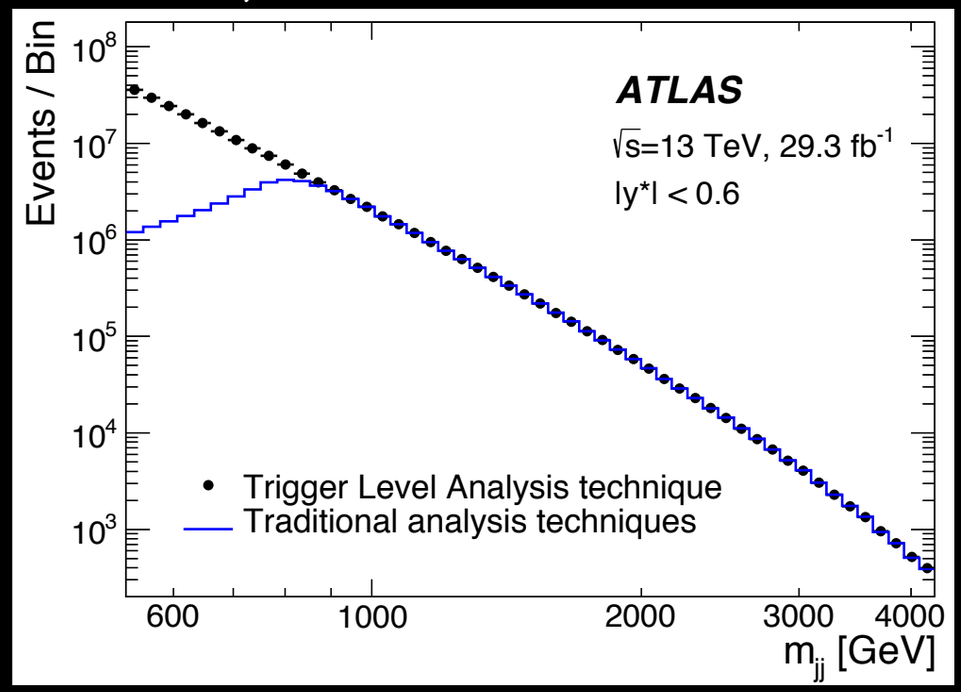


Scientific question:
dark matter

Experimental tools:
ATLAS experiment @ LHC

Specific interest:
Data selection (*trigger*)
& real-time analysis techniques,
software and machine learning

Phys. Rev. Lett. 121, 081801 (2018)



Funding: ERC Consolidator Grant
MSCA International Training Network

Job description

- **“Too much data”** problem by no means unique to LHC physics
- Data is abundant in industry, so need fast decision-making (short **time-to-insight**)
- **Solution:** real-time analysis (RTA)
  - Tools to accelerate **RTA in industry & research**: machine learning, hybrid computing architectures (GPU, FPGA)
- We would like to work with someone software-oriented to focus on:
  - **New techniques** to collect and reconstruct data (*partial event building*)
  - **Data compression** and **outlier detection** using machine learning
  - **FAIR** (https://www.go-fair.org/fair-principles/) **data** and **software** - including “**green software**” aspects

Logistics

- The position is not yet open, but can be soon - waiting for candidates to contact us at caterina.doglioni@manchester.ac.uk / tobias.fitschen@cern.ch / sukanya.sinha@cern.ch

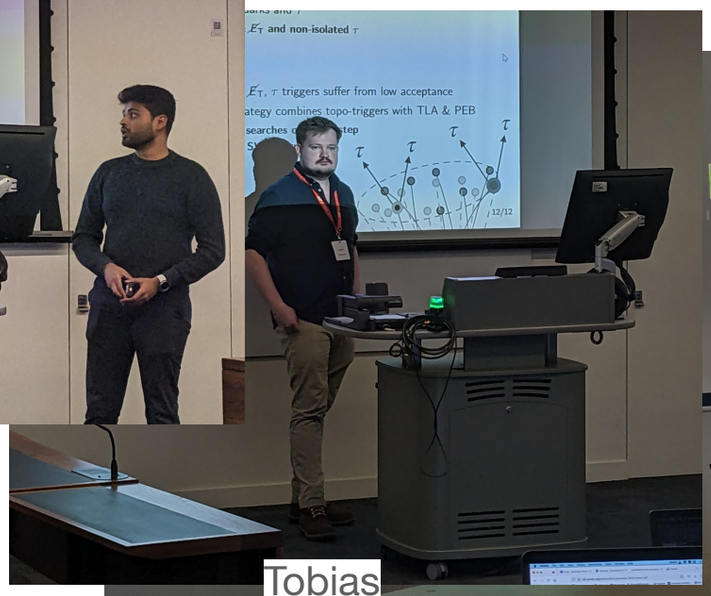
- Can start as soon as possible (after necessary bureaucracy, approx. August/Sept 2023)

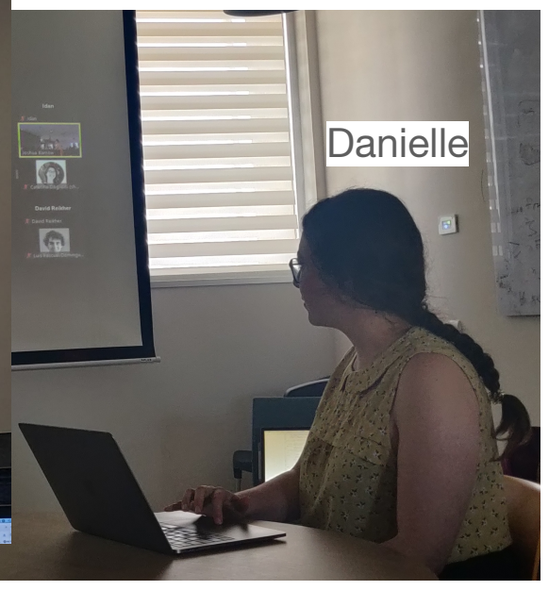
- Position will be based in Manchester, with potential trips and long-term stays at CERN

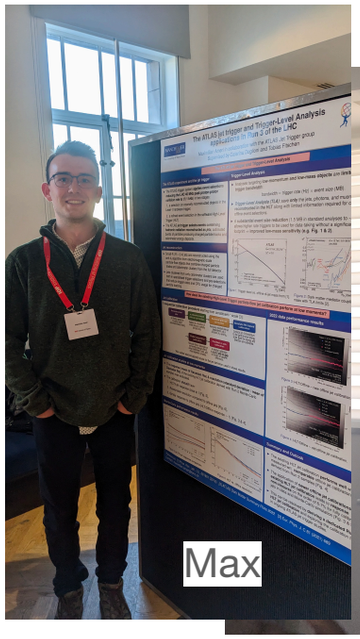
- 2 year position with possibility of renewal

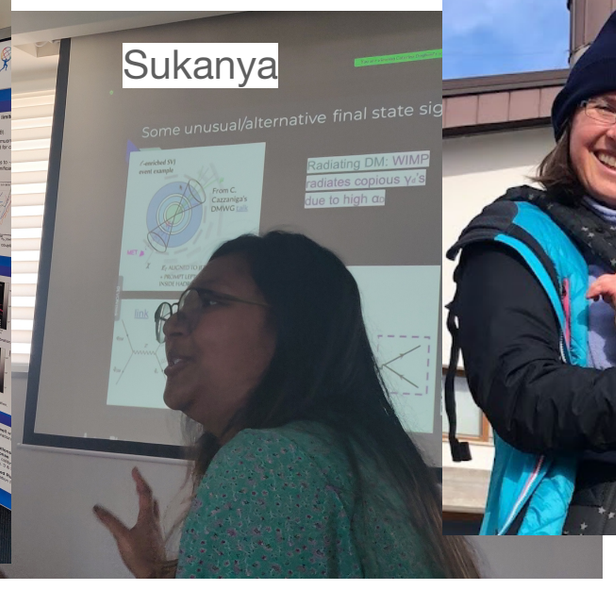
- Costs of visa and travel to Manchester covered

What is important to us









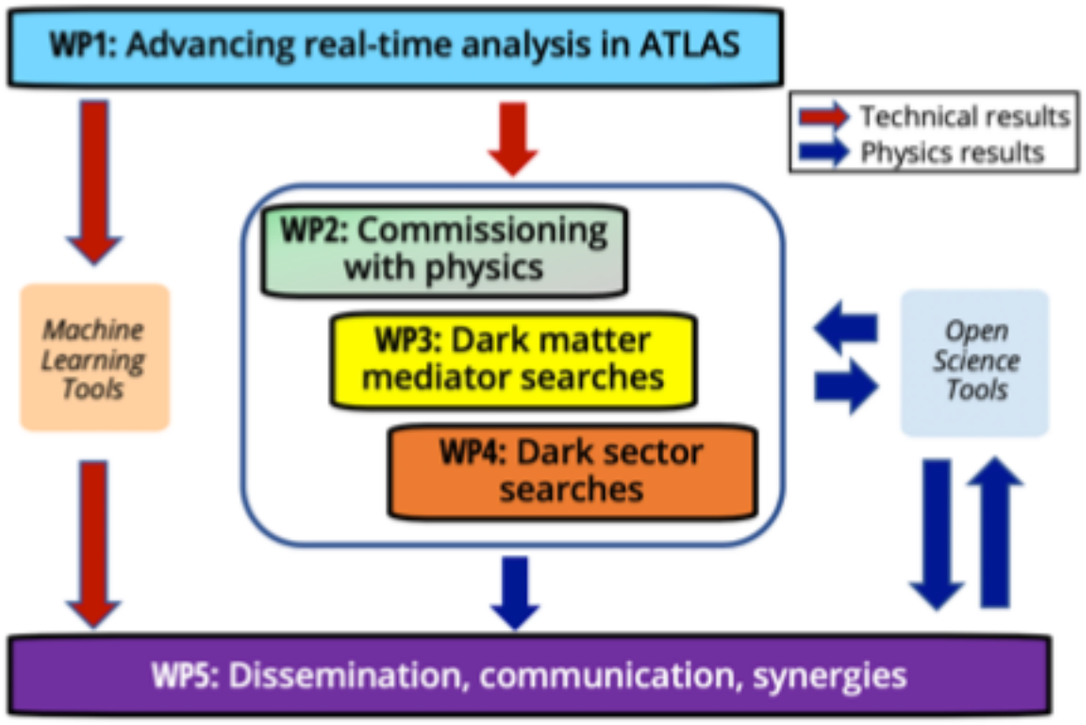
- We like working in a diverse, inclusive and respectful environment
- We are mindful of everyone's work-life balance preferences
- Mentoring and career development (within and outside academia) are very important for us
- We work in a team (including Master's students and interns)
  - Part of the (large and dynamic) Manchester particle physics group
  - Group outings and social events

Backup slides

The REALDARK Project (ERC Consolidator)

Upgrade ATLAS trigger for next LHC run with new data-taking workflows (Partial Event Building)

Make **real-time analysis** widely usable for searches and measurements in ATLAS (and at the LHC)



Further exploration of the electroweak scale @ LHC(~100 GeV)

Sustainability and reusability of LHC/DM analyses, in terms of data and pipelines

Machine learning for data compression

DM @ colliders complementarity with accelerator experiments & astrophysics

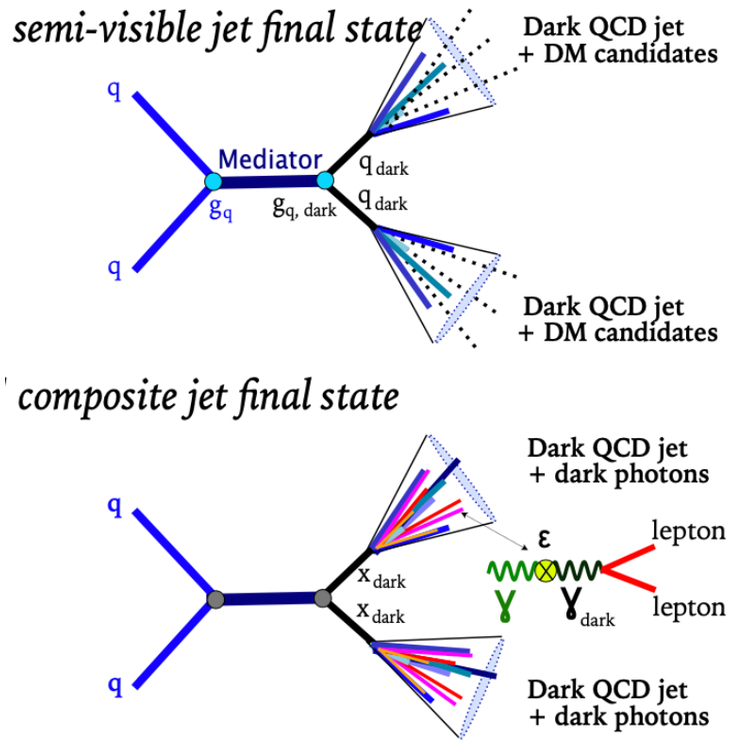
Non-WIMP dark matter searches with non-standard jet signatures

Team: Tobias Fitschen, Sukanya Sinha (postdocs), Max Amerl, Danielle Wilson (PhD)
Looking for **1 Research Software Engineer / Physicist with a strong software background**

European Research Council
Established by the European Commission

ATLAS EXPERIMENT

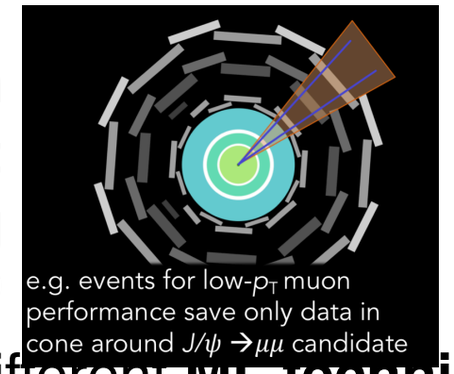
Danielle Wilson & Sukanya Sinha:
Searches for dark jets with novel data-taking techniques and ML in ATLAS



- But ***what if DM is not that simple?***
  → look into more complex dark sectors, where DM could be embedded into the jets: *dark QCD/dark showers*

H. Russell, EPS-HEP 2019,

We will need more information than "just the jets" in TLA:
partial event building
(still smaller than full event)



With this information, investigate different **ML techniques** to distinguish dark QCD/ordinary QCD based on jet content

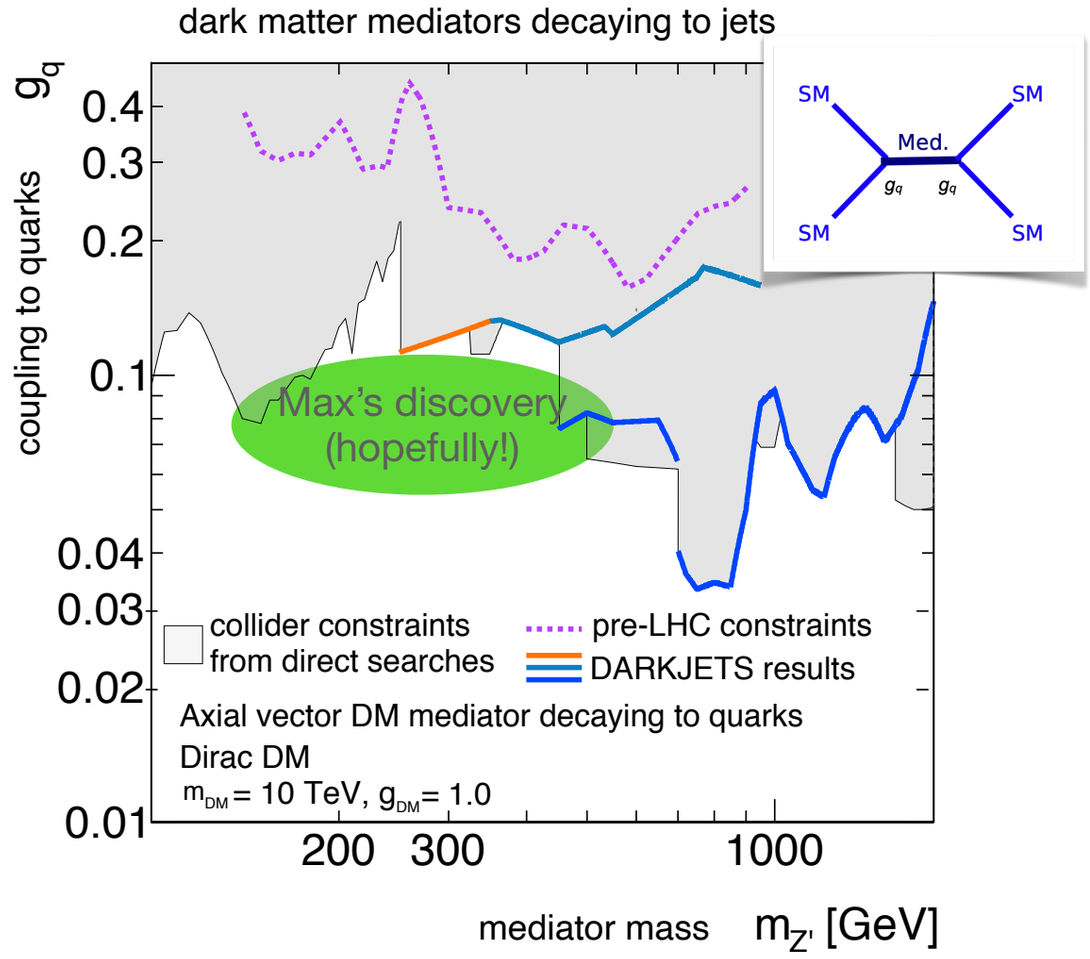
Danielle's PhD project *(co-supervisor: Mike Seymour)*:

- QT: ML-based Jet Vertex Tagger to remove pile-up
- Make use of existing measurements && input from theory to define models of *dark QCD*
- Use PEB/ML to search for *dark jets* == hadronic-like jets with DM particles

Max Amerl & Tobias Fitschen: *Searching for dark matter with real-time analysis techniques at ATLAS*

- Trigger leads ATLAS to save only *interesting* events
  (<< 1% of total events produced by LHC)
  - This works for most ATLAS physics…
  - …but not for **rare processes with large backgrounds**, e.g. DM mediators

- **Solution:** do as much analysis as possible in the trigger system, and only save **smaller** final-state objects (e.g. jets, photons)
  → **Trigger Level Analysis (TLA)**



Max's PhD project *(co-supervisors: Darren Price (currently doing masterclasses))*:

- Commission Run-3 jet trigger and Trigger Level Analysis stream with early data
- Search for dark matter mediators with the TLA technique in unexplored regions
- Share ATLAS searches data, results, and tools with the entire community searching for DM

Pratik Jawahar: *accelerated anomaly detection* in the SMARTHEP European Training Network

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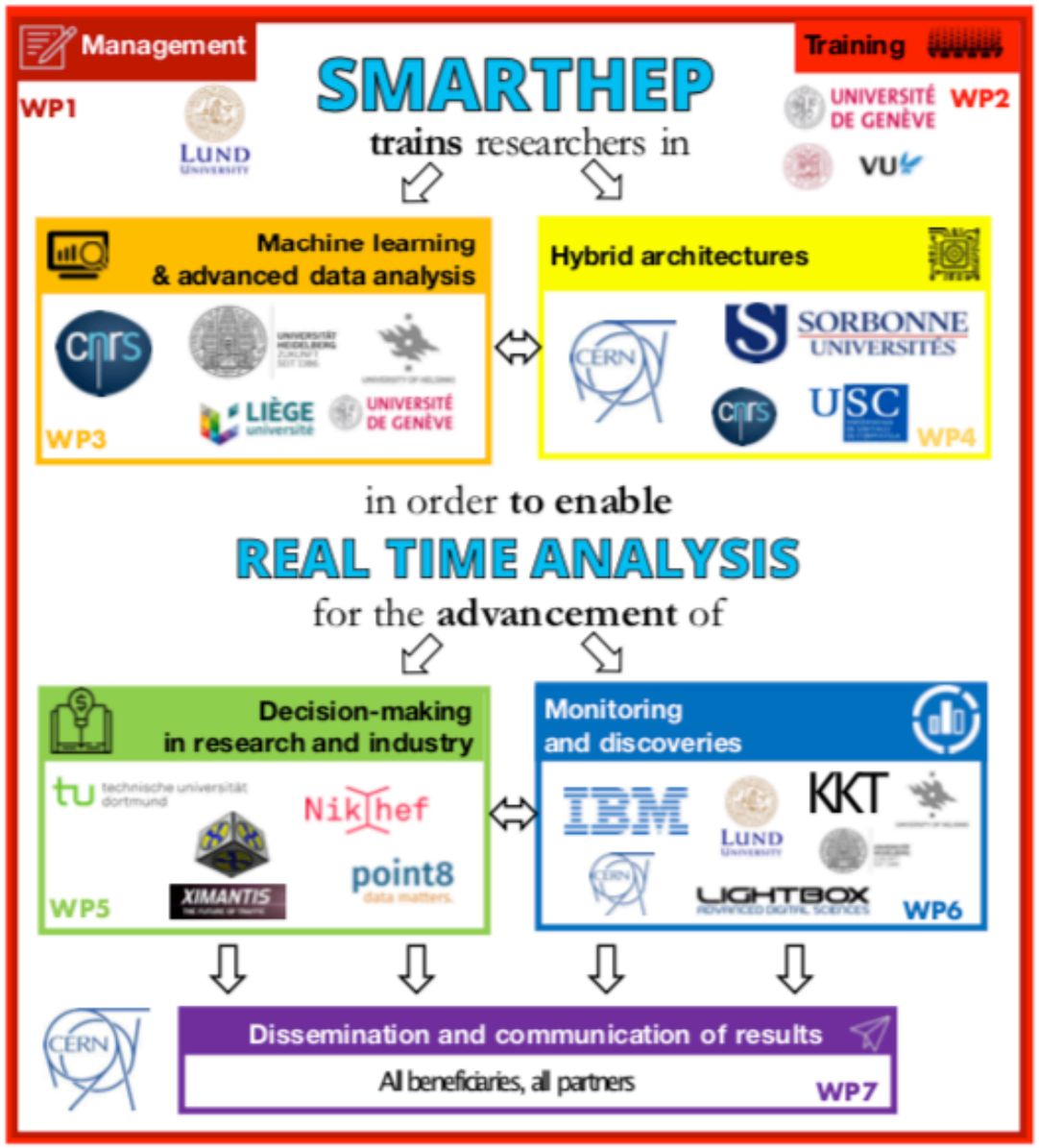
Pratik's PhD project *(co-supervisors: Alex Oh, Jiri Masik)*:

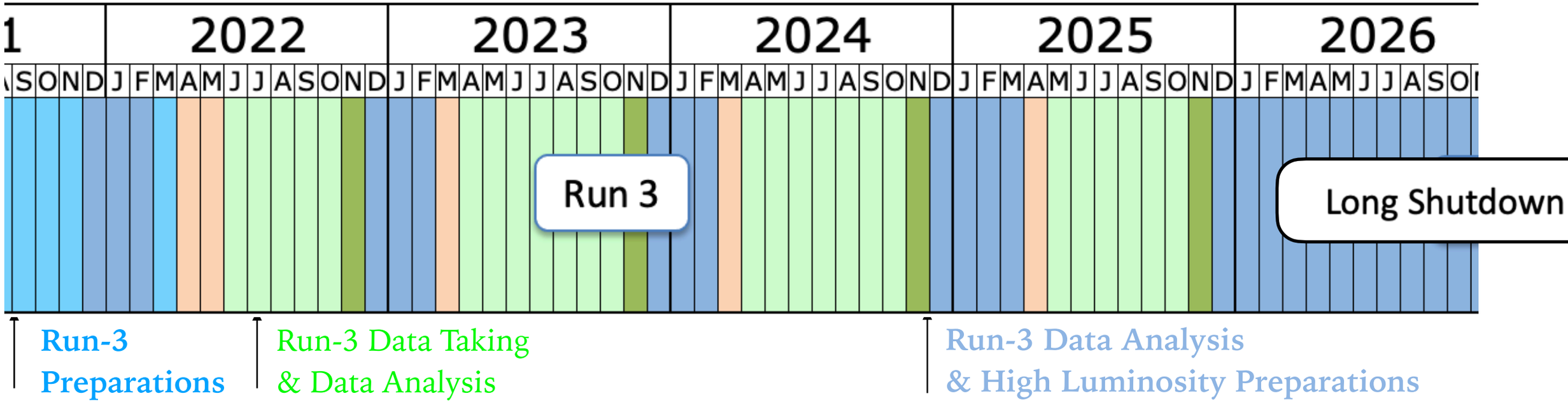
- Commission Run-3 tracking trigger algorithms
- Employ machine learning solutions, especially unsupervised learning (anomaly detection), for new physics discoveries in dark sectors
- Use accelerators (GPU/FPGA) for particle tracking at the HL-LHC

SMARTHEP trains
12 (+N) **PhD students**
20 participants: industries, labs and academic institutions



Timelines

LHC Schedule for the next 5 years



SMARTHEP (2021-2025)

REALDARK (2021-2026)

New team & network with expertise in real-time analysis + industry connections

ATLAS-Manchester expertise and leadership in trigger & data acquisition, connections to dark matter experiments (FASER, DarkSide)

High Luminosity LHC and Future Colliders