

# SMARTHEP

REAL-TIME ANALYSIS FOR  
SCIENCE AND INDUSTRY

## Introduction to kick-off meeting

University of Manchester,  
21-25/11/22

**Caterina Doglioni (coordinator)**  
**Jonathan Masterson (interim PM)**



SMARTHEP is funded by the European Union's Horizon 2020 research and innovation programme, call H2020-MSCA-ITN-2020, under Grant Agreement n. 956086

# SMARTHEP intro

(a reminder,  
and some more details  
especially for the ESRs)



# Basic idea

Traditional data analysis is **asynchronous**:

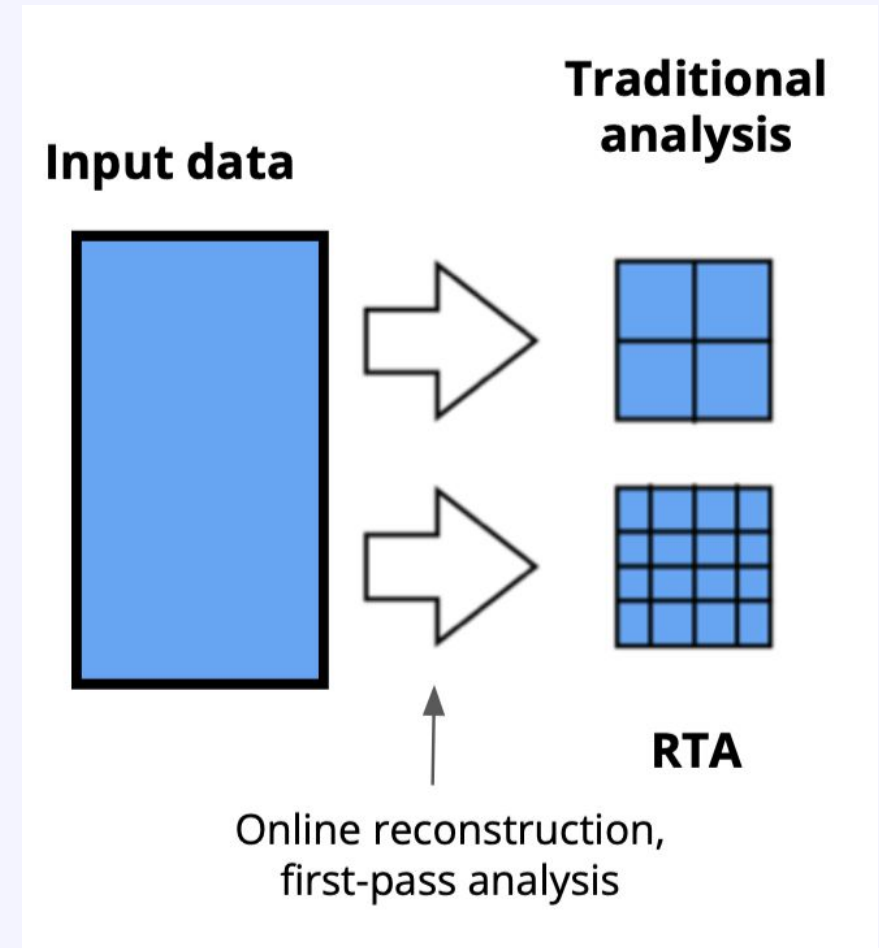
*First record and store data,  
then reconstruct/analyze it*



**Real-time** data analysis

*Analyse data as soon as it is collected*

- only store (smaller) final-state information
- reduce time-to-insight
- accelerate decision making



*only store (smaller) final-state information:  
useful for saving more data in LHC experiments*

# Where SMARTHEP comes from

All four main **LHC experiments** all use **RTA** techniques

**ALICE:** [online reconstruction \(O2\)](#) **ATLAS:** [Trigger Level Analysis](#)  
**CMS:** [Data Scouting](#) **LHCb:** [Turbo stream](#)

+ the *trigger* system is a real-time decision making system

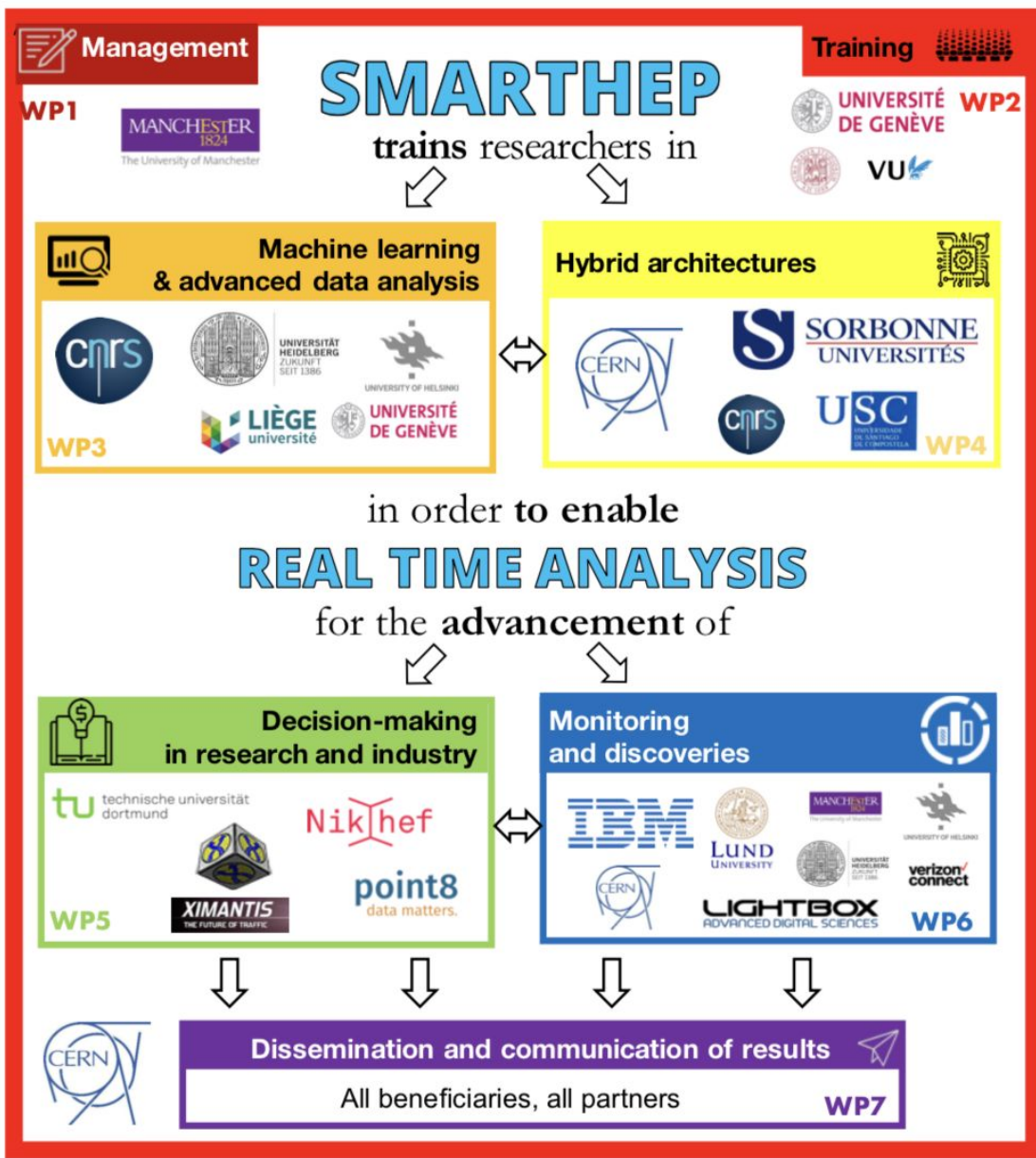
**“Too much data”** & **“need to analyse data asap”** problems  
**not unique** to particle physics

+ use cases in financial transactions, fleet & traffic management, predictive maintenance...



Given these common needs,  
how do we **collaborate** to advance RTA at the LHC and beyond?





## Synergies between LHC & industry:

- Different use cases
  - Different dataset size/ complexity  
→ Collaborate on **common tools**:
- 1. Machine learning (Work Package 1)**  
→ enables fast and efficient inference
  - 2. Hybrid computing architectures (WP3)**  
→ accelerate RTA w/ FPGA, GPU, multithreading
- Concrete outcomes in **decision-making (WP4)**, **monitoring and discoveries (WP5)**



# Sample physics outcomes

- Calibration of ALICE TPC for heavy-ion physics
- Improvements & optimization of the trigger system for Run-3 and High-Luminosity LHC
- Data analysis with real-time analysis workflows, e.g.
  - Lepton flavour violation analyses
  - New physics searches

*More in ESR talks  
this afternoon!*



# Sample industry outcomes

- Algorithms for real-time traffic prediction (Ximantis)

- Real-time analysis of videos and sensor data collected by dashcams (camera on vehicle)

- Running fast analysis in embedded system

*More in ESR talks  
this afternoon!*

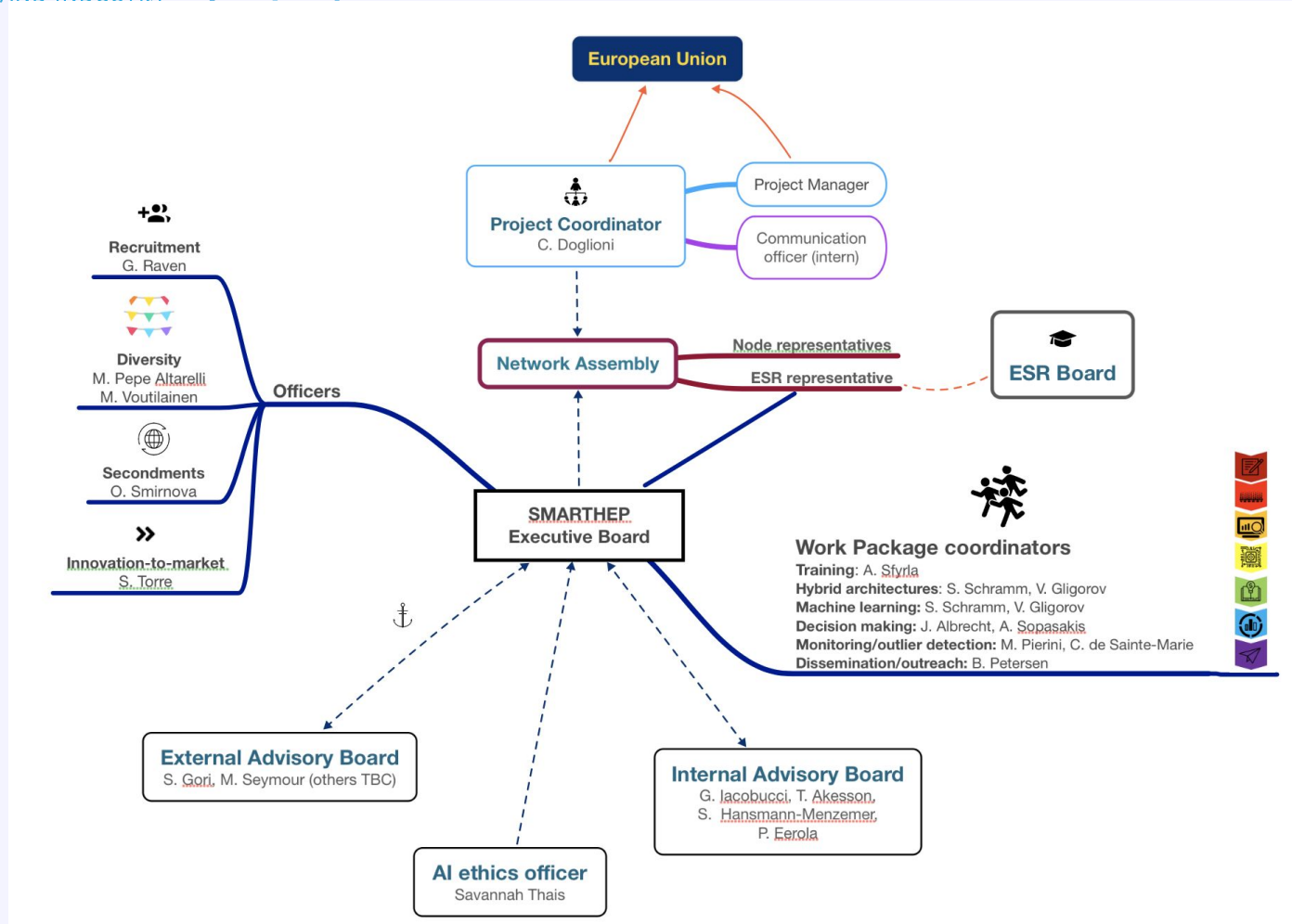
- Automating decision-making for fraud detection

*Q: My industry / secondment topic has changed since the original description...is this an issue?*

*A: This is expected - as long as it trains you and produces outputs of topics within the network it will be OK!*



## Who is who



### Project officers:

Experts who can advise the network and the ESRs on specific topics (including ethics)

### Work package coordinators:

SMARTHEP supervisors who follow and coordinate the work of each of the topics in the network (work packages also for management, training and dissemination)

### Network assembly:

Decision-making/voting body, includes ESR representation

### Executive board:

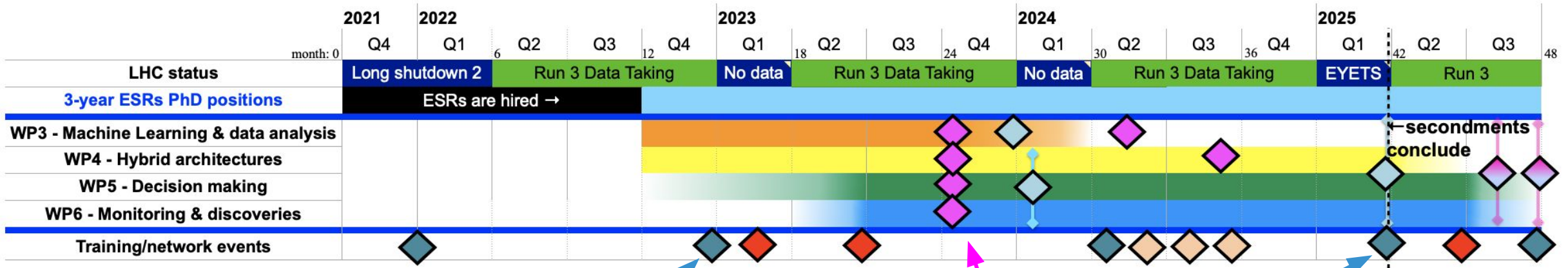
Unless otherwise specified, EB has open meetings for anyone who wants to help with running the network



## Longer-term plan

### SMARTHEP Activity Plan

- ◆ Main research milestones
- ◆ Main commercial milestones
- ◆ Network-organized schools (all ESR)
- ◆ Network-organized schools (ESR choose 1)
- ◆ Network events and conferences



[Virtual kick-off meeting](#)

[This kick-off meeting](#)

Mid-term check with the EU Project Officer

[UniGe ML + Physics school](#)

Advanced ML school (TBC)

Whitepapers on state-of-the art (discussion on Wednesday + writing course)  
[further research/commercial milestones: collections of papers and algorithms from individual projects]

Yearly network meetings

Accelerator boot-camps

Commercial applications school



# Open and FAIR data

Findable, Accessible, Interoperable, and Reusable digital assets.

**With SMARTHEP, we intend to be part of the effort to improve data *FAIR-ness* and *reproducibility & sustainability* of software**

Tomorrow morning: Data Management Plan (EU-funded project obligation)

- LHC: following the CERN Open Data policy
- Individual discussions for industry beneficiaries and partners

Software discussion ongoing in high energy physics, especially **within the HEP software Foundation** (talk by B. Hegner on Wednesday afternoon)

# Communication & dissemination opportunities for different audiences

[we can brainstorm together!]

## Research community (papers and conferences)

- Whitepapers
- Individual results

Q: should we submit an “intro to SMARTHEP” abstract to CHEP 2023?

## General public

- (micro-)Blogs from the ESRs (we can start this week)
- From next year, discuss specific activities for Masterclasses / World Wide Web day / data challenges

## Policy-makers

At the end of the network, possibility (w/o obligation) to write a “best practices” paper

Coordinator’s thought: it would be nice to participate in national/EU discussions on sustainable goals

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## Should we tweet?

If you’re interested and have an account, we have a distributed TweetDeck profile for SMARTHEP



## We can also try other options!

*Plan to advertise a position for a communication officer (intern at UofM) to help out with this*



# This week

- Monday:
  - Afternoon/evening:
    - ESR presentations
    - Social dinner
- Tuesday
  - Morning:
    - In parallel: data management plan & ethics discussions, then ESR self-assembly
    - Network Assembly
  - Afternoon:
    - Networking event with other real-time analysis projects
    - Brief introduction to ML and ethics, Code of Conduct
- Wednesday
  - Morning:
    - Visit to Jodrell Bank
  - Afternoon:
    - Outreach event for final-year undergraduates
    - HEP Software Foundation talk
    - Preparation for whitepapers writing course
- Thursday
  - Scriptoria course geared towards whitepapers
- Friday
  - Closing words & departure






# Next January, at CERN/UniGe

- **9-13/1/2023**


- **Monday morning:** CERN visit, ethics in ML lecture (TBC)
- **Monday 14:00 - Tuesday 13:00:** mid-term check with EU Project Officer - ESRs must be present in-person at this event
- **Tuesday afternoon - Friday 15:00:** UniGe ML&Physics school
- Mid-term check with the Project Officer [[agenda](#)]
  - Coordinator will introduce the network and plans
  - ESRs will give a short (but more formal) < 10' presentation on their project
    - Project Officer asked us to remark here if significant differences from original plan
- UniGe ML school [[agenda](#)]
  - Particle physics (theory: T. Sjöstrand, experiment: A. Sfyrla) + ML with hands-on component (M. Pierini, S. Schramm)
  - Seminars (+ apero) on multimessenger astronomy & CERN experimental programme





**SMARTHEP**  
REAL-TIME ANALYSIS FOR  
SCIENCE AND INDUSTRY

First Network School on  
**Collider Physics** and  
**Machine Learning**

10-13 January 2023  
University of Geneva  
[https://indico.cern.ch/e/SMARTHEP\\_SchoolOne](https://indico.cern.ch/e/SMARTHEP_SchoolOne)



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# Logistics

Jonathan Masterson  
(interim PM)



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# Monday social dinner

Reservation for 8 pm at the [Indian Tiffin Room](#), 2 Isabella Banks Street, First Street, Manchester, M15 4RL



For those who want to socialize at a nearby pub and then walk to the venue, we will leave after the end of the presentations today & be found at Grand Central Manchester (80 Oxford Road) until 19:40.

For those who want to stop by the Hyatt, Tiffin Room is about 15' away (see google maps for most direct route)



# Wednesday social event

Visit to Jodrell Bank where Lowell Telescope and SKA Organization headquarters are located (includes lunch)

A coach will pick us up outside the Schuster building at 9 am at the bus stop behind the Alan Turing building [will put coordinates on agenda] and bring us back there by 14

