This project has received funding from the European Union’s Horizon 2020 Research and Innovation programme under GA No 101004730.

Task 10.6: Machine Learning Techniques for Accelerator and Target Diagnostics

I.FAST kickoff meeting, 2021-05-04

Thomas Shea, European Spallation Source ERIC

iFAST

Overview

Mission: Develop **low-latency** Machine Learning (ML) techniques to improve performance and availability of high-power facilities at the intensity frontier.

Beneficiaries

- ESS
- RTU

Additional participants

- CosyLab – via subcontract from ESS
- SNS/ORNL – collaboration

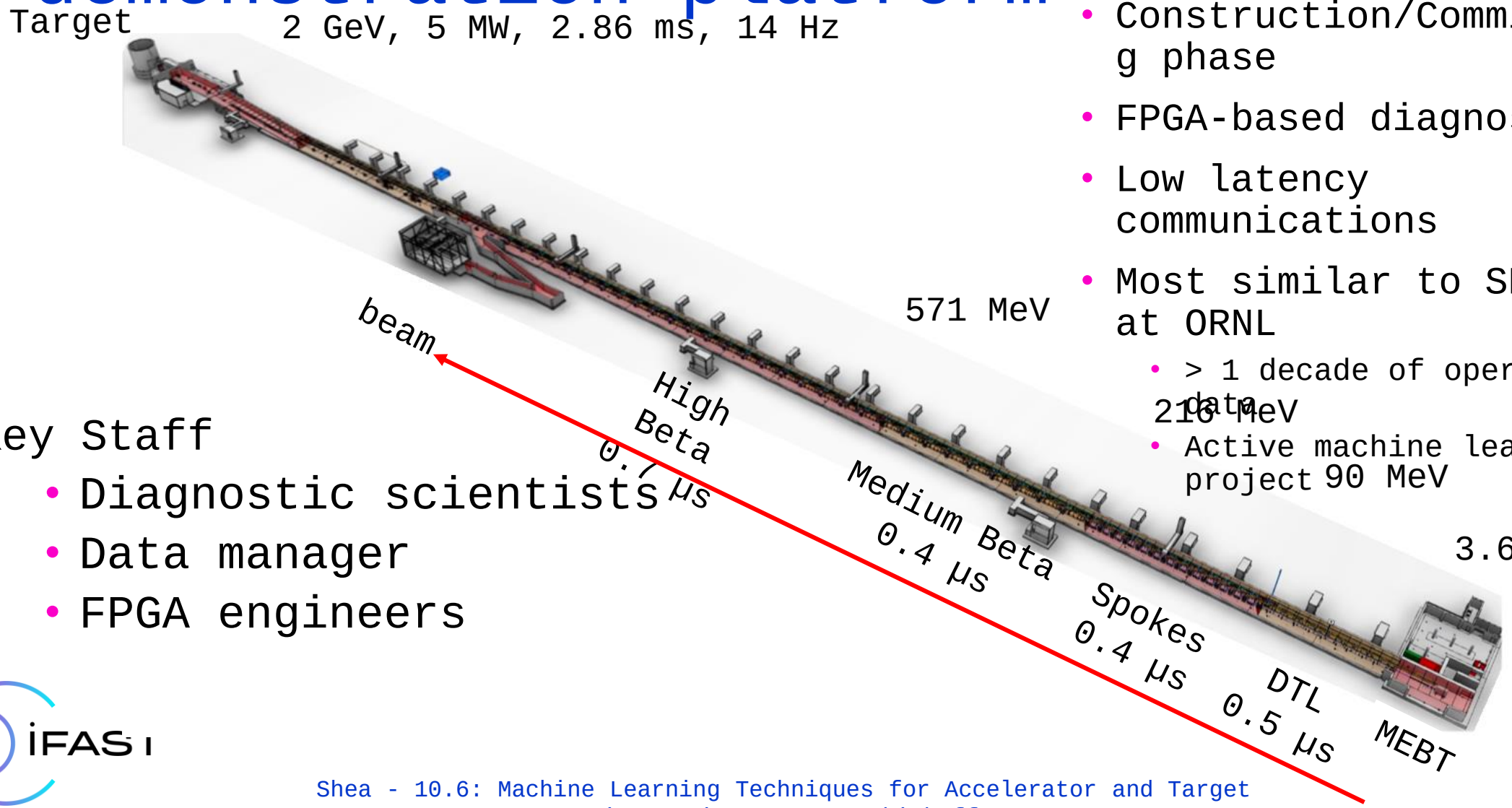
Part 1

- *Duration: 18 months*
- Milestone: MS48 ML model selection and implementation plan; Report due month 18

Part 2

- *Duration: 18 months*
- Deliverable: D10.5 Technical Report on machine learning at ESS – Evaluation and verification results, architecture of the final implementation, and achieved performance at the ESS facility; due month 34

ESS as participant and demonstration platform



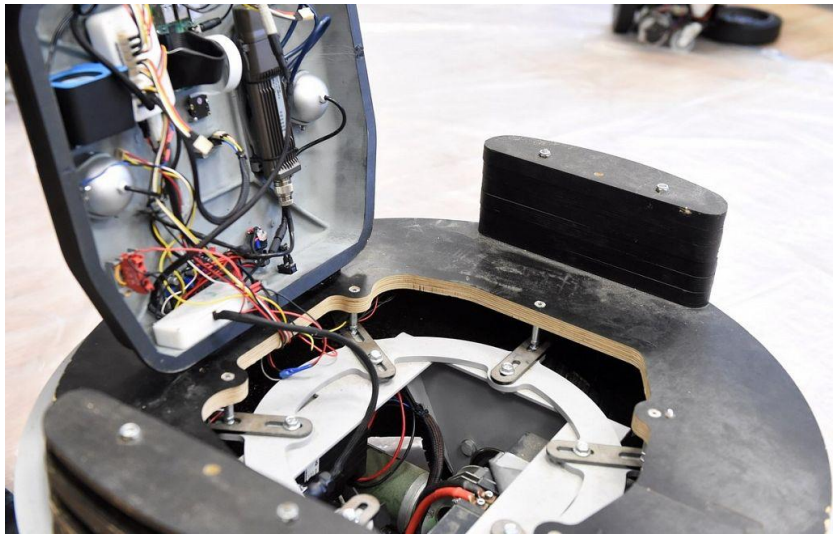
- Construction/Commissioning phase
- FPGA-based diagnostics
- Low latency communications
- Most similar to SNS linac at ORNL
  - > 1 decade of operational data
  - Active machine learning project

Key Staff

- Diagnostic scientists
- Data manager
- FPGA engineers

RTU as participant

- Support programming and implementation of the system
- Faculty of Computer Science and Information Technology will directly contribute with its expertise in AI, ML and FPGA
- It is planned that RTU will contribute with one full-time master level student, who will be made available for work at ESS – co-financed by I.FAST
- RTU will ensure supervision of the student at senior-researcher / professor level – bearing the costs



Strength in ML, low latency applications

Part 1. The Data

Example SNS data record (beam current difference)

Record named SCL_Diag:DCM01:MPS_Meta

Dictionary

keys	Value	Description
name	String	PV name
tags	string	['Before-N+4', 'Before' 'During', 'After', 'After+1']
timestamp	datetime	python time
parameters	dictionary	

key	Value	Description
TS1	I32	SNS time in sec
TS2	I32	SNS time in ns
ID	I32	Cycle Id
Trig	U8	Trigger
Size	I32	#samples
dt	DBL	later version only
SumCh0	DBL	Sum of Ch0 (charge)
SumCh1	DBL	Sum of Ch1 (charge)
SumDif	DBL	difference (charge)
Alarm	I32	alarm
bWidth	I32	number of turns
rPeriod	DBL	Ring Period in sec

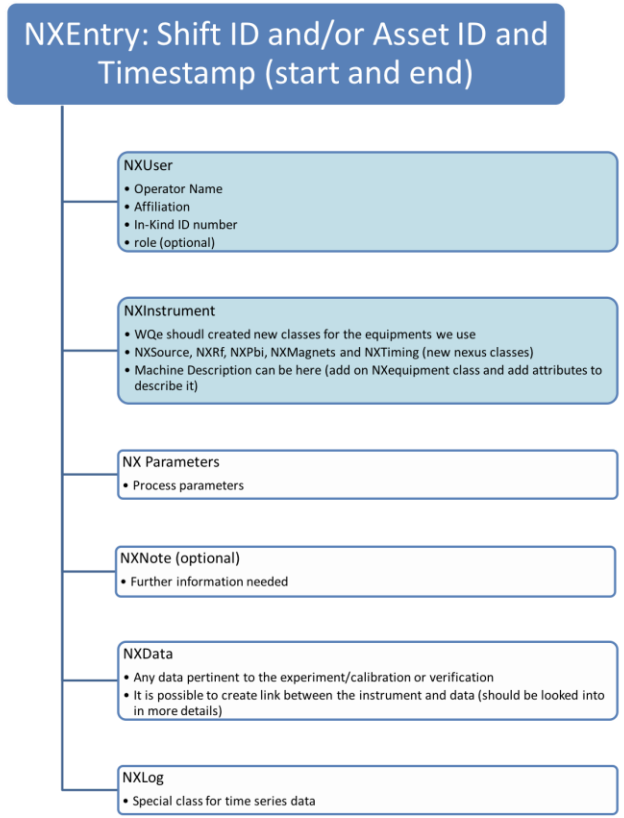
Develop Data Exchange Standard base on NeXus*

Assess the predictive capabilities of several ML algorithms trained and evaluated with:

- operation data from SNS (USA, 13 years of operations data)
- commissioning data from the ESS
- simulation results

*https://www.nexusformat.org

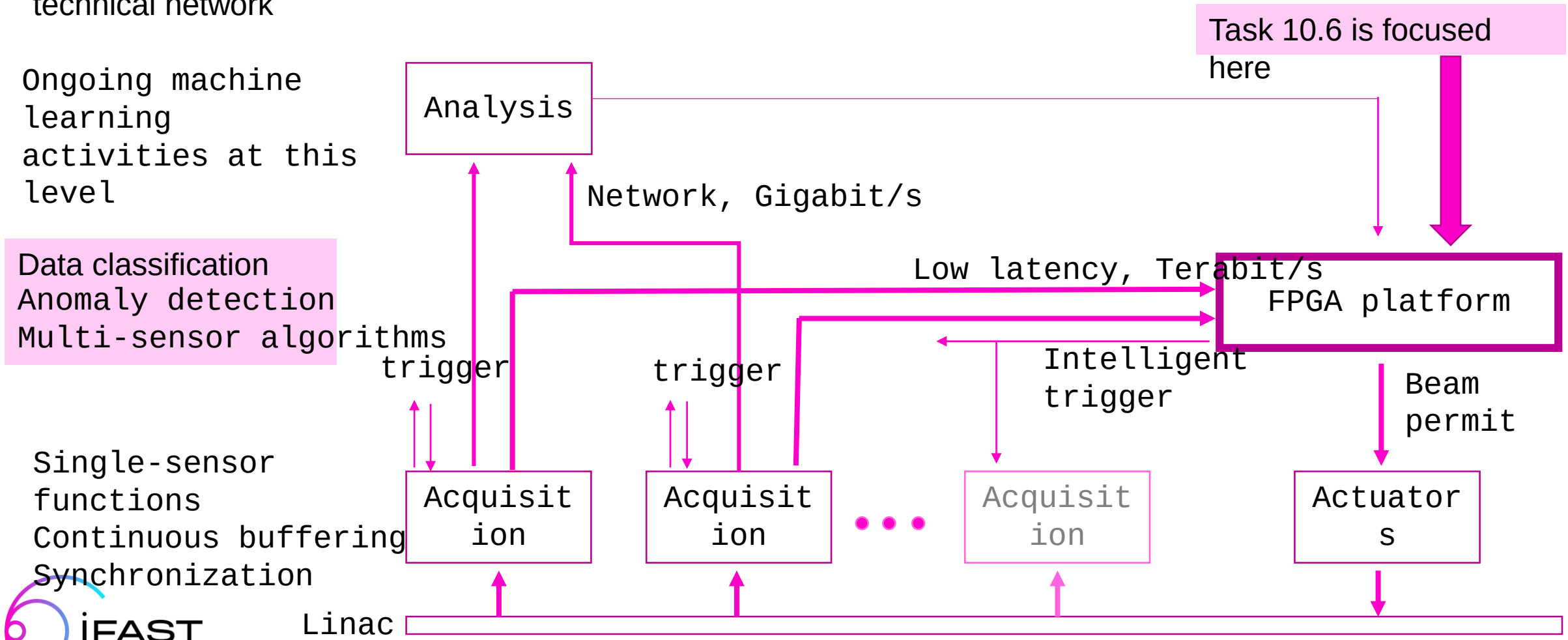
NeXus data format (ESS diagnosti

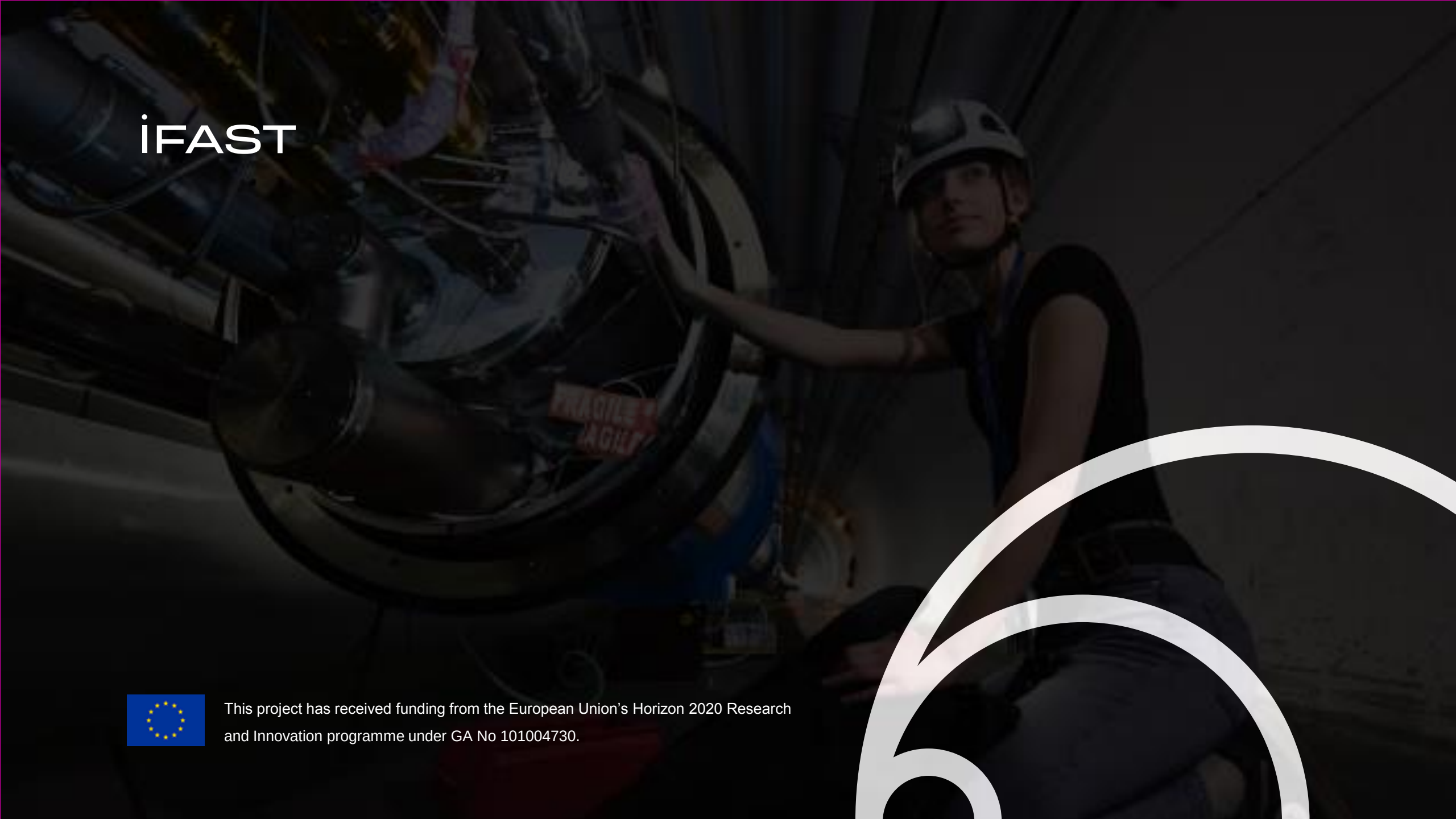


"But first, we must have the data" – C. Salt

Part 2. The Demonstration

Implement on a Field Programmable Gate Array (FPGA)-based systems at the edge of the ESS technical network





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