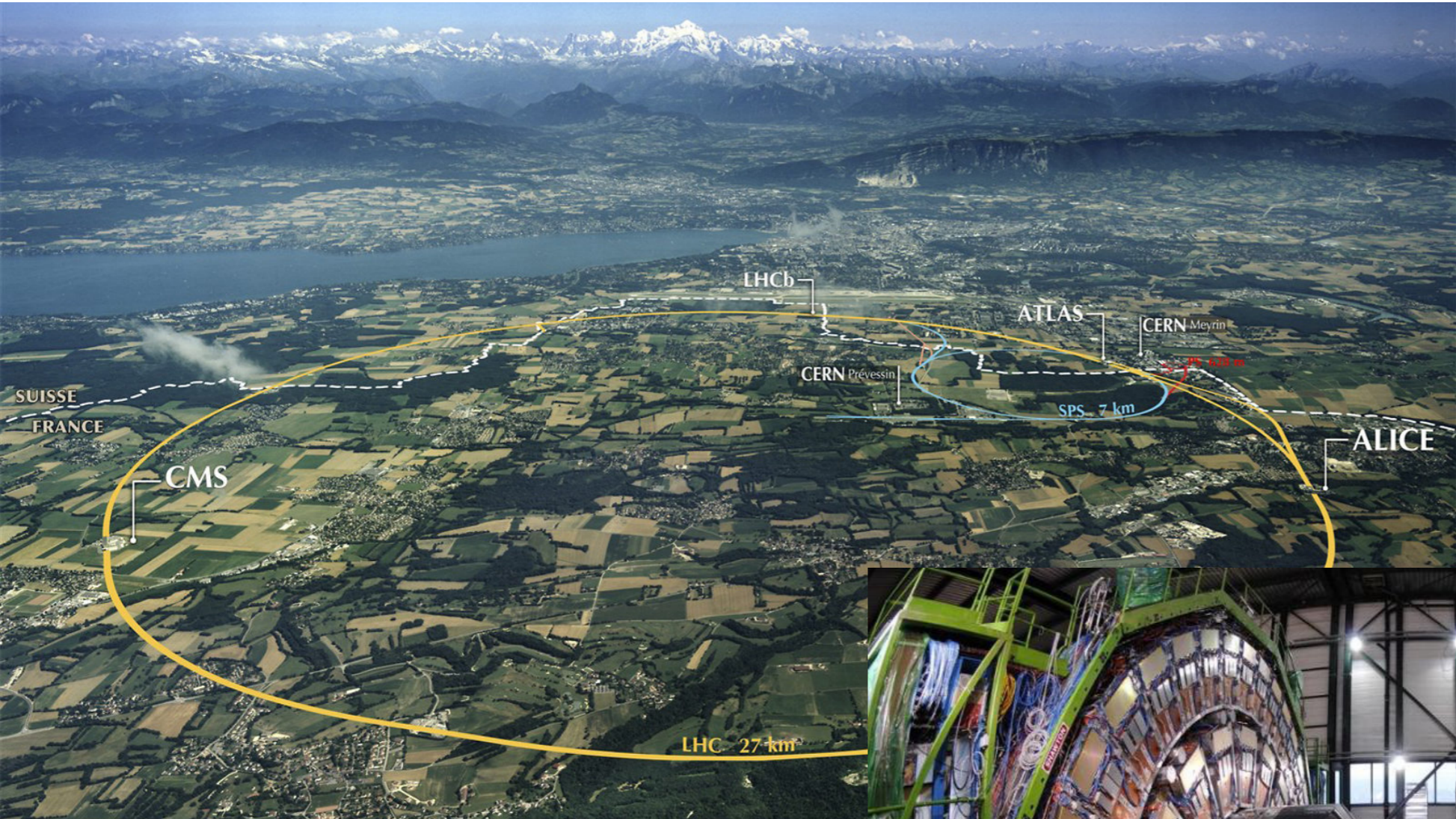


Machine Learning in High Energy Physics

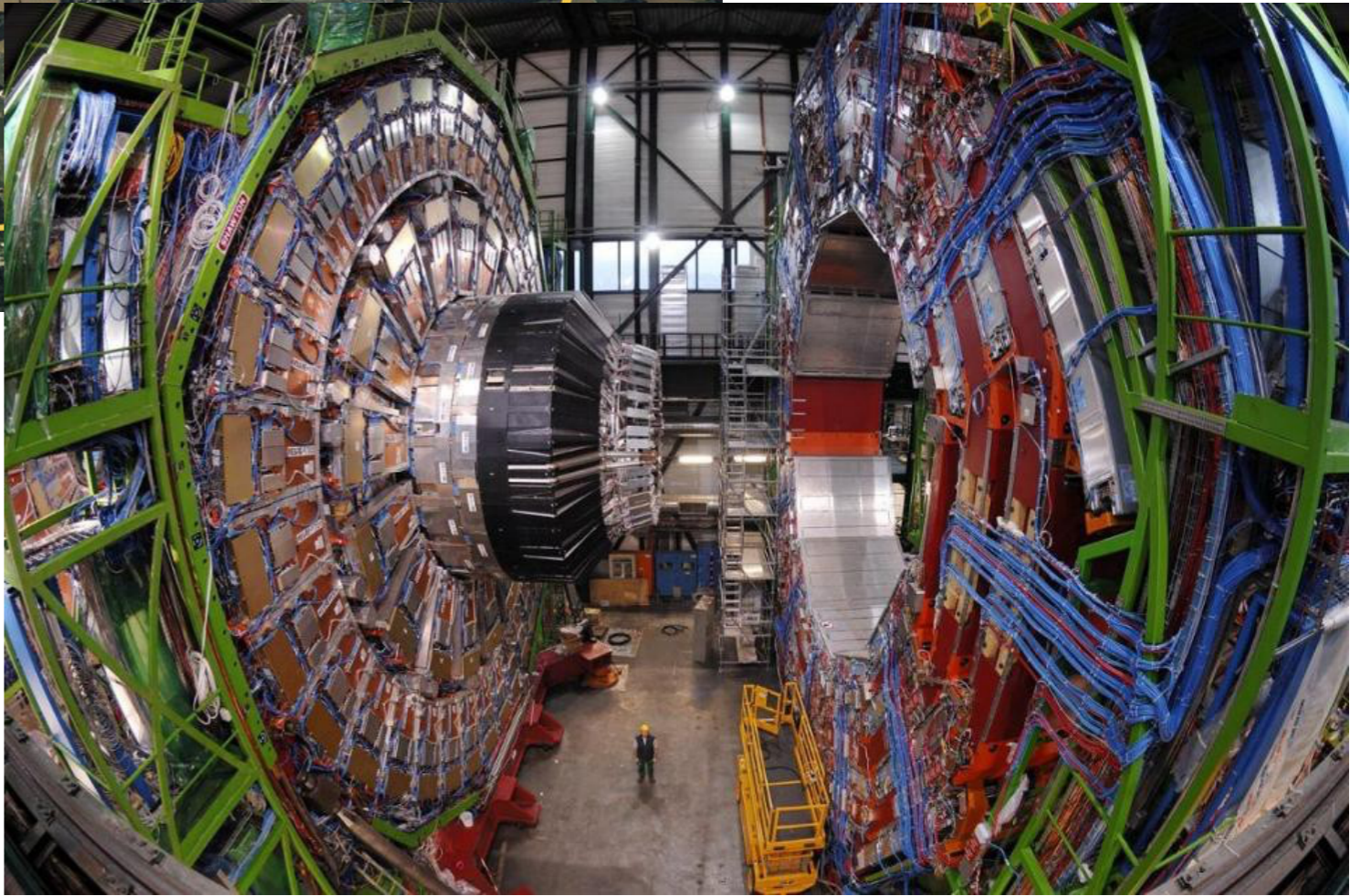
Daniel Tapia Takaki

August 11, 2018

CERN Large Hadron Collider (LHC)



CMS experiment



High-Energy Physics: The Problem

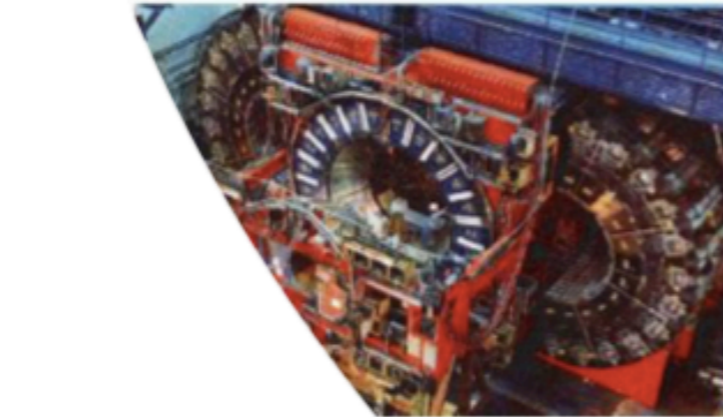
- Embarrassingly parallel:
 - Each *event* can be computed completely independently
 - No communications between events
 - Can be launched in separated processes
- Why are you here then?
 - Is there additional sources of parallelism to be found *inside* events processing?
 - Why do we need more parallelism?

7/23/18

CoDas-HEP



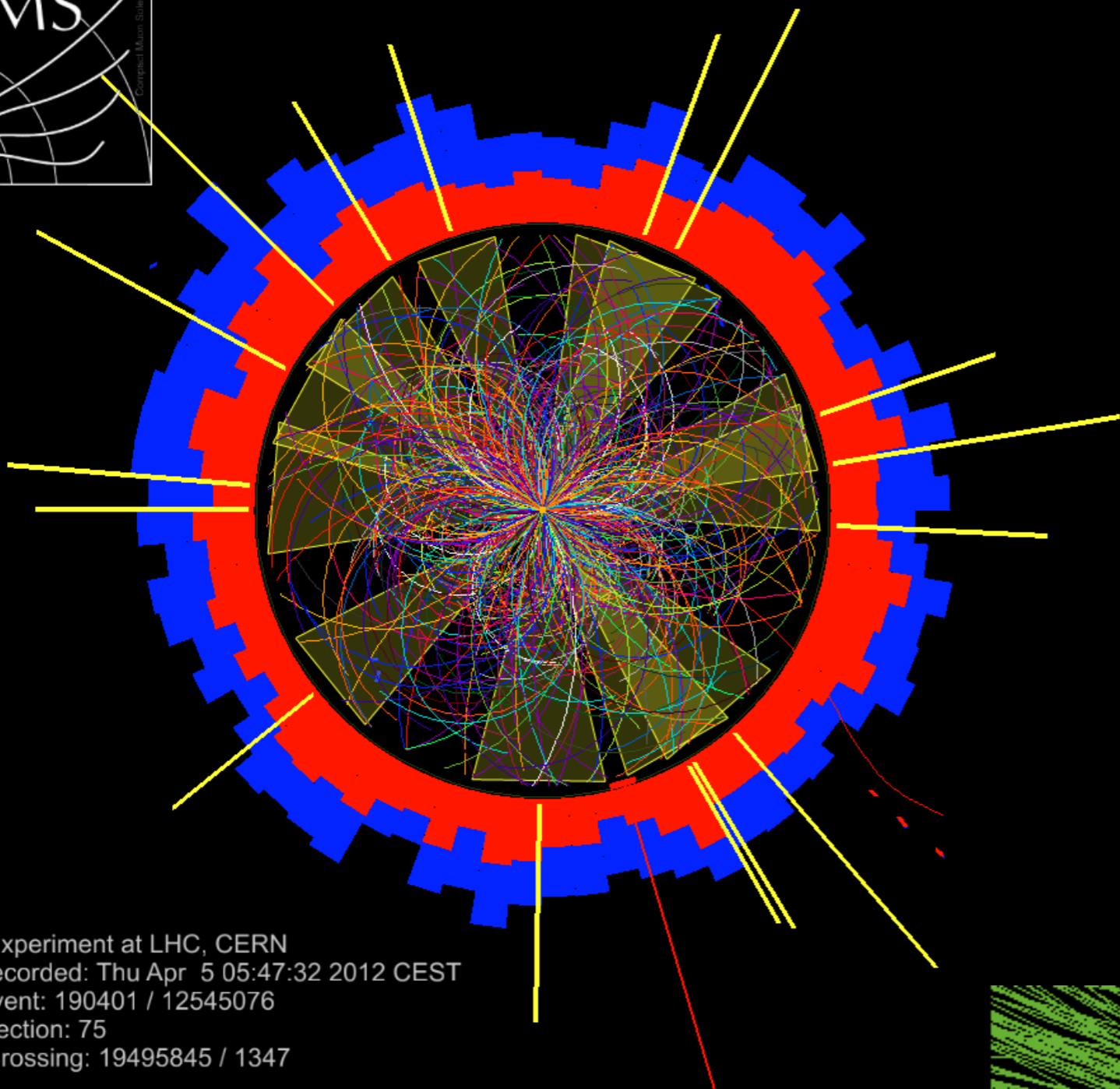
P.Elmer



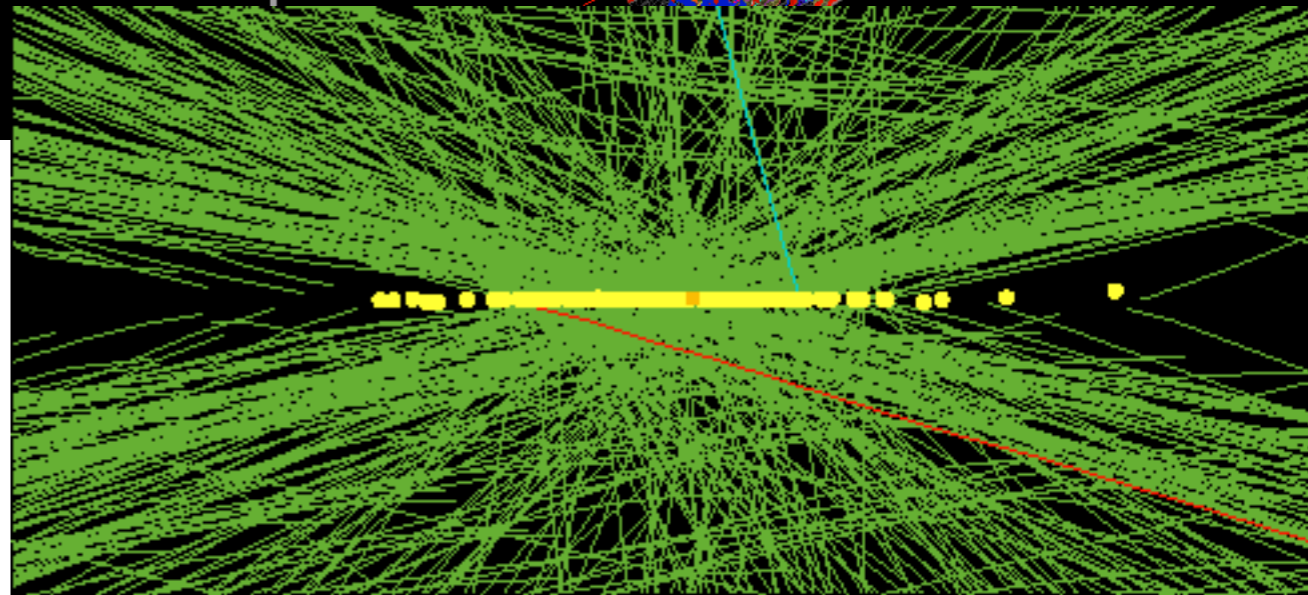
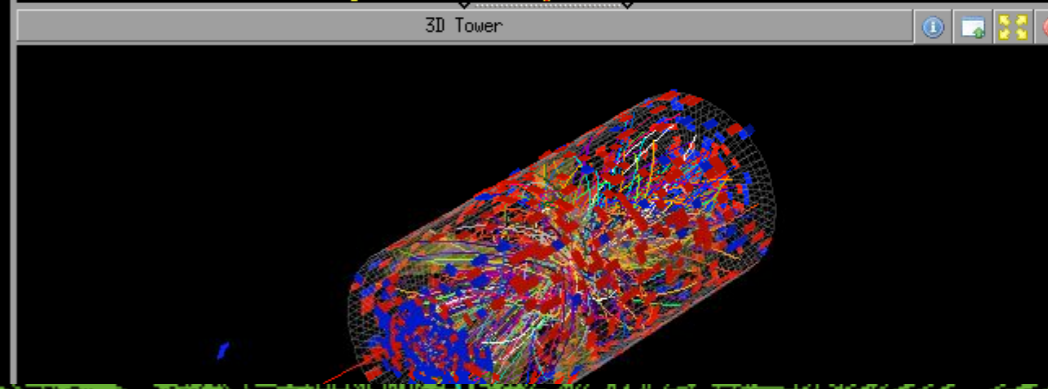
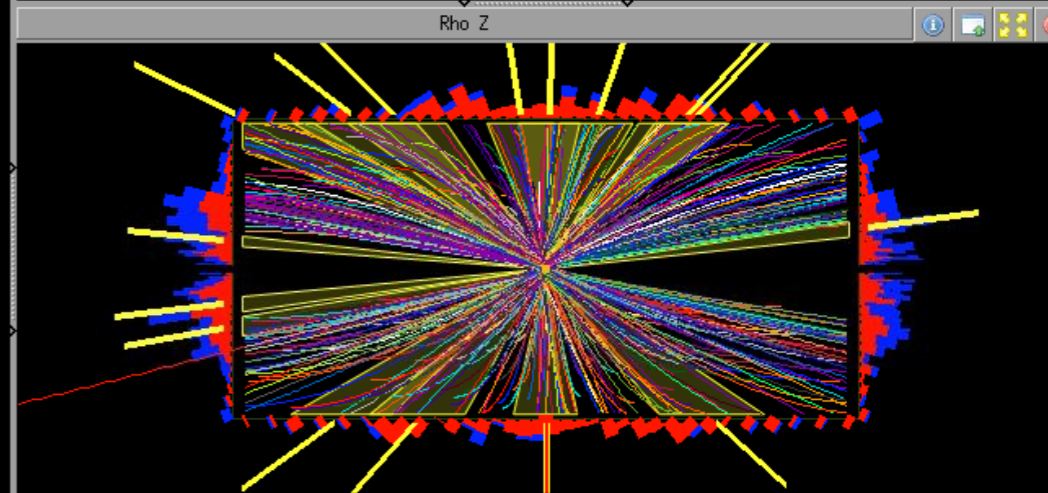
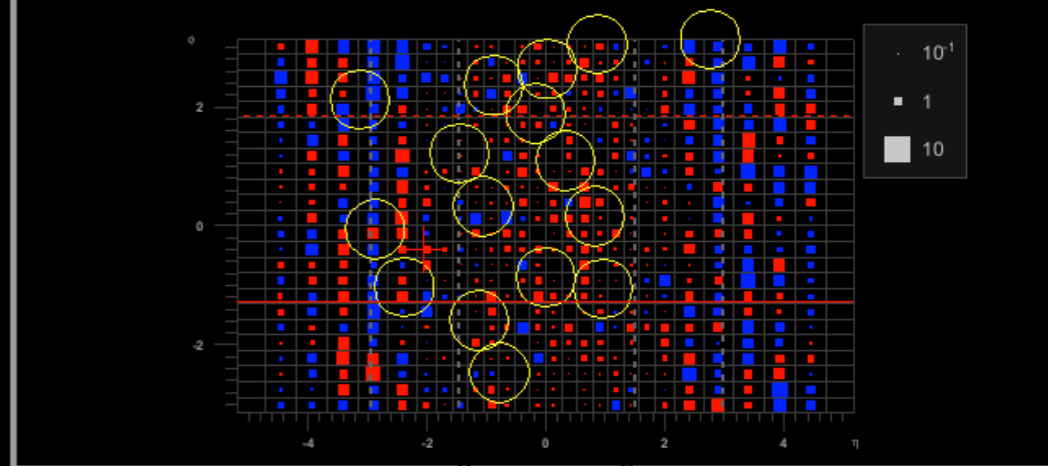
Four significant improvements needed in HEP

- **Physics performance** of reconstruction and analysis algorithms;
- **Execution time** of computationally expensive parts of event simulation, pattern recognition, and calibration;
- **Realtime implementation** of machine learning algorithms;
- **Reduction of the data footprint** with data compression, placement and access.

The current most frequently used machine learning algorithms in HEP are Boosted Decision Trees (BDTs) and Neural Networks (NN)



CMS Experiment at LHC, CERN
 Data recorded: Thu Apr 5 05:47:32 2012 CEST
 Run/Event: 190401 / 12545076
 Lumi section: 75
 Orbit/Crossing: 19495845 / 1347



Higgs
challenge



the HiggsML challenge

May to September 2014

When **High Energy Physics** meets **Machine Learning**

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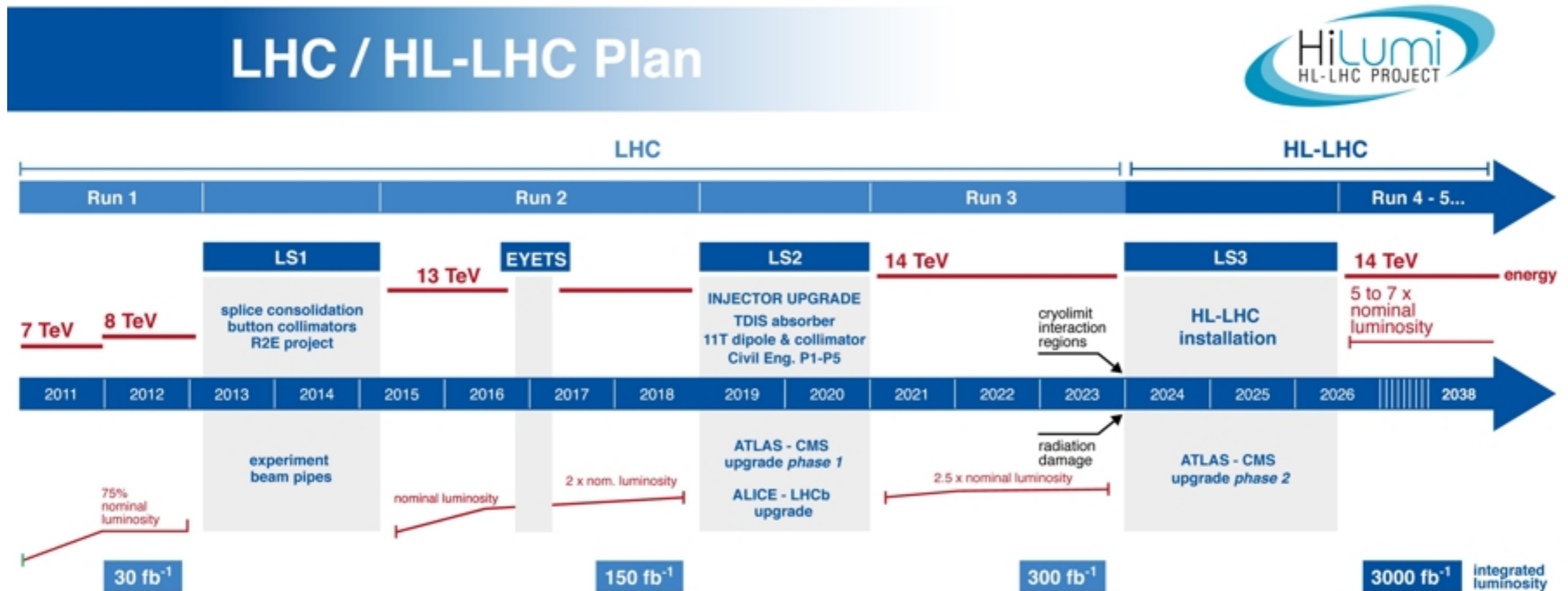
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[Organisation and thanks](#)

[Contact](#)

The challenge has run from May to September 2014 on the [Kaggle's platform](#). It was very successful (the most popular challenge on Kaggle so far) with 1785 teams of 1942 players, 35772 submissions, more than a thousand forum posts. The new challenge is now to make sure the wealth of ideas, software, algorithms exposed by the participants percolate into HEP physicists daily life.

2nd phase: High-Luminosity LHC



For HL-LHC machine learning will be heavily used

Machine Learning for HL-LHC

- Pattern recognition
- Real-time analysis, reconstruction
- Resolution, calibrations
- MC tuning
- Physics analyses

HEP White Paper published one month ago

- 2018 White Paper: Machine Learning in High Energy Physics Community
<https://arxiv.org/abs/1807.02876>

Recent workshops

- 4th Machine Learning in High Energy Physics Summer School (August 6-12, 2018)
<https://indico.cern.ch/event/687473/>
- 2nd Computational and Data Science School for HEP / Princeton <https://indico.cern.ch/event/707498/>
- Data Science in High Energy Physics, 2017
<https://indico.fnal.gov/event/13497/>
- Reconstruction, Trigger, and Machine Learning for the HL-LHC. April 2018
<https://indico.cern.ch/event/714134/>

Workshops in Mexico

- Workshop on Machine Learning @ UNAM
April 25-27, 2018
<https://indico.nucleares.unam.mx/event/1363/overview>
- UNISON Workshop on Data Analytics applications
<https://indico.cern.ch/event/749562/overview>