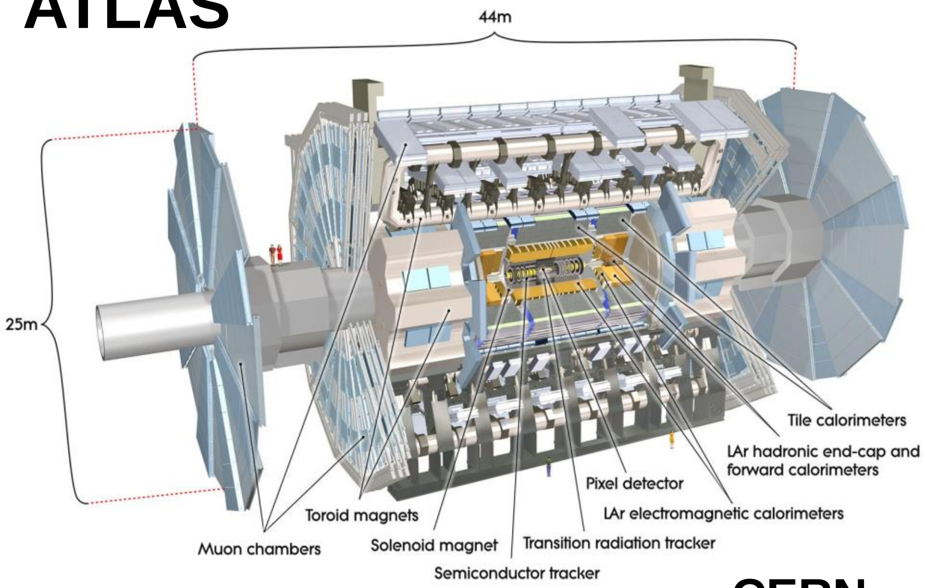
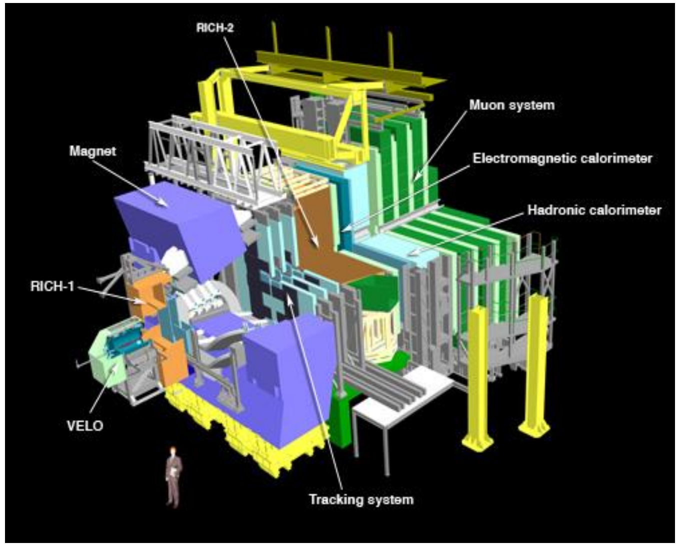
Particle Physics, Workflows and Data Orchestration

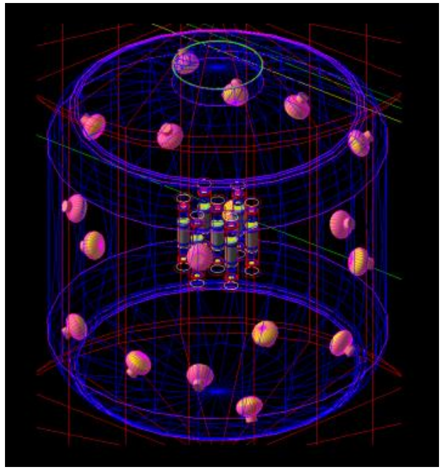
ATLAS



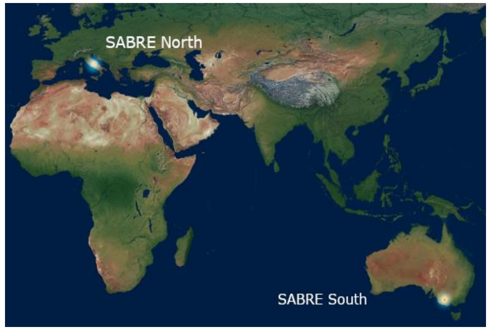
CERN, Geneva



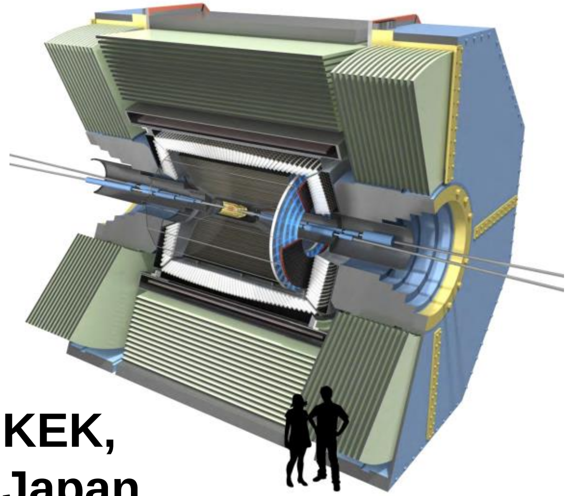
LHCb



SABRE

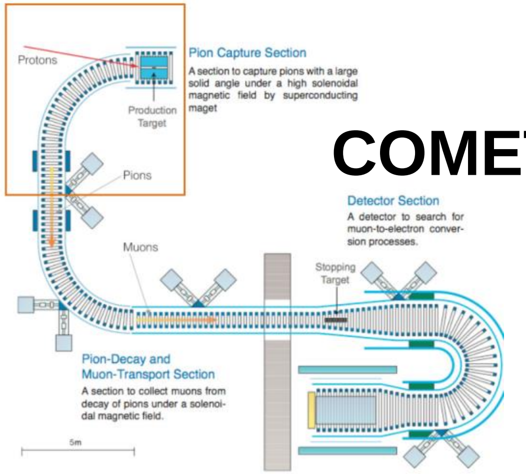


BELLE II



KEK, Japan

COMET



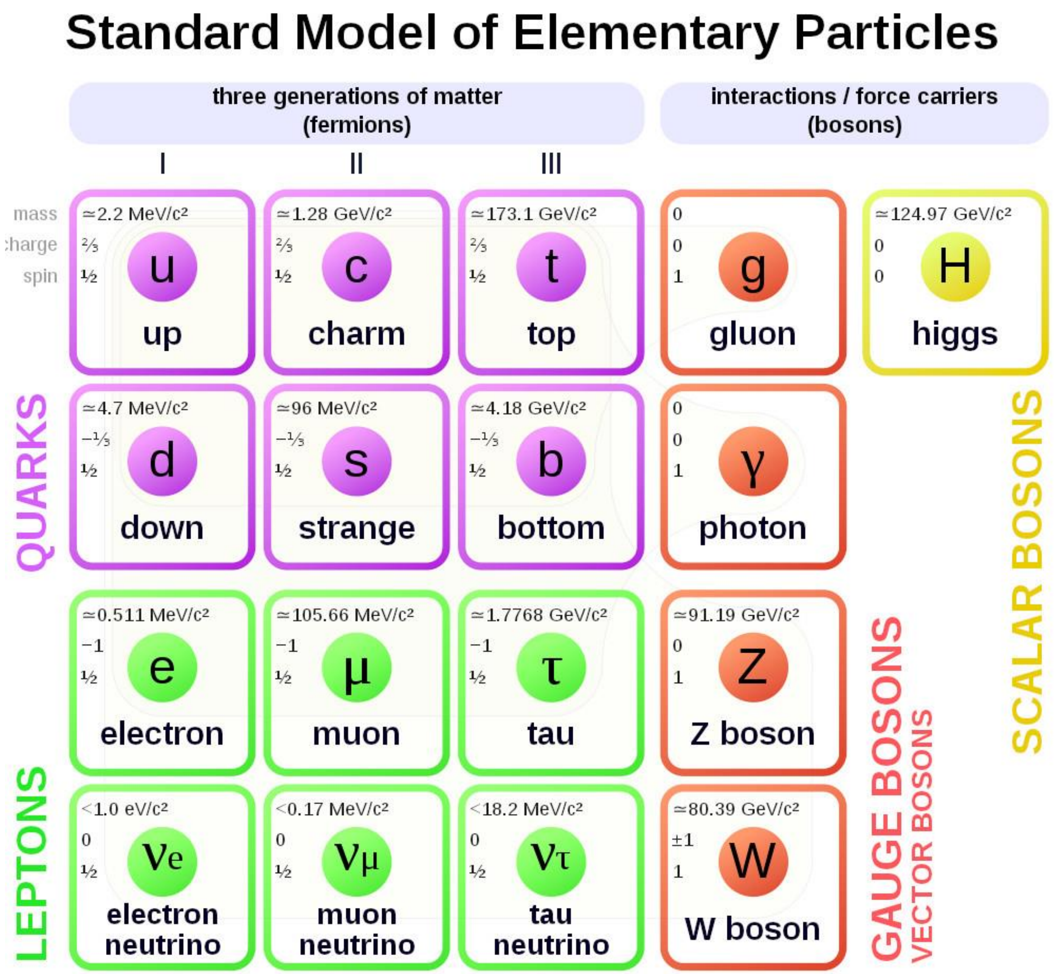
Martin Sevior, The University of Melbourne

On behalf of Australian Particle Physics

Big questions addressed by Particle Physics

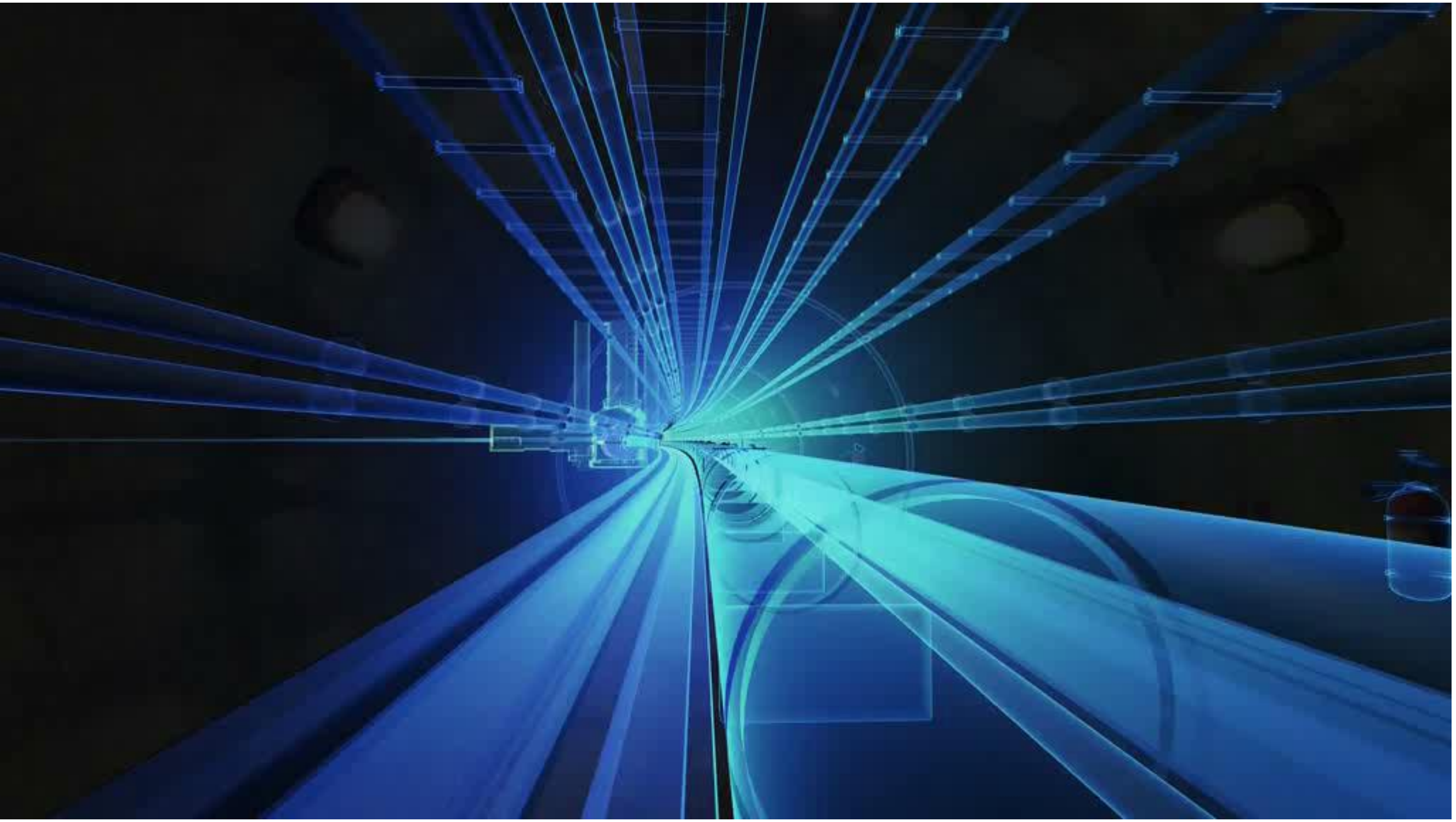
The Standard Model of
Fundamental Physics does not explain:

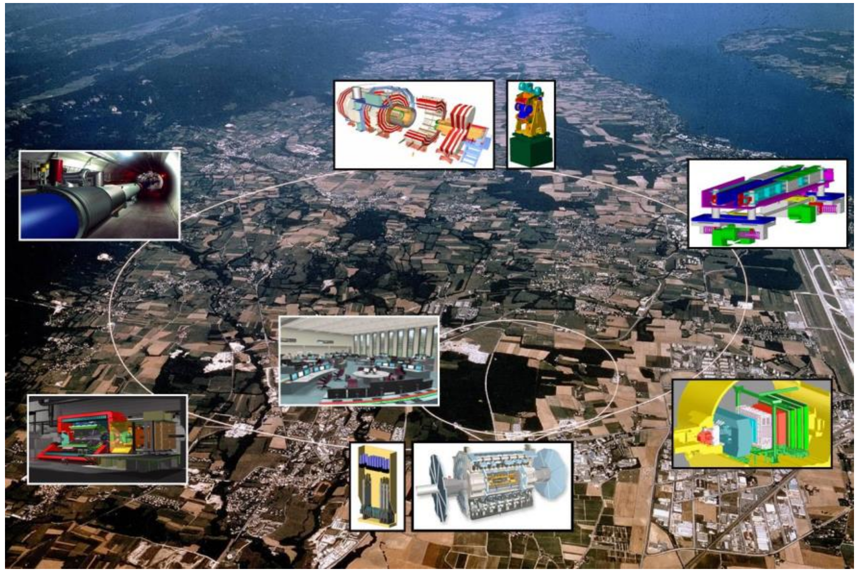
- Non-baryonic Dark Matter
- Inflation Field
- Dark Energy
- Universal Baryonic Asymmetry
- Neutrino Masses
- Neutrino Mixing
- Radiative corrections to the Higgs Mass

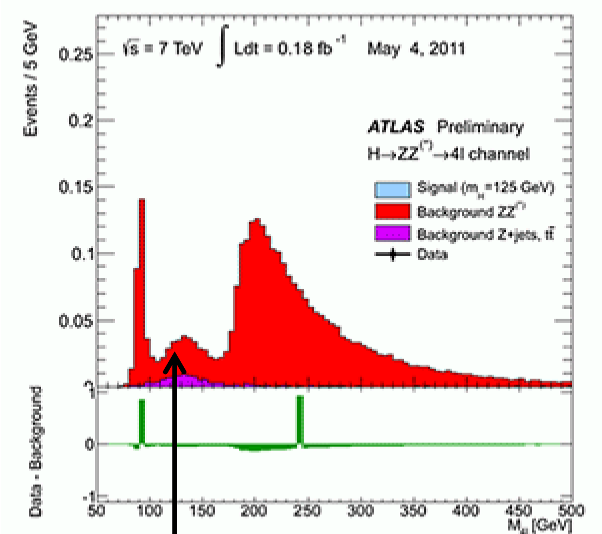


What is the New Fundamental Physics?

ATLAS - Search for New Physics by creating new particles







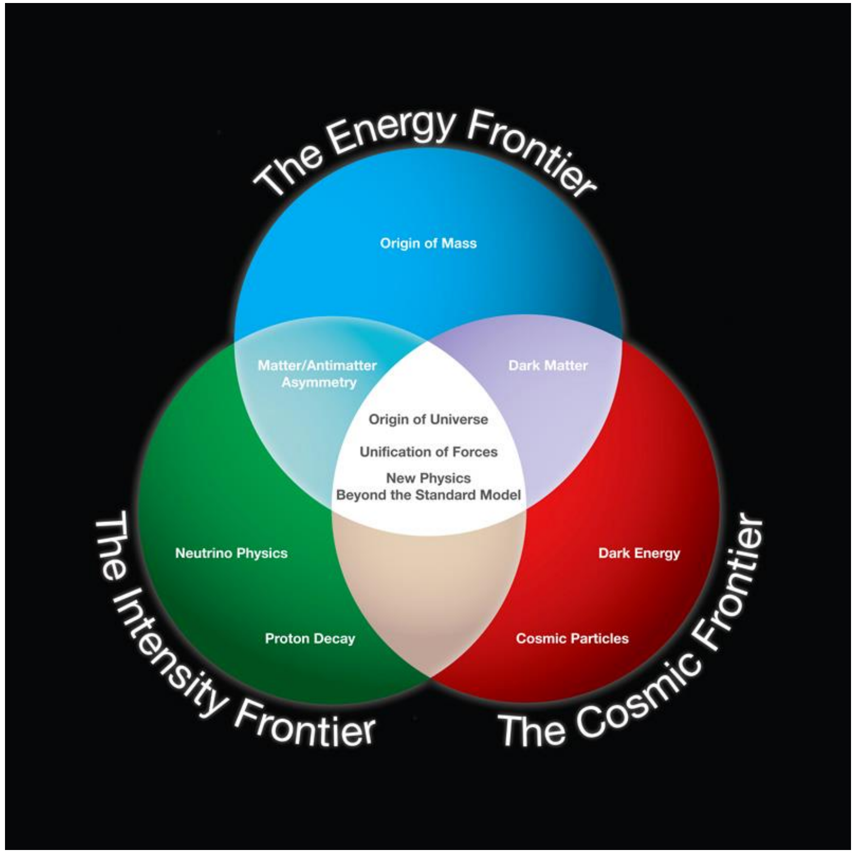
(2012)

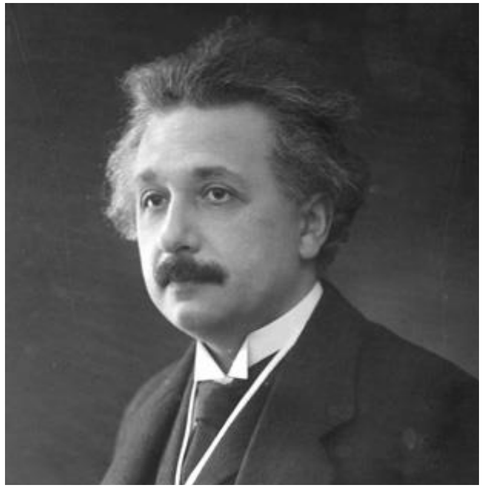
Higgs

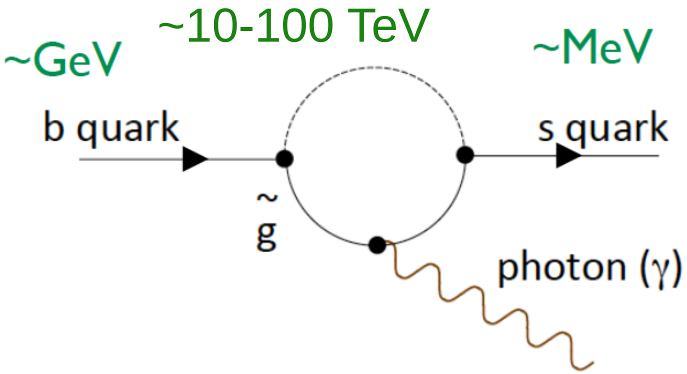
Parallelization is trivial.
Data can be broken into chunks.
Challenge is the sheer scale.

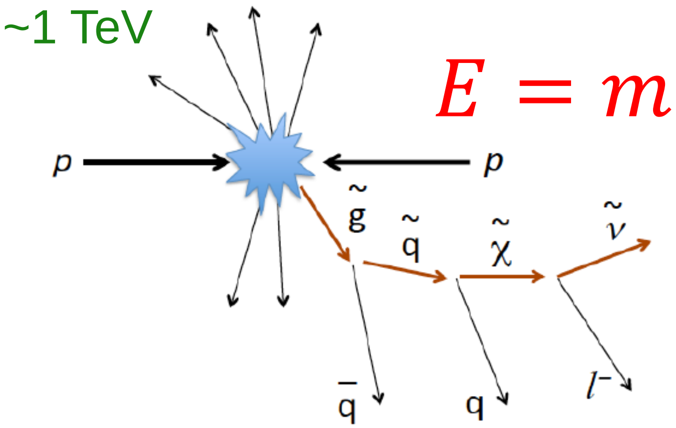
Flavour Physics – Belle II, LHCb & COMET

$\Delta m \Delta t \sim \hbar$









$E = mc^2$

Provides a unique probe to unravel deeper mysteries of universe with intense sources and highly sensitive detectors

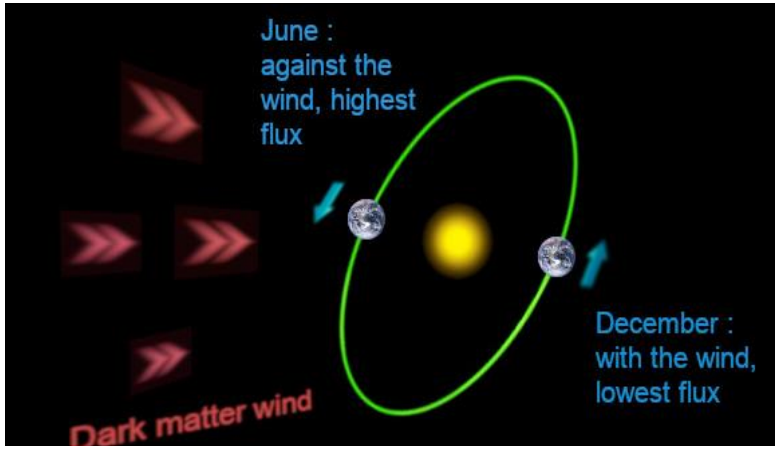
SABRE

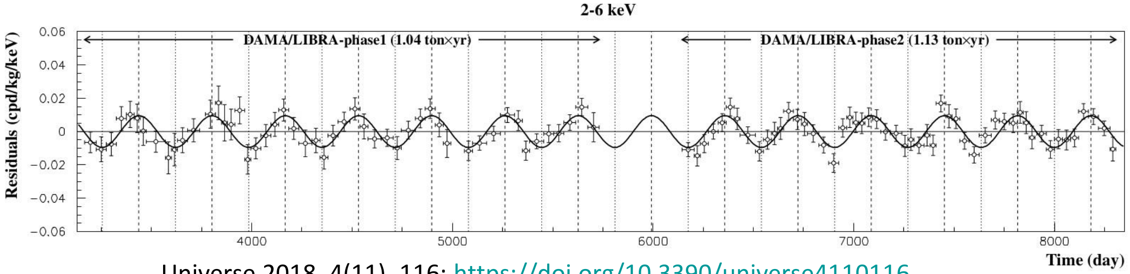
Search for non-baryonic Dark Matter via direct detection

Challenge is to minimize backgrounds => Underground

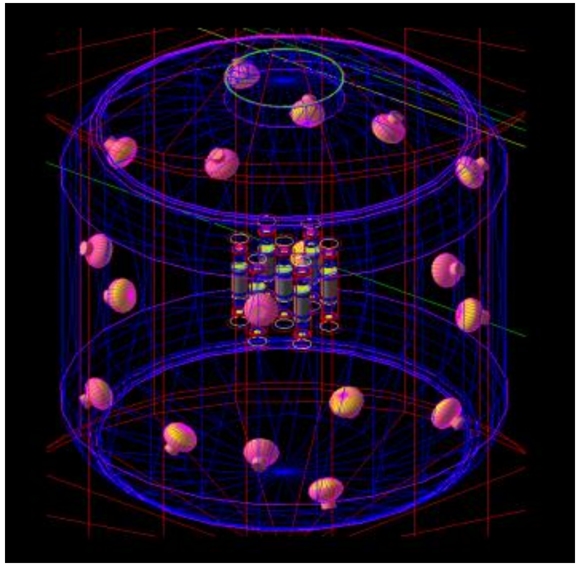
Look for Annual Modulation:

=> Northern and Southern Hemisphere Labs





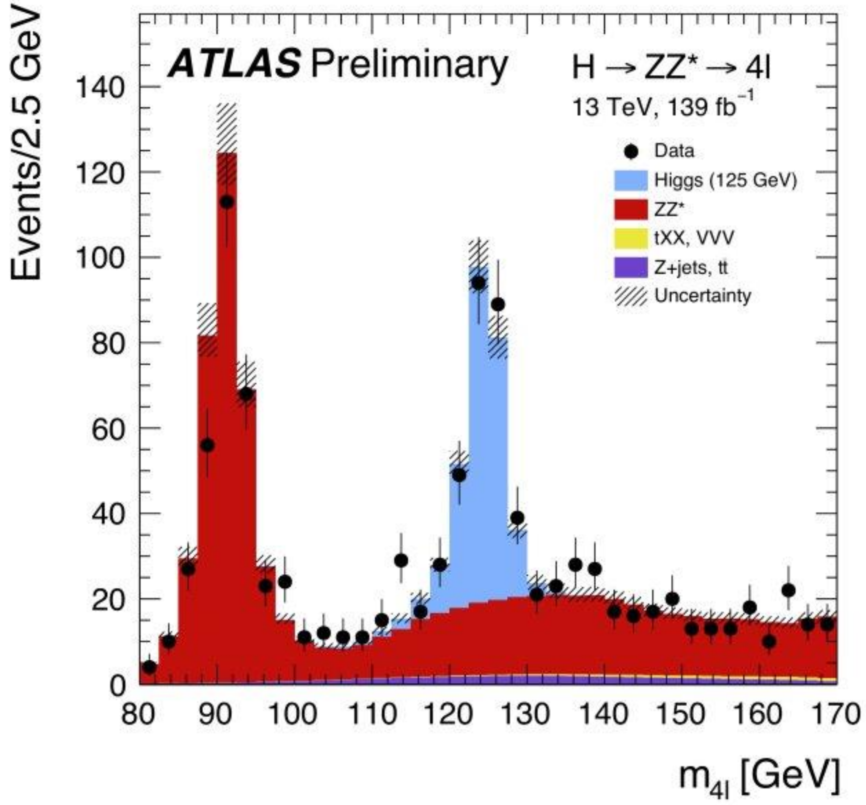
Universe 2018, 4(11), 116; https://doi.org/10.3390/universe4110116



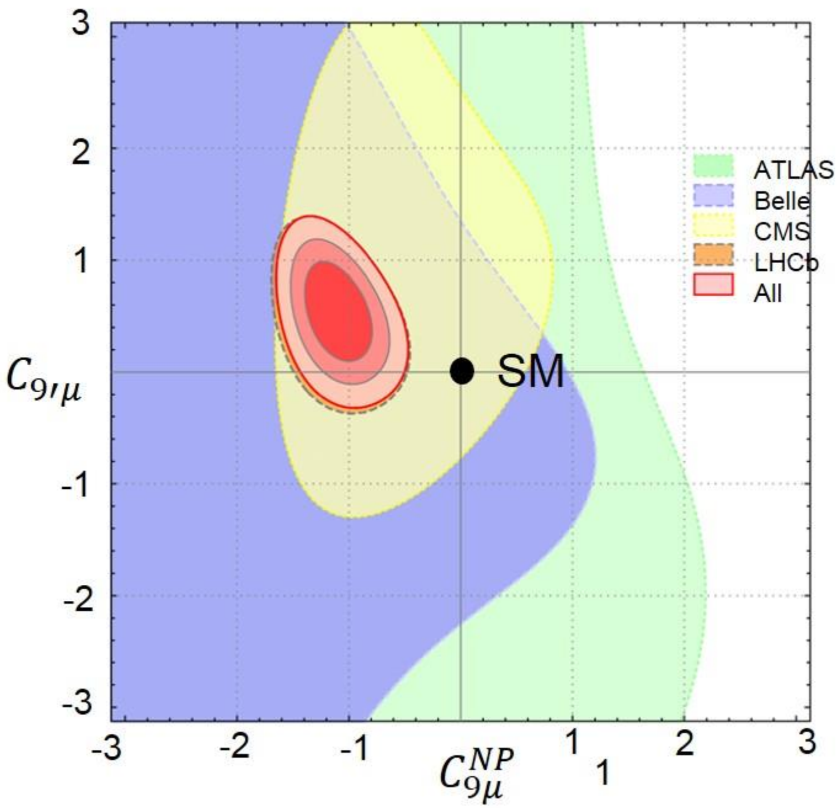
Layout of SABRE detector

Underground at Stawell Goldmine

Current Status



Higgs Measurements

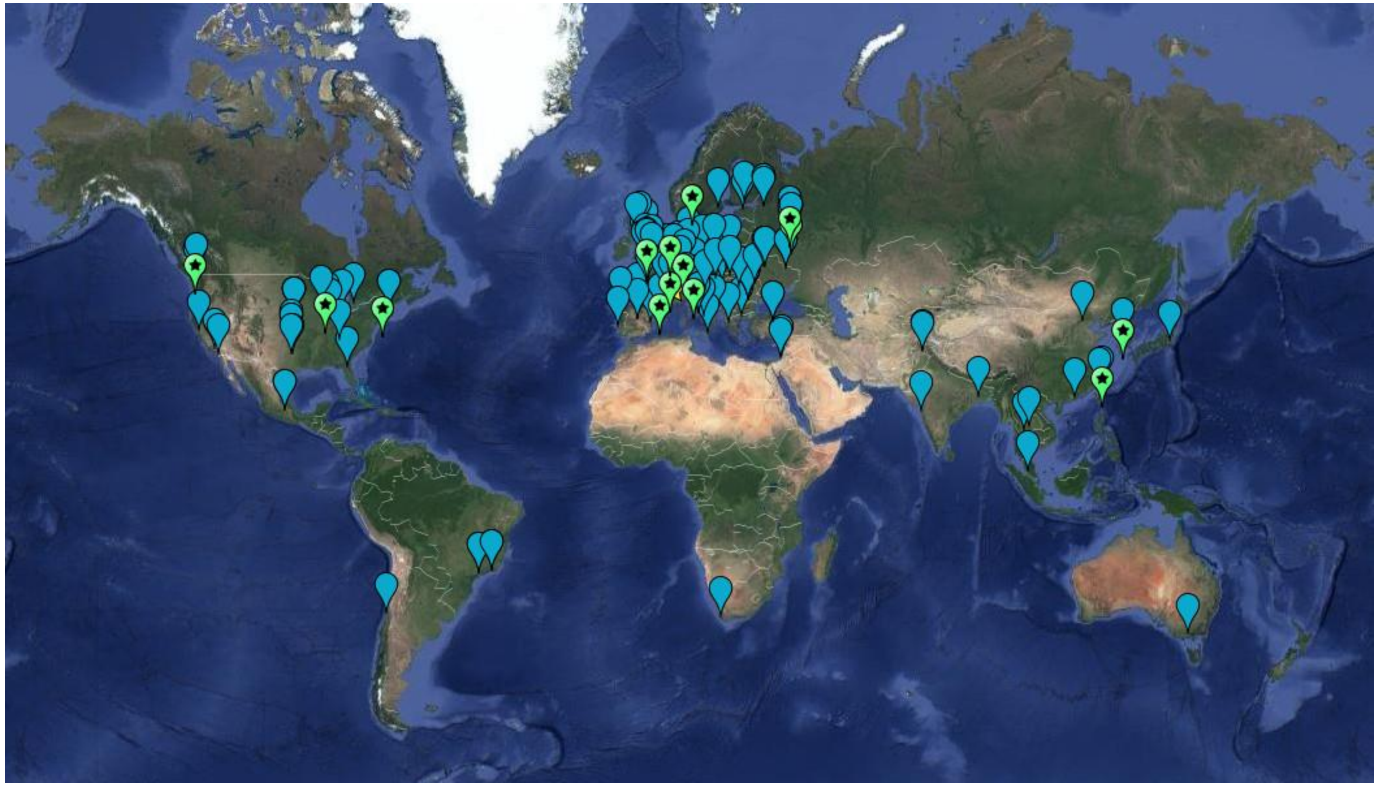


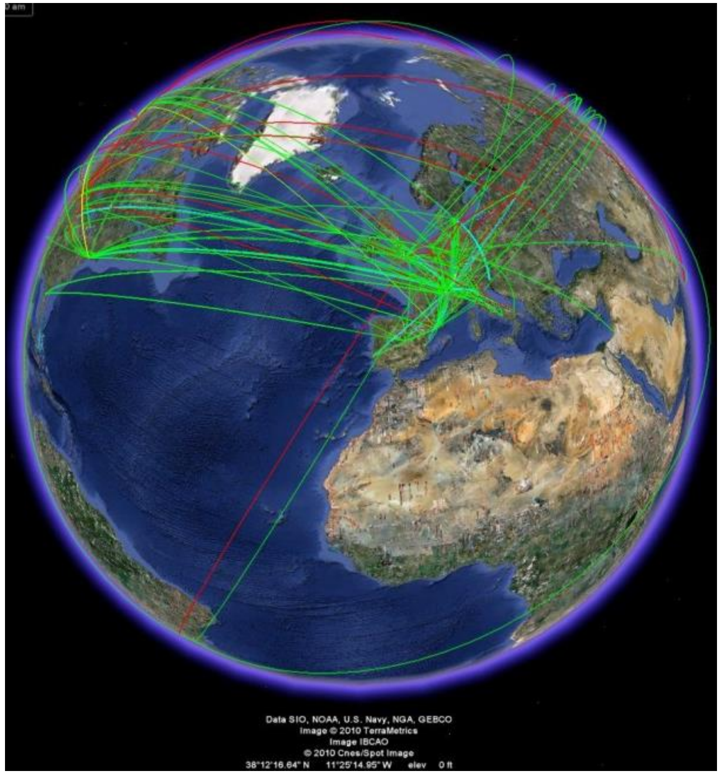
Flavour Physics tensions
with SM calculations

Sophisticated searches and precision measurements will be made to determine the nature of New Physics

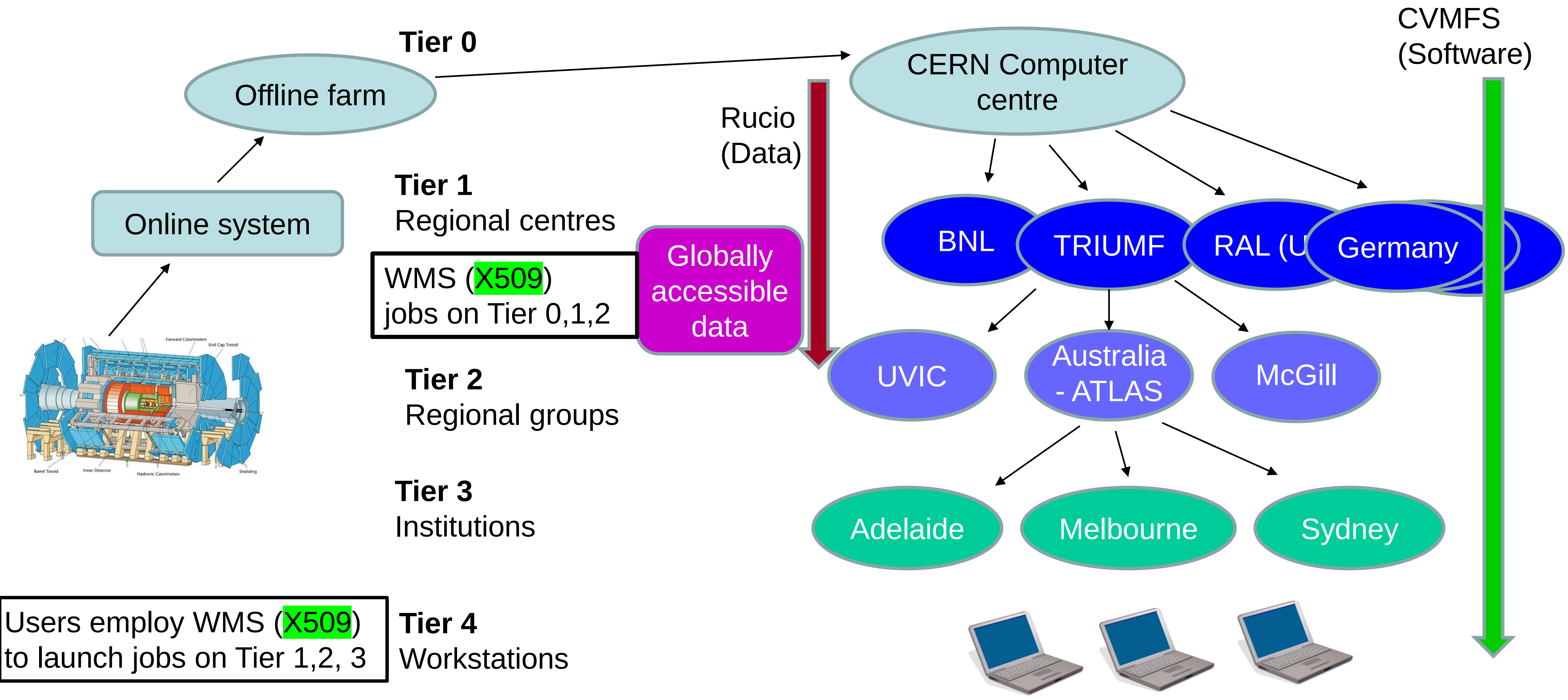
Global Computing

Scale of Computing Resource is too large for CERN (and KEK).
Employ Computing Clusters around the world. This is the WLCG





Workflows & Data Orchestration



Current scale of data flow of WLCG

Sustained WLCG data flow of 50 GB/s => 1600 PB/year

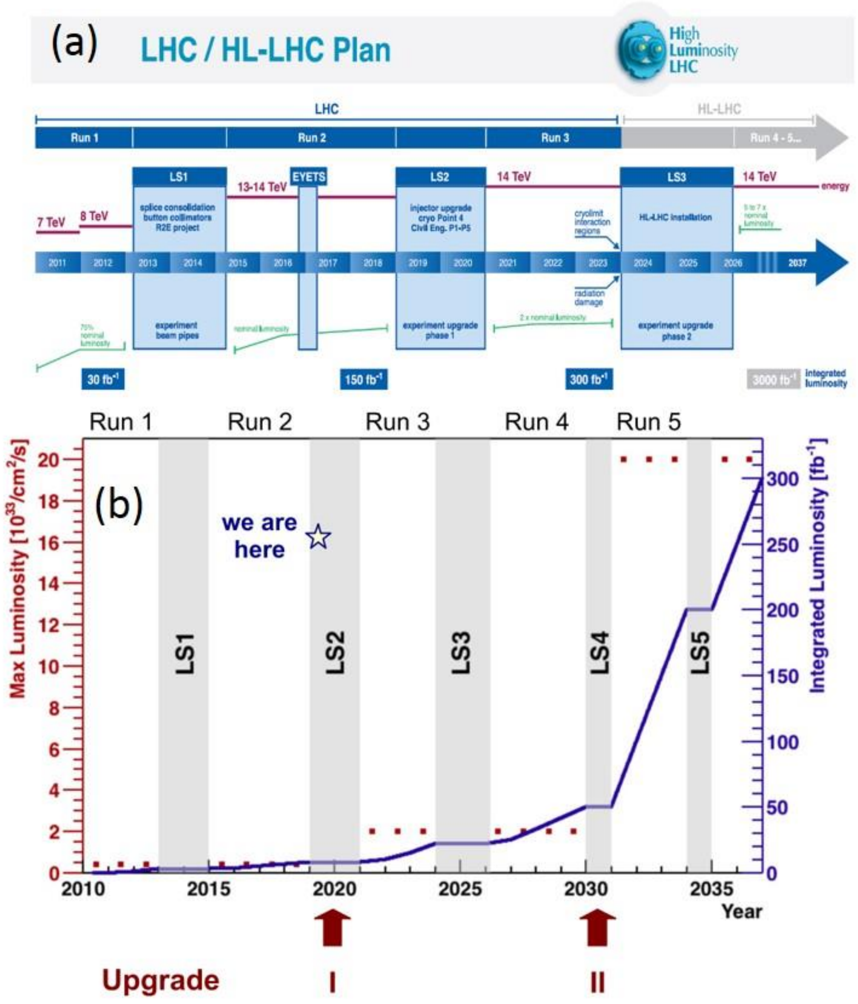
15 TB

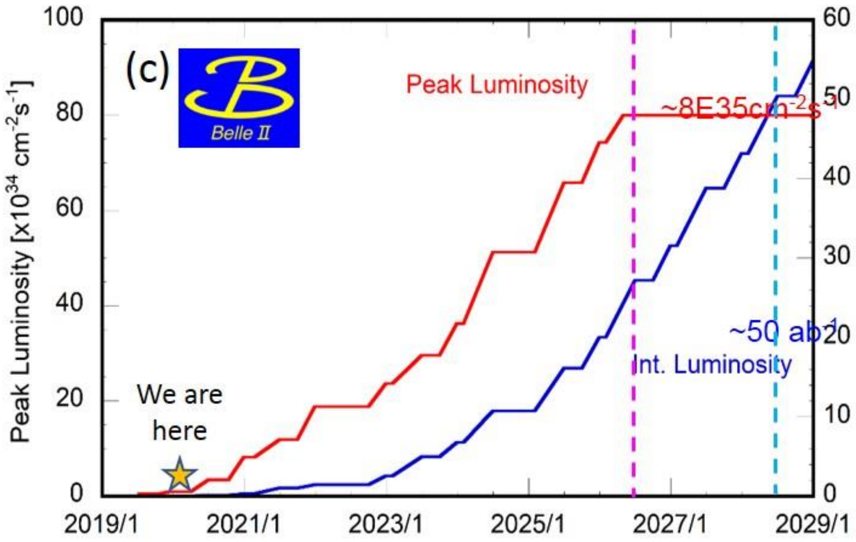
7.5 TB

Day

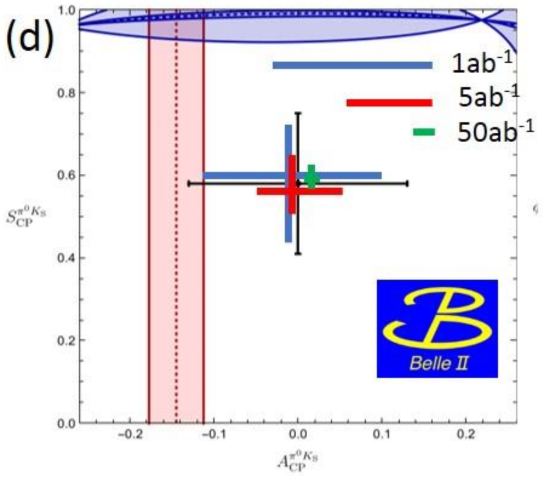
Australia-ATLAS at unimelb
Data flow ~ 3 PB/year, (around 1% of ATLAS)
(Thank you AARNET!)

Future Experimental requirements





Factor of ~50 increase in data volumes over next decade

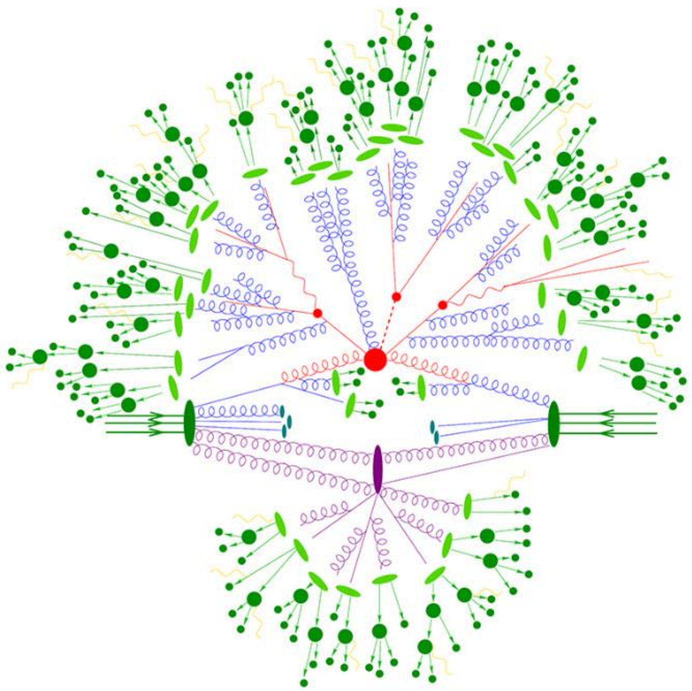


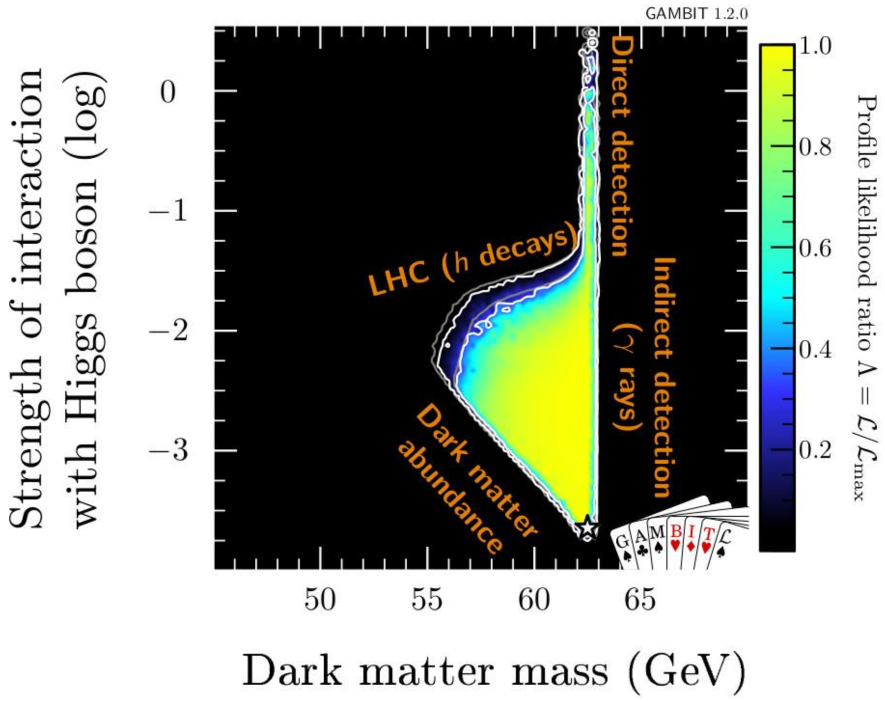
ALL experimental groups **must** contribute to computing effort.

Australia must supply 1%-2% (CPU & storage) to participate

Particle Theory Workflows

Two most typical use cases for non-desktop particle theory computing:





1. Calculation of theory predictions: Monte Carlo simulation of events at colliders, cosmic ray air showers, etc

2. Parameter scans: calculation of multiple predictions at many different parameter combinations + comparison to data

(Slides from Pat Scott)

Particle Theory Workflows

1. Calculation of theory predictions:

- Programmatic workflow needed to process many Monte Carlo events (similar to experiment)
  - ➢ generation of initial events
    - ➢ decays/interactions/showering/hadronisation of products
      - ➢ detector simulation

- Data orchestration needed in
  - ➢ passing large event samples to detector simulations
  - ➢ passing detector-level events to analysis software for comparison with public experimental data

Particle Theory Workflows

2. Parameter scans:

- Programmatic workflow needed in
  - choosing parameter combinations
  - executing theory calculations
  - processing theory predictions and experimental data with likelihood calculators
  - performing final statistical tests comparing parameters & whole theories

- Data orchestration needed in
  - providing experimental data to likelihood functions
  - distilling results down to a manageable size
  - saving and sharing full sets of predictions and outcomes of statistical tests at all parameter combinations