

24th International Conference on
Computing in High Energy & Nuclear Physics
4-8 November 2019, Adelaide, Australia



Universal Science in Australia

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THE UNIVERSITY
of ADELAIDE

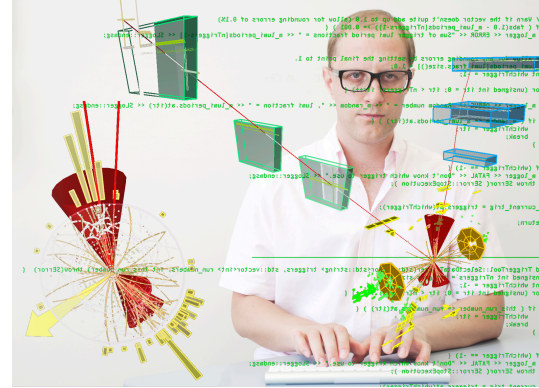
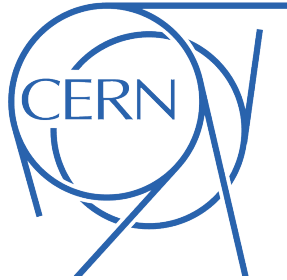


Australian Government
Australian Research Council



CoEPP
ARC Centre of Excellence for
Particle Physics at the Terascale

Who am I?



Prof Paul Jackson



Founded the experimental high energy physics group in Adelaide in 2011

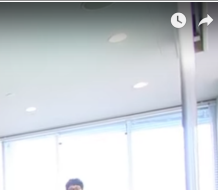
Lead our group on the ATLAS and Belle II experiments at CERN in Europe and KEK in Japan

Prior to that I spent several years at CERN and held positions in the US (Stanford, Ohio State), Italy (Roma) and Canada (Victoria)

The Adelaide High Energy Physics group - See the World!



K M I M K I KOBAYASHI-MASKAWA INSTITUTE FOR THE ORIGIN OF PARTICLES AND THE UNIVERSE



8:39 / 11:03 Scroll for details

Abhishek at SLAC/
Stanford University



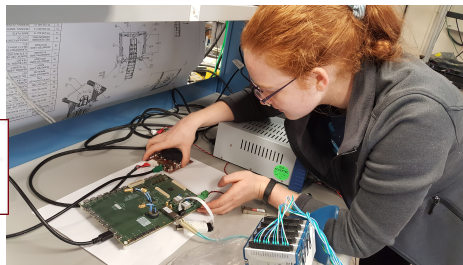
Sophie at Kobayashi-Maskawa Institute/ Nagoya Uni, Japan



Shanette at Belle II, KEK in Japan



Emily at UC
Berkeley/LBNL



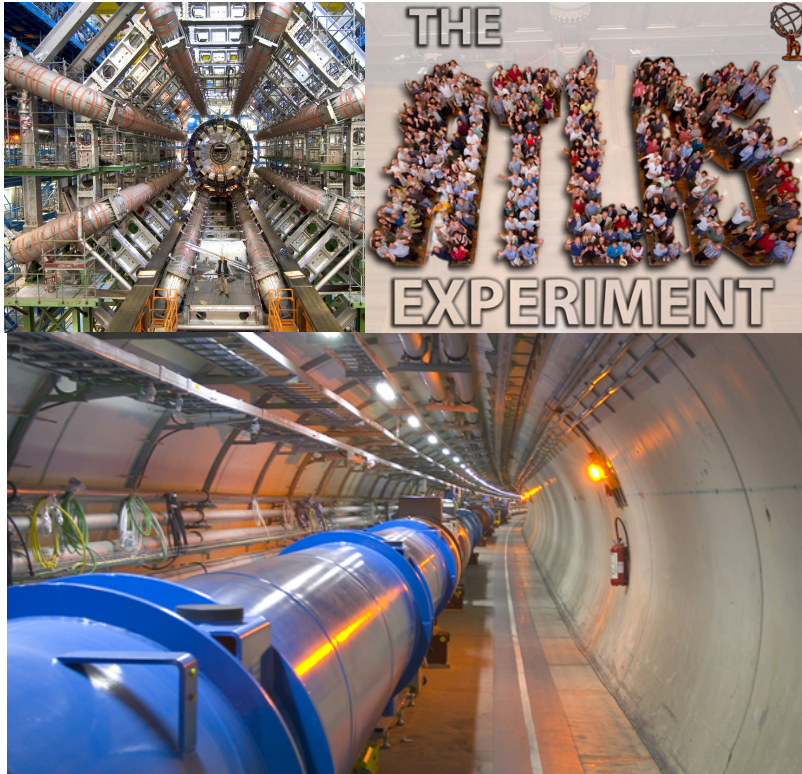
Jason at CERN



What do we work on?

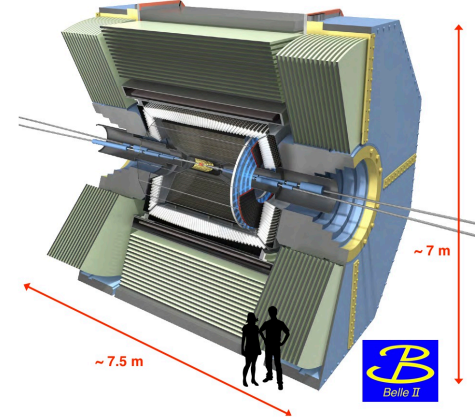
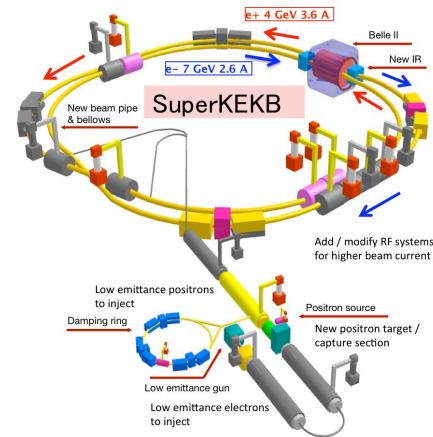
ATLAS experiment at the CERN Large Hadron Collider in Geneva, Switzerland

2013 Nobel Prize for discovery of the Higgs Boson



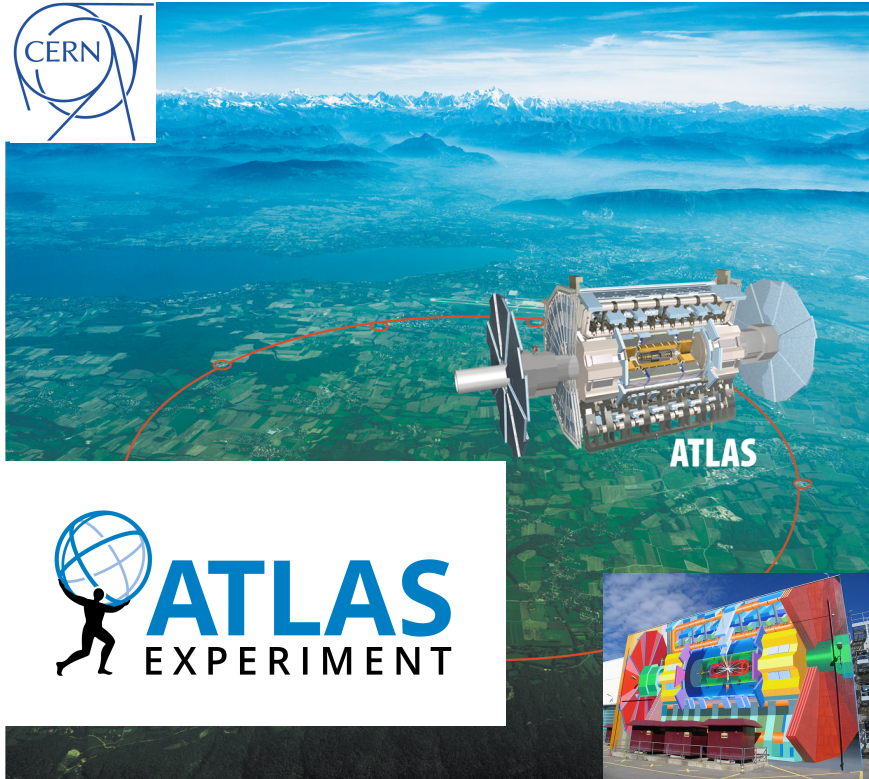
Belle II experiment at the SuperKEKB e^+e^- Collider in Tsukuba, Japan

2008 Nobel Prize for discovery of the CP Violation in the B meson system (awarded for work performed with BaBar and Belle experiments)



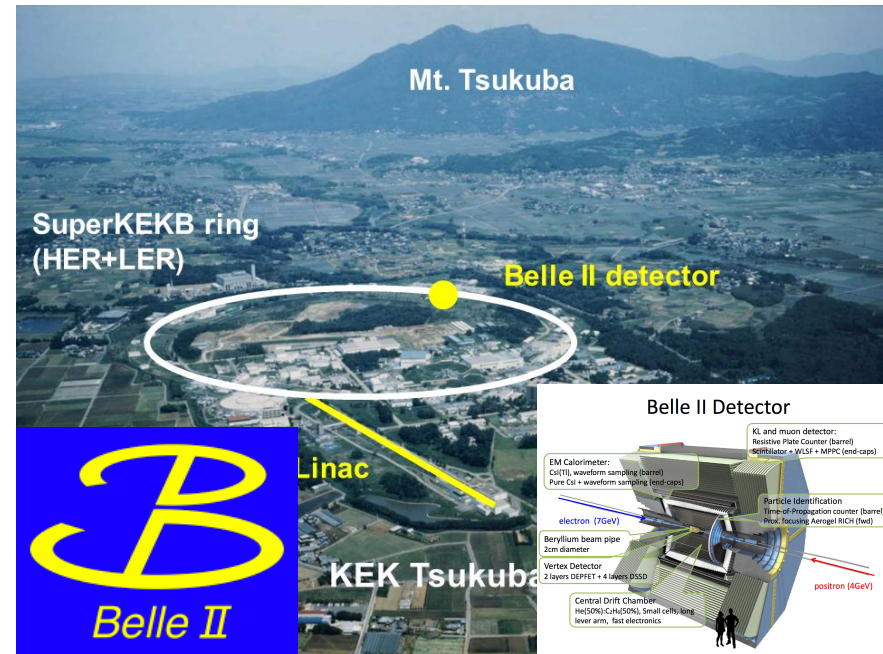
Why do we work on these experiments?

Energy Frontier



- Measure particles at high energies
- Direct search for new phenomena

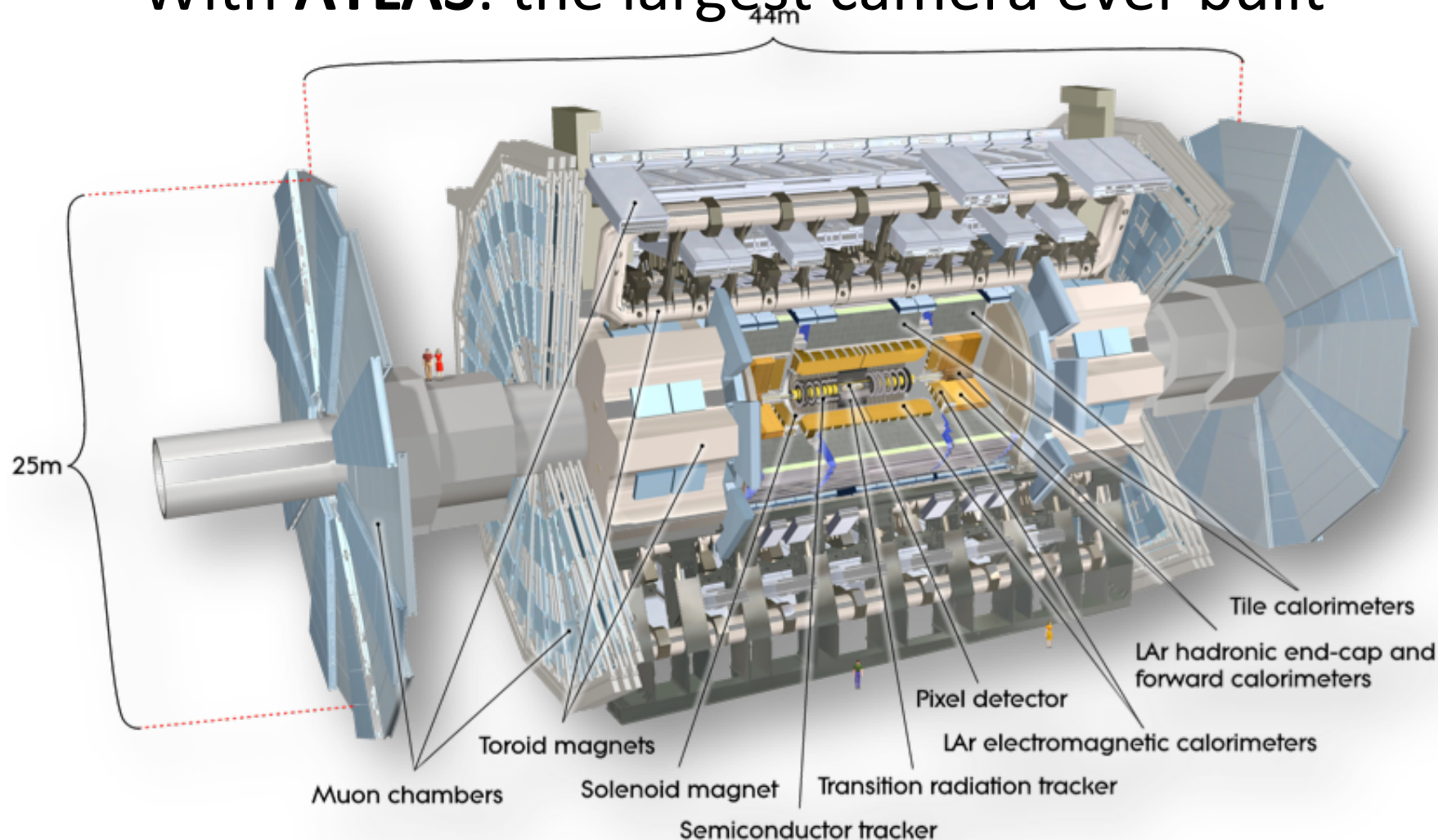
Intensity Frontier



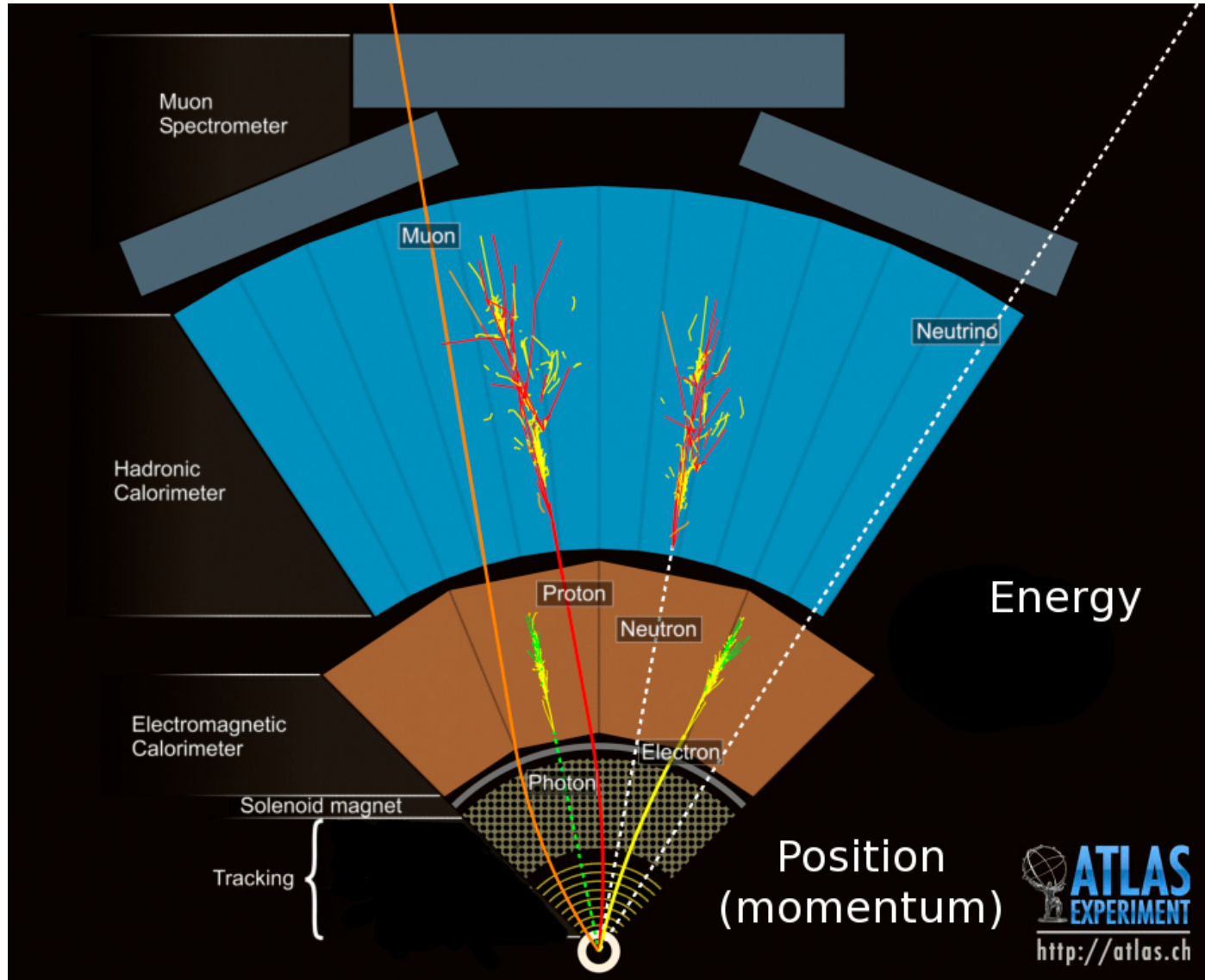
- Measure particles at lower energies
- Indirect search for new phenomena

How do we see what happens when beams collide?

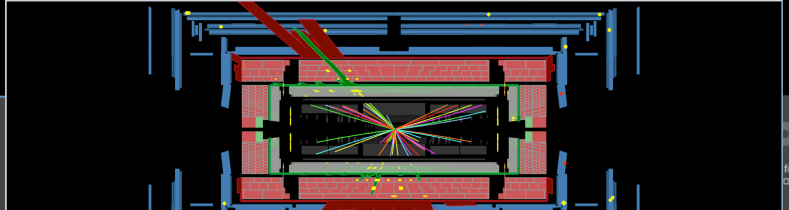
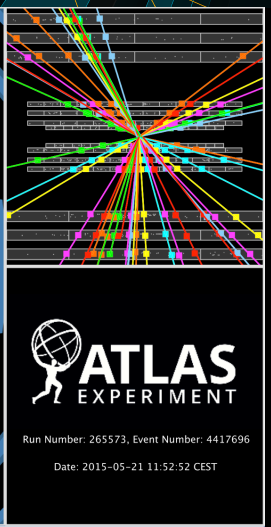
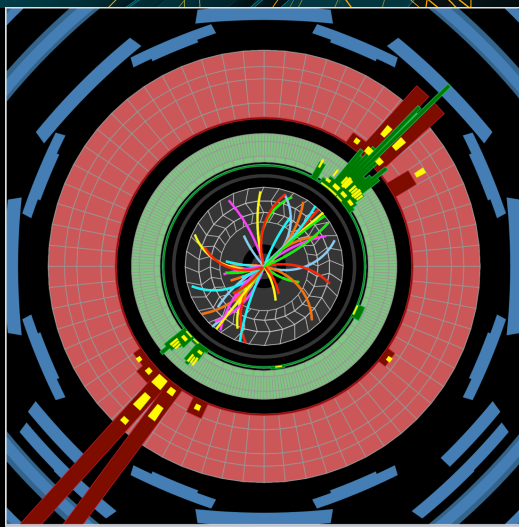
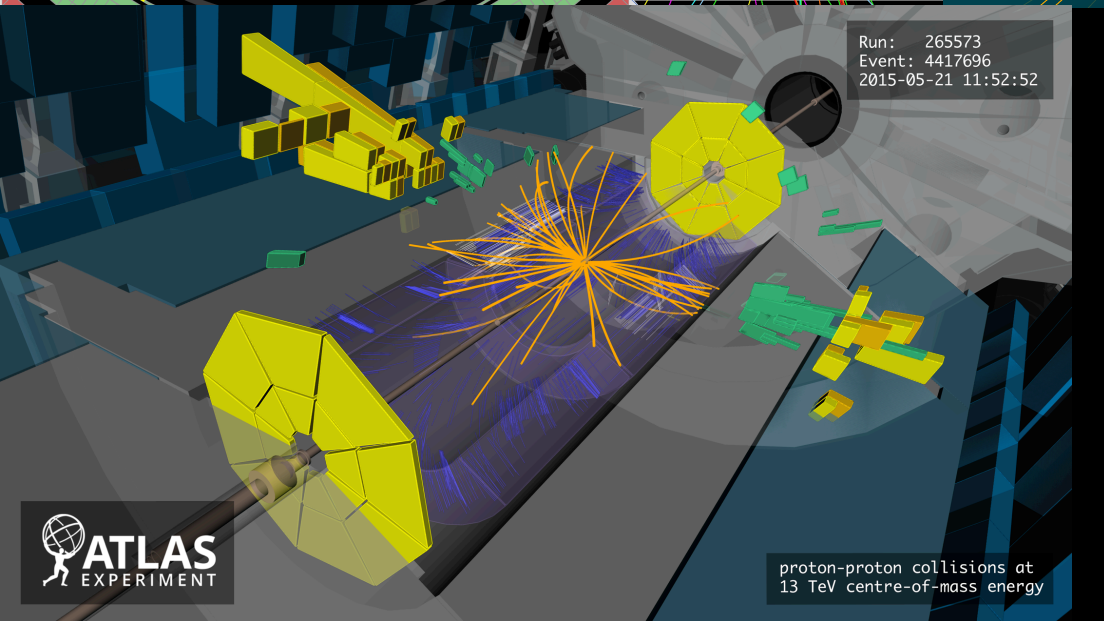
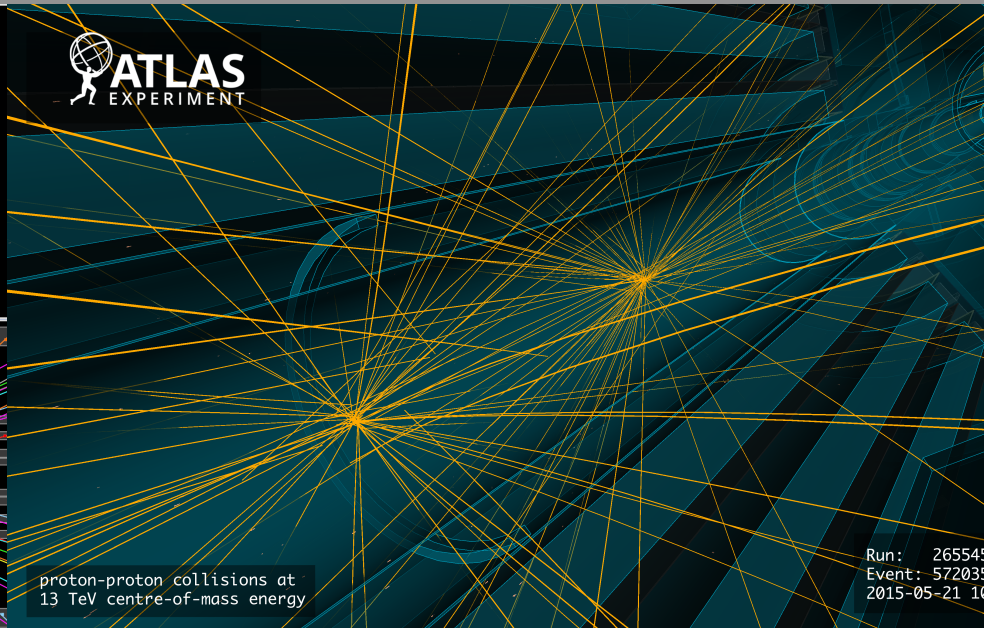
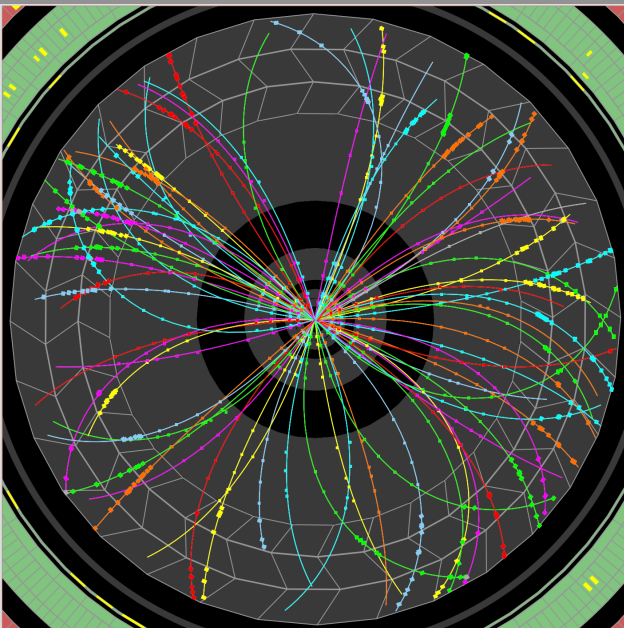
With **ATLAS**: the largest camera ever built



See what happens



Take pictures of collisions – analyse data all around the world



Mont Blanc

The *Large Hadron Collider* (LHC)

Geneva,
Switzerland

Geneva Airport



2 beams of counter-rotating protons

100 m underground

Recreate conditions billionths of a second after the big-bang



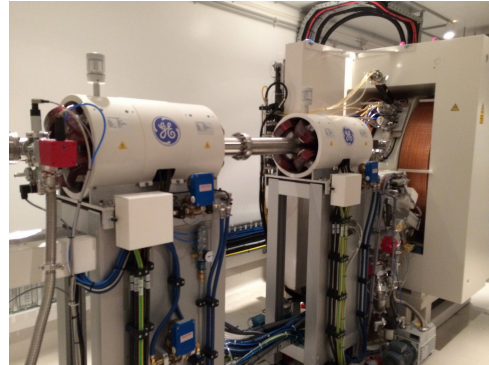
27 km

We do not have a LHC in Adelaide



Particle Physics in Adelaide

We **do** have a cyclotron here in Adelaide.....and we work with scientists at SAHMRI



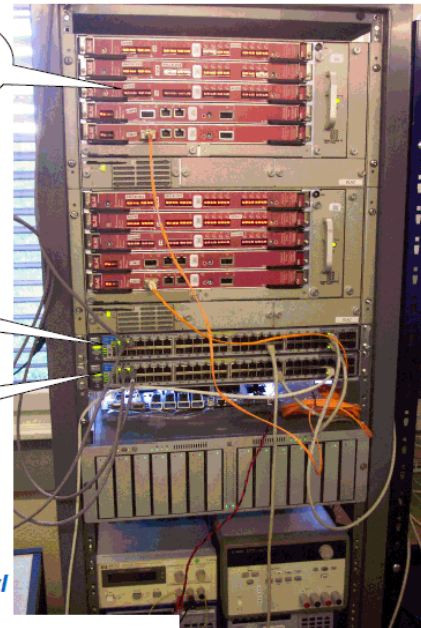
We also build equipment for future upgrades of particle physics experiments

RCE/CIM
ATCA Crates

DAQ Switch
48x1GE + 2x10GE

GPN Switch
48x1GE

HP ProCurve 3500yl
2x 10GE Y2 SR



Development/Test
Machines
2x 1GE NIC



2x Dual-3GHz Xeon

Infrastructure
Server for
DHCP, DDNS
NFS, NTP



PowerEdge 2900



STAWELL UNDERGROUND PHYSICS LAB



Australian Government
Australian Research Council

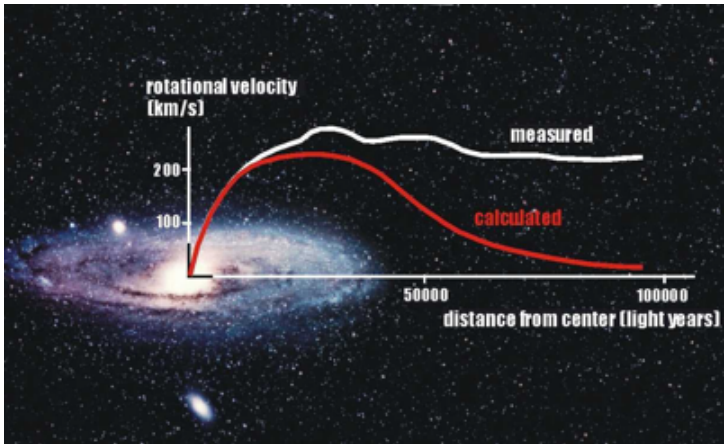


Nuclear-based science benefiting all Australians



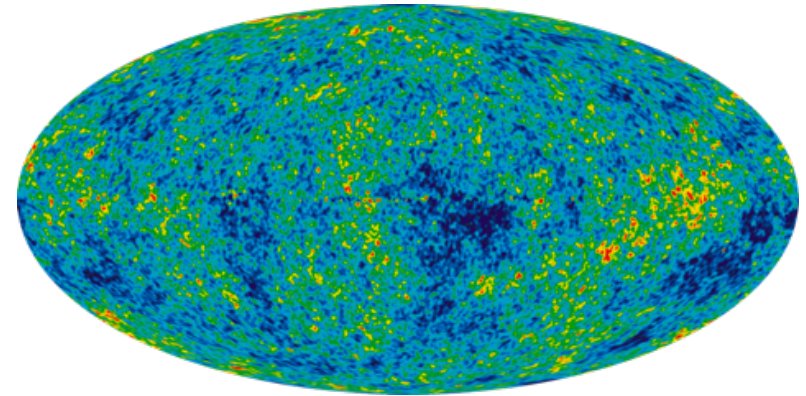
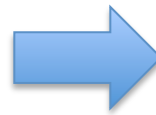
A new experimental facility in Australia to search for *Dark Matter* in a low background environment

Why look for “Dark Matter” ?



When we measure galaxies they rotate as if there is more stuff in them.

When make maps of the Universe and there are clumpy structures



Clusters of galaxies passing through one another leave tell tale signs of an invisible component.

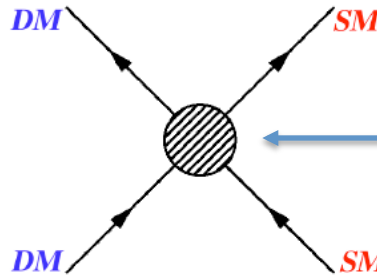
How could we Measure/Discover Dark Matter??

DM = invisible stuff we're trying to find
 SM = visible stuff we're made of



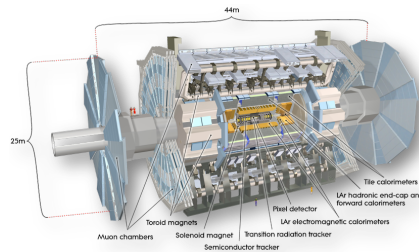
Use vast array of telescopes

"Break it"

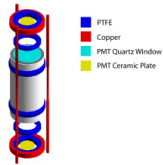


Some magic happens in here!

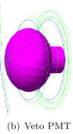
"Make it"



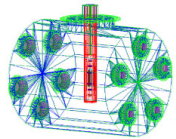
@LHC



(a) Detector Module (internal parts, NaI(Tl) crystal in grey).



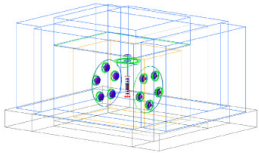
(b) Veto PMT



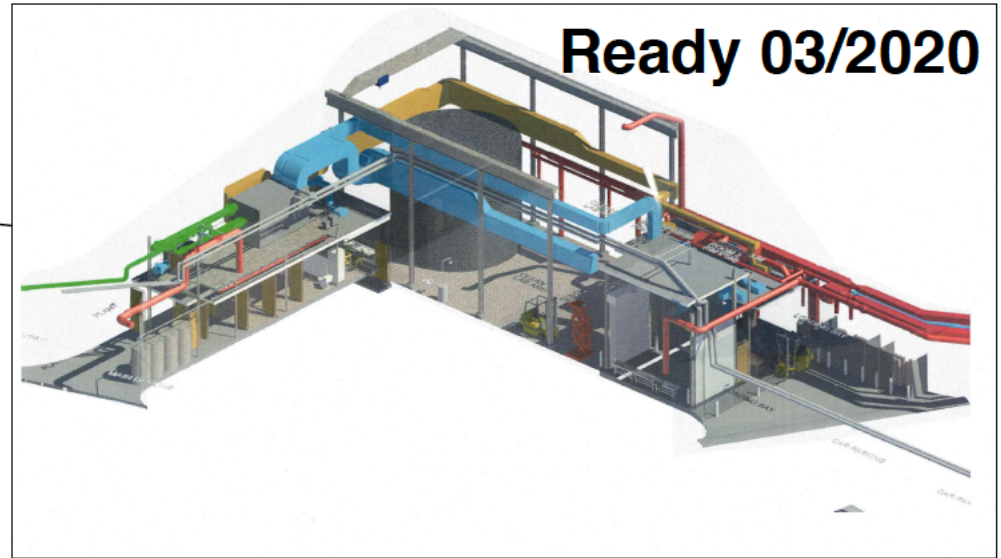
(c) Steel vessel and Crystal Insertion System (CIS)

"Shake it"

Deep underground Lab needed

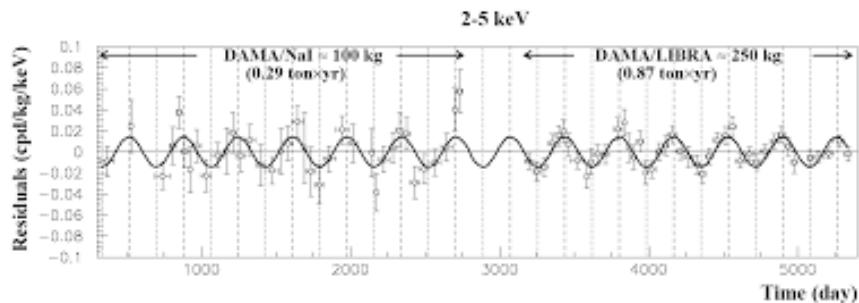
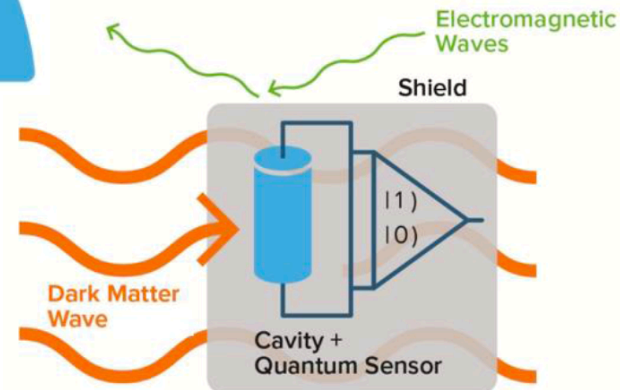


(d) Full setup including external shielding



Low background science Stawell Underground Physics Lab.

Join the search for Dark Matter, in Australia



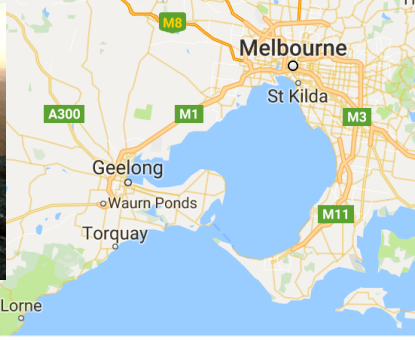


6 h 28 min
597 km

7 h 35 min

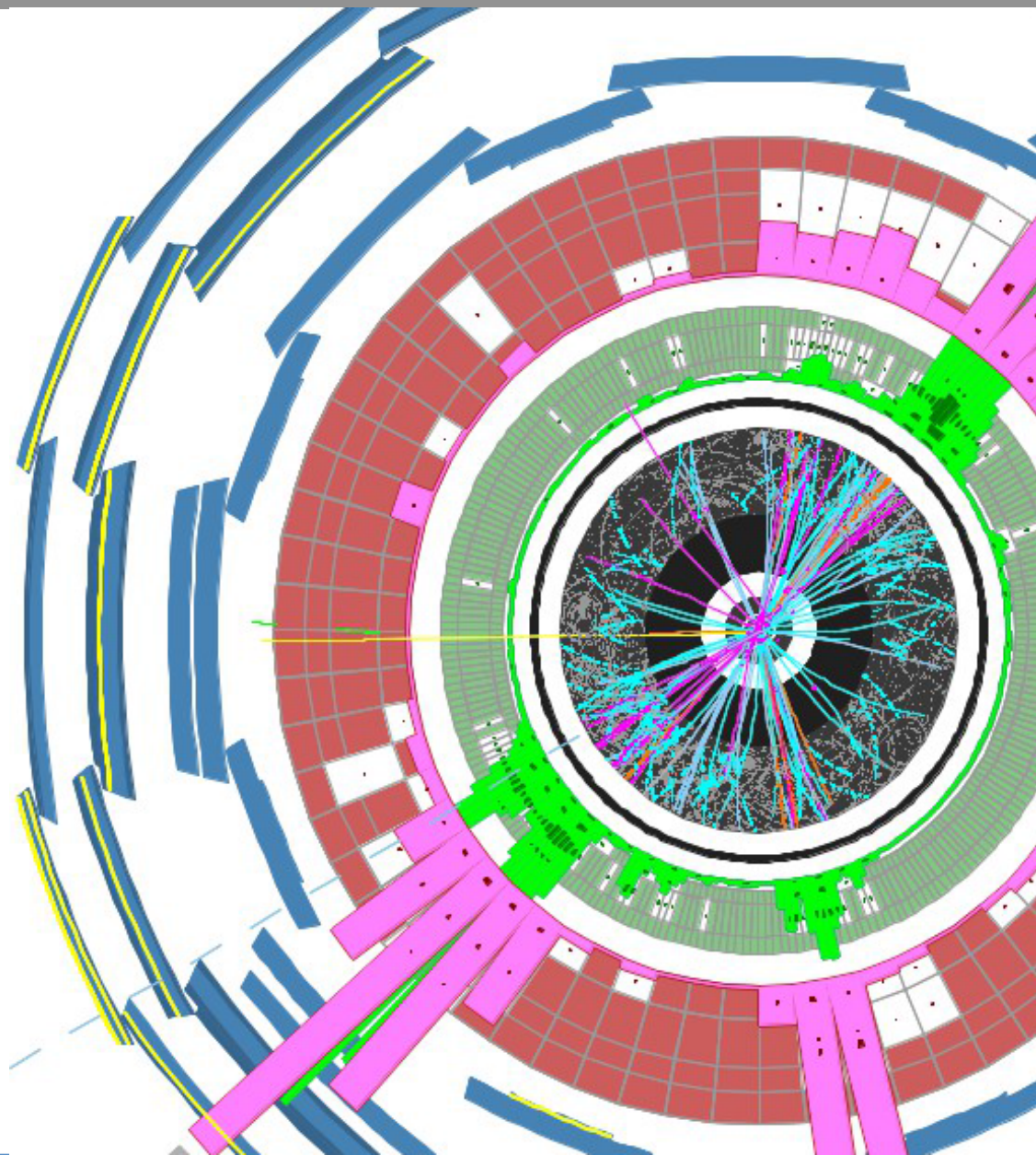
5 h 25 min
493 km

5.5 hours from Adelaide
3 hours from Melbourne



- Students commencing studies in particle physics in this era are incredibly fortunate 😊
 - *A truly unique opportunity*
 - *We have lots of capacity for new students*

The next big discovery may be made by someone who hasn't yet started researching in the field – ***join us!!***





THE UNIVERSITY

of ADELAIDE

CENTRE FOR DARK MATTER PARTICLE PHYSICS

Video credit: Renaud et al. (2017)



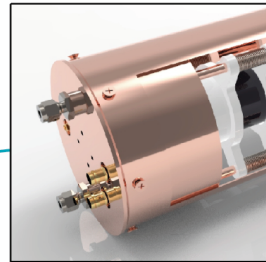
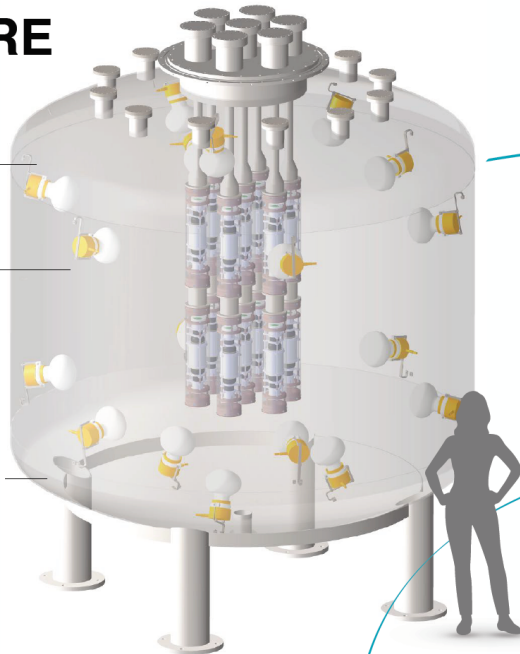
SABRE

20 cm oil-proof PMTs

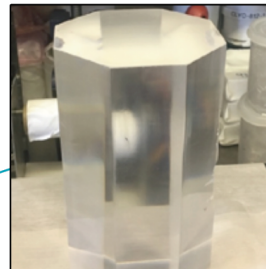
Liquid scintillator

Steel vessel with vibration damping

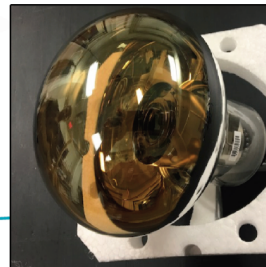
Copper enclosure



New low radioactivity
engineering techniques



Highest purity NaI
crystals ever made!



Low radioactivity
photon detectors



<https://www.darkmatter.org.au/>

DIRECT DETECTION

Earth moves through a dark matter halo and these experiments can directly detect that wind

The Centre will construct and operate state-of-the-art dark matter direct detection experiments in Australia, at SUPL and UWA, and play an important role in international experiments. It will contribute to the design of completely new detection technologies to enable even greater sensitivity, via a robust R&D program in collaboration with ANSTO and DST Group.

SUPL Status

Occasional updates on the progress of the Stawell Underground Physics Laboratory.



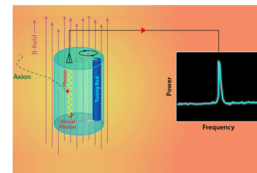
**SABRE South status :
vessel construction**

Fabrication of the vessel for SABRE South has been completed.



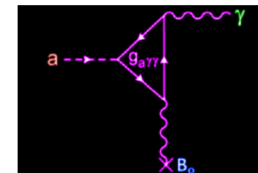
The ORGAN at UWA

An axion-detection experiment at the University of Western Australia.



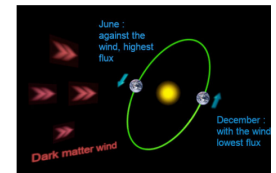
To catch an axion

How does one detect an axion?



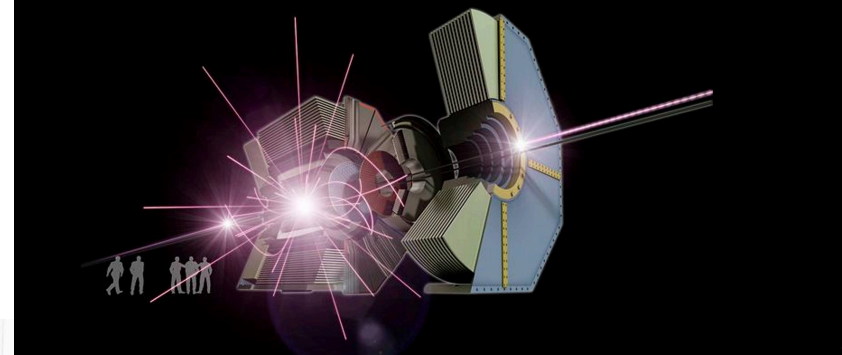
Axions - the lighter alternative

Lighter than a WIMP, but more of them...

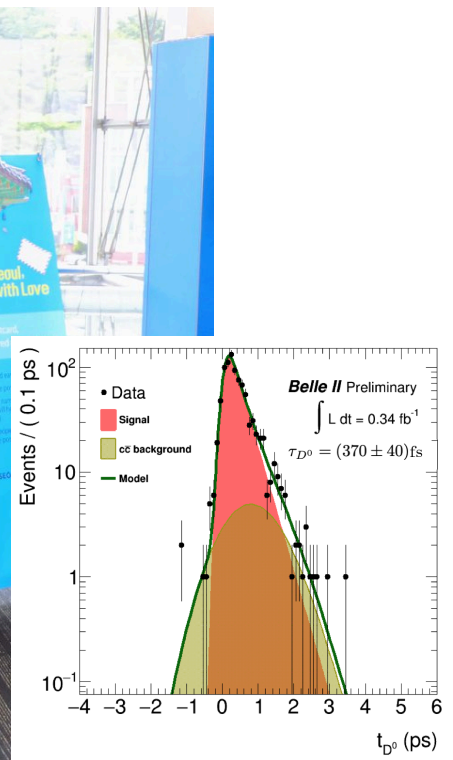


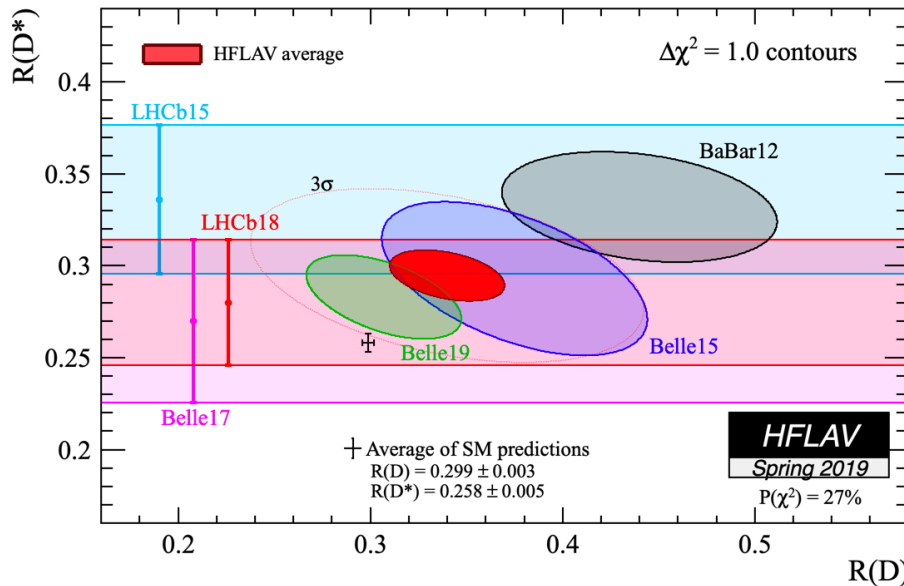
Tuning in to A.M.

Why we would expect an annual variation in the dark matter count rate.

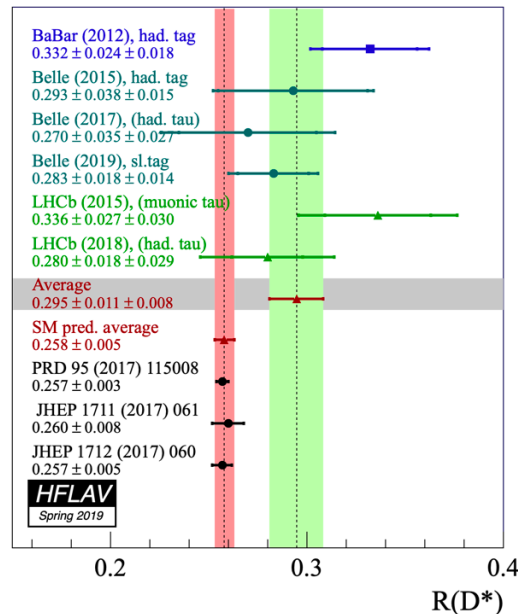
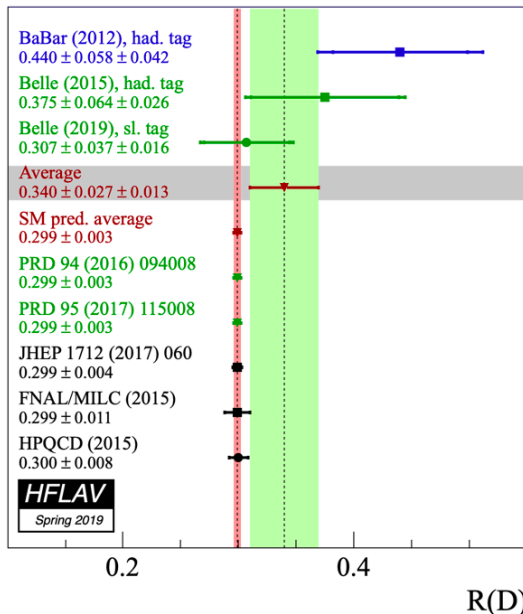
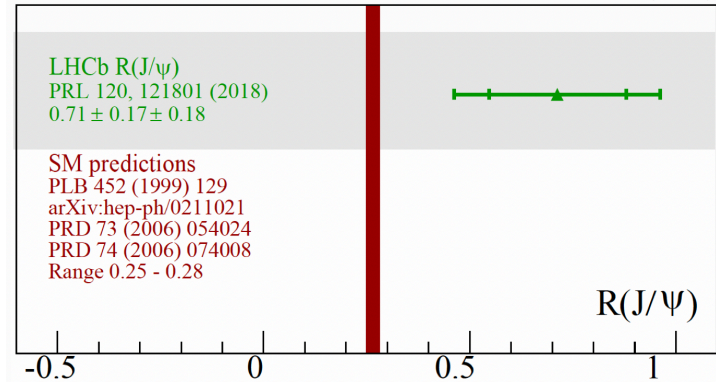


Belle II now has grown to ~947 researchers from 26 countries





Persistent deviations from SM expectations!



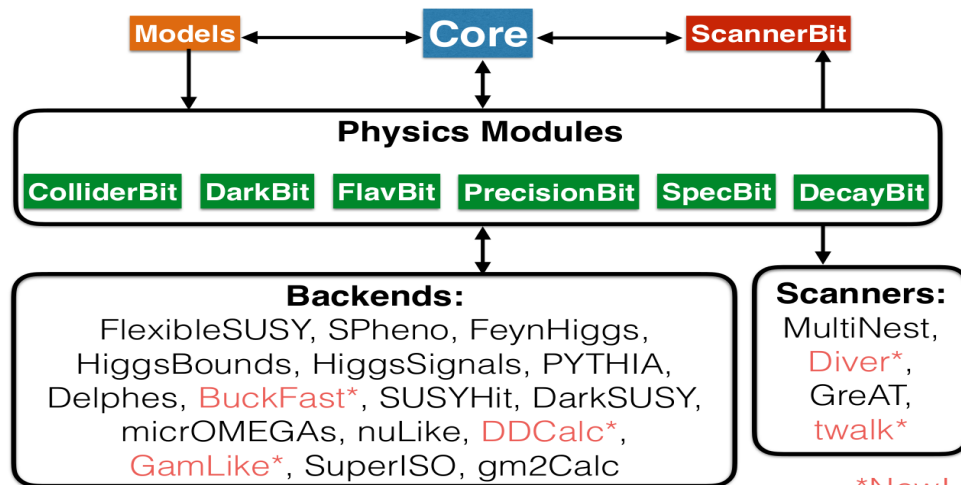
Combined significance $\sim 4\sigma$

Three experiments,
 10 measurements, all above
 the SM prediction
 using different techniques

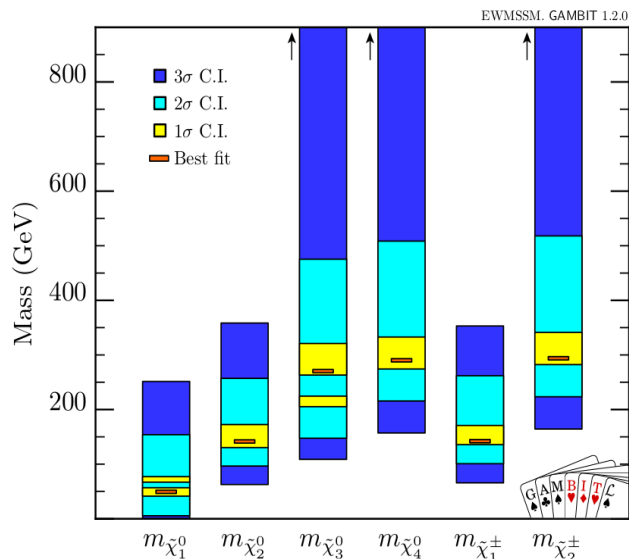


30+ physicists:
Adelaide
co-leader

Global And Modular BSM Inference
Tool - used to combine datasets
from many expts – large scale data
science challenge – new techniques
developed to solve

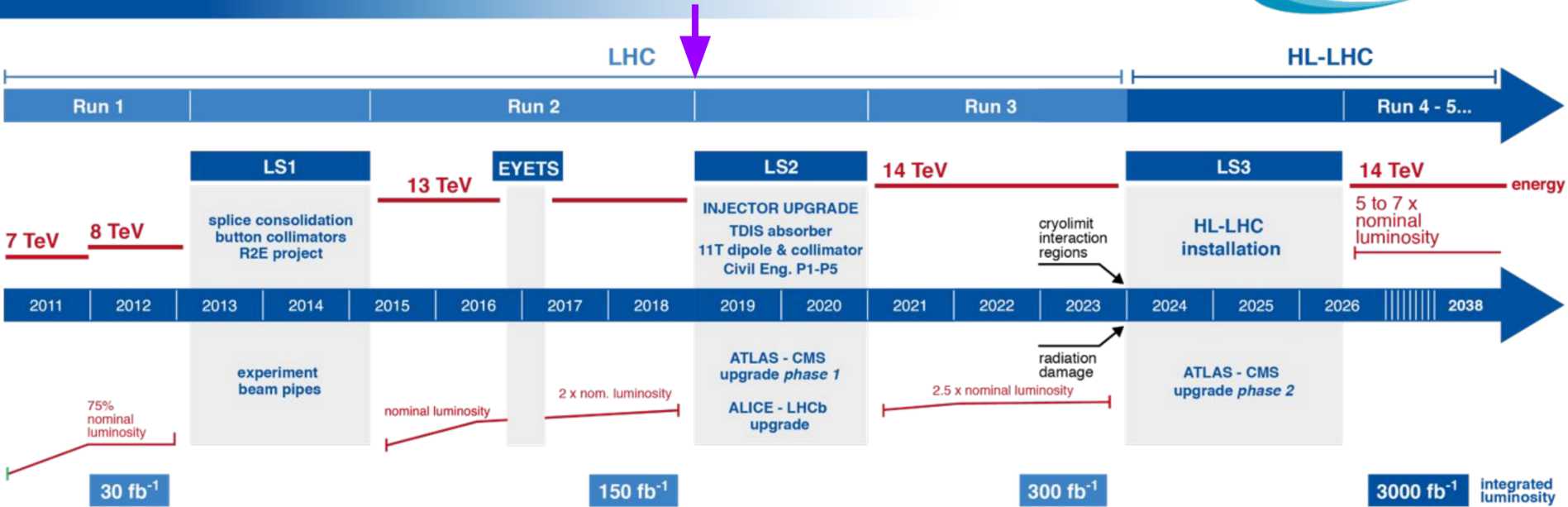


GAMBIT takes the best codes, and a variety of new packages and combines them to test measurements from various different sources.

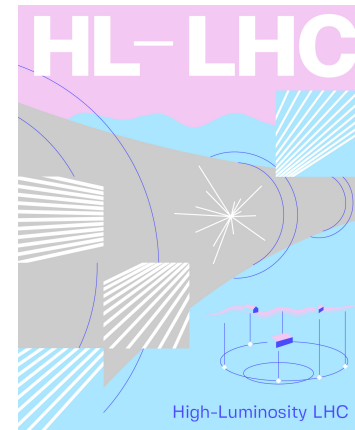


We can test models for new physics against data we collect in our expts. *This leads to a predictions for masses of new particles.*

LHC / HL-LHC Plan



- LHC Run 1 and Run 2 have been completed.
 - Data analyses in full progress.
- LS2 (Long Shutdown 2019-2020) is **underway**
 - ATLAS Phase I Upgrade.
- LS3 (Long Shutdown 2024-2026) after Run 3.
 - LHC - Major Upgrade to HL-LHC (High Luminosity LHC).
 - ATLAS - Phase II Upgrade.

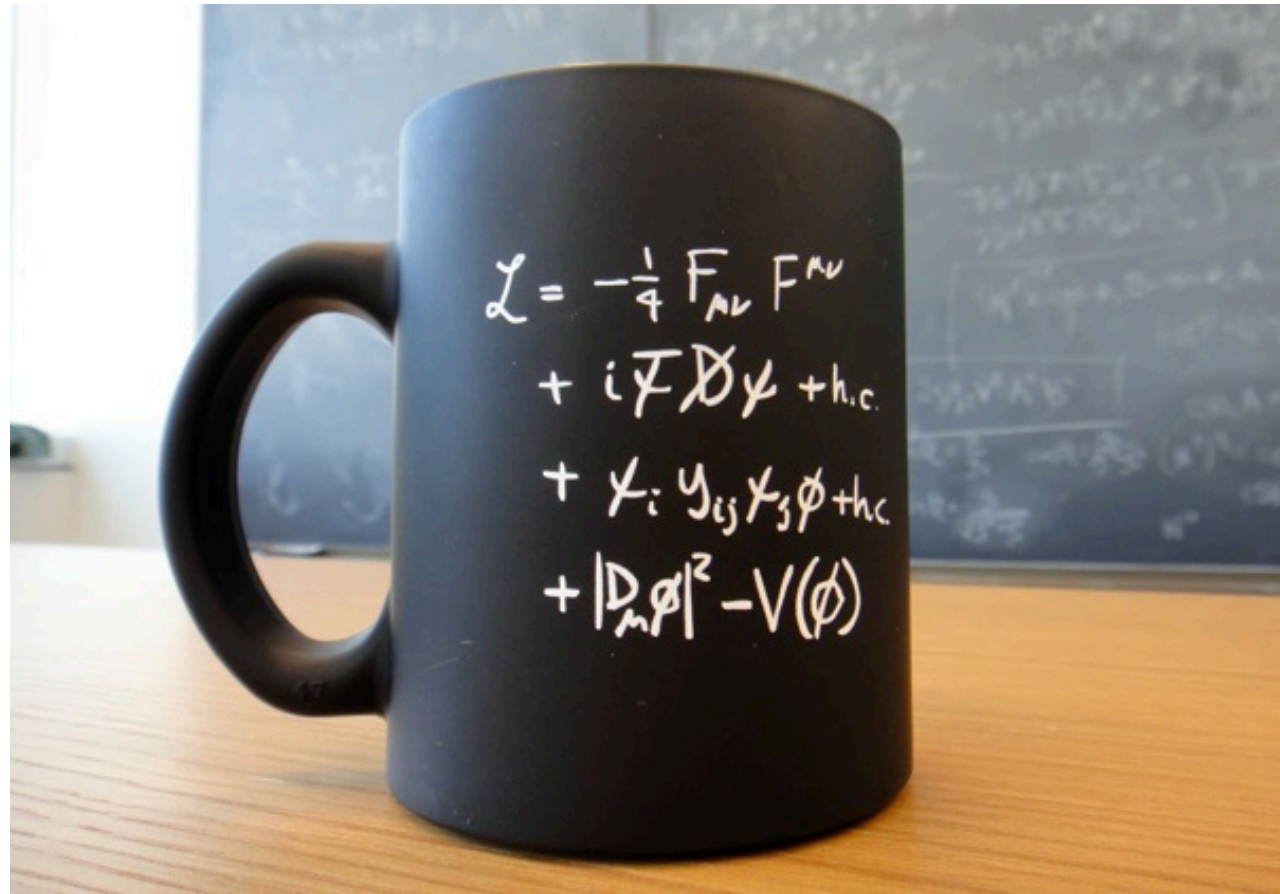


Symmetric

Simple

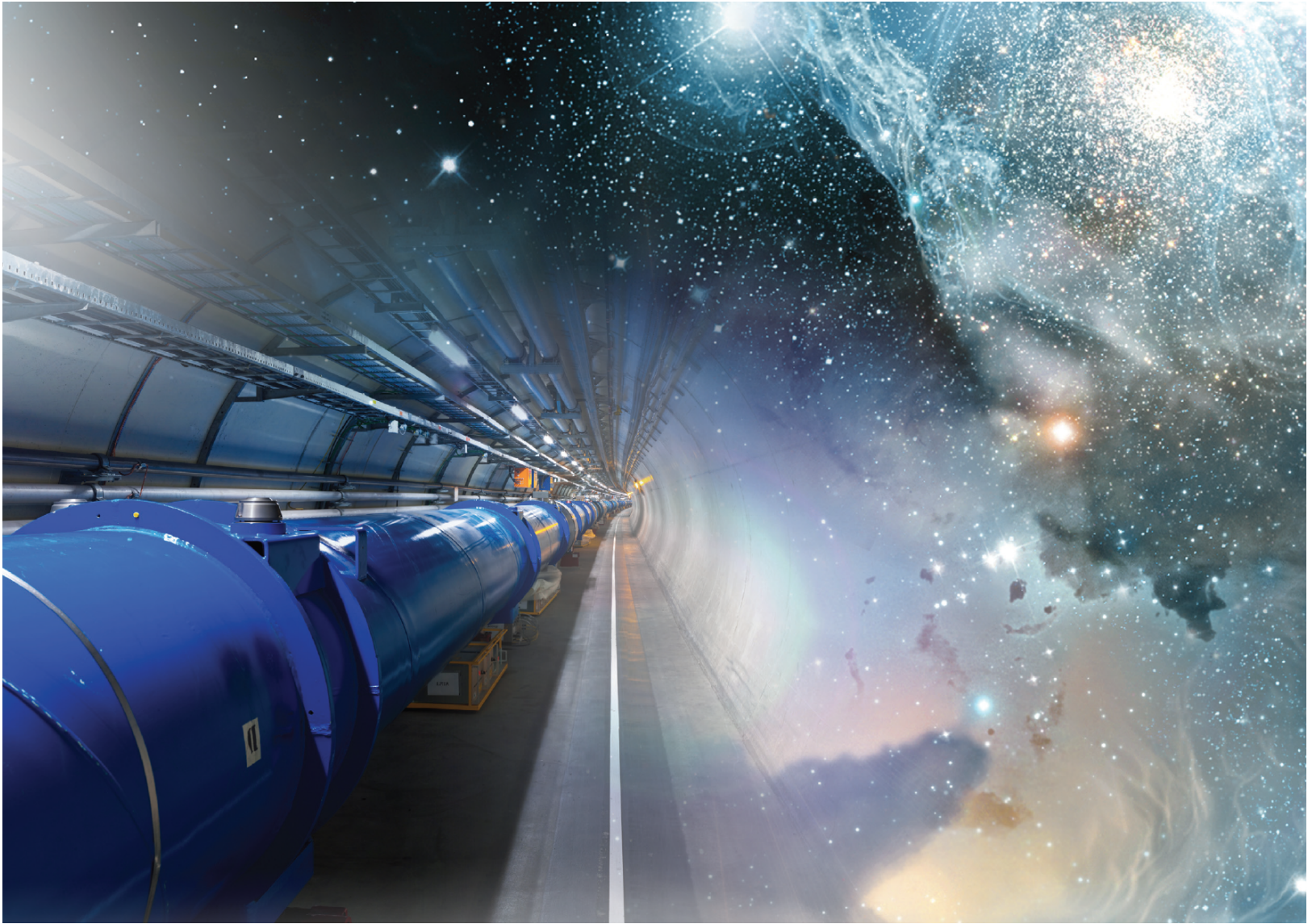
Elegant

Predictive



Our theory friends calculate things.....

We build detectors , make a computer simulations and test theory with our data!!



Since 1936, as many as 24 of the Nobel Prizes awarded for Physics were for contributions based on the use of accelerators (i.e. particle physics)