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MAKING DETECTOR - CORRECTED MEASUREMENTS USING THE LHC DATA

Students:

Cristiana Oana

Matei Plescan

Supervisor:

Louie Corpe

WHAT DID WE REALLY DO?

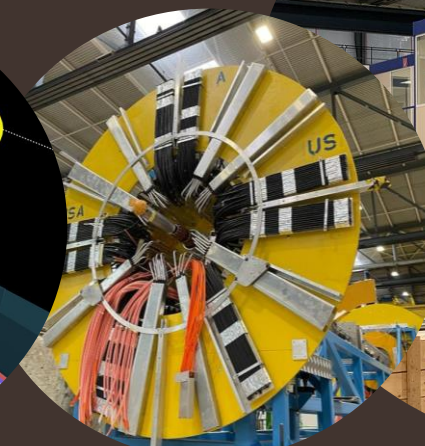
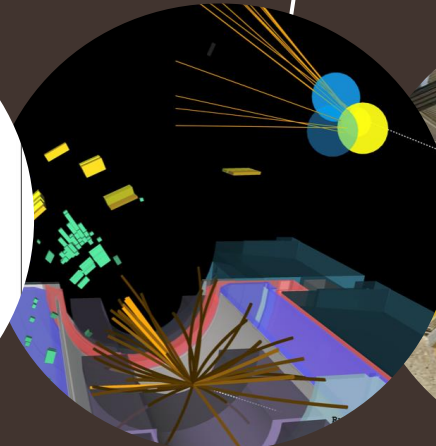
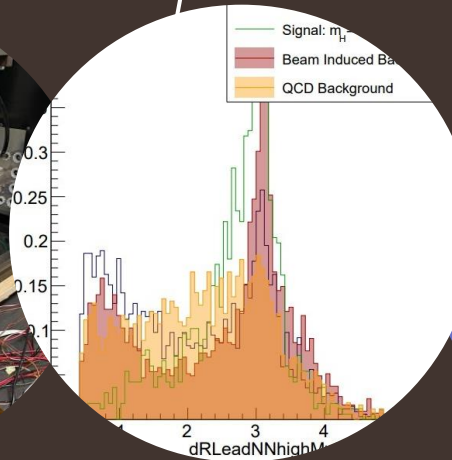
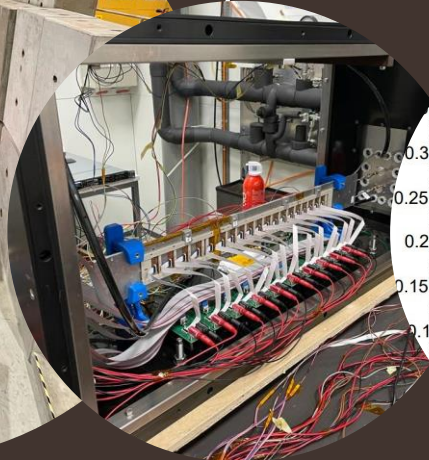
How do we design new detectors? (the North Area)

Designing searches (separating signal from background)

Visiting ATLAS, Large Magnet Facility, the North Area

Cooling systems

Measurements (studying neutrinos & dark matter)

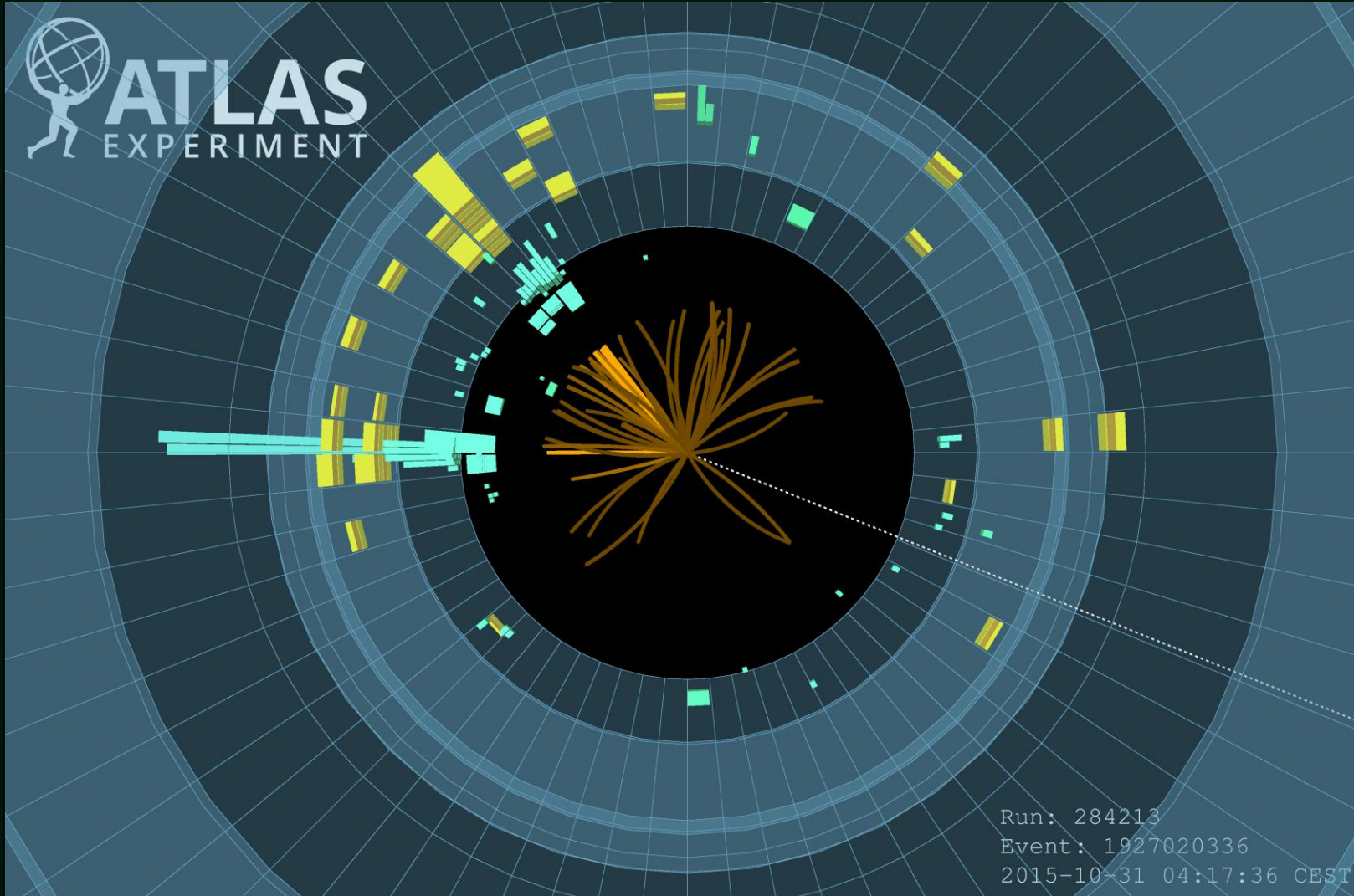


MEASUREMENTS NEUTRINOS & DARK MATTER

During the proton-proton collisions, many processes can occur. We are looking to find out if the Standard Model explains well those that happen in nature. ATLAS is specifically designed to detect particles, but some of the outcome, such as invisible particles, may escape it unnoticed.



HOW DO WE KNOW THEY'RE HERE?

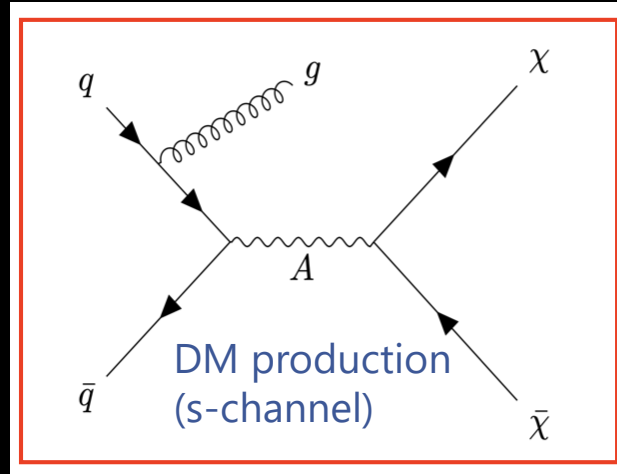
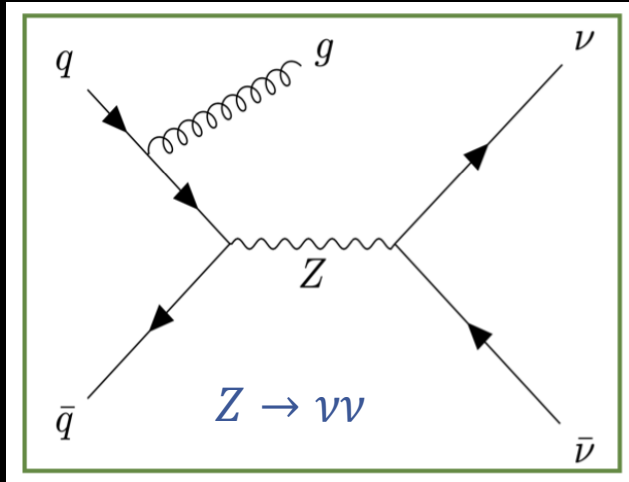


We obviously cannot see them.

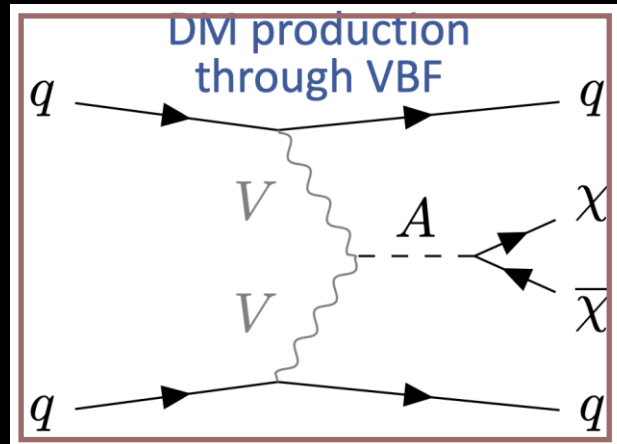
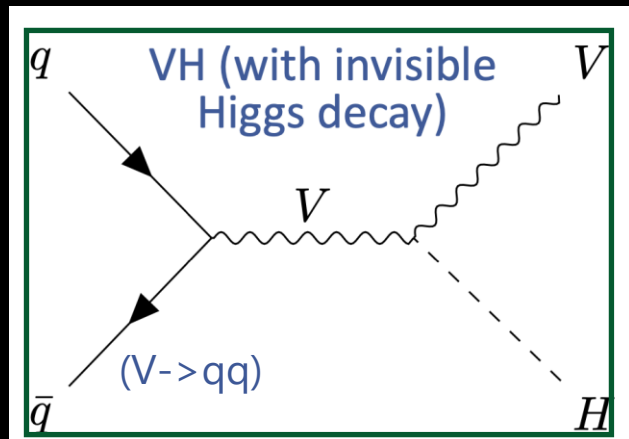
But we can indirectly notice them by measuring their missing energy (or mass) when proton-proton collisions occur.

Standard Model

Dark Matter (DM) Production

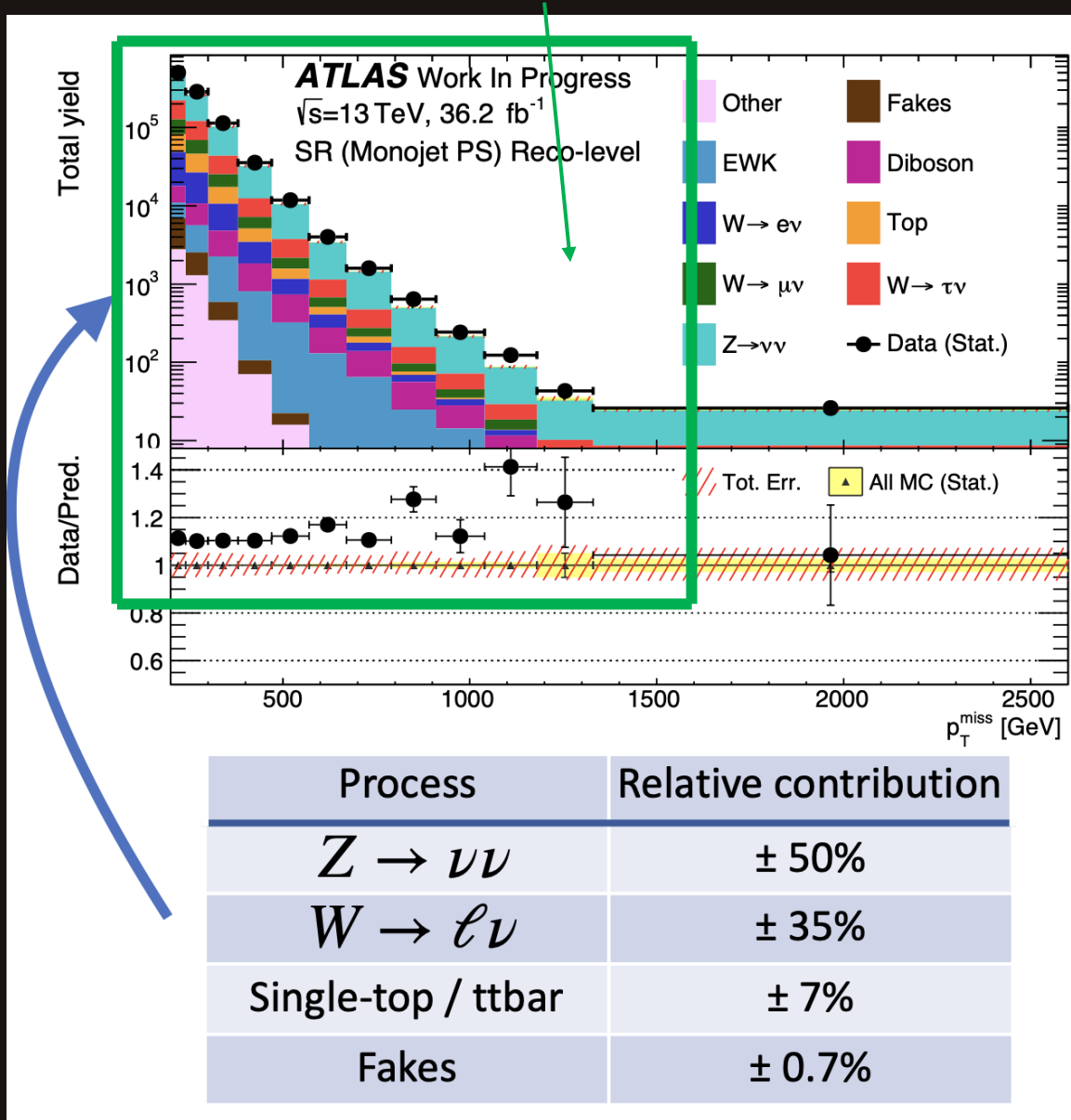


Missing energy + 1 jet



Missing energy + 2 jets

WORK IN PROGRESS



Here you can see how we're looking for abnormalities in the data we collect, using statistical models & predictions.

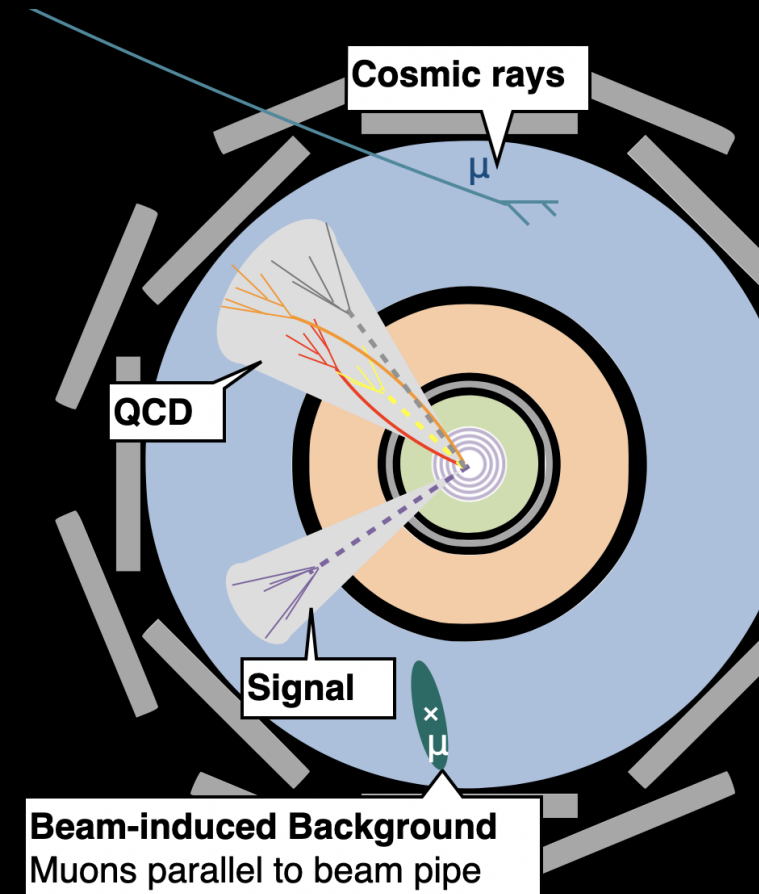
DARK MATTER OR MISMODELLING?

DESIGNING SEARCHES SEPARATING SIGNAL FROM BACKGROUND

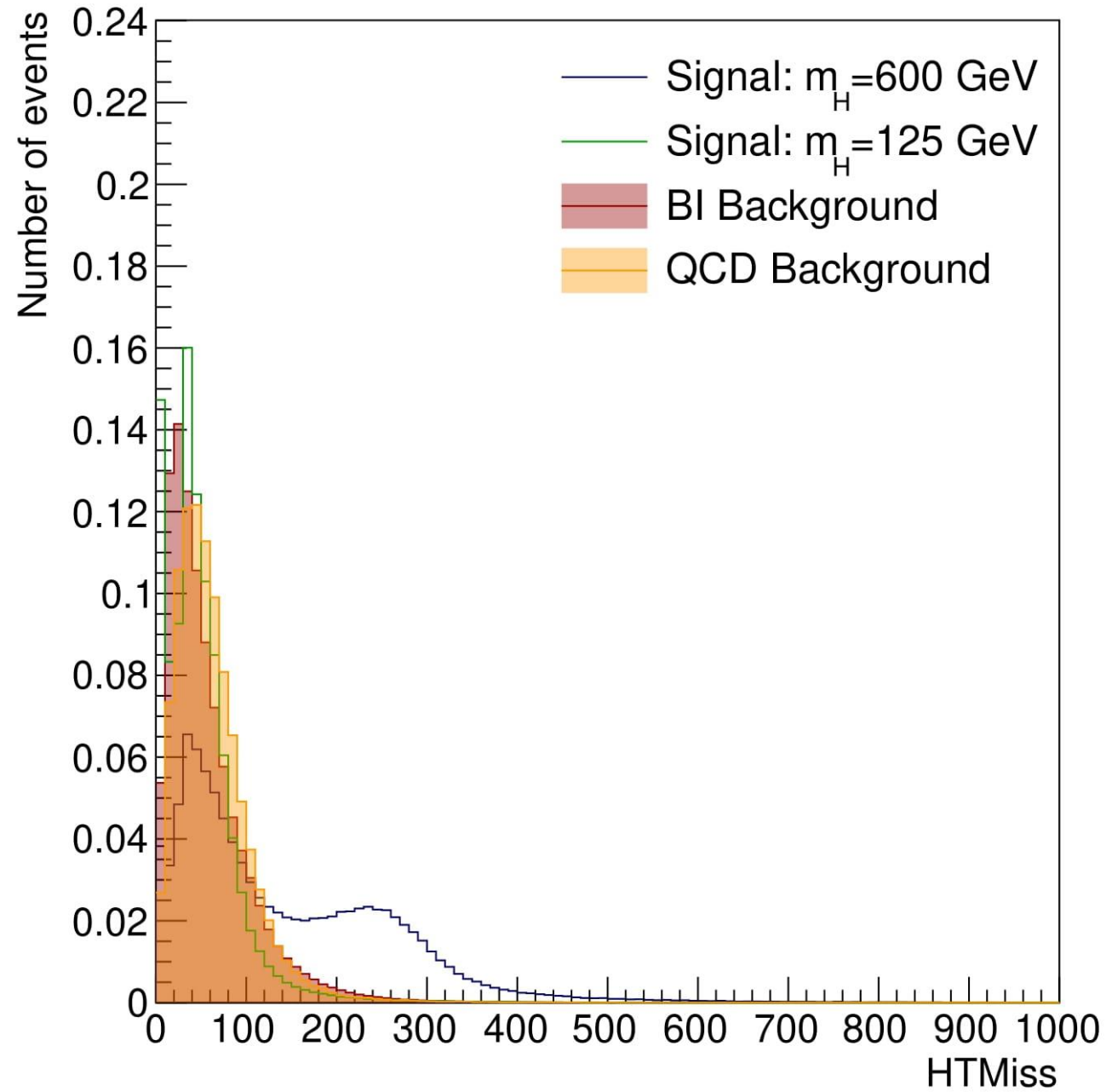
SOFTWARE

```
1 counter+=1
2 varValue = getattr(signalEvent, var)
3 histogram_signal1.Fill(varValue)
4 print(var , varValue)
5 if counter > maxEvent : break
6
7 counter=0
8 for backgroundEvent in background1Tree:
9     counter+=1
10    varValue = getattr(backgroundEvent, var)
11    histogram_background1.Fill(varValue)
12    print(var , varValue)
13    if counter > maxEvent : break
14
15 counter=0
16 for signalEvent in signal2Tree:
17     counter+=1
18     varValue = getattr(signalEvent, var)
19     histogram_signal2.Fill(varValue)
20     print(var , varValue)
21     if counter > maxEvent : break
22
23 counter=0
24 for backgroundEvent in background2Tree:
25     counter+=1
26     varValue = getattr(backgroundEvent, var)
27     histogram_background2.Fill(varValue)
28     print(var , varValue)
29     if counter > maxEvent : break
30
31 histograms_background1[var] = histogram_background1
32 histograms_signal1[var] = histogram_signal1
33 histograms_background2[var] = histogram_background2
34 histograms_signal2[var] = histogram_signal2
35
36 c = r.TCanvas("c","c", 500, 500)
37
38 for var, ranges in listOfVariables.items():
39     histograms_signal1[var].Draw()
40     histograms_background1[var].Draw("same")
41     histograms_signal2[var].Draw("same")
42     histograms_background2[var].Draw("same")
43
44 c.Print(var+".pdf")
```

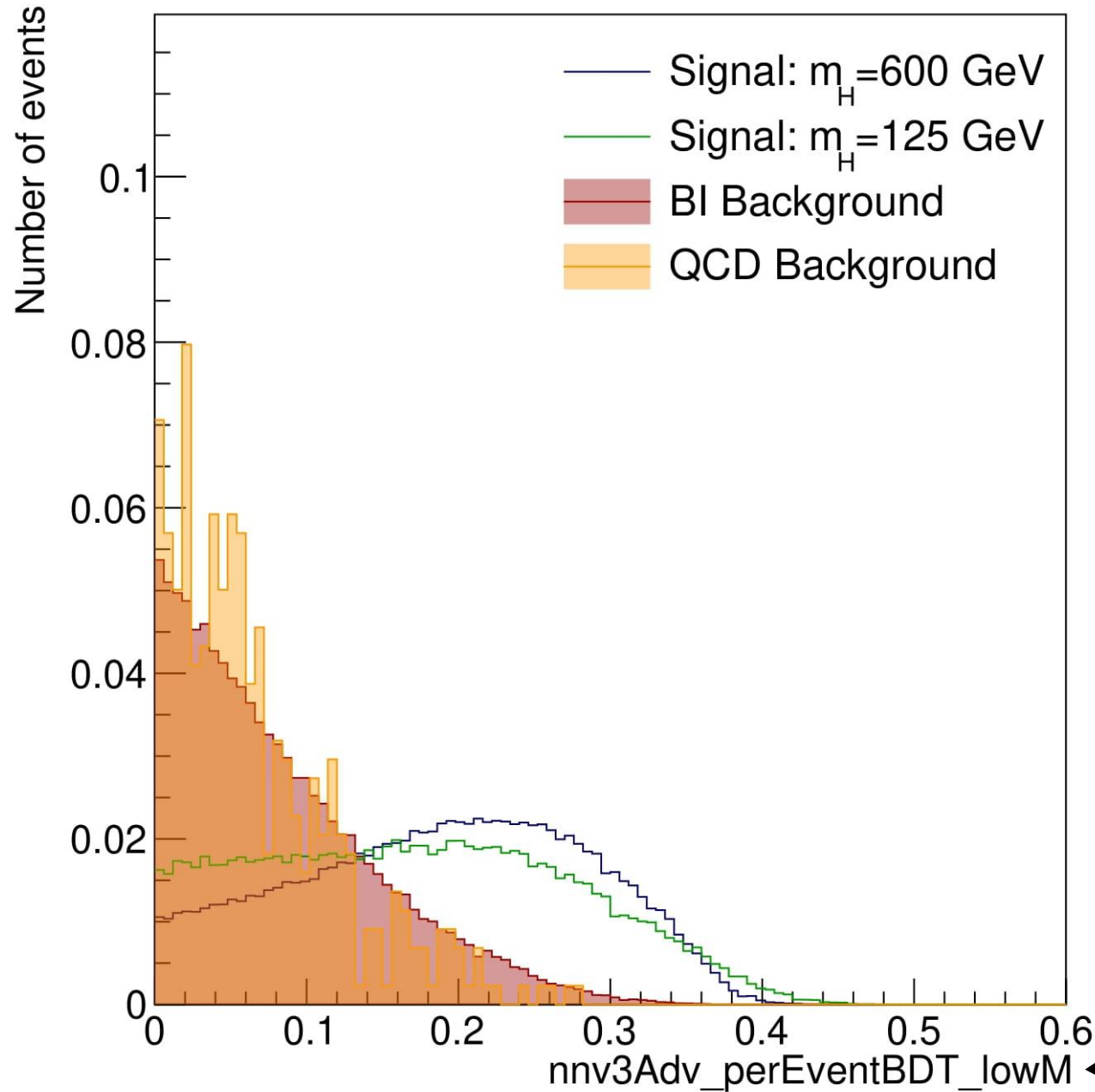
We used simulated LHC data in order to create selections which could be used to ease the search for long-lived particles from proton-proton collisions in ATLAS.



The search for long-lived particles

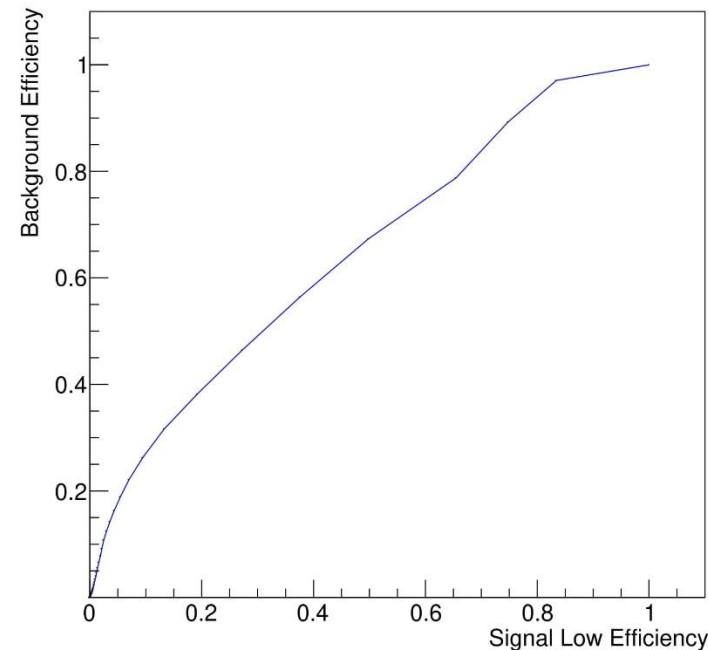
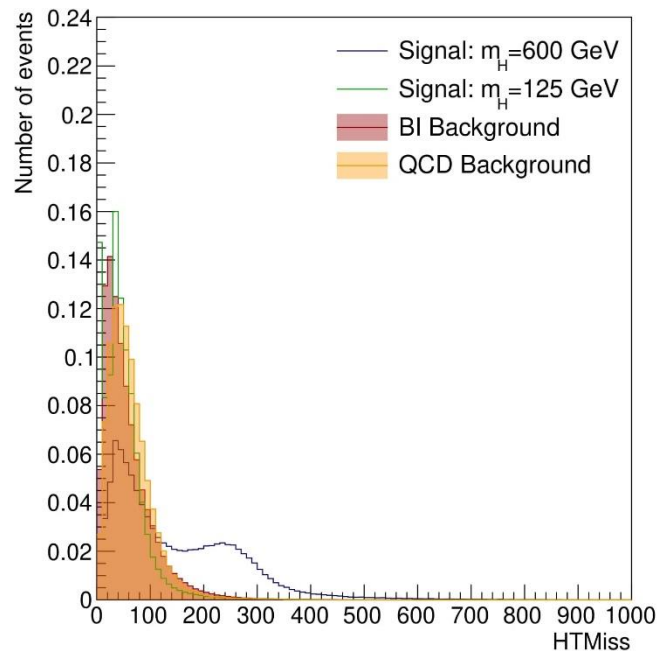


The search for long-lived particles

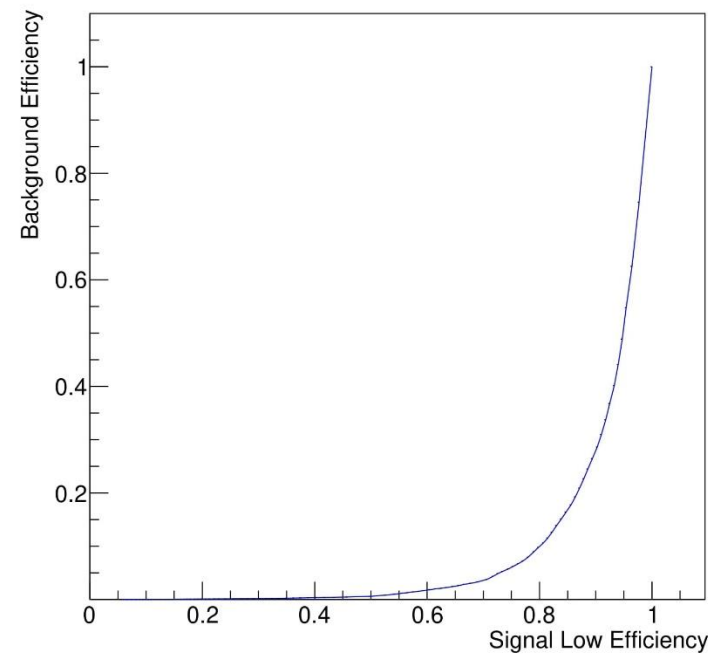
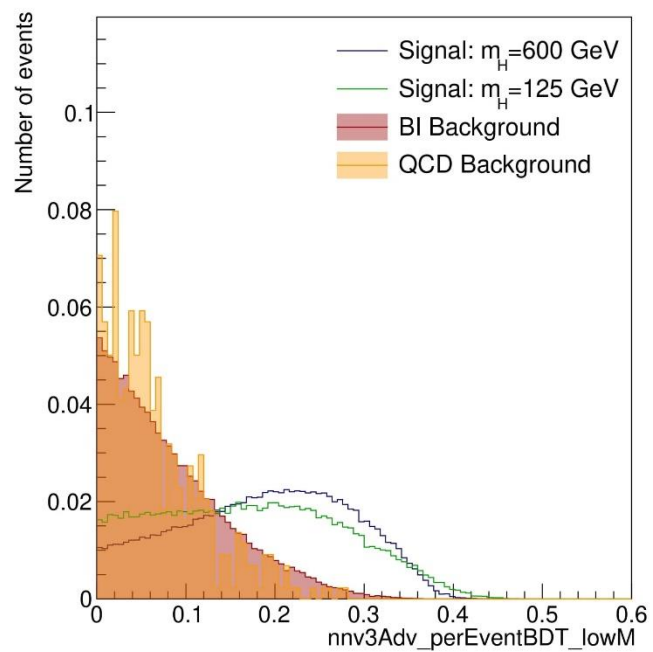


AI-assisted selection
targeting low mass signal
particles

The search for long-lived particles

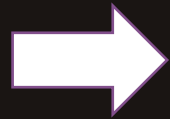


The search for long-lived particles

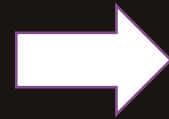


NEW DETECTORS

Resolution of 25 ps

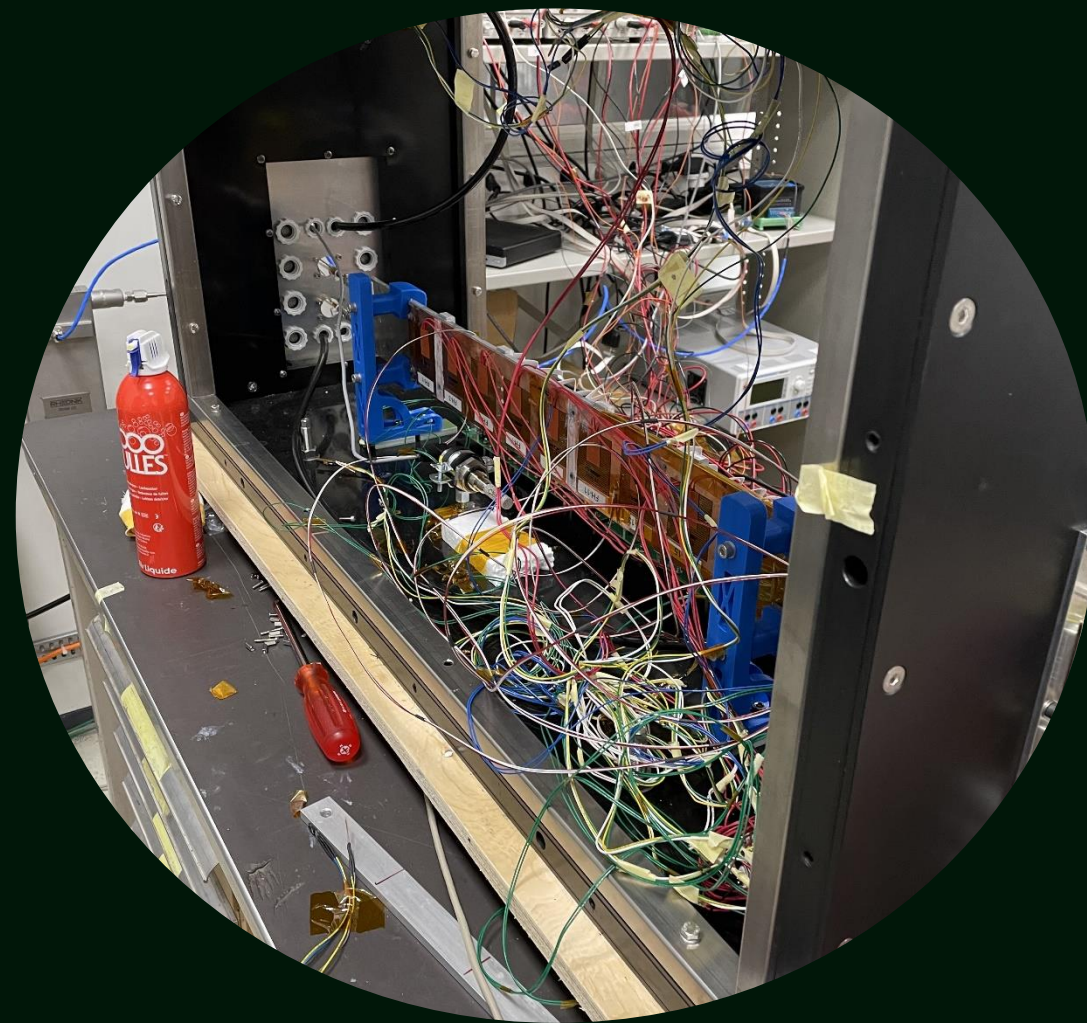
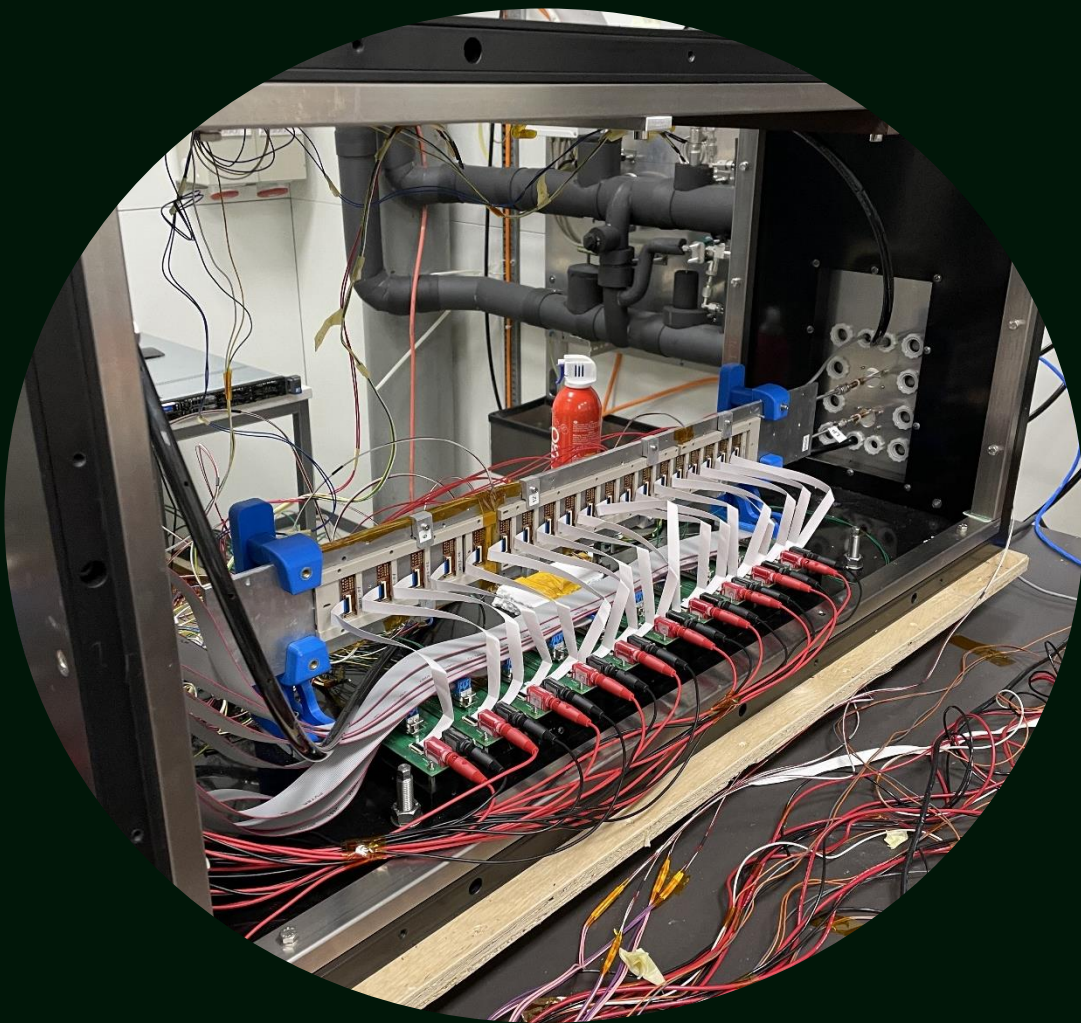


Better tracking



Better
differentiation
between signal and
background

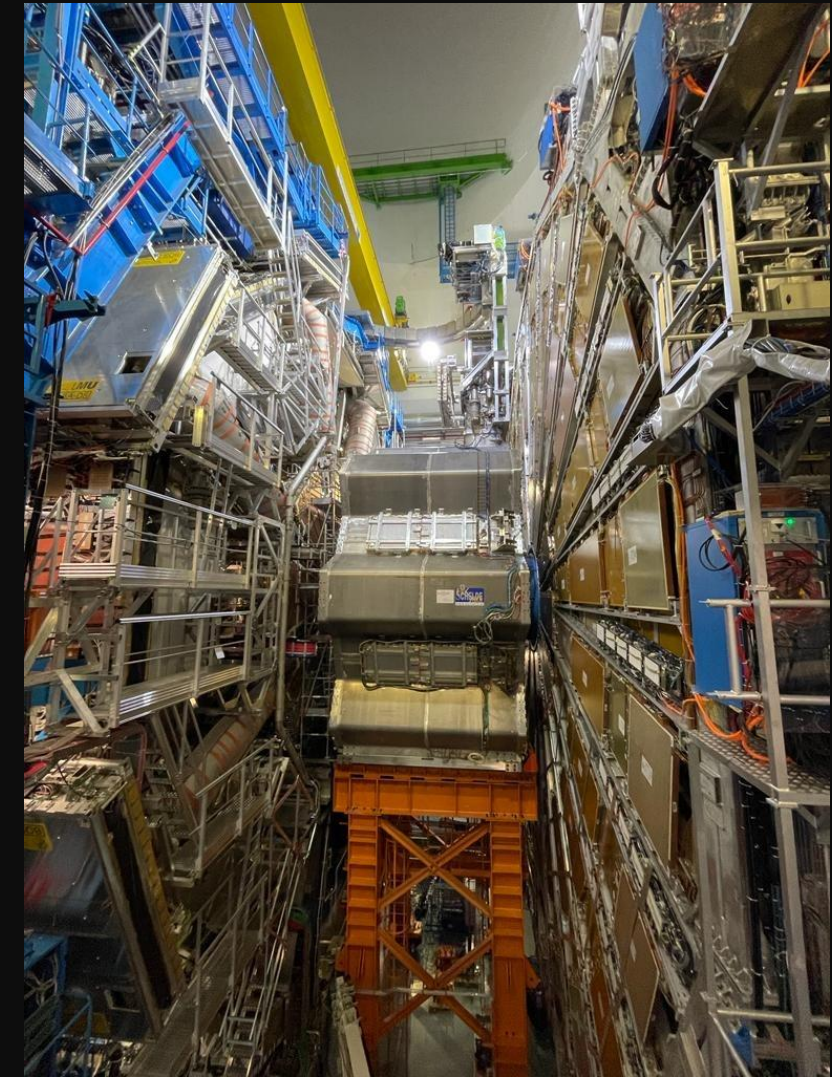
Cooling systems for new detectors



A wide-angle photograph of a large industrial facility, likely a particle accelerator component manufacturing plant. The scene is filled with massive concrete structures, metal frameworks, and various pieces of machinery. In the foreground, there are red perforated metal plates and black boxes with labels like '116'. To the right, a yellow structure has a label 'HNA 390'. Further right, a black cabinet is labeled 'YDAP PPE182'. The floor is a mix of concrete and green-painted sections. The lighting is bright and even, typical of an industrial interior.

EXPLORING CERN – ATLAS,
Large Magnet Facility, The North
Area & many more









Special thanks to
Louie and all the
organizing team!

