ATLAS at the LHC

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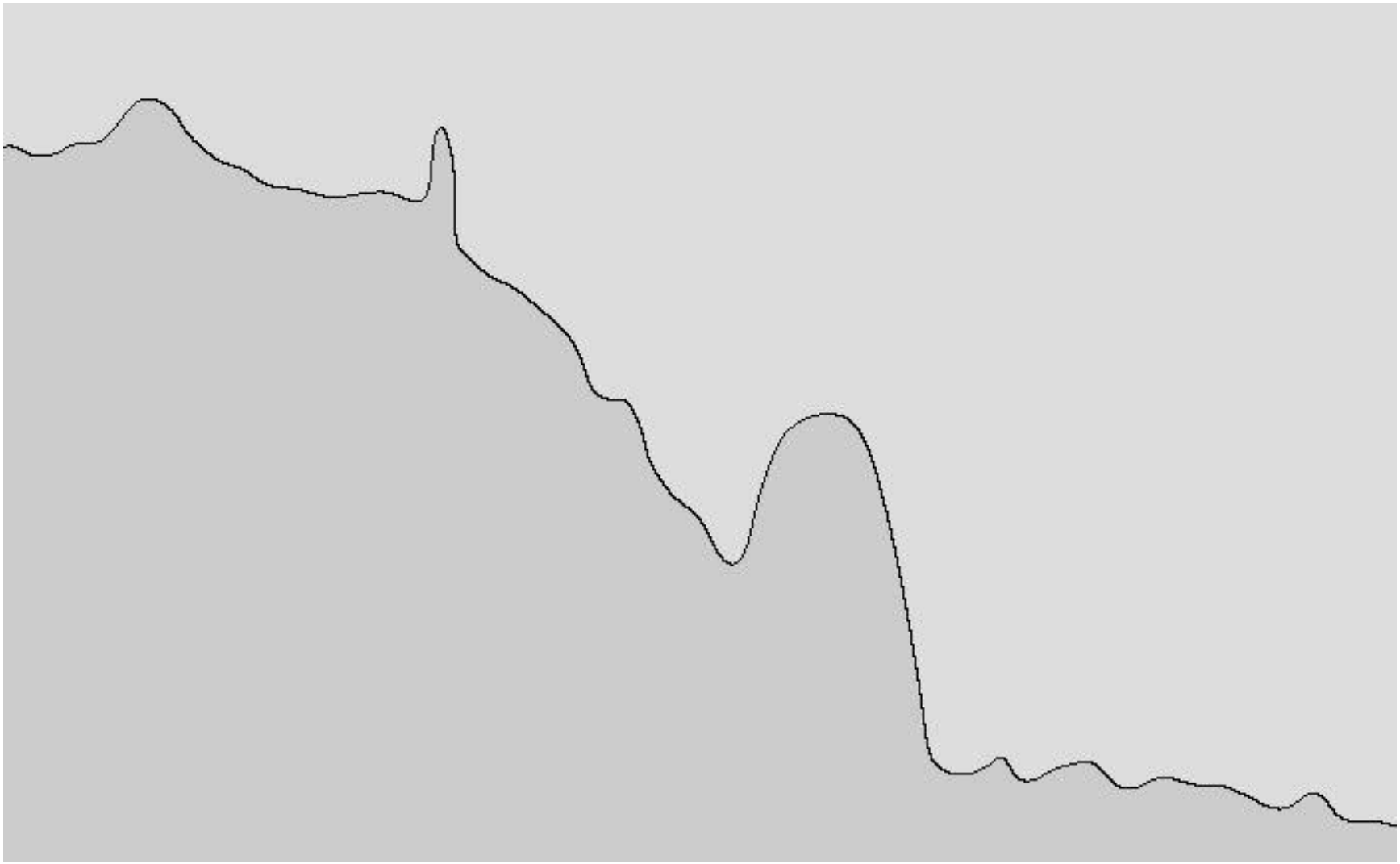
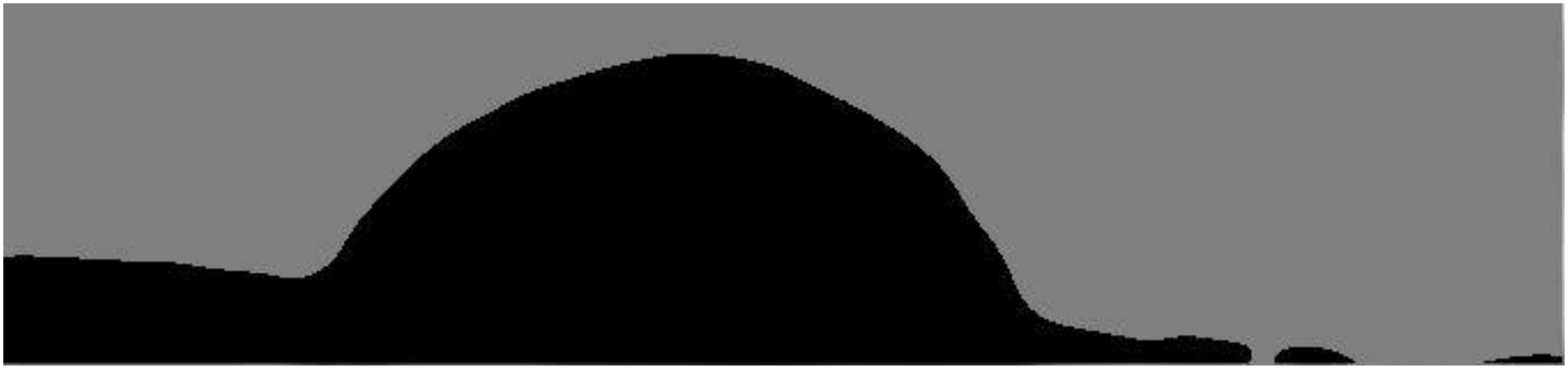
Announcing My Great Discovery!

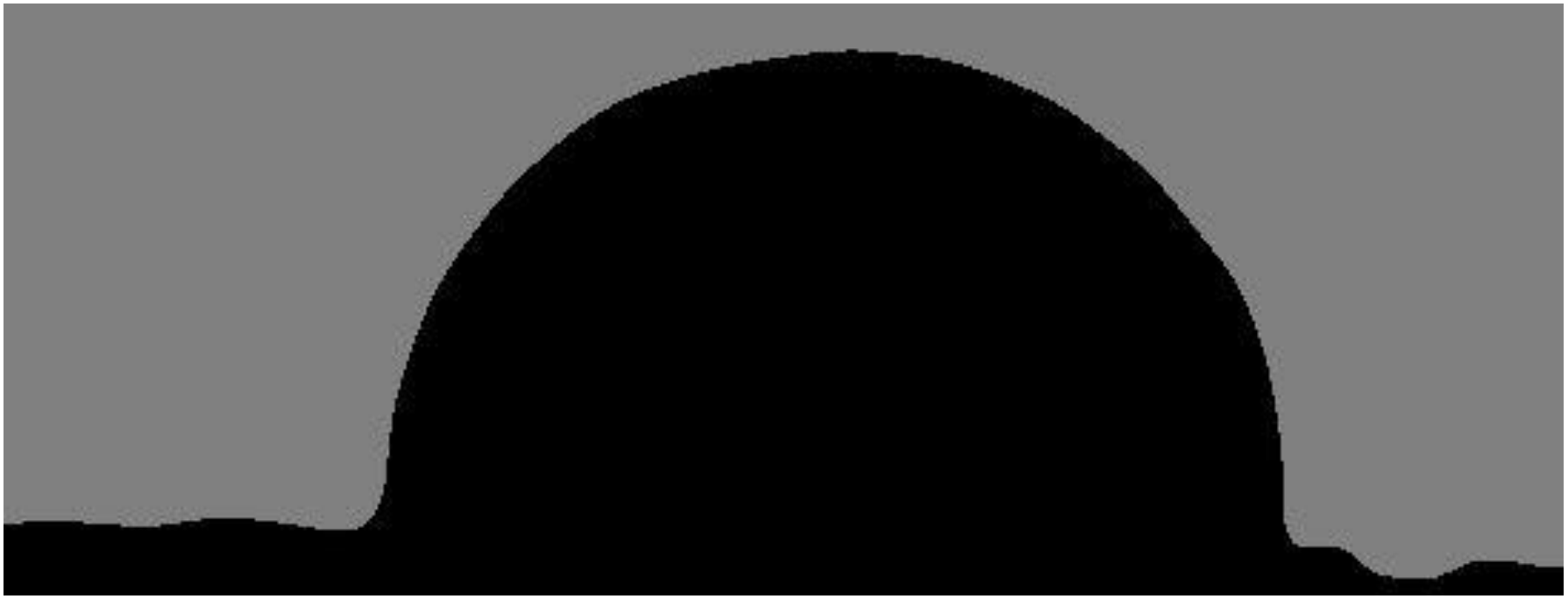
Raw Data



Reduce The Background:

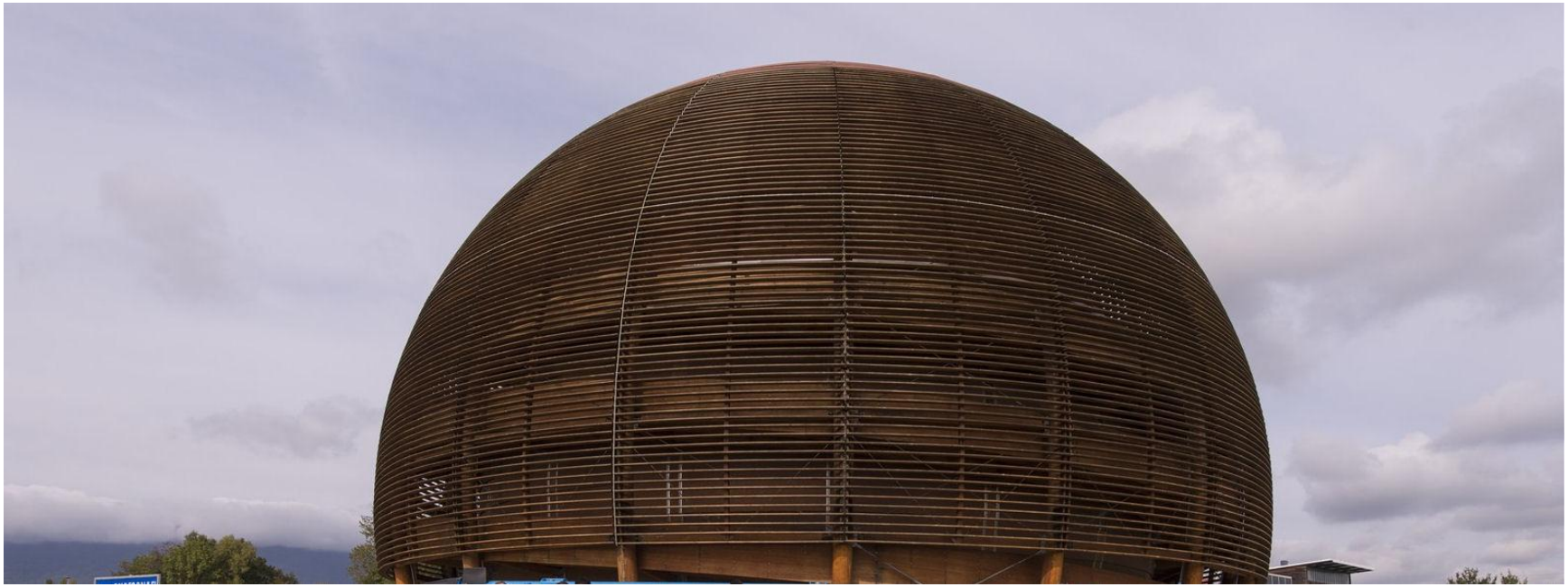


Refine the Signal:



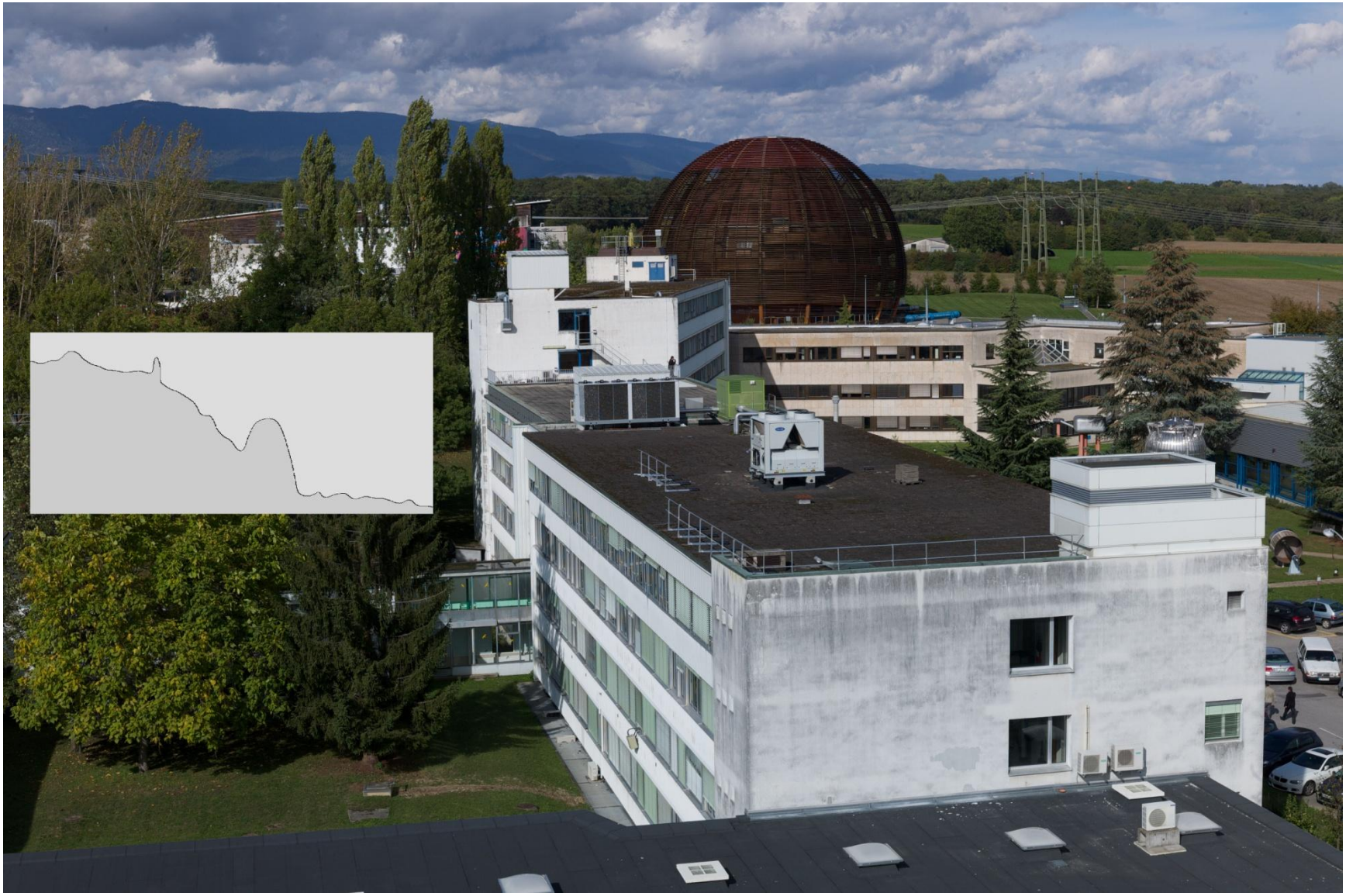
No Doubt about it, a clear signal!

Next, Identify the Discovery:



I’m Delighted to say, I’ve discovered The CERN!


Accelerating Science
Accélérateur de science



And I’ve Discovered Much More:

I’ve discovered others who have also discovered CERN!

Newcomers:

Notice the diversity of, gender, race, age, eye color, hair color-length-curvature, and clothing; but all have one trait in common:

It’s the big smile!

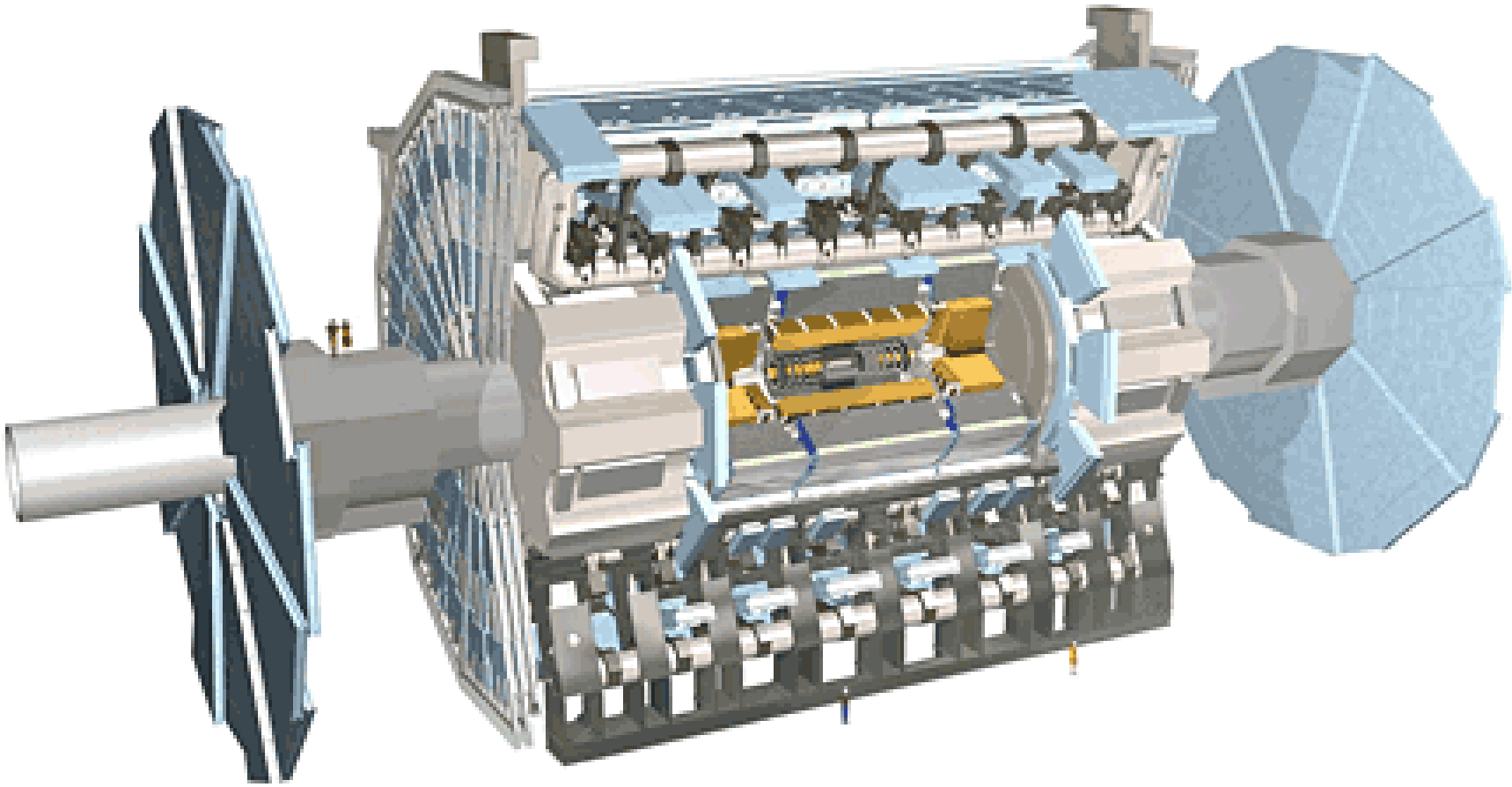
Time to get down to business:

The reality is that physics research will harden you.

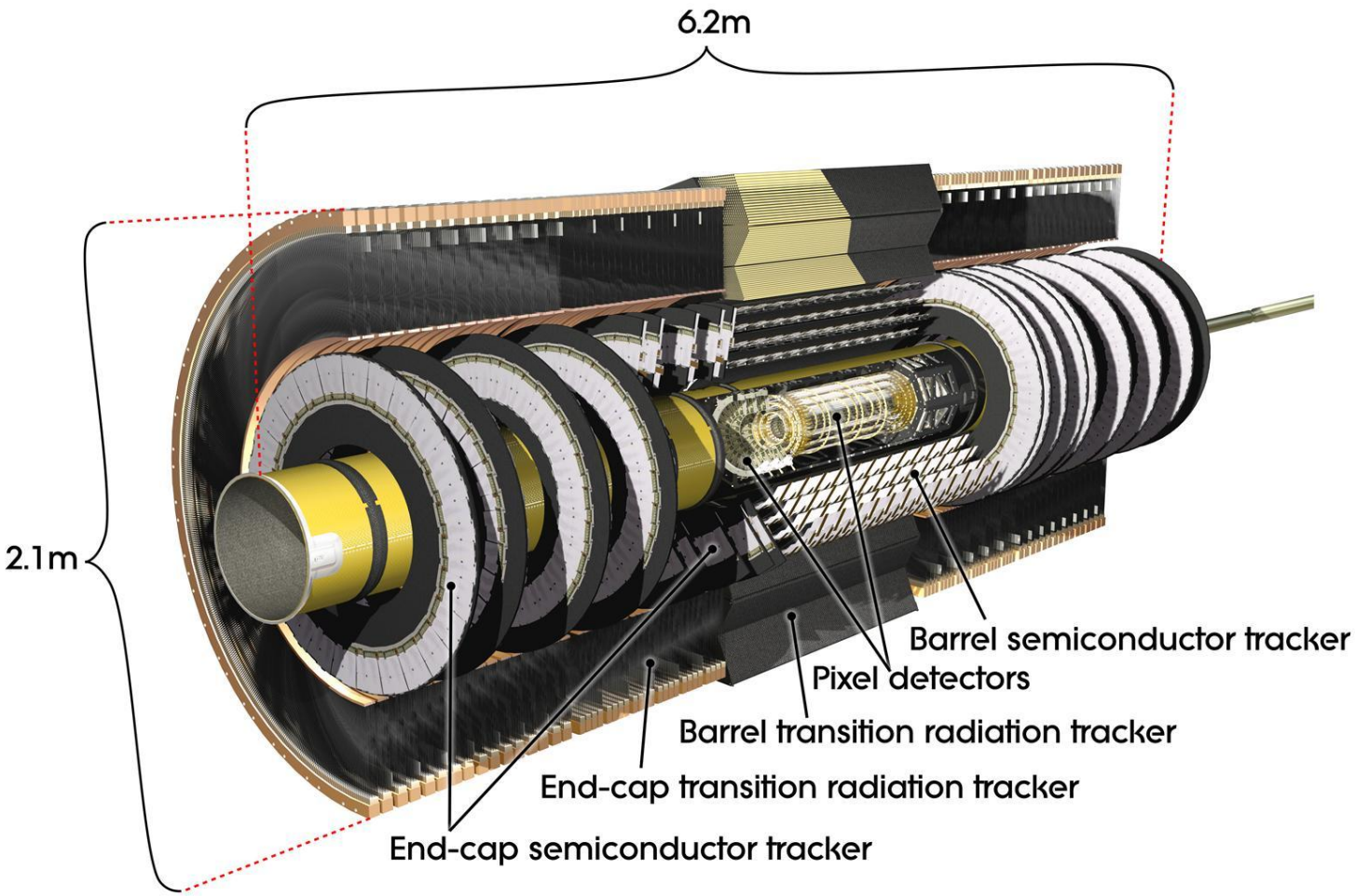
Understandable:

When you consider the magnitude of the project:

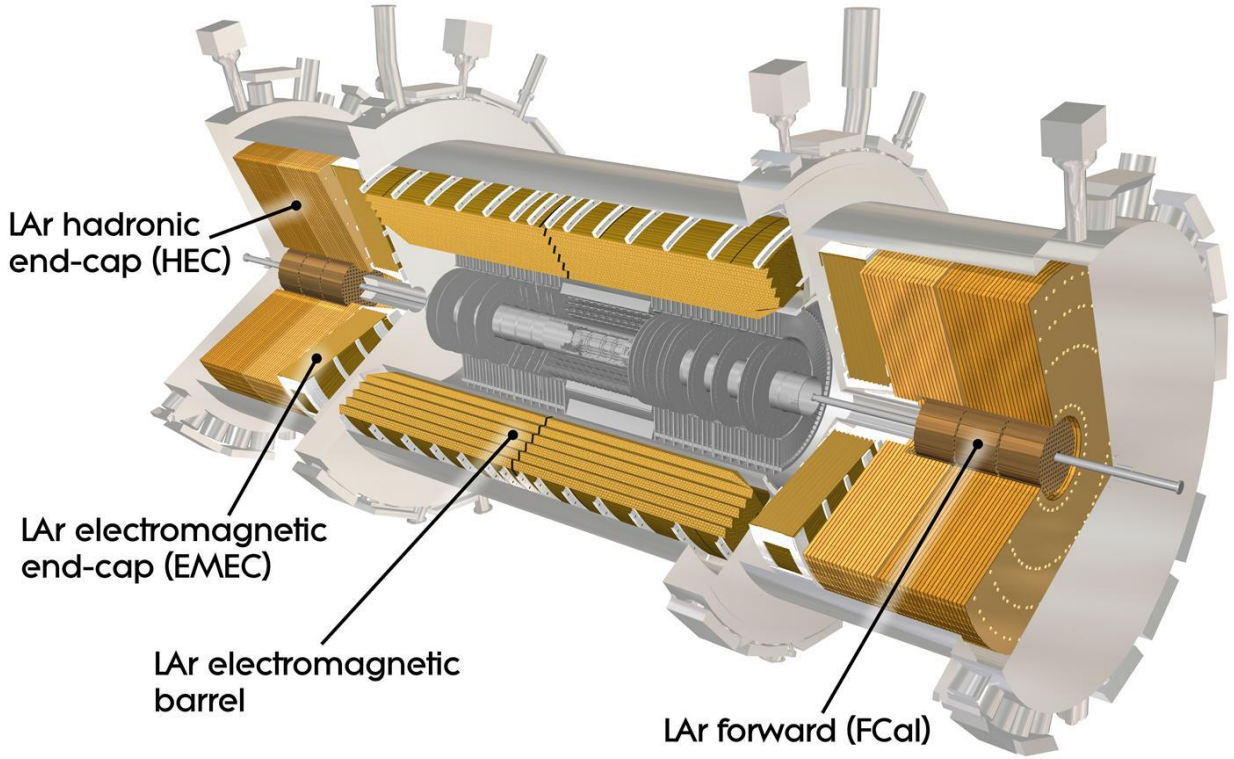
Introducing the ATLAS Detector:



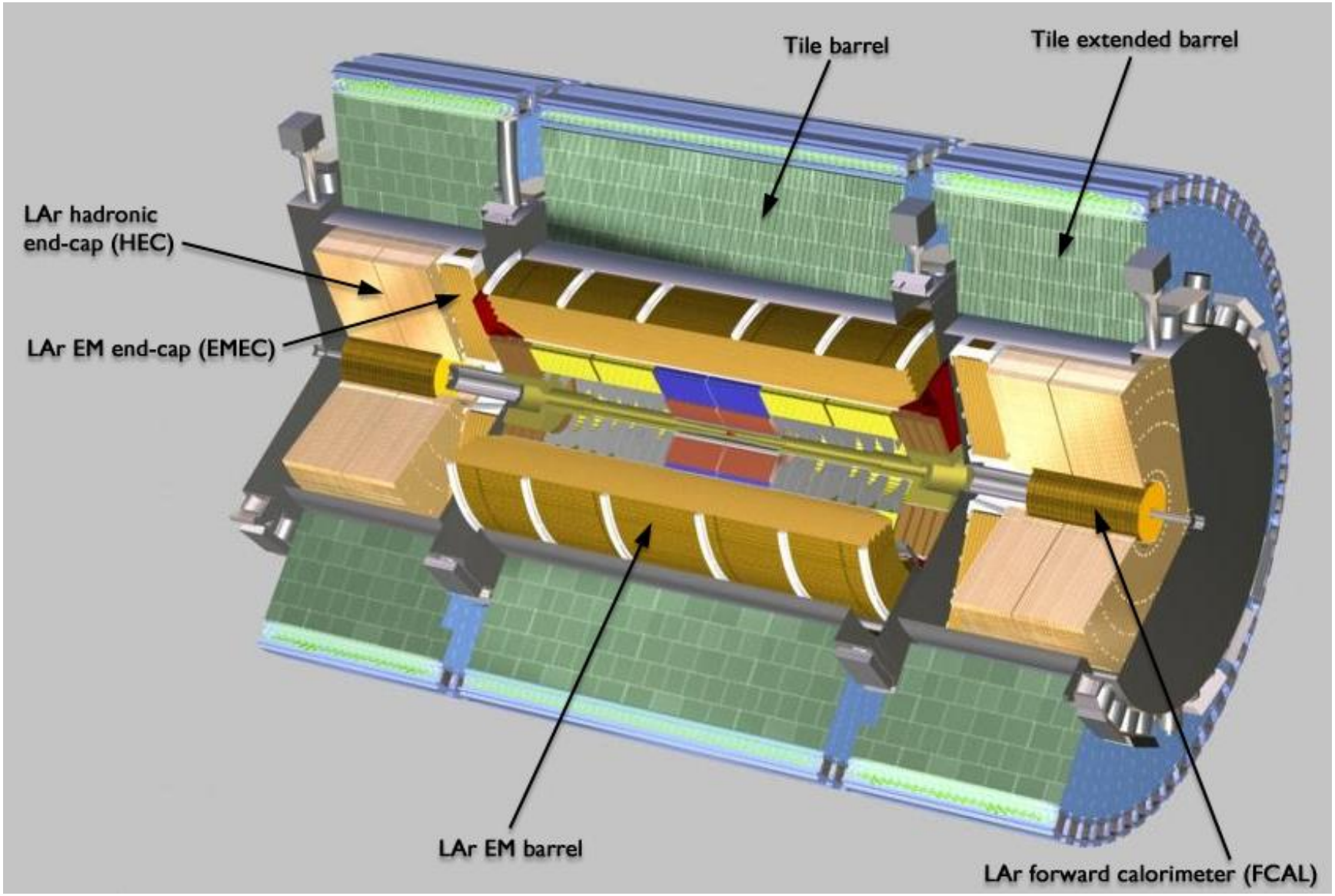
Inner Detector:

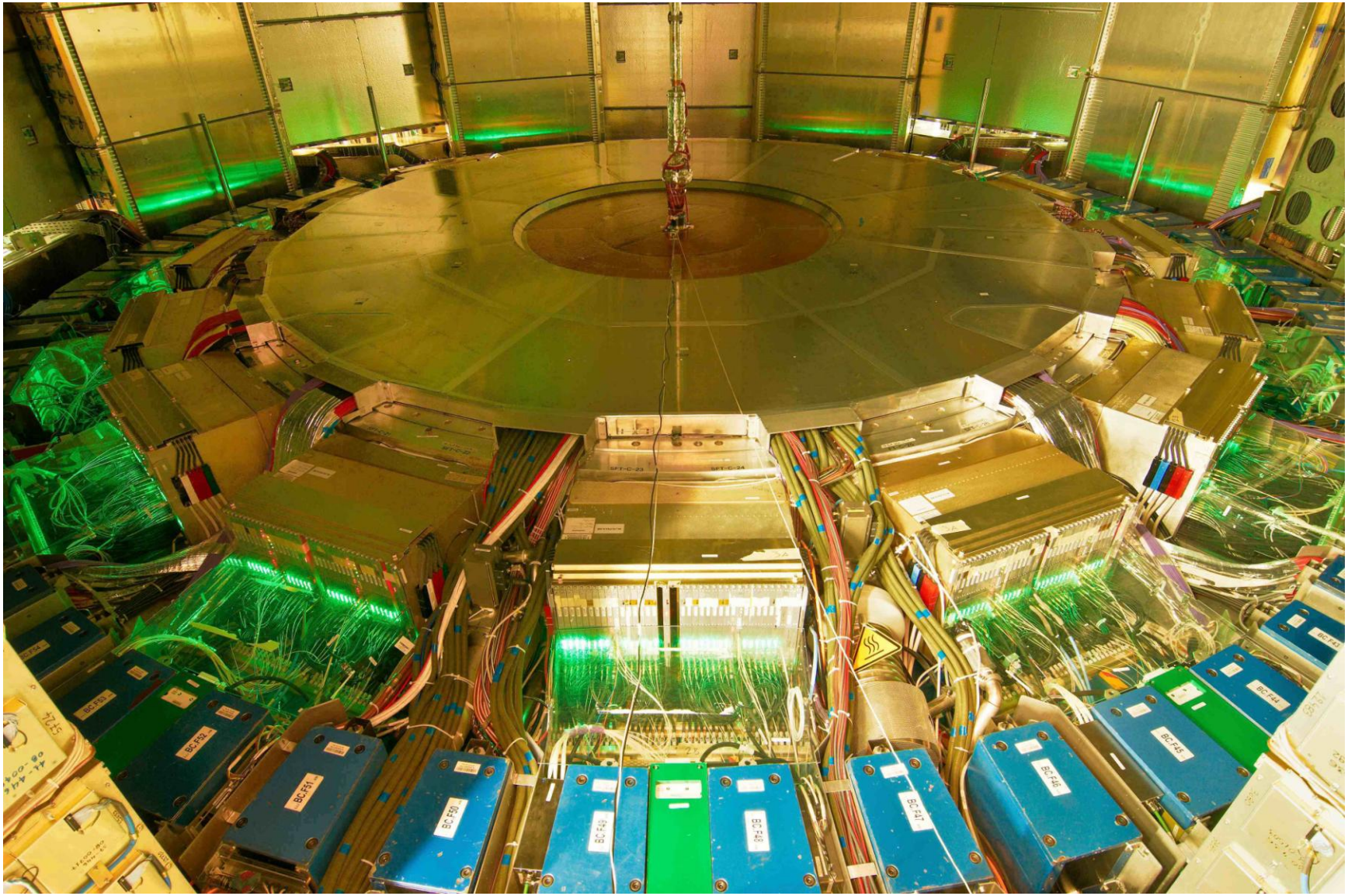


Liquid Argon Detector (E&M):

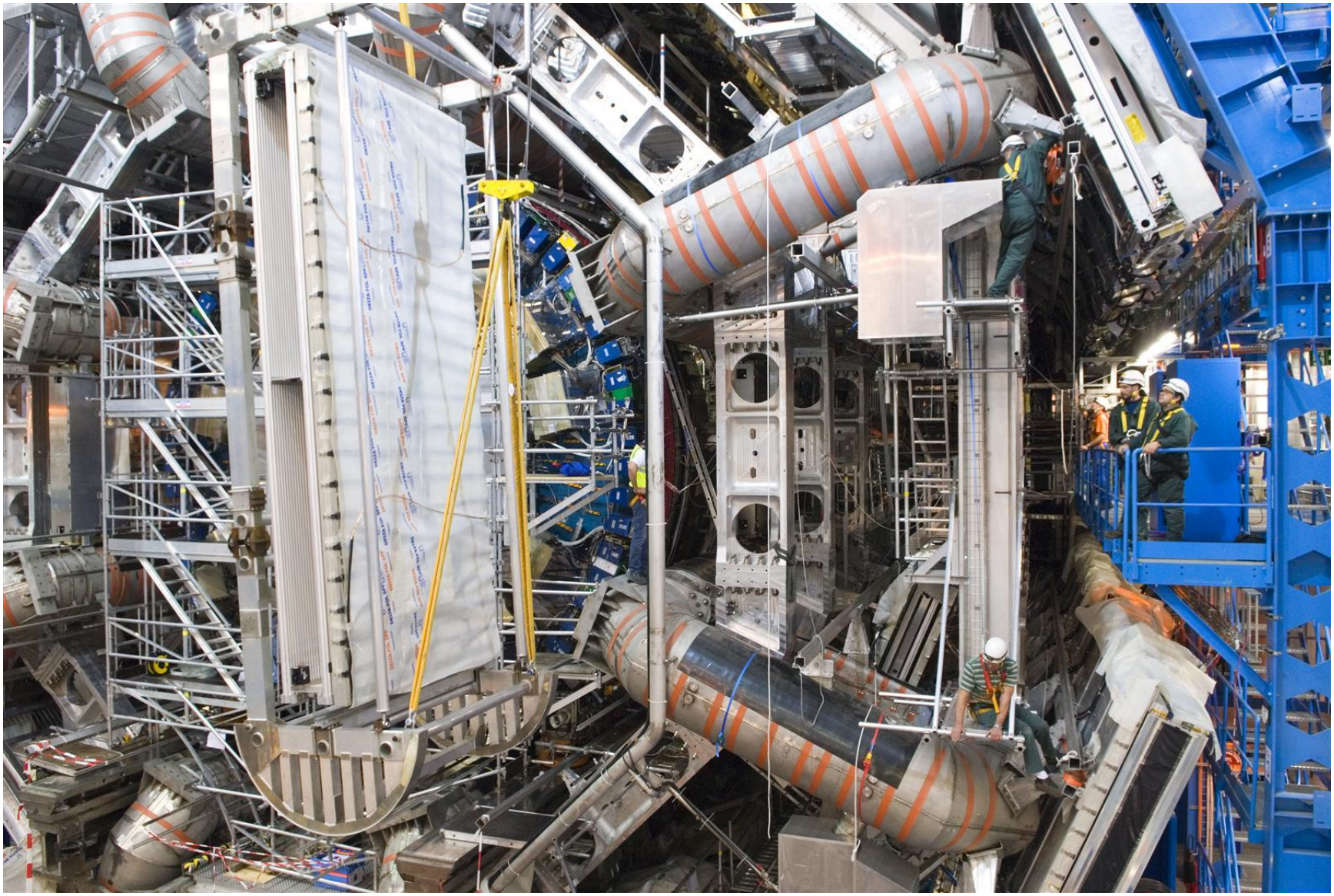


The Tile Calorimiter (Hadrons):

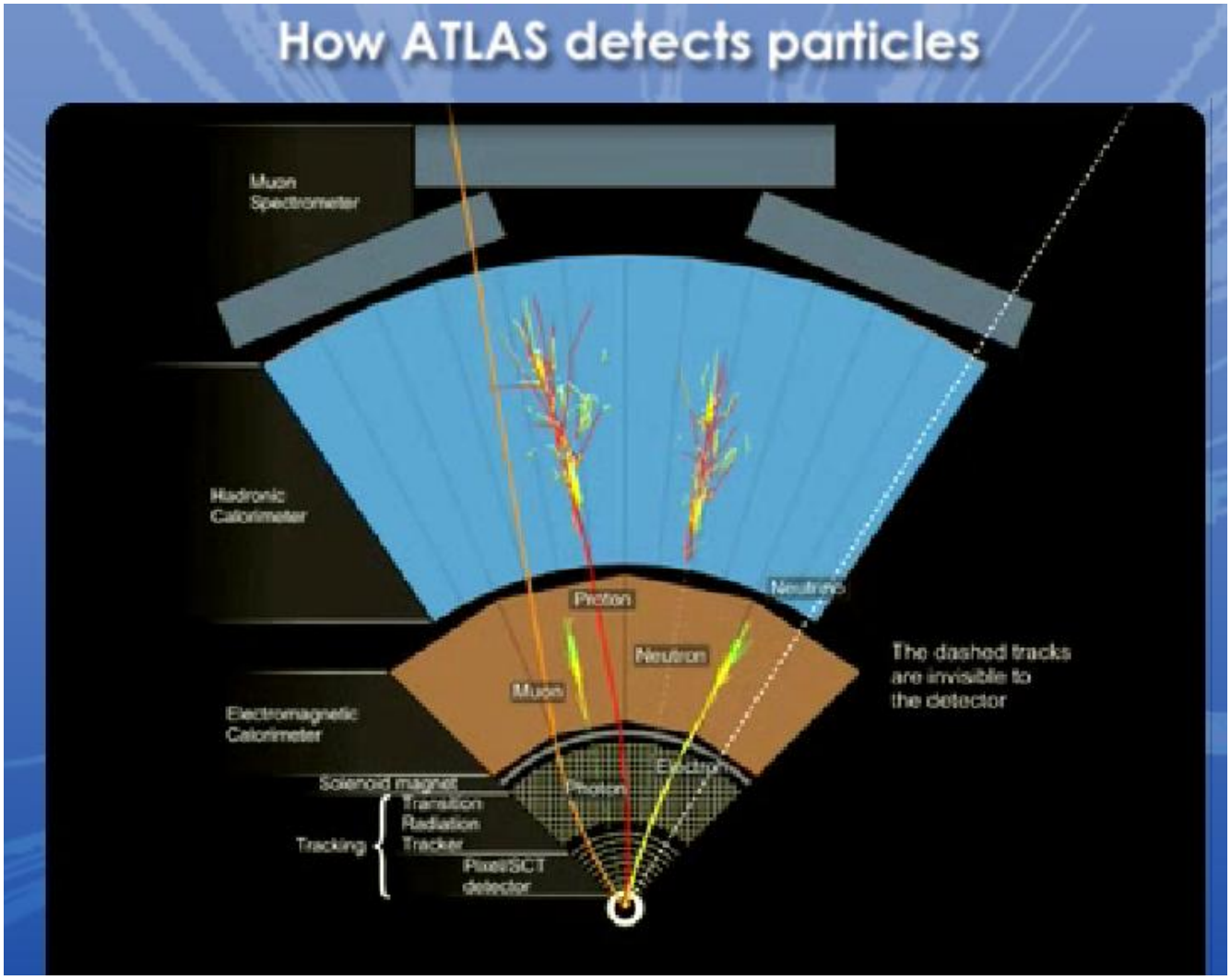



SFT-C-23
SFT-C-24
BC-F31
BC-F30
BC-F29
BC-F28
BC-F27
BC-F26
BC-F25
BC-F24
BC-F23

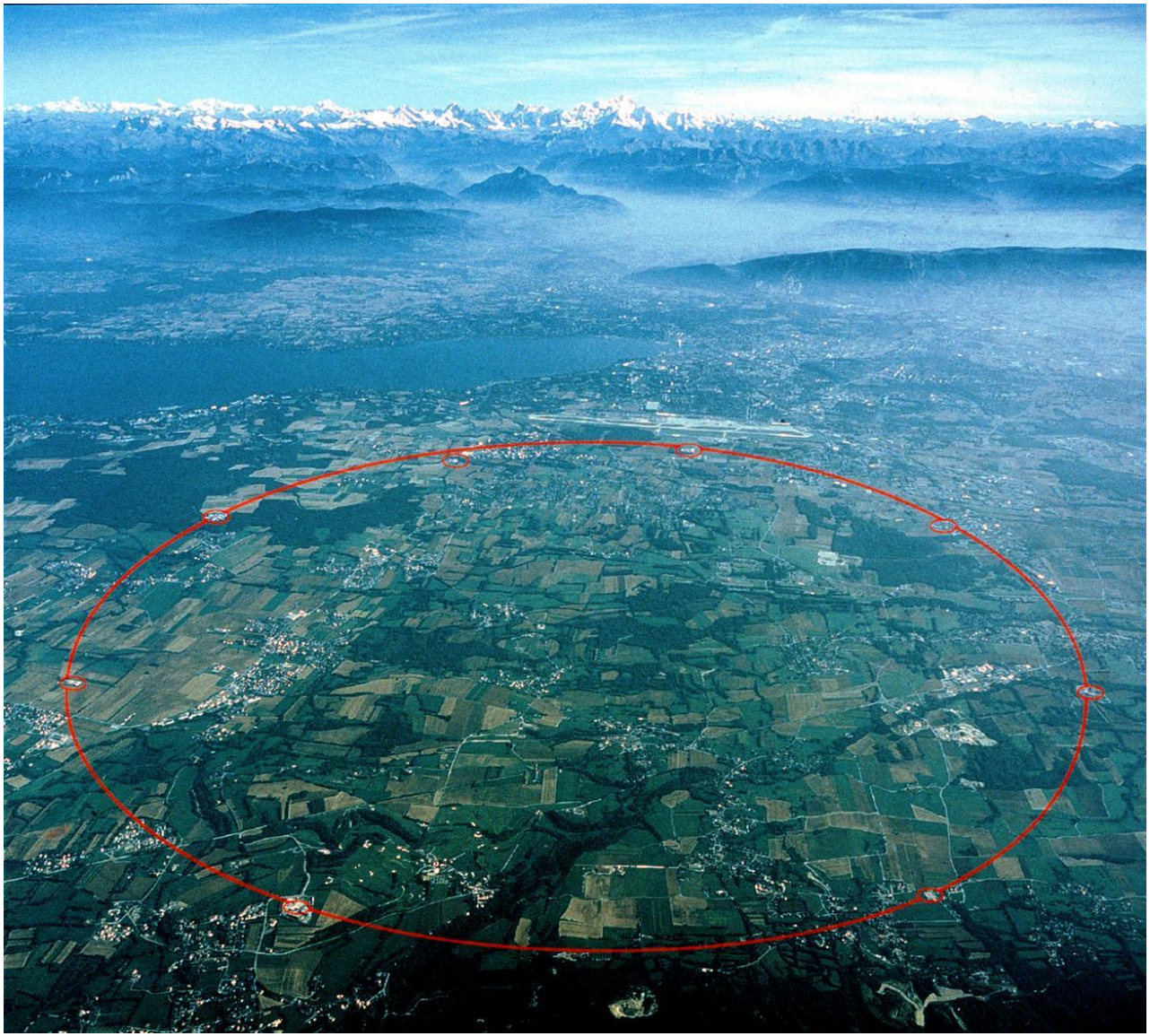
Muon System:



How ATLAS Works: [(Video)]



Part of the LHC at CERN:

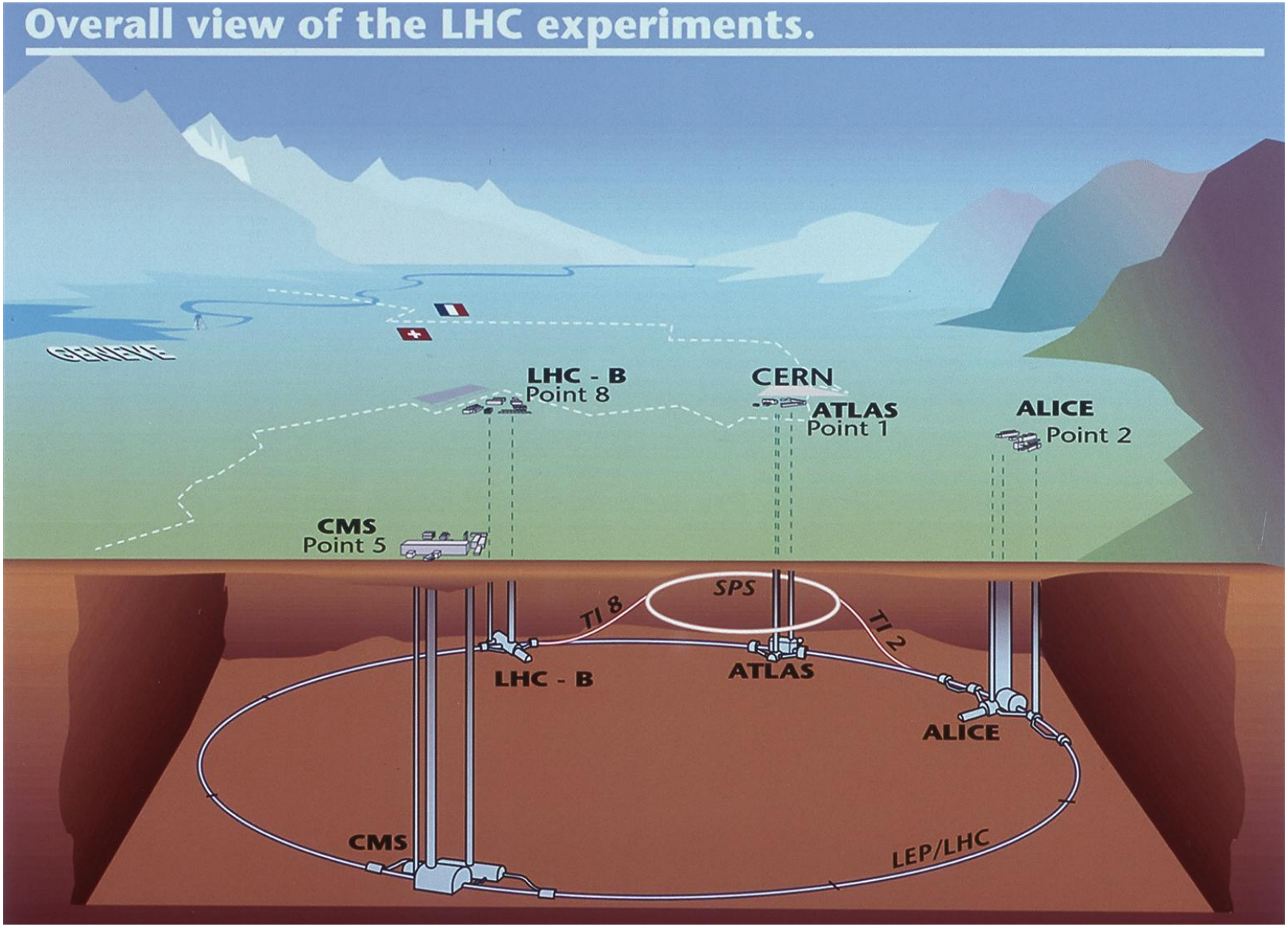


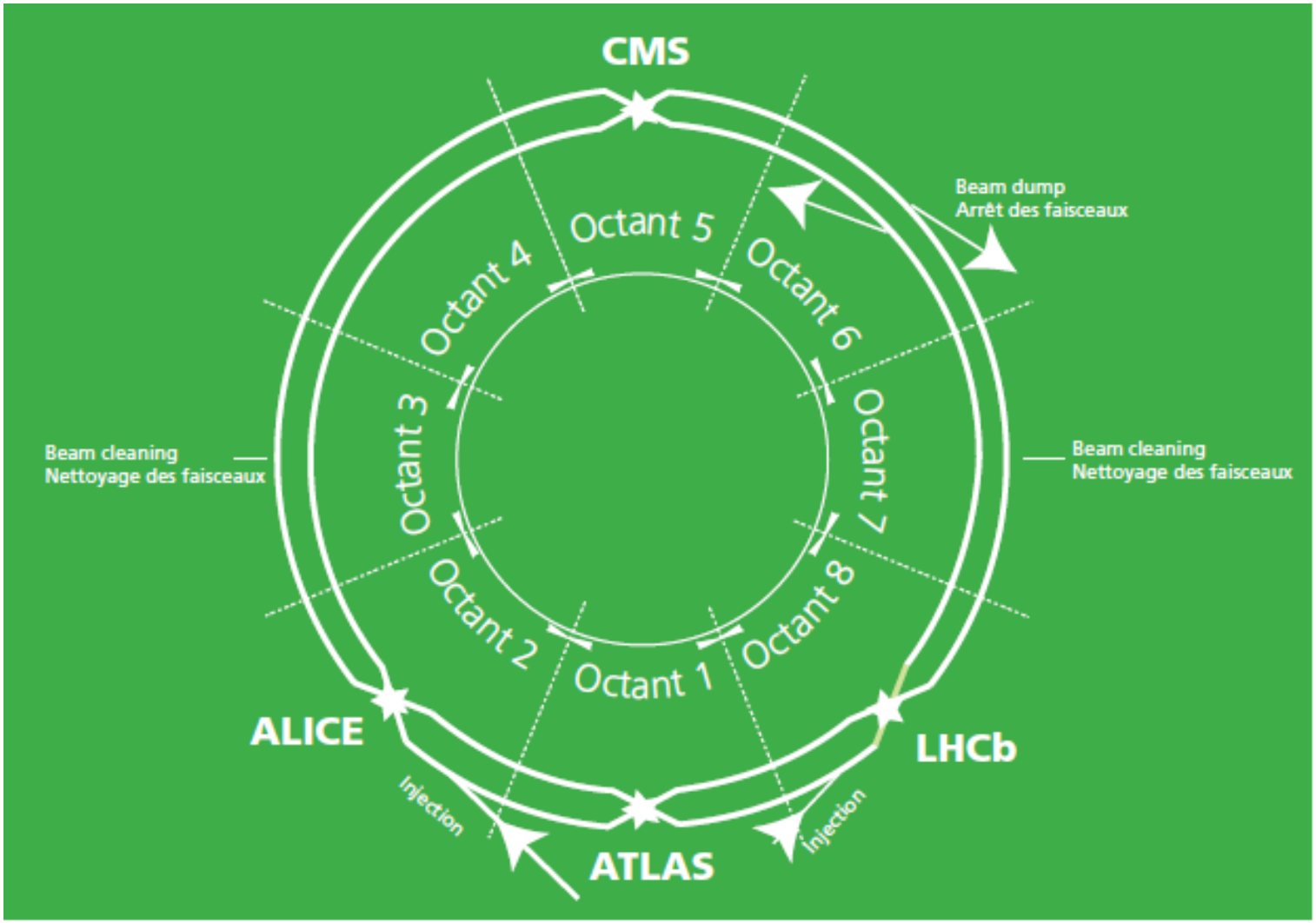
The following table lists the important parameters for the LHC.

Quantity	number
Circumference	26 659 m
Dipole operating temperature	1.9 K (-271.3°C)
Number of magnets	9593
Number of main dipoles	1232
Number of main quadrupoles	392
Number of RF cavities	8 per beam
Nominal energy, protons	7 TeV
Nominal energy, ions	2.76 TeV/u (*)
Peak magnetic dipole field	8.33 T
Min. distance between bunches	~7 m
Design luminosity	10^{34} cm^{-2} s^{-1}
No. of bunches per proton beam	2808
No. of protons per bunch (at start)	1.1×10^{11}
Number of turns per second	11 245
Number of collisions per second	600 million

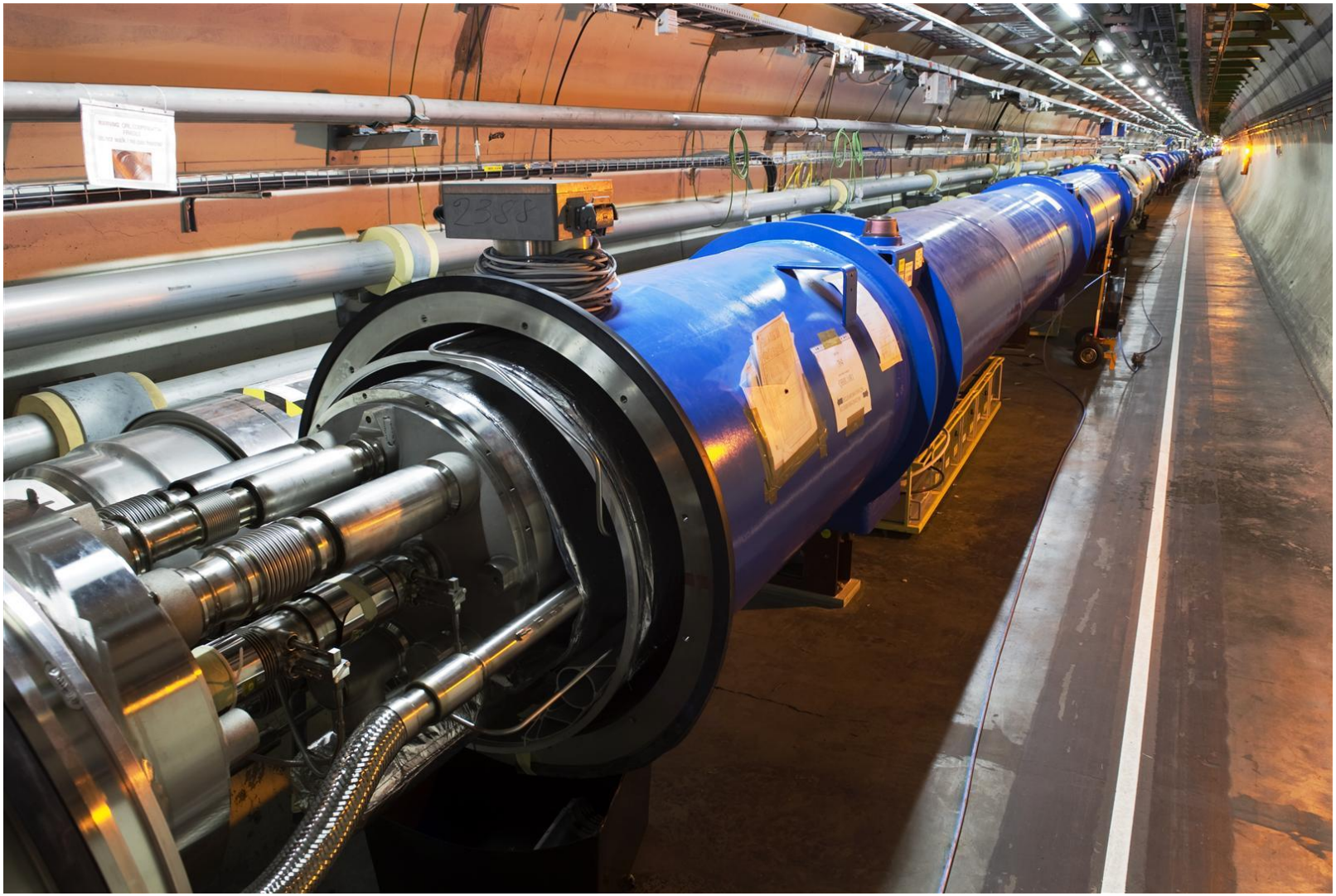
(*) Energy per nucleon

Centered at 100m (or so) below point 1:

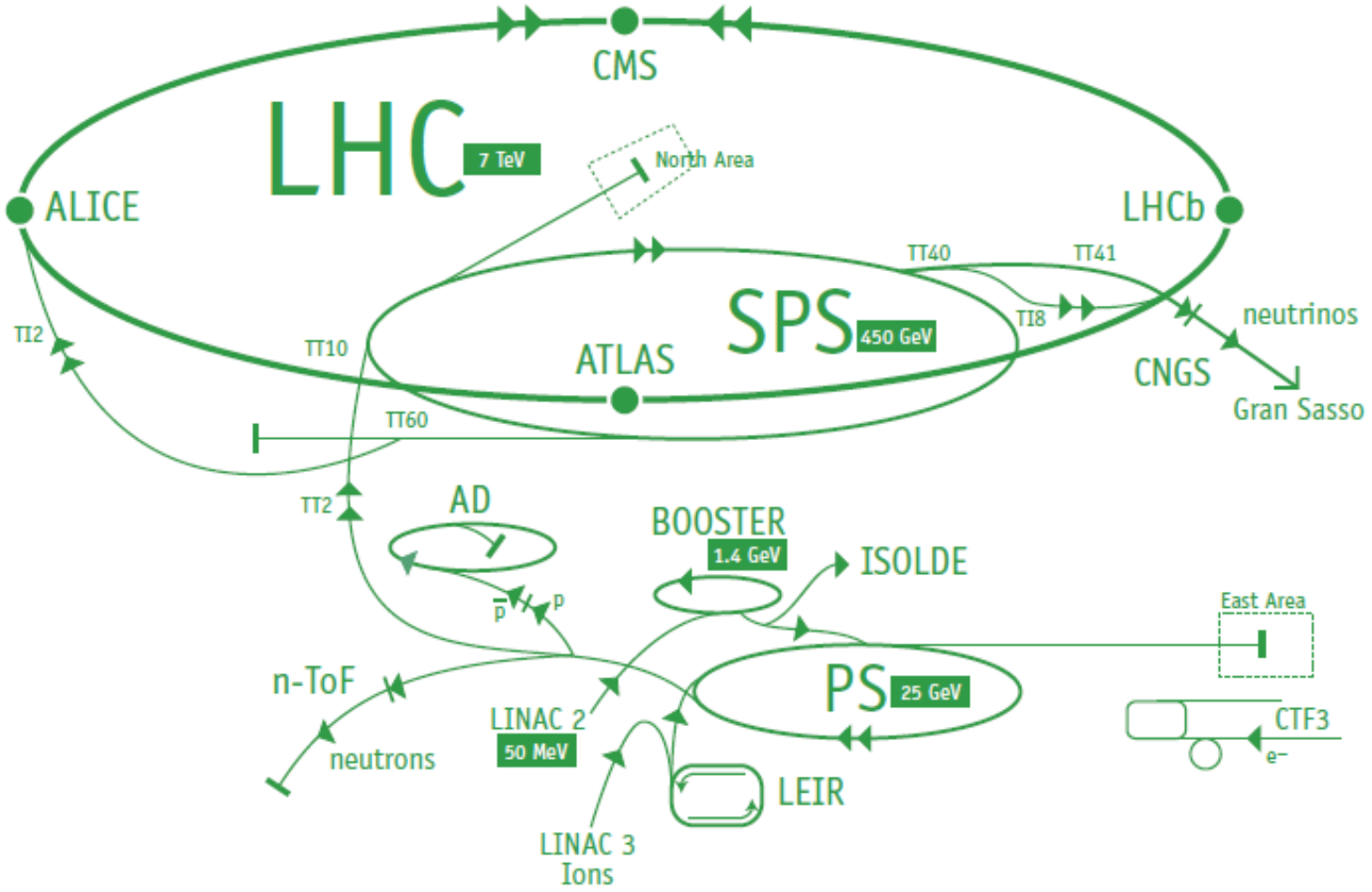



CMS
Beam dump
Arrêt des faisceaux
Octant 5
Octant 4
Octant 6
Octant 3
Octant 7
Beam cleaning
Nettoyage des faisceaux
Beam cleaning
Nettoyage des faisceaux
Octant 2
Octant 8
Octant 1
ALICE
LHCb
Injection
Injection
ATLAS

Inside the Tunnel:

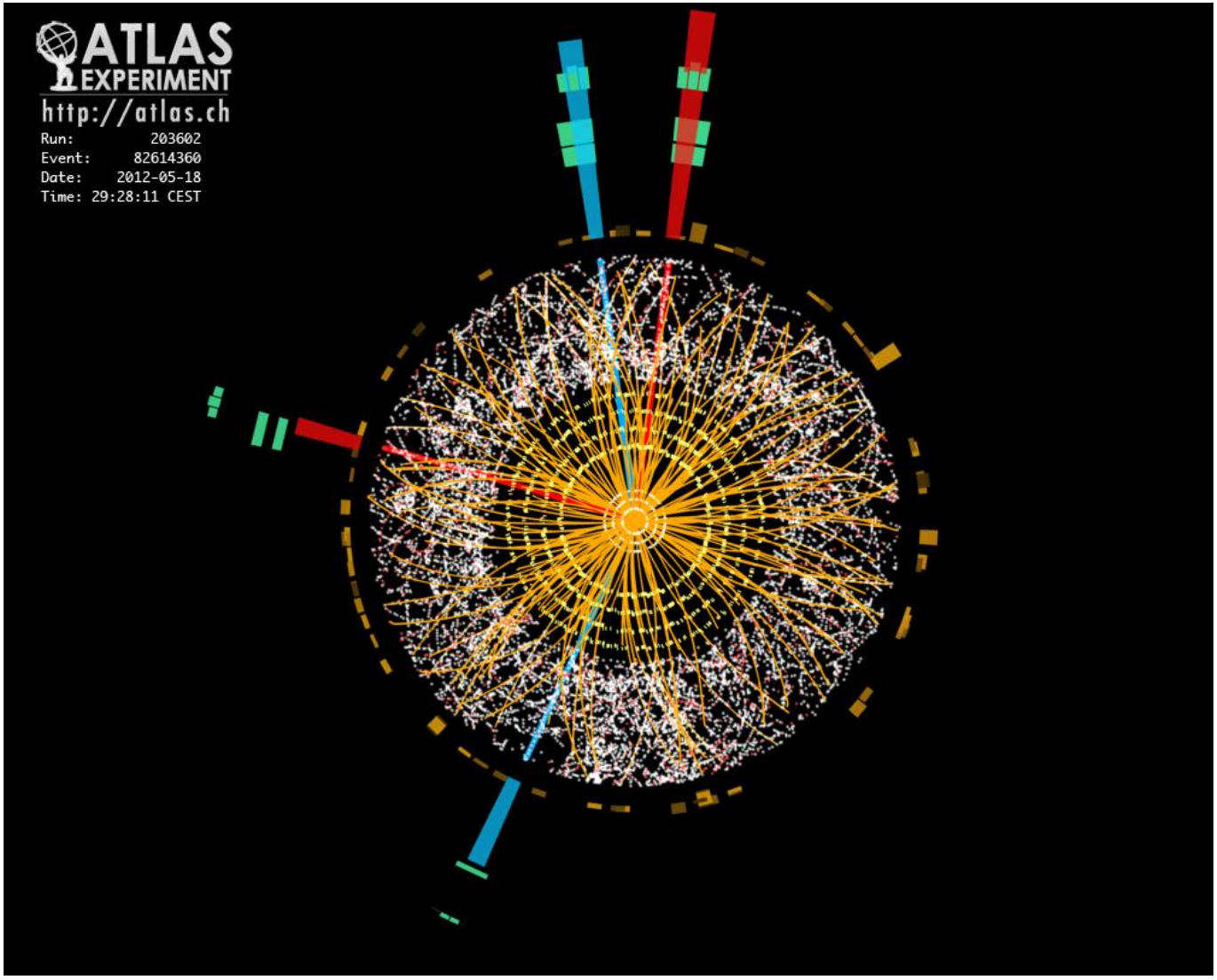


The Proton Stream:

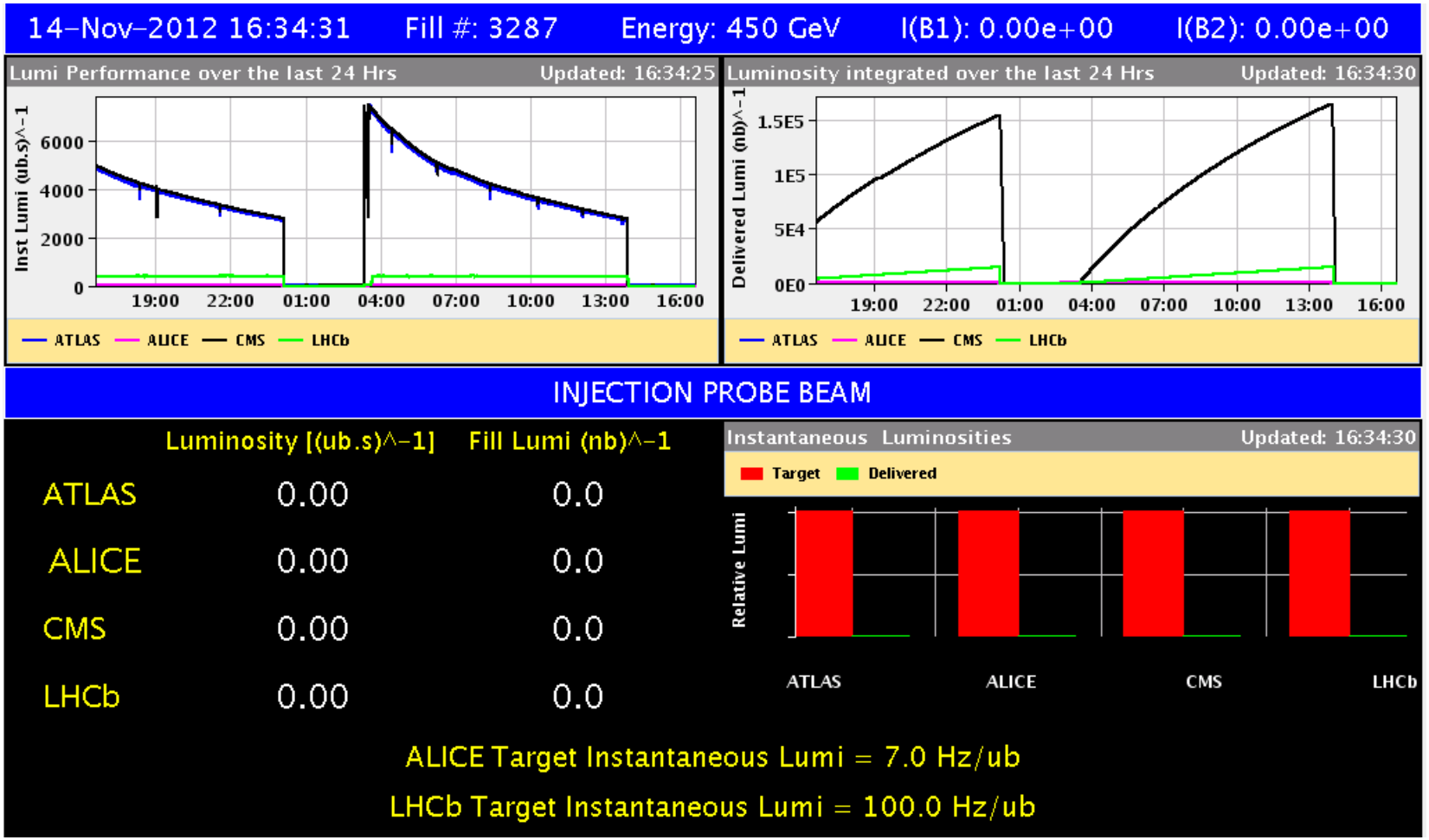


ATLAS Control Room:

Event Display:

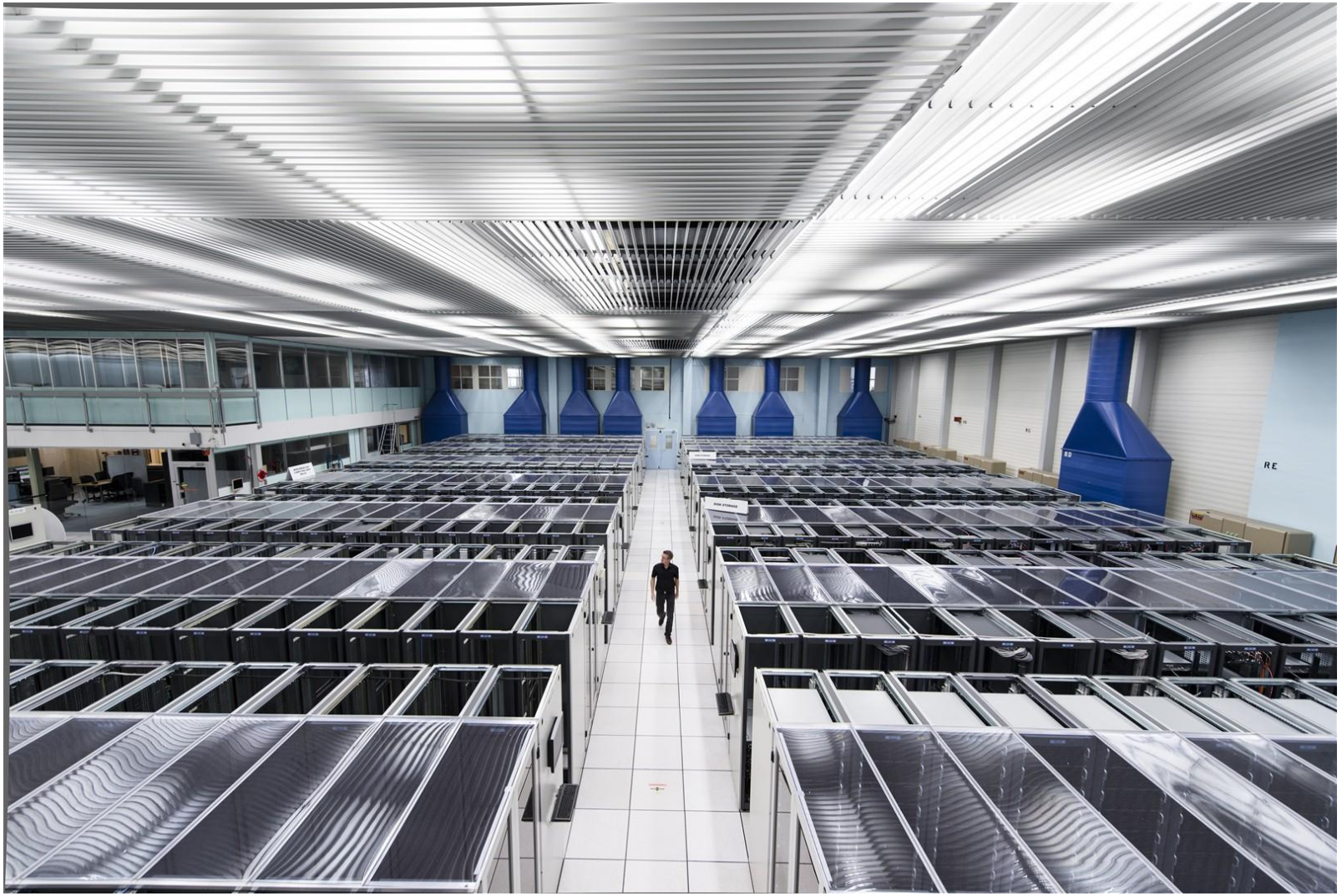


Monitoring the LCH: http://www.atlas.ch



Computing:

Computing Center:



Coding in Linux:

```
# for each ident
for i in $(cat dogo.list)
do
 echo $i
 mkdir -p ./output/${i}
 nohup nice bash -l ./dogo.sh $i &>\
                    ./output/${i}/${i}.out&
done
```

Coding with root in C++ and/or python:

```
void dogo( TString ident="data11" ){
  TString param_file = "inputPars.dat";
  TString do_mc="true";
  if( ident.BeginsWith("data11") ){
    do_mc = "false";
    param_file = "data11Pars.dat";
  }
  TString output = "./output/"+ident;
  gSystem->Exec("mkdir -p "+output);
  TChain t("physics");
  Okla::build_file_list (
                          output + "/input.txt",
                          path + "user.teeba.*" + ident + "*"
                        );
  Okla::add_files(t, output+"/input.txt");
  TString options = TString("")
    + " param_file=" + param_file
    + " identifier=" + ident    //
    + " input_path=."           //
    + " output_path=" + output  //
    + " do_mc=" + do_mc
    ;
  TNtupleAnalyzer Analyzer;
  t.Process(&Analyzer,options);
}
```

Two quotations from the experimental papers presented in this publication:

"*... The search for the Higgs boson, the only elementary particle in the Standard Model that has not yet been observed, is one of the highlights of the Large Hadron Collider physics program.*"

- ATLAS Collaboration

"*... The decay to two photons indicates that the new particle is a boson with spin different from one. The results presented here are consistent, ... with expectations for a standard model Higgs boson.*"

- CMS Collaboration

Hi Chris,

Plan A:

Collaboration with Dilip Kumar jana: (Summer 2011 to Present)
H**->WW->lvqq**
Bonus work with H->WW->lvlv

Plan A: Take the analysis code from the H->WW->lvlv group and modify it to work with lvqq.

Use MC samples where available, and estimate the QCD from the data using the matrix method.

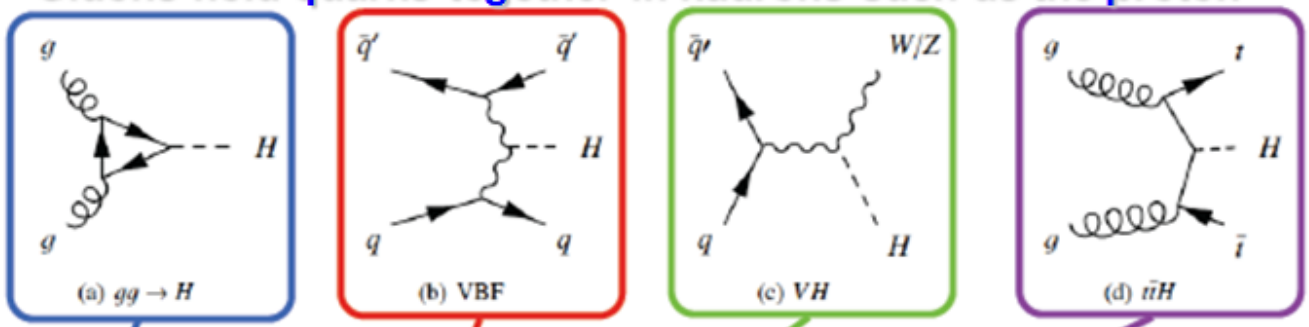
Generate a limit plot to exclude the Higgs in the mass range 200-600 GeV

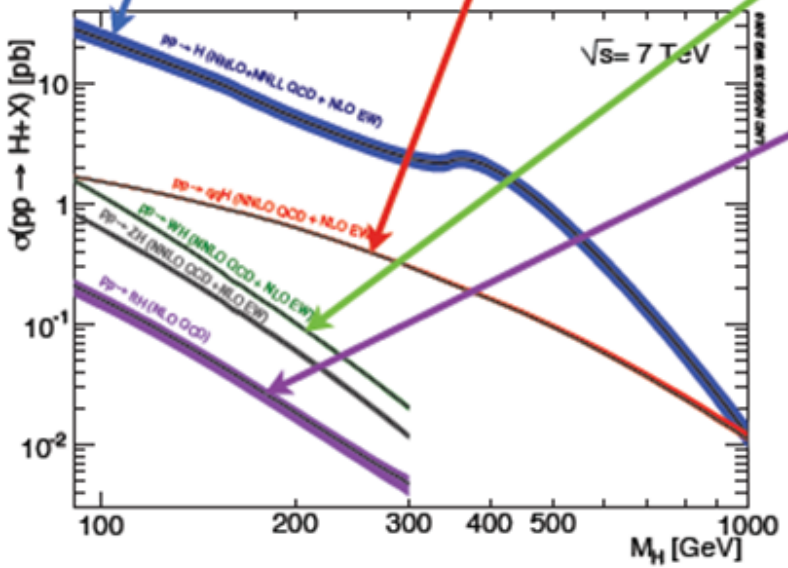
Plan B: Discover the high mass Higgs

Slides ~~stolen~~ borrowed from a Distinguished Physicist:

SM Higgs production at the LHC

Gluons hold quarks together in hadrons such as the proton



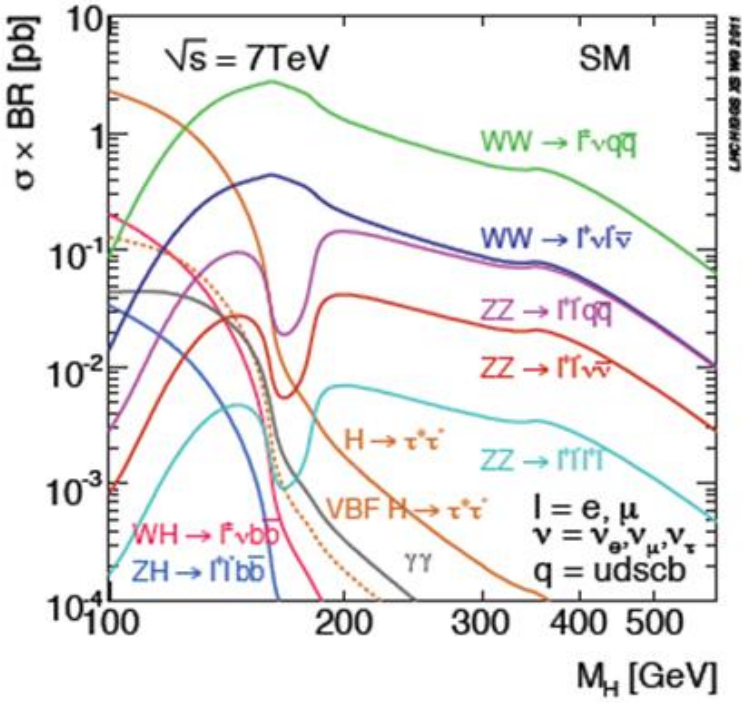


- At $\sqrt{s}$ = 8 TeV cross section 25-30% higher than at 7 TeV at low masses
- VBF, VH and ttH have smaller cross section but better S/B

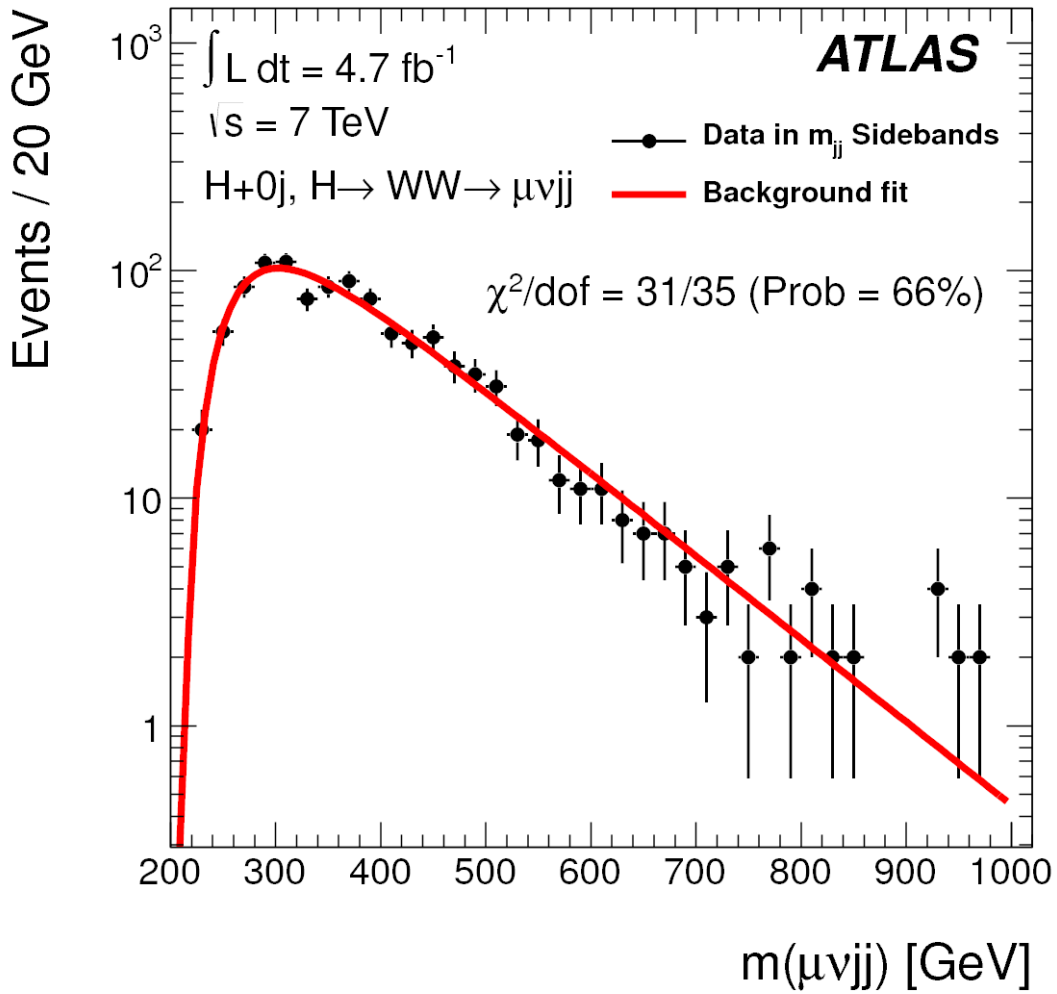
Slides ~~stolen~~ borrowed from a Distinguished Physicist:

Higgs decays

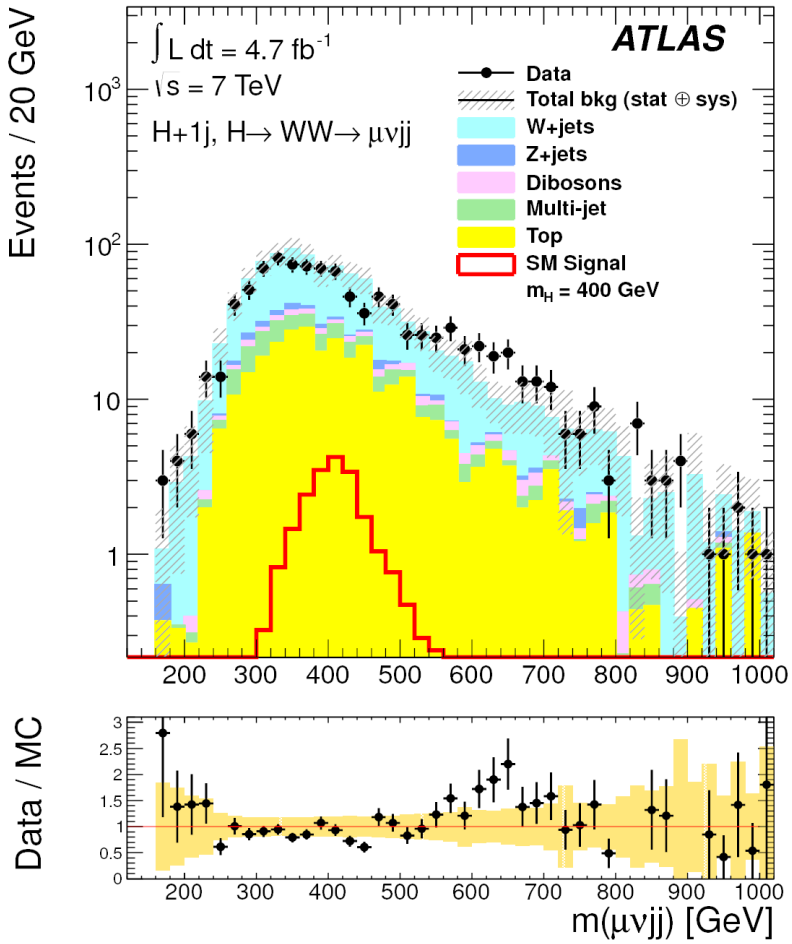
- 5 decay modes studied:
  - High masses: **ZZ, WW**
  - Low masses: **bb, ττ, γγ, WW, ZZ**
- low mass especially challenging due to huge backgrounds (esp. bb, ττ)
- best **mass resolution** (1-2%):
  - H→γγ, H→ZZ→llll



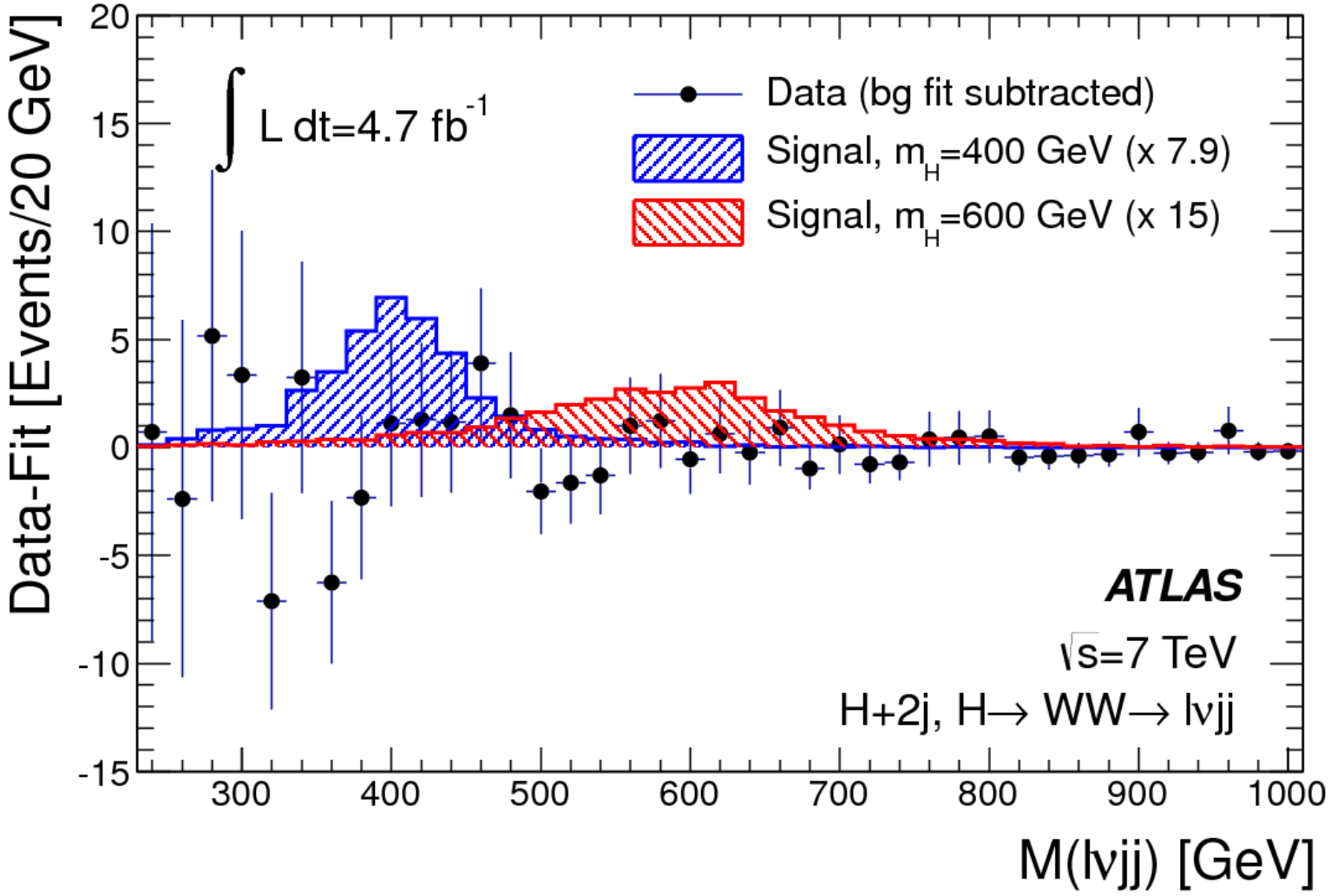
H->WW->lvqq: fits



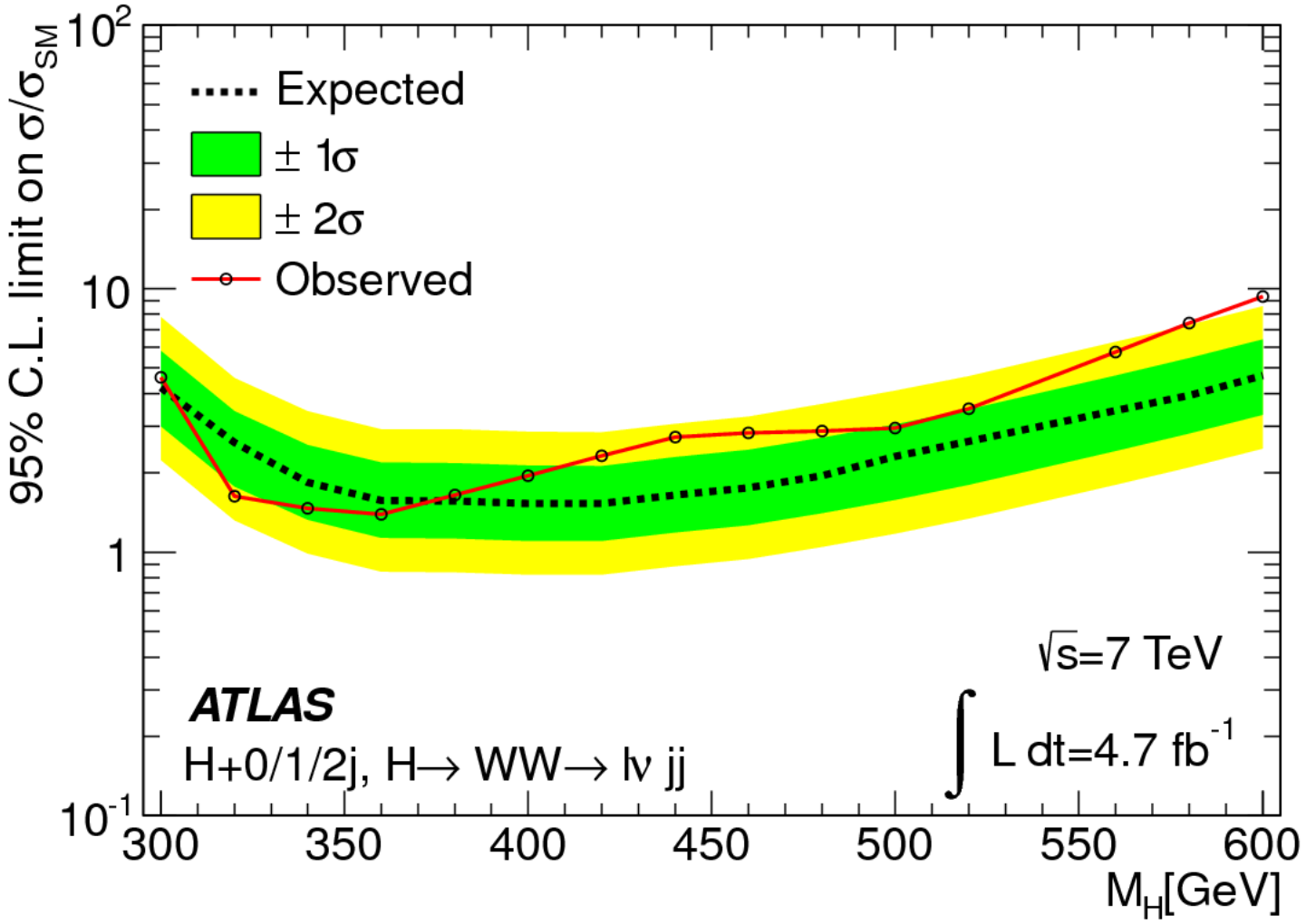
H->WW->lvqq MC background and signal vs. data comparisons:



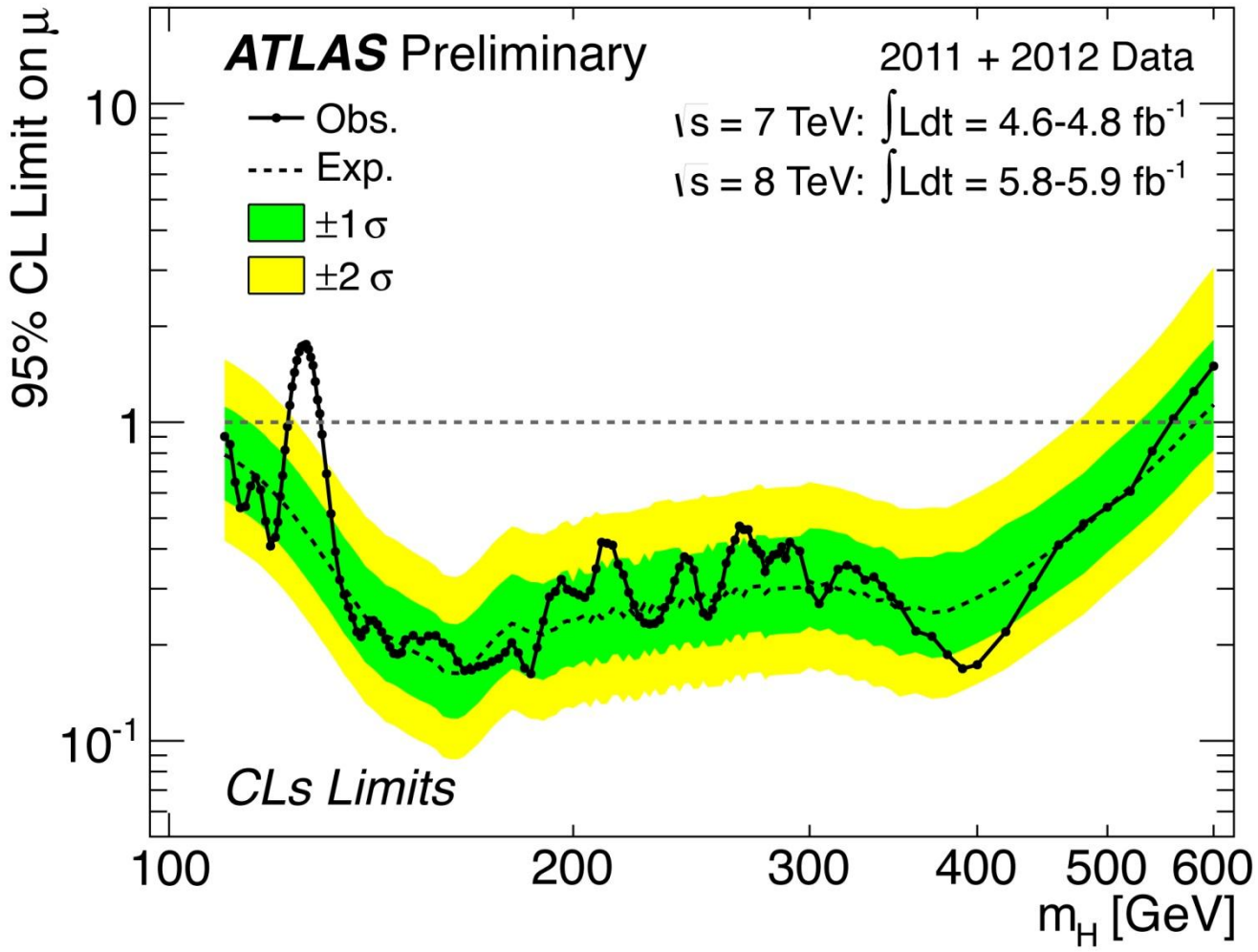
H->WW->lvqq: Difference compared to signal MC



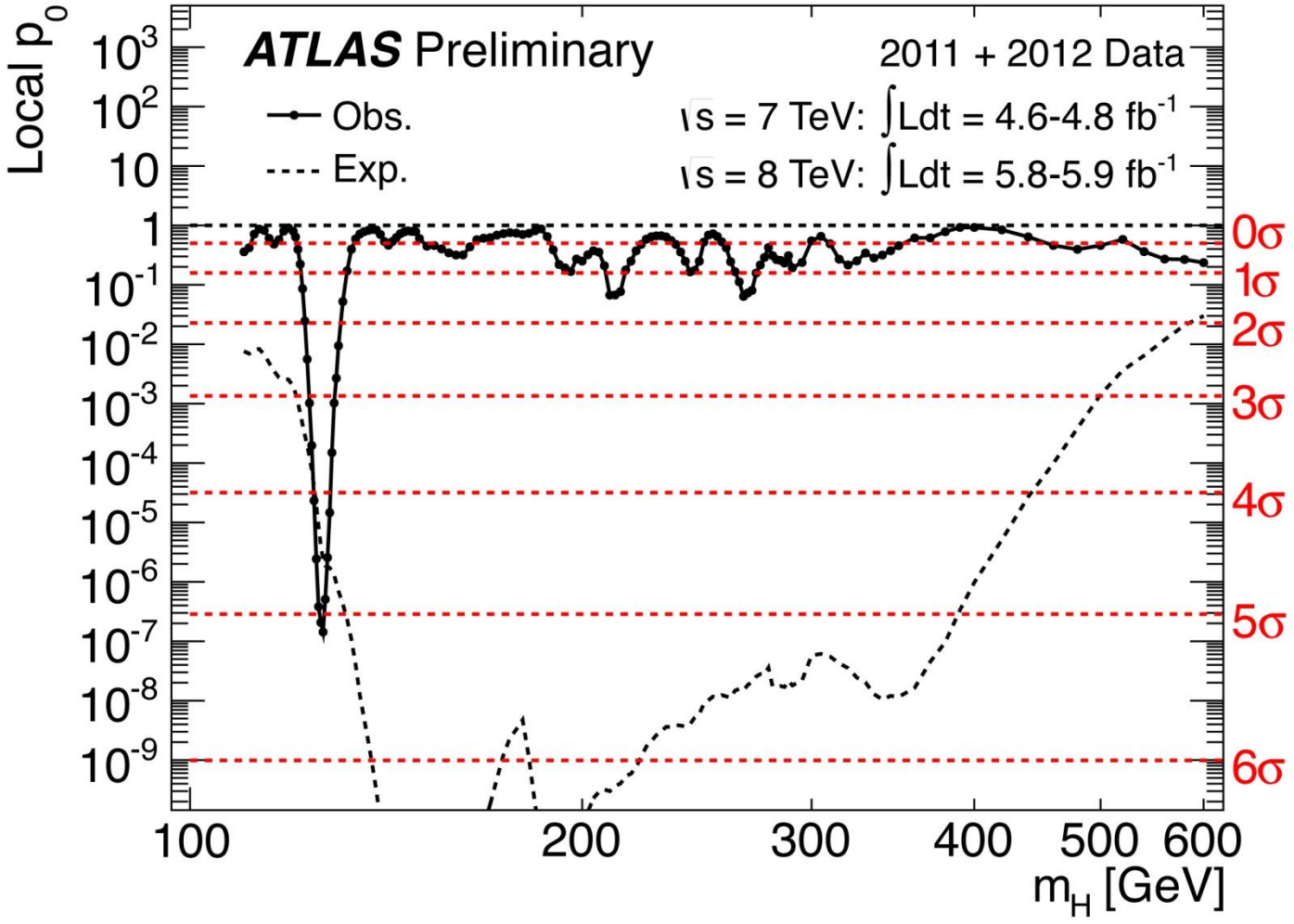
H->WW->lvqq: Confidence Limit



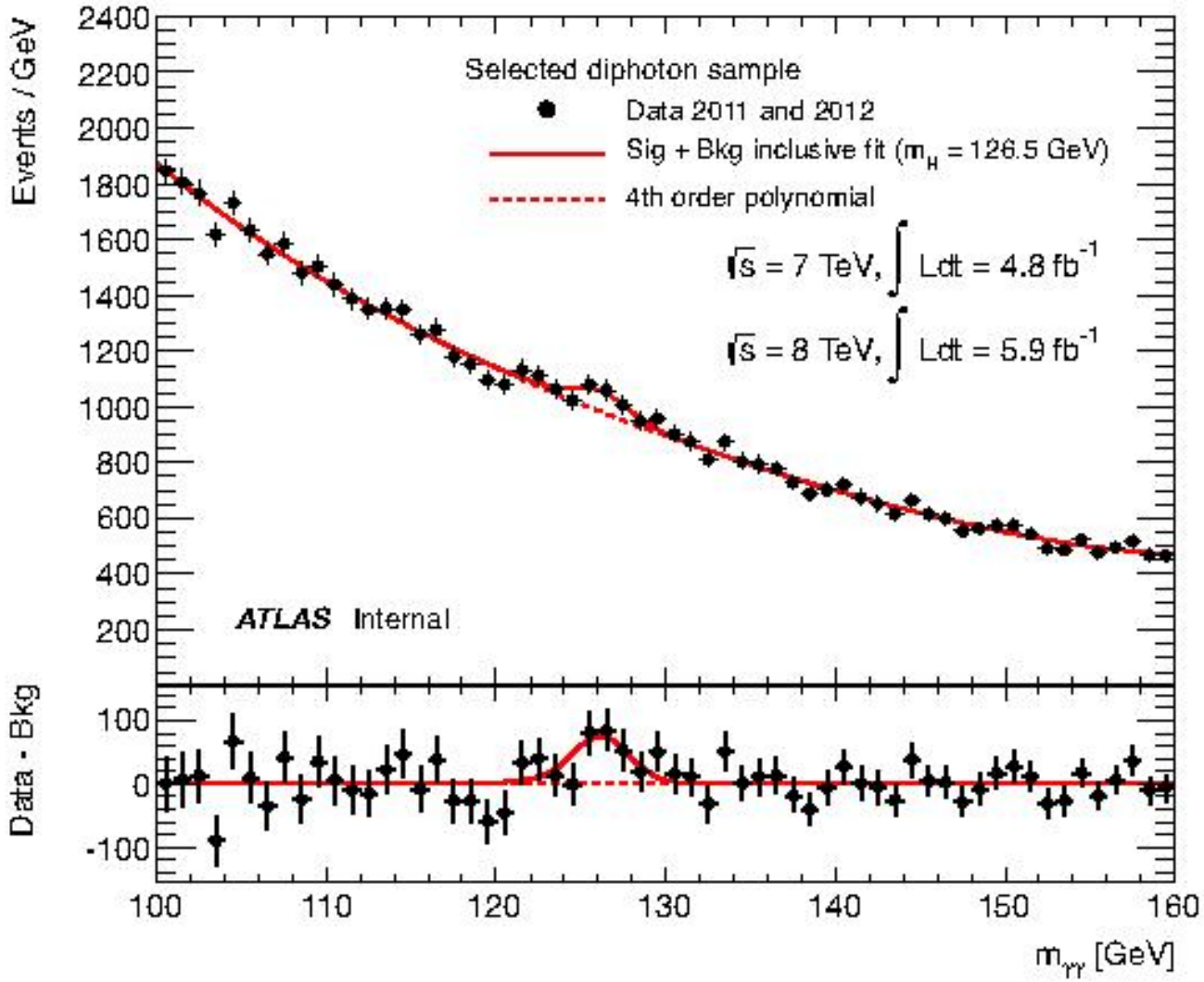
"Higgs-Like" Discovery: CL



"Higgs-Like" Discovery: sigma



“Higgs-Like” Discovery: perspective



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Congratulations to both
Atlas and CMS Collaborations
and to the builders of the LHC
on a magnificent achievement!

Peter Higgs

30 August 2012

Hi Chris,

It was pleasure to work with you on Higgs Searches. Thank you.

Dilip Kumar

“Higgs-Like” Discovery: Announcement

New Beginning: All Smiles

Back to Work:

Shed some light upon and measure the properties of this new Discovery!

References

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The CERN Brochure 2010-09 CERN-Brochure-2009-003-Eng.pdf

Videos and images from www.atlas.ch Terms of use of ATLAS images

H->WW->lvjj Higgs results *10.1016/j.physletb.2012.10.066*

Special thanks to Professor Skubic for loaning some of his slides.