SWAN
Service for
Web-based ANalysis

https://swan.web.cern.ch

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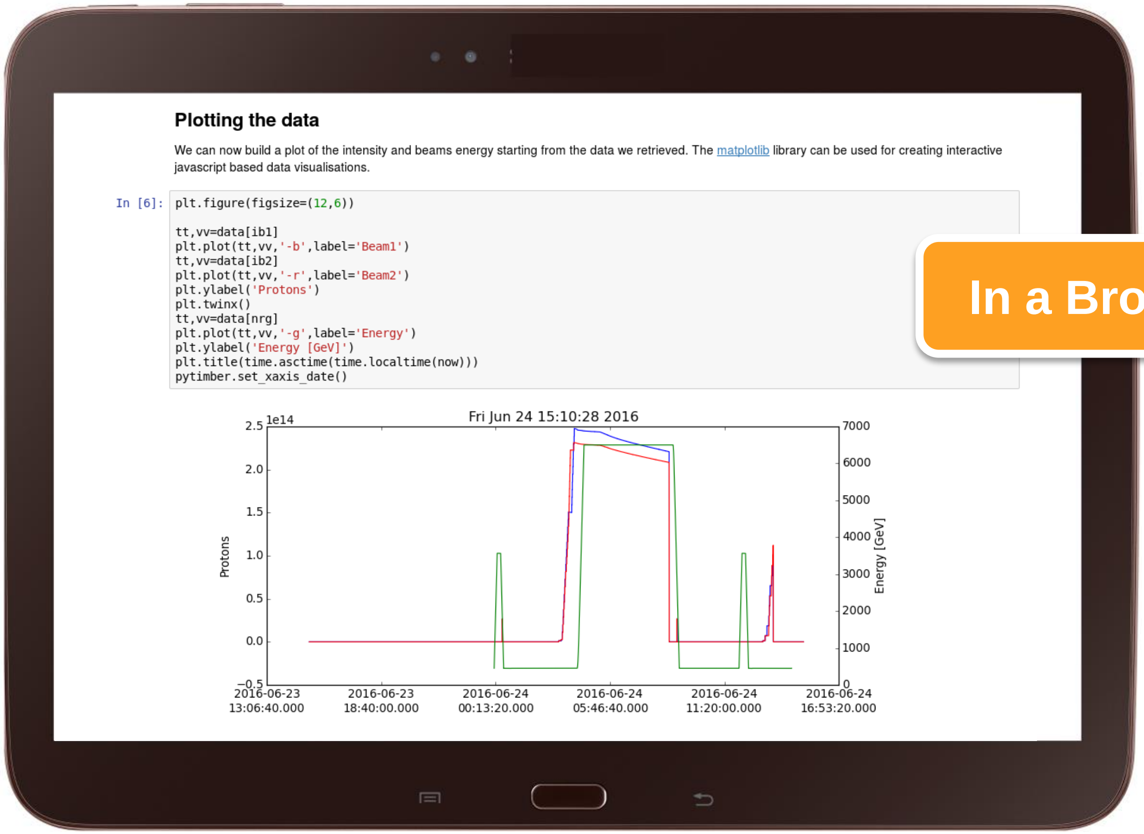
Interface: The Notebook

Jupyter Notebook: A web-based interactive computing interface and platform that combines code, equations, text and visualisations



In a Browser

Interface: The Notebook

Text

Code

Graphics

Access TTree in Python using PyROOT and fill a histogram

First import the ROOT Python module.

In [1]:
```
import ROOT
%jsroot on
```

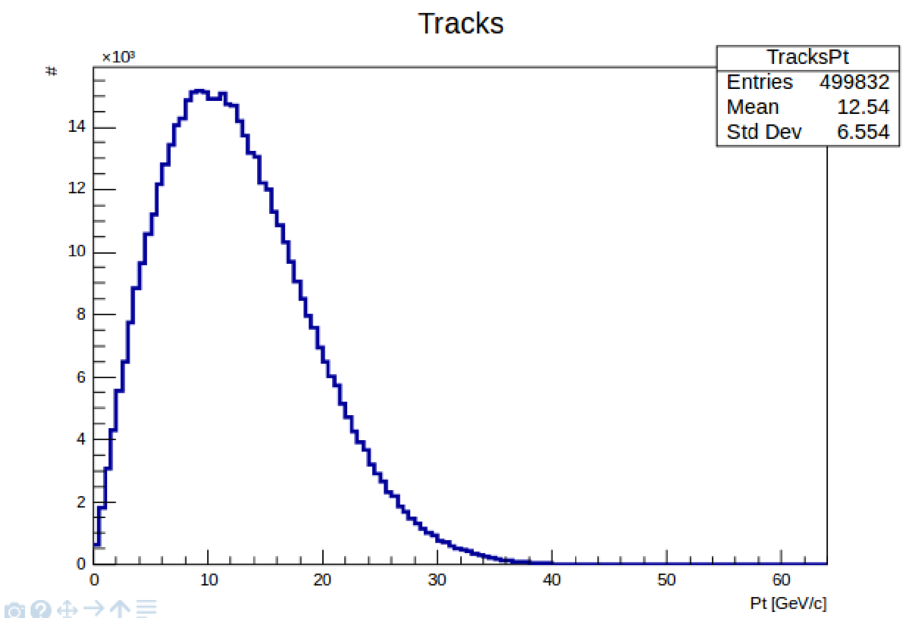
```
Welcome to JupyROOT 6.07/07
```

Open a file which is located on the web. No type is to be specified for "f".

In [3]:
```
f = ROOT.TFile.Open("http://indico.cern.ch/event/395198/material/0/0.root");
```

Loop over the TTree called "events" in the file. It is accessed with the dot operator. Same holds for the access to the branches: no need to set them up - they are just accessed by name, again with the dot operator.

In [4]:
```
h = ROOT.TH1F("TracksPt","Tracks;Pt [GeV/c];#",128,0,64)
for event in f.events:
    for track in event.tracks:
        h.Fill(track.Pt())
c = ROOT.TCanvas()
h.Draw()
c.Draw()
```



Interface: The Notebook

Jupyter Notebook: A web-based interactive computing interface and platform that combines code, equations, text and visualisations

ROOT has been fully integrated with the Jupyter technology

- Two flavours: Python and ROOT C++
- JavaScript interactive visualisation

For more information please see:
https://indico.cern.ch/event/505613/contributions/2228339

SWAN: Data analysis "as a service"

Interface: Jupyter Notebooks

Goals:

- Analysis only with a web browser
  - Platform independent ROOT-based data analysis
  - Calculations, input and results "in the Cloud"
- Easy sharing of scientific results: plots, data, code
  - Storage is crucial: mass & synchronised
- Simplify teaching of data processing and programming
  - Gallery of analysis examples
- Integration with other analysis ecosystems: R, Python, …

SWAN in the CERN Ecosystem

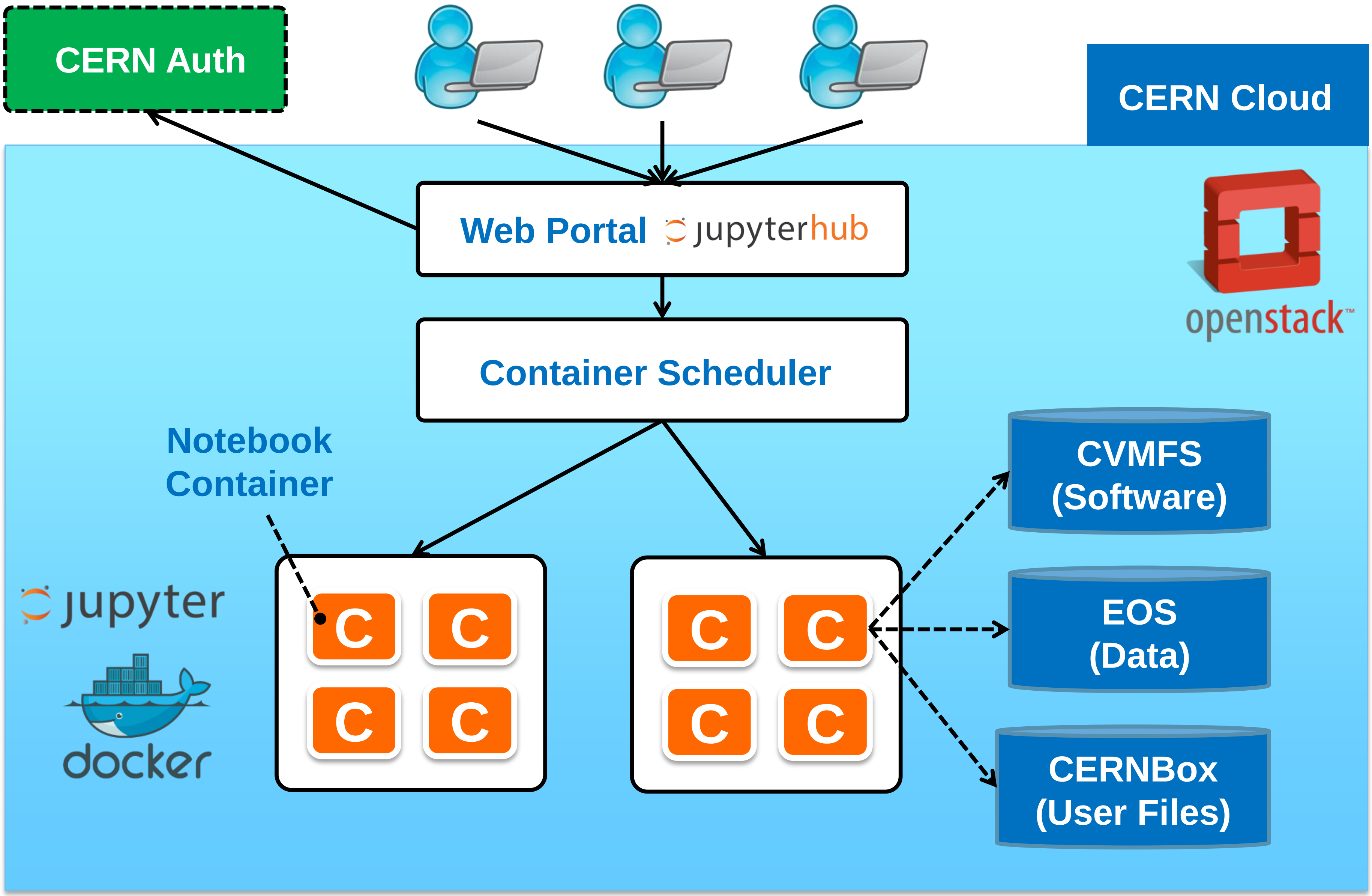
SWAN federates a set of production technologies at CERN:

- Authentication with CERN credentials (SSO)
- Infrastructure: virtual machines in OpenStack Cloud
- Software distribution: CVMFS
  - Centrally distributed software
- Storage access: CERNBox, EOS
  - Experiments' and users' data

Plus some external technologies:

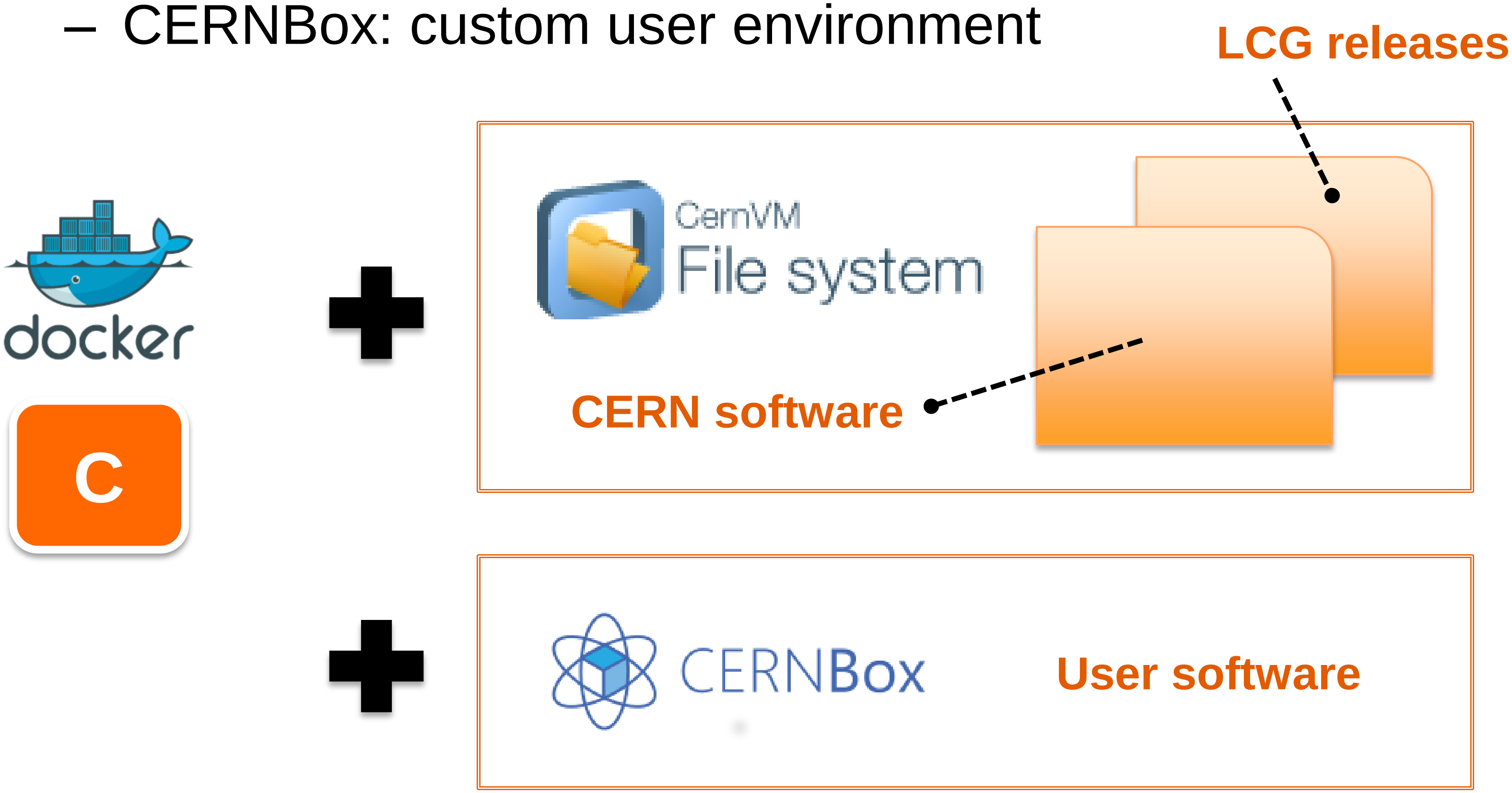
- JupyterHub
- Docker

Service Architecture

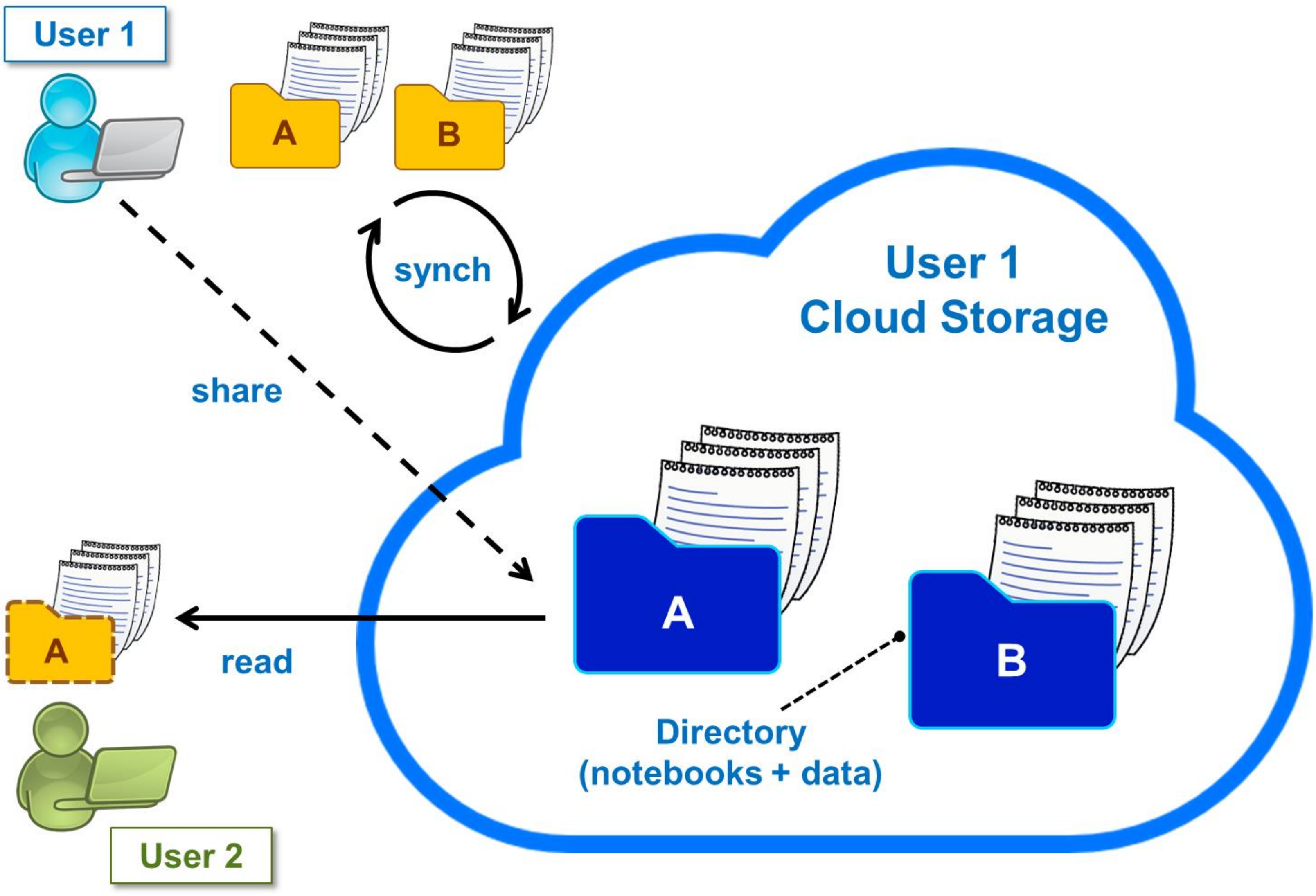


Software Environment

- Strategy to configure the software environment:
  - Docker: single thin image, not managed by the user!
  - CVMFS: configurable environment via "views"
  - CERNBox: custom user environment

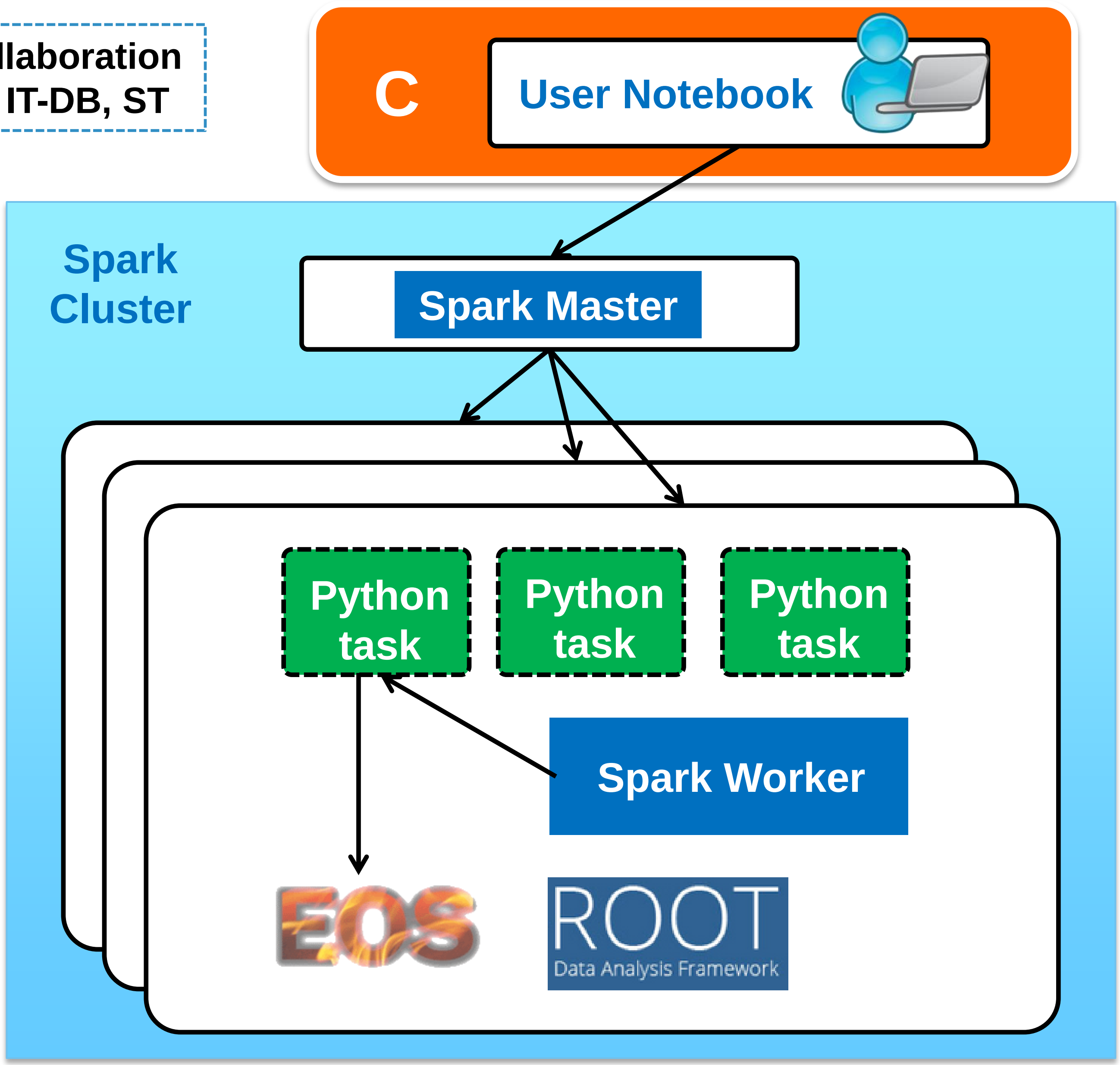


CERNBox: Sync & Share



R&D: Offloading from SWAN

In collaboration with IT-DB, ST



For more information please see:
https://indico.cern.ch/event/505613/contributions/2228338

SWAN Today

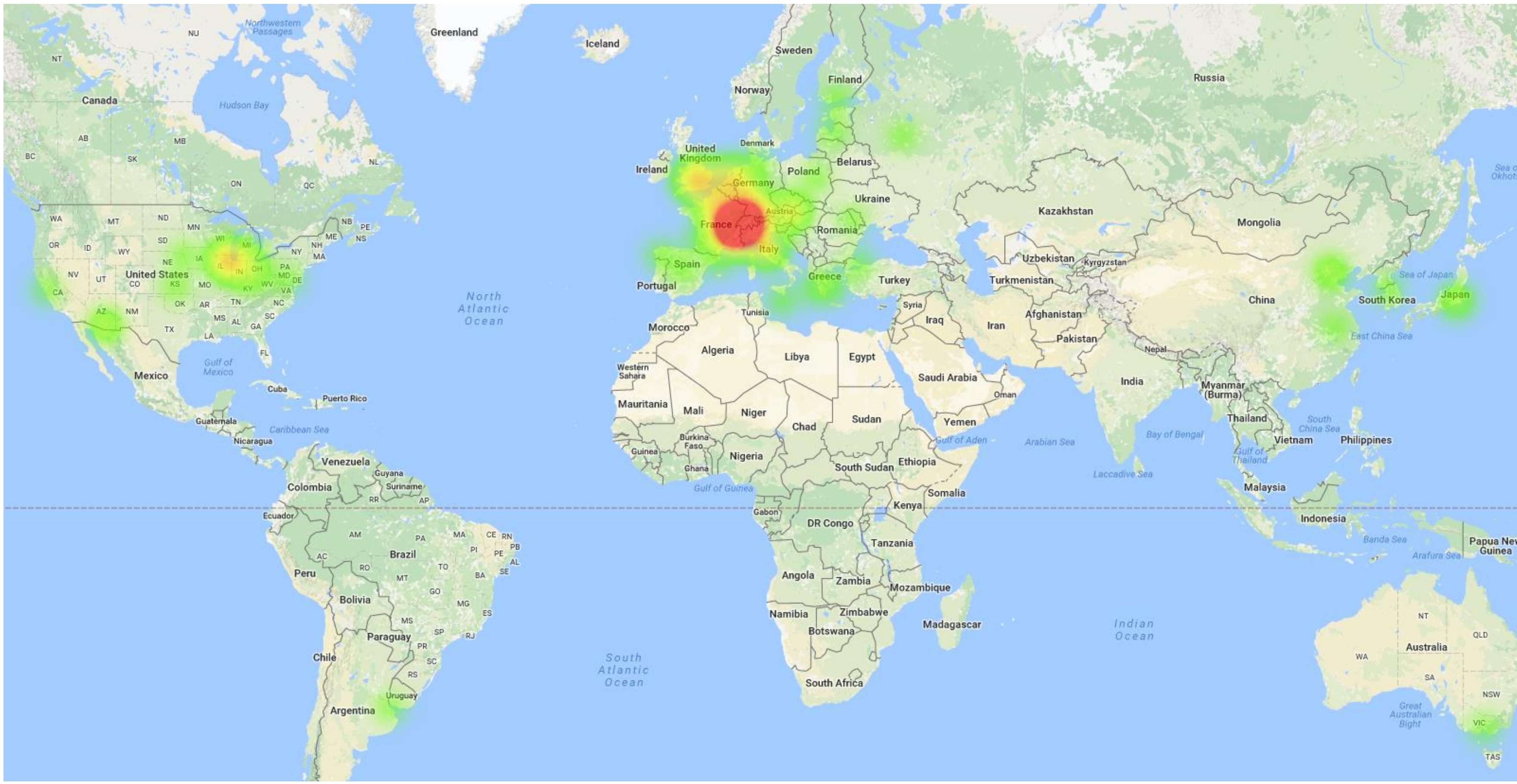
- Pilot Service released in June

  https://swan.cern.ch

- Open to everyone with a CERN account
  – And a CERNBox account activated
- Stats of the first 100 days (Jun – Sep):
  – 1800 sessions created (avg 18 per day)
  – 3700 notebooks opened (avg 37 per day)
- See backup slides for some user examples

SWAN Users

- Service open outside CERN since end of July



Summary, Plans

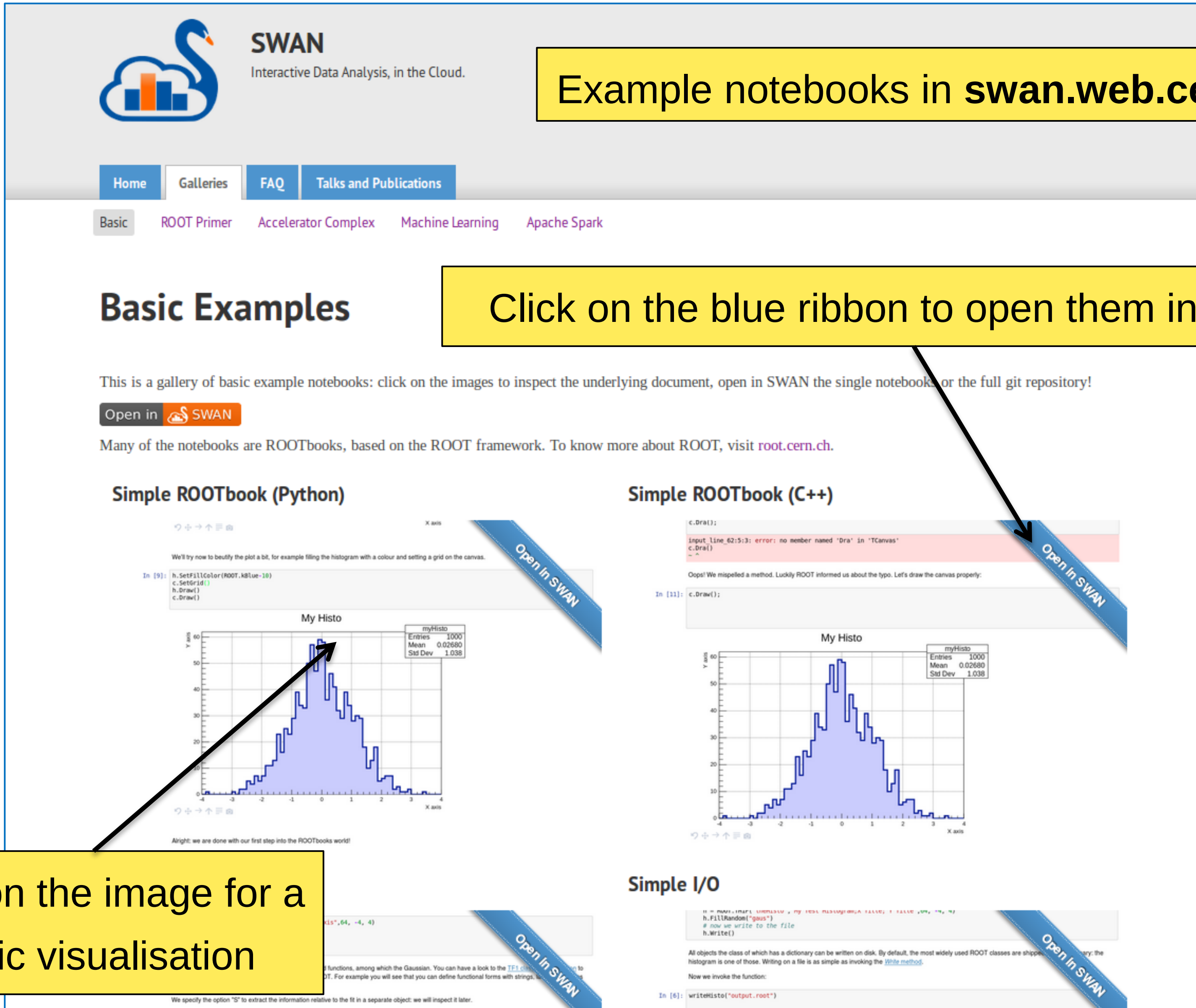
- SWAN pilot service available
  - ROOT integrated with Jupyter
  - CVMFS for software distribution
  - EOS mass storage + CERNBox synchronisation
- Future plans:
  - Incorporate user feedback
  - Facilitate use of experiment software
  - Enrich CVMFS with new (useful) packages
  - Improve experience with storage: sharing
  - Exploit external resources (e.g. Spark clusters)

Backup

A Notebook Gallery

Example notebooks in **swan.web.cern.ch**

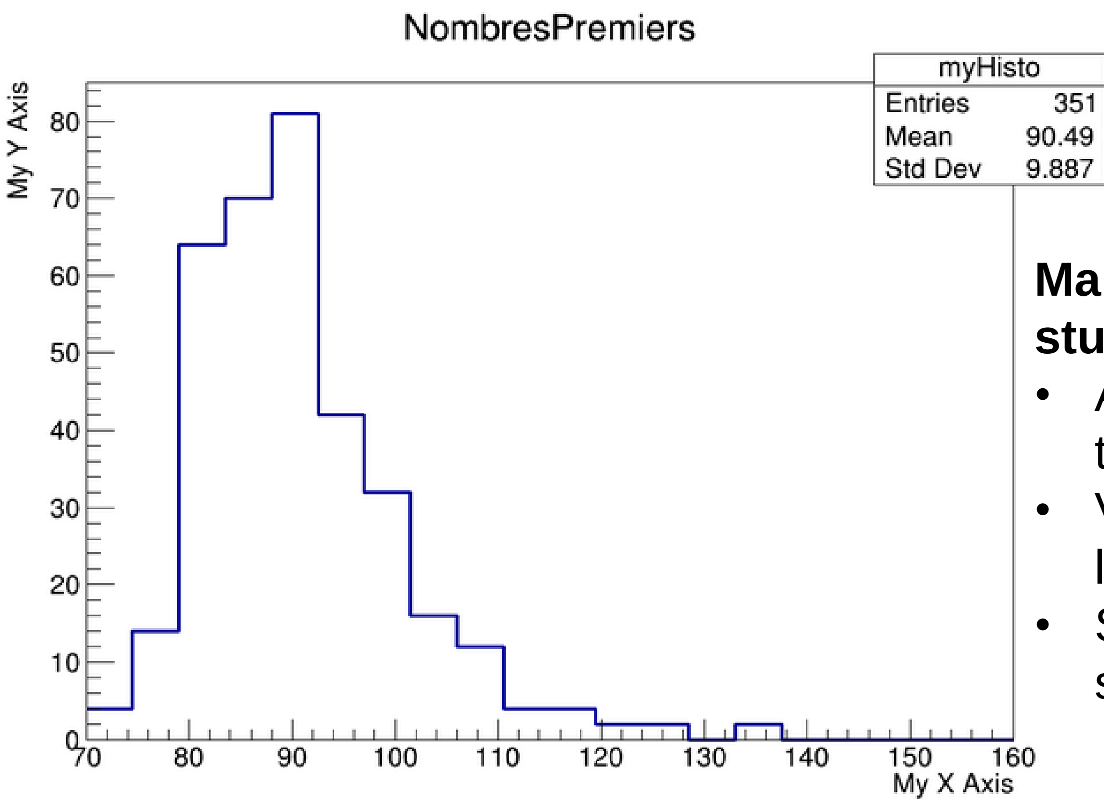
Click on the blue ribbon to open them in SWAN!



Click on the image for a static visualisation

```
In [138]: import ROOT
htemp = ROOT.TH1F("myHisto","NombresPremiers;My X Axis;My Y Axis",20,70,160)
for i in range(len(data)):
    d = data[i][0]
    htemp.Fill(float(d))
c = ROOT.TCanvas("myCanvas","myCanvasTitle",1024,768)
htemp.Draw()
c.Draw()
```

```
TROOT::Append:0: RuntimeWarning: Replacing existing TH1: myHisto (Potential memory leak).
TCanvas::Constructor:0: RuntimeWarning: Deleting canvas with same name: myCanvas
```



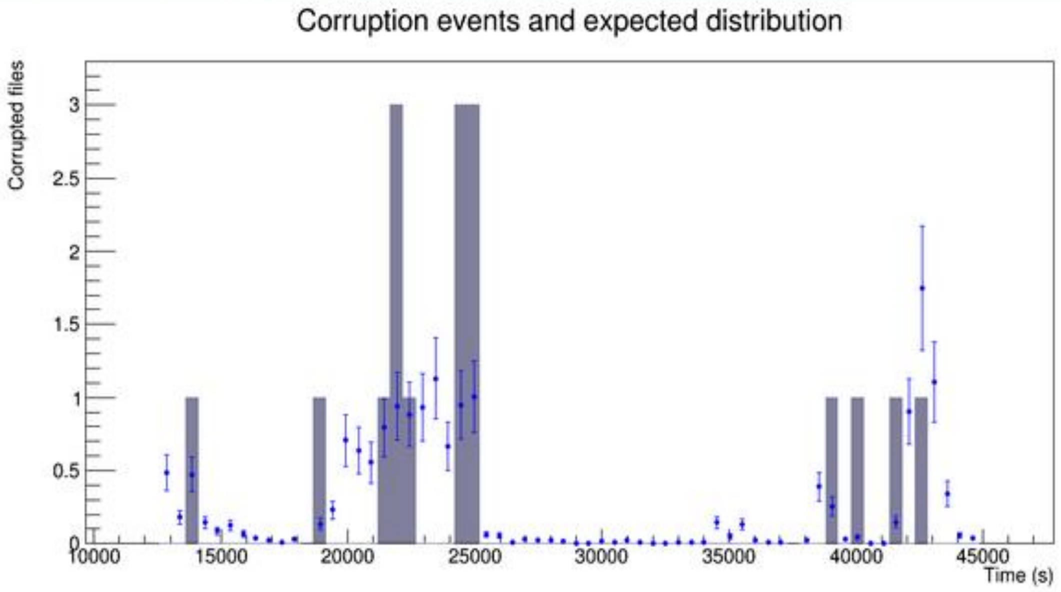
Mano S. (14 years old), K12 student

- Approaches programming for the first time
- Verifies numerically what he learned at school
- Shares results with his supervisor and classmates

```
Graph_x.Draw("P")

# Predefined function:
#fit_x1 = ROOT.TF1("fit_x1", "pol2", 0, 900)
#fit_x1.SetLineColor(kRed)
#Graph_x.Fit("fit_x1")

# Writing function explicitely:
#myfit = ROOT.TF1("myfit", "[0] + [1]*x", 0, maxt-mint)
#myfit.SetParameters(0,10.0)
#myfit.SetParameters(1,0.0022)

#myfit.SetLineColor(kRed)
#Graph_x.Fit("myfit","+")       # Option "+" to add fit

canvas.Update()
canvas.Draw()
if (SavePlots):
    canvas.SaveAs("Figure2.png")
```

```
Chi2/ndf with the hyphotesis corruption prob = 0.0022: 55.43/62 in the interval from Wed Jun 10 23:30:00 2015 to Thu
Jun 11 08:30:00 2015
```

```
Info in <TCanvas::Print>: png file Figure2.png has been created
```



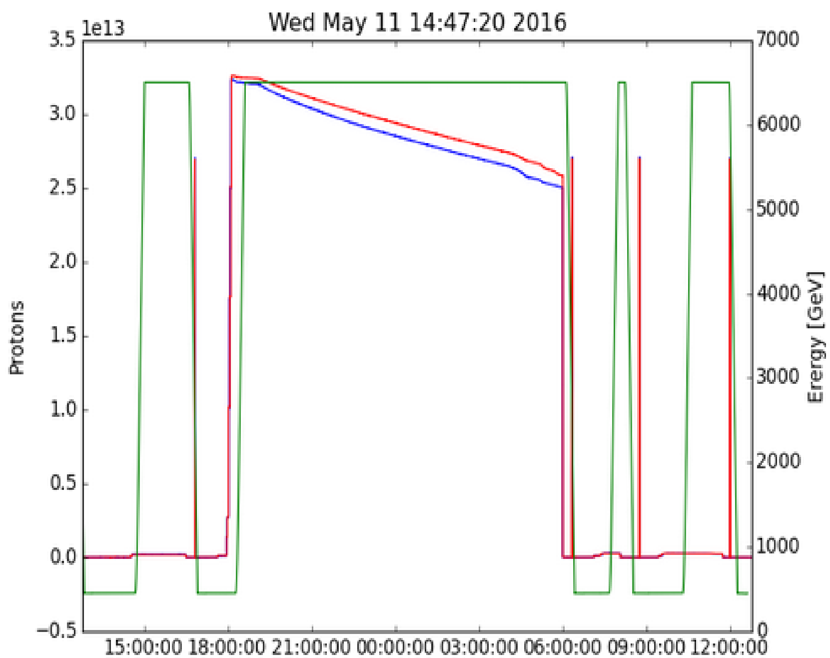
G. Lo Presti, M. Lamanna

"Castor data corruption incident"

- Describe incident, data source, analysis and results in a single document

```
In [3]: now=time.time()
        ib1="LHC.BCTDC.A6R4.B1:BEAM_INTENSITY"
        ib2="LHC.BCTDC.A6R4.B2:BEAM_INTENSITY"
        nrg="LHC.BOFSU:OFSU_ENERGY"
        data=db.get([ib1,ib2,nrg],now-3600*24,now)
```

```
In [4]: plt.clf()
        tt,vv=data[ib1]
        plt.plot_date(epoch2num(tt),vv,'-b',label='Beam1')
        tt,vv=data[ib2]
        plt.plot_date(epoch2num(tt),vv,'-r',label='Beam2')
        plt.ylabel('Protons')
        plt.twinx()
        tt,vv=data[nrg]
        plt.plot_date(epoch2num(tt),vv,'-g',label='Energy')
        plt.ylabel('Erergy [GeV]')
        plt.title(time.asctime(time.localtime(now)))
```



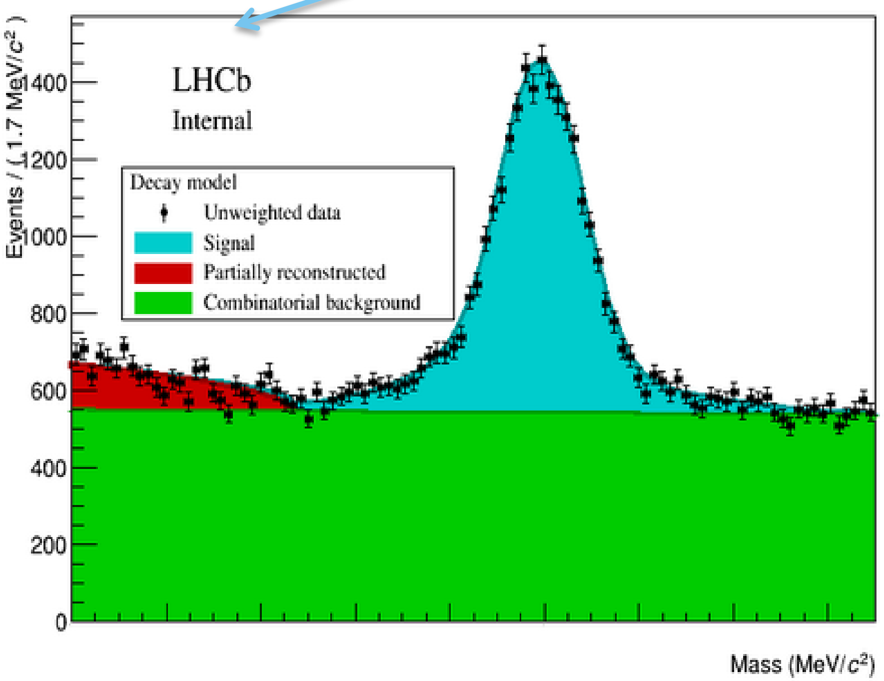
R. De Maria, BE-ABP-HSS

https://github.com/rdemaria/pytimber/blob/master/examples/LHC%20Page1.ipynb

- Read measurements coming from pick-ups in a database
- Plot time series
- Needs also SciPy and to share the notebooks with his colleagues

```
title = { "model": "Signal" ,  "pdfBkg" : "Partially reconstructed" , "cmbBkg": "Combinatorial background"}

for (component, color) in [ ("model",kCyan), ("pdfBkg",kRed), ("cmbBkg",kGreen)]:
    model.plotOn (frame, LineColor(color+2) , DrawOption('L'), Components(component), LineWidth(5))
    model.plotOn (frame, FillColor(color+1) , DrawOption('F'), Components(component), LineWidth(0), Name("P"+component
))
    leg.AddEntry ( frame.findObject ("P"+component), title[component] , "F" )

data.plotOn ( frame, MarkerColor ( ROOT.kBlack ) )
frame.Draw()
Graphics().lhcbMarker(0.2,0.8, "Internal")

leg.Draw()

ROOT.gPad.Draw()
```

Results coming from real data!(published now)



L. Anderlini

Rare B meson decay in LHCb

- Read data from EOS
- Setup complex fit
- Document and inspect results