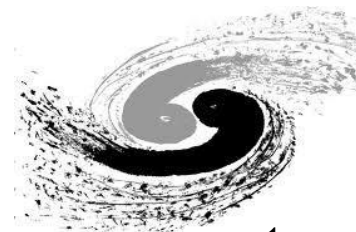
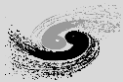


Synchronization and Sharing Services in IHEP

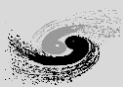
Qi Mengyao ,Lin Tao
On behalf of Computer Center, IHEP
qmy@ihep.ac.cn





Contents

- *IHEP Introduction*
- *IHEPBox at IHEP*
- *Data Analysis Service*
- *Ongoing work*
- *Summary, Plans*



Major Experiments at IHEP

- IHEP: The largest fundamental research center in China
- IHEP serves as the backbone of China's large science facilities



BEPC & BEPCII



BES III
Beijing Spectrometer III



Beijing Synchrotron
Radiation Facility



Yangbajing Cosmic
Ray Observatory



Daya Bay Reactor
Neutrino experiment



HXMT
Hard X-ray
Modulation Telescope



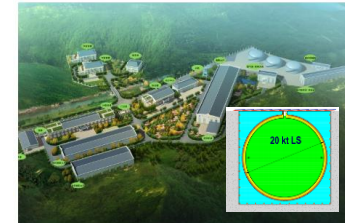
CSNS
China Spallation
Neutron Source



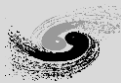
HEPS
High Energy
Photon Source



LHAASO
Large High Altitude Air
Shower Observatory



JUNO
Jiangmen Underground
Neutrino Observatory



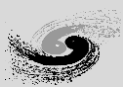
Major Experiments at IHEP

- BEPCII/BESIII
 - 5PB data in 5 years
- DYB
 - 400TB per year data collected
- JUNO
 - ~2PB raw data per year
- LHAASO
 - ~6PB raw data per year
 - accumulate 20PB+ in 10 years
- HXMT
- Atlas and CMS Tier2 site
 - 940TB disk, 1088 CPU cores

Iustre

EOS



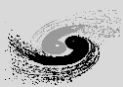


IHEPBox at IHEP

IHEPBox provide a cloud synchronization service

- Available for all IHEP users
- Synchronize files (data at IHEP) and data access
- Easy way to share with other users
- All major platforms supported
- Based on ownCloud integrated with EOS

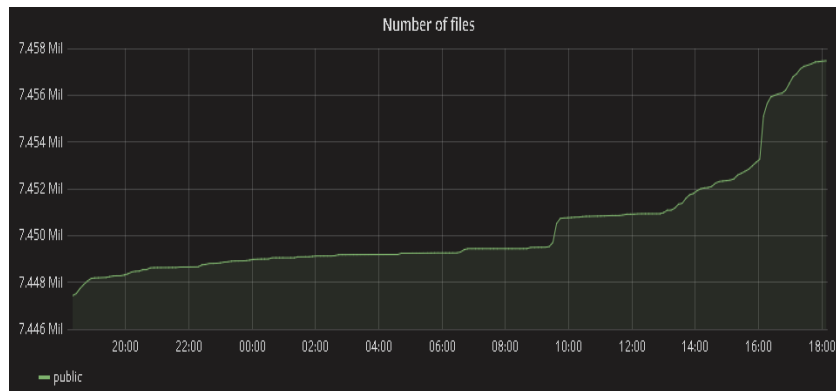




IHEPBox Service Numbers

Fast growing service

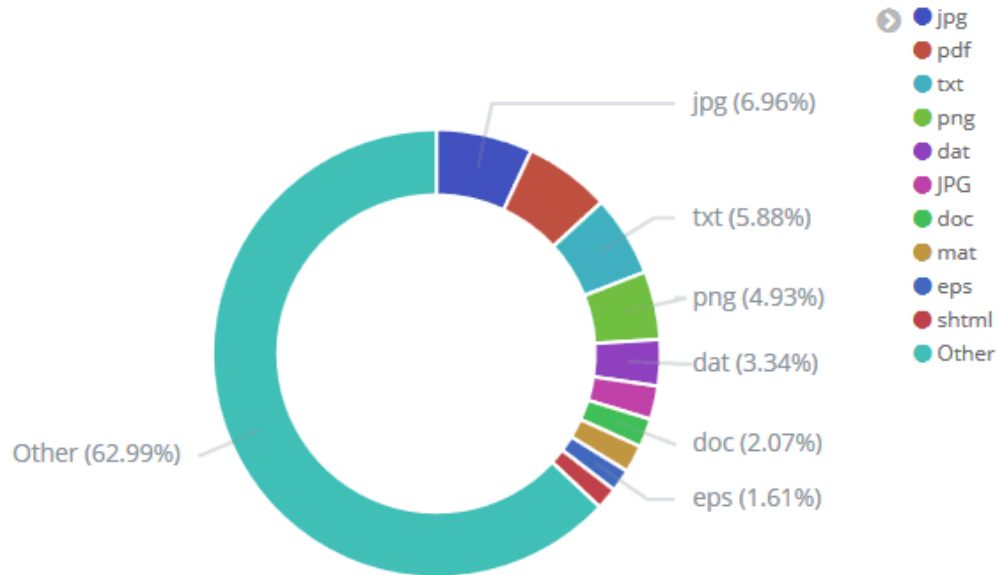
- Add-ons to integrate new ways to interact with IHEPBox , such as documents/galleries/calendar/activity...
- Large and growing user base
- 8K+ users, 100GB per user
- 160 TB ,used 42TB
- 17M+ files



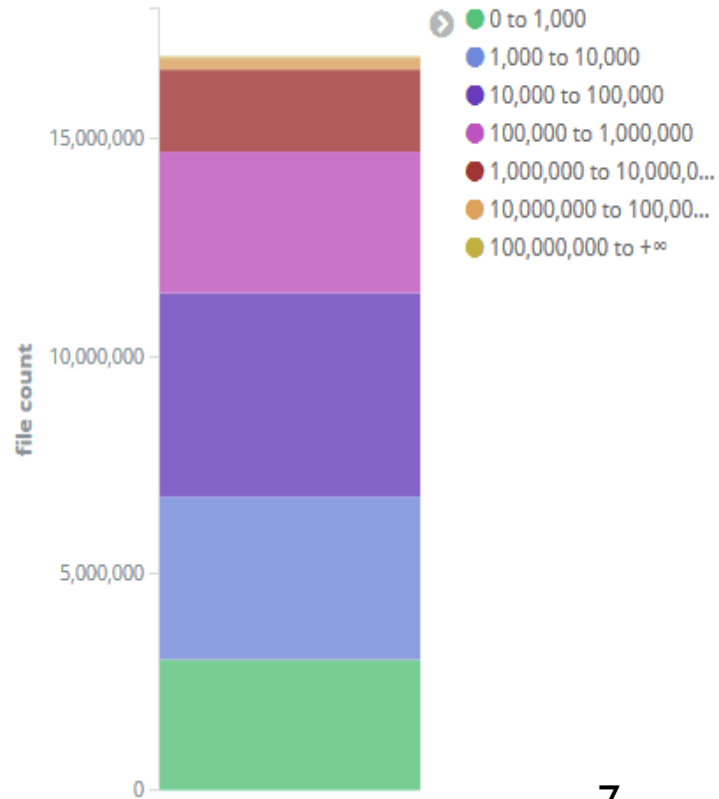


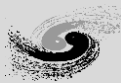
IHEPBox Service Numbers

ihepbox filetype distribute



ihepbox file size distribute





IHEPBox at IHEP

- Users

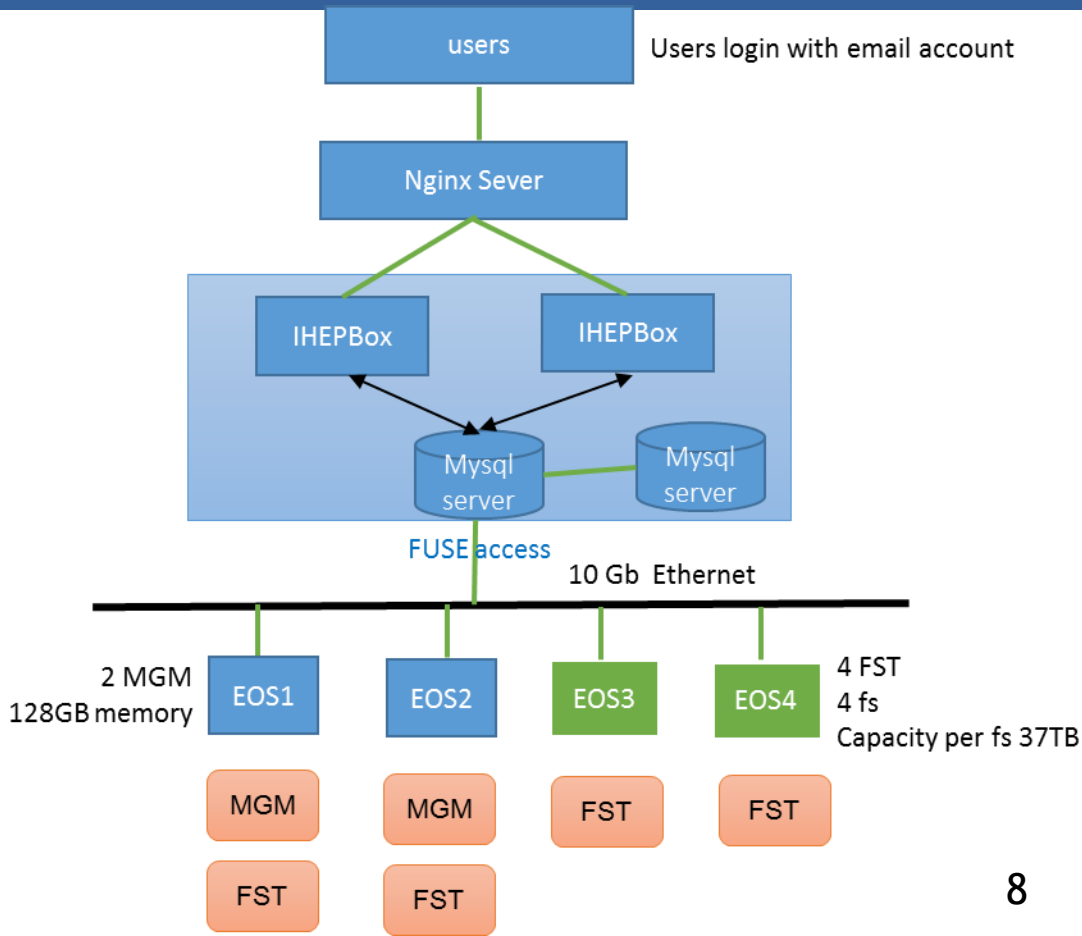
- IHEP LDAP users
- Local users

- Application Service

- 1 * Nginx
- 2 * IHEPBOX Servers

- Data Storage

- 4 * fst
- Two replication
- 2 * Mysql servers





Data analysis service

- Physics analysis tasks is challenge due to “big data” (PB scale).
- A physics analysis task is split into many jobs manually, while each job will process a part of dataset.
- For the physics analysis, the same dataset will be loaded many times due to iteration.
 - 1、 Write code, edit job option and update selection criteria.
 - 2、 Submit batch jobs.
 - 3、 After jobs finished, plot data, analyze result.
 - 4、 Go to step 1.
- Submitting jobs and plotting are the most time consuming part.
- Loading dataset many times also cause I/O performance.

Q: How to reduce the iteration time? A: “Analysis as a Service”



Analysis workflow

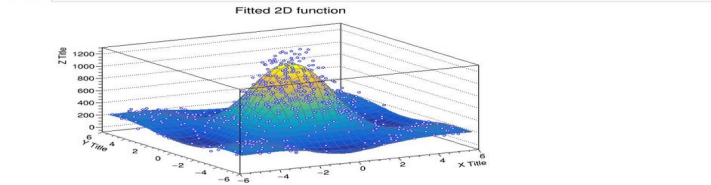
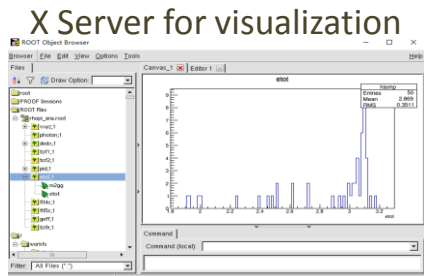
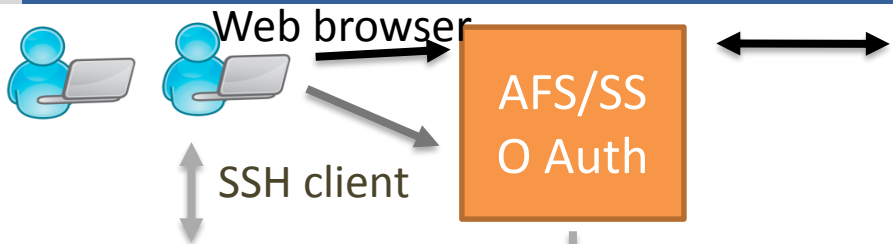
```

Fill the function to the generated data.
In [3]: f2.SetParameters(0.7, 1.5); // set initial values for fit
f2.SetTitle("Fitted 2D function");
dte.Fit(5f2);
f2.Chi=517; ASD FROM MIGRAD STATUS=CONVERGED 38 CALLS 39 TOTAL
EDM=2.65702e-12 STRATEGY= 0 ERROR MATRIX ACCURATE
EXT PARAMETER STEP FIRST
NO. NAME VALUE ERROR SIZE DERIVATIVE
1 p0 6.81725e-01 4.2173e-01 2.49825e-05 6.98231e-04
2 p1 1.46884e+00 9.36798e-01 5.15197e-05 3.78774e-04

Configure the canvas for plotting the result.
In [4]: TCanvas c1;
f2.SetLineStyle(1);
f2.SetLineStyleColor(4000 - 5);
f2.Draw("Surf");
auto Xaxis = f2.GetAxis(); Xaxis->SetTitle("X Title"); Xaxis->SetTitleOffset(1.5);
auto Yaxis = f2.GetAxis(); Yaxis->SetTitle("Y Title"); Yaxis->SetTitleOffset(1.5);
auto Zaxis = f2.GetAxis(); Zaxis->SetTitle("Z Title"); Zaxis->SetTitleOffset(1.5);
dte.Draw("Surf");

Display the 2D graph in the notebook.
In [5]: c1.Draw();

```

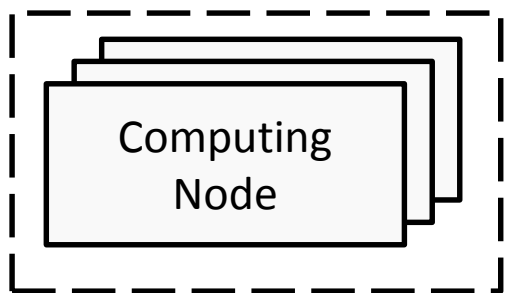
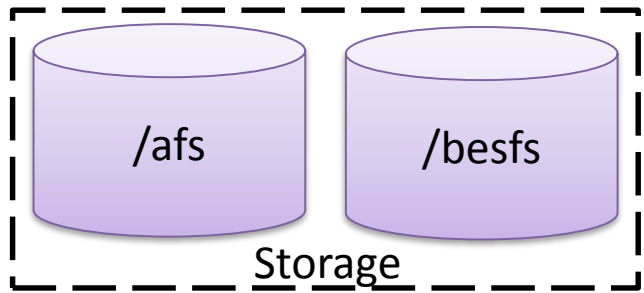


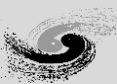
web-based analysis service



- Common software
- Middleware
- Computing facilities

Powerful computing resources

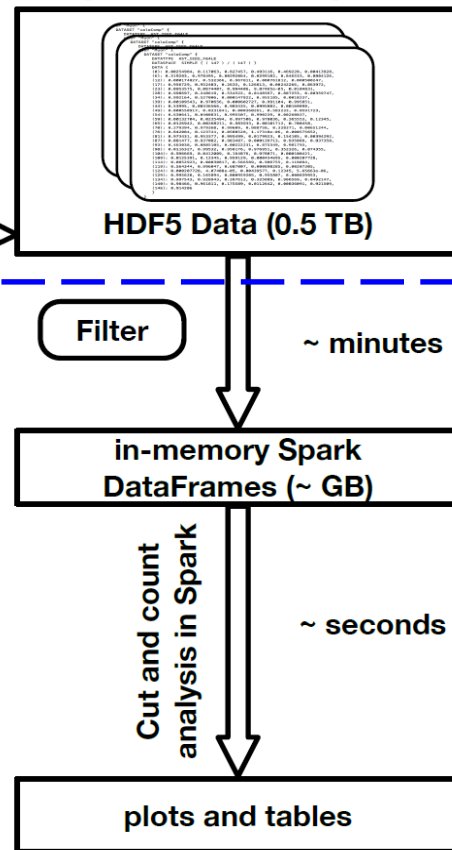
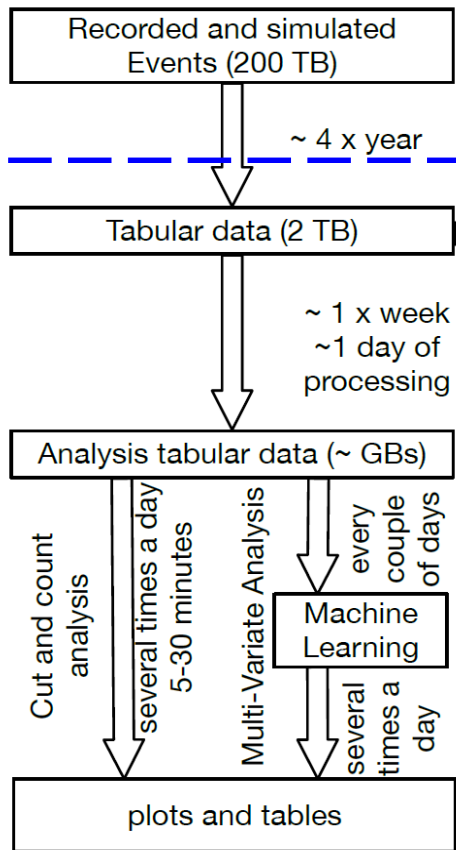




Using “big data” technology: in-memory analysis. Read once, Analysis multiple times

Traditional analysis

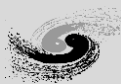
- Event by event processing.
- Split by jobs, then merge results.
- Intermediate files are created for each stage.
- I/O bottleneck.



Data structure become more important.

“big data” analysis

- In memory analysis.
- The properties are processed parallel.
- Join operation later.



Architecture:

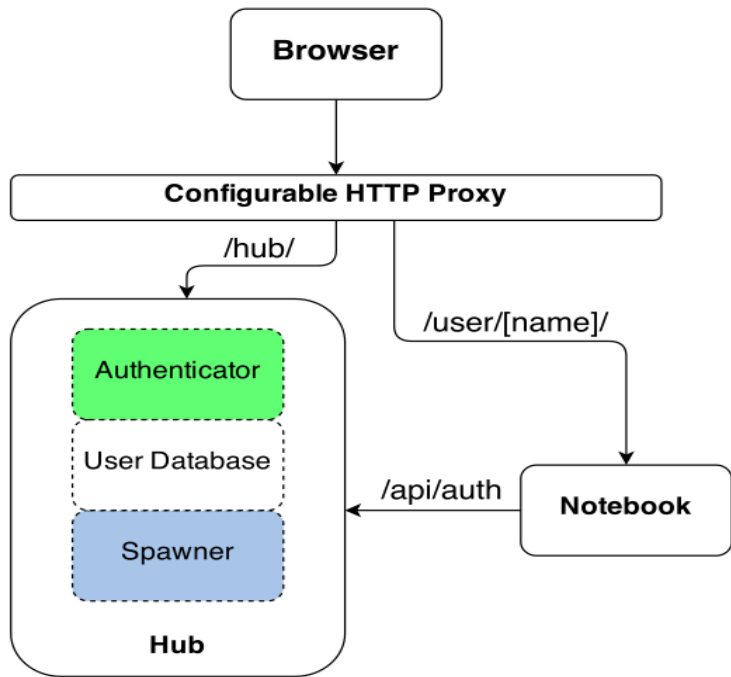


+



kubernetes

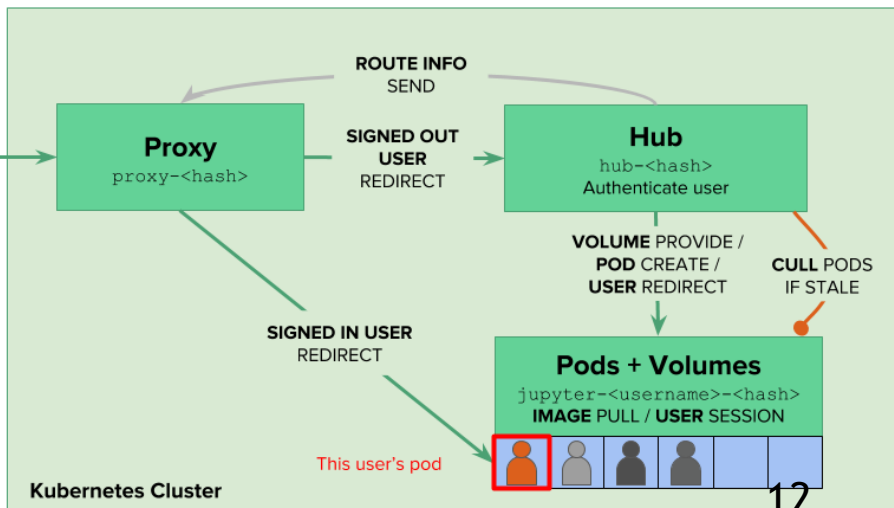
- Kubernetes manages the computing resources.
- On-demand, scalable computing.
- The backend can be also integrated with HTCondor.



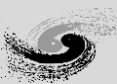
JupyterHub Architecture
high-level details)

Cloud Volumes
Provides persistent storage

Image Registry
Provides environment images



- JupyterHub manages multiple instances of the single-user Jupyter notebook.
- Authenticates users.
- Spawns notebooks for users.



Login using AFS account.

:8000/user/lin/tree?



Files Running Clusters

Select items to perform actions on them.

<input type="checkbox"/>	0	▼	📁 /
<input type="checkbox"/>	📁		authorsxml
<input type="checkbox"/>	📁		bin
<input type="checkbox"/>	📁		boss-notebook
<input type="checkbox"/>	📁		data
<input type="checkbox"/>	📁		Desktop
<input type="checkbox"/>	📁		deviceQuery
<input type="checkbox"/>	📁		dot

Notebook in different kernel.

Normal file

Folder

Terminal

Sign in

Warning: JupyterHub seems to be served over an unsecured HTTP connection. We strongly recommend enabling HTTPS for JupyterHub.

Username:

Password:

Sign In

Current AFS status

- 2521 IHEP AFS users

Quit

Logout

Control Panel

Upload your code/data.

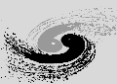
Upload

New

- Notebook:
- Bash
- Python 3
- tensorflow-gpu-1.6
- tensorflow-gpu-1.7

- Other:
- Text File
- Folder
- Terminal

	Last Modified	File size
	2 years ago	
	20 days ago	
	18 days ago	
	2 months ago	
	4 years ago	
	a month ago	
	a year ago	



Fill the function to the generated data.

```
In [3]: f2.SetParameters(0.7, 1.5); // set initial values for fit
f2.SetTitle("Fitted 2D function");
dte.Fit(&f2);
```

EXT	PARAMETER	VALUE	ERROR	STEP	SIZE	DERIVATIVE	FIRST	ERROR MATRIX	ACCURATE
1	p0	6.81725e-01	4.37173e-01	2.46425e-05	8.08231e-04				
2	p1	1.46084e+00	9.36798e-01	5.15197e-05	3.78774e-04				

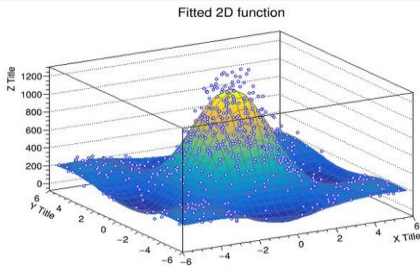
Configure the canvas for plotting the result.

```
In [4]: TCanvas c1;
f2.SetLineWidth(1);
f2.SetLineColor(kBlue - 5);
f2.Draw("Surf1");

auto Xaxis = f2.GetAxis(); Xaxis->SetTitle("X Title"); Xaxis->SetTitleOffset(1.5);
auto Yaxis = f2.GetAxis(); Yaxis->SetTitle("Y Title"); Yaxis->SetTitleOffset(1.5);
auto Zaxis = f2.GetAxis(); Zaxis->SetTitle("Z Title"); Zaxis->SetTitleOffset(1.5);
dte.Draw("PB Same");
```

Display the 2D graph in the notebook.

```
In [5]: c1.Draw();
```



Multiple language support: C++ and Python



Access TTree in Python using PyROOT and fill a histogram

First import the ROOT Python module.

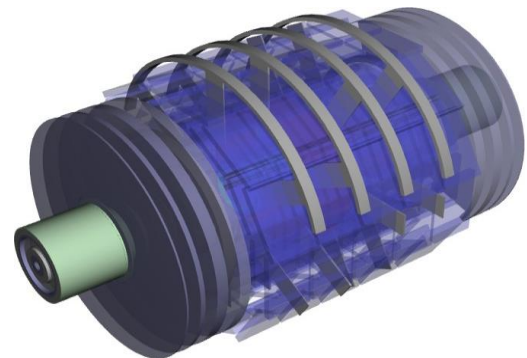
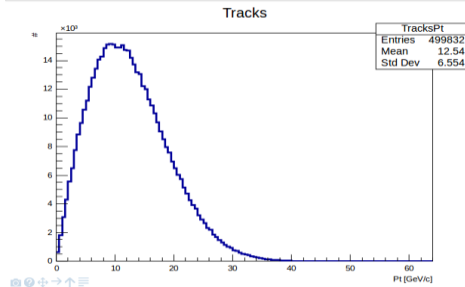
```
In [1]: !import ROOT
!jupyter
Welcome to Jupyter 6.07/07
```

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

```
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:
    h.Fill(track.Pt())
c = ROOT.TCanvas()
h.Draw()
c.Draw()
```



ROOT Kernel extension.

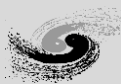


Status

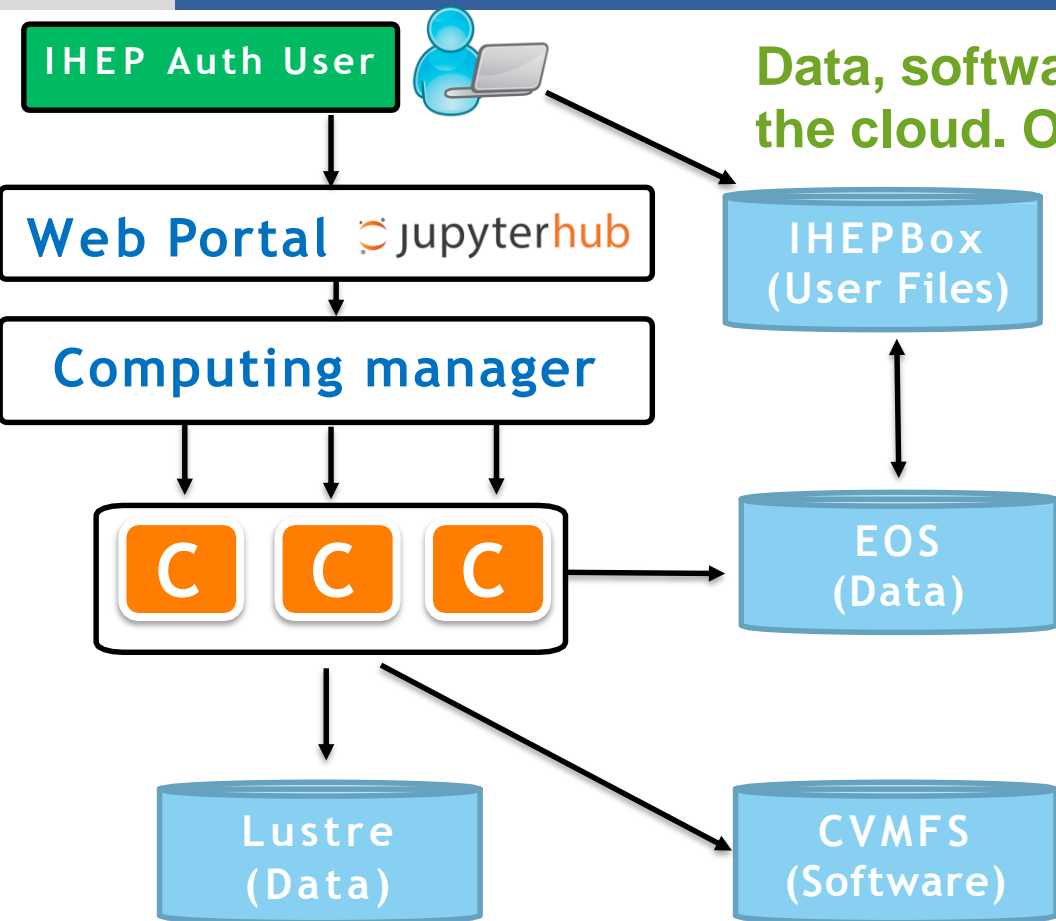
- Jupyter software stack is deployed at AFS.
- Users can start Jupyter and ROOT 6 in their own space.
- Setup JupyterHub in a virtual machine and setup Kubernetes in two blade servers.

Challenges

- Need to klog manually to get AFS token.
- Support multiple users and experiments.
- Unified data access between SSH and Web.
- How to benefit from “big data” technology.

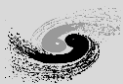


Ongoing : Cloud-based open platform



Data, software and computing resources in the cloud. Only a web browser is needed!

- Authentication : **IHEP SSO**
- Infrastructure:
 - **Jupyter + IHEPBox + EOS**
- Software distribution: **CVMFS**
- Storage, in two flavours:
 - DATA : EOS and Lustre
 - User Files: IHEPBox



Ongoing : IHEPBox Integration

IHEP Files

- All files
- Favorites
- Shared with you
- Shared with others
- Shared by link
- All projects
- Your projects

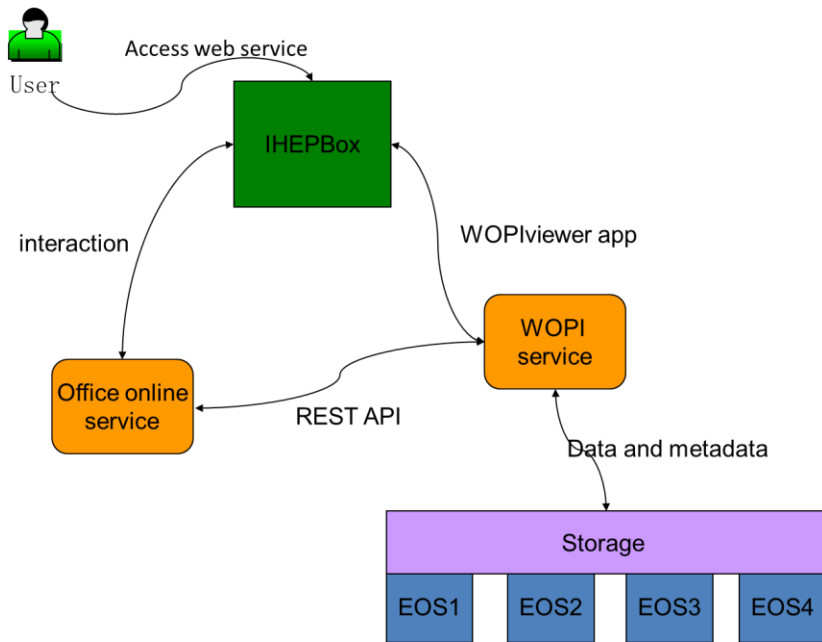
unit

	Simple_ROOTbook_cpp.ipynb	Open in SWAN	486 kB	3 days ago
	Simple_ROOTbook_py.ipynb	Open in SWAN	326 kB	a day ago
	test.py		6 kB	a month ago
	Untitled.ipynb	Open in SWAN	< 1 kB	a day ago
	Untitled1.ipynb	Open in SWAN	< 1 kB	a day ago
	Untitled2.ipynb	Open in SWAN	< 1 kB	20 days ago

Notebook can be opened in IHEPBox

Ongoing : IHEPBox and WOPI server

A WOPI server will be developed to connect Microsoft Office Online to IHEPBox



The screenshot shows a presentation slide titled "From Sync&Share to Collaborative Platforms". The slide features logos for "cosystem", "CERNBox", "owncloud", and "EOS". The main text on the slide reads "ways to interact with your data Cloud Computing" and "OT histograms)". Below this, there are icons for "Office", "jupyter", and "spark". The slide is part of a presentation in a browser window, with the URL "cbx-web-04.cern.ch/index.php/onlyoffice/100..." visible. The presentation is titled "ONLYOFFICE Presentation Editor" and "G. Lo Presti - CS3 2017 - From S&S to Collaborative platforms.pptx". The slide number is 4 of 12.



- Prototype service available
 - CVMFS for software distribution
 - EOS、Lustre mass storage
 - IHEPBox Synchronization and sharing
- Future plans:
 - Jupyter service for deployment ,integrate with IHEPBox
 - Unified login accounts
 - Experiments data, users' data accessible on EOS
 - Office online service available
 - Integrate with experiments software
 - Open to all users