XENON1T Computing on OSG

OSG All Hands Meeting @ SDSC

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Open Science Grid

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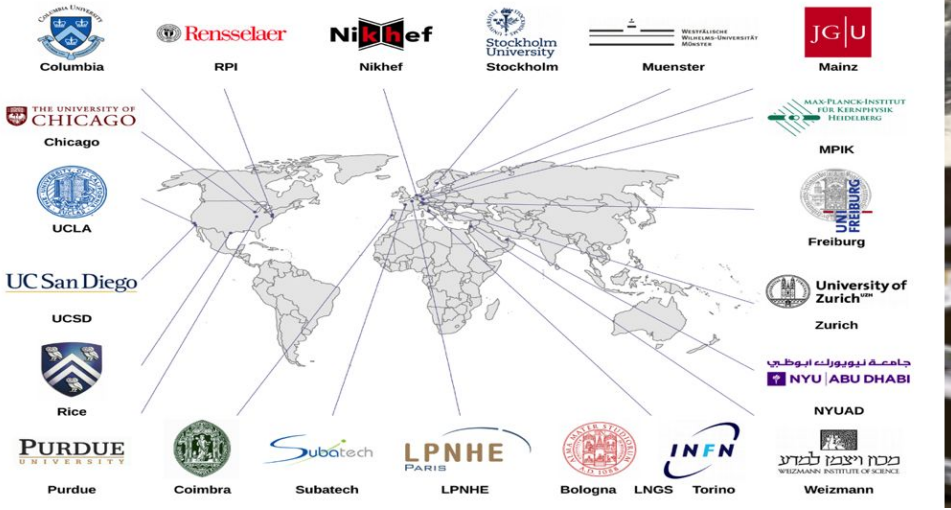
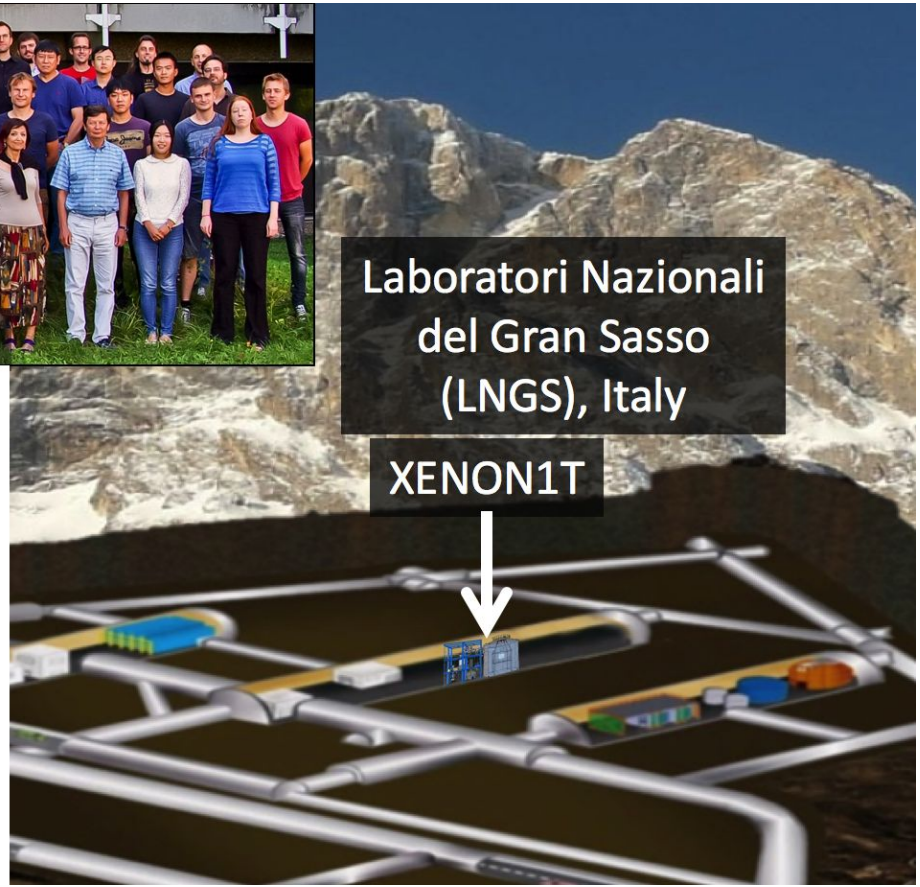
Overview

- Experiment & Science
- Data management
- Infrastructure at UChicago MWT2
- Data Processing Workflow
- Monte Carlo simulation
- OSG Usage
- Future Plans

~130 scientists from 22 institutions

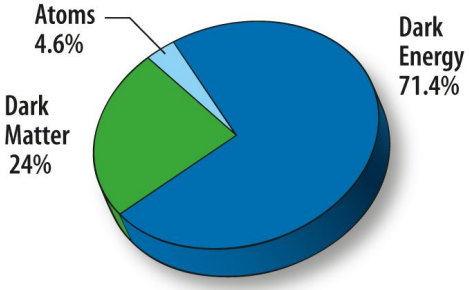

Columbia
RPI
Nikhef
Stockholm
Muenster
Mainz
Chicago
MPIK
UCLA
Freiburg
UCSD
Zurich
Rice
NYUAD
Purdue
Coimbra
Subatech
LPNHE
Bologna
LNGS
Torino
Weizmann

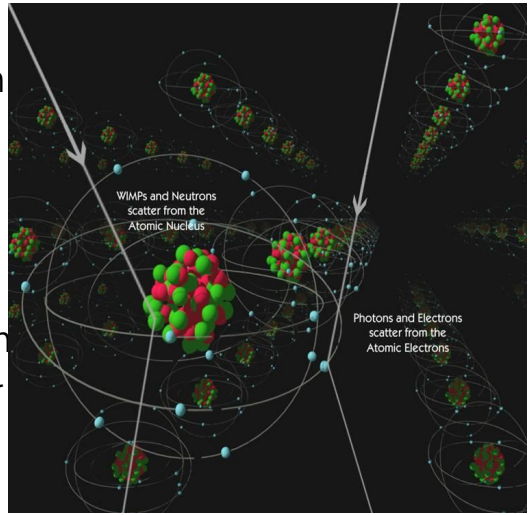

Laboratori Nazionali del Gran Sasso (LNGS), Italy
XENON1T

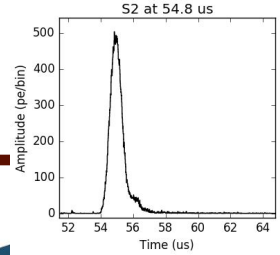
- 1st ton-scale experiment
- 3.2t of LXe, 2t in TPC
- All systems commissioned since Fall 2016
- Calibration and science data taking now ongoing

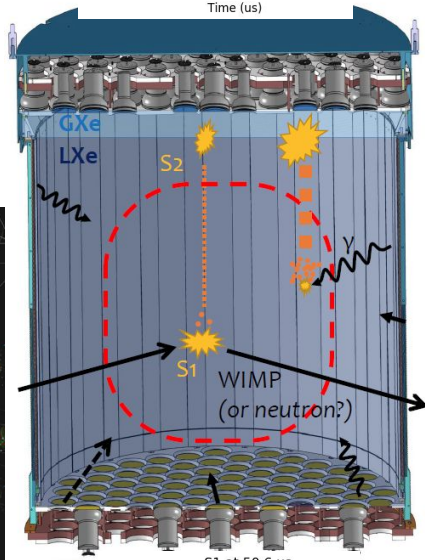
XENON1T Science

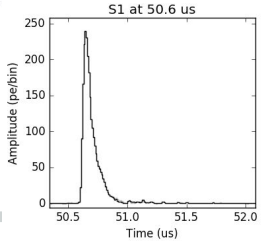
- No idea what 95.4% of Universe is made of
- Looking for Dark Matter candidate - Weakly Interactive Massive Particles (WIMP) - through nuclear recoil on liquid Xenon
- WIMP nuclear recoil produces charge and time signature in the detector readout that can easily distinguish nuclear recoil from other interactions

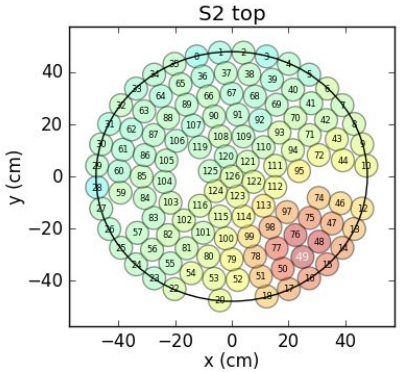


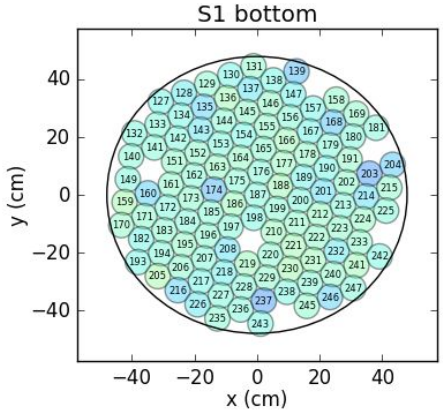






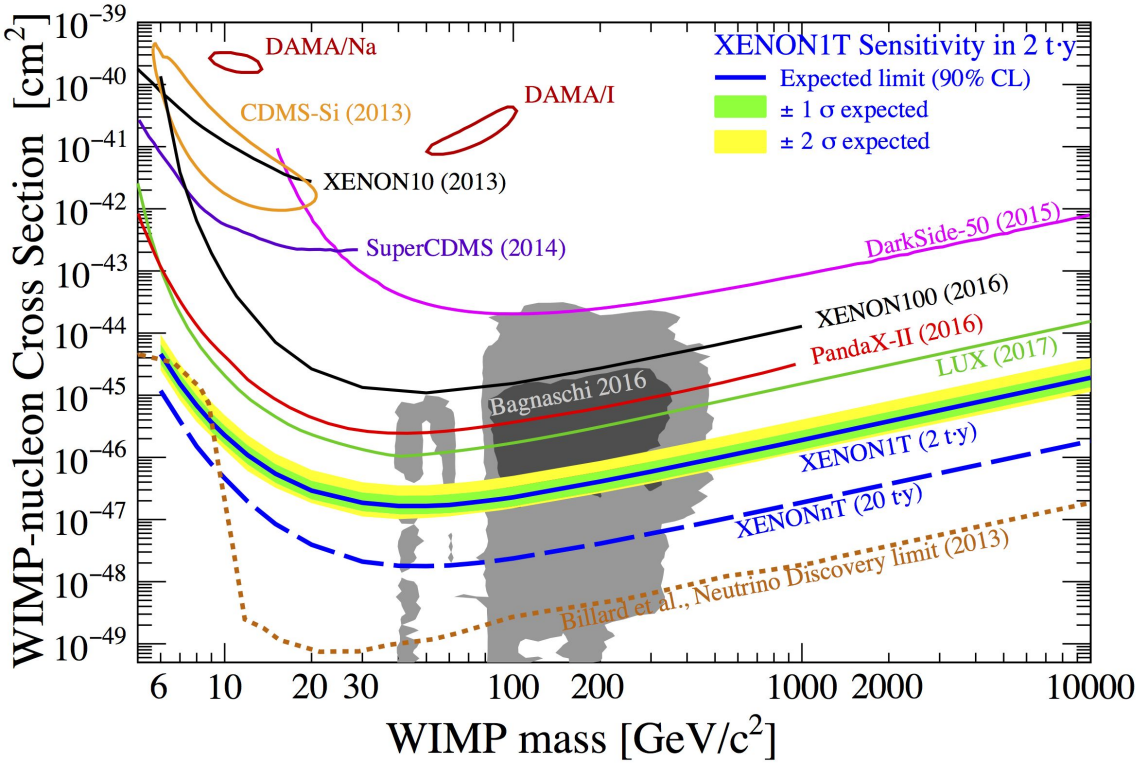






Projected WIMP Limits

- Projected to be sensitive in theoretical space
- Preparation for future larger detectors (XENONnT)



Computing Requirements

- Particle physics computing, i.e. data transfer to various sites, event reconstruction, Monte Carlo production
- Data: ~1 TB/day, first 90 days with MC 1-2 PB
- CPU: ~30 MCPUhours/year
- Main Support Tasks:
  - Data transfer from LNGS to various sites, and between sites
  - OSG access and support for event reconstruction and Monte Carlo production

Data Management

- Setup a distributed data management system using "Rucio" (data management system developed and used by ATLAS) and FTS at BNL
  - Rucio: File catalog service, subscription "rule" model for data placement and deletion, etc.
  - FTS: Reliable file transfer
- Currently 6 storage endpoints defined in the US, Europe and Israel

Rucio Stats

- Rucio management server is a SL7 VM running MariaDB
- Number of Datasets: 5043
- Number of Files: 340943
- Total Storage Used: 301.8 TB
- Total Storage Remaining: 340.7 TB (642.5 TB total available)

Xenon1T Rucio Status

IN2P3 RSE Status #813 2 hours ago	IN2P3 RSE Transfer #814 57 minutes ago
LNGS RSE Status #2424 2 hours ago	LNGS RSE Transfer #1004 1 hour ago
Nikhef RSE Status #2420 2 hours ago	Nikhef RSE Transfer #1001 2 hours ago
RCC RSE Status #2136 1 hour ago	RCC RSE Transfer #508 2 hours ago
Rucio Central Service #2428 1 hour ago	Stash RSE Status #2419 1 hour ago
Stash RSE Transfer #993 1 hour ago	Weizmann RSE Status #344 2 hours ago
Weizmann RSE Transfer #346 1 hour ago	

Brought to you by Jan Molak

Monitoring Automated FTS Transfers

Generated at 6:29:41 PM (fts03.usatlas.bnl.gov)

Overview | Jobs | Optimizer | Error reasons | Statistics | Configuration | Job id

Filter destination SE: xenon.biggrid.nl | Source storage | Destination storage | 12 hours | Apply | Reset

Overview

Showing 1 to 3 out of 3 from the last 12 hours

First | Previous | 1 | Next | Last

source

destination

Transfer rate

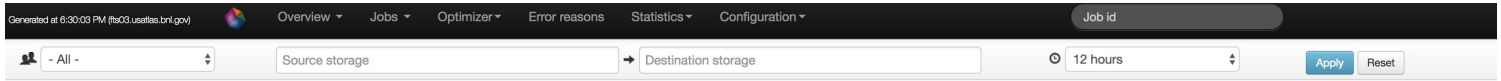
		VO	Submitted	Active	Staging	S.Active	Finished	Failed	Cancel	Rate (last 1h)	VO Thr.
srm://tbn18.nikhef.nl	gsiftp://gridftp.grid.uchicago.edu	xenon.b	32382	12	-	-	11333	43	5	99.62 %	31.14 MB/s
gsiftp://ccdcacli022.in2p3.fr	gsiftp://gridftp.grid.uchicago.edu	xenon.b	3215	12	-	-	1498	381	174	79.72 %	1.61 MB/s
gsiftp://xe1t-datamanager.lngs.infn.it	srm://tbn18.nikhef.nl	xenon.b	-	-	-	-	348	1	-	99.71 %	-
			35597	24	0	0	13179	425	179	96.88 %	-

First | Previous | 1 | Next | Last

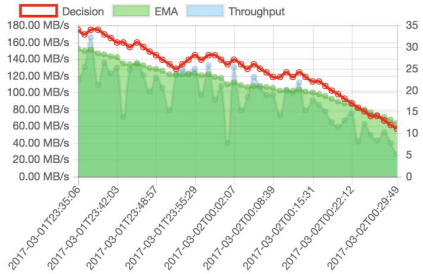
Bad shape There are submitted but no active, less than 3 active with more than 3 submitted, or a failure rate >= 20%
Underused Less than three actives, but no submitted waiting.
Good shape Success rate >= 90%, or more than three actives with a failure rate < 20%.
Nothing special No active, no submitted, success rate between 80% and 90%.

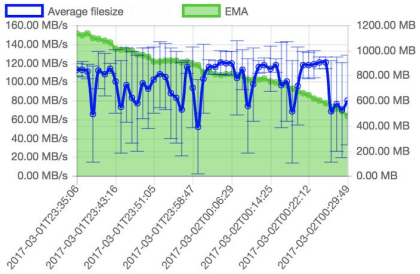
Thanks to BNL for lending use of FTS instance

Monitoring Automated FTS Transfers



Details for srm://tbn18.nikhef.nl → gsiftp://gridftp.grid.uchicago.edu





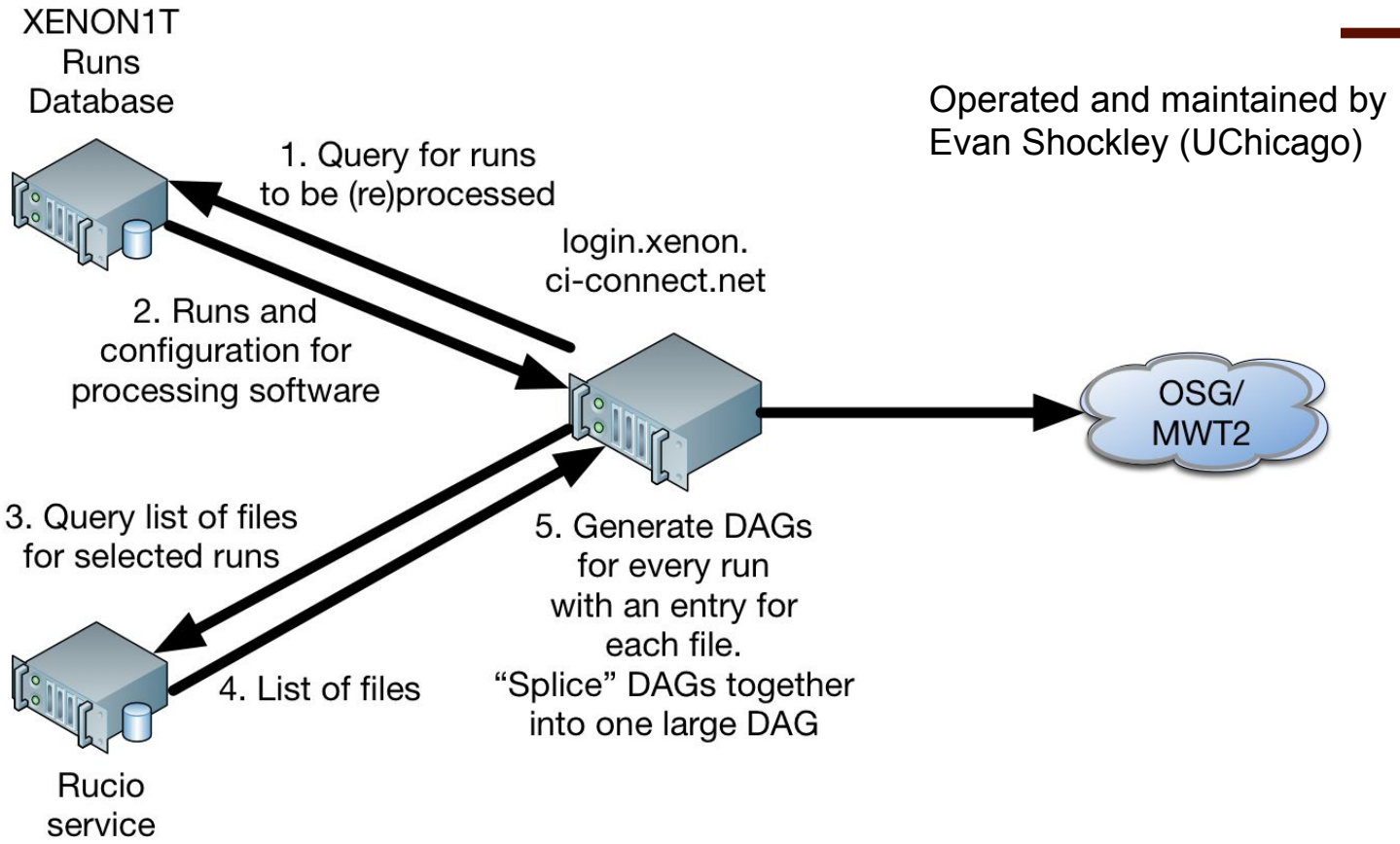
First | Previous | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | Next | Last

Timestamp	Decision	Running	Queue	Success rate (last 1min)	Throughput	EMA	Diff	Explanation
2017-03-02T00:29:49	11	12	32382	100.00%	25.404 MB/s	63.950 MB/s	-1	Good link efficiency, throughput deterioration
2017-03-02T00:28:44	12	13	32389	100.00%	40.042 MB/s	68.233 MB/s	-1	Good link efficiency, throughput deterioration
2017-03-02T00:27:38	13	14	32399	100.00%	53.257 MB/s	71.365 MB/s	-1	Good link efficiency, throughput deterioration
2017-03-02T00:26:34	14	11	32410	100.00%	42.797 MB/s	73.377 MB/s	0	Good link efficiency, throughput deterioration, avg. filesize decreasing

Xenon1T Infrastructure - UChicago

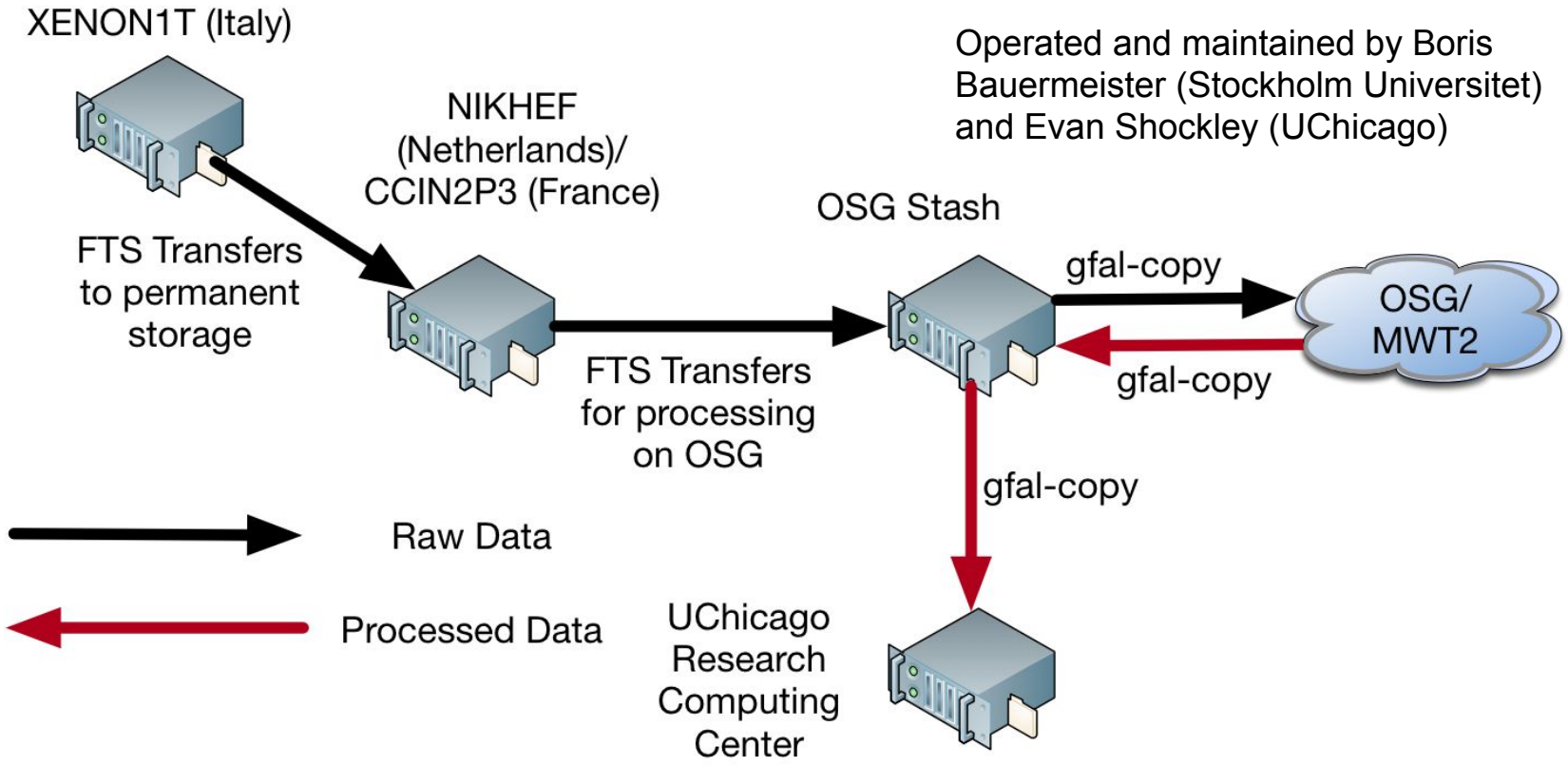
- Dedicated submit host - login.xenon.ci-connect.net
- MWT2 Friends - Special opportunistic priority on MWT2 compute resources
- 2x GridFTP doors for OSG Stash, shared with SPT
- CVMFS Stratum 0 - CVMFS deployment automated through DeployHQ targeting for new releases and changes to Xenon Git repository
- Backup Jupyterhub for analysis workshop

Data Processing Workflow



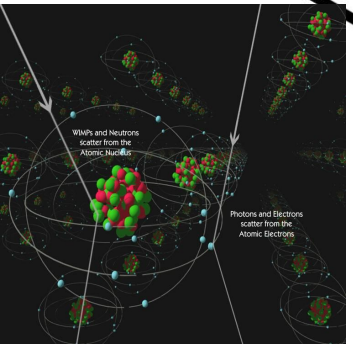
Operated and maintained by
Evan Shockley (UChicago)

Data Flow for Processing

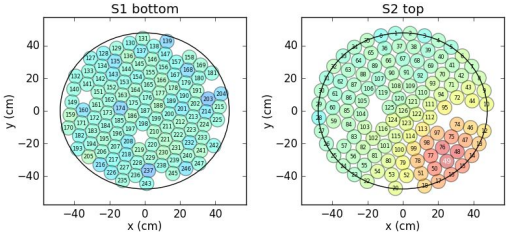


MonteCarlo Workflow

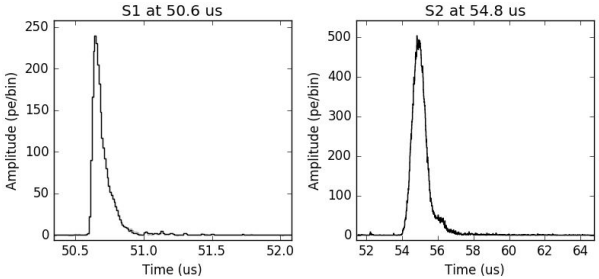
GEANT4
Event Generatioin



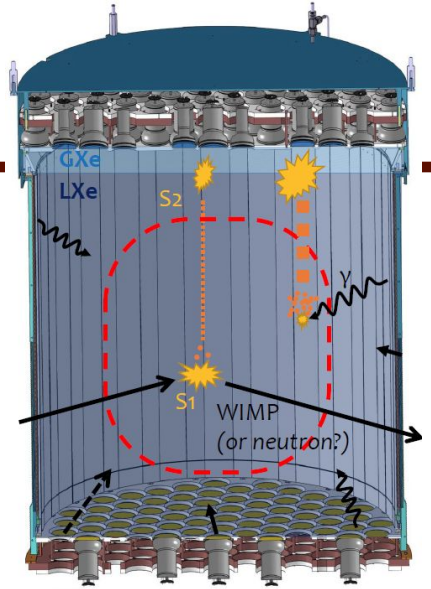
Generate Detector Response (S1 and S2)



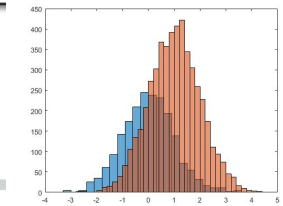
Waveform Generation



Reconstruction



Analysis ready output



Operated and maintained by Patrick de Perio (Columbia), Fabio Valerio Massoli (Bologna), and Jialing Fei (UCSD)

MonteCarlo Workflow

- Implemented using **Pegasus** workflow manager to handle running jobs and errors
- Submit to OSG or EGI sites using a switch at runtime

```
mc_process.py --flavor G4 --config optPhot --source-macro
run_optPhot_fullvolume.mac --batch-size 10000 --events 1000
--mc-version v0.1.7 --pax-version v6.2.1 --grid-type osg
```

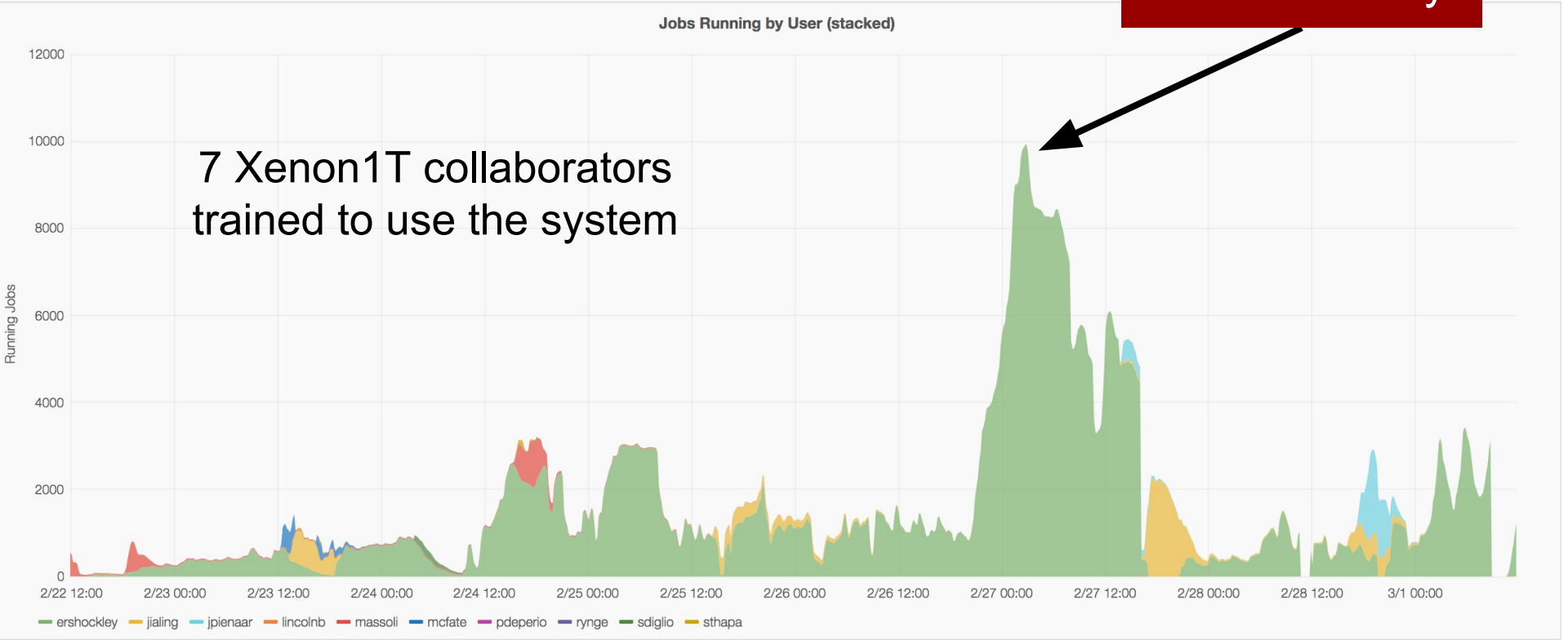
- 10+ data sets generated so far using OSG resources with production still ongoing

Status Today

- Data:
  - Rucio service has been stable modulo some peak usage periods, increased the maximum number of concurrent DB connections to resolve
  - OSG helped XENON1T become part of LHCOne
  - Transfer speeds between EU sites and US can vary greatly, under investigation
- Processing
  - Reprocessing campaign has started, expected use ~42 kCPUHours
  - Overall used 583933 CPUhours in Feburary for reprocessing campaign and Monte Carlo production - Number 1 OSG Connect group

OSG Usage

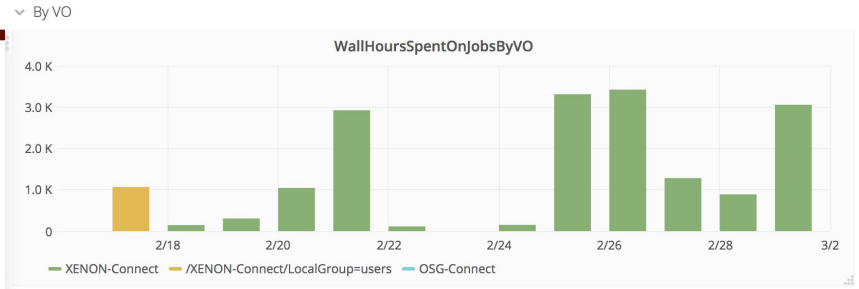
10000 cores simultaneously!

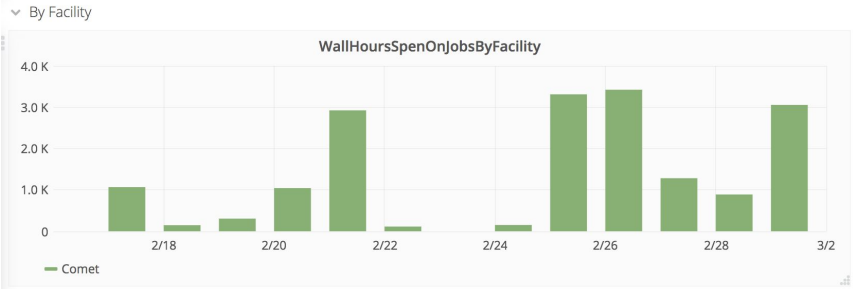


7 Xenon1T collaborators trained to use the system

Comet usage with glideinWMS

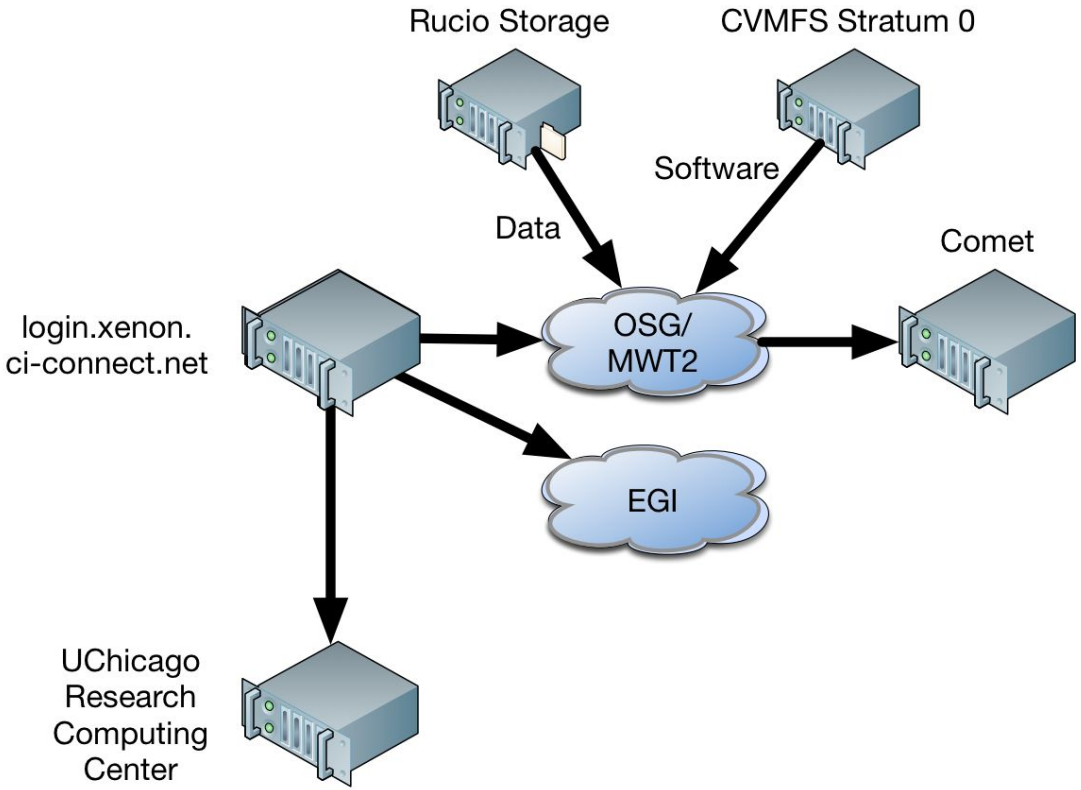
- Added Comet as a dedicated target for XENON1T VO through glideinWMS
- Goes through osg-flock and a special glidein is started on the UCSD side
- Uses docker to setup environment
- Transparent to XENON1T users
- **Thanks to Edgar and Mats!**





Xenon1T Compute Environment

- Integrated **campus cluster, OSG, EGI & HPC resources** into one submission environment
- Data management system that allows transparent access to data across continents



Future Plans

- Expand US storage for future reprocessing campaigns
- JuypterHub - Move from current JupyterHub to new OSG Connect JupyterHub once ready
- Continued use of Comet and other NSF HPC resources
- Looking into integrating CCIN2P3 and NIKHEF into glideinWMS

Summary

- OSG is working closely with XENON1T for their data management, data processing infrastructure, and MC production
- Build a compute environment that integrates grid, HPC, and campus resources
- “OSG”-ready infrastructure deployed and already heavily used
- Looking forward to the first results in 2017!