



COMPASS Grid Production System

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COMPASS collaboration



Common Muon and Proton Apparatus for Structure and Spectroscopy



24 institutions from 13 countries
– nearly 250 physicists

- CERN SPS north area
- Fixed target experiment
- Approved in 1997 (**20 years**)
- Taking data since 2002

Wide physics program

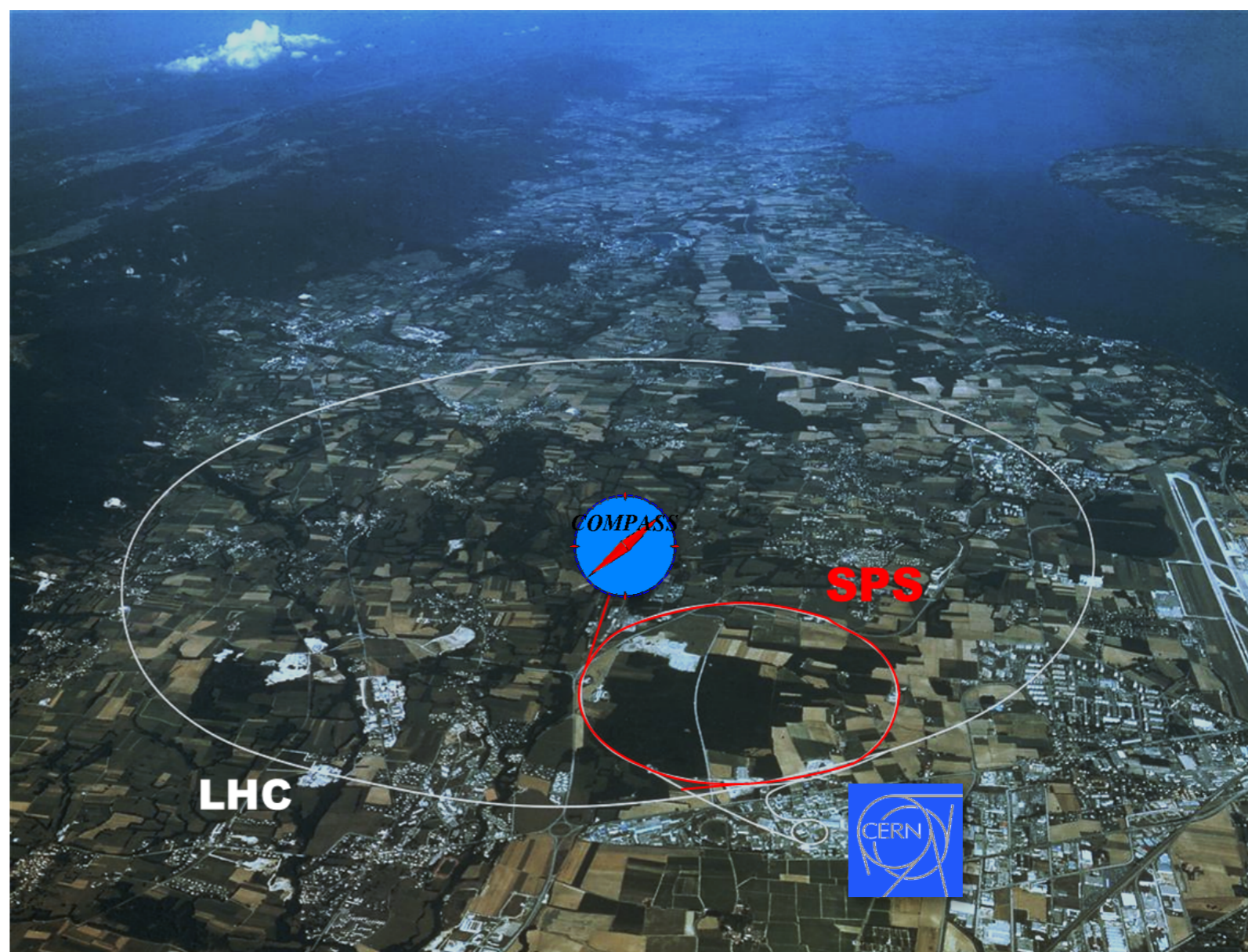
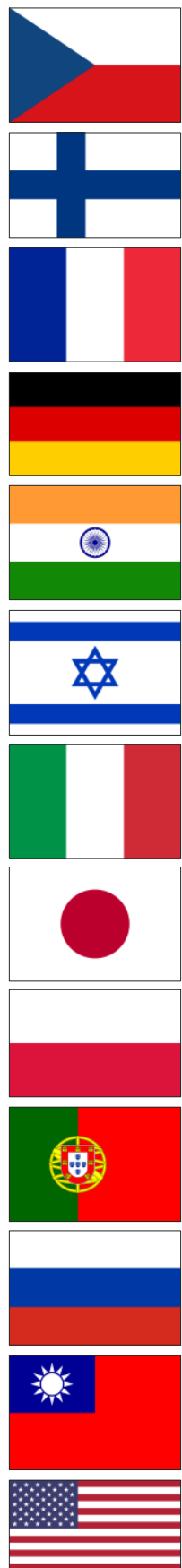
COMPASS-I

- Data taking 2002-2011
- Muon and hadron beams
- Nucleon spin structure
- Spectroscopy

COMPASS-II

- Data taking 2012-2018 (**2021?**)
- Primakoff
- DVCS (GPD+SIDIS)
- Polarized Drell-Yan
- **Transverse deuteron SIDIS**

Many “beyond 2021” ideas



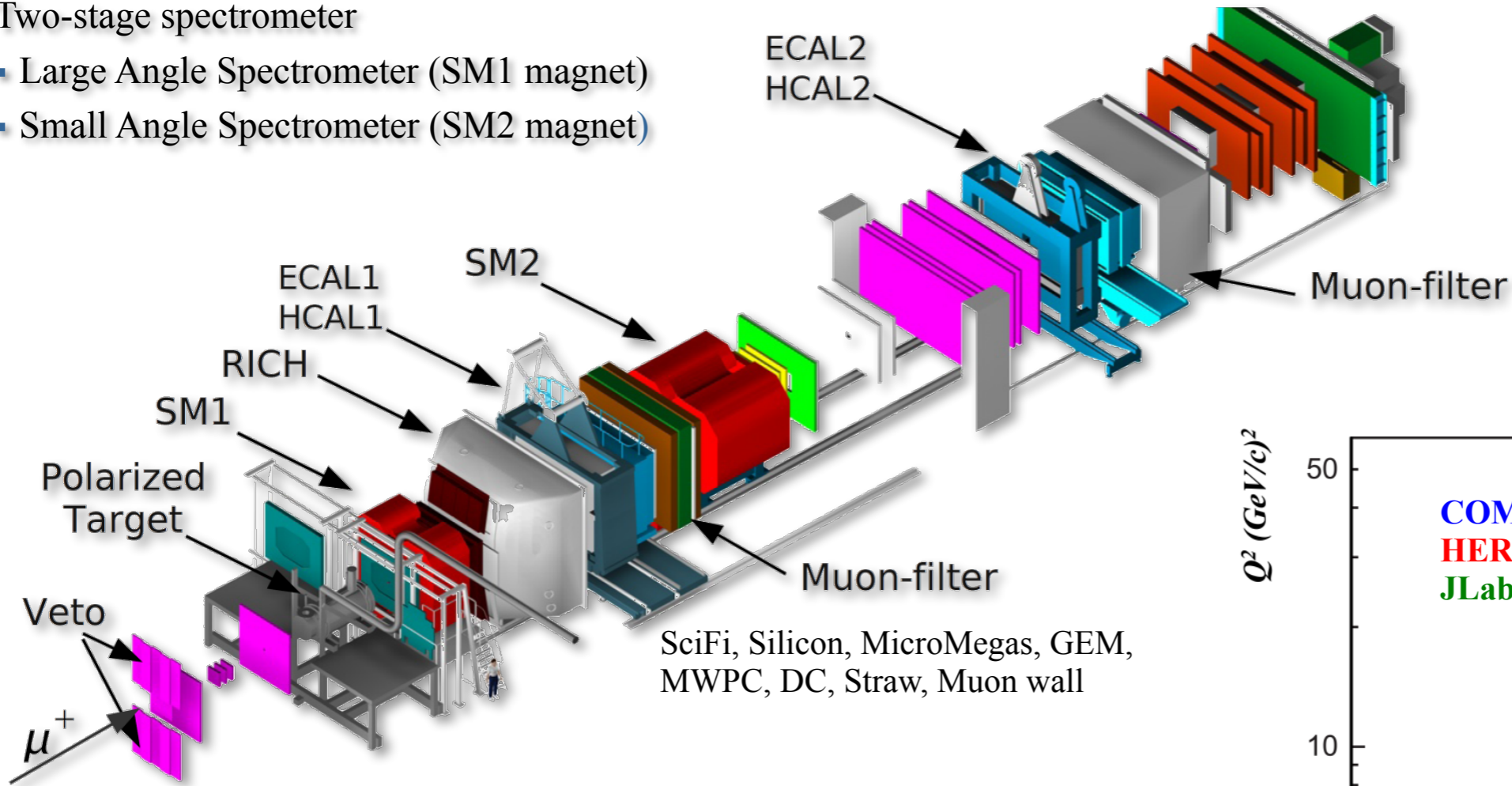
COMPASS web page: <http://wwwcompass.cern.ch>

COMPASS experimental setup: Phase I (muon program)

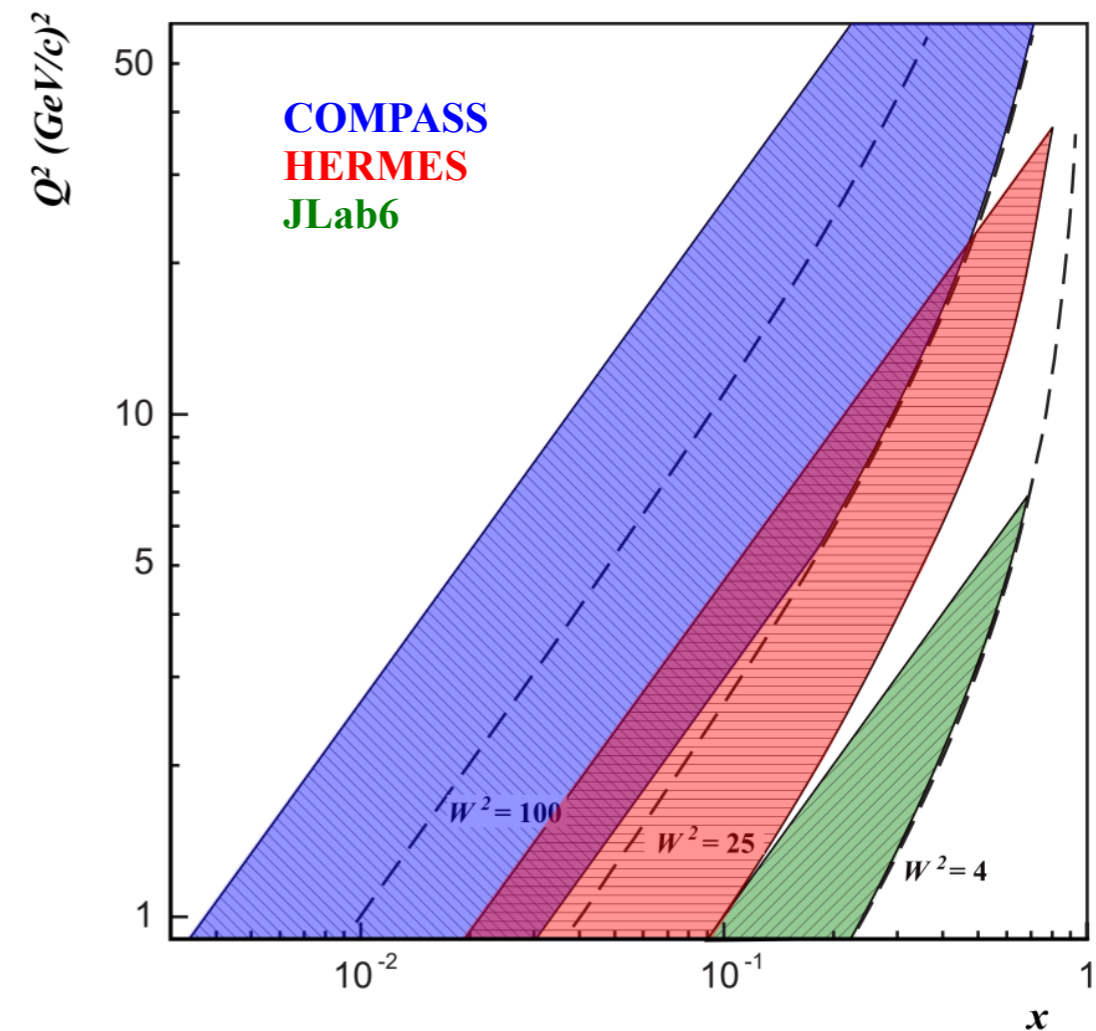


Two-stage spectrometer

- Large Angle Spectrometer (SM1 magnet)
- Small Angle Spectrometer (SM2 magnet)



- High energy beam
- Large angular acceptance
- Broad kinematical range
- Momentum, tracking and calorimetric measurements, PID



Data-taking years: 2002-2011

Longitudinally polarized (80%) μ^+ beam:

Energy: 160/200 GeV/c, Intensity: $2 \cdot 10^8 \mu^+/\text{spill}$ (4.8s).

Target: Solid state (${}^6\text{LiD}$ or NH_3)

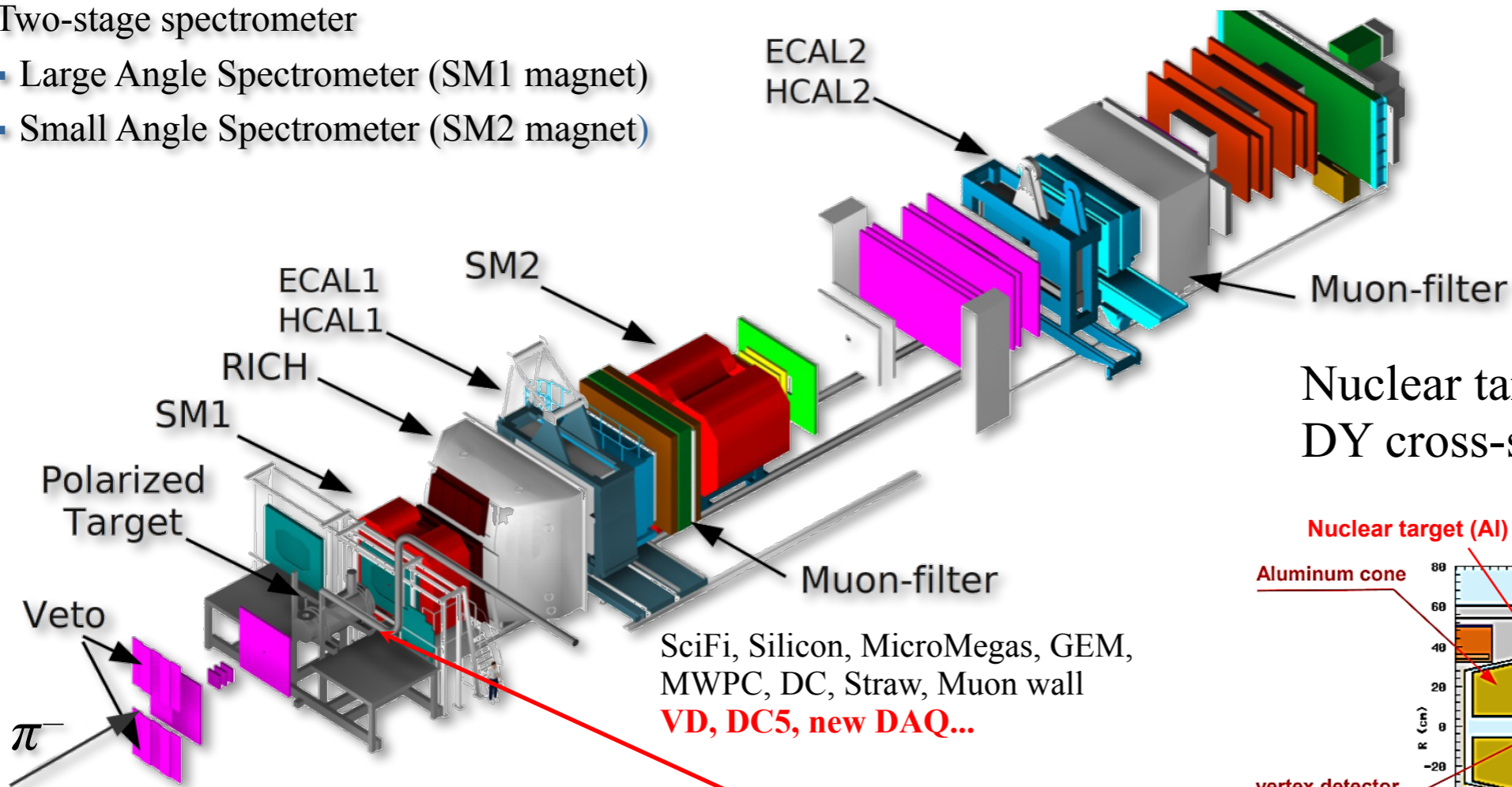
- ${}^6\text{LiD}$ 2-cell configuration. Polarization (L & T) $\sim 50\%$, $f \sim 0.38$
- NH_3 3-cell configuration. Polarization (L & T) $\sim 80\%$, $f \sim 0.14$

COMPASS experimental setup: Phase II (DY program)



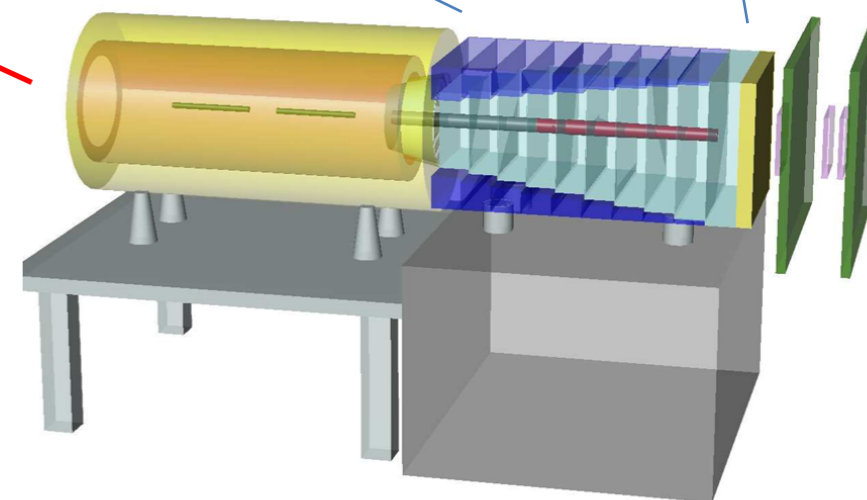
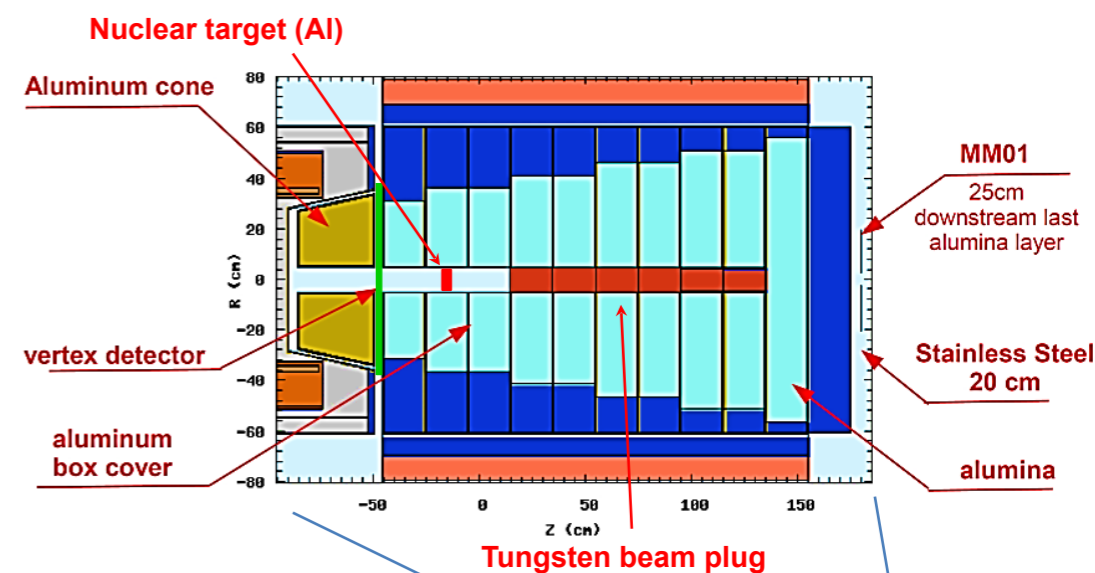
Two-stage spectrometer

- Large Angle Spectrometer (SM1 magnet)
- Small Angle Spectrometer (SM2 magnet)



- High energy beam
- Large angular acceptance
- Broad kinematical range
- Momentum, tracking and calorimetric measurements, PID

Nuclear targets → unpolarized DY,
DY cross-sections, EMC effect



SciFi, Silicon, MicroMegas, GEM,
MWPC, DC, Straw, Muon wall
VD, DC5, new DAQ...

Data-taking years: 2014 (test) 2015 and 2018

High energy π^- beam:

Energy: 190 GeV/c, Intensity: $10^8 \pi/s$

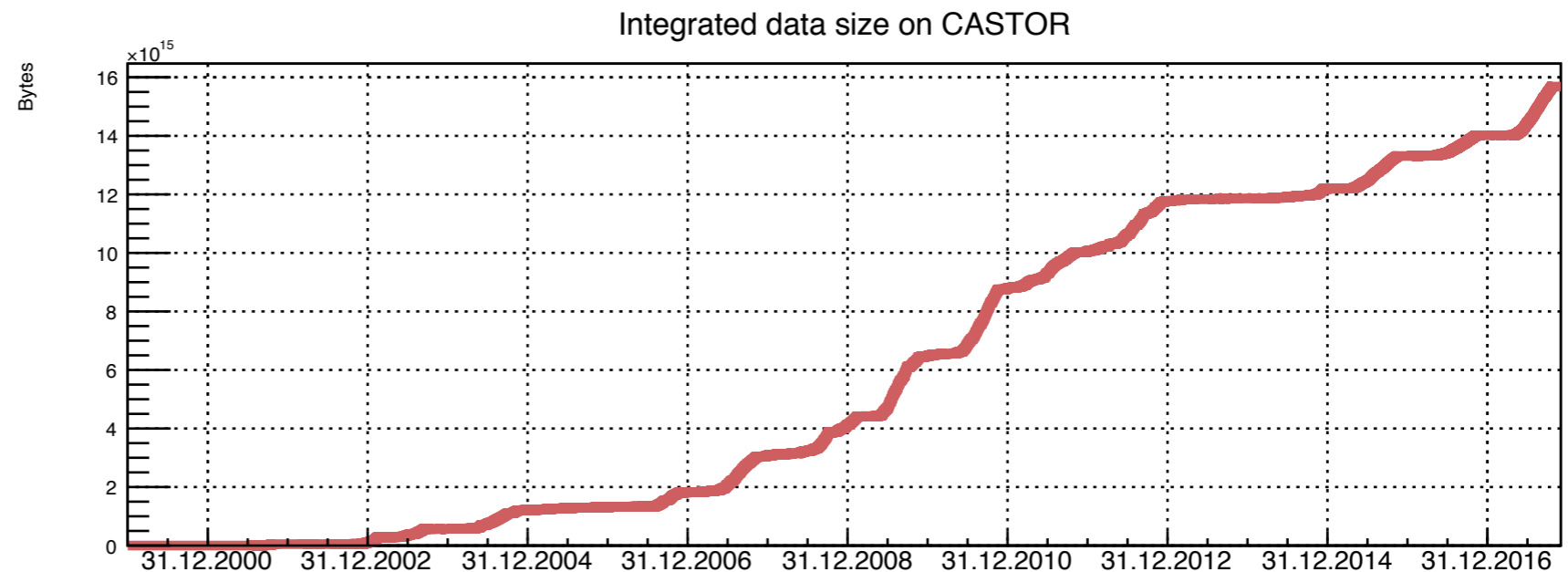
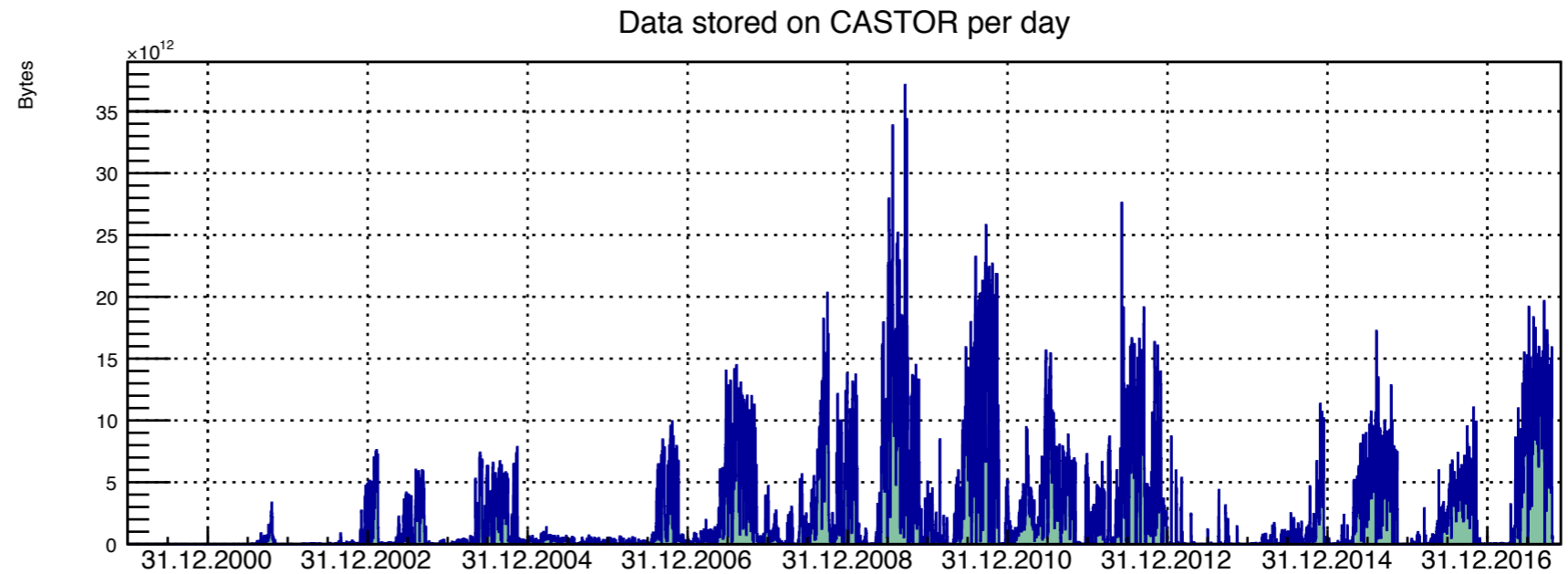
Target: Solid state

- NH_3 2-cell configuration. Polarization $T \sim 73\%$, $f \sim 0.18$
- Data is collected simultaneously with both target spin orientations
Periodic polarization reversal to minimize systematic effects



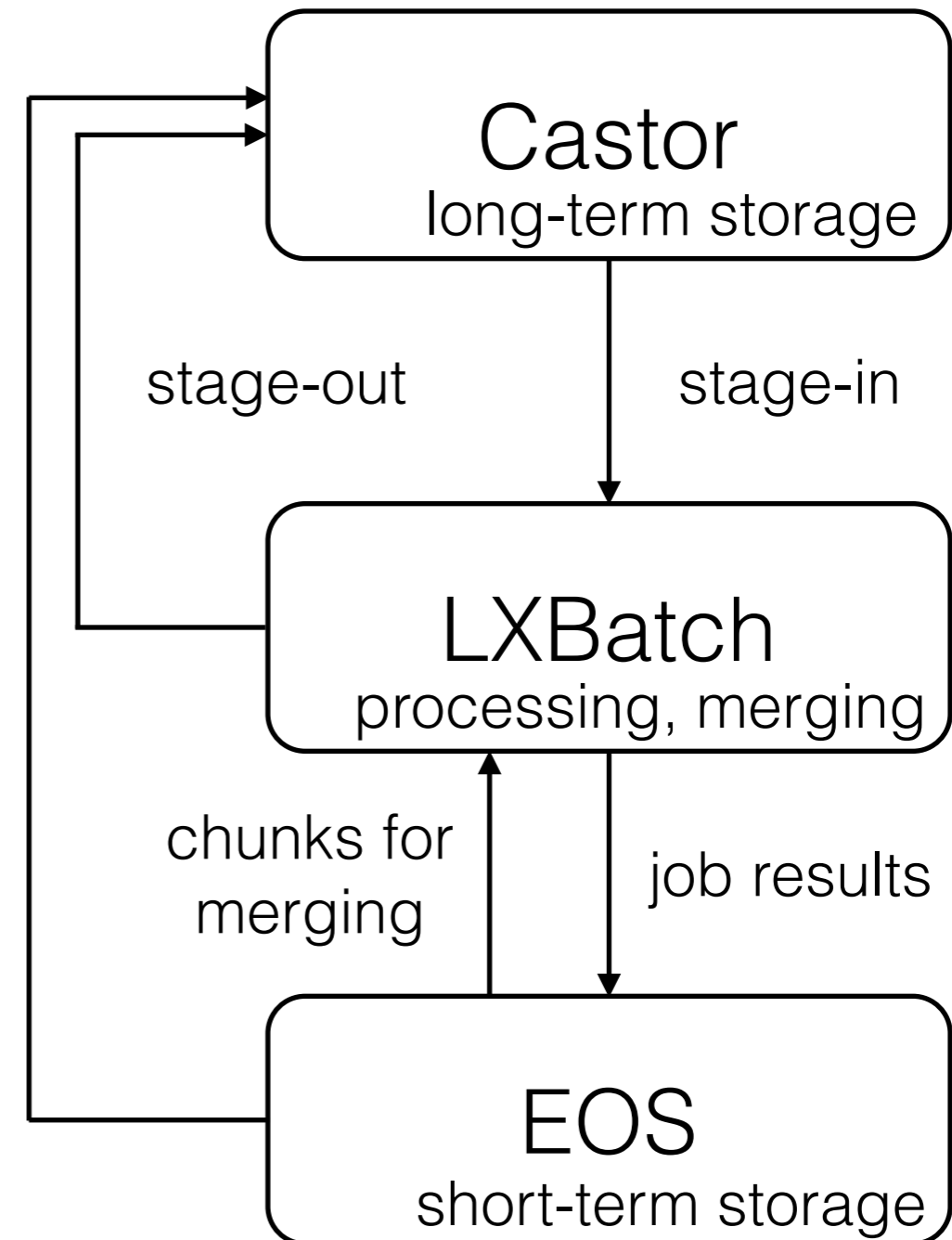
Raw data

2001 - 13 TB
2002 - 196
2003 - 230
2004 - 496
2006 - 390
2007 - 912
2008 - 523
2009 - 1223
2010 - 1740
2011 - 518
2012 - 878
2015 - 801
2016 - 571
2017 - 1391



Classic production work flow

- Raw data stored on Castor
- Data is being requested to be copied from tapes to disks before processing
- Task moves files directly from Castor to lxbatch for processing, several programs are used for processing
- After processing results are being transferred to EOS for merging or short-term storage or directly to Castor for long-term storage
- Merging, cross checking
- Results are being copied to Castor for long-term storage
- All routines executed under production account at lxplus and use bash commands





ProdSys redesign motivation

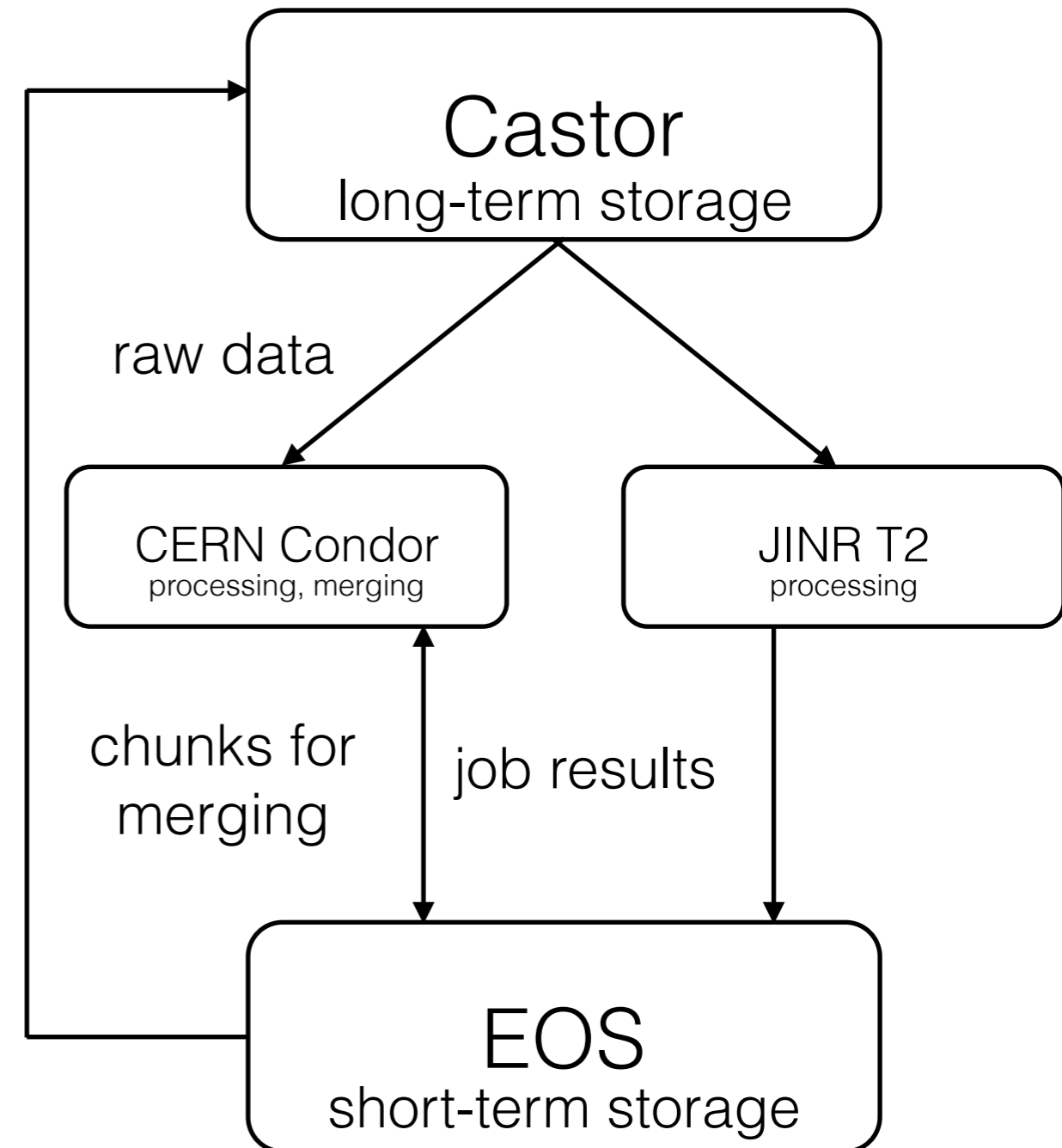
- Replace computing site from LSF, which will be decommissioned by the end of 2018, to Condor
 - Even more: get ability to switch computing sites, get more resources, any type, not only LSF
 - Even more: get a system which is able to send jobs to some HPC
- Remove strict connectivity to AFS, which will be replaced by EOS FUSE
- Remove connection to Castor, which will be replaced by EOS

Grid environment

- AFS COMPASS group
 - Production account
- Local batch queue
- EOS directory
- AFS directory to deploy production software
- Virtual organisation
 - Production role
- Computing element
- EOS storage element
- CVMFS

Grid production work flow

- Raw data stored on Castor
- Files are being requested to be copied from tapes to disks before processing
- Task moves files via xrootd directly from Castor to CERN Condor
- After processing results are being transferred to EOS for merging and short-term storage
- Merging is done on CERN Condor
- Results are being copied to Castor for long-term storage
- All management routines work using X509 proxy authentication





ProdSys components

1. Task requests layer: Web UI
2. Job definition layer
3. Job execution layer: PanDA
4. Workflow management
5. Data management
6. Monitoring



1. Task requests layer

Web UI:

- execution parameters
- paths
- version of software
- list of chunks or runs
- etc.

Name:	<input type="text" value="dvcs2016P08-DDD_mu-_part3"/>
Type:	<div><div>test production</div><div>mass production</div><div>✓ DDD filtering</div></div>
Home:	<input type="text" value="/cvmfs/compass.cern.ch/"/>
Path:	<input type="text" value="generalprod/singleproc/"/>
Soft:	<input type="text" value="dvcs2016P08-DDD"/>
Production:	<input type="text" value="dvcs2016P08-DDD"/>
Year:	<input type="text" value="2016"/>
Period:	<input type="text" value="P08"/>
ProdsIt:	<input type="text" value="0"/>
Phastver:	<input type="text" value="7"/>
Template:	<input type="text" value="template.opt"/>
Files source:	<input type="text" value="files list"/>

May be list of runs as well



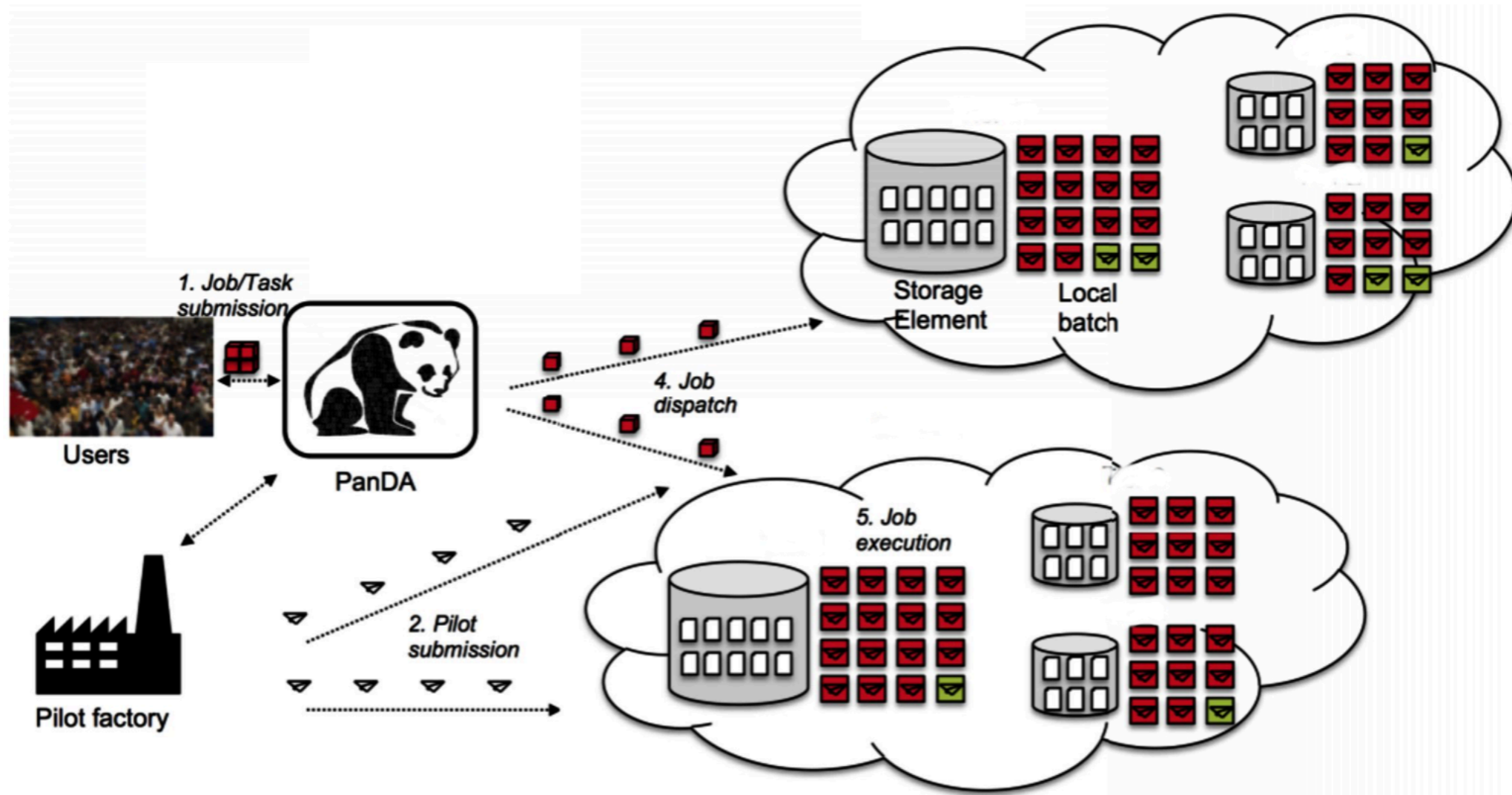
2. Job definition layer

Automatically generates list of jobs for task basing on parameters

Job actions allow to manage any set of selected chunks

Action: ✓ -----	Go	0 of 100 selected							
<input type="checkbox"/>	TA								
<input type="checkbox"/>	dv								
<input type="checkbox"/>	dv								
<input type="checkbox"/>	dvcs2016P09t2r13_mu+	/castor/cern.ch/compass/data/2016/raw/W14/cdr11080-275678.raw	275678	11080	2182398	1	finished		
<input type="checkbox"/>	dvcs2016P09t2r13_mu+	/castor/cern.ch/compass/data/2016/raw/W14/cdr11089-275678.raw	275678	11089	2182397	1	finished		
<input type="checkbox"/>	dvcs2016P09t2r13_mu+	/castor/cern.ch/compass/data/2016/raw/W14/cdr11086-275678.raw	275678	11086	2182396	1	finished		
<input type="checkbox"/>	dvcs2016P09t2r13_mu+	/castor/cern.ch/compass/data/2016/raw/W14/cdr11063-275678.raw	275678	11063	2182395	1	finished		
<input type="checkbox"/>	dvcs2016P09t2r13_mu+	/castor/cern.ch/compass/data/2016/raw/W14/cdr11049-275678.raw	275678	11049	2182394	1	finished		
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<input type="checkbox"/>	dvcs2016P09t2r13_mu+	/castor/cern.ch/compass/data/2016/raw/W14/cdr11094-275678.raw	275678	11094	2182392	1	finished		
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<input type="checkbox"/>	dvcs2016P09t2r13_mu+	/castor/cern.ch/compass/data/2016/raw/W14/cdr11088-275678.raw	275678	11088	2182390	1	finished		
<input type="checkbox"/>	dvcs2016P09t2r13_mu+	/castor/cern.ch/compass/data/2016/raw/W14/cdr11076-275678.raw	275678	11076	2182389	1	finished		

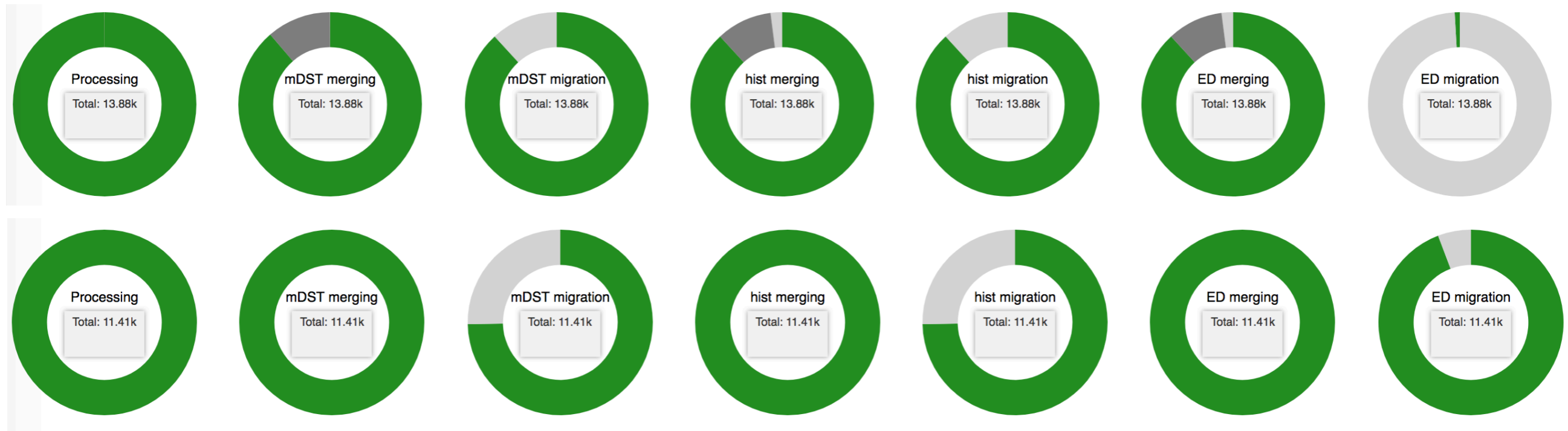
3. Job execution layer: PanDA



4: Workflow management

Decision making mechanisms guide task from the definition till archive

Each step of each task is managed independently



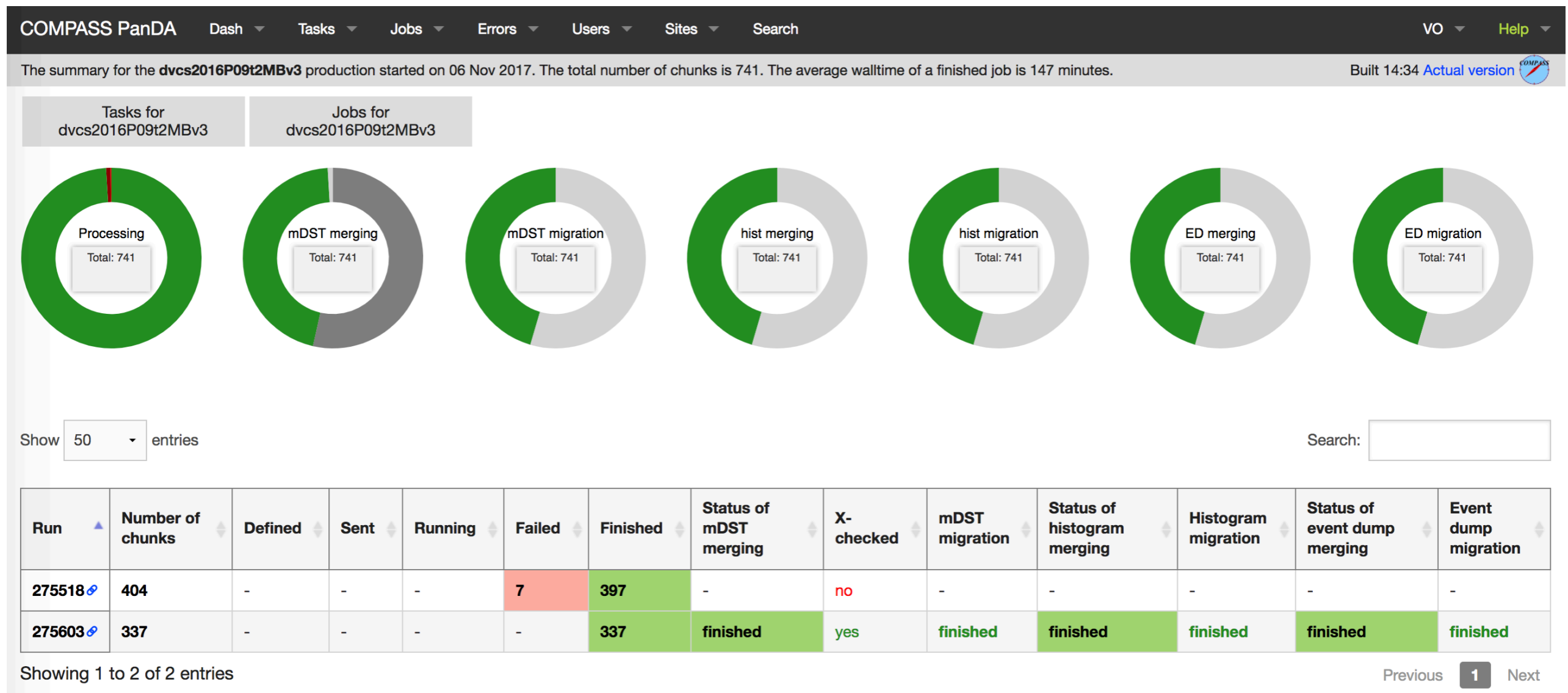
5: Data management

- Stage-in and stage-out files on Castor
- Number of events in raw files being delivered to ProdSys database
- Job results move to Castor as soon as they are ready
- Job log files are zipped and moved to Castor when task is finished
- Job results and PanDA pilot log files are being removed from EOS when task is finished



6: Monitoring

Covers all activity during production/task/job lifecycle





Infrastructure overview

- PanDA server over MySQL, Monitoring, AutoPilotFactory, Production System deployed in Dubna at JINR cloud service
- Condor CE at CERN
- PBS CE at JINR
- EOS SE at CERN
- PerfSonar service at JINR cloud network segment to monitor network connectivity between JINR and CERN



Data catalog

- Raw and processed data are stored on Castor
- Raw data catalog in Oracle
 - Naming convention: year/period/run/chunk
- ProdSys database as catalog of processed data
 - Naming convention: year/period/production/run-chunk-processing options



Production job types

- Normal
 - File downloads from CASTOR to computing node
 - After processing being transferred to EOS
- Merging
 - Data stages in from EOS
 - Up to 40 results of normal jobs merged into one file with desired filesize (4Gb)
 - After processing result file being transferred to EOS
- Cross check
 - Internal job, uses PanDA job metrics
 - Compares number of events in file chunks and in merged file per run



Stats and performance

- Since August 2017
 - ~2 000 000 chunks of raw data processed
 - ~60 000 000 of events processed
 - ~400TB of merged data produced and migrated to Castor
 - ~4 000 000 jobs processed since August: reco, ddd filtering, merging of mDST, hist and event dumps
- Up to 20 000 of jobs being processed simultaneously



Processing on Blue Waters

- Raw data delivered to BW manually via Globus Online
- Production software installed on local file system
- Calibration db runs on each computing node, i.e. per each 32 jobs, first job on the node starts new db instance
- PanDA Multi-Job Pilot is used, extended by COMPASS logic
- Task submission, management and monitoring fully integrated into ProdSys UI and PanDA monitoring
- Processing 2-3K jobs, 100 nodes, target is to process 100k of jobs

Summary

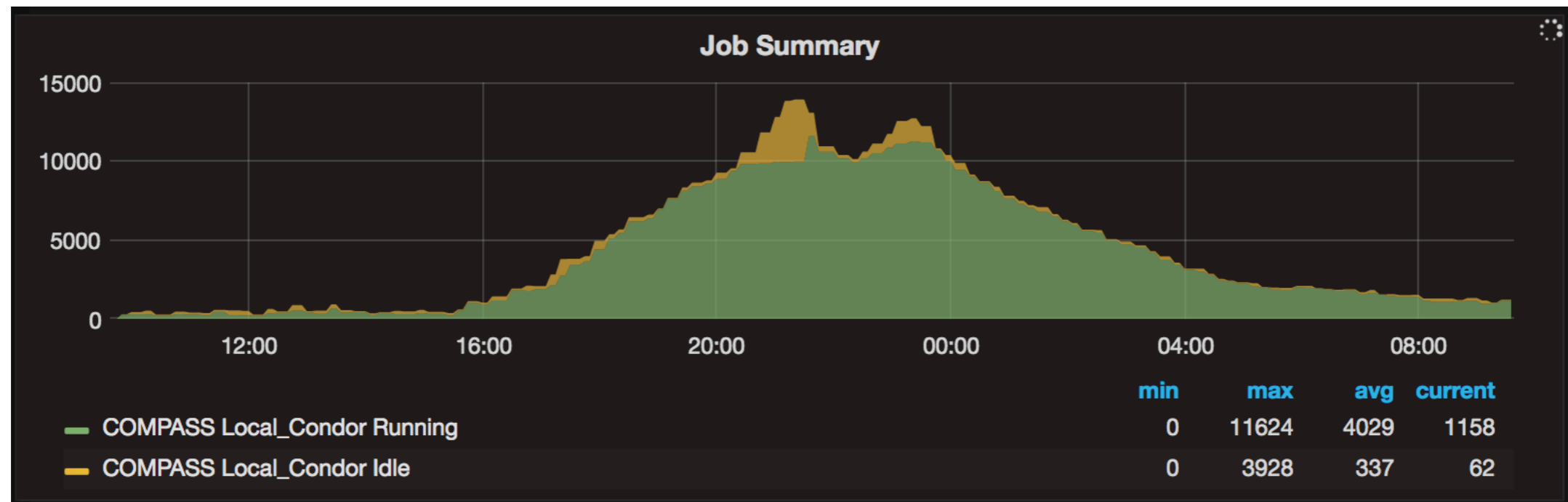
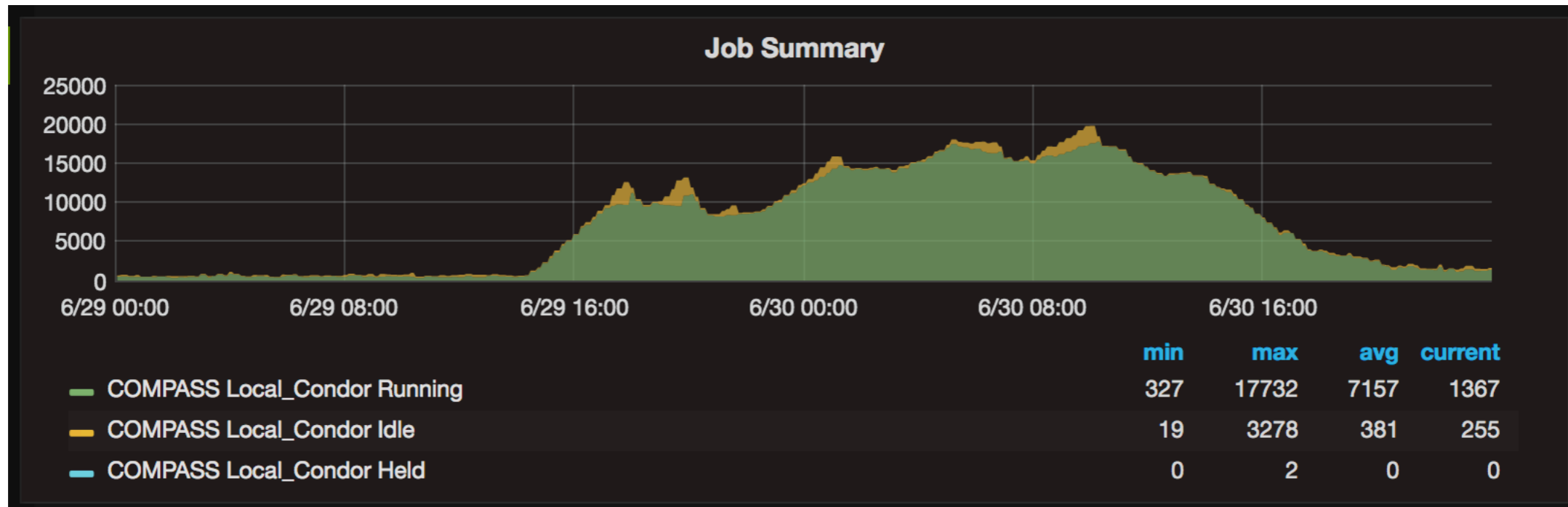
- COMPASS Grid Production System provides automated data processing from task definition till archiving
- Key features:
 - Production management Web UI allows to define a task, send, follow and manage task at any step during processing
 - Via PanDA layer jobs may be delivered to any type of computing resource: Condor, LSF, PBS, etc.
 - Rich monitoring



Backup



System performance





JINR Tier2

Resource Centre JINR-LCG2 — Total number of jobs by VO and Month (Official VOs)

VO	Feb 2017	Mar 2017	Apr 2017	May 2017	Jun 2017	Jul 2017	Aug 2017
alice	23,805	33,069	57,822	37,082	29,131	28,196	26,196
atlas	349,363	323,132	397,144	366,224	320,417	335,946	308,144
biomed	3,962	5,079	17,423	54,963	3,277	2,186	1,186
cms	70,670	87,329	68,556	48,814	46,711	55,061	66,144
dteam	0	0	0	2	0	0	0
fermilab	2,320	11,253	9,313	36,665	66,805	27,778	33,144
lhcb	39,035	47,090	81,684	64,305	55,729	76,062	51,144
ops	14,146	15,674	15,441	13,687	12,989	13,476	13,144
vo.compass.cern.ch	0	0	2	208	0	198	64
Total	503,301	522,626	647,385	621,950	535,059	538,903	567,144
Percent	8.07%	8.38%	10.38%	9.97%	8.58%	8.64%	9.14%

1 - 9 of 9 results