



THE CMS EXPERIMENT

Current Model &

Future Requirements

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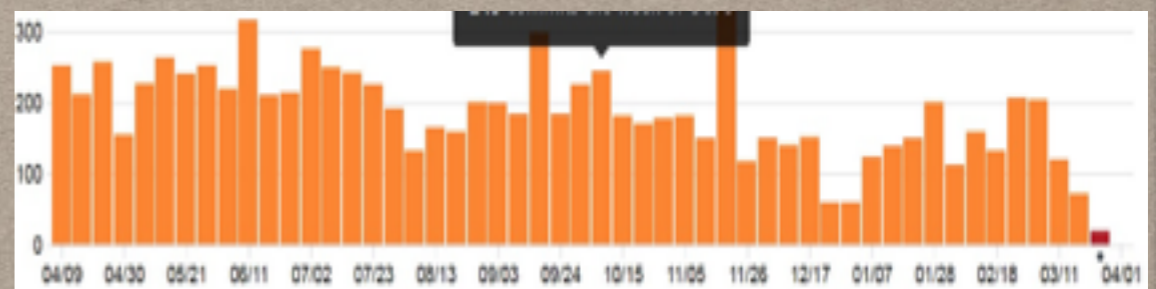
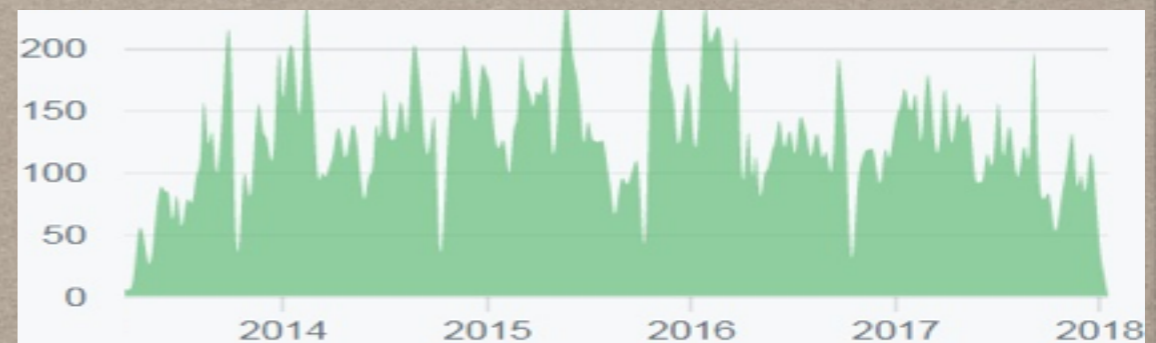
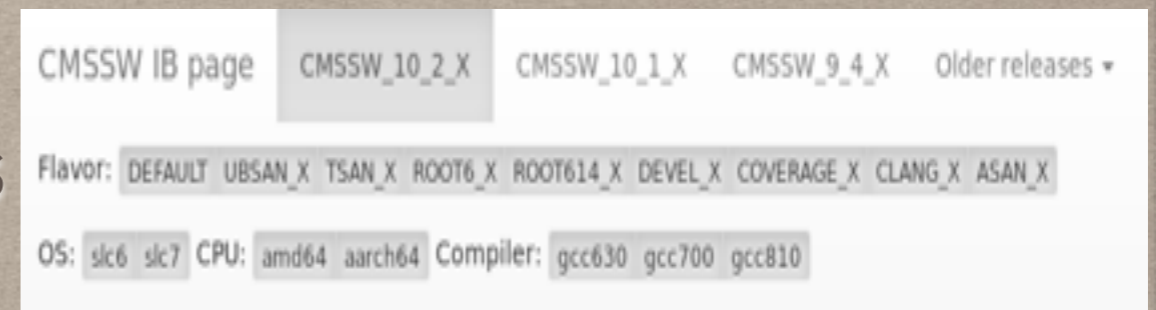
CMS-Offline Software

- CMS Offline Software ([CMSSW](#)) has a large code base
 - 15K **C++/C/Fortran** source files (excluding headers) in over 1200+ packages
 - LOC: 3M **C++/C**, 1.2M **Python**, 275K **Fortran**
 - 2250 shared libs, 650+ executables/tests
 - 1500+ **EDM/Rivet/DD4Hep** Plugins
 - 260+ **ROOT PCMs**
 - 360+ external packages/tools
 - Not all of these externals are required for building

CMS-offline Software



- 8 Open release cycles: 5.3.X, 7.1.X,.... 10.2.X
- CMS SW code is available on **Github**
- 120 contributors/months
- 200 commits/week
- Mirrored @ CERN **Gitlab**
- Reference @ **CVMFS**



Current Model

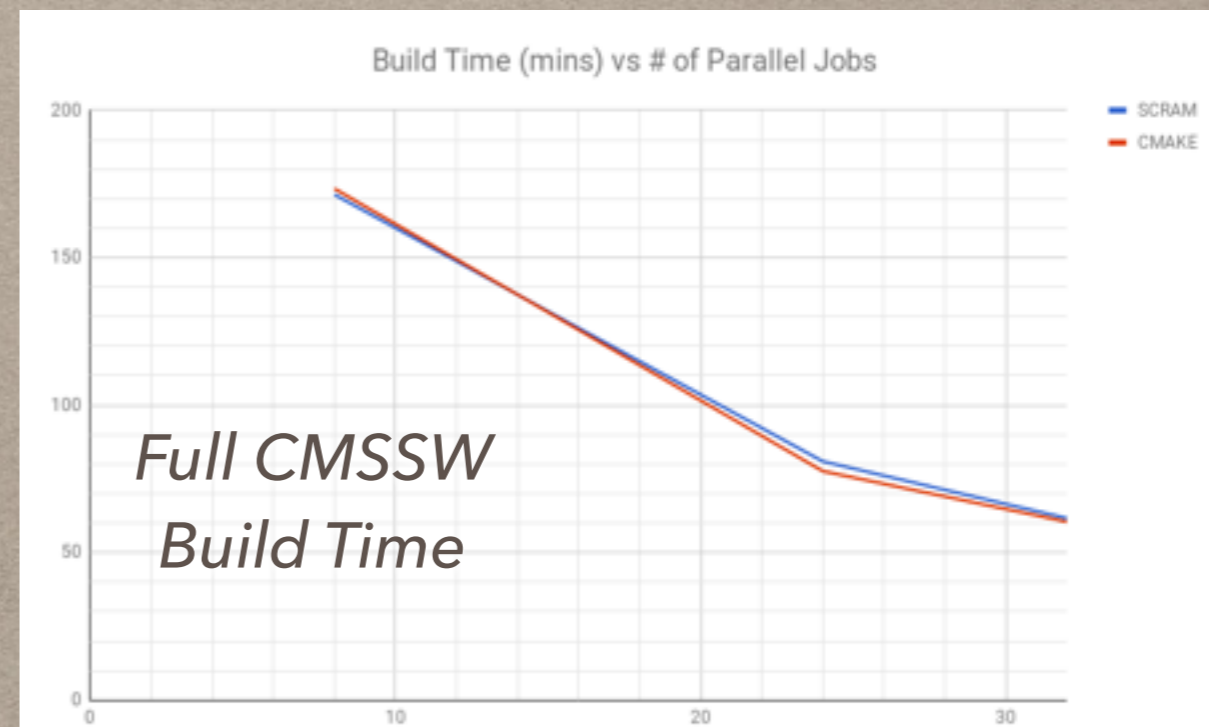
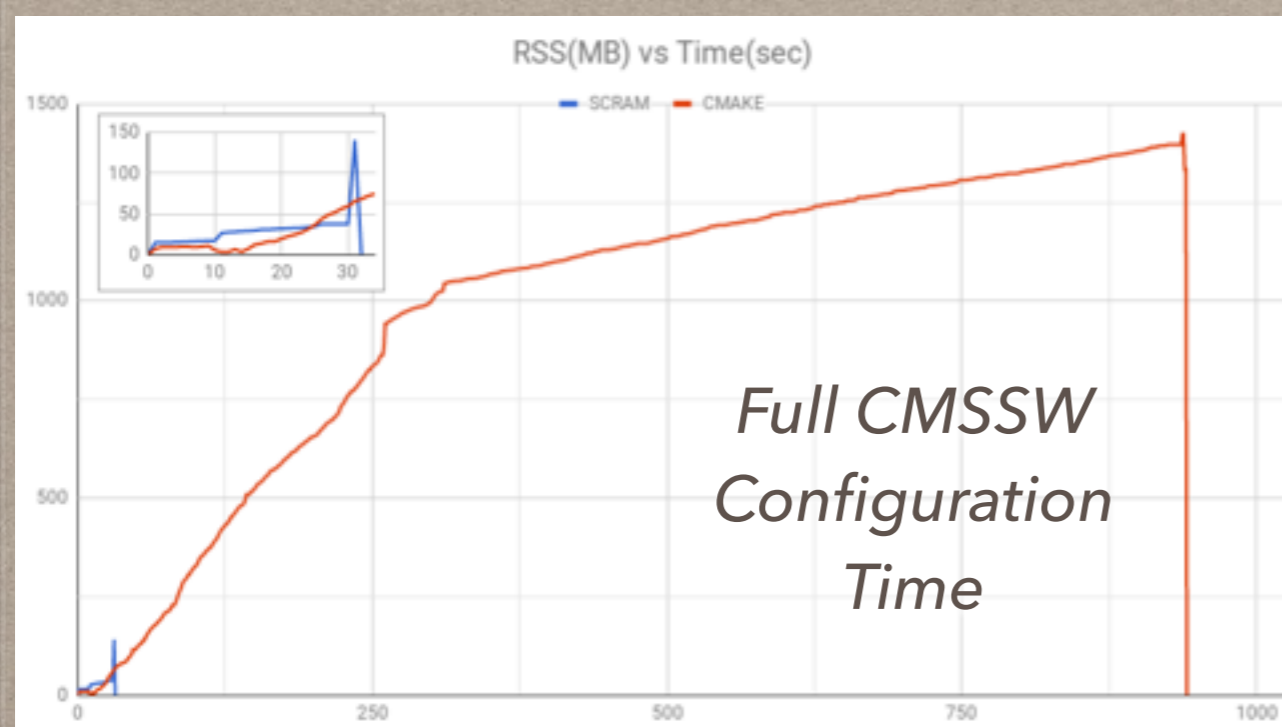


CMSSW Build System

- Over 20 years, CMS is using SCRAM to configure and build **CMSSW**
- **SCRAM** is written in **PERL** and uses **MAKE**
 - XML based build rules → **MAKE** fragments
 - Setting/Cleaning up runtime/build environment
 - Full, partial, patch release build supported
 - **FWLITE**

CMSSW Build System

- Recently we have looked in to **CMAKE** again
 - **CMAKE** overhead is too high for CMS developers
 - High disk usage: OK for release build but could slow down user dev on shared FS
 - Disk space: 30x (340MB vs 11 MB)
 - # of generated files: 12x (12 files/product vs 1 file/product)
 - I re-wrote **SCRAM** in 2008 to reduce its overhead from 2.5mins to 30sec





Packaging & Distribution

- CMS does not use software stack provided by **LCG**
 - We were using it till 2005/6 though
- Package Manager: [cmsBuild](#) (**PKGTOOLS**)
- Packaging: **RPM** (relocatable)
- Distribution: [cmspkg](#)
 - Developed to replaces the use of **APT**
 - Faster upload time (secs instead of hours)
- Build recipes: [CMSDIST](#)
 - Collection of simplified syntax **RPM** specs



CMS Software Stack

- Software stack for development release is built for many architectures and external tools versions
 - **SLC6/CC7**
 - **AMD64/AARCH64**
 - **GCC 6/7/8, ICC, LLVM**
 - Special IBs for **ROOT** (6.14 and master branches), **GEANT4**
- Software stack for production release cycles is built for couple of architectures though



CMS Software Stack

- **CMSSW** Integration Builds (IBs) along with externals are build twice a day.
 - IBs are built for all open release cycles/architectures (50 IBs/day)
 - Build full **CMSSW** if externals changed or its a new week (Sunday)
 - Build patch release if only **CMSSW** code changed w.r.t last IB
 - No change -> No build (only for some production release cycles)
 - RPMs are upload to CMS **RPM** repository server
 - IBs are installed on **CVMFS** ([/cvmfs/cms-ib.cern.ch](http://cvmfs/cms-ib.cern.ch))
 - IBs and external SW stack are kept on **CVMFS** for N weeks ($N \geq 2$)

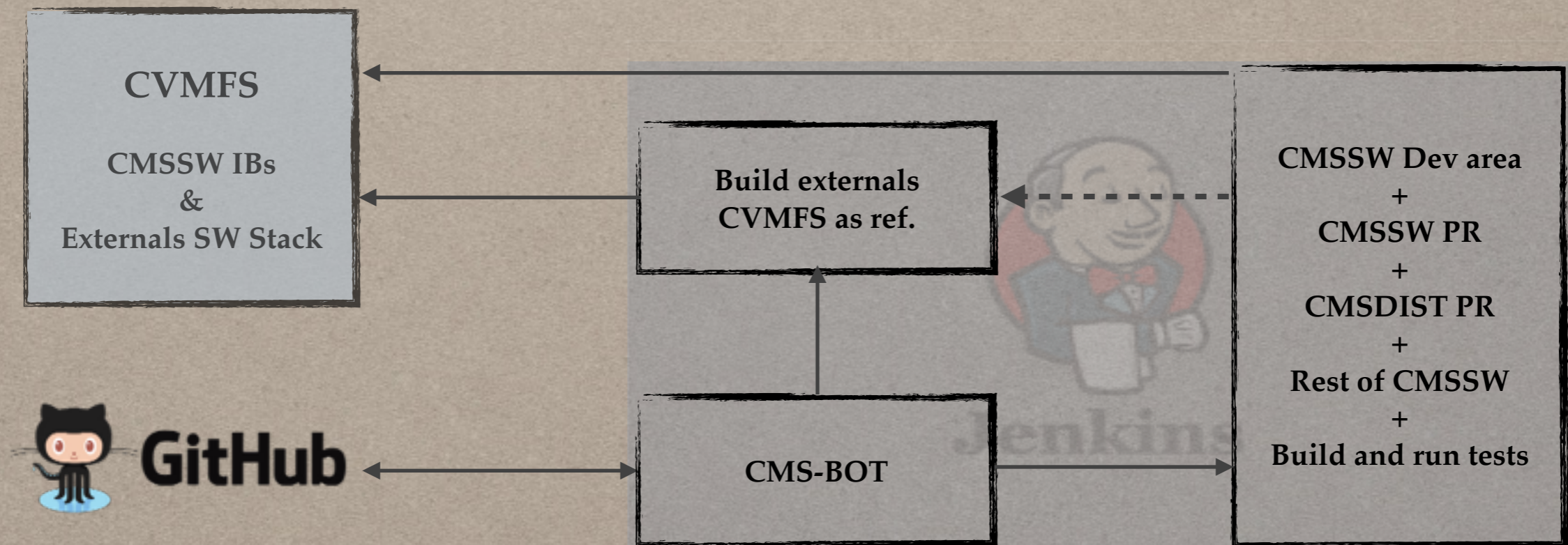
CMSSW_10_2_X_2018-05-25-2300

IB Top - Comparison Baseline DQM Tests HLZ Validation Valgrind Code complexity metrics Flaw finder IgProf Static Analyzer SA thread unsafe SA failures 1 SA thread unsafe EventSetup products Header consistency

	DEFAULT	slc7 aarch64 gcc700	slc7 amd64 gcc810	slc7 amd64 gcc700	slc6 amd64 gcc700	slc7 amd64 gcc630	UBSAN_X amd64 gcc700	TSAN_X amd64 gcc700	ROOT6_X amd64 gcc630	ROOT614_X amd64 gcc630	DEVEL_X amd64 gcc630	CLANG_X amd64 gcc700	ASAN_X amd64 gcc700
	slc6 amd64 gcc630 Patch	slc7 aarch64 gcc700 Full Build	slc7 amd64 gcc810 Full Build	slc7 amd64 gcc700 Full Build	slc6 amd64 gcc700 Full Build	slc7 amd64 gcc630 Full Build	slc6 amd64 gcc700 Full Build	slc6 amd64 gcc700 Full Build	slc6 amd64 gcc630 Full Build	slc6 amd64 gcc630 Full Build	slc6 amd64 gcc630 Full Build	slc6 amd64 gcc700 Full Build	slc6 amd64 gcc700 Full Build
Builds	0	1	107	1	1	0	10394	1	0	0	34721	400	11
Unit Tests	0	1	4	0	0	0	165	137	0	0	338	8	41
RefVals	3401	2	602	39	1	17	416	416	2	2	643	37	378
Other Tests	0	0	0	0	0	0	0	0	0	0	0	0	0
FWLite	0												
Q/A	0	0	0	0	0	0	0	0	0	0	0	0	0

Continuous Integration

- Github webhook and Jenkins based CI setup
- One workflow to test and integrate CMSSW and external packages changes



Continuous Integration



Updated root to tip of branch master #4018

Merged smuzaffar merged 1 commit into cms-sw:IB/OISSW_10_2_X/rootgcc6 from mrodozov:root-update-master-20180522 7 days ago

cmsbuild added **externals-pending** **orp-pending** **pending-signatures** **tests-pending** labels 8 days ago

mrodozov commented 8 days ago Member + 😊 ...

please test

cmsbuild commented 8 days ago • edited Member + 😊 ...

The tests are being triggered in jenkins.
<https://cmssdt.cern.ch/jenkins/job/ib-any-integration/28099/console>

cmsbuild commented 7 days ago Member + 😊 ...

+1
Tested at: [160ae87](#)
<https://cmssdt.cern.ch/SDT/jenkins-artifacts/pull-request-integration/PR-4018/28099/summary.html>

jfernan2 commented 22 days ago Contributor + 😊 ...

please test with [cms-sw/cmsdist#3977](#)

cmsbuild commented 7 days ago Member + 😊 ...

Comparison is ready
<https://cmssdt.cern.ch/SDT/jenkins-artifacts/pull-request-integration/PR-4018/28099/summary.html>

Comparison Summary:

- No significant changes to the logs found
- Reco comparison results: 0 differences found in the comparisons
- DQMHistTests: Total files compared: 31
- DQMHistTests: Total histograms compared: 2901712
- DQMHistTests: Total failures: 2
- DQMHistTests: Total nulls: 0
- DQMHistTests: Total successes: 2901520
- DQMHistTests: Total skipped: 190
- DQMHistTests: Total Missing objects: 0
- DQMHistSizes: Histogram memory added: 0.0 KiB(30 files compared)
- Checked 128 log files, 14 edm output root files, 31 DQM output files

Labels ⚙️

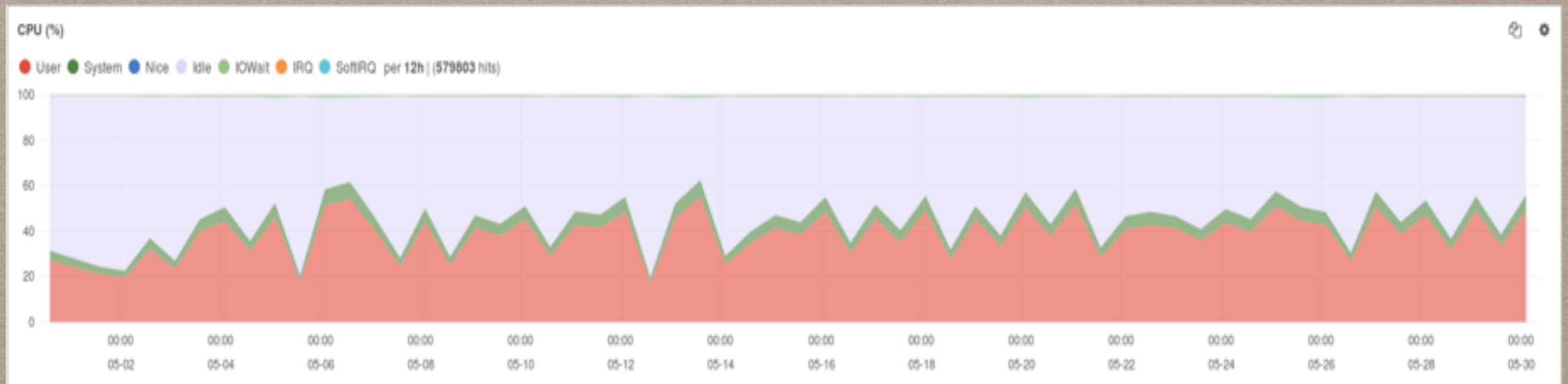
- externals-approved**
- fully-signed**
- orp-pending**
- tests-approved**

📁 97 Open ✓ 21,783 Closed Author Labels Projects Milestones Reviews Assignee Sort

- 🔗 Update max number of LS in beamspot ICWs ✓ **externals-approved** **code-checks-approved** **comparison-available** **fully-signed** **orp-approved** **tests-approved** 11
#23168 by stefanor was merged 5 hours ago 🔼 CMSDT_10_2_X
- 🔗 Create RFAIDMF.md ✓ **code-checks-approved** **comparison-available** **externals-approved** **fully-signed** **orp-approved** **tests-approved** 12
#23165 by janna was merged 5 hours ago 🔼 CMSDT_10_2_X
- 🔗 fix headers TrackPropagation/RingKutta ✓ **code-checks-approved** **comparison-available** **fully-signed** **orp-approved** **reconstruction-approved** **tests-approved** 11
#23160 by mrodozov was merged a day ago 🔼 CMSDT_10_2_X
- 🔗 data processing scenarios for Run2_2018_highBetaStar ✓ **code-checks-approved** **comparison-available** **fully-signed** **orp-approved** **reconstruction-approved** **tests-approved** 12
#23149 by chack77 was merged 18 hours ago 🔼 CMSDT_10_2_X

Build Infrastructure

- 400 Virtual Cores
 - OpenStack VMs (8 Core/16GB each)
- 80 Physical cores
- Few TechLab ARM64 machines



Future Requirements



Machine Learning

- Usage of Machine Learning (ML) techniques are growing
 - Many ML external has been added to **CMSSW**
 - We now have 175 py2 externals shipped
- We already have **CMS Event Data Producer** using **Tensorflow**
- **Issue:** Some externals are not available for all arches



Mirco-architectures

- To better utilize the **HPC** resources, we need releases/externals build for specific instruction sets
 - **sse4, avx, avx2**
- Not all externals or full **CMSSW** need to be build with specific instruction set
 - For example we could have for slc7/amd64/gcc700 architecture
 - **CMSSW_10_2_0**: Default
 - **CMSSW_10_2_0_AVX2**: with **avx2** instruction set
 - Shares all externals with default except those which have **avx2** flavour available



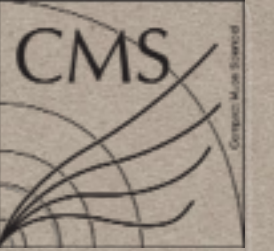
Transition to Python 3

- We have start shipping Python 3.6 in CMS SW Stack
 - To avoid having separate full distribution based on Py2 and Py3, we build python packages for both

<package>/<version>/lib/python2.7

<package>/<version>/lib/python3.6

- Dropped usage of PYTHONPATH
 - Patched python to make use of env variables to select right path
- **Issue**
 - Some packages are only available for either Py2 or Py3
 - User defined PYTHONPATH



Any more questions ... :-)