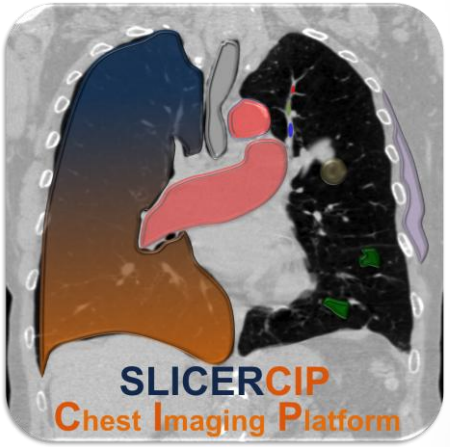
Applied Chest Imaging Laboratory
Boston, Massachusetts. USA

BRIGHAM AND WOMEN'S HOSPITAL
HARVARD MEDICAL SCHOOL

Chest Imaging Platform (CIP)



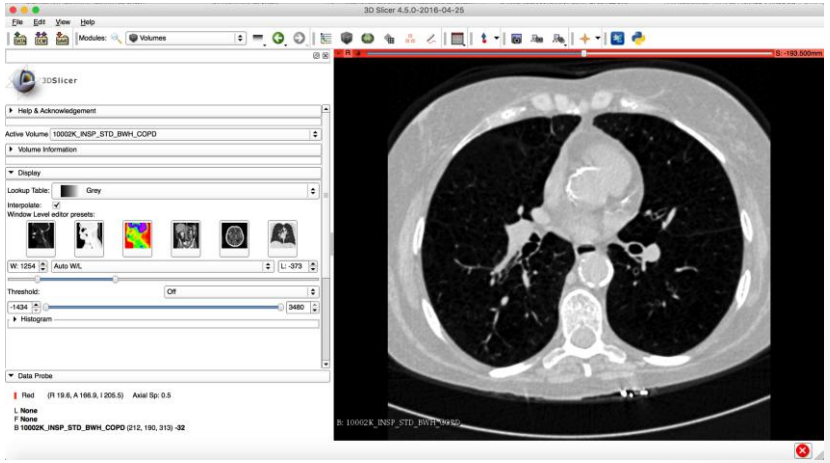
A complete set of tools for research in Quantitative Chest Imaging

CIP fundamentals

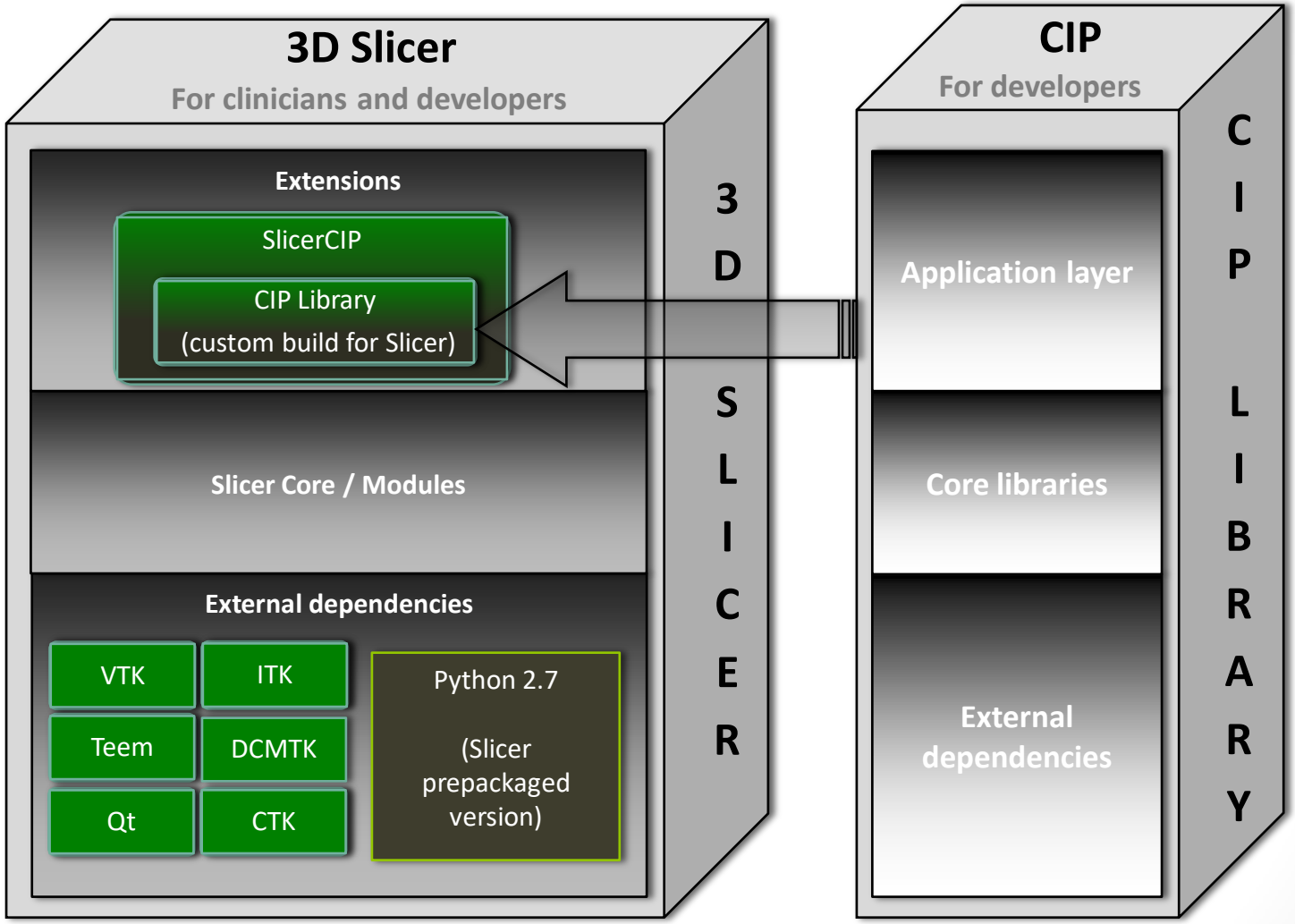
- Scope:
  - Mixed team of physicians and engineers
    - Bring computing research to clinical research
  - Chest CT studies
  - Lung phenotyping quantification
  - Lung and cardiovascular diseases (COPD, emphysema, ILD, bronchiectasis, lung cancer...)

CIP:

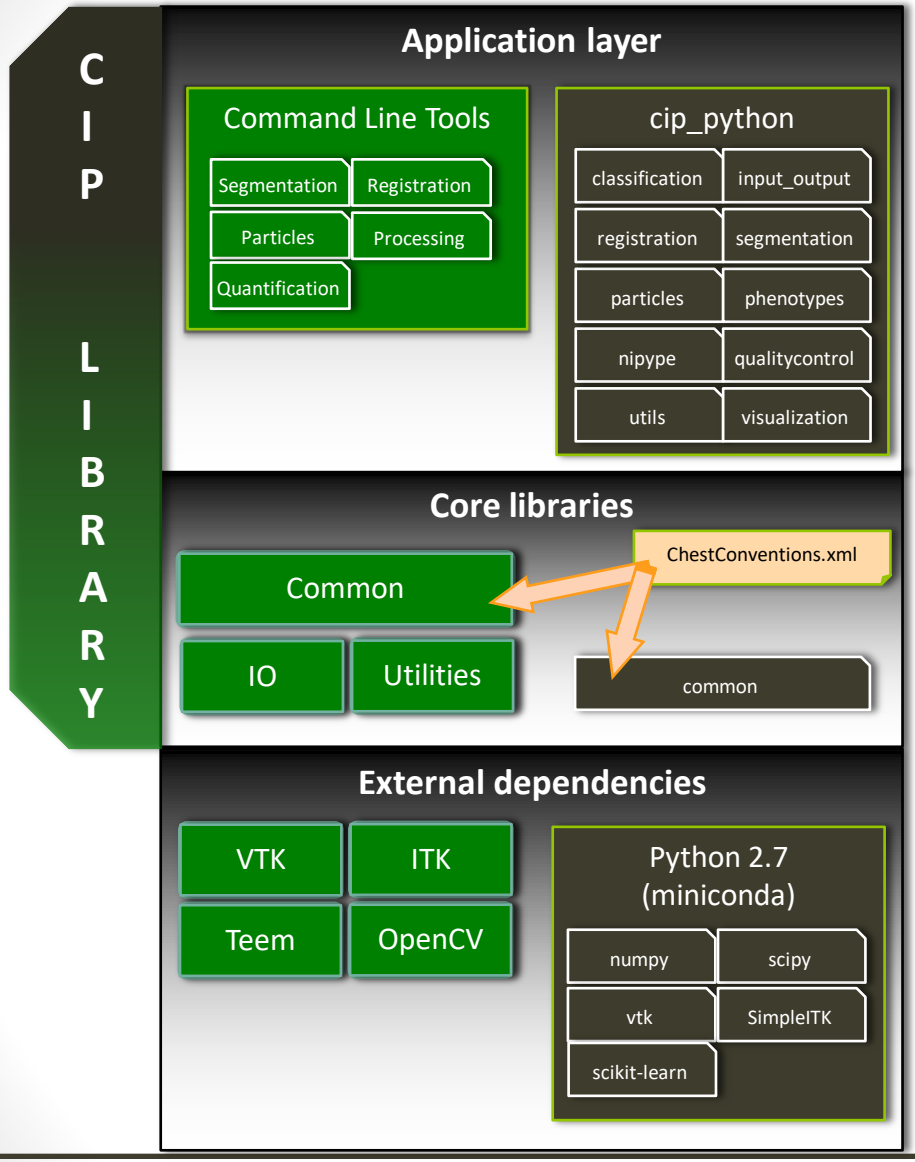
- **CIP Library** → a software library for <u>developers</u>
- **SlicerCIP** → a <u>clinical</u> workstation based on *3D Slicer*
- Open source (C++, Python), multiplatform



General architecture

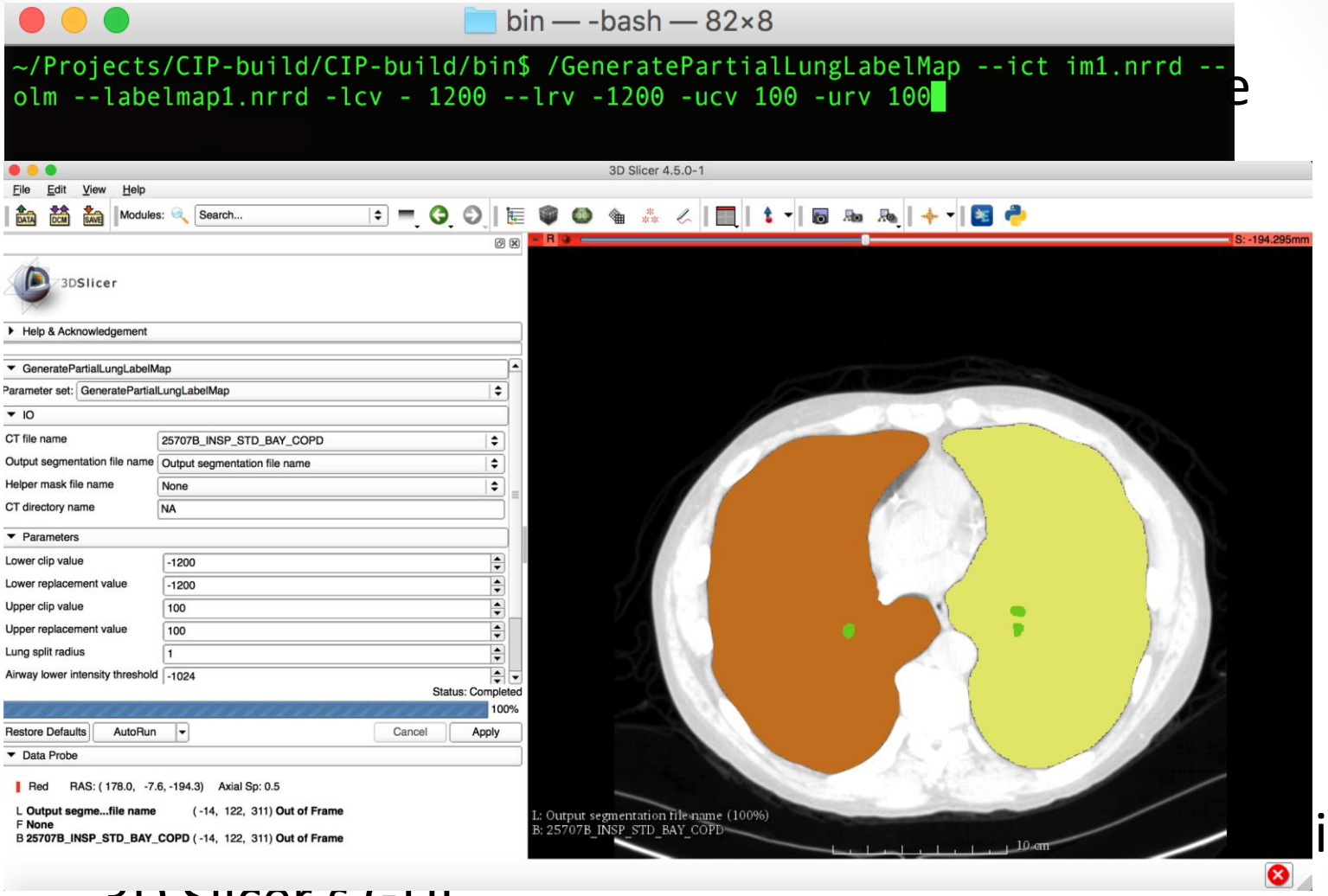


CIP Library



- Main software component that contains most of the developed research algorithms
- Plenty of components that can be used as an standalone or included in other projects
- 80% C++, 20% Python
- Uses some of the most commonly used libraries in medical imaging:
  - VTK
  - ITK
  - Teem
  - OpenCV

CIP Library: Command Line Interfaces



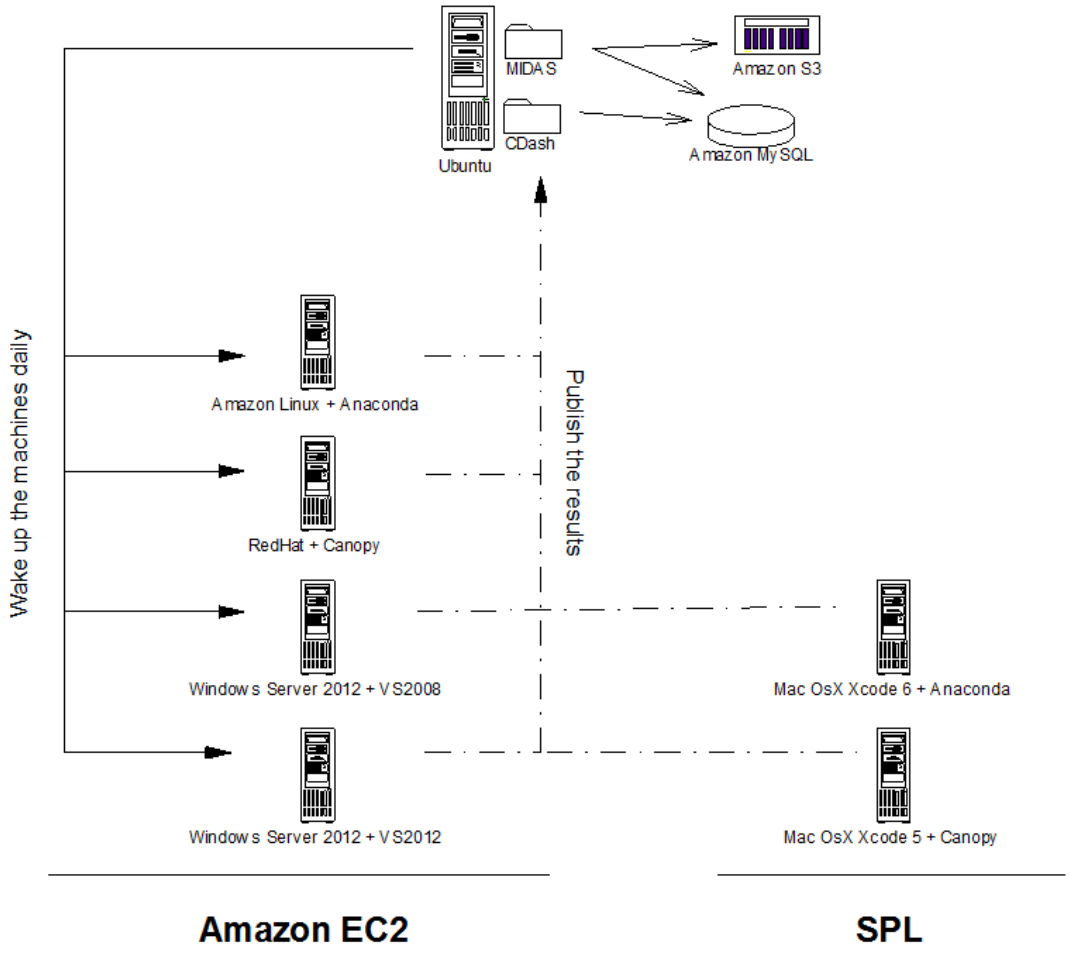
in

3D Slicer's GUI

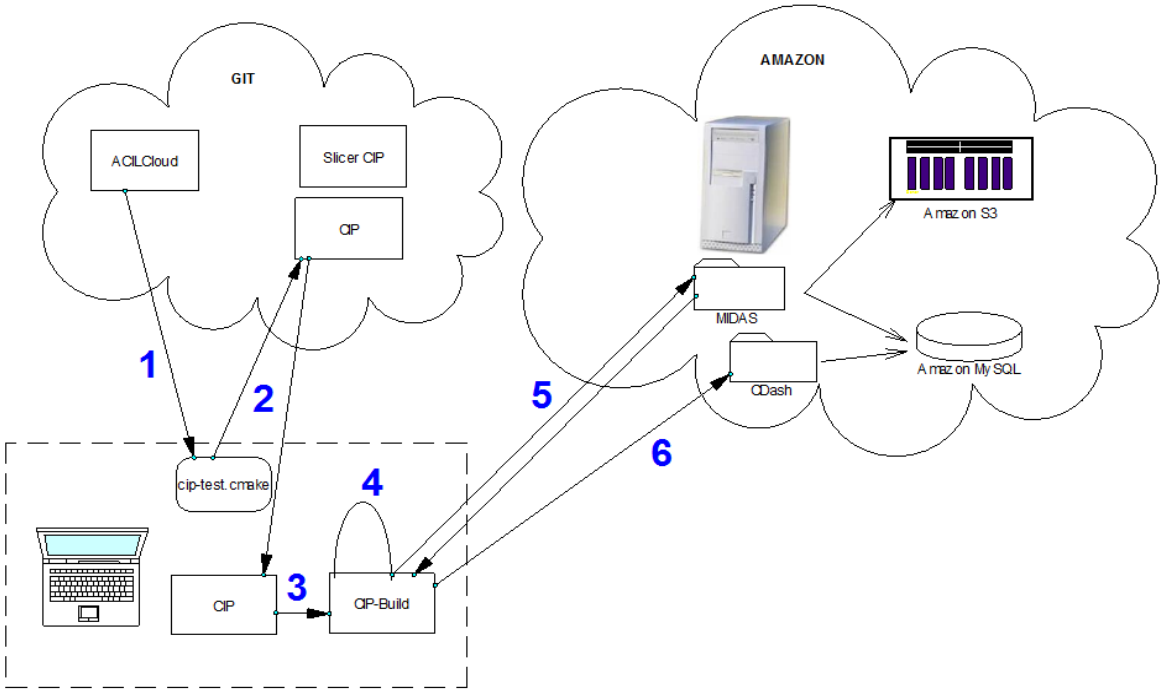
CIP Library: cip_python

- Collection of Python tools
- “Plug & Play Python”
  - To simplify the installation process, we provide with a customized Python distribution (based on Anaconda) with all the packages that we depend on already preinstalled
- Analog categories to CLIs
- Include nipype classes to create typical workflows that involve the use of several tools (more workflows coming soon...)

Cloud testing infrastructure



Testing process

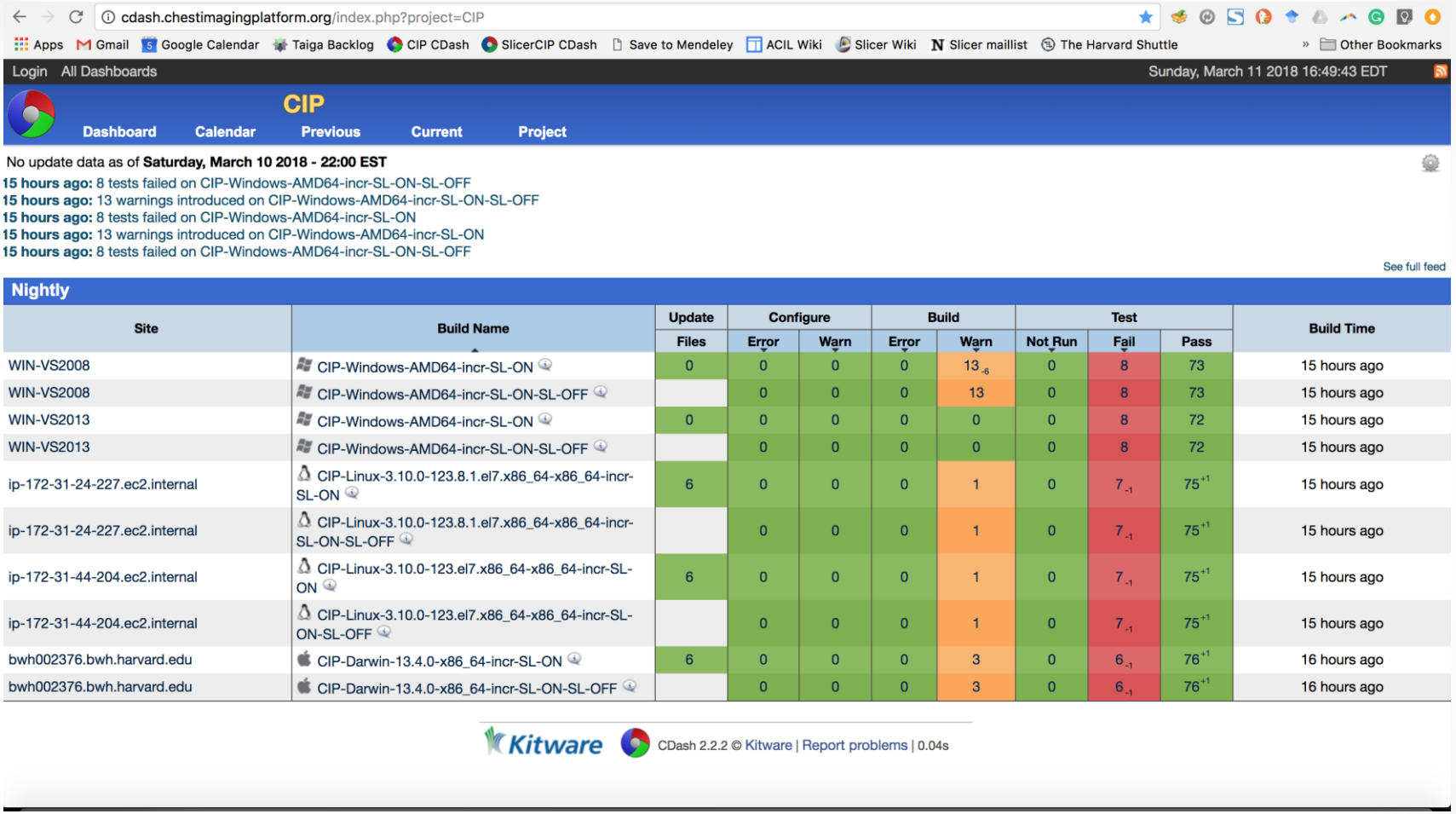


1. Download last version of test scripts
2. Get CIP source code last version
3. Compile CIP
4. Run tests
5. For large tests, request for MIDAS images (not cached)
6. Publish the results to CDash

Step 1 is executed manually (GIT pull) or scheduled in Amazon machines

Steps 2-6 are executed via "cip-test.cmake" file

CDash results



cdash.chestimagingplatform.org/index.php?project=CIP

Apps | Gmail | Google Calendar | Taiga Backlog | CIP CDash | SlicerCIP CDash | Save to Mendeley | ACIL Wiki | Slicer Wiki | Slicer maillist | The Harvard Shuttle | Other Bookmarks

Login All Dashboards — Sunday, March 11 2018 16:49:43 EDT

CIP

Dashboard Calendar Previous Current Project

No update data as of **Saturday, March 10 2018 - 22:00 EST**

15 hours ago: 8 tests failed on CIP-Windows-AMD64-incr-SL-ON-SL-OFF
15 hours ago: 13 warnings introduced on CIP-Windows-AMD64-incr-SL-ON-SL-OFF
15 hours ago: 8 tests failed on CIP-Windows-AMD64-incr-SL-ON
15 hours ago: 13 warnings introduced on CIP-Windows-AMD64-incr-SL-ON
15 hours ago: 8 tests failed on CIP-Windows-AMD64-incr-SL-ON-SL-OFF

See full feed

Nightly

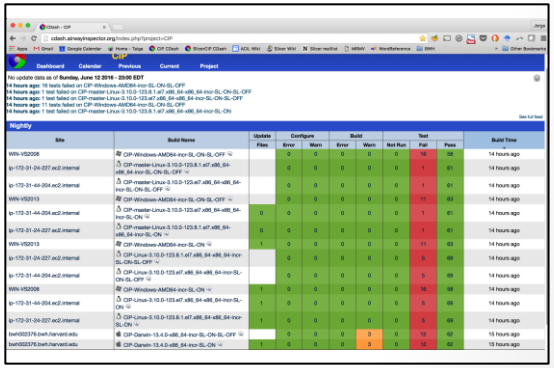
Site	Build Name	Update	Configure		Build		Test			Build Time
		Files	Error	Warn	Error	Warn	Not Run	Fail	Pass	
WIN-VS2008	CIP-Windows-AMD64-incr-SL-ON	0	0	0	0	13 -6	0	8	73	15 hours ago
WIN-VS2008	CIP-Windows-AMD64-incr-SL-ON-SL-OFF		0	0	0	13	0	8	73	15 hours ago
WIN-VS2013	CIP-Windows-AMD64-incr-SL-ON	0	0	0	0	0	0	8	72	15 hours ago
WIN-VS2013	CIP-Windows-AMD64-incr-SL-ON-SL-OFF		0	0	0	0	0	8	72	15 hours ago
ip-172-31-24-227.ec2.internal	CIP-Linux-3.10.0-123.8.1.el7.x86_64-x86_64-incr-SL-ON	6	0	0	0	1	0	7 -1	75 +1	15 hours ago
ip-172-31-24-227.ec2.internal	CIP-Linux-3.10.0-123.8.1.el7.x86_64-x86_64-incr-SL-ON-SL-OFF		0	0	0	1	0	7 -1	75 +1	15 hours ago
ip-172-31-44-204.ec2.internal	CIP-Linux-3.10.0-123.el7.x86_64-x86_64-incr-SL-ON	6	0	0	0	1	0	7 -1	75 +1	15 hours ago
ip-172-31-44-204.ec2.internal	CIP-Linux-3.10.0-123.el7.x86_64-x86_64-incr-SL-ON-SL-OFF		0	0	0	1	0	7 -1	75 +1	15 hours ago
bwh002376.bwh.harvard.edu	CIP-Darwin-13.4.0-x86_64-incr-SL-ON	6	0	0	0	3	0	6 -1	76 +1	16 hours ago
bwh002376.bwh.harvard.edu	CIP-Darwin-13.4.0-x86_64-incr-SL-ON-SL-OFF		0	0	0	3	0	6 -1	76 +1	16 hours ago

Kitware CDash 2.2.2 © Kitware | Report problems | 0.04s

http://cdash.chestimagingplatform.org/index.php?project=CIP

Using best practices

- There is a stable version and a nightly version of the code for both the CIP Library and the SlicerCIP extension
- All the source code is Open Source, stored in Github
- Both components are tested every night in different platforms
  - CIP Library: custom CDash board
  - SlicerCIP: custom tests integrated in the common Slicer infrastructure



CIP: how to download and install

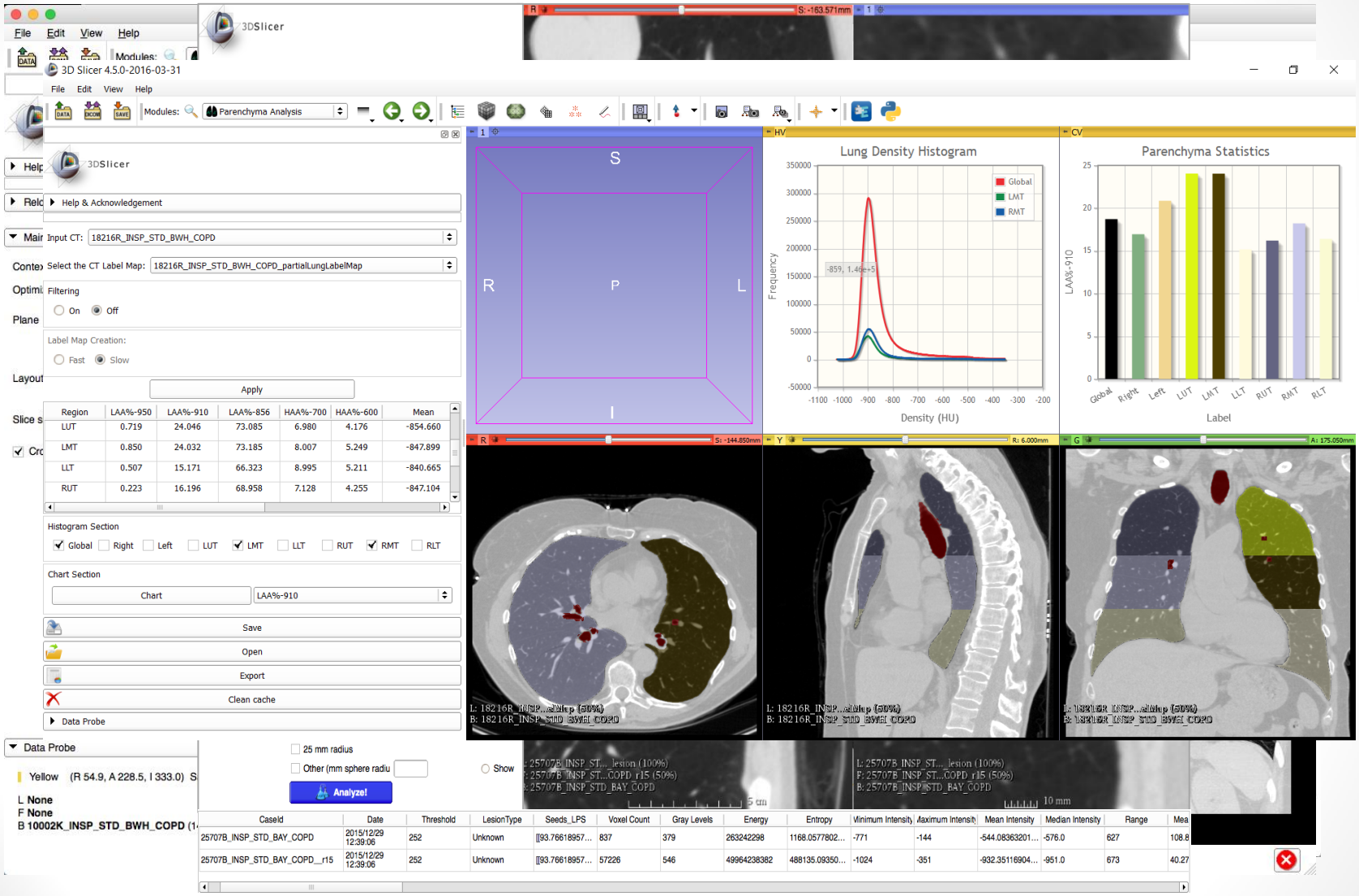
- Source code (Github):
  - **CIP Library**:
    https://github.com/acil-bwh/ChestImagingPlatform
  - **SlicerCIP**:
    https://github.com/acil-bwh/SlicerCIP

- Installation:
  - **CIP Library**: superbuild mechanism (with a single "make" command all the components and the dependencies will be built)
  - **SlicerCIP**: one click installation from the Slicer Extension Manager

SlicerCIP

- SlicerCIP is the Chest Imaging Platform extension developed for 3D Slicer.
- 3D Slicer is a medical imaging open platform based on similar libraries that CIP (VTK, ITK, etc.), that eases the integration
- Two main blocks in the extension:
  - **Modules**: customized “plugins” for Slicer
  - **Toolkit**: GUI “wrapper” that allows to invoke the CIP Library CLIs directly from Slicer

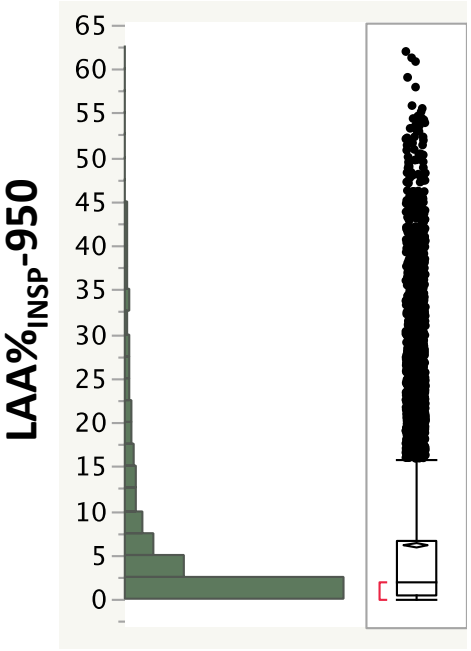
SlicerCIP: examples



Study case: Densitometry analysis in COPDGene

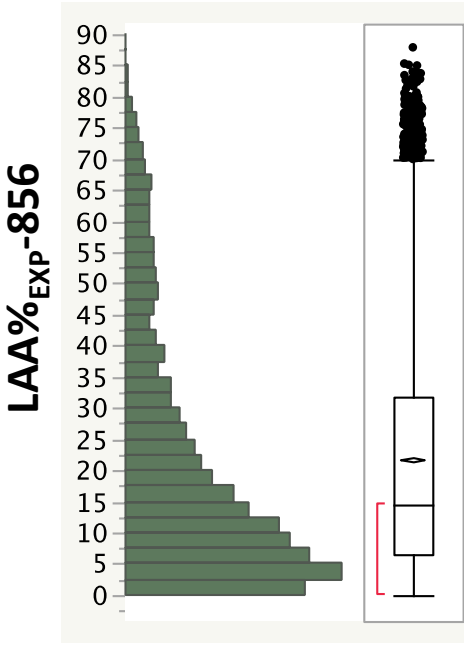
- Quantification of emphysema ($LAA\%_{INSP}$-950) and gas trapping ($LAA\%_{EXP}$-856)

Emphysema Score Distribution



N= 9,608

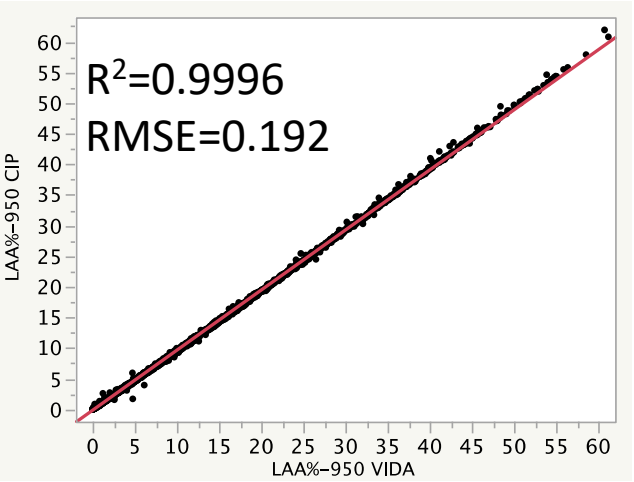
Gas Trapping Score Distribution



N=8,698

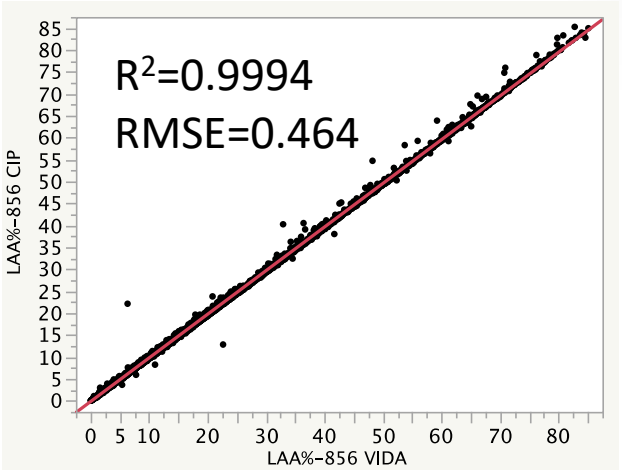
Correlation Analysis

Emphysema Scores



N=5782

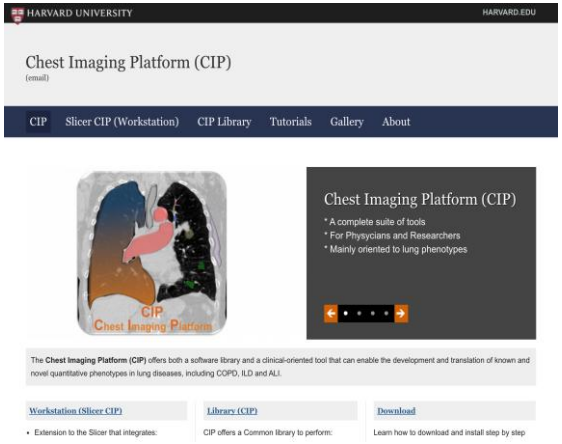
Gas Trapping Scores



N=5116

		GOLD 0	GOLD 1	GOLD 2	GOLD 3	GOLD 4
Emphysema	N	2375	457	1091	732	397
	R^2	0.9990	0.9989	0.9995	0.9996	0.9994
	RMSE	0.0804	0.1945	0.1819	**0.231**	**0.310**
Gas Trapping	N	2076	401	969	642	373
	R^2	0.9993	0.9989	0.9986	0.9995	0.9972
	RMSE	0.2482	0.3892	**0.5692**	0.3673	**0.6702**

ACIL
(Applied Chest Imaging Laboratory)



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