Improvements in SlicerRT, the radiation therapy research toolkit for 3D Slicer
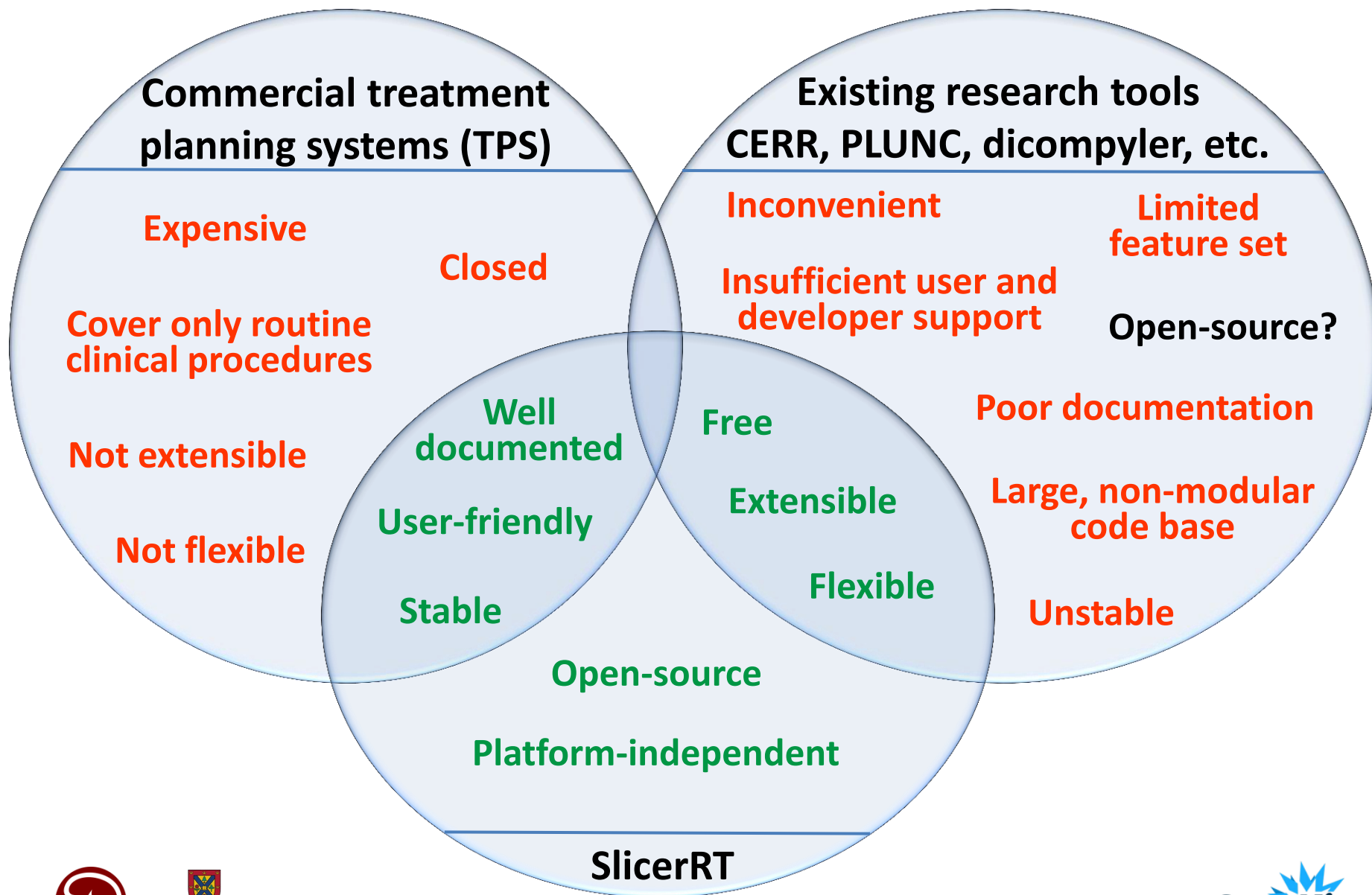
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[1]Laboratory for Percutaneous Surgery, Queen's University, Canada
[2]University Health Network, Toronto, ON, Canada

Motivation behind SlicerRT

Commercial treatment planning systems (TPS)

Expensive

Closed

Cover only routine clinical procedures

Not extensible

Not flexible

Existing research tools CERR, PLUNC, dicompyler, etc.

Inconvenient

Limited feature set

Insufficient user and developer support

Open-source?

Poor documentation

Large, non-modular code base

Unstable

Well documented

Free

User-friendly

Extensible

Stable

Flexible

Open-source

Platform-independent

SlicerRT

SparKit

DICOM-RT import/export

- Import integrated into core DICOM import plugin mechanism
- Supported data types:
  - RT structure sets
    → Contours
    → Fiducial point
  - RT dose map
  - RT image
  - RT plan isocenter, beams
  - Planning CT, MR, etc.
- Basic DICOM-RT export is implemented
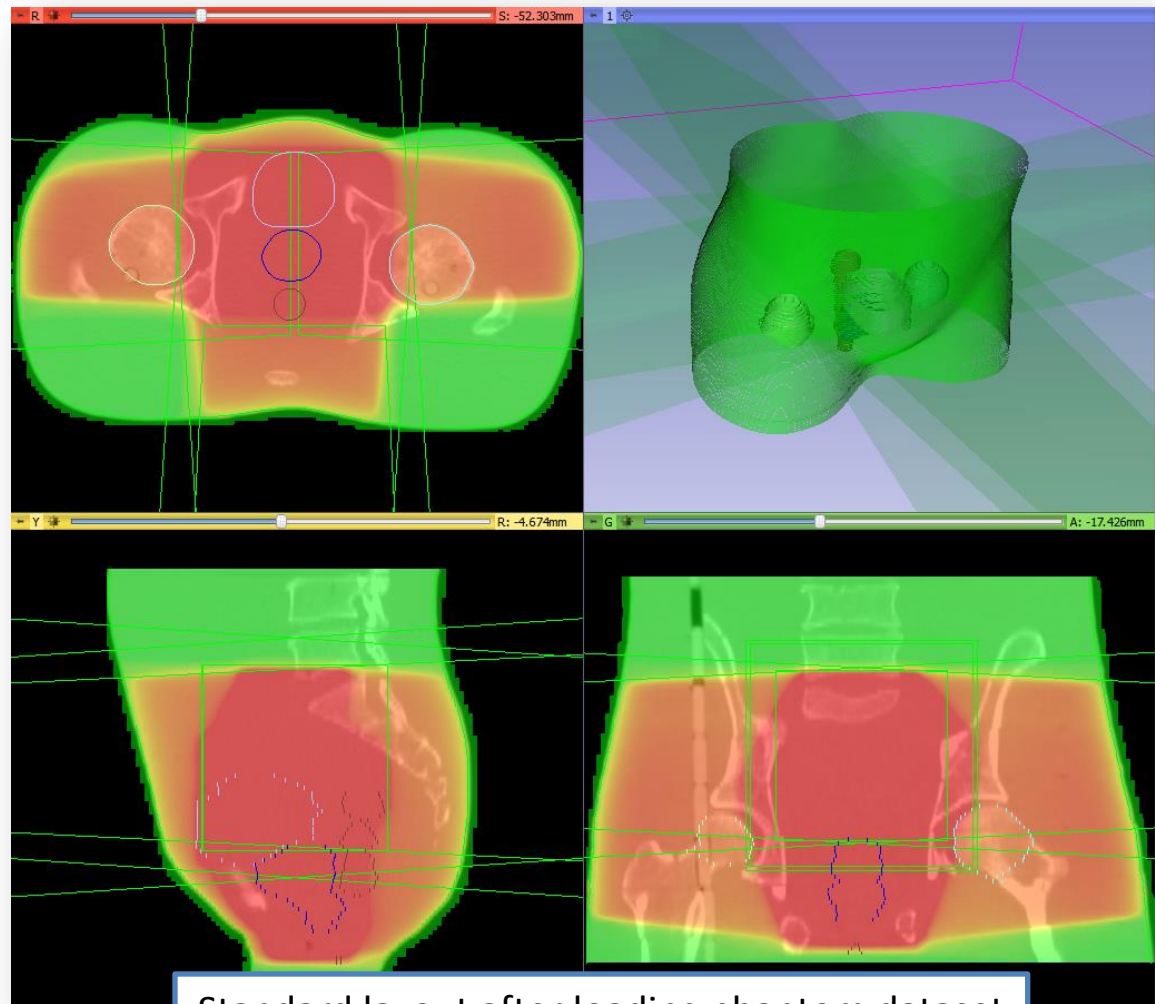

Standard layout after loading phantom dataset

Contour analysis

- Multiple representations (automatic conversion)
  - Ribbon model
  - Rasterized volume
  - Closed surface model
- Contour comparison
  - Dice coefficient
  - Hausdorff distance
- Contour morphology
 - Expand, shrink
  - Combine using logical operators

Ribbon model

Rasterized volume

Closed surface

Expand B

Shrink B

A ∪ B

A ∩ B

A - B

SparKit
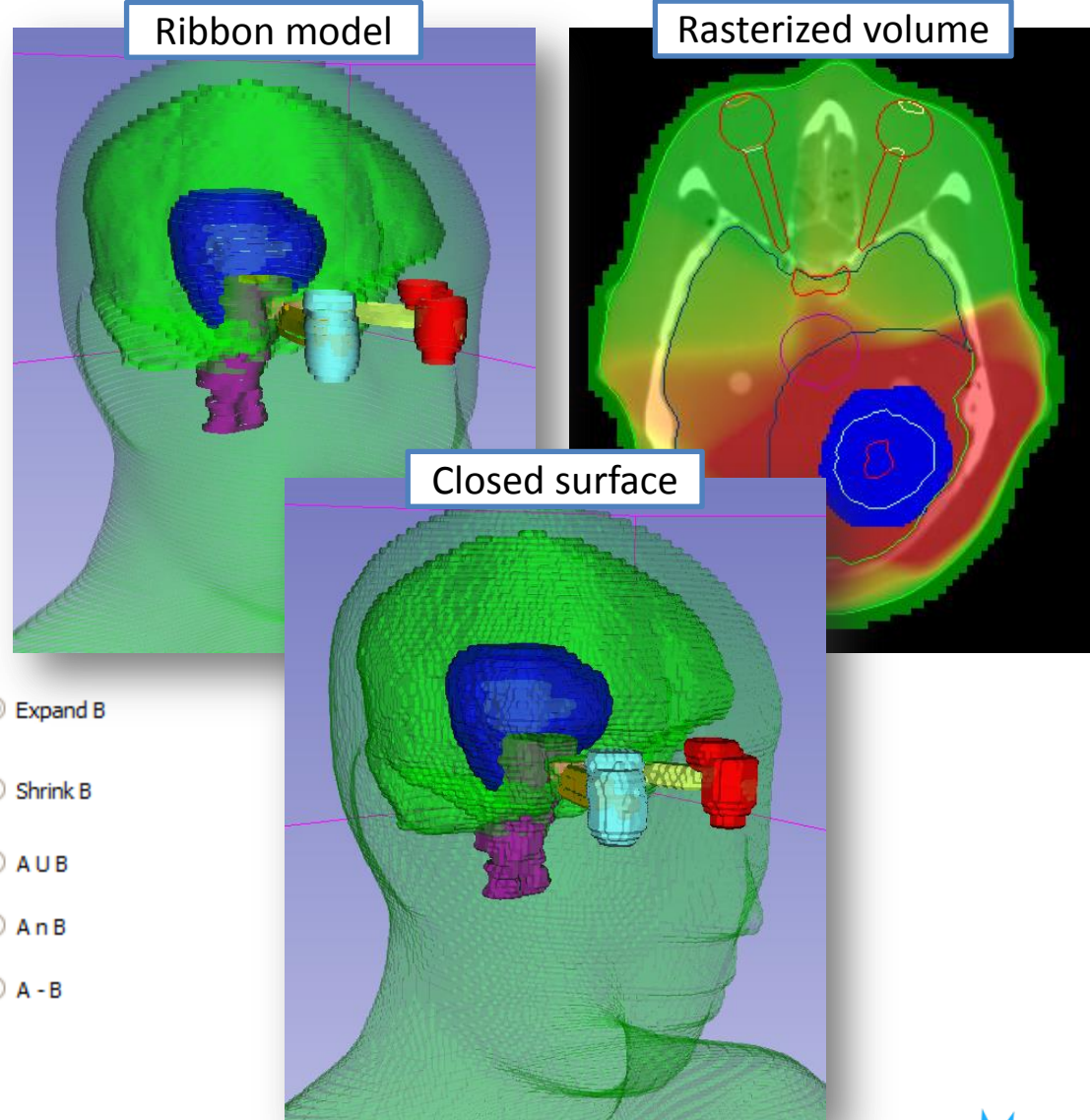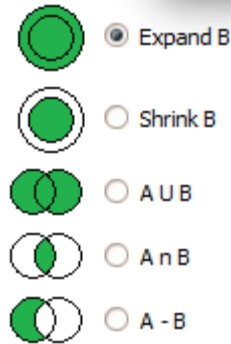
Dose analysis

- Dose volume histogram (plot visualization + metrics)

- Dose accumulation

- Dose comparison (gamma)

- Isodose contours / surfaces

- External beam planning (photon, proton)

- Registration

  - BSpline registration

  - Landwarp registration

Isodose contours and surfaces
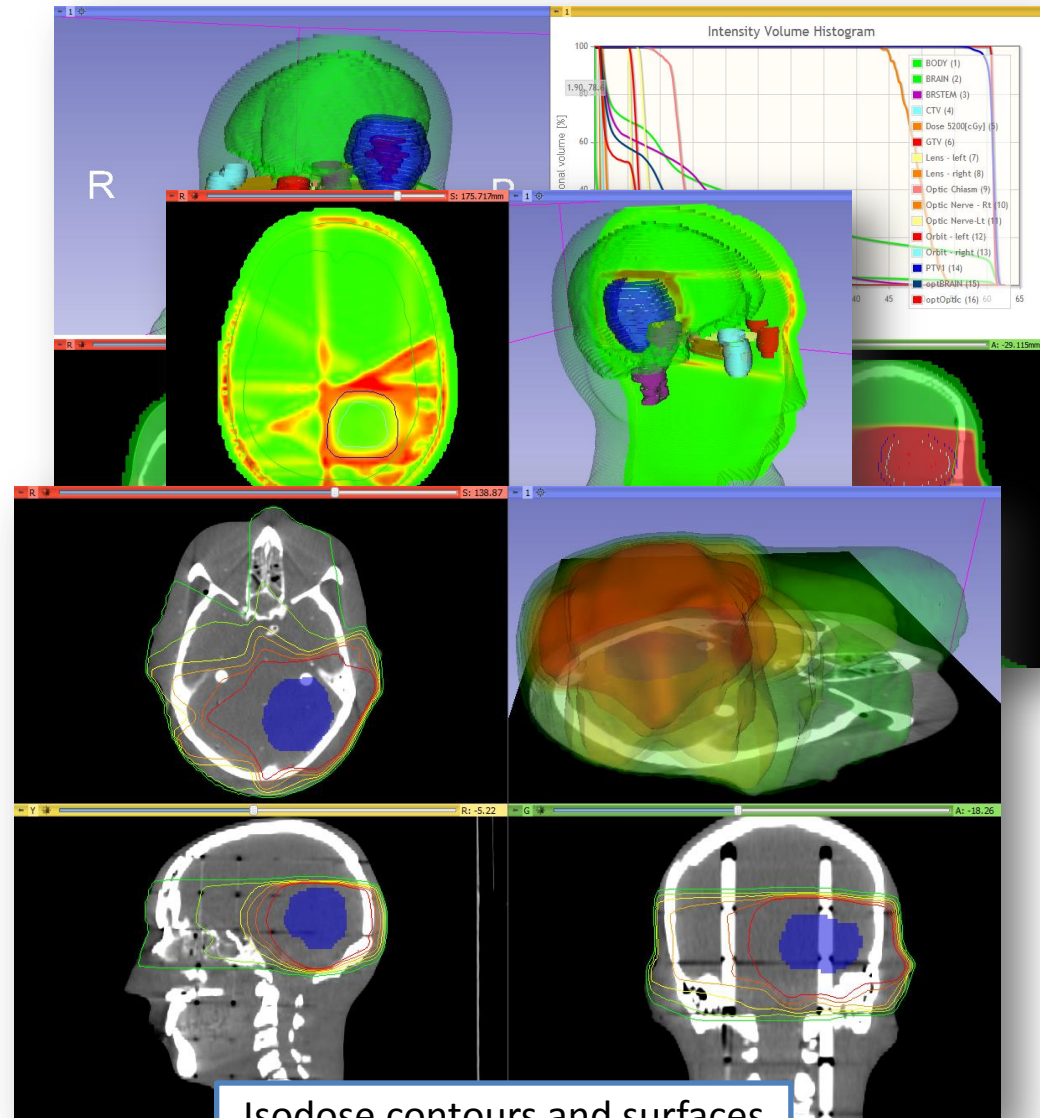
External beam planning

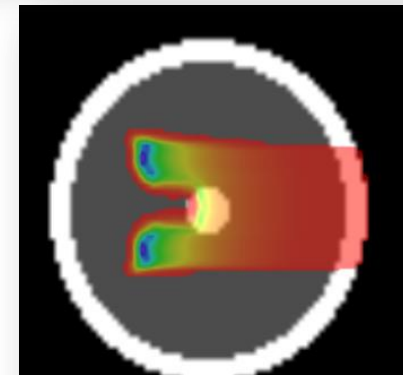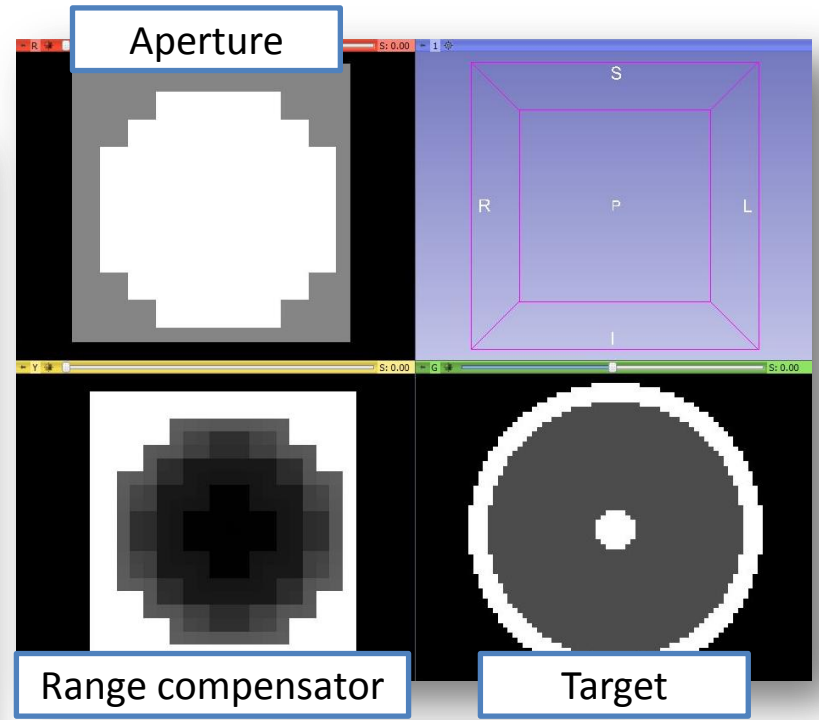This module provide basic framework for RT planning and dose calculation for photon and proton
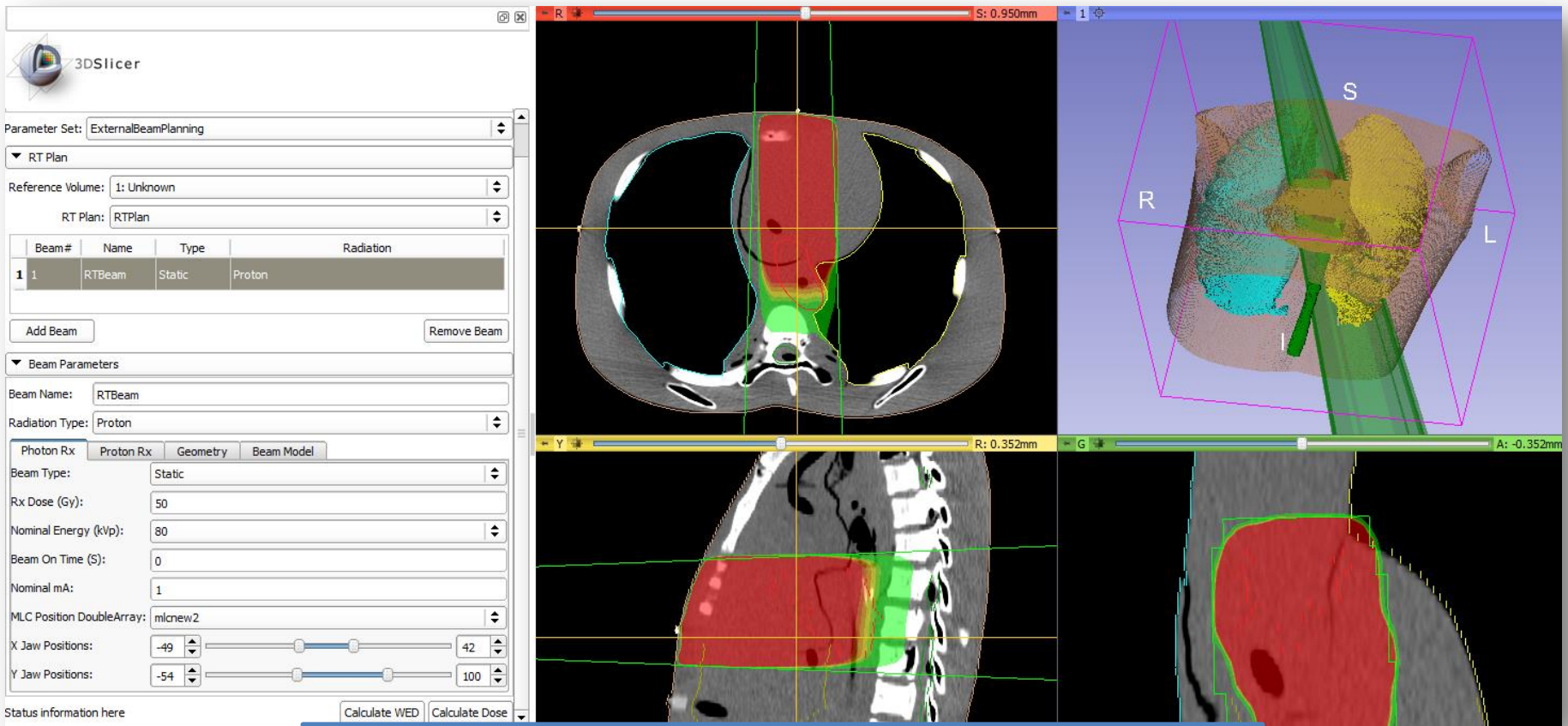
Photon MLC beam created in external beam planning module

External beam planning - proton

Aperture

Range compensator

Target
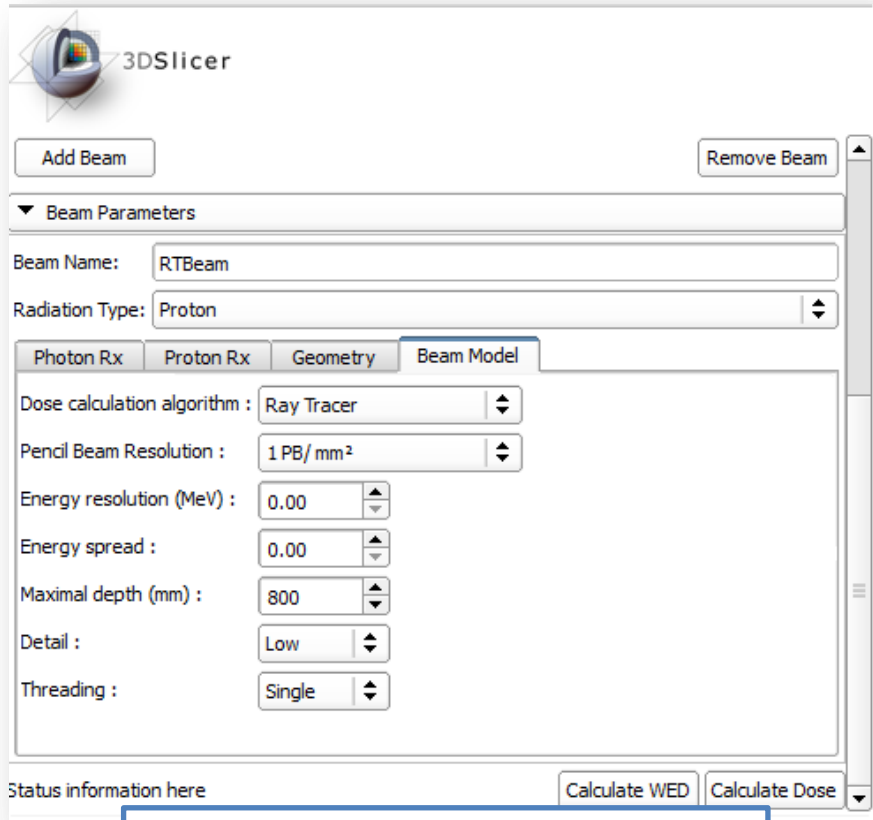
External beam planning module UI

Beam dose distribution

Subject hierarchy

New concept for organizing data

- Nice and intuitive way of organizing and handling data
  Bring basic features in a data-centered tree view, such as
    - Show/hide
    - Transform branch

- Extendable through plugins
  Broad API allowing many customizations, such as
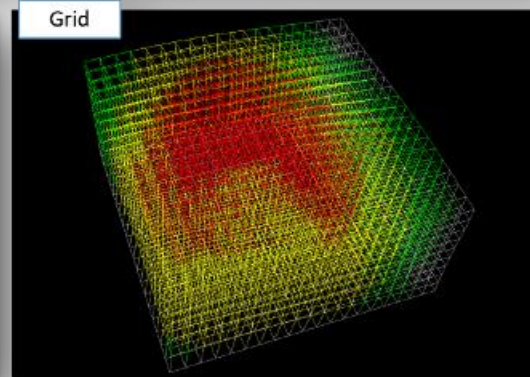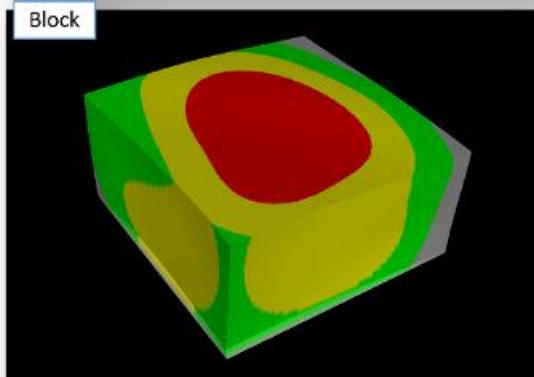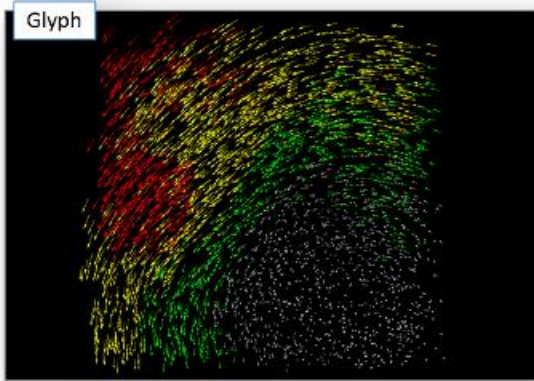   - DICOM export
    - Registration

Subject hierarchy module widget
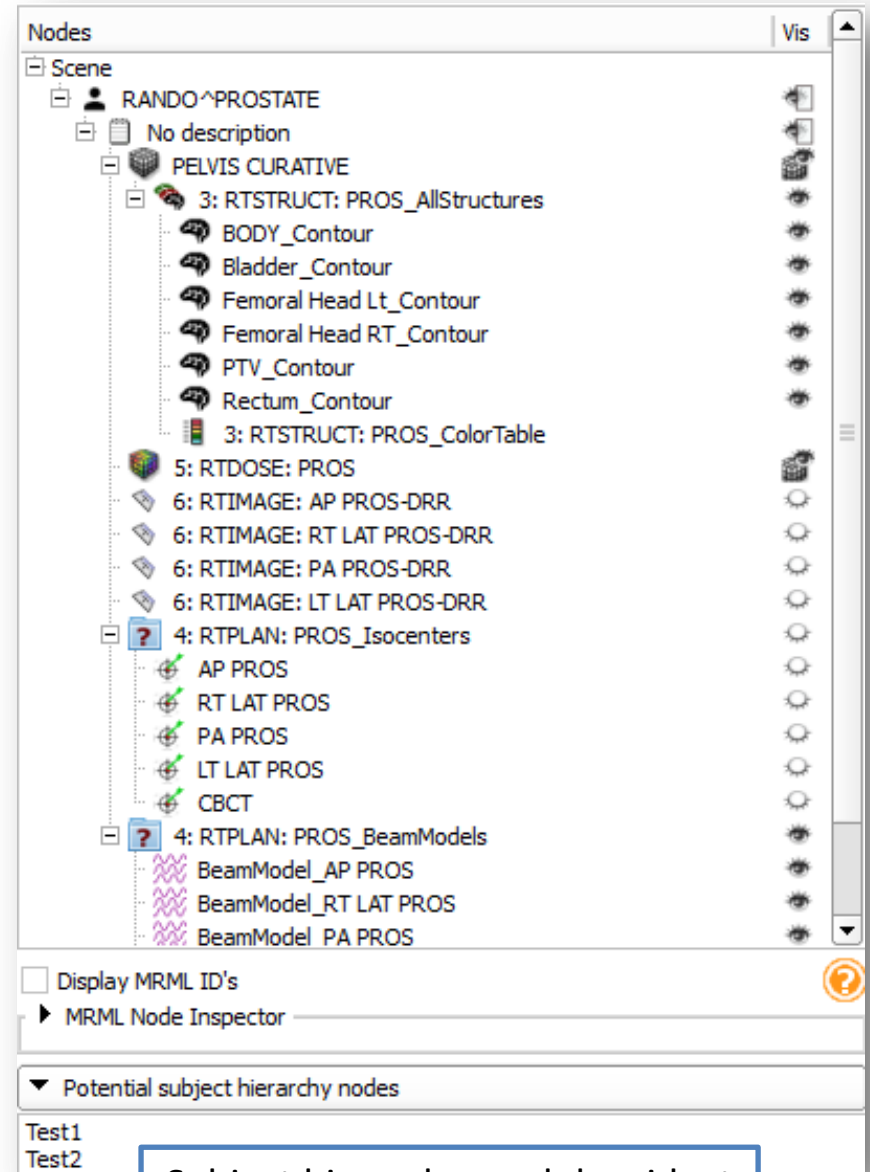
Subject hierarchy - plugins

- Default
- DICOM
- Volumes
- Registration
- Parse local data
- Contours
- RT objects
- Many more to come …
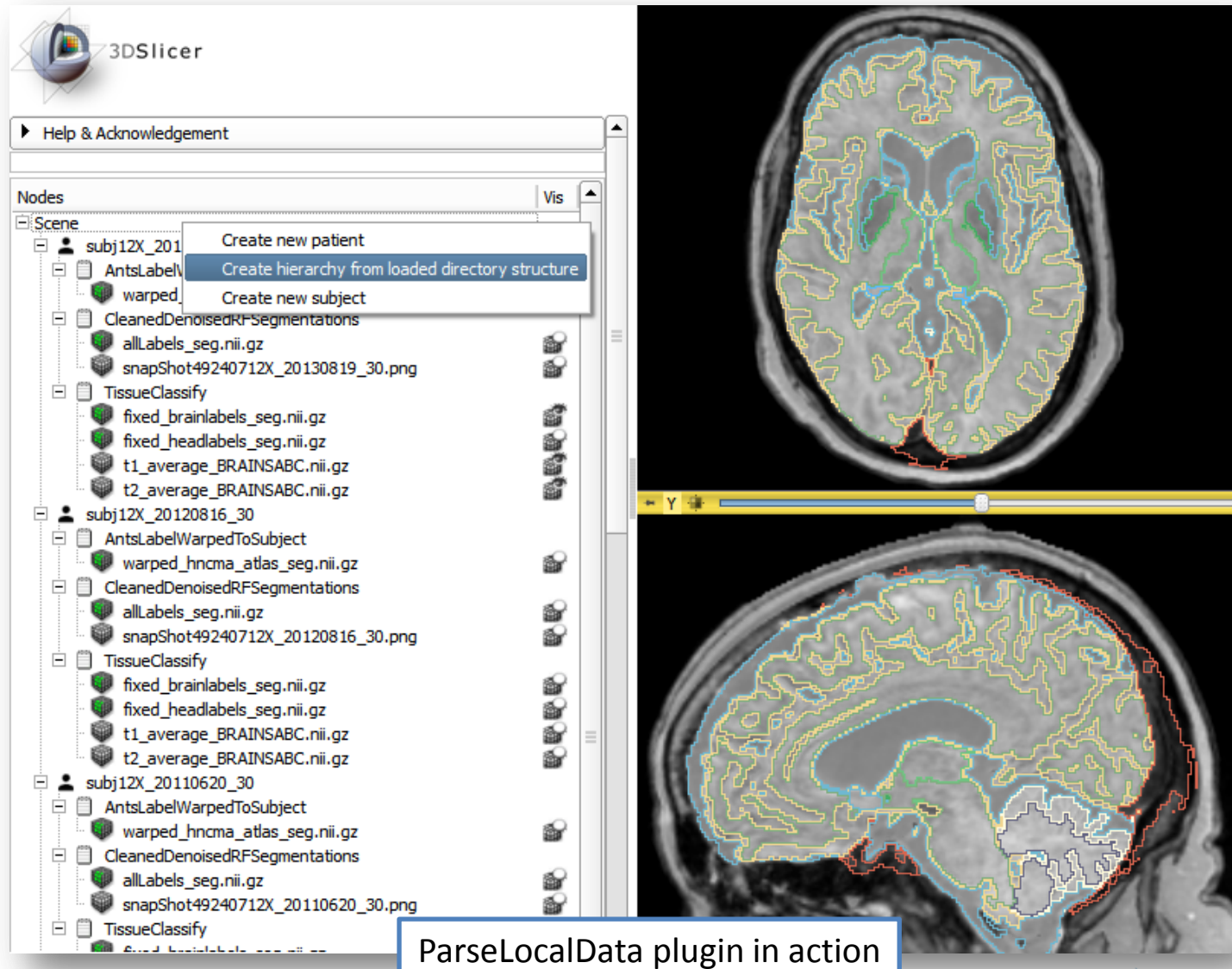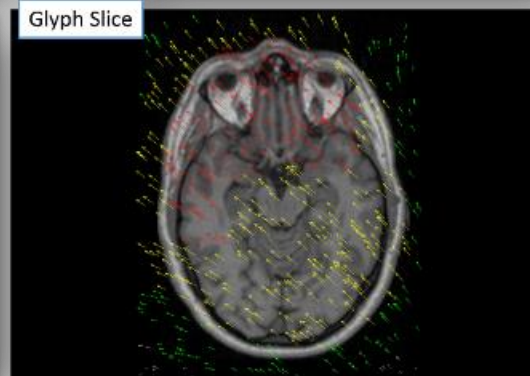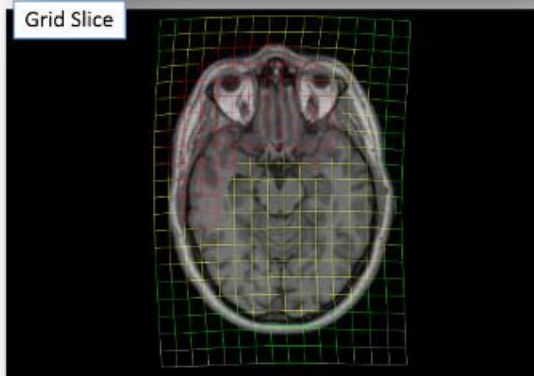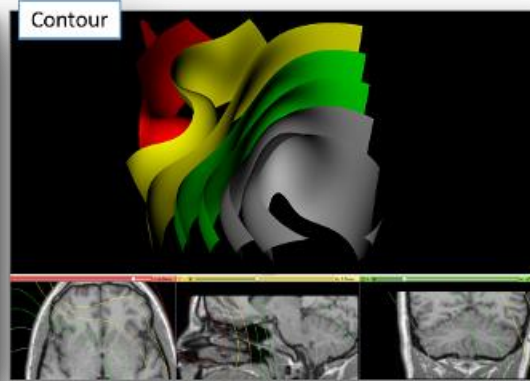
ParseLocalData plugin in action

Transform visualizer

Gel dosimetry analysis
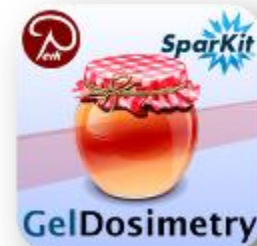
- "Slicelet" for gel dosimetry analysis workflow
- Wizard-like simplified user interface
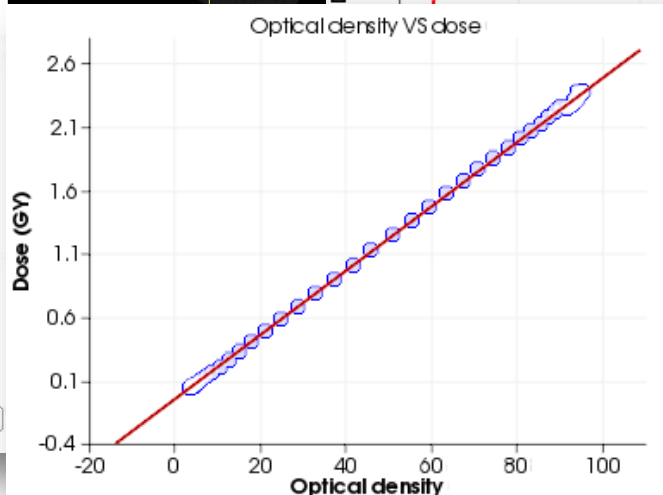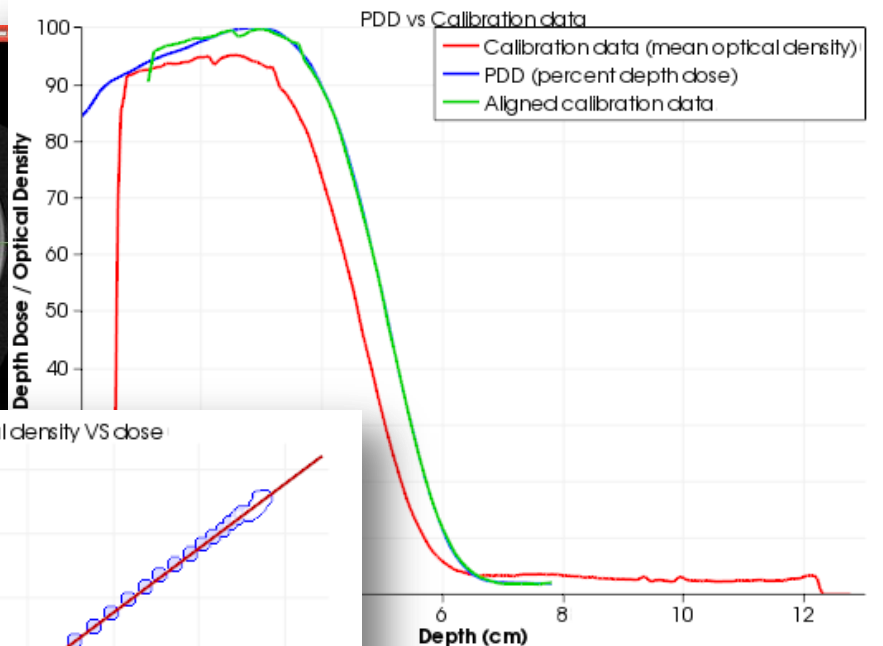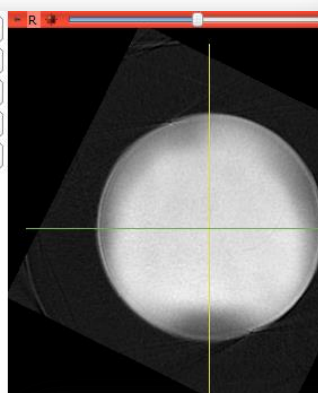
SlicerRT extension for 3D Slicer

- Collection of RT-specific modules, includes Plastimatch
- Distributed as a 3D Slicer extension: can be downloaded, installed, upgraded using the extension manager in Slicer
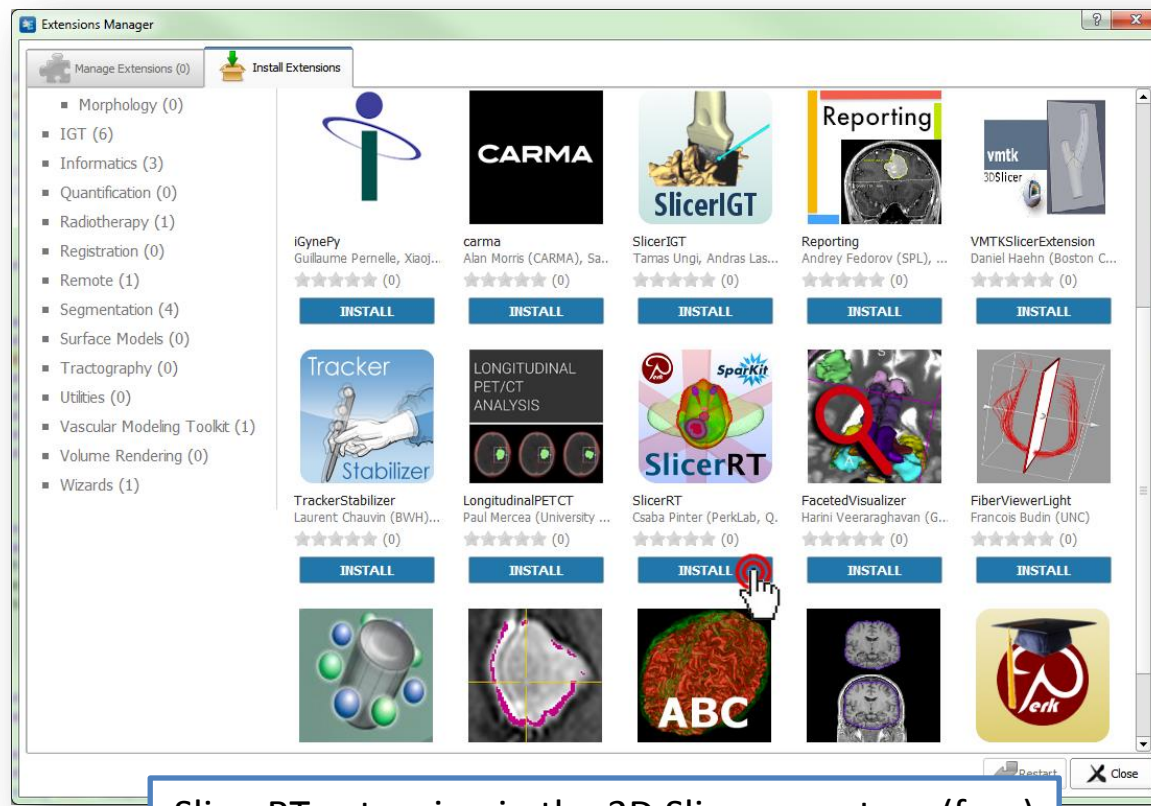
SlicerRT extension in the 3D Slicer app store (free)

Next steps

Planned for the next 6 months:

- DICOM-RT export

- External beam planning

- Contour mechanism – integration to 3D Slicer core

- Digitally reconstructed radiograph (DRR)

- Rasterization evaluation and improvements

- Scripting examples

- More testing and validation

More information: http://SlicerRT.org

Thank you for your attention!