APERTIF

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SlicerAstro: a 3-D interactive visual analytics tool for HI data

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Future HI blind survey

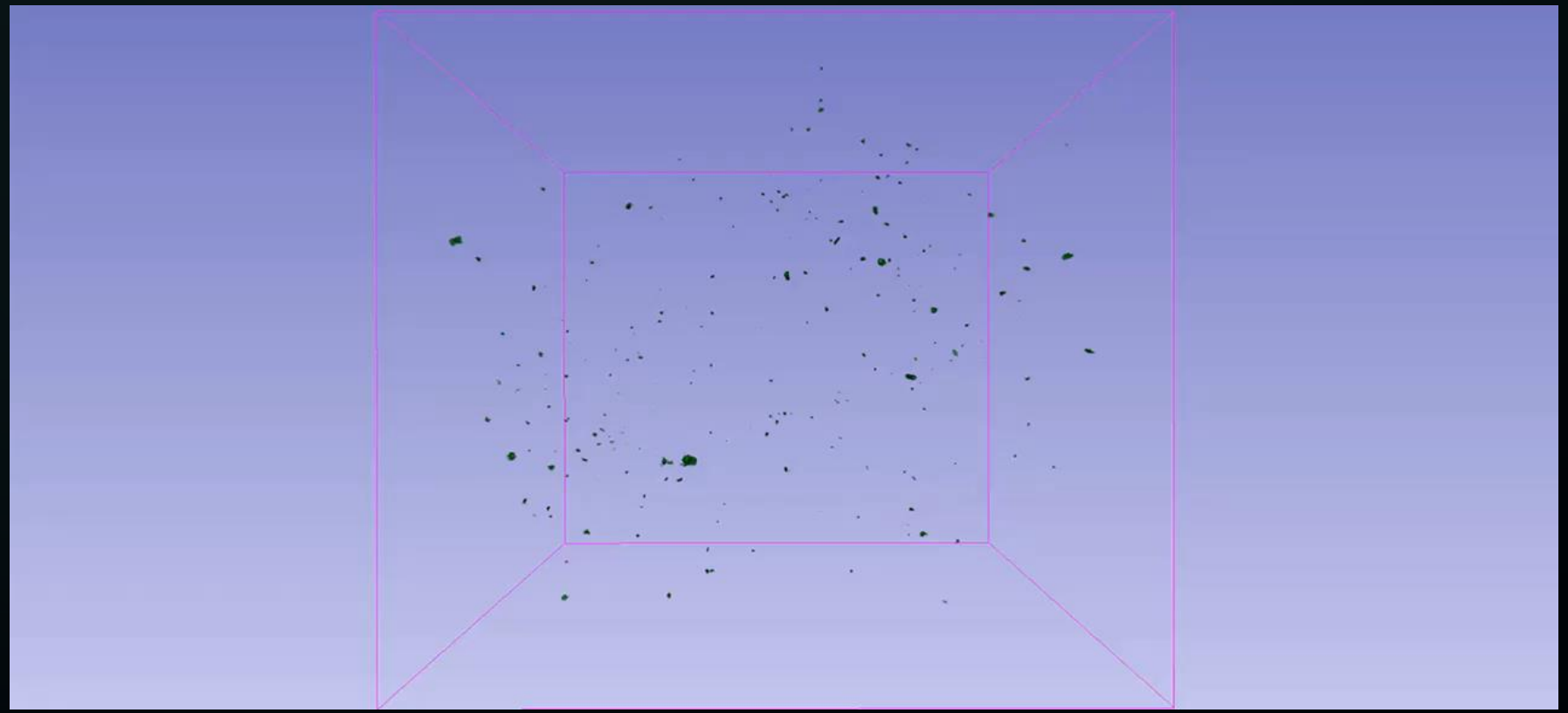
APERTIF (*Verheijen et al., 2009, in Panoramic Radio Astronomy, PoS*)
will observe HI in hundreds of thousands of galaxies.
Data rate 10 cubes/week. We will enter in the *Big* data domain for two reasons:

1 An APERTIF data cube :
~ 10^{11} voxels.

most (99%) will be dominated by noise

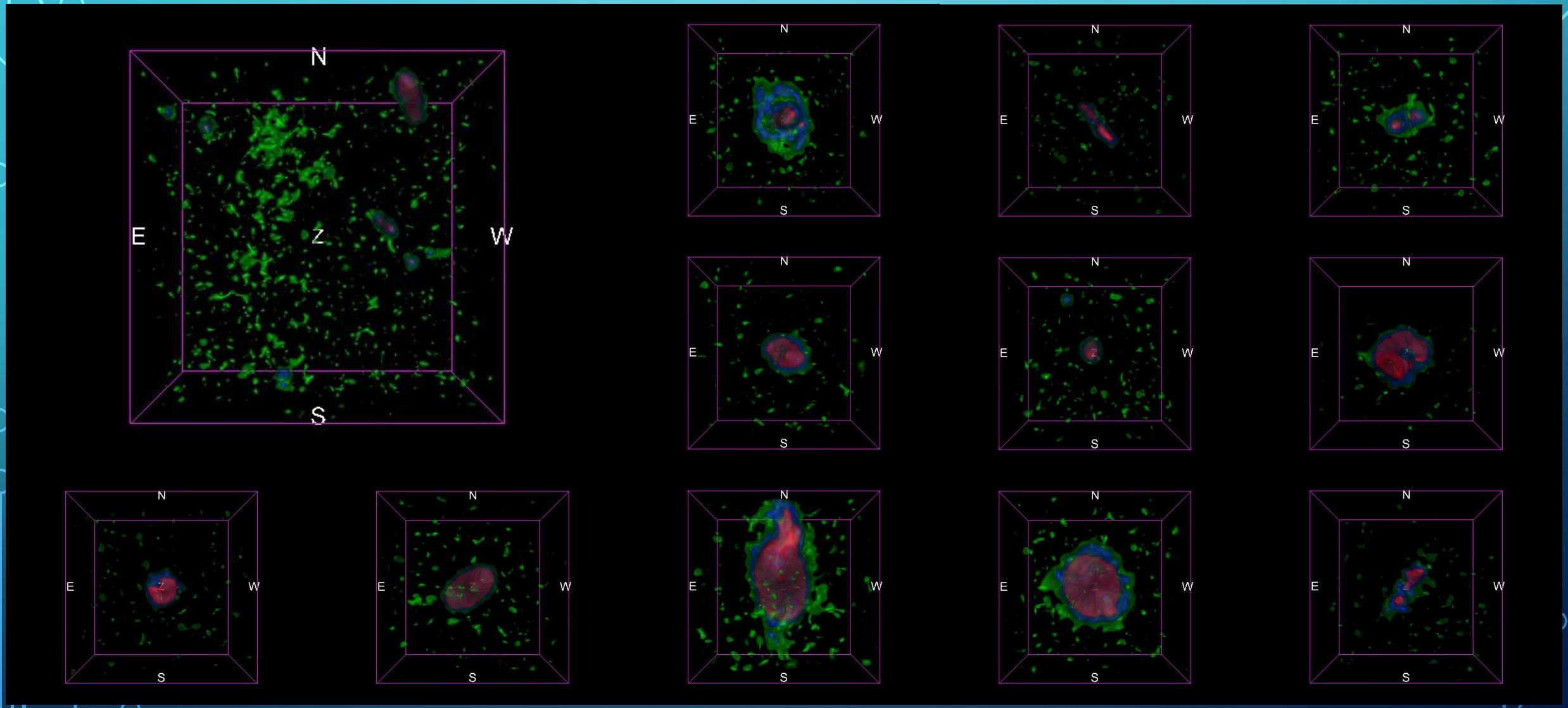
2 Each data cube contains ~100 HI sources

Subcubes around sources will typically contain ~10^5 voxels;



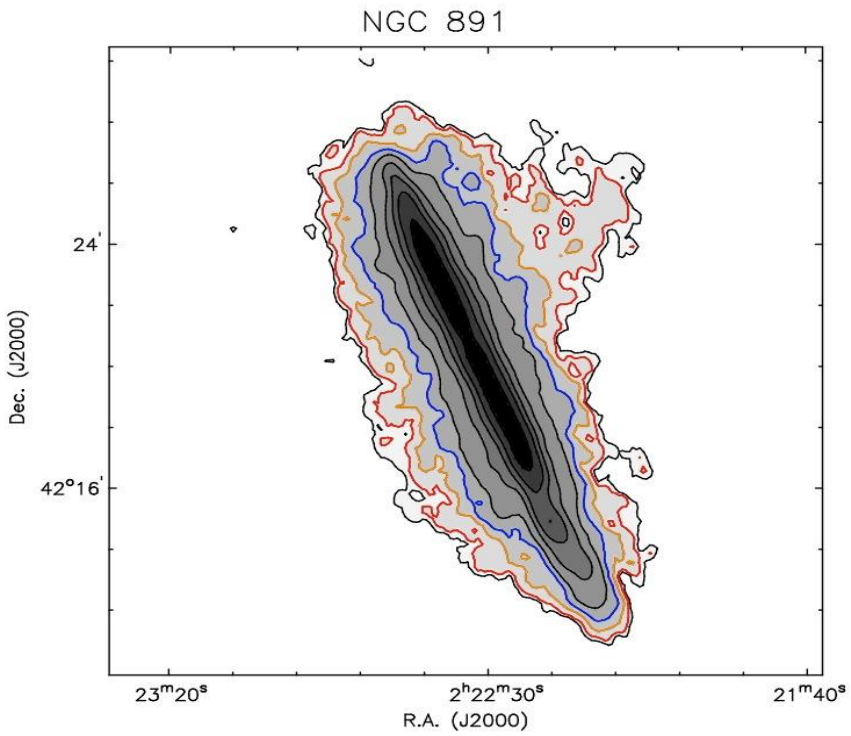
Data from Ramatsoku et al., 2016.

Galaxies in the Ursa Major cluster (courtesy Busekool and Verheijen)

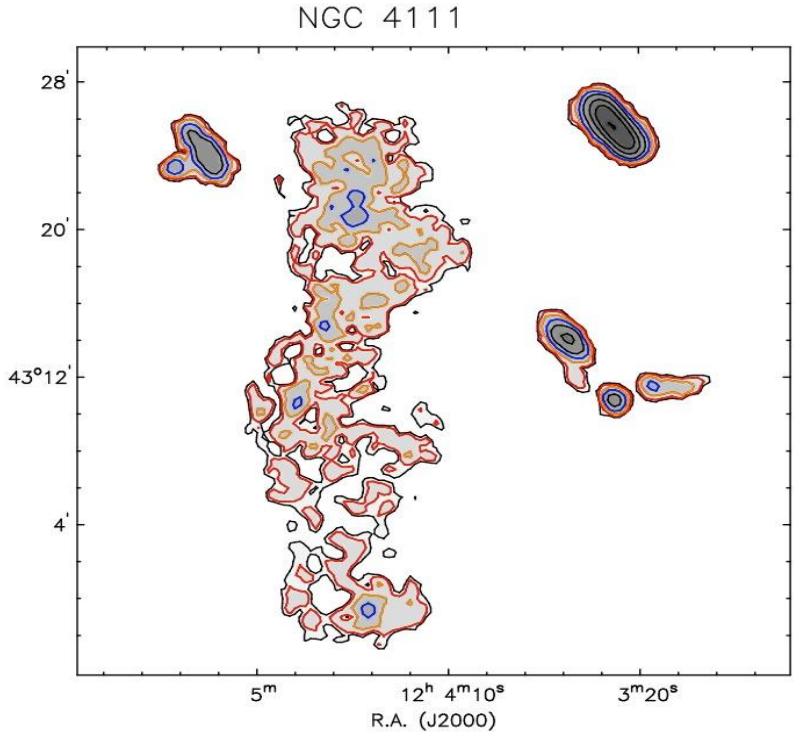


Signatures of gas accretion and removal

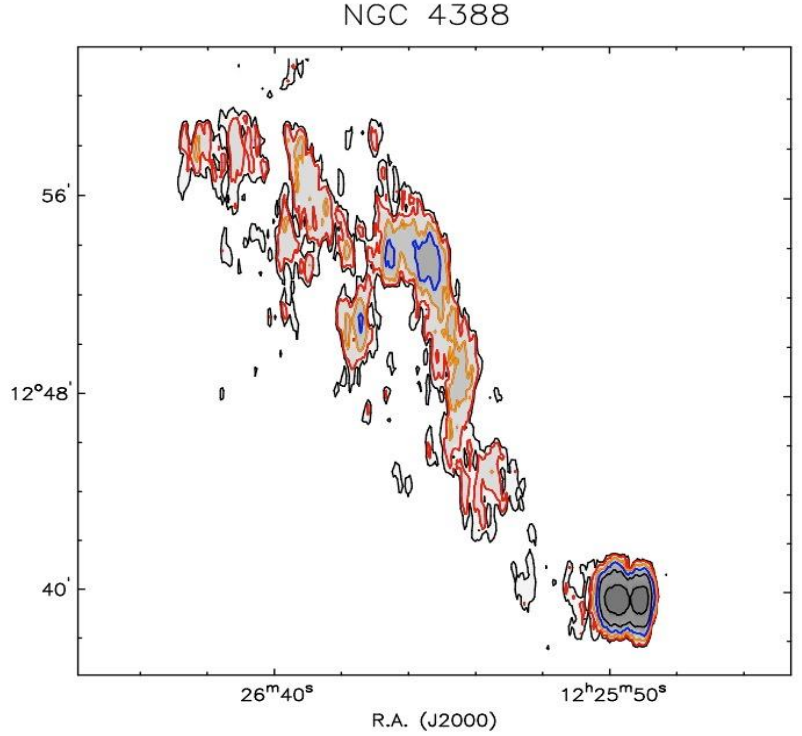
extraplanar gas



tidal filaments



ram-pressure tails



Images credits to M. Verheijen

Common to these tell-tale signatures:

- low column density
- unusual kinematics

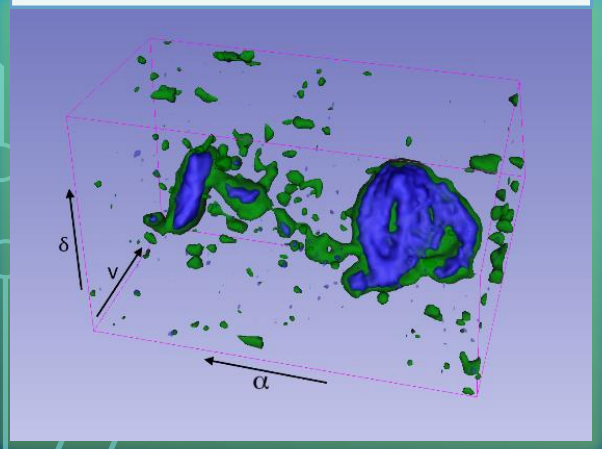
good visualization techniques can help finding such features

SlicerAstro: Aim of the project

SlicerAstro: an interactive 3D visual analytics toolset to boost the inspection and analysis of 3-D astronomical data for 3D Slicer

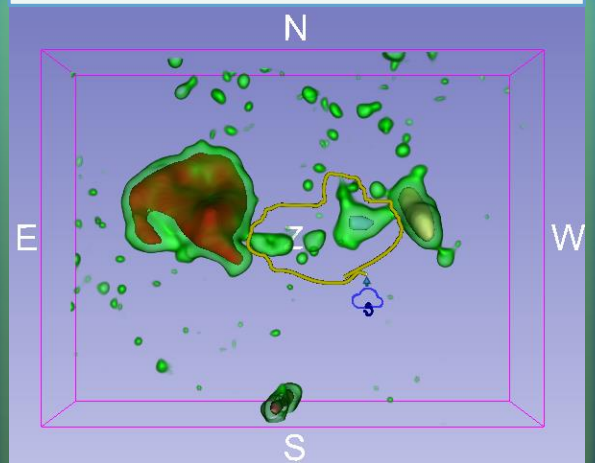
handling FITS and WCS coordinates

Interactive smoothing

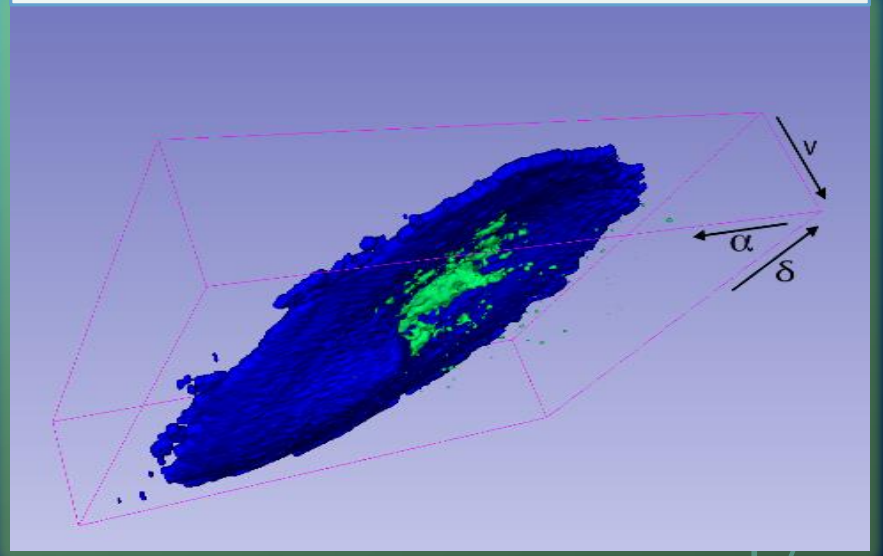


SlicerAstro

3-D selection



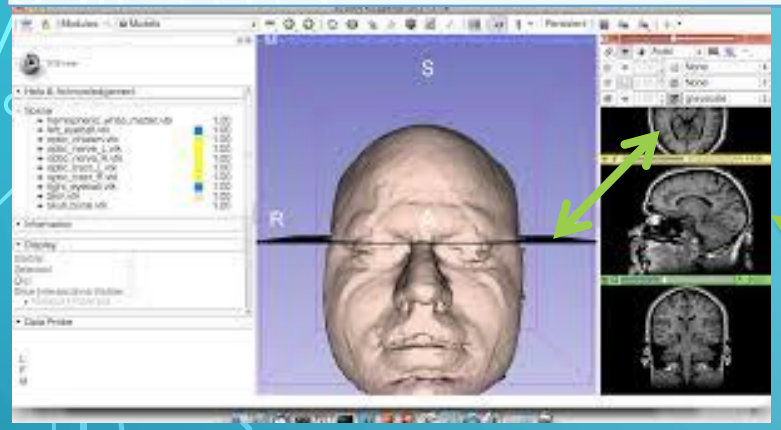
Comparative visualization of data and kinematic models



Punzo et al., *2017, submitted to Astronomy and Computing.*

Why 3DSlicer?

Synergies between astronomical and medical visualization



Open Source

www.slicer.org

3DSlicer

Long-term maintainability

SPL Kitware erk

High level of modularity

C++

CPU/GPU Volume Rendering (VTK>7.1)

VTK

Multi-platform (Qt>4.8.7)

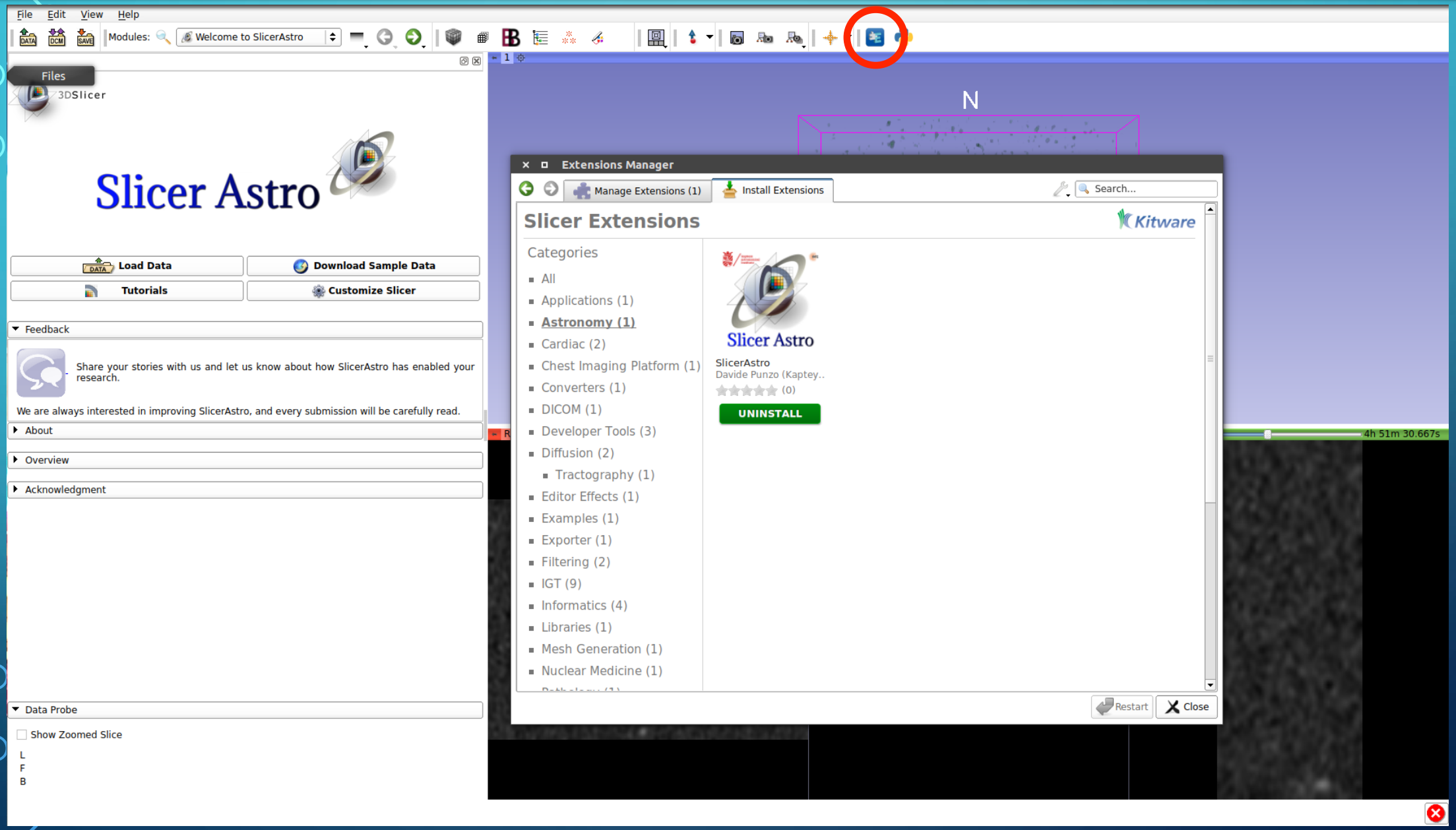
Qt Code less. Create more. Deploy everywhere.

Well documented:

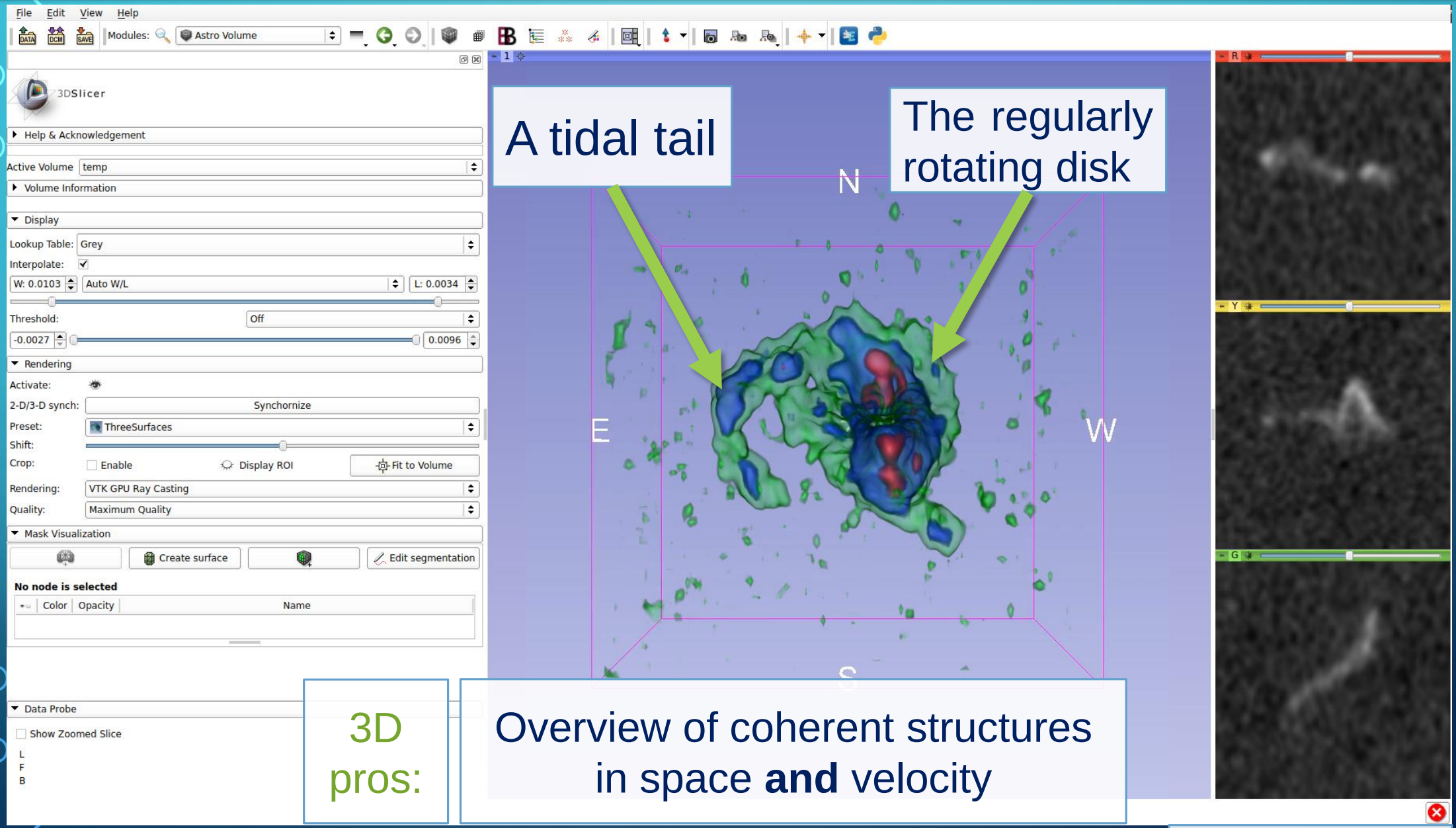
- SlicerWiki
- github.com/Slicer/Slicer
- Mantis bug report

See also Punzo et al., *2015, Astronomy and Computing, 12, 86.*

Downloading SlicerAstro



SlicerAstro: inspecting HI in a galaxy



3D pros:

Overview of coherent structures in space **and** velocity

See also Punzo et al., *2015, Astronomy and Computing, 12, 86.*

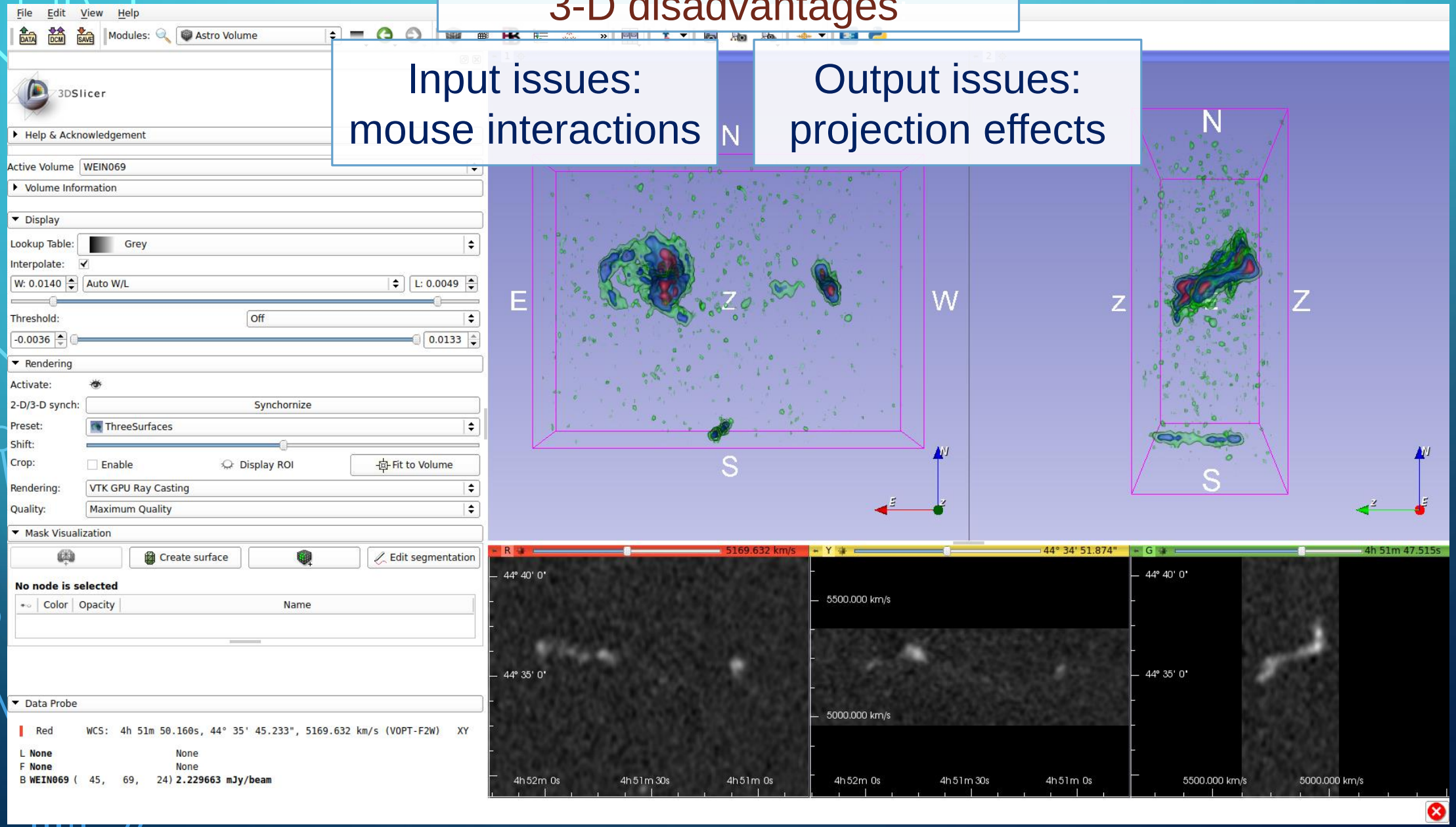
Data by M. Ramatsoku

SlicerAstro: inspecting HI in a galaxy

3-D disadvantages

Input issues:
mouse interactions

Output issues:
projection effects

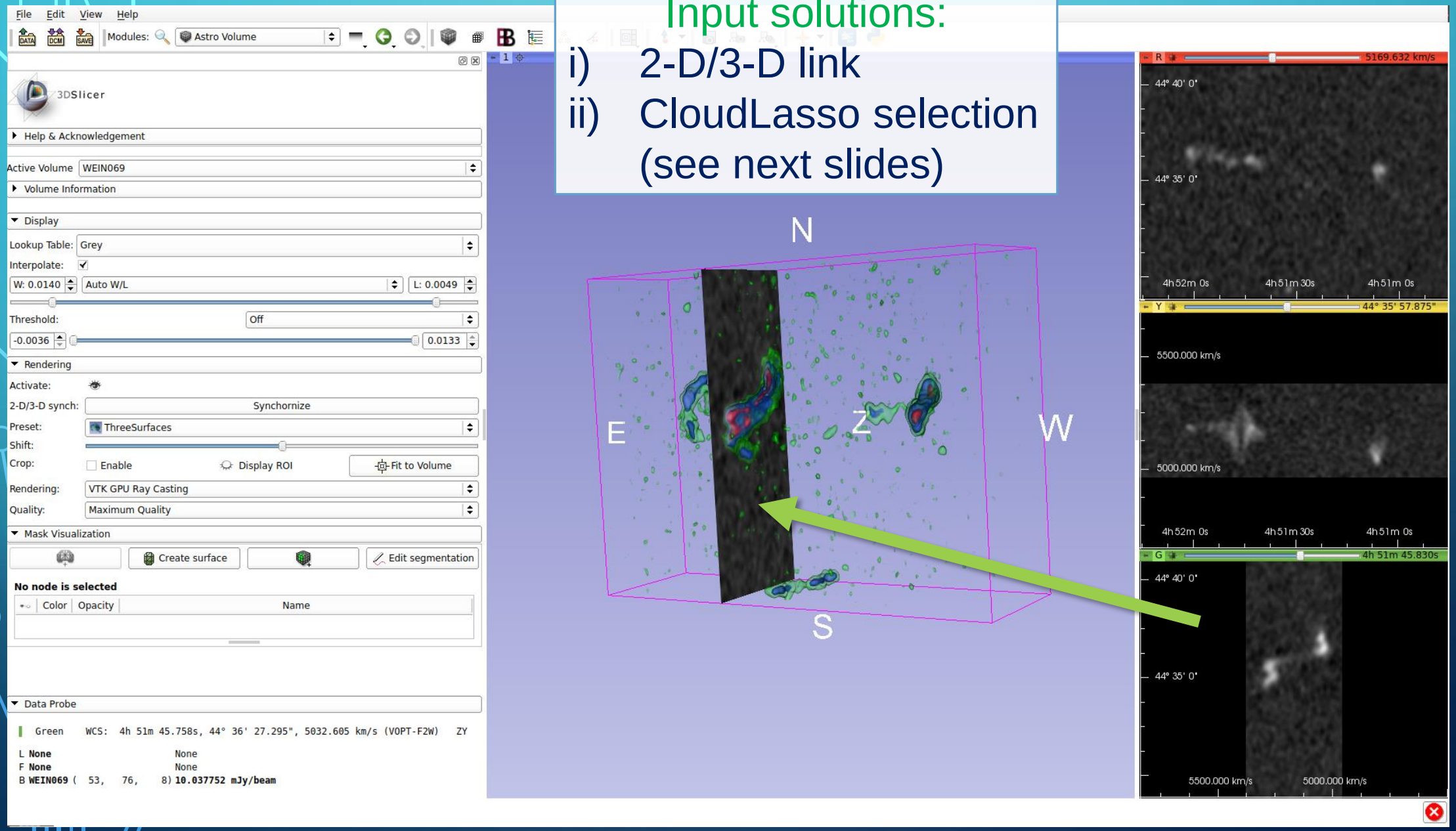


SlicerAstro: inspecting HI in a galaxy

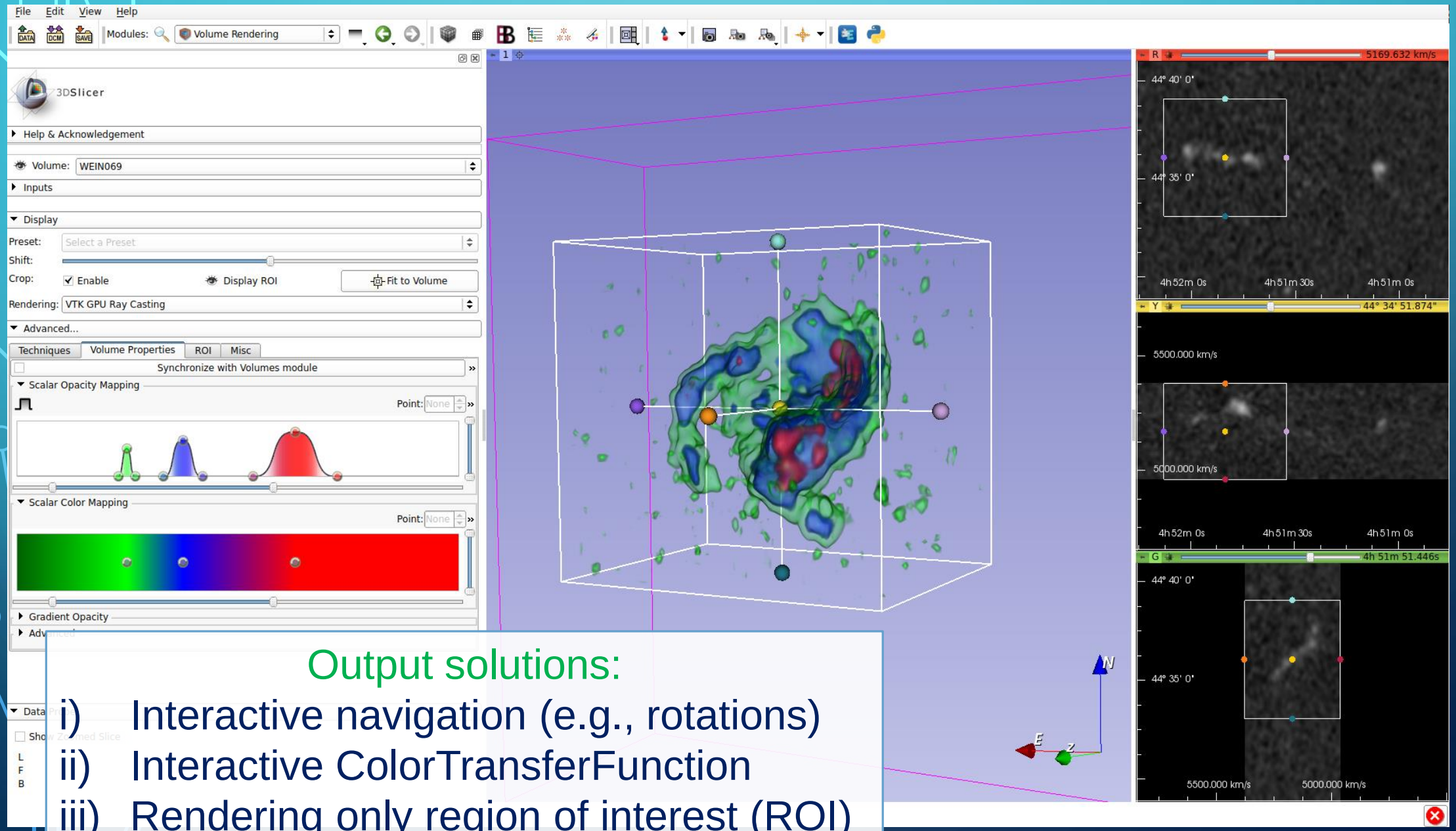
Input solutions:

i) 2-D/3-D link

ii) CloudLasso selection (see next slides)



SlicerAstro: inspecting HI in a galaxy



Output solutions:

i) Interactive navigation (e.g., rotations)

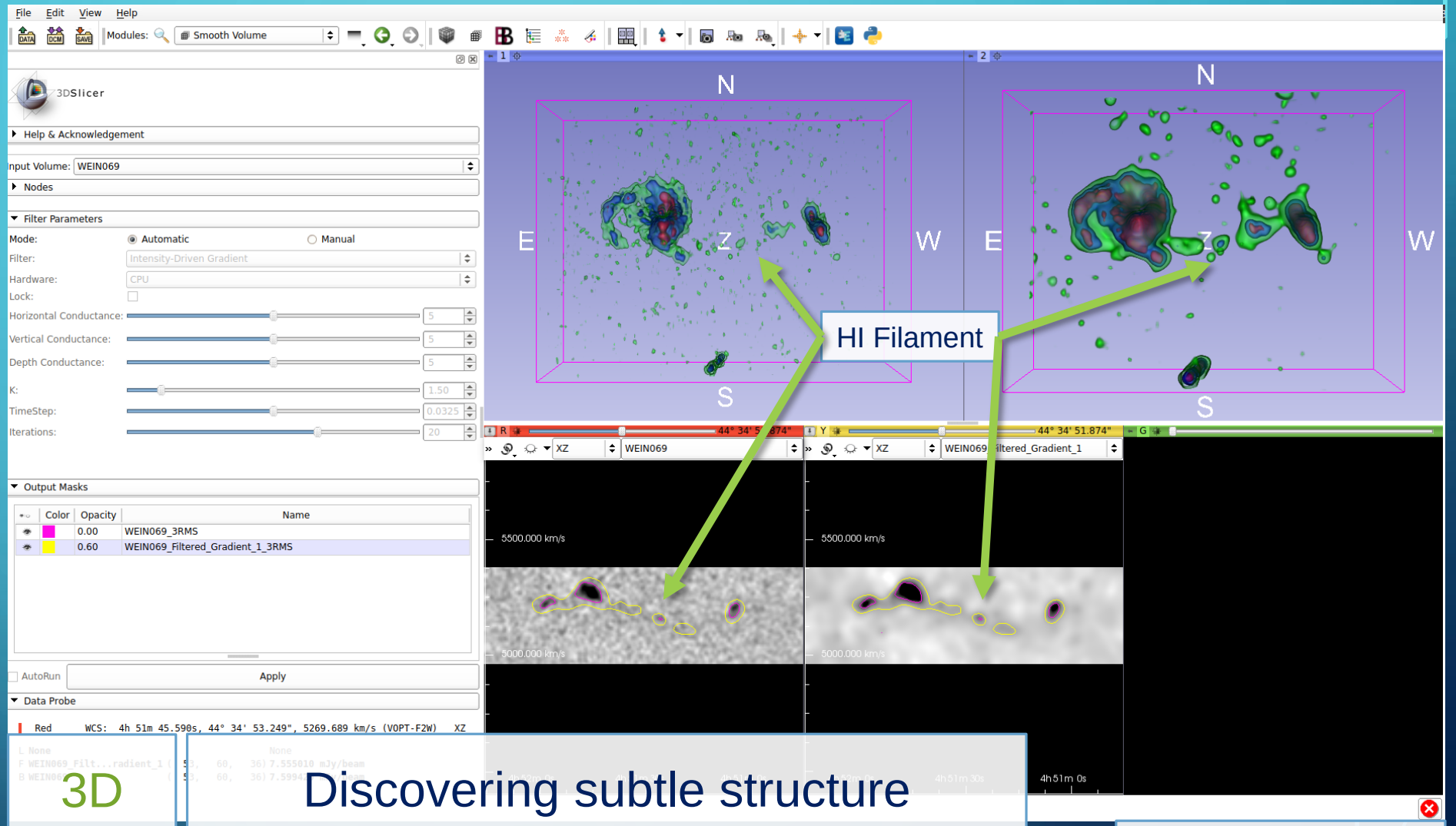
ii) Interactive ColorTransferFunction

iii) Rendering only region of interest (ROI)

SlicerAstro: inspecting a faint HI filament

CPU (OpenMP) / GPU(OpenGL) filtering techniques:

A	Box
B	Gaussian
C	Intensity-driven gradient



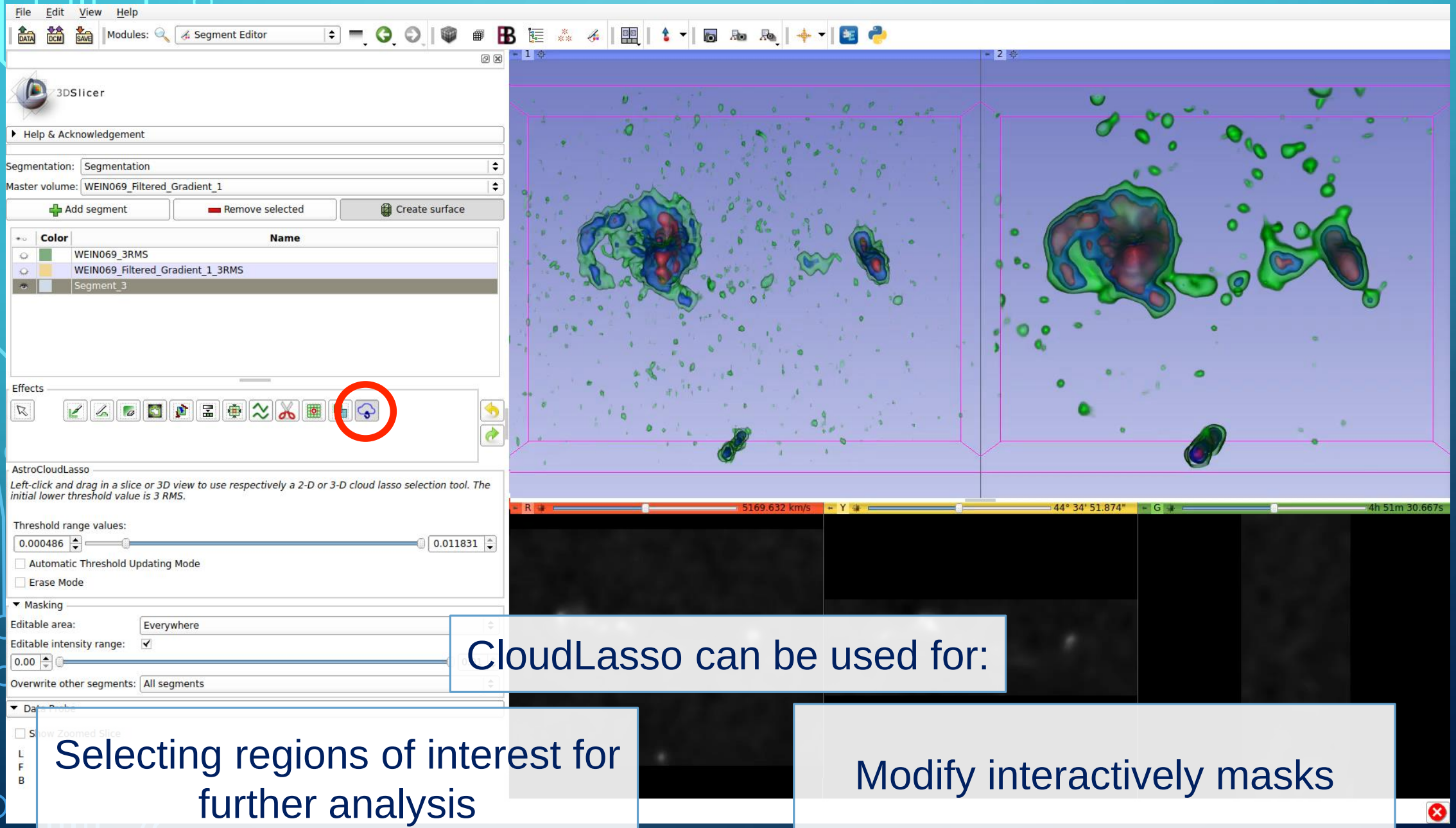
3D pros:

Discovering subtle structure (very low signal-to-noise ratio data).

Data by M. Ramatsoku

See also Punzo et al., *2016, Astronomy and Computing, 17, 163.*

3-D selection in SlicerAstro



CloudLasso can be used for:

Selecting regions of interest for further analysis

Modify interactively masks

3-D comparative visualization of models in SlicerAstro

3DSlicer

Help & Acknowledgement

Input Volume: WEIN069

Nodes

Input Mask

Model Fitting Parameters

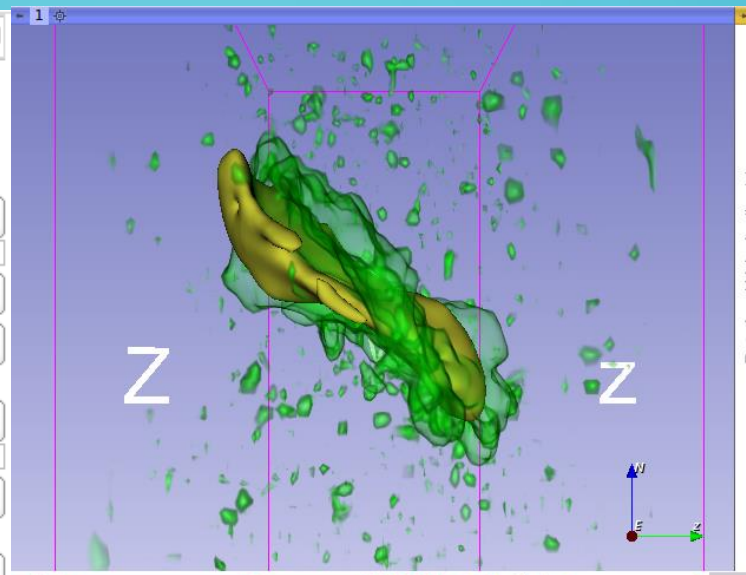
Output

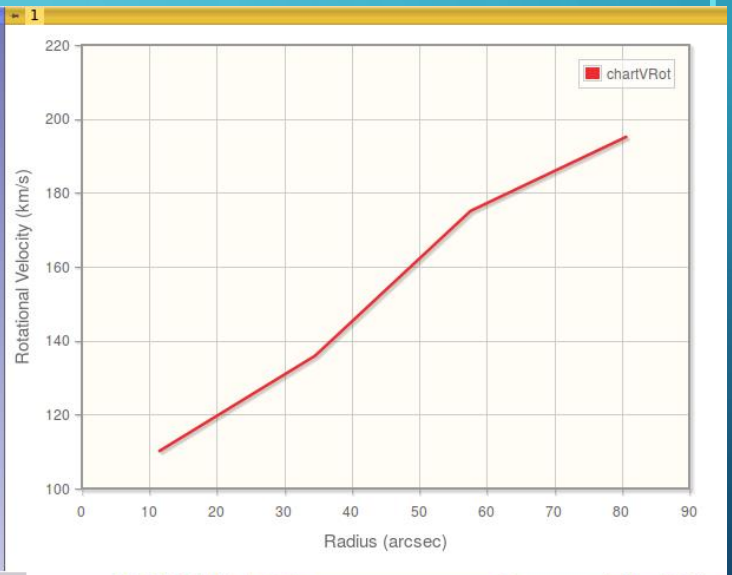
Contour level: 3.00 RMS

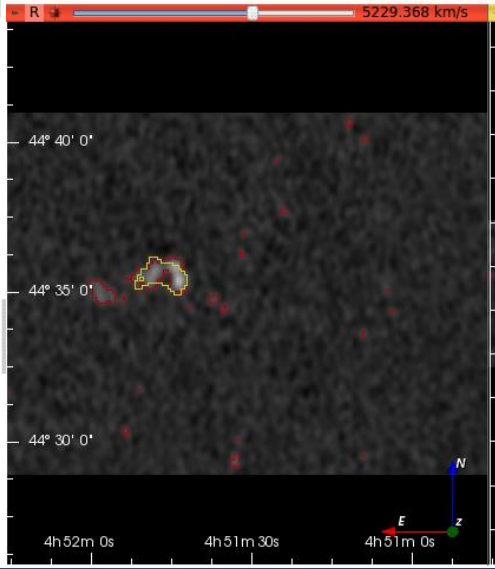
Visualize Model

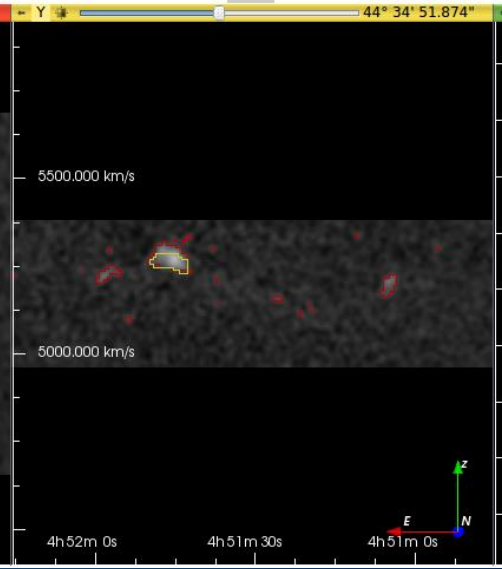
	Radius (arcsec)	VRot (km/s)	Inc (degree)	Phi (degree)	VSys (km/s)	VDisp (km/s)	C
1	11.52	110.159	40.3133	191.993	5086.73	8.54883	1
2	34.56	135.901	41.8284	186.599	5086.73	17.5959	1
3	57.6	175.081	40.7324	188.395	5086.73	6.69922	1
4	80.64	195.106	39.095	188.75	5086.73	6.45571	1

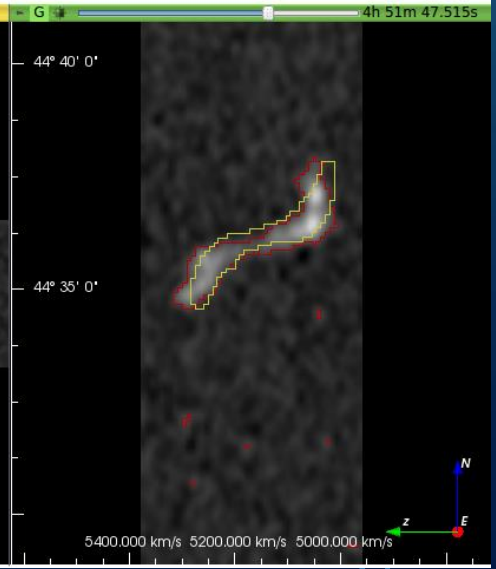
Calculate and Visualize Model



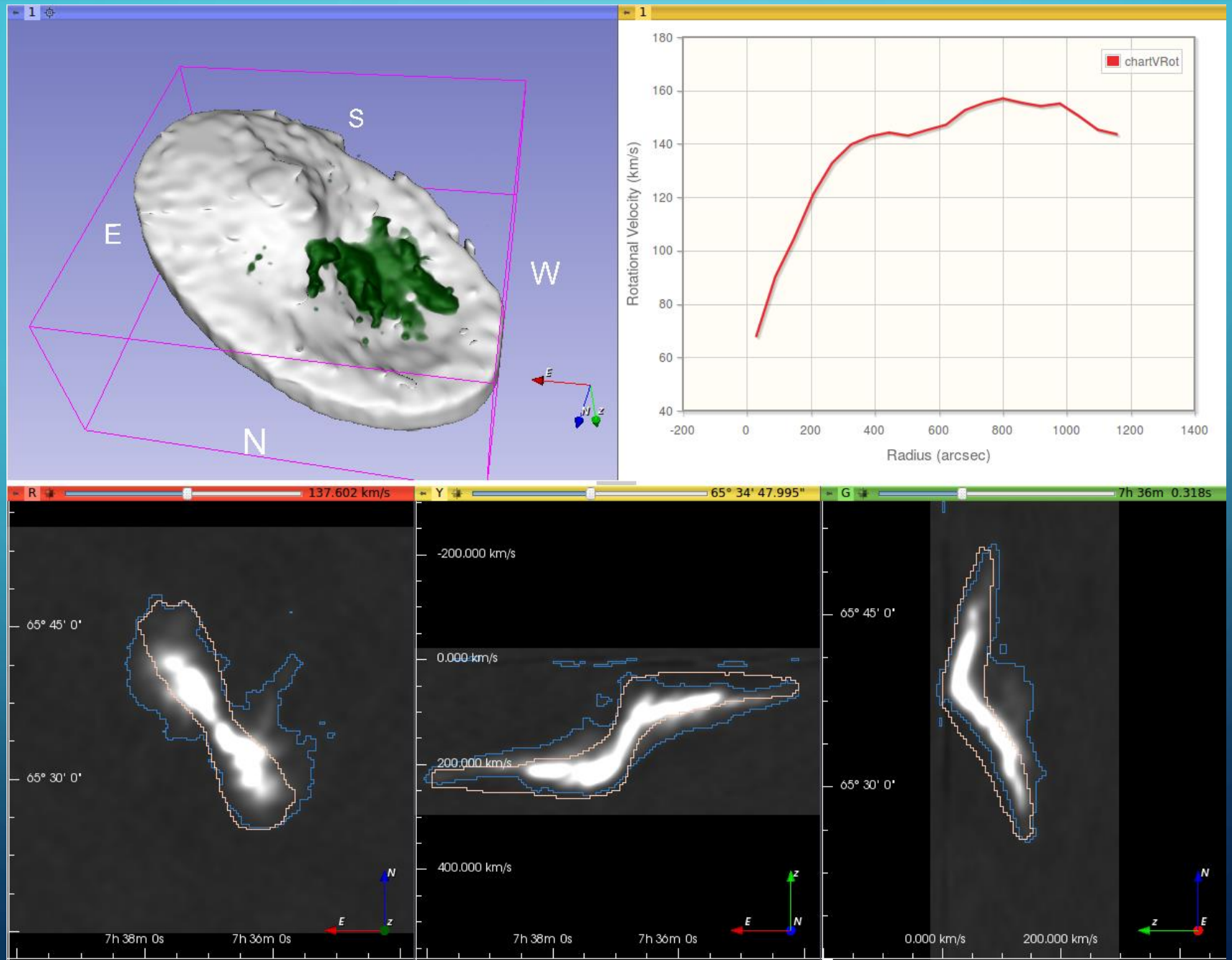








3-D comparative visualization of models in SlicerAstro



Ongoing work

SlicerAstro is under development:

our TO DO list

1. Live 1-D profiles;
2. Histograms and statistics;
3. Moments maps;
4. P-V diagrams;
5. Data-cube cropping;
6. Overlay data-cube with different WCS and gridding;
7. Virtual Observatory connection.

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AGILE approach:

Development cycle driven by the users!!!

Better interface friendliness

Bug corrections

Additional Features (e.g, analysis)

Final Remarks

A

The main aim of SlicerAstro is to aid source inspection and interactive analysis of spectral line data;

B

The 3-D visualization gives an immediate overview of coherent structures in space **and** velocity;

C

The 3-D visualization (coupled with filtering ad modeling) greatly helps the discovery of faint structures;

D

SlicerAstro source code available at:
https://github.com/Punzo/SlicerAstro

Binaries (Linux and Mac) available in the 3DSlicer Extension Manager
http://download.slicer.org/

We thank S. Pieper (Isomics), A. Lasso (Queen's University) and K. Martin (Kitware) for their feedback and help.