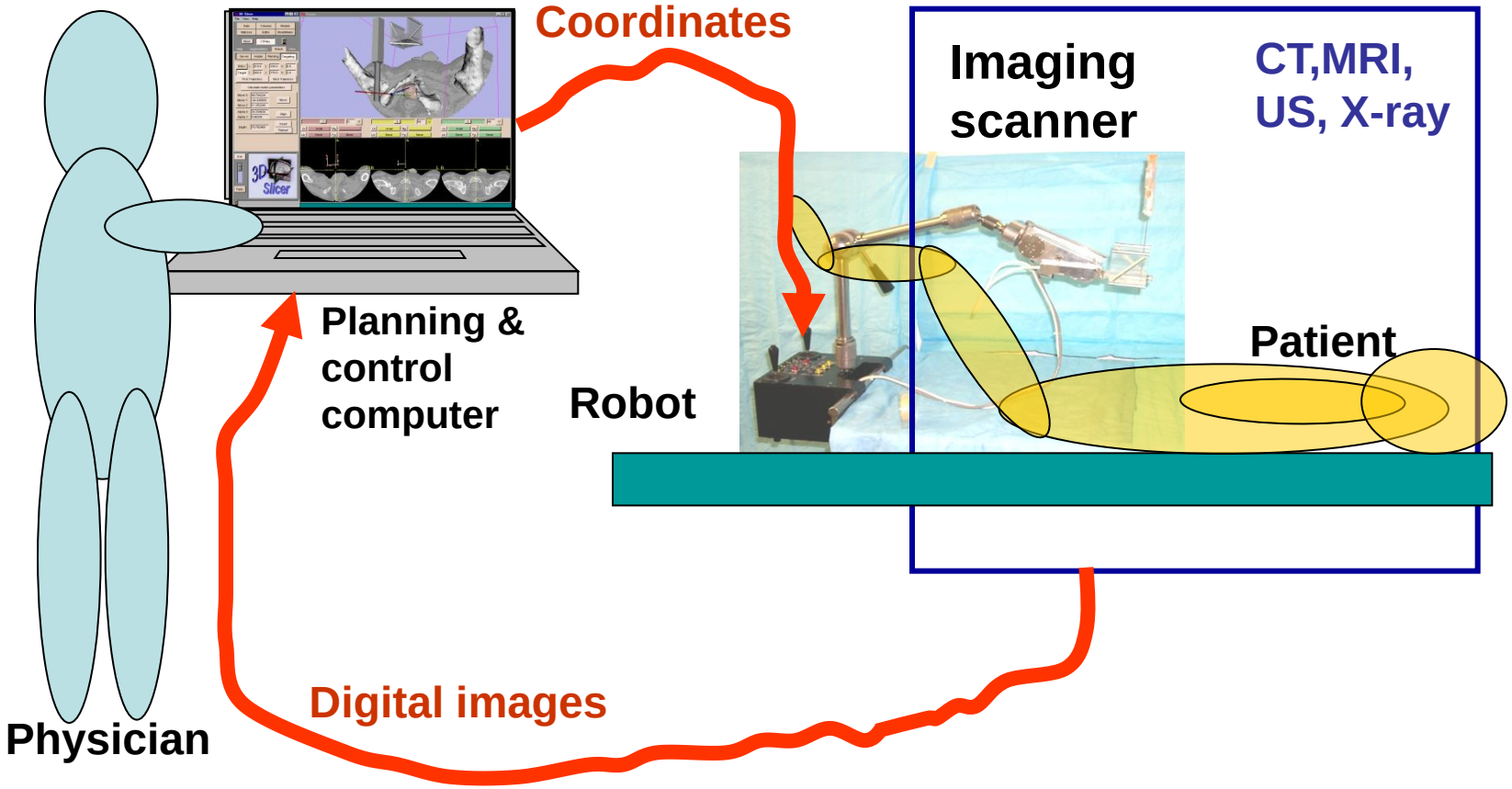
NA-MIC
National Alliance for Medical Image Computing
http://na-mic.org

Coming of age for a NA-MIC DBP

Gabor Fichtinger, Andras Lasso, Tamas Ungi, Csaba Pinter, Tomi Heffter, Sid Vikal, David Gobbi, and Attila Tanacs

Queen's University, Canada

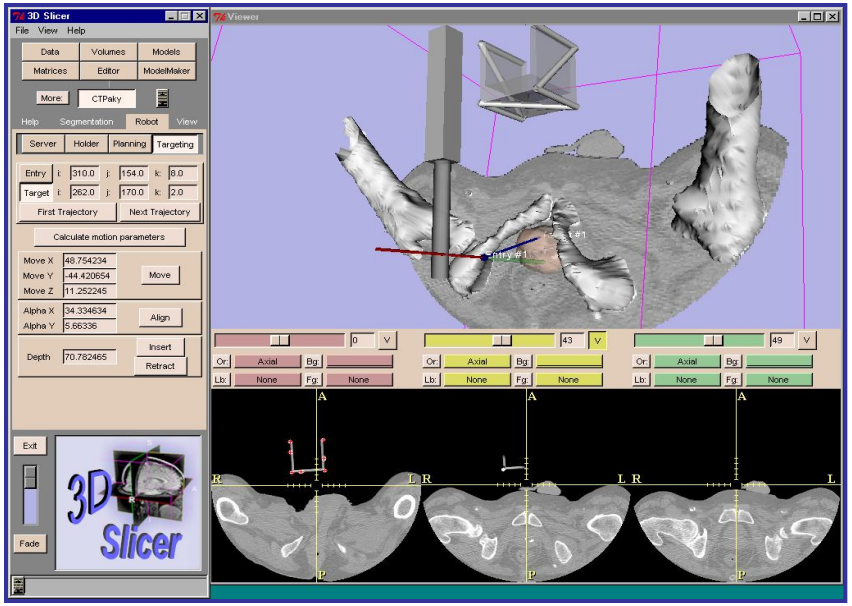
In-situ image-guided surgery

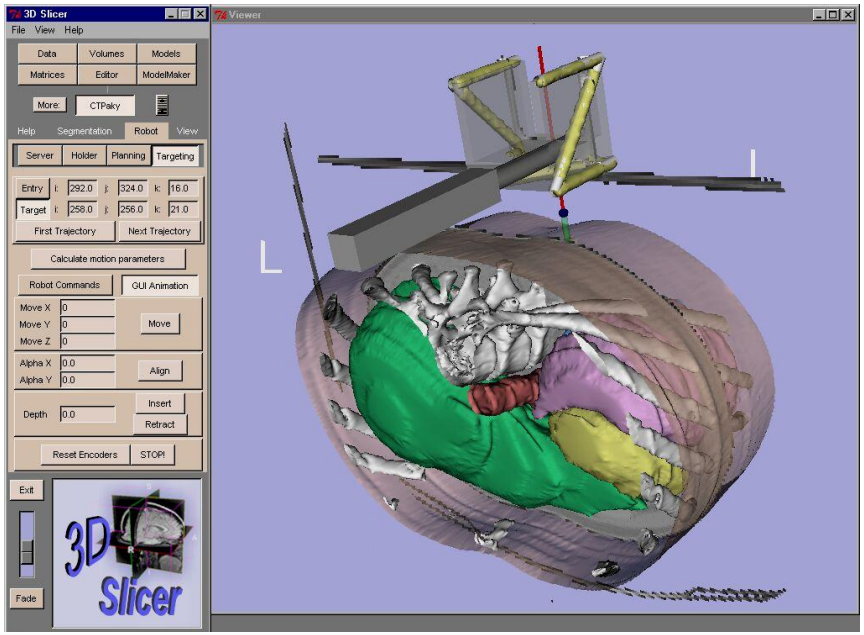


First implementation

Fichtinger et al. Acad Rad, 2002

First implementation





Tanacs, 2002

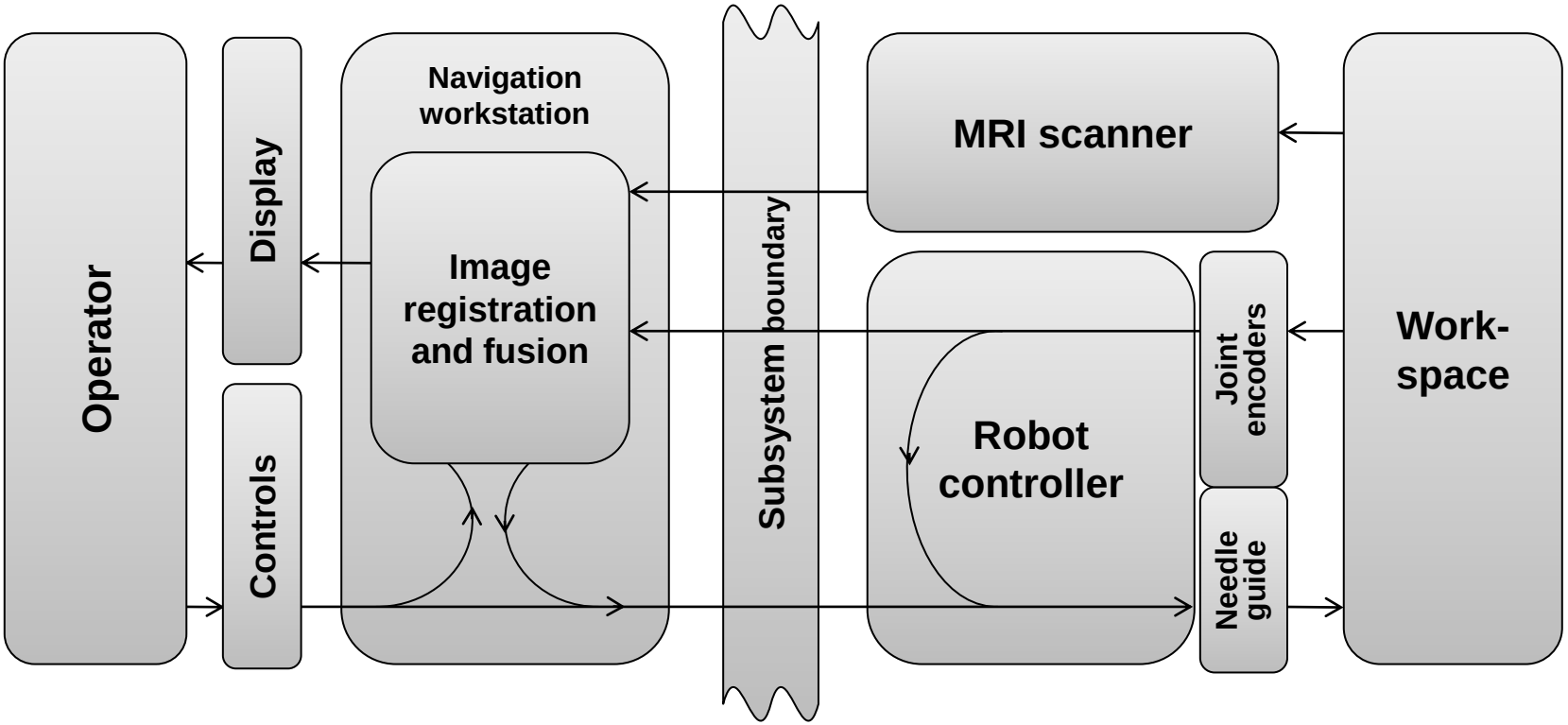
Hypothesis

It is possible to architect IGS systems that, to a large extent, are invariant to imaging modalities, scanners, trackers, and surgical devices, and even to anatomical sites and diseases.

Goals as a NA-MIC DBP

- Develop generic IGS platform on Slicer
- Apply it in image-guided needle surgery
  - Robot-assisted prostate interventions
  - Spinal interventions
- Go clinical

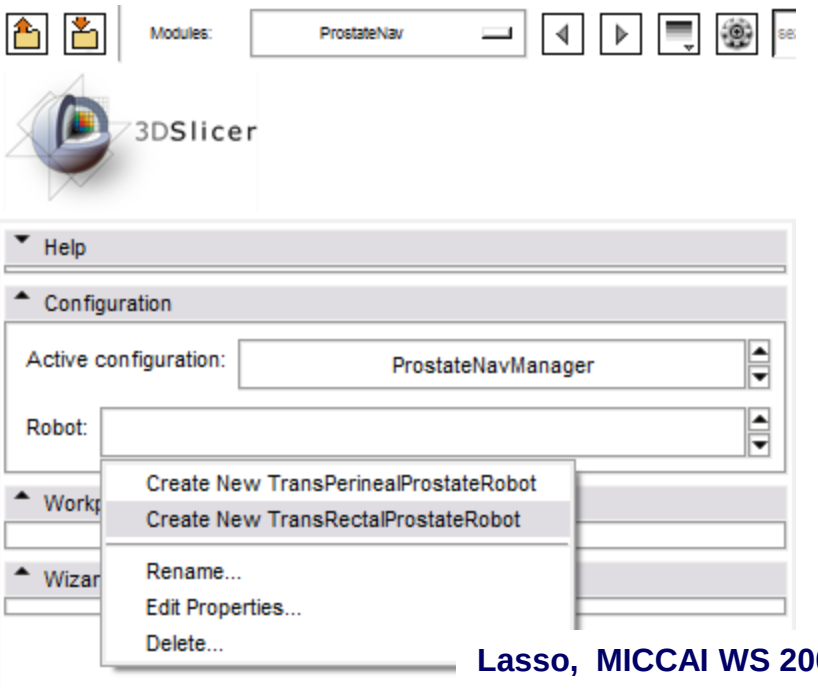
Heterogeneous human supervisory control (HHSC)



Lasso, 2012

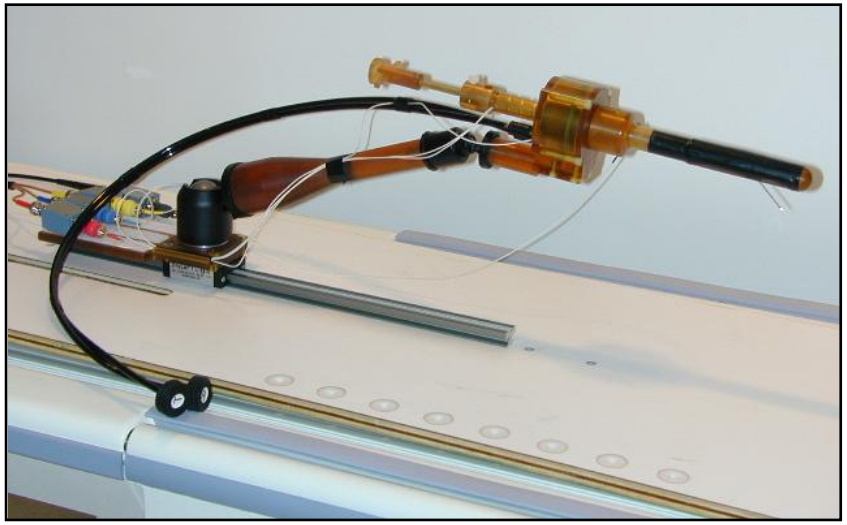
Robotic prostate biopsy in MRI

Configurable to multiple robot systems



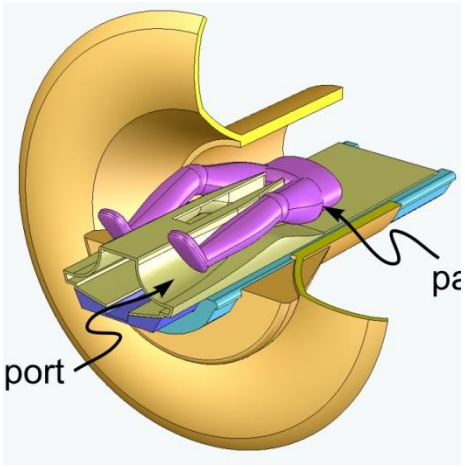
Lasso, MICCAI WS 2009

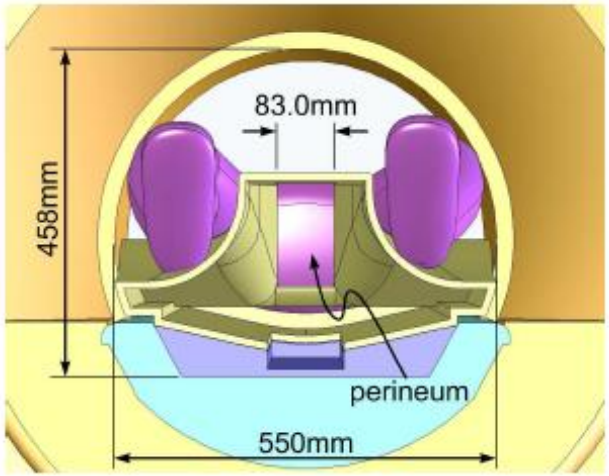
Transrectal system at JHU/NIH



Krieger *et al.* IEEE TMBE, 2005
(Best paper in 2005-2009)

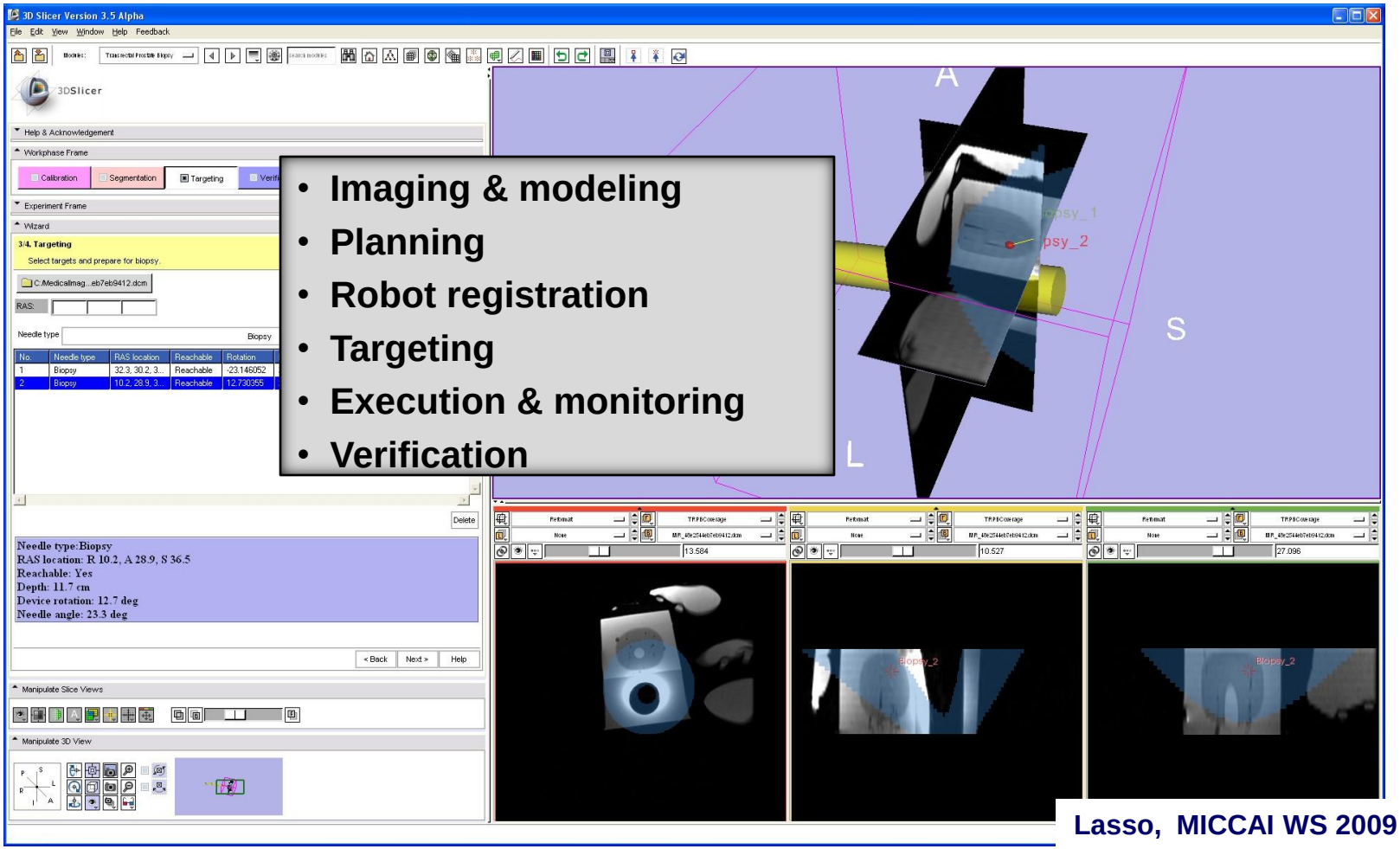
Transperineal system at BWH





Fischer *et al.* IEEE ASME, 2007
Song et al, IJCARS 2011

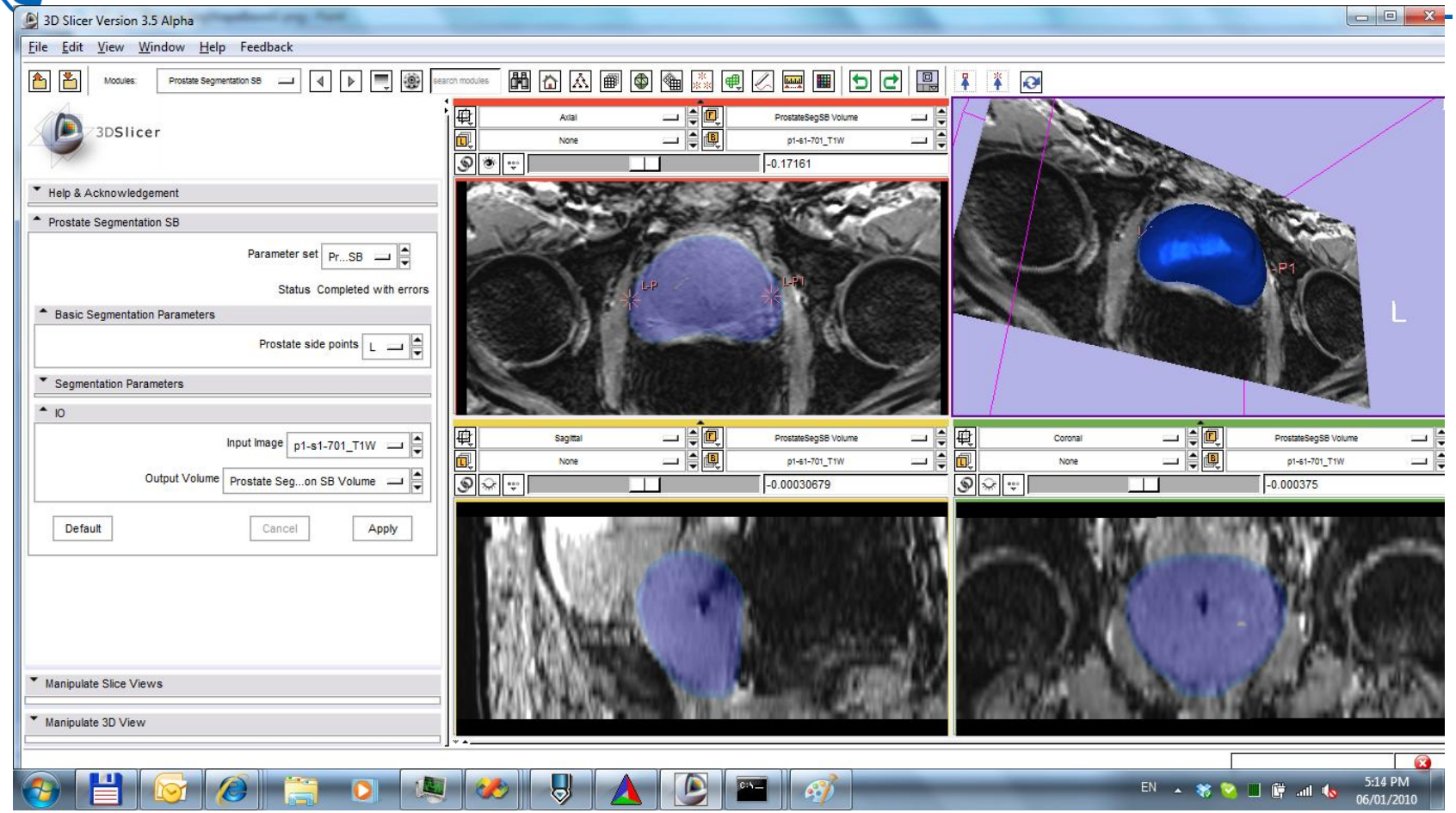
Workflow definition



- Imaging & modeling
- Planning
- Robot registration
- Targeting
- Execution & monitoring
- Verification

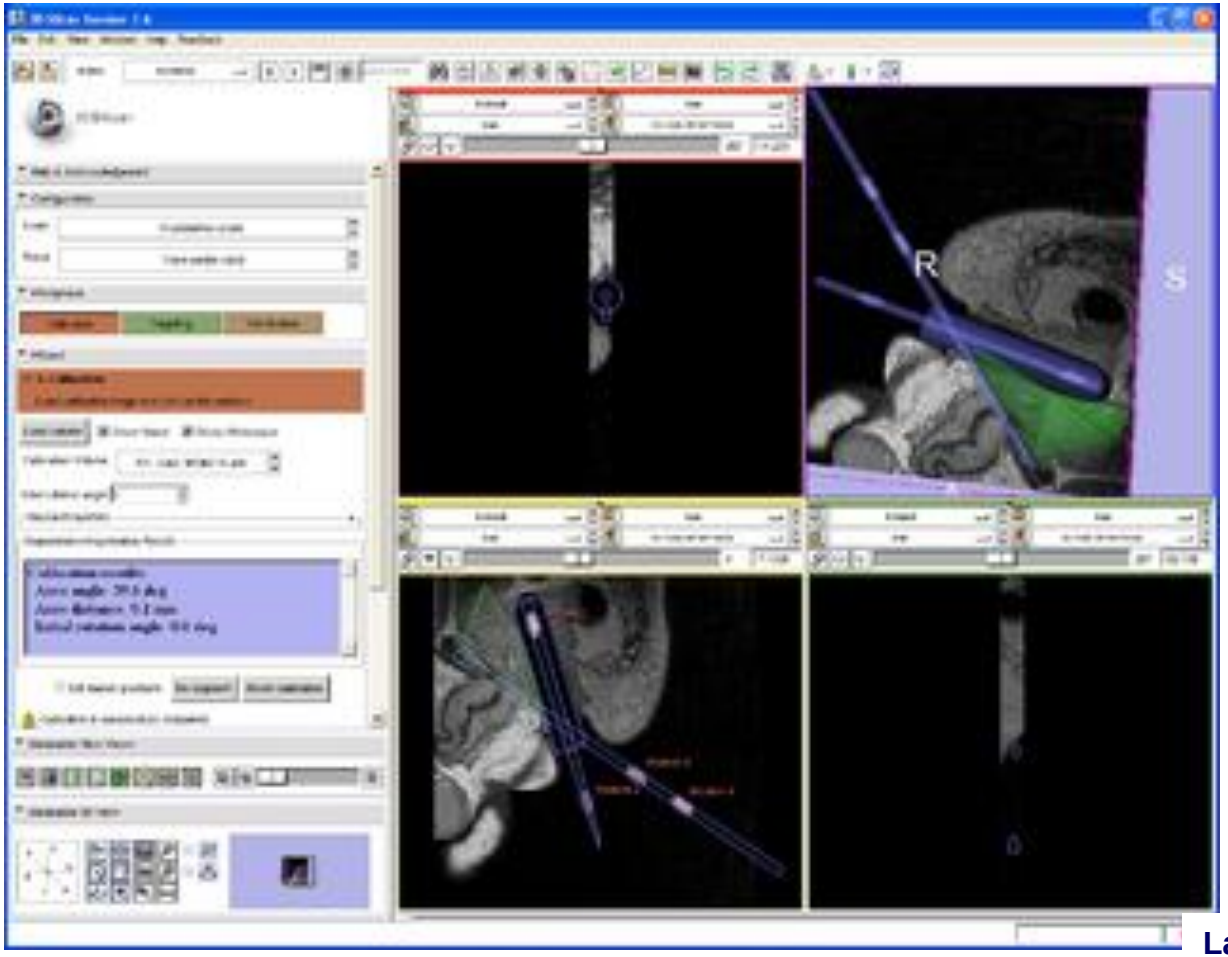
Lasso, MICCAI WS 2009

Modeling and planning



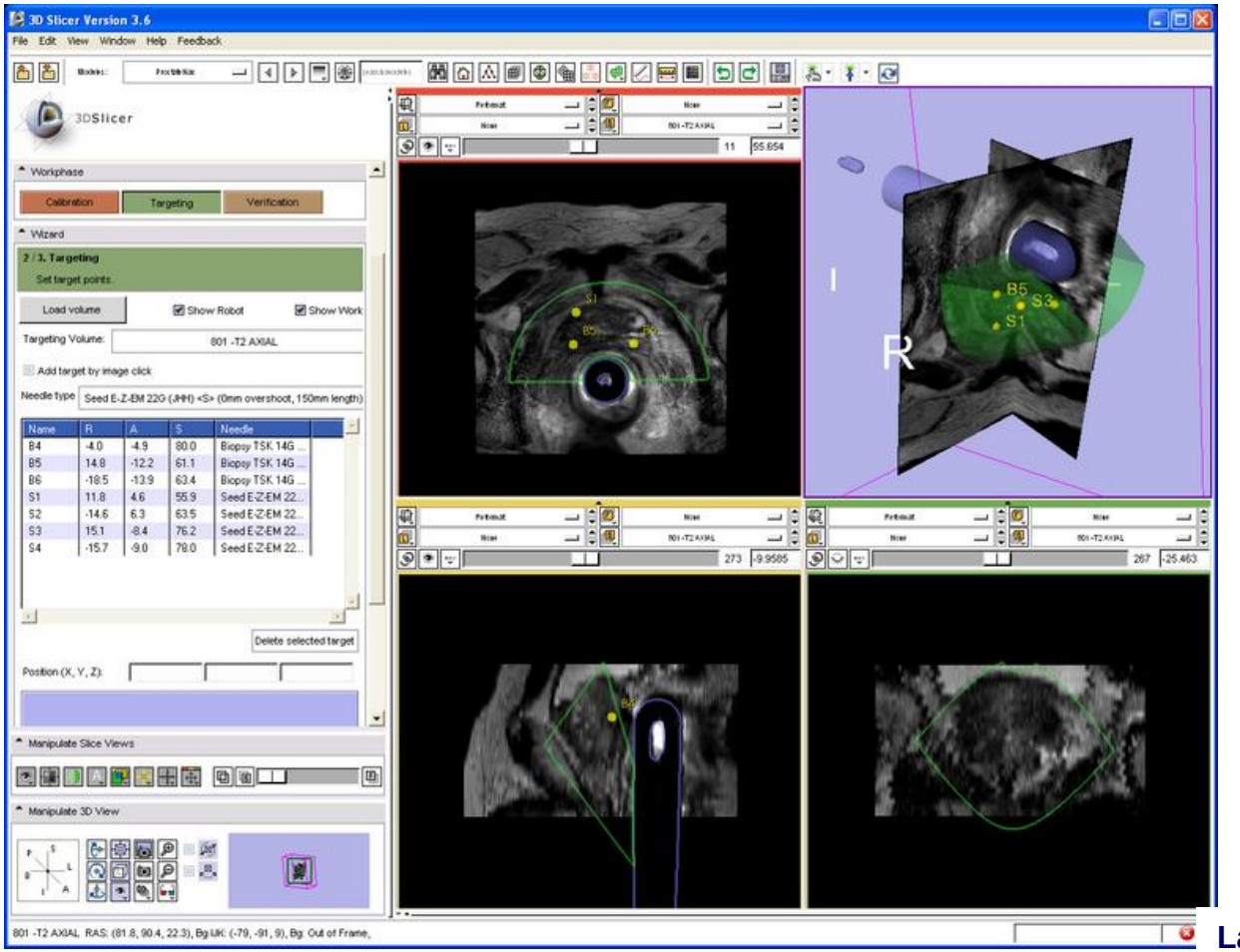
Gao, Tannenbaum *et al.* IEEE TMI 2010

Robot registration



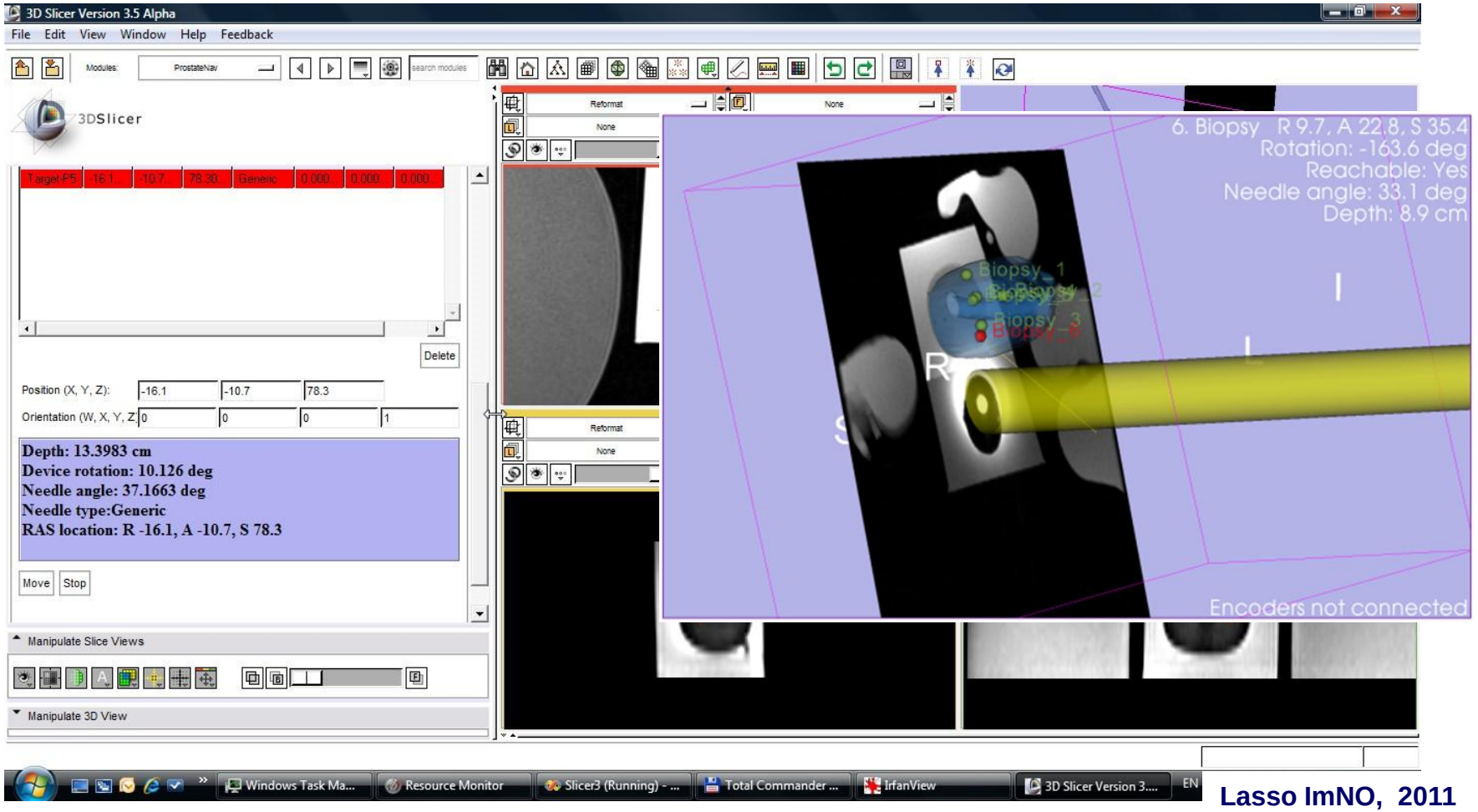
Lasso ImNO, 2011

Targeting the biopsy sites



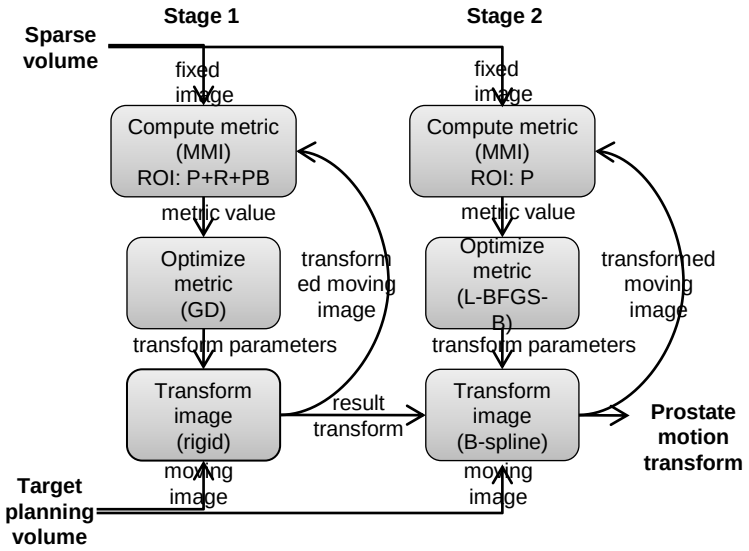
Lasso ImNO, 2011

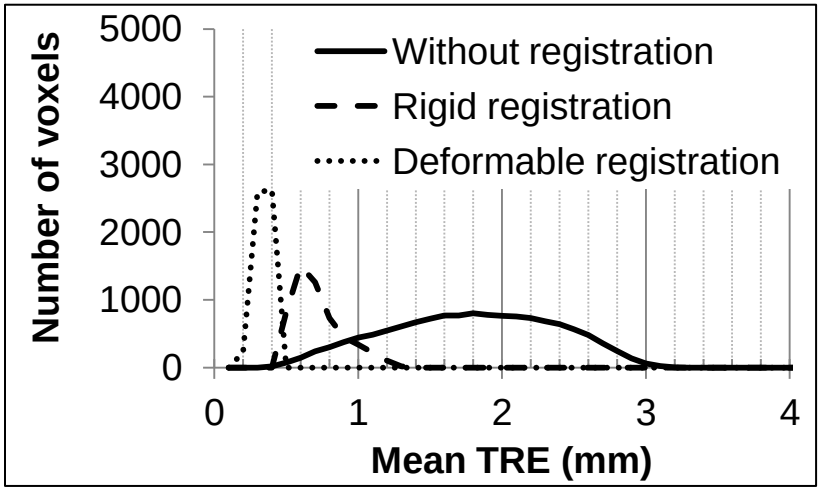
Monitoring in 2nd display

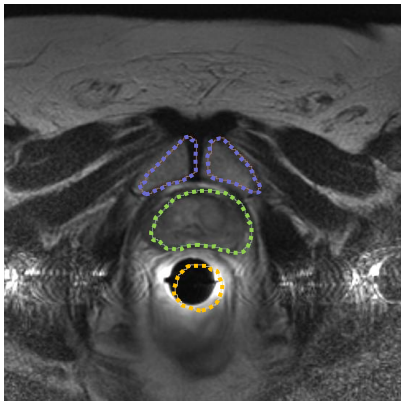


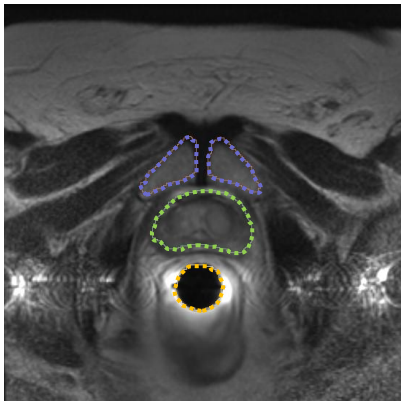
Lasso ImNO, 2011

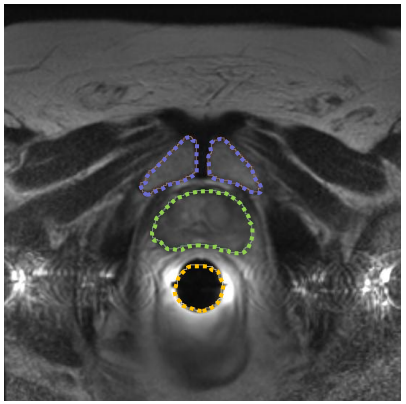
Motion tracking

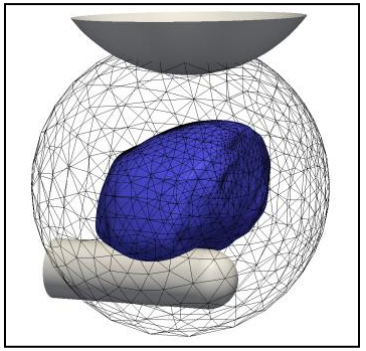






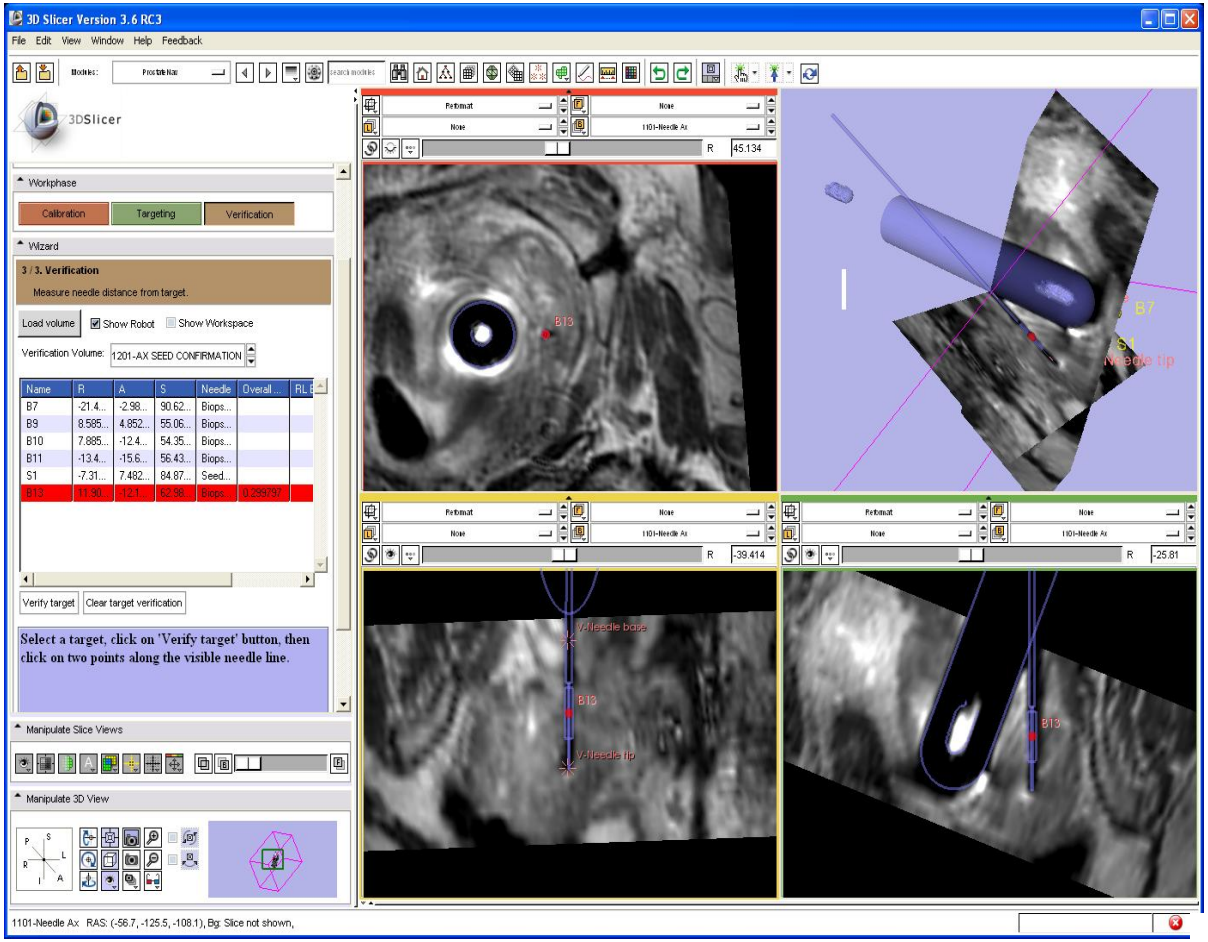






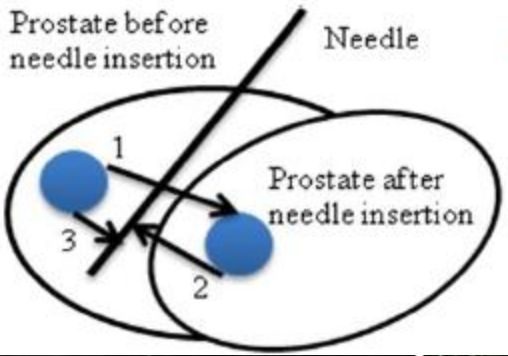
Tadayyon *et al*. IEEE TBME 2011
Lasso 2012

Verification

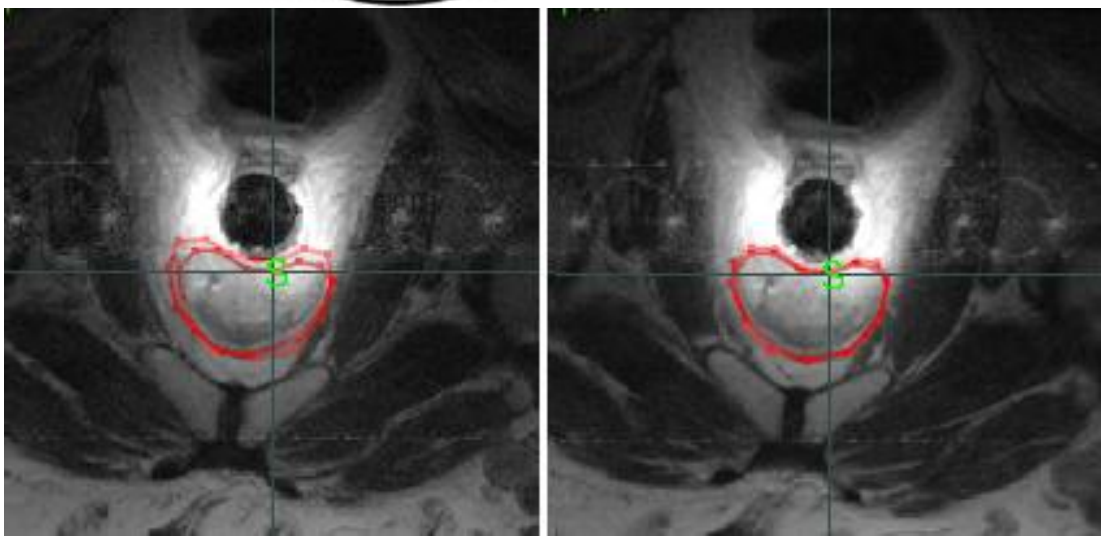


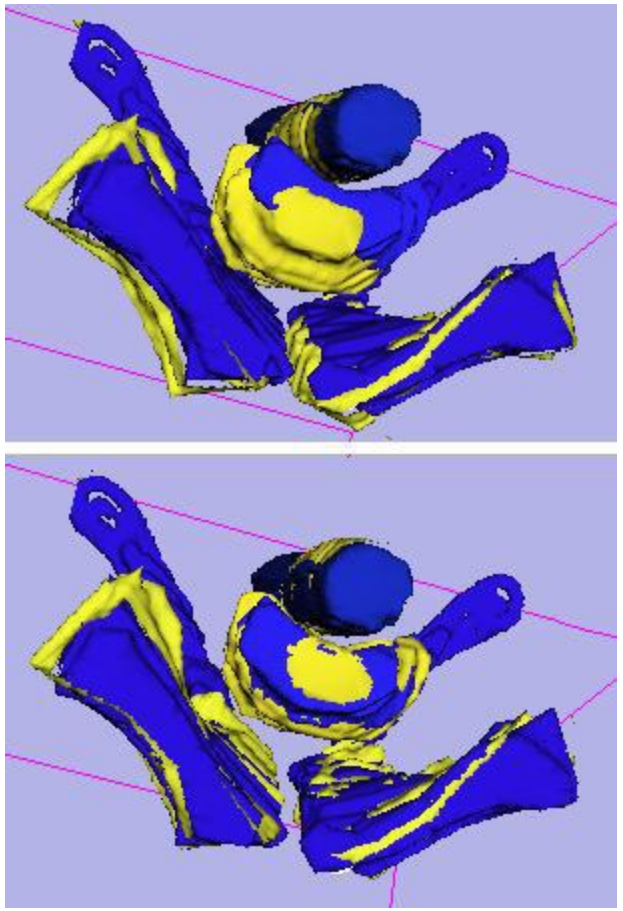
Lasso ImNO, 2011

Clinical trial analysis



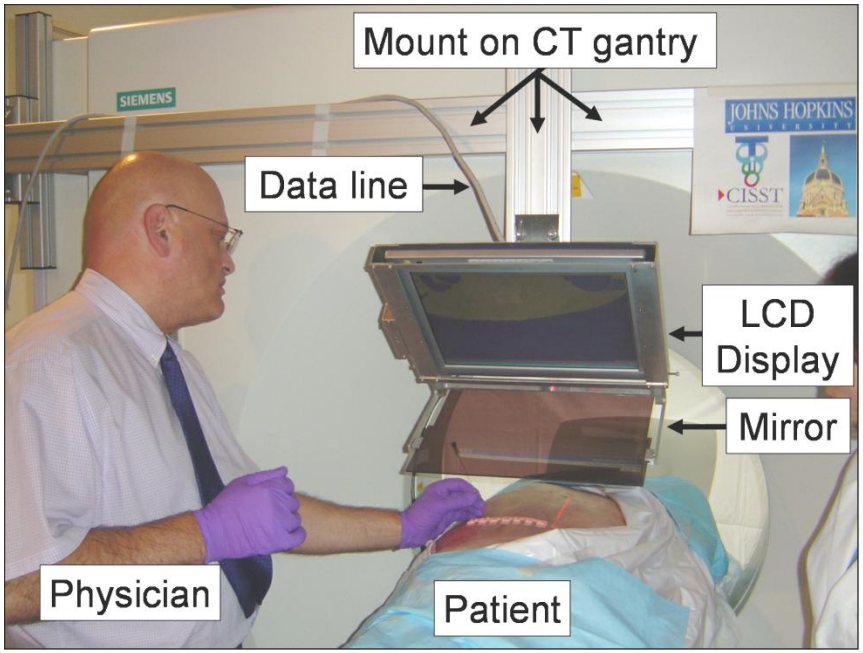
Target
1 - Target displacement
2 - Biopsy error
3 - Needle placement error

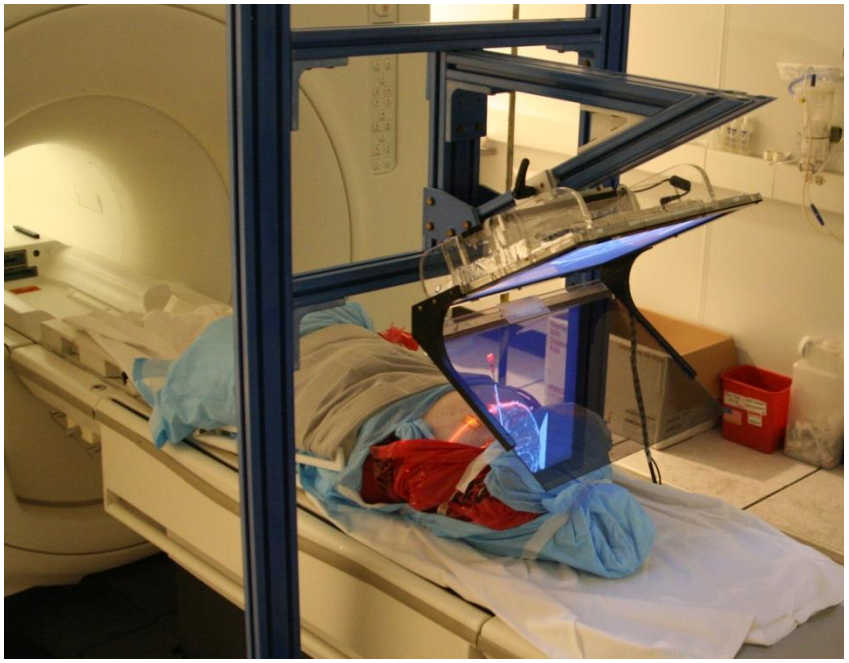




Xu *et al.* MICCAI, 2010

Augmented reality guidance

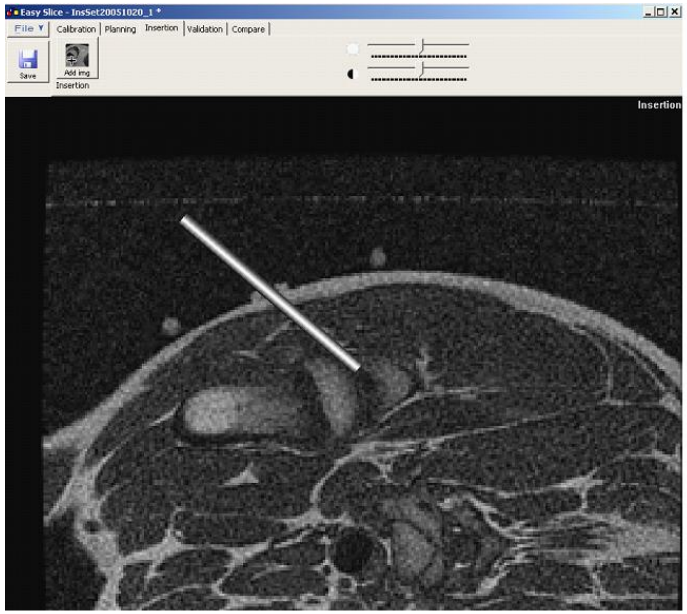




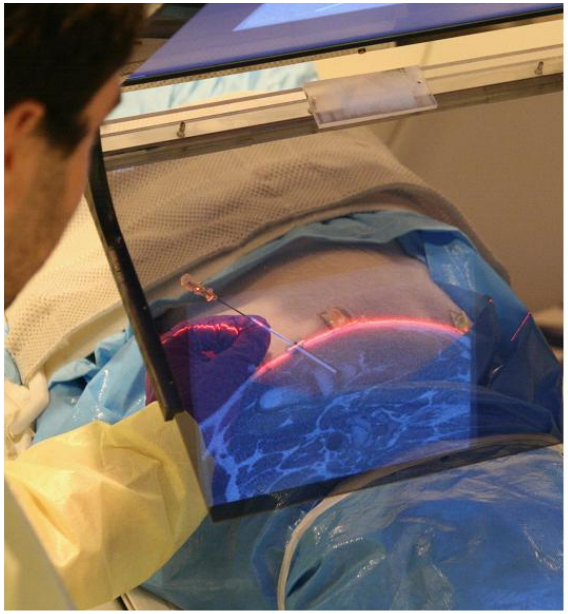
Fichtinger *et al.* IEEE TMBE, 2005

Fischer *et al.* JCAS, 2007

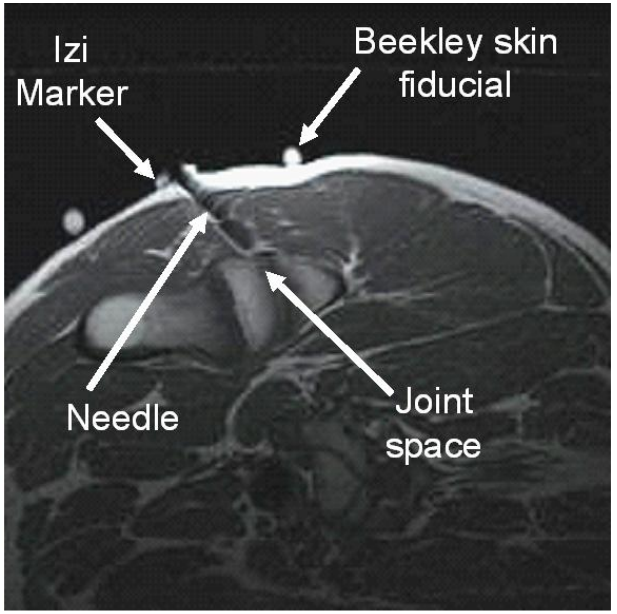
Clinical workflow



Planning



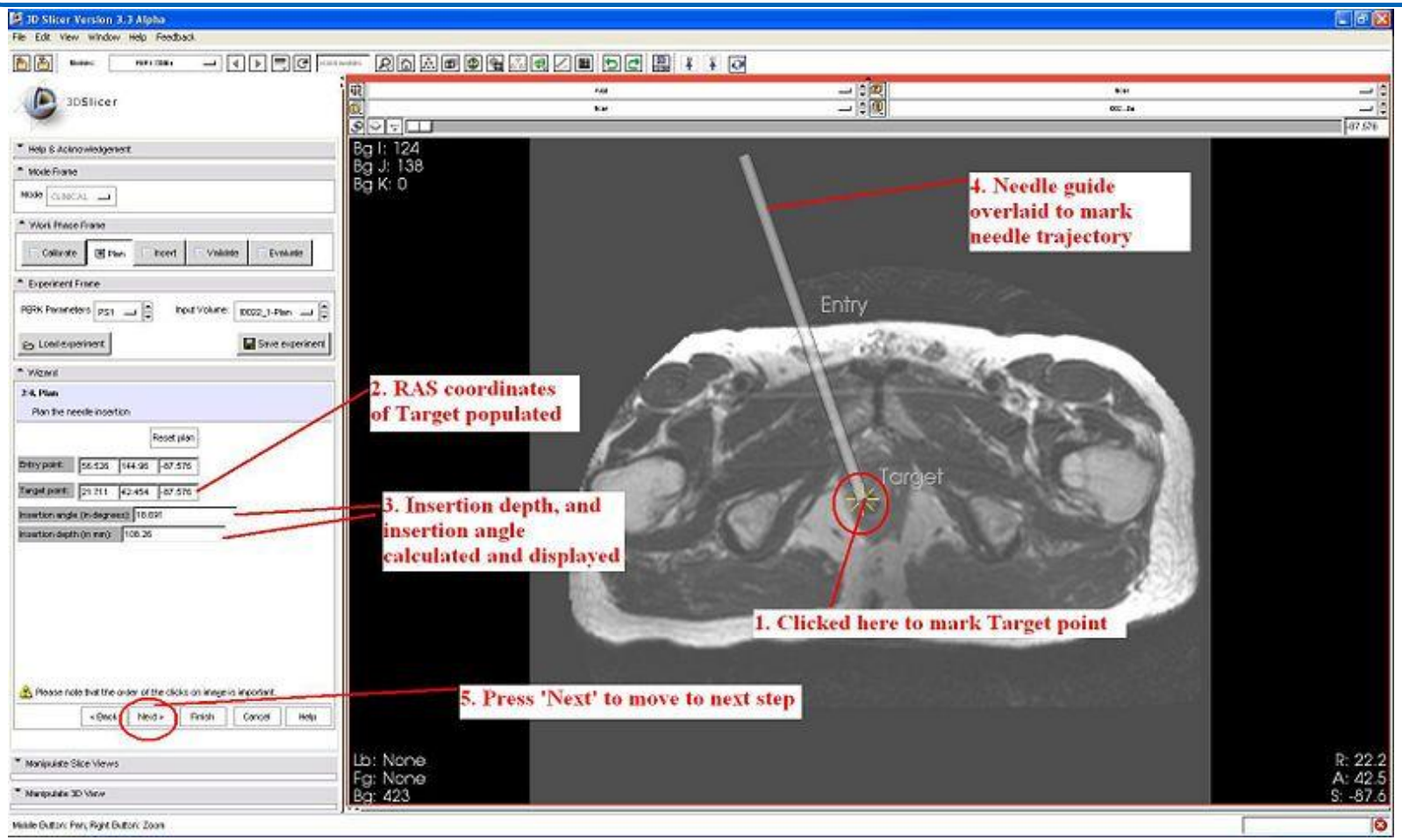
Insertion



Validation

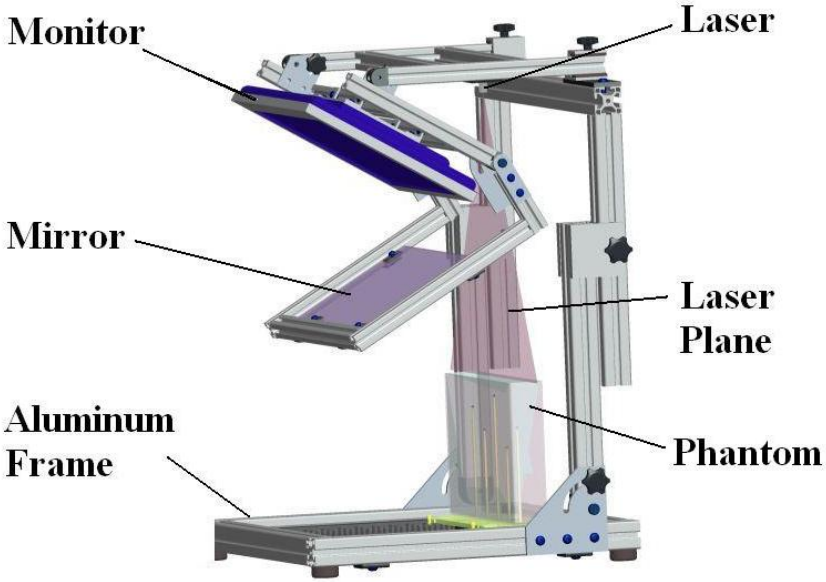
Fischer *et al.* JCAS, 2007

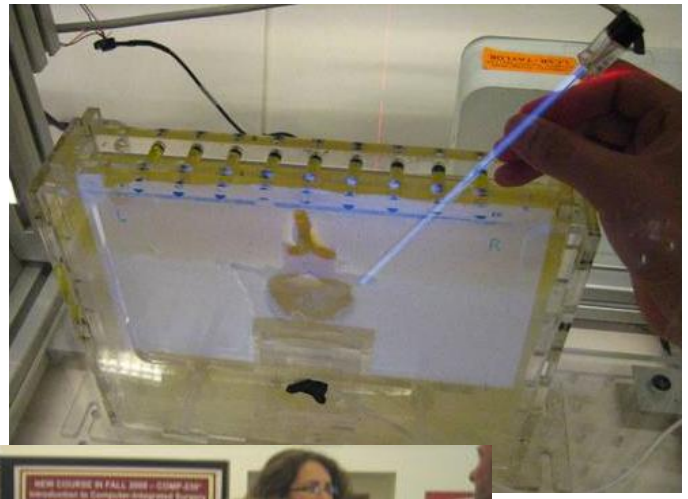
Slicer interface



Vikal *et al.* CMIG, 2009

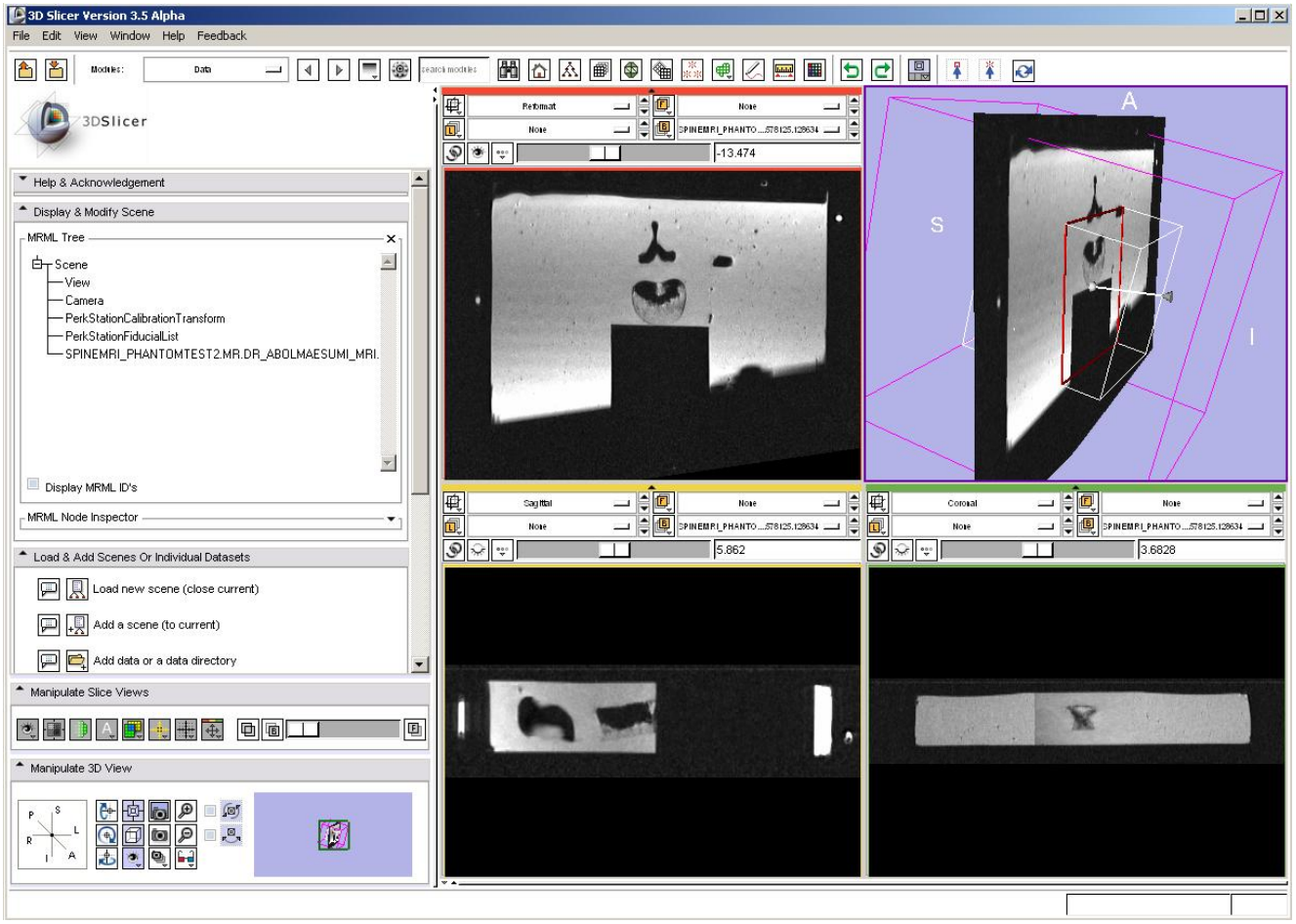
The Perk Station





Vikal *et al.* CMIG, 2009

Perk Station interface



Vikal *et al.* CMIG, 2009

What we learned from NAMIC

- Open source collaborative development pays off in the end only
- It needs people of the same mind, passion and vision – very difficult to come by
- Spending NAMIC funds solely on engineering was a wise and necessary decision
- Work with your friends

Graduation plan

- Form the “Canadian NAMIC”
- Concentrate on IGS and translational clinical engineering
- Work with NAMIC, the older and wiser brother
- Set the rules
- Choose the right partners
- Get funded

SPARKit – Software Platform and Adaptive Radiotherapy Kit

- Affiliated with OCAIRO (Ontario Consortium for Adaptive Interventions in Radiation Oncology) of +20 industry-funded investigators
- Funded by Cancer Care Ontario as a Applied Cancer Research Unit
- Shared, reusable and customizable software infrastructure to assist clinical translation of experimental diagnostic and therapeutic approaches
- The scope of SPARKit is IGRT & associated IGS procedures

SPARKit partners & rules

Partners

- Queen's University, Kingston (Gabor Fichtinger, PI)
- Robarts Research Institute, London (Terry Peters)
- Princess Margaret Hospital, Toronto (David Jaffray)

Rules

- Open to buy-in by other groups (up to our funding limit)
- All money goes to clinical application engineering
- 3D Slicer is mandatory
- Trials, algorithm development etc. must be funded separately

SPARKit engineering staff

Queen's University, Kingston

- **Andras Lasso, Tamas Ungi, Csaba Pinter**

Robarts Research Institute, London

- **Elvis Chen**

Princess Margaret Hospital, Toronto

- **Kevin Wang**
  - **50% SPARKit & 50% other grants**
    - **All present at AHM**

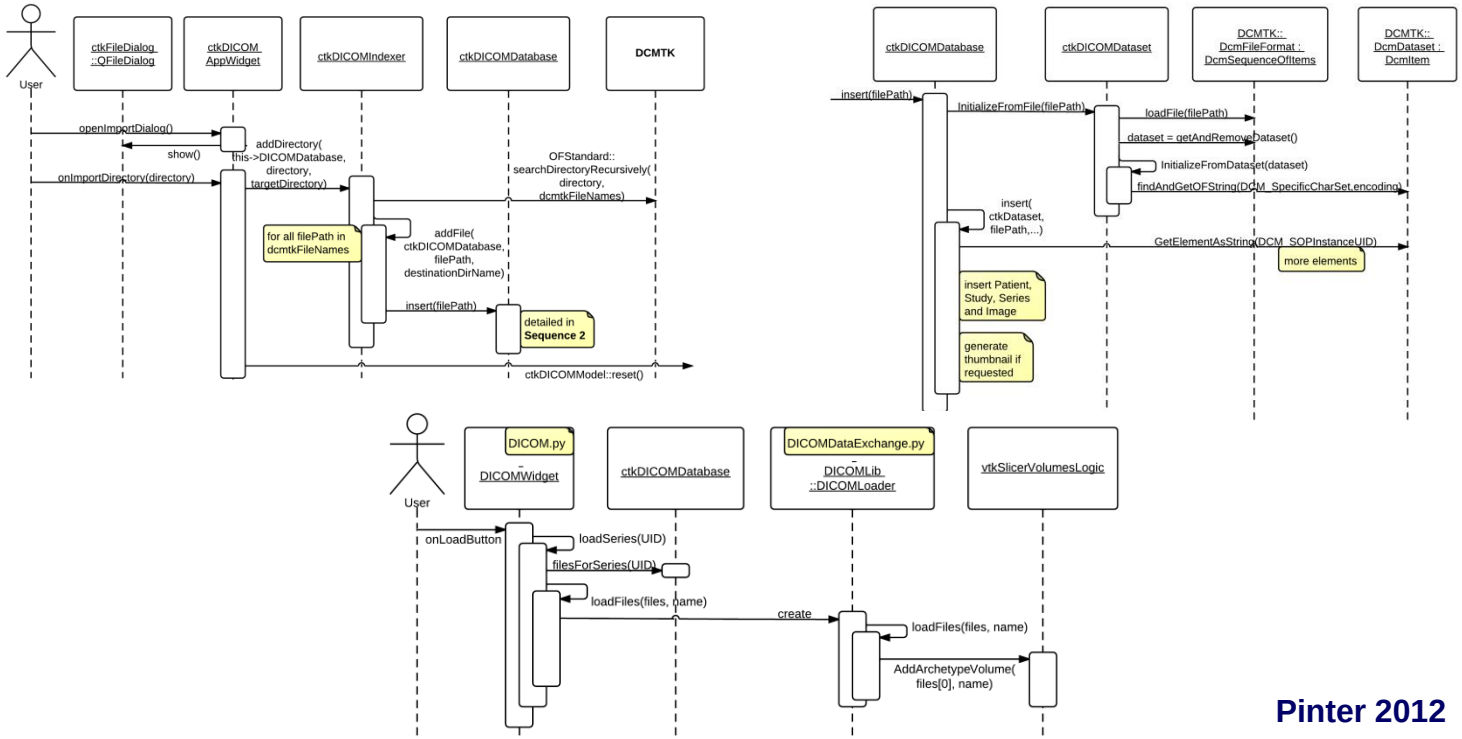
SPARKit projects

- MRI-guided prostate interventions ✓
- MR image overlay guidance ✓
- Slicer Radiation Therapy
- Ultrasound calibration
- Ultrasound-guided needle placements
- Percutaneous needle placement training

Slicer Radiation Therapy

Csaba Pinter, Andras Lasso, Kevin Wang

- Address common needs of OCAIRO investigators
- DICOM RT I/O in Slicer-4 to provide dose maps, contours, DVH…



Pinter 2012

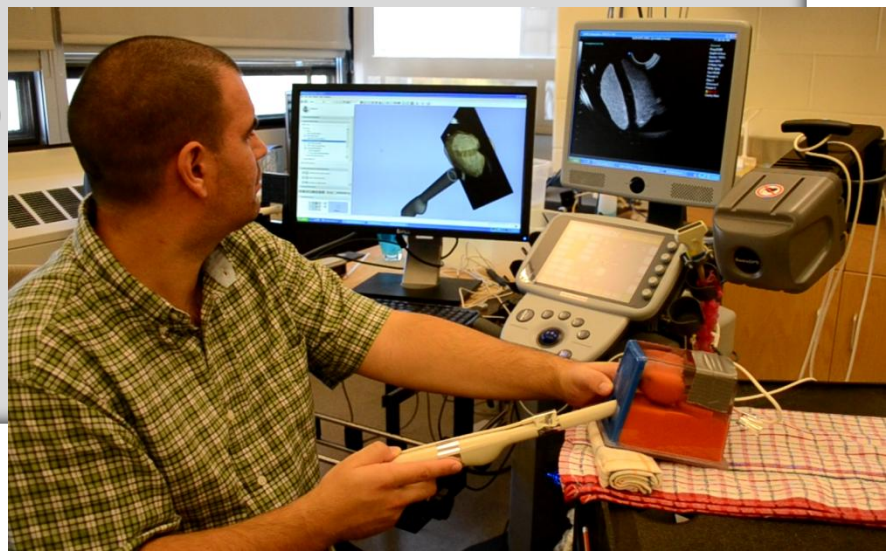
Public Library for Ultrasound

SparKit

Andras Lasso, Csaba Pinter, Tamas Ungi

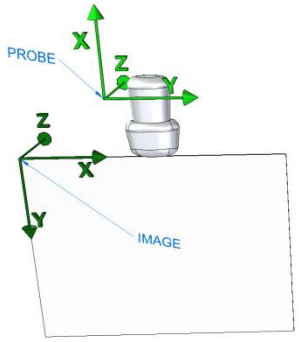
- Goal: Facilitate rapid clinical application prototyping of ultrasound-guided interventions
- Google Scholar on “tracked ultrasound” about 48,000 hits
- Scope: tracked ultrasound calibration, data acquisition, processing, and streaming
- Open-source (since October 2011)
- BSD license, no strings attached
- Users: UBC, Robarts, planned at

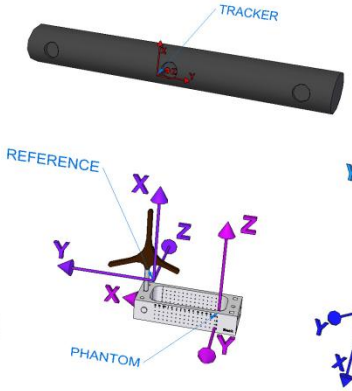
  JHU, BWH, PTI/AMS

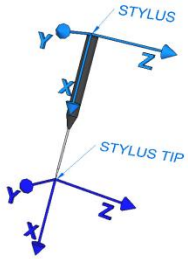


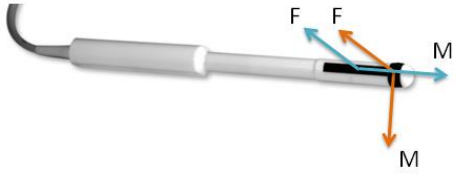
Ungi et al. 2012

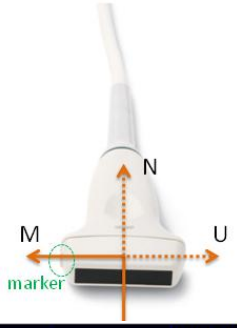
Why is ultrasound difficult?



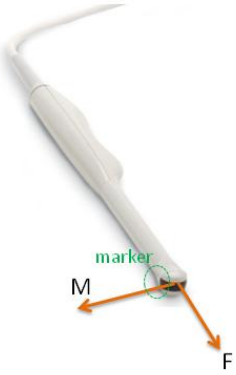


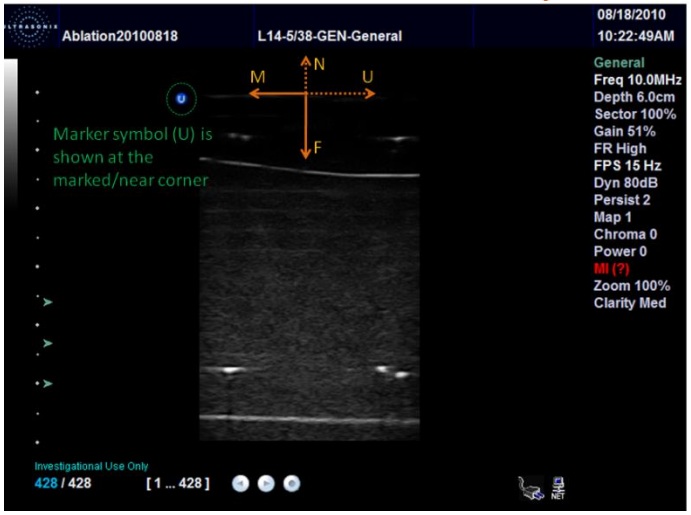






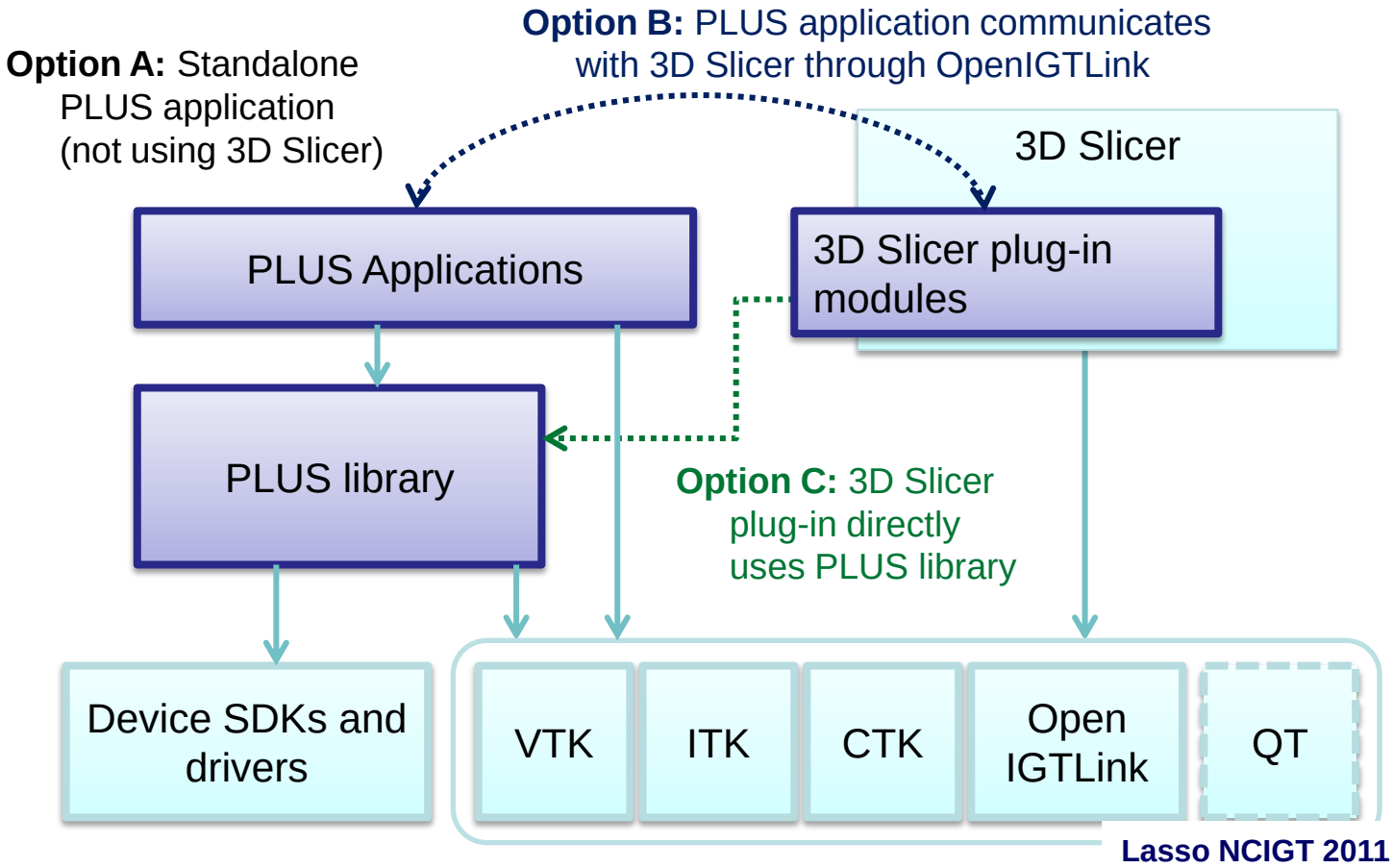
Transducer axes:
M = marked
U = unmarked = -marked
F = far
N = near = -far





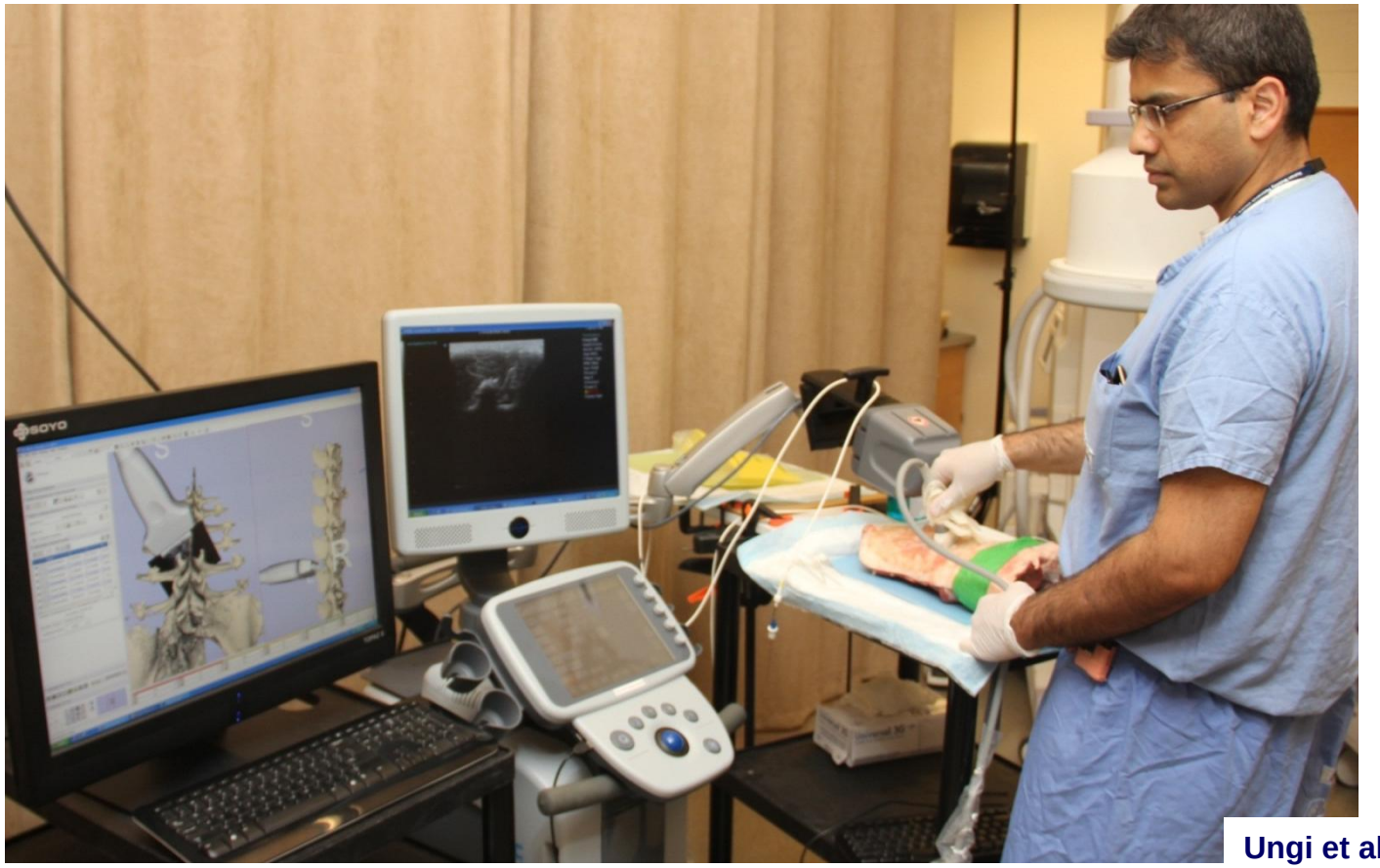
Lasso et al. 2012

PLUS architecture



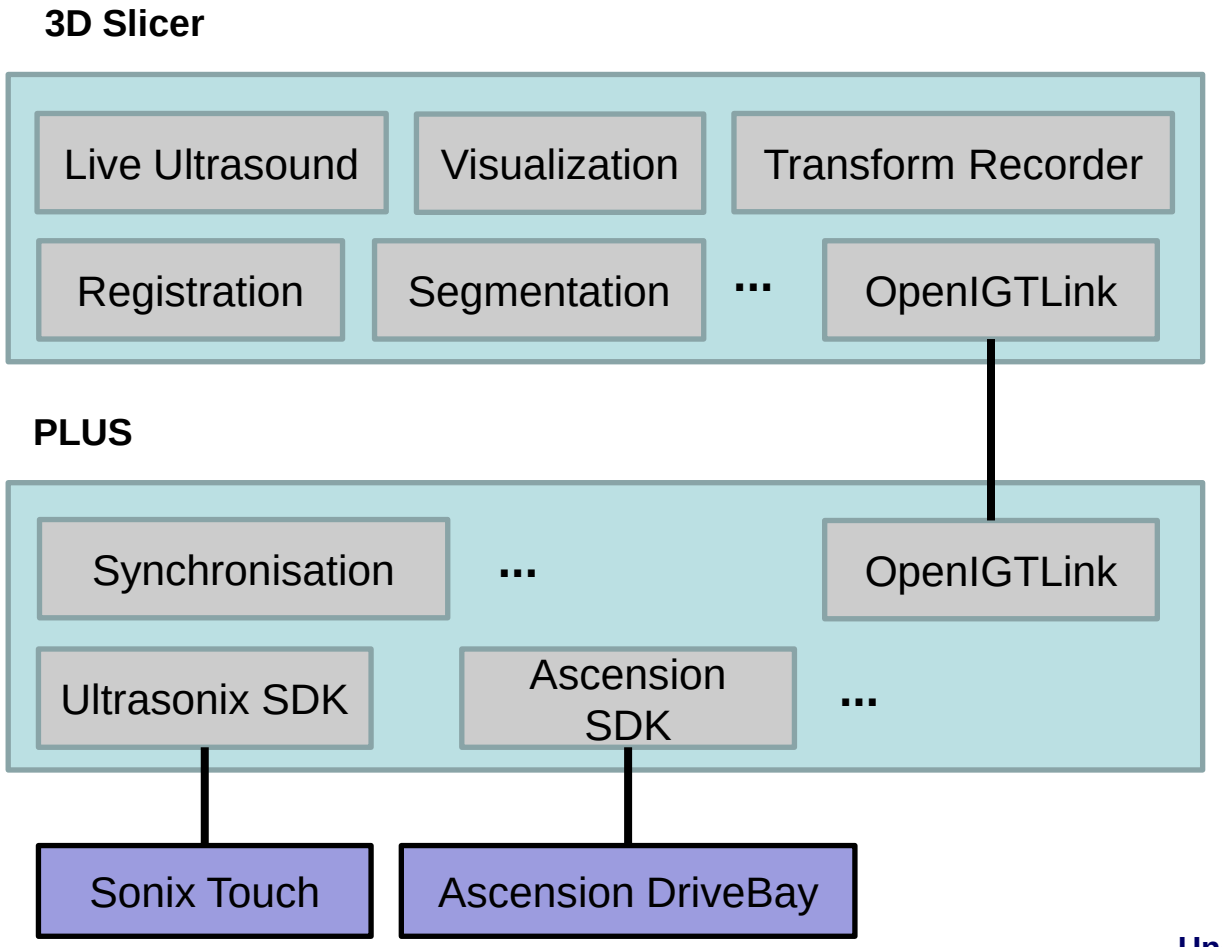
Ultrasound navigation

Tamas Ungi, Elvis Chen



Ungi et al. 2012

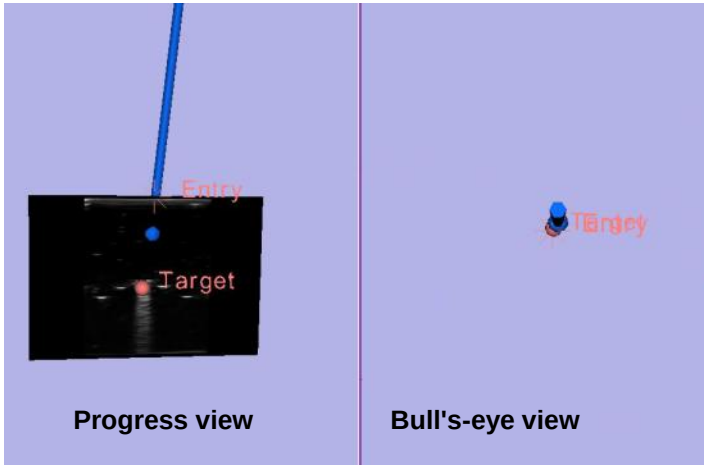
Configurable architecture

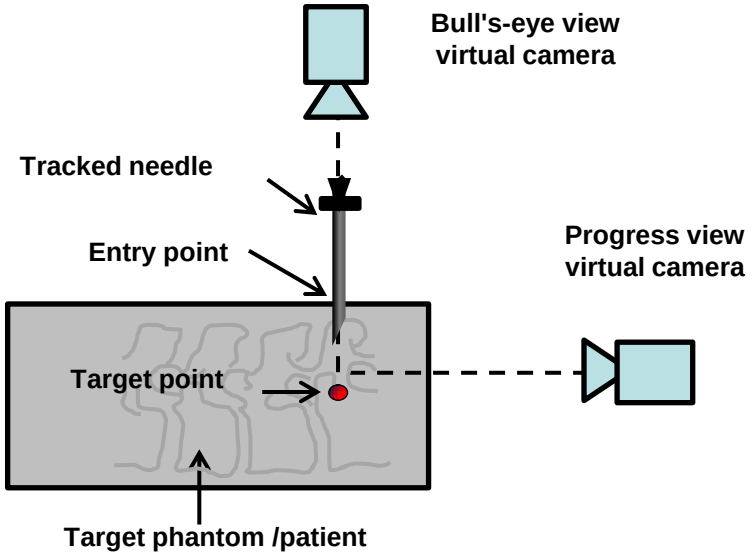


Ungi et al. 2012

Snapshot ultrasound mode

Dual 3-D layout in 3D Slicer





	Tracked snapshot guidance	Plain ultrasound guidance
Number of insertions	60	60
Success rate (%)	93% *	71%
Insertion time (s)	117 ±19	138 ±34

Ungi et al. 2012

Lessons learned

- Patience
- Leverage other grants
- Stick to the rules
- Choose partners from friends
- Stay in the NAMIC family

Thank you