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sense and simplicity

HW emulation in MRI development

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MRI technology development
June 05, 2012

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About myself

- 34 years old, married, 2 children
- M.Sc. Biomechanical engineering -> Ph.D. Medical Physics -> Philips
- MRI Domain expert, Methods & Reconstruction
- Pulse sequences, reconstruction algorithms, workflow, image quality, hardware interaction

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Contents

- MRI basics
- Design
- HW emulation examples

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MRI basics

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MRI basics

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Some configurations

Achieva 1.5T XR

rampable magnet.

upgradeable to 3.0T on site without swapping the magnet.

Panorama HFO

1.0T high field open magnet.

Sonalleve MR-HIFU

MR-guided high intensity focused ultrasound therapy

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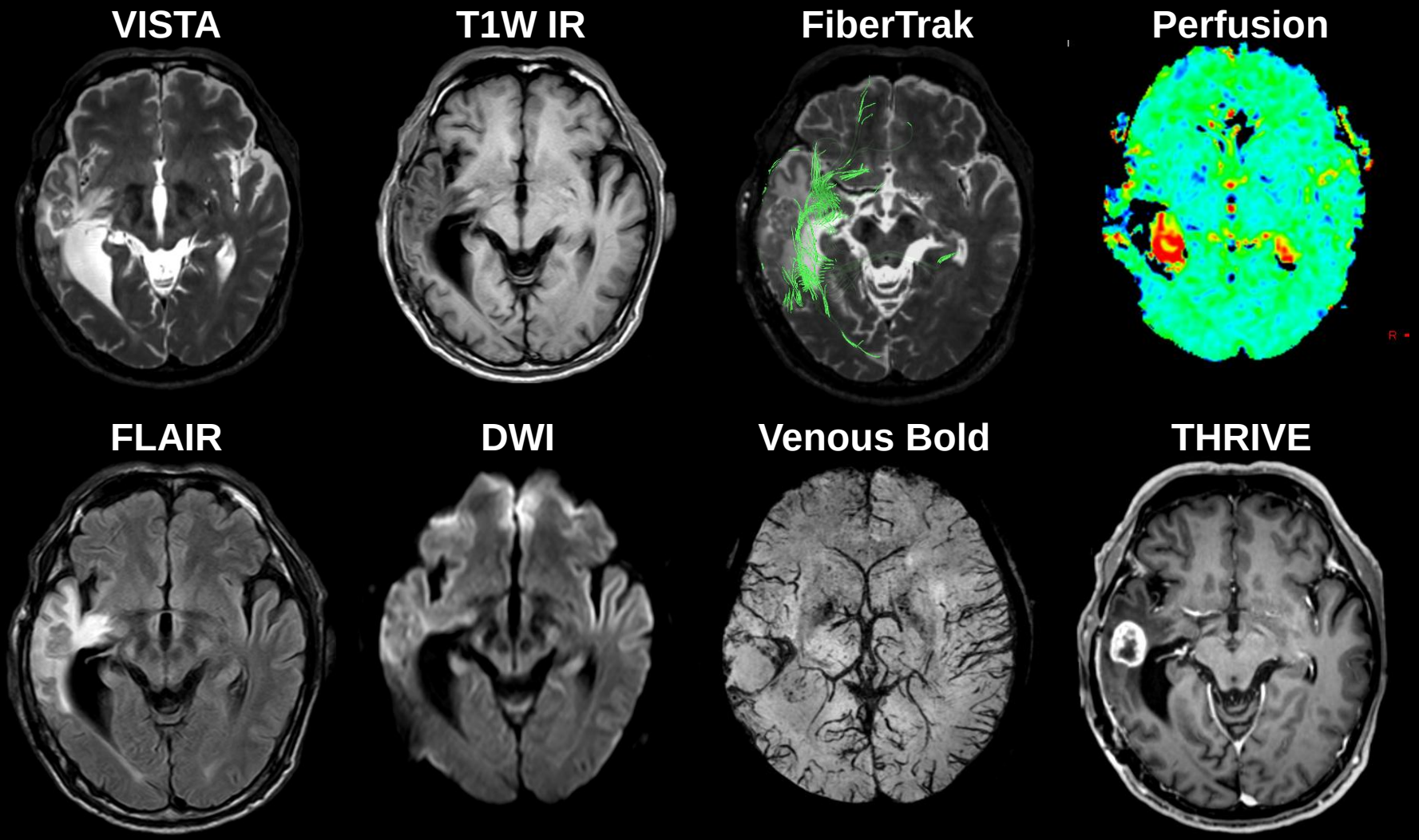
Example images

Comprehensive Brain imaging –Tumor



Courtesy : Utsunomiya Central Clinic, Japan

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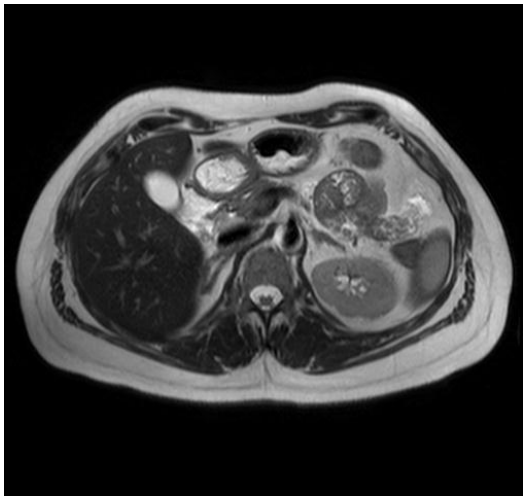
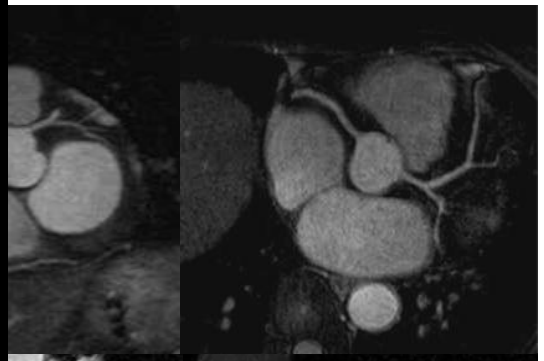
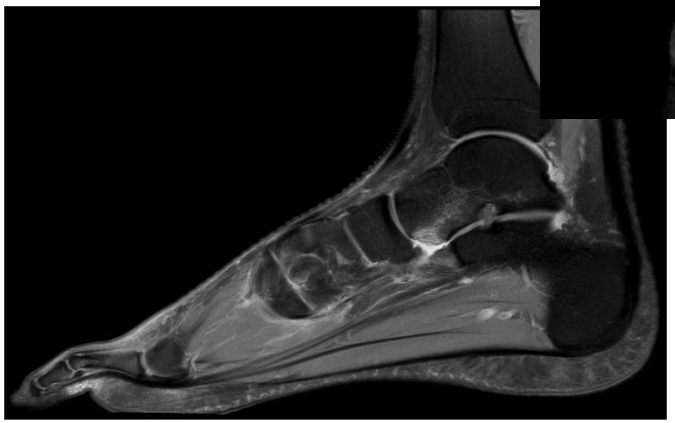
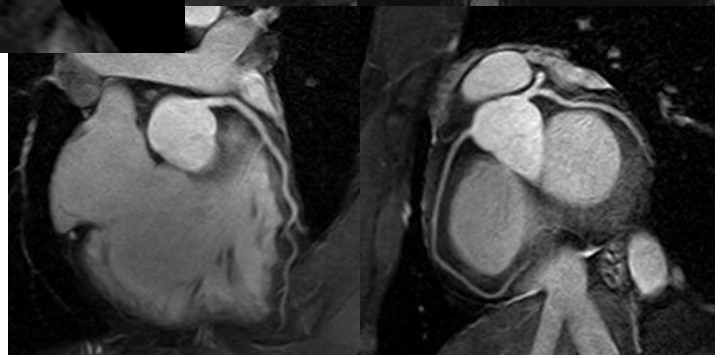
Example images





system design

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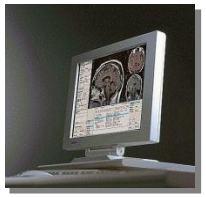
3 computer system



HP-INTEL
workstation
Two DualCore CPU
3 GHz
6 GB memory

user interaction

instrument action

HOST

Ethernet

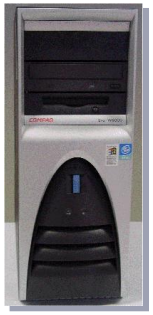
CDAS

Ethernet

RECON burst

RECON

Spectrometer
computer:
Philips designed
computer:
PentiumIV chip



HP-INTEL
workstation
Dual Quadcore CPU
3 GHz
16-32 GB memory

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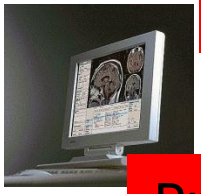
Starting a scan…



State observers

HOST

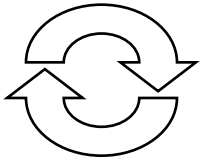
Ethernet

State observers

CDAS

Protocol Program PDF

RECON



Scan protocol

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…during a scan

Database

State observers

HOST

State observers

CDAS

Measurement Program MPF

Images Raw data

Data vectors
Labels e.g. ky, kz

RECON

Reconstruction Program

Reconstructs images
checks data vectors and labels against the RC-parameters;
ABORT in case of inconsistency

State observers

- Scanning/planning state
- Table and integrated posterior coil position
- Coils
- Gradient and RF Amplifiers
- Technical and scanner room temperature
- Connected physiology devices
- Helium level
- Cooling Water temperature
- Etc, etc, etc

Emulation

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HW emulation

- Initial costs high, especially the magnet, but also amplifiers, coils, …
- Maintenance costs
- Volunteers
- Availability: Multi-site, over 200 engineers in different domains

  →Emulation/simulation

Examples

- VMWare, Reconstruction Test Machine (RTM), Software Test Machine (STM)
- Coil simulation, scannersim, reconsim, patient communication, patient environment
- SW regression testing
- Refscan insertion
- System performance tooling (SPT)
- Computer links
- Physiology simulation

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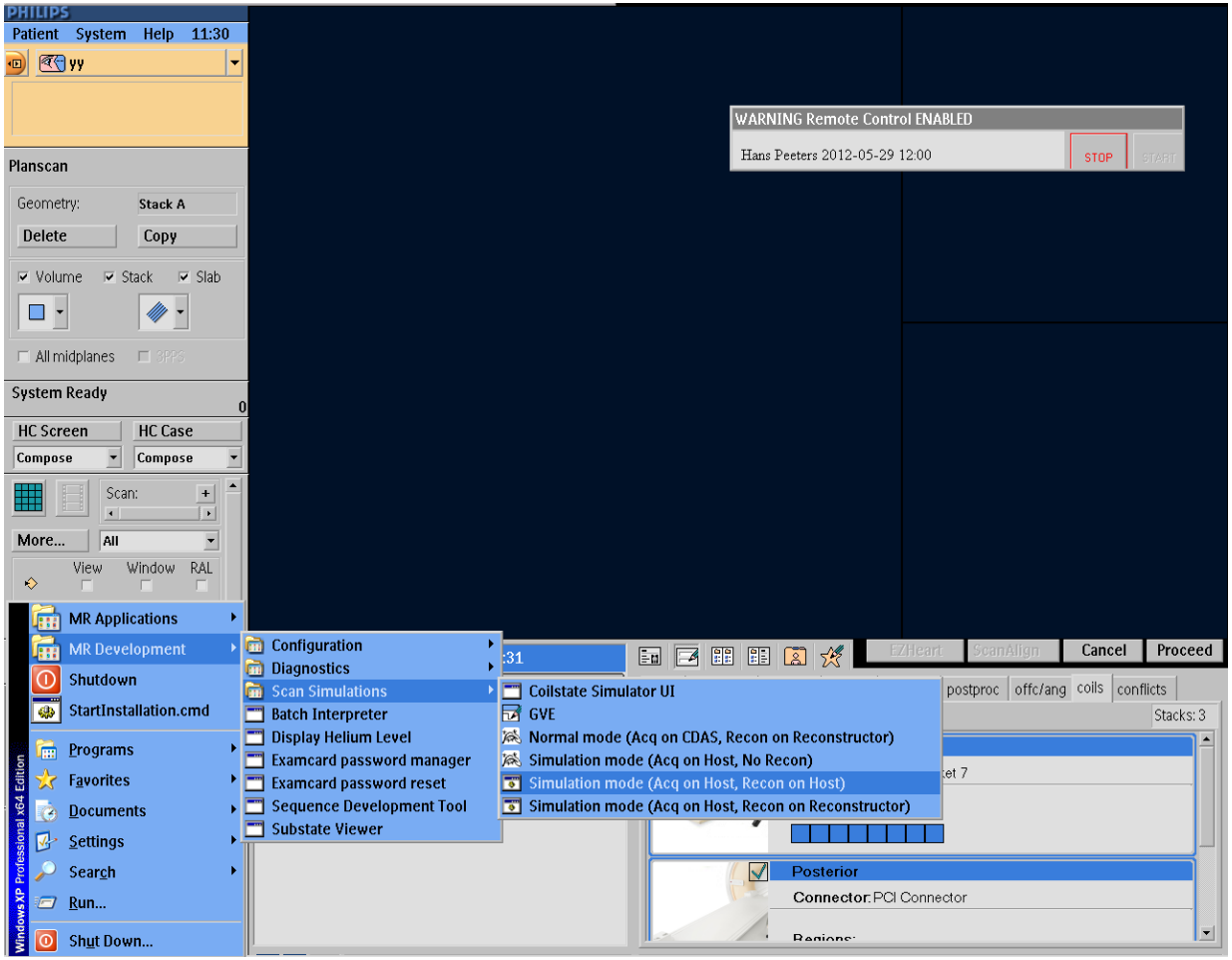
Some simulation processes



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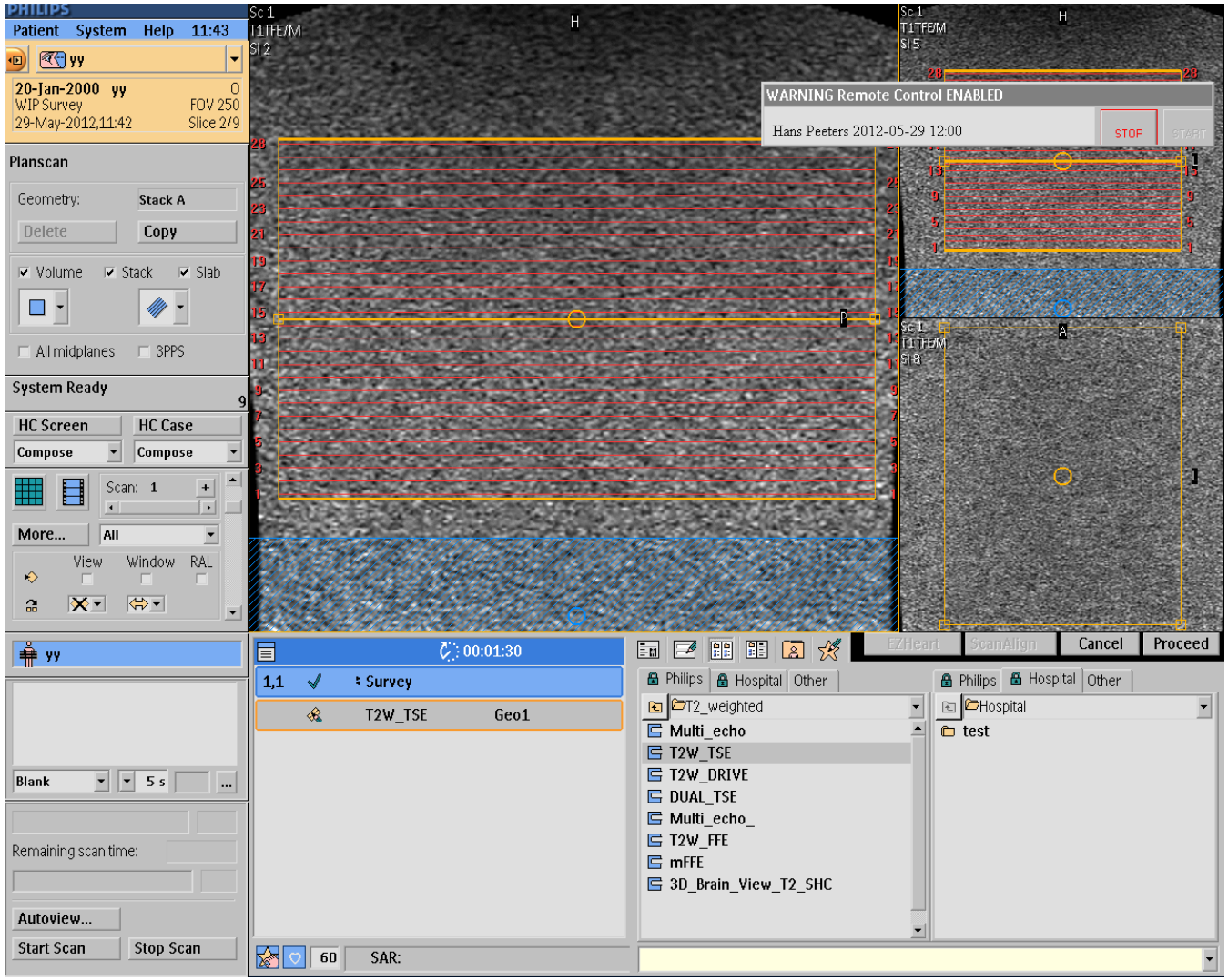
Planning STM



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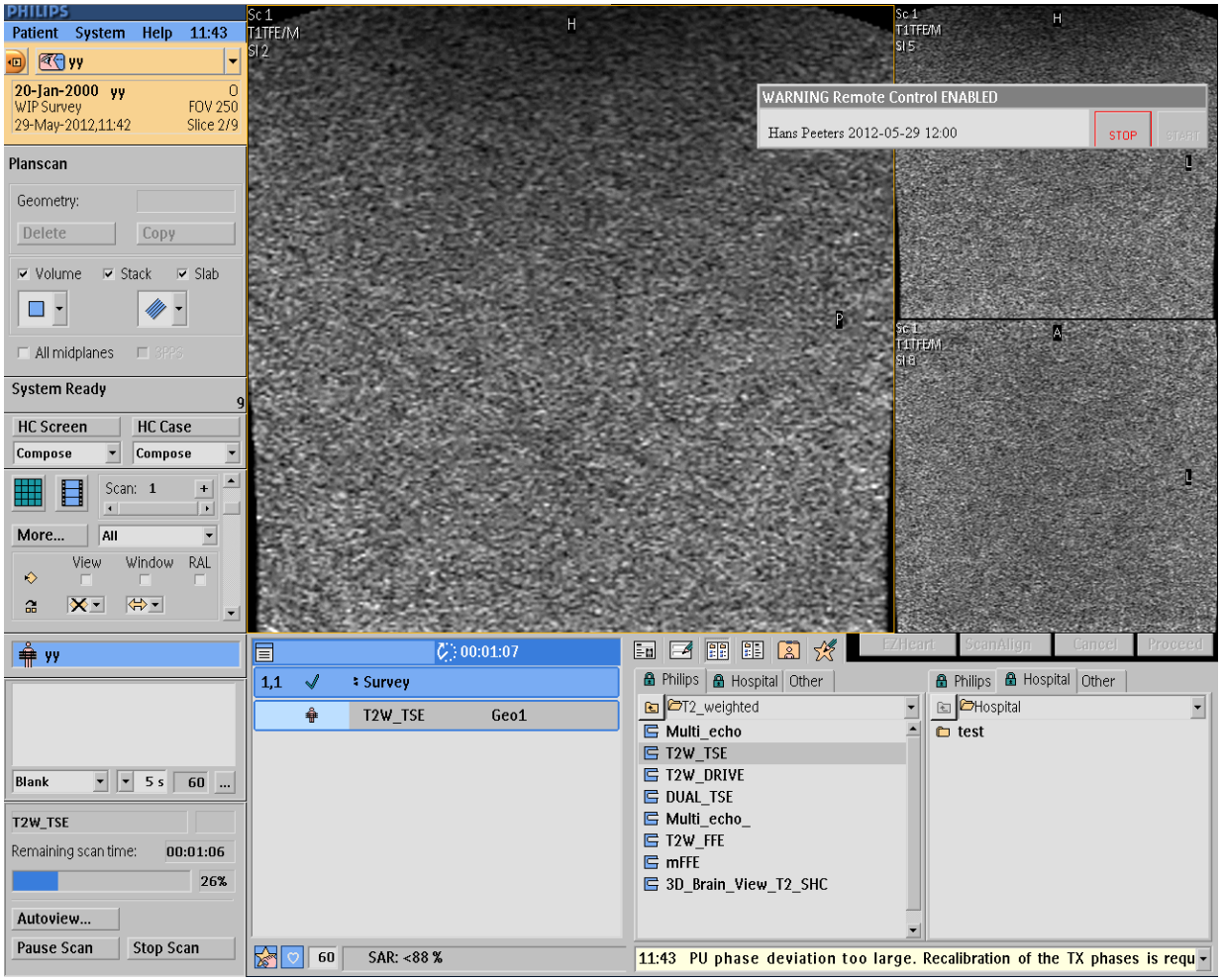
Scanning STM



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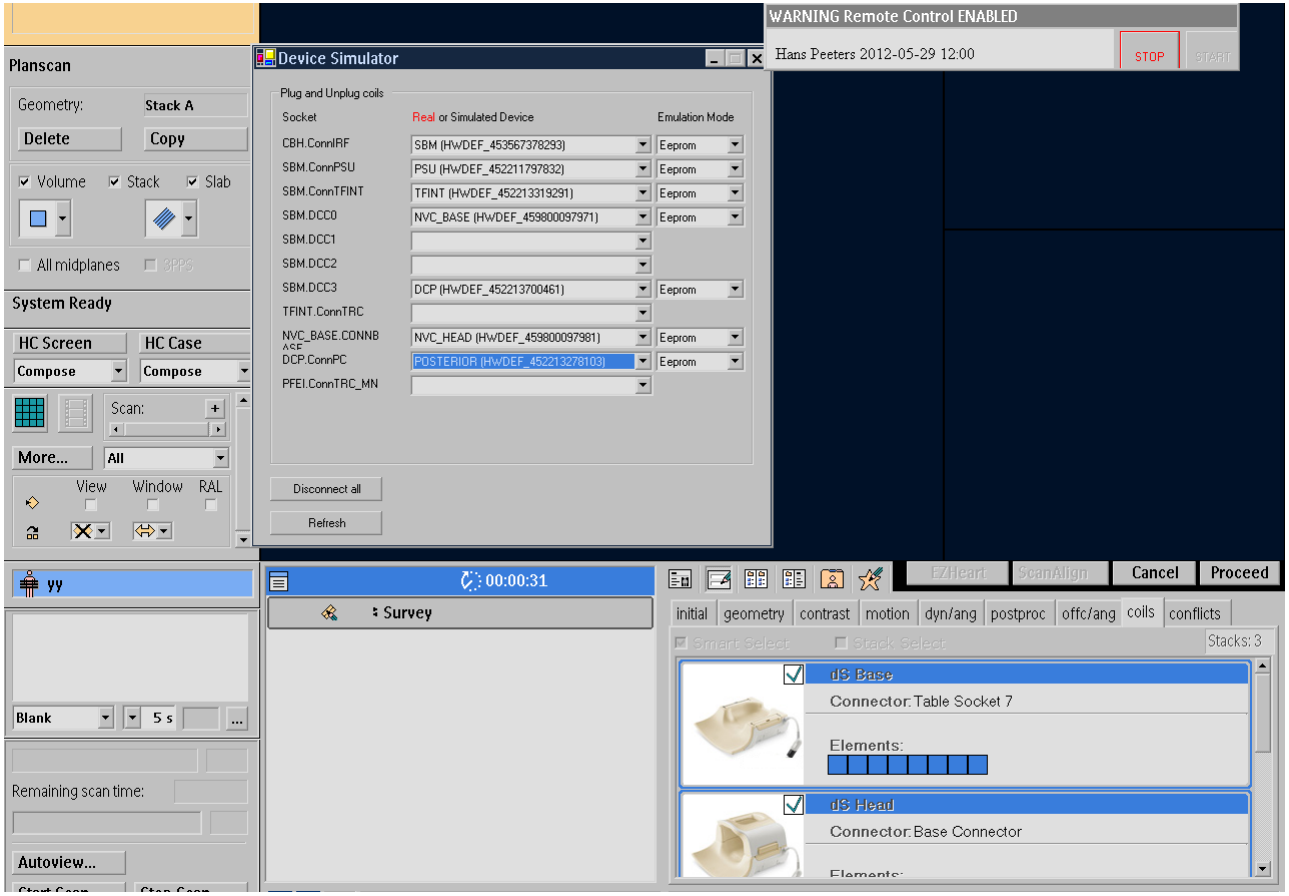
Coil simulation



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Coil simulation

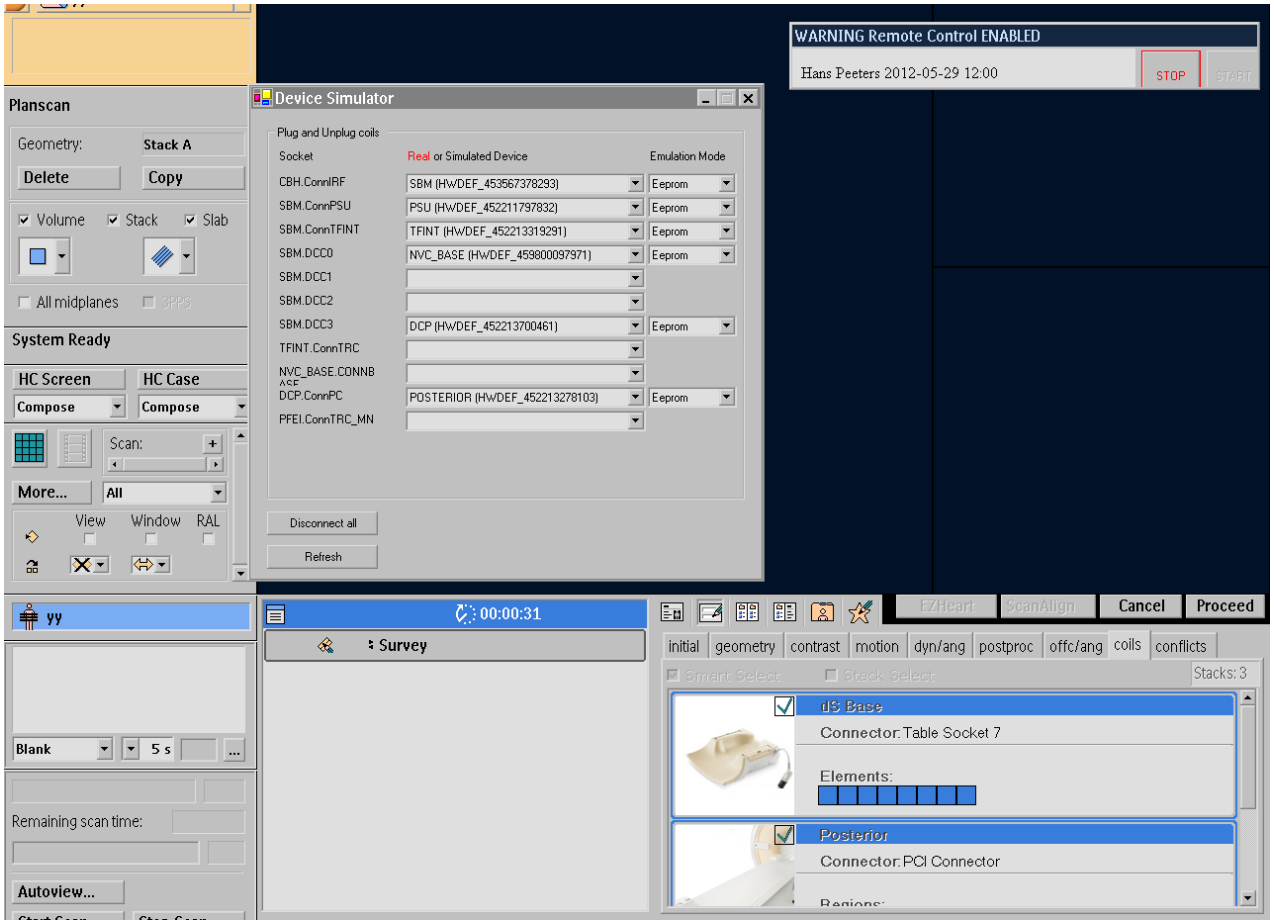

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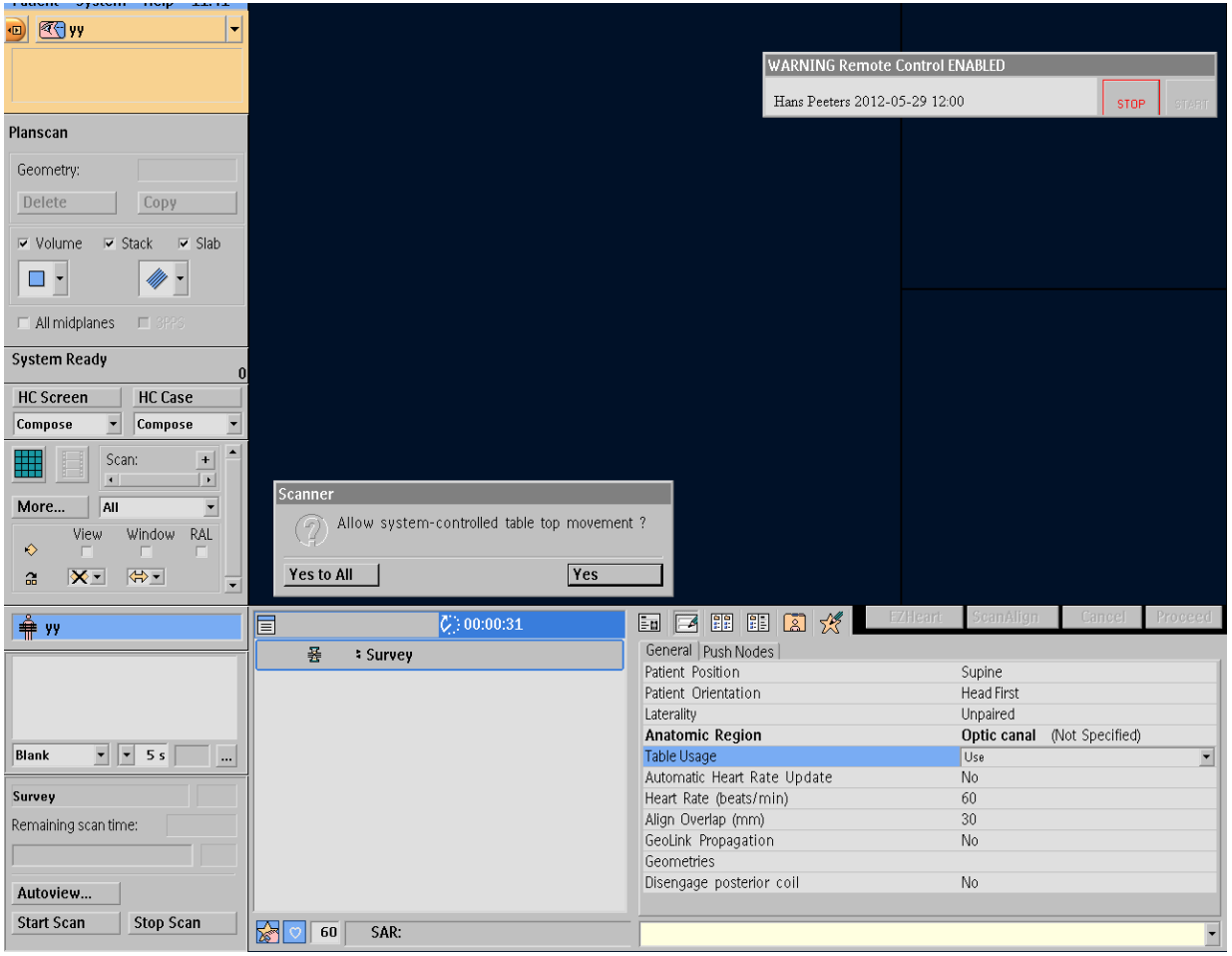
Table position



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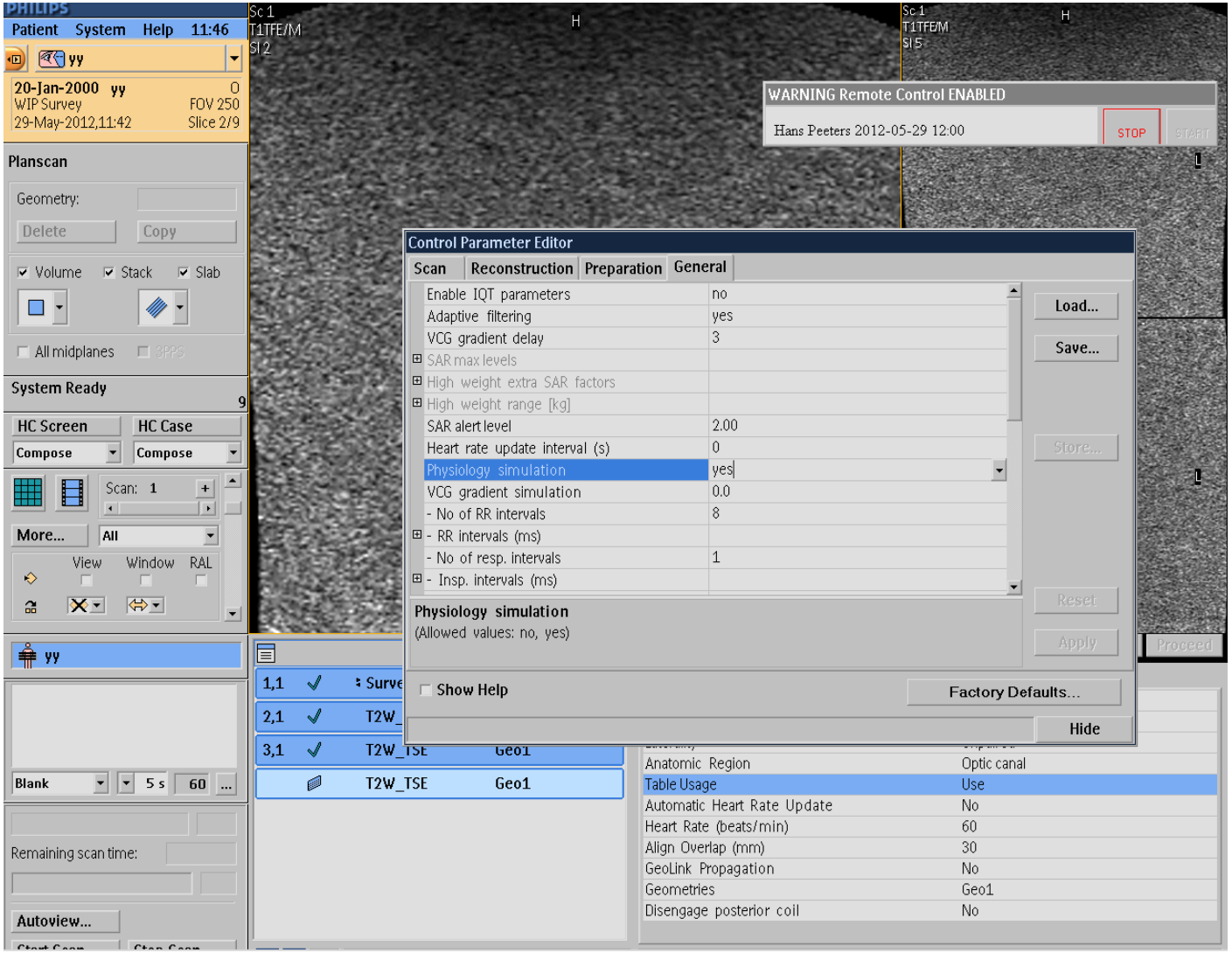
Physiology simulation



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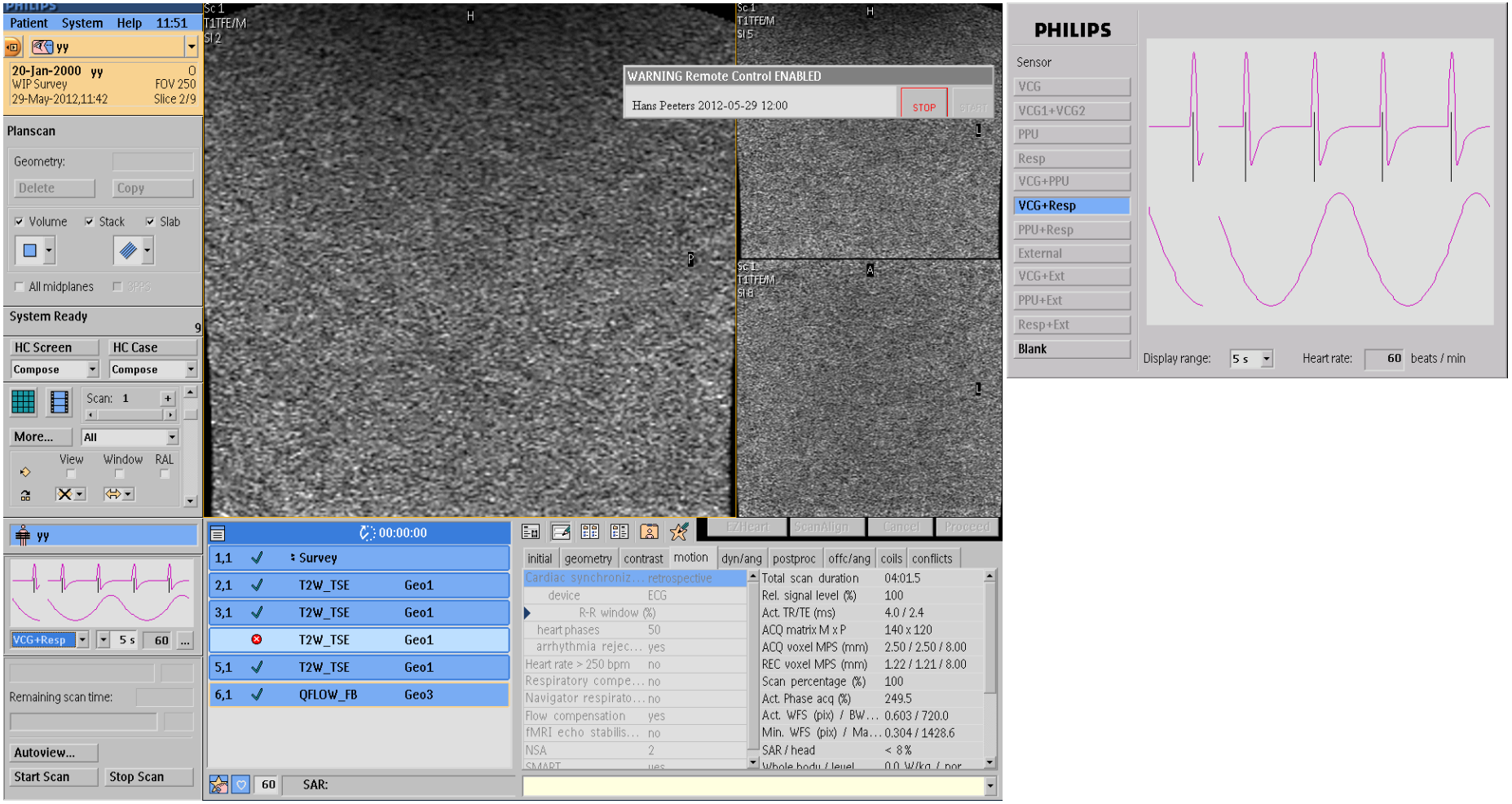
Physiology simulation



Summary

- MRI is a 3 computer system
- Many hardware components that need to be monitored
- Hardware is expensive
- Volunteers are not always available and expensive
- Emulation\simulation is a must
- To my opinion tooling is part of the development project and should be maintained as normal product sw

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