

Declaration of Conflict of Interest or Relationship

Speaker Name: Bradley J Erickson

I have the following conflict of interest to disclose with regard to the subject matter of this presentation:

Company name: IBM

Nature of Relationship: Co-Director of Collaboration

ADNI Image Management

Bradley J Erickson, MD PhD

Departments of Radiology and
Biomedical Engineering

Mayo Clinic

Rochester, Minnesota U.S.A.

**Contribution from Matt Bernstein, PhD



Outline

- Protocol distribution
- Quality assurance methods
- Post-processing
- Site communication
- Lessons learned

Protocol Generation: Distribution

- Protocol distribution:
 - electronic format
 - machine loadable format (scan card, .edx, etc.)
 - avoid the local technologist typing-in parameters!

ADNI Protocol Parameters

• <http://www.loni.ucla.edu/ADNI/Research/Cores/>

o General Electric Healthcare

- ADNI 1.5T GE 9.1M4_BC
- ADNI 1.5T GE 11.0M4 BRM 8Ch
- ADNI 1.5T GE 11.0M4 TwinSpeed BC
- ADNI 1.5T GE 11.0M4 TwinSpeed 8Ch
- ADNI 1.5T GE 12.0M3 TwinSpeed 8Ch
- ADNI 1.5T GE 12.0M4 TwinSpeed 8Ch
- ADNI 1.5T GE Phantom QC 11.0M4 TwinSpeed BC
- ADNI 1.5T GE QC Phantom 12.0M4 TwinSpeed 8Ch
- ADNI 1.5T GE QC_Phantom 12.0M3 TwinSpeed 8Ch
- ADNI 1.5T GE QC Phantom 11.0M4 TwinSpeed 8Ch
- ADNI 1.5T GE QC Phantom 9.1M4 BC
- ADNI 1.5T GE QC Phantom 11.0M4 BRM 8Ch
- ADNI 3T GE 12.0M4 TwinSpeed 8Ch
- ADNI 3.0T GE_VH3M4 CRM BC
- ADNI 3.0T GE E2 M4 CR 8Ch
- ADNI 3.0TGE G3M4 TwinSpeed 8Ch
- ADNI 3T GE Phantom QC 12M4 TwinSpeed 8Ch
- ADNI 3.0T GE QC Phantom VH M4 CRM BC
- ADNI 3.0T GE QC Phantom G3M4 TwinSpeed 8Ch
- ADNI 3.0T QC Phantom GE E2 M4 CRM 8Ch
- ADNI 1.5T GE 14.0M4 TwinSpeed 8Ch
- ADNI 1.5T GE QC Phantom 14.0M4 TwinSpeed 8Ch
- ADNI 1.5T GE 14.0M4 TwinSpeed BC
- ADNI 1.5T GE QCPhantom 14.0M4 TwinSpeed BC
- ADNI 3T GE 14.0M4 TwinSpeed 8Ch
- ADNI 3T GE QC Phantom 14.0M4 TwinSpeed 8Ch

59 sites

89 scanners

38 discrete platform configurations

o Philips Medical Systems

- ADNI Philips Protocols.pdf
- ADNI Philips 1.5T Multi-Channel Scan List ASO
- ADNI Philips 1.5T R103 Multi-Channel
- ADNI Philips 1.5T R122 Multi-Channel
- ADNI Philips 3.0T R104 Multi-Channel
- ADNI Philips 1.5T Quad Head Scan List ASO
- ADNI Philips 1.5T R103 Quad Head
- ADNI Philips 1.5T R122 Quad Head
- ADNI Philips 3.0T Multi-Channel Scan List
- ADNI Philips 3.0T R122 Multi-Channel

o Siemens Medical Solutions

- ADNI Siemens 1.5T Avanto VB11
- ADNI Siemens 1.5T Sonata VA21 CP
- ADNI Siemens 1.5T Sonata VA25 8Ch
- ADNI Siemens 1.5T Sonata VA25 CP
- ADNI Siemens 1.5T Symphony Quantum VA21 VA25 CP
- ADNI Siemens 1.5T Symphony Ultra VA21 CP
- ADNI Siemens 1.5T Symphony Sprint VA25
- ADNI Siemens 1.5T Symphony VA30 CP
- ADNI Siemens 3.0T Allegra VA25
- ADNI Siemens 3.0T Trio VA25 8Ch
- ADNI Siemens 3.0T Trio VB12T
- ADNI Siemens 1.5 Avanto VB13
- ADNI Siemens 3T TrioTim VB13
- ADNI Siemens Human 1.5T Avanto VB15
- ADNI Siemens Human 3TVB15 Trio
- ADNI Siemens QCPhantom 1.5T Avanto VB15.pdf
- ADNI Siemens QCPhantom 3T VB15 Trio
- ADNI Siemens Human 1.5T VB15 Espree
- ADNI Siemens Phantom 1.5T VB15 Espree

Outline

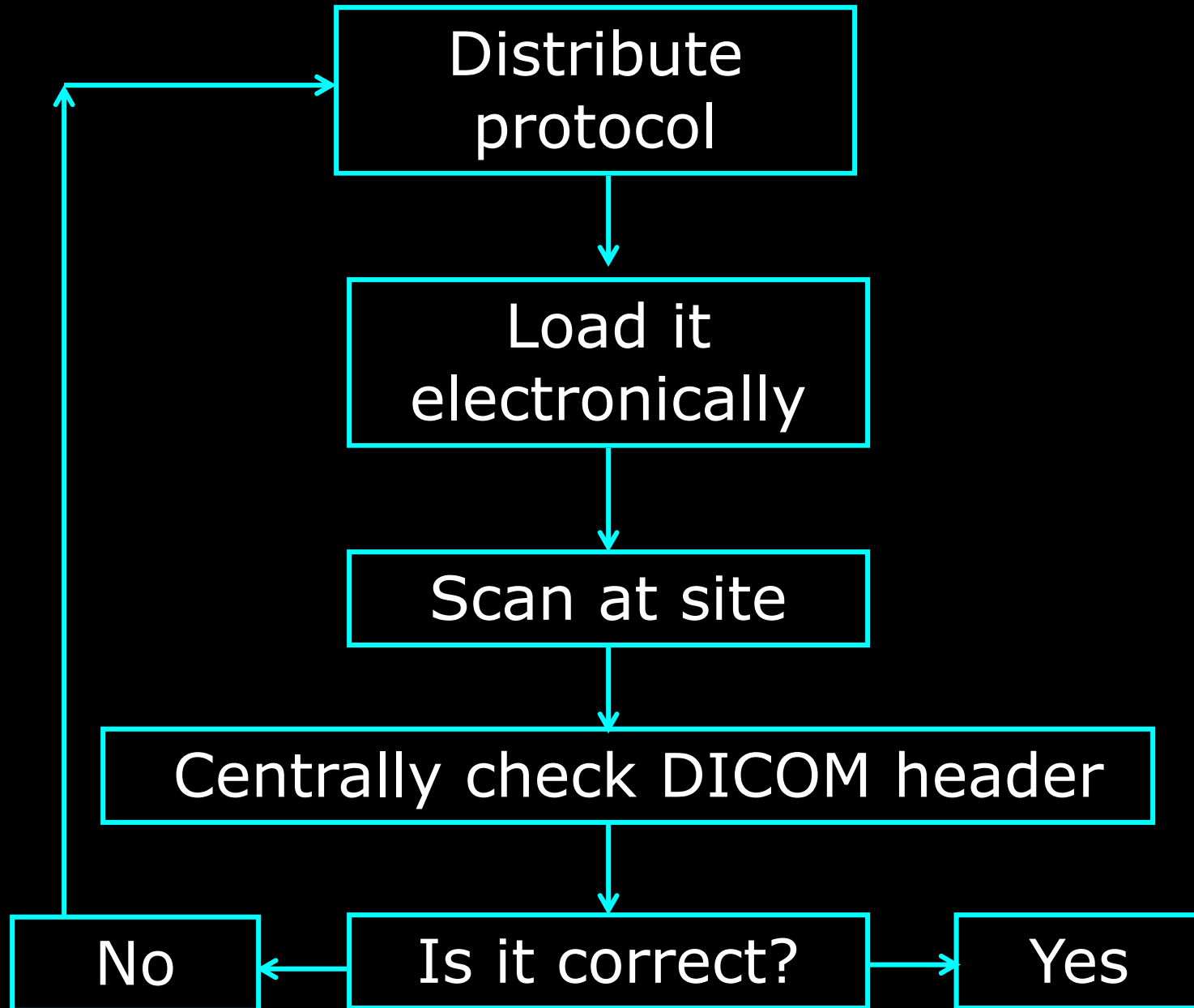
- Protocol distribution
- Quality assurance methods
- Post-processing
- Site communication
- Lessons learned

Quality Assurance

- Automated check of DICOM header
- Quantitative analysis of phantom data
- Visual check by a Medical Imaging Analyst
- Central read by a Radiologist
- Automated QC checks of subject images

Dicom Header Check

- Trial distributes MR protocol in electronic, machine-loadable form
- Trial: automatically check the DICOM header
 - during site qualification and
 - for every subject exam
- Redistribute protocol to site, if necessary
- Closes the loop--ensures an accurate protocol



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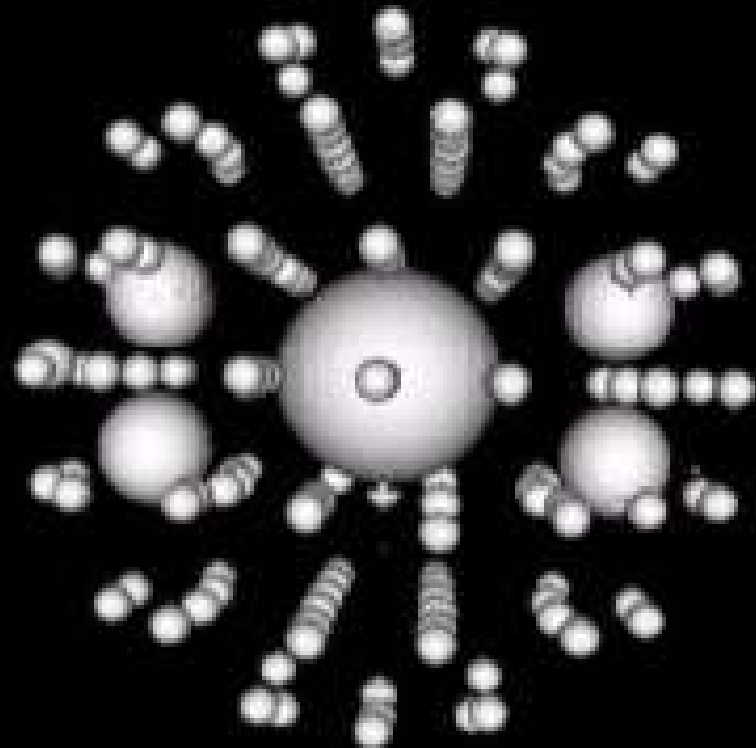
Quantitative Analysis: Phantom

- What are the critical measurements for the trial?
 - Alzheimer's disease...spatial accuracy
 - fMRI methods...temporal stability over a scan
- Can you get by with widely-available phantoms?
 - MRI manufacturer-supplied phantom
 - in United States: ACR phantom
- Or, do you need a specialized phantom?
 - fBIRN: agar gel phantom
 - Alzheimer's studies and trial: ADNI phantom

ADNI Phantom

- Quantitatively checks:
 - MRI system calibrations
 - signal-to-noise ratio (SNR)
 - contrast
 - site's reporting of their own gradient hardware

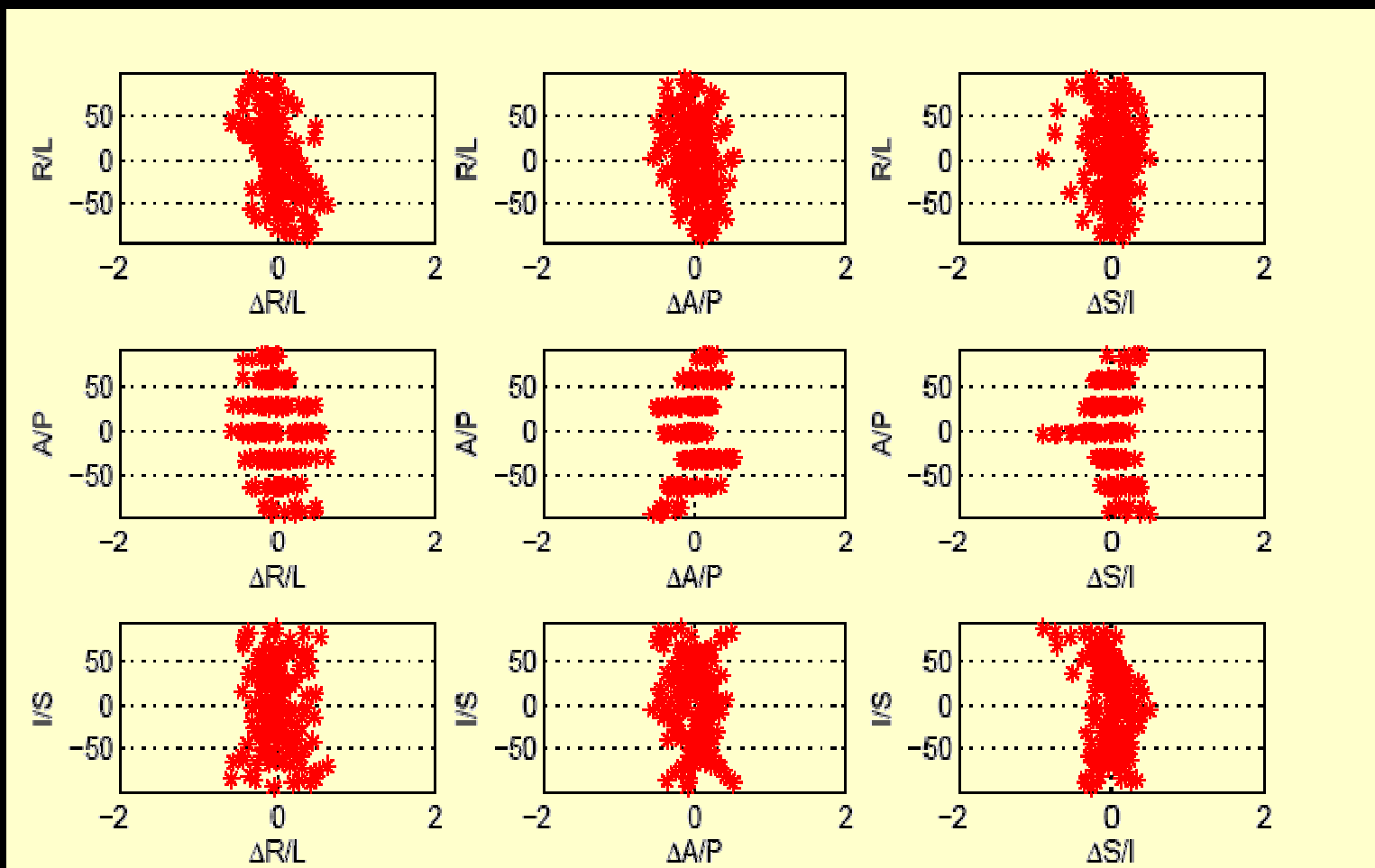
ADNI MRI Phantom



Gunter et al, *Medical Physics*, 2009

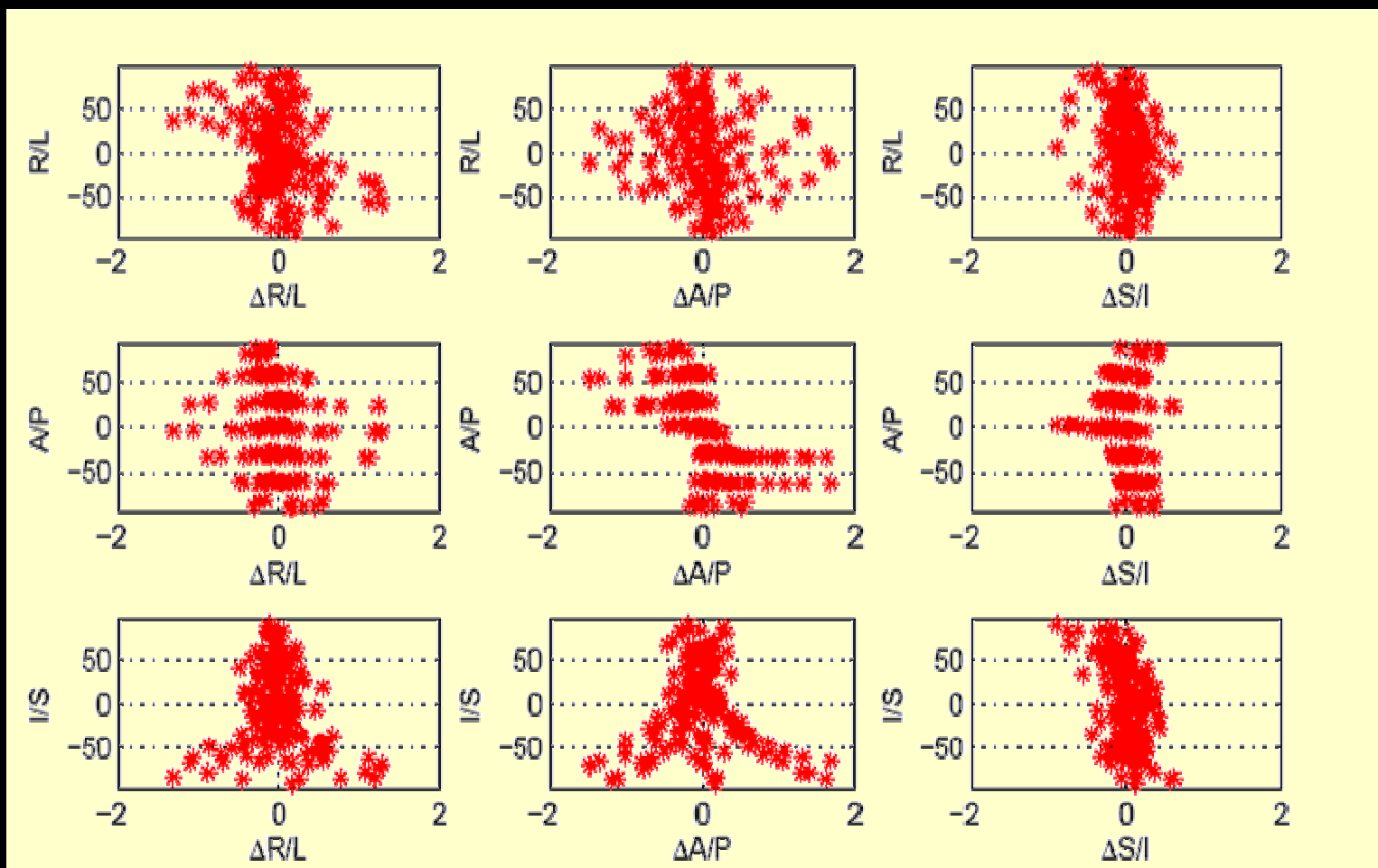
AQUAL Analysis Program

Pre-upgrade

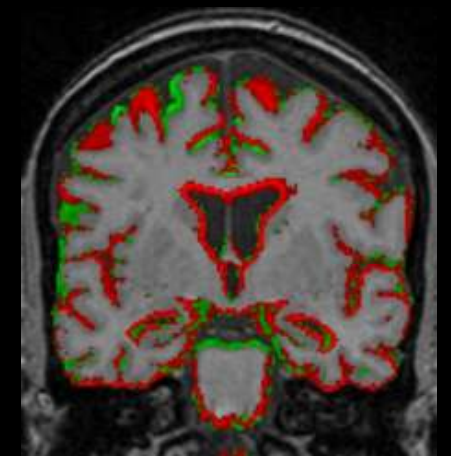
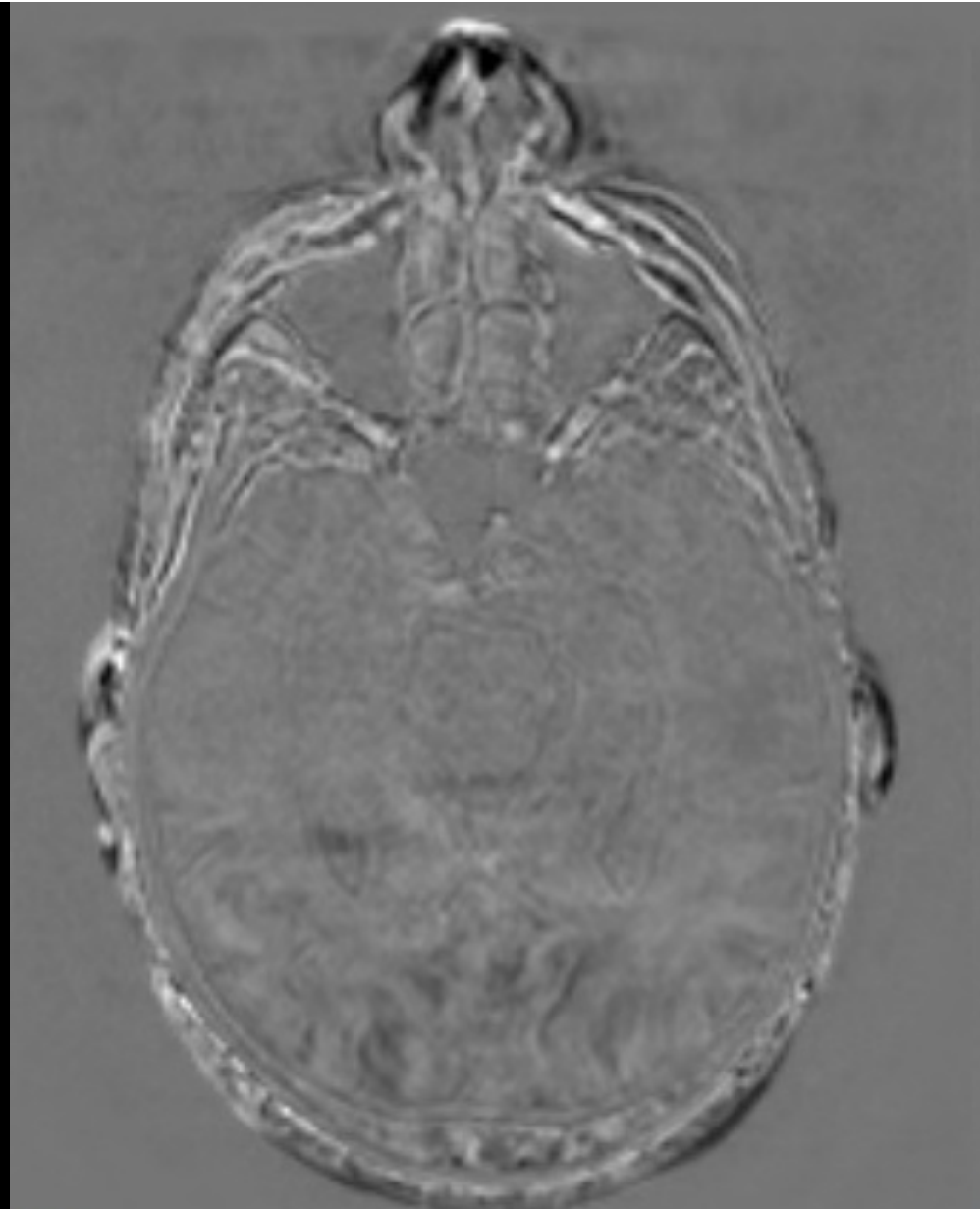


Gunter et al, Medical Physics 2009

AQUAL Analysis Program Post-upgrade



Gunter et al, Medical Physics 2009



Pre- and Post-upgrade registered image subtraction

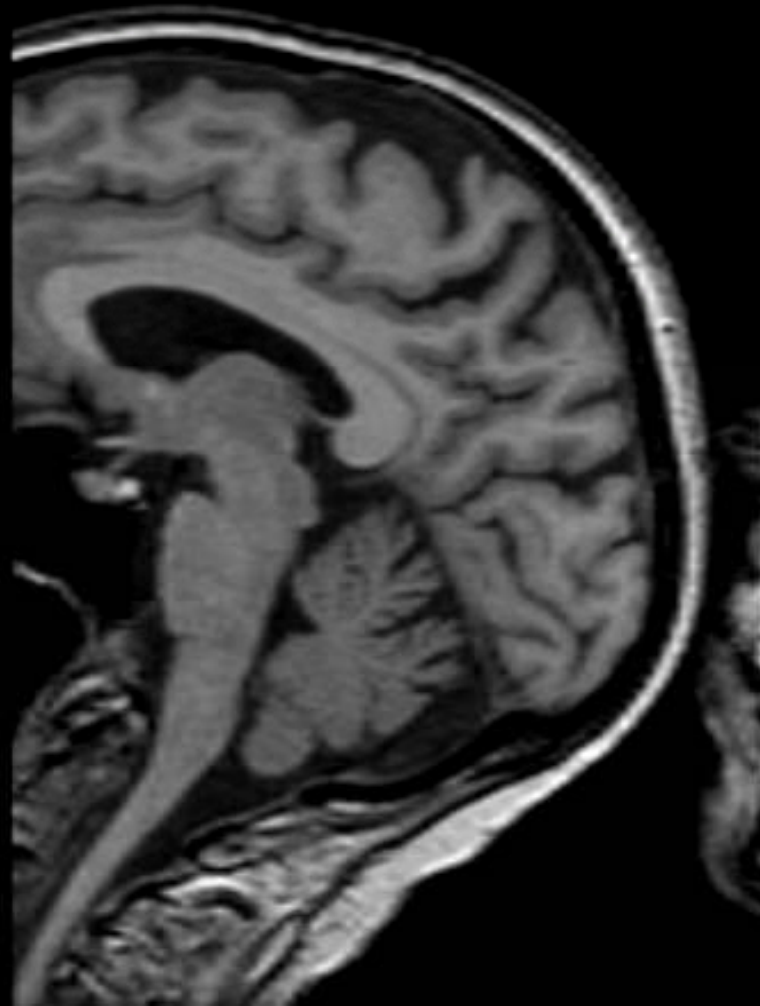
Quality Assurance

- Automated check of DICOM header
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- **Visual check by a Medical Imaging Analyst**
- Central read by a Radiologist
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Visual QA by a Medical Imaging Analyst

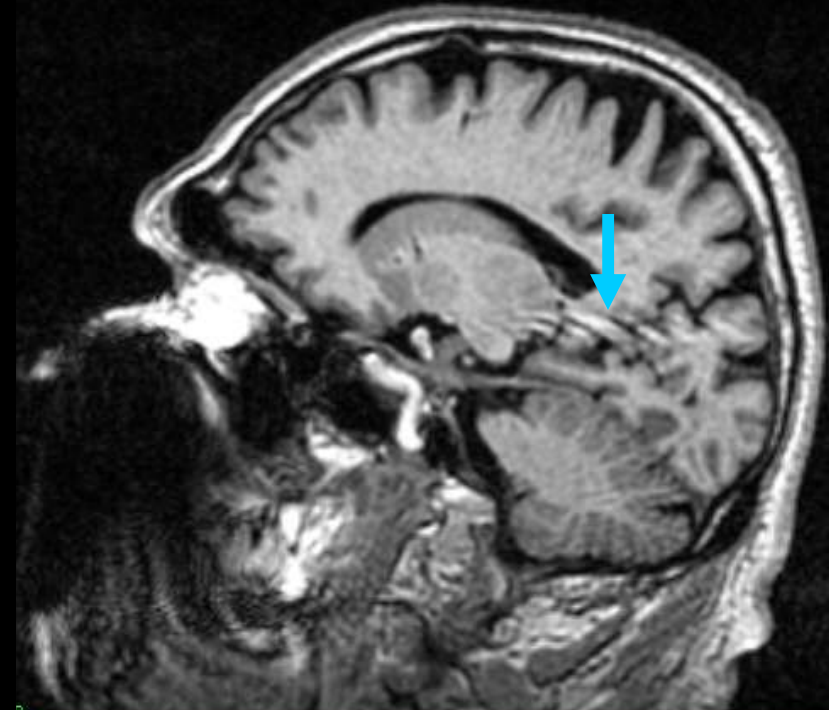
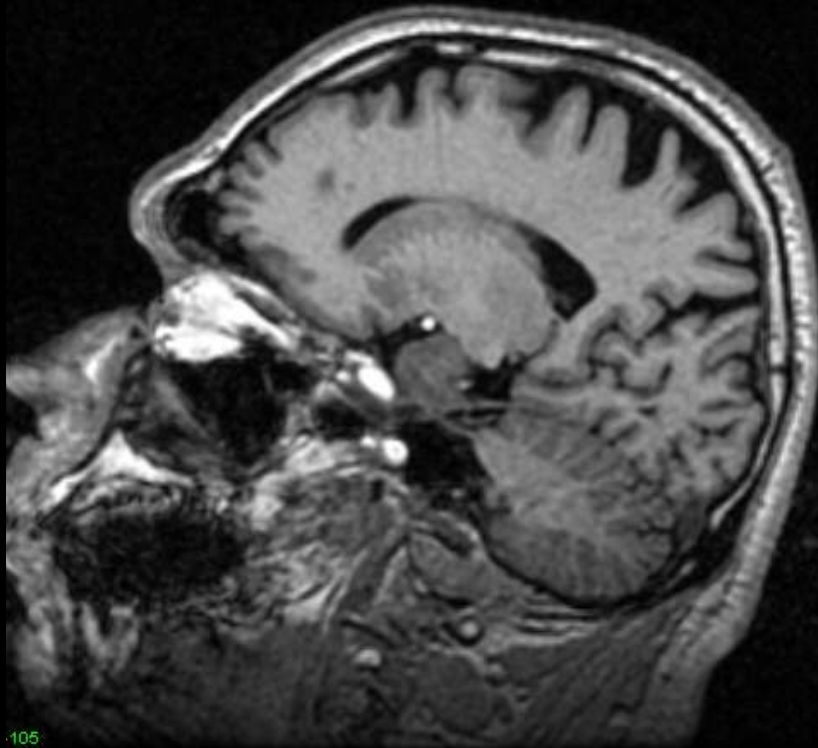
- Central grading of image quality
- Detect specific problems
 - artifacts: motion, susceptibility, etc.
- If necessary, triage findings to Radiologist and/or MRI Physicist for further evaluation

Incomplete Data Transmission



Baseline

6 Month



105

Dental Work

Quality Assurance

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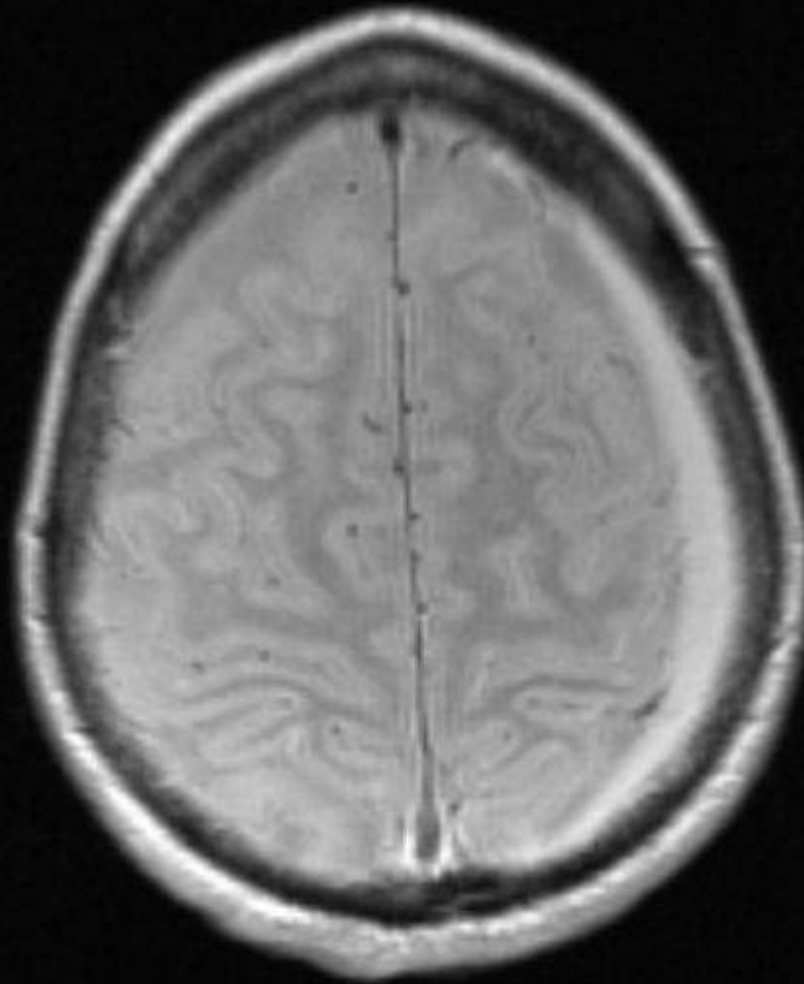
Central Reads by a Radiologist

- Central read by a Radiologist:
 - doesn't replace clinical read at each site
 - ...but does help drive standardization
- Natural history study:
 - evaluation of subject at inclusion & follow-ups
 - r/o condition like stroke, tumor, etc.
- Therapeutic trial:
 - all of the above, plus
 - special inclusion/exclusion conditions
 - monitor for complications

Central Reads

- In addition to subject inclusion/exclusion...
- Central read at each follow-up exam
 - detect new condition or complication

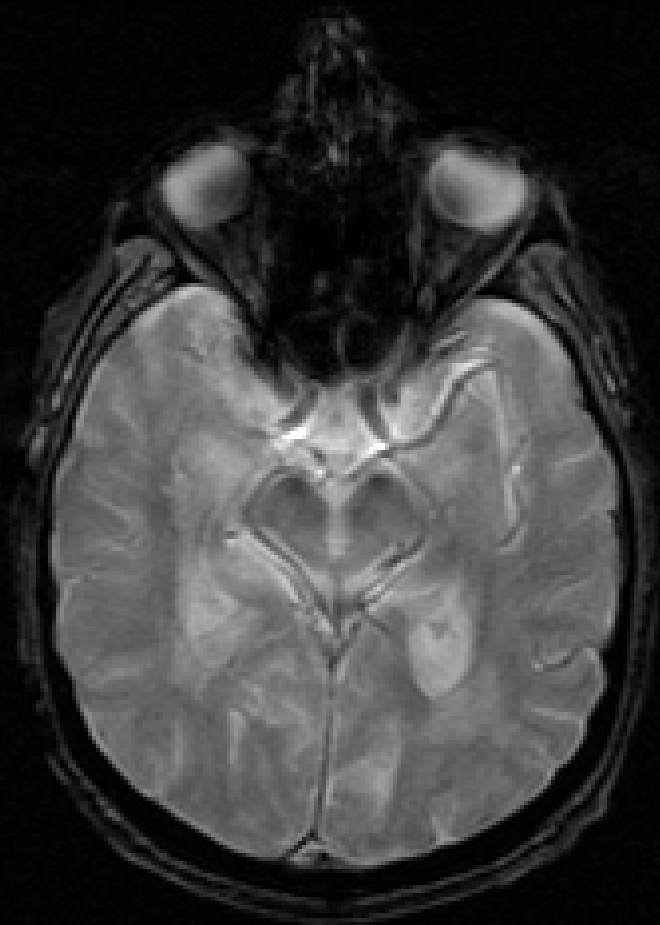
Subdural Hematoma:
Excluded at 12 Months



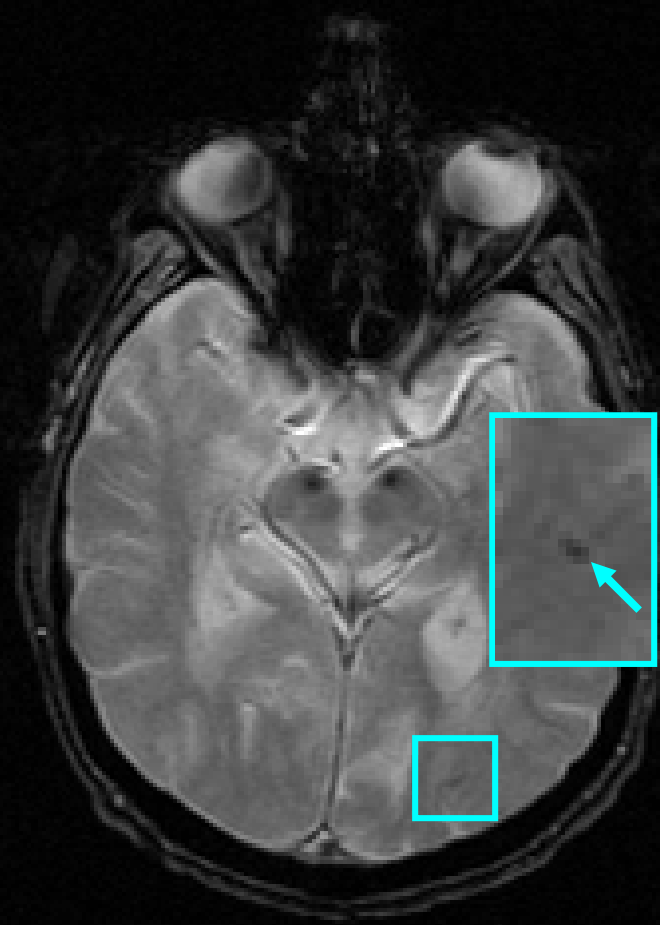
Central Reads

- Perhaps greatest value of a central read:
 - specialized or subtle findings
 - ...not of foremost interest to local Radiologist

Microbleeds on T2* Weighted GRE



Baseline



Month 3 follow-up

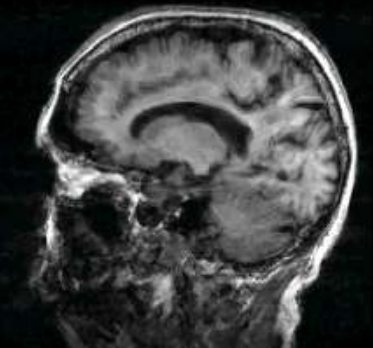
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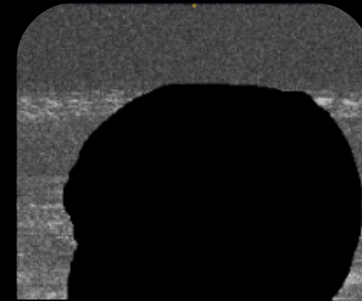
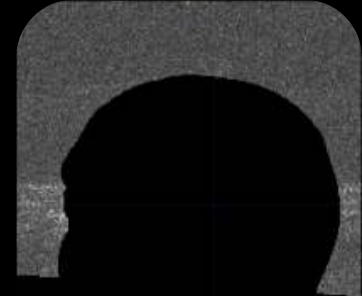
Automated QC

- Does not replace all visual inspection, but...
 - perfectly reproducible
- Potentially can be done while subject still in scanner
 - offer real-time advice whether to repeat scan
 - don't want to leave that decision up to the local Technologists

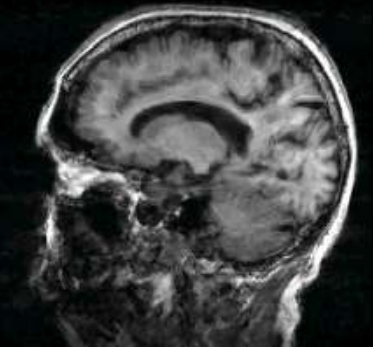
Automated Quality Checking



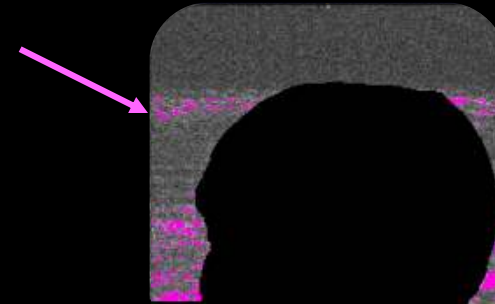
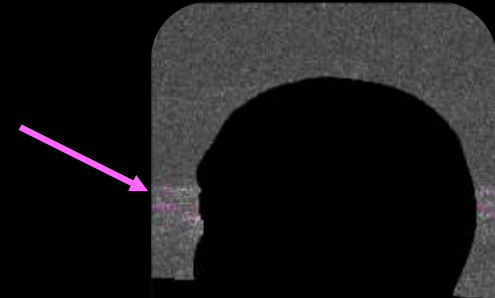
Step 1:
Segment
air background



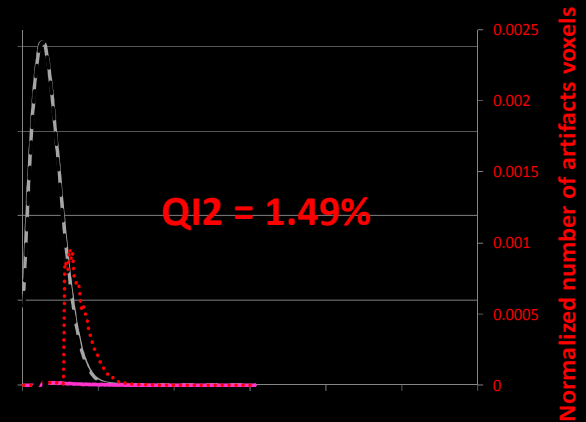
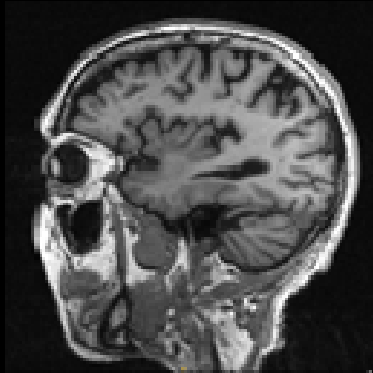
Automated Quality Checking



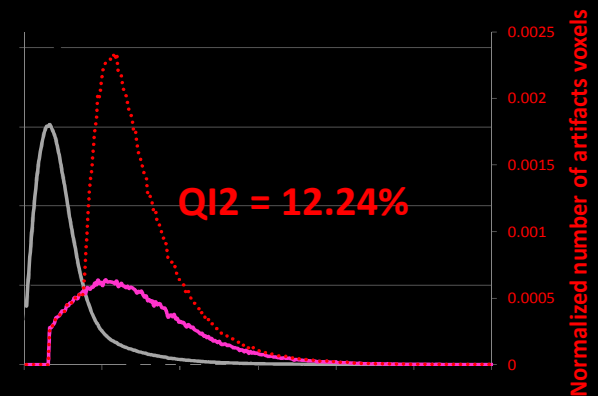
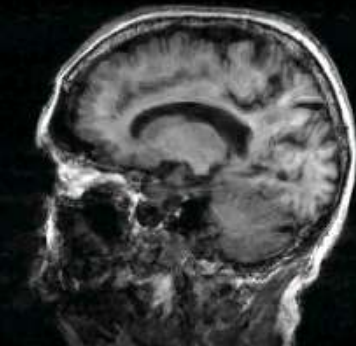
Step 2:
Detect
artifactual
pixels



Automated Quality Checking



Step 3:
Histogram &
noise distribution
analysis

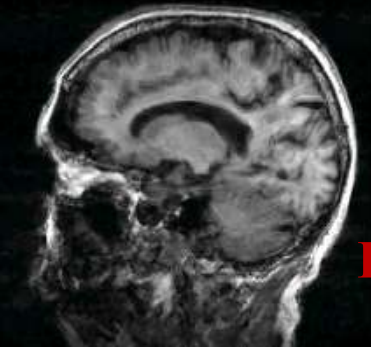


Automated Quality Checking



**High-quality
scan**

Automated
Decision



**Low-quality
scan**

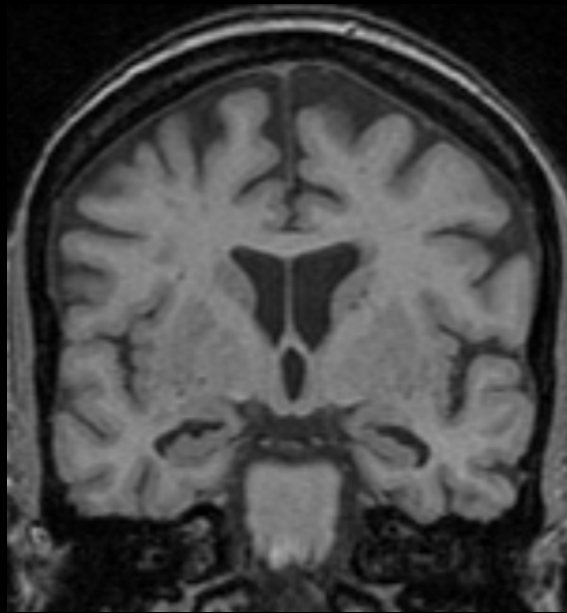
Outline

- Protocol development and distribution
- Quality assurance methods
- **Post-processing**
- Site communication
- Lessons learned

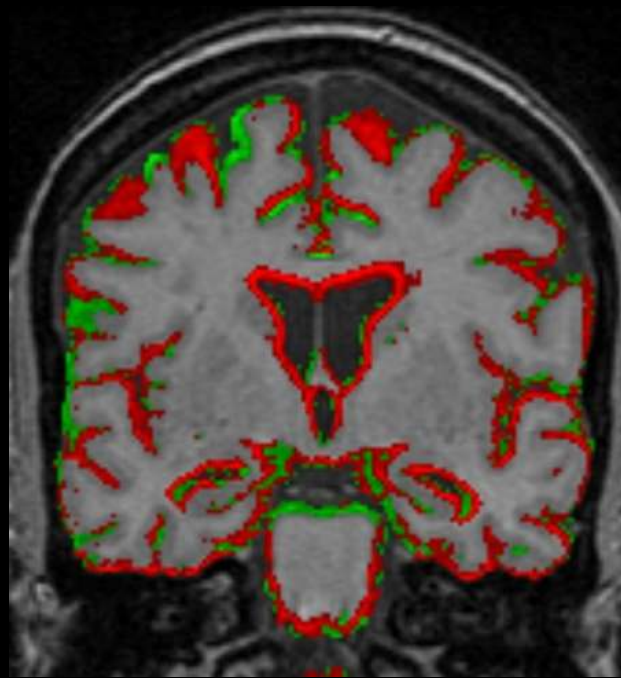
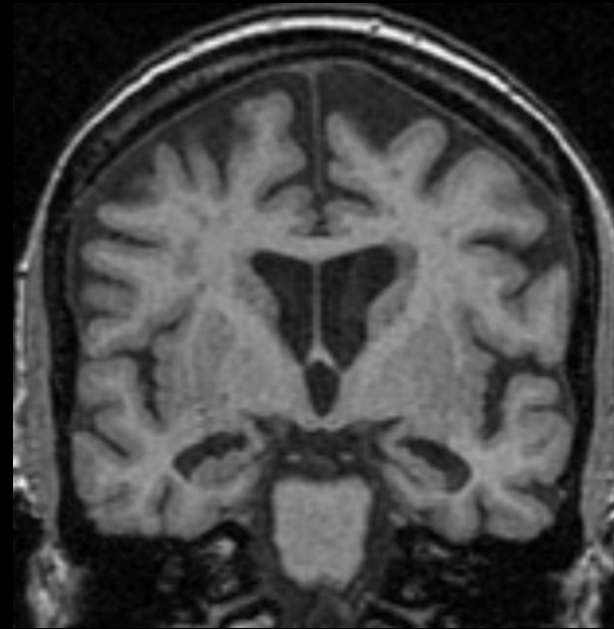
Image Processing Corrections

- Important tool for standardization
 - many are available now as product options
...at least on newer scanners
 - trial might need to do some of its own, off-line
- Few examples of corrections:
 - 3D image registration in longitudinal trial
 - image registration in time series (fMRI, etc)
 - homogeneity correction
 - spatial distortion correction, many others...

BASELINE MRI



REGISTER to Previous

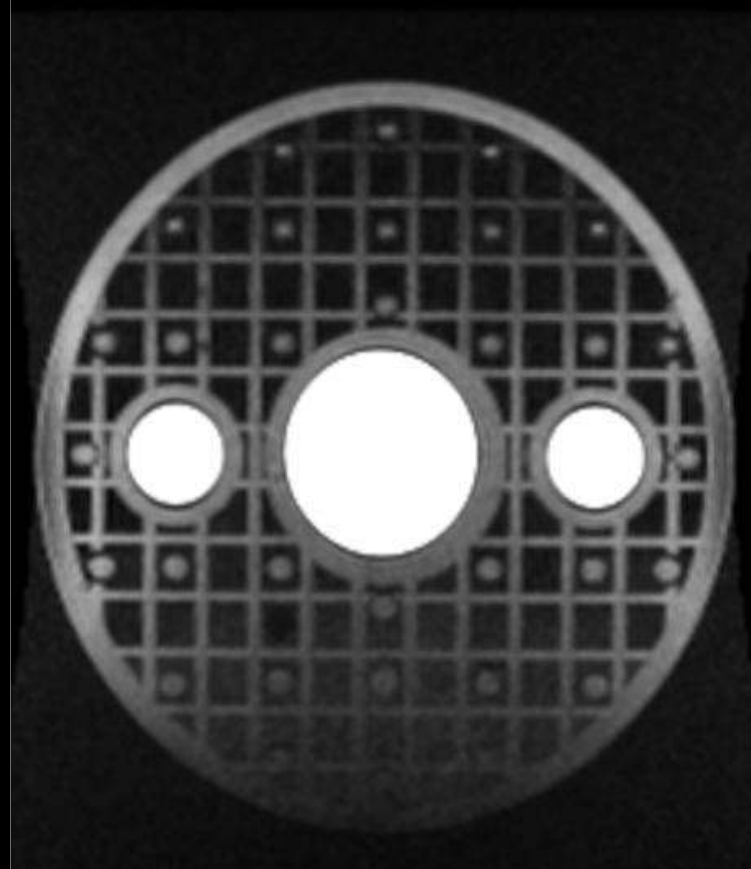


■ BRAIN VOLUME LOSS

BSI¹ OVERLAY

¹Freeborough
IEEE TMI 1997

3D Gradient Distortion Correction ("gradwarp")



Jovicich, Neuroimage 2006

Outline

- Protocol development and distribution
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- **Site communication**
- Lessons learned

Site Communication

- Dedicated site liaison for each trial/study
 - ideally, an experienced MR Tech
- Liaison is primary author of site training guide
 - emphasize: patient positioning and handling
 - emphasize: give the trial as much advance warning as possible before an upgrade
 - de-emphasize: specific protocol parameters

Outline

- Protocol development and distribution
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Lessons Learned

- Trial is a guest (low-priority user) at site
- Communication with MRI sites essential
- Protocol dry run (Prep Phase) for large trials
 - testing at few sites for each major platform
- Deliver electronic, machine loadable protocol
- Qualitative and Quantitative QA: phantom
- Work closely with imaging device vendors