The tools and technologies to make collaborations work!

Empowering Solutions for Multi-institution Collaboration

Large scale medical imaging infrastructures

NAMIC TRAINING
Hans J. Johnson, Ph.D.

2012-03-21

Why is this important?

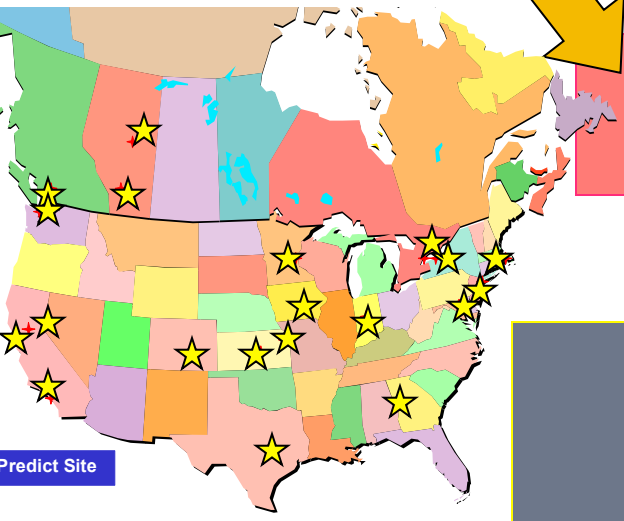
- PREDICT-HD Project
- NeuroNext Initiative

Each Study Site

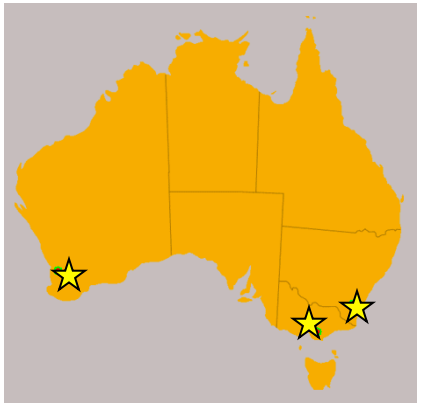
Neuropsychology Lab

DNA Lab

MRI



Data Management



Study Coordination

NEURO NEXT

Network of EXcellence in neuroscience Trials

Skip Navigation | En Español

National Institute of Neurological Disorders and Stroke

National Institutes of Health

Search

Reducing the burden of neurological disease...

NeuroNEXT: Network for Excellence in Neuroscience Clinical Trials

NeuroNEXT will provide a robust, standardized, and accessible infrastructure to facilitate rapid development and implementation of protocols in neurological disorders affecting adult and/or pediatric populations. The network includes multiple Clinical Sites, one Clinical Coordinating Center (CCC) and one Data Coordinating Center (DCC).

You DO NOT need to be part of the NeuroNEXT infrastructure to apply to conduct a study within the network. Applications from academic investigators, advocacy groups/foundations, small businesses and the pharmaceutical industry are welcomed.

Just google "NeuroNext"
http://www.ninds.nih.gov/news_and_events/proceedings/20101217-NEXT.htm

NEURO NEXT

Network of EXcellence in neuroscience Trials

- Designed to increase the Efficiency of clinical trials
- Facilitate patient recruitment and retention
- Increase the quality of neuroscience clinical trials
- Enable public-private partnerships
- ========
- Sharing expertise and infrastructure across diseases
- Leverage Research opportunities as they arise in different disease areas

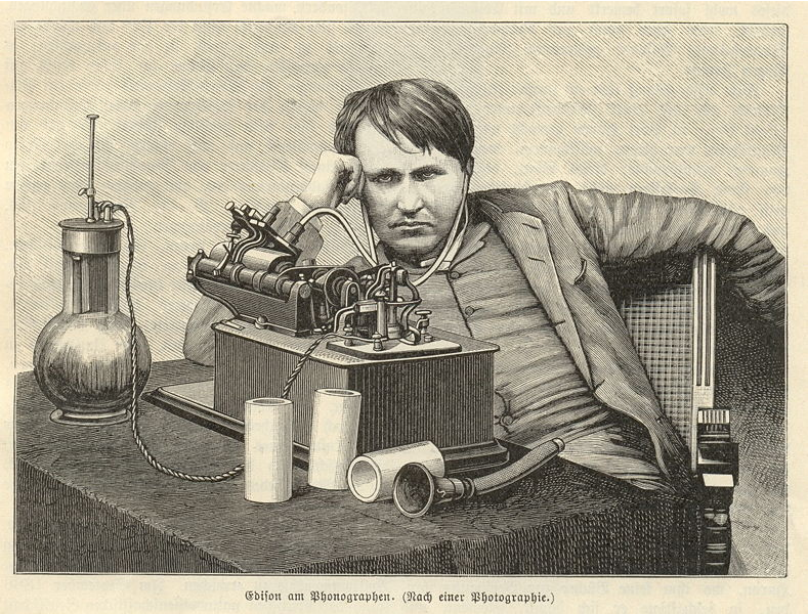
- THAT SOUNDS GREAT!
- So … What's all the fuss about?

- It's been tried before, with limited success
  - Technology alone can not solve this problem
  - We must understand the entire environment and possible resistance to a particular technological solution

The Current Wars!

- Those who cannot remember the past are condemned to repeat it. – George Santayana
- A tale of the difficulties in deploying great technology

The Characters in our tale



Thomas Edison

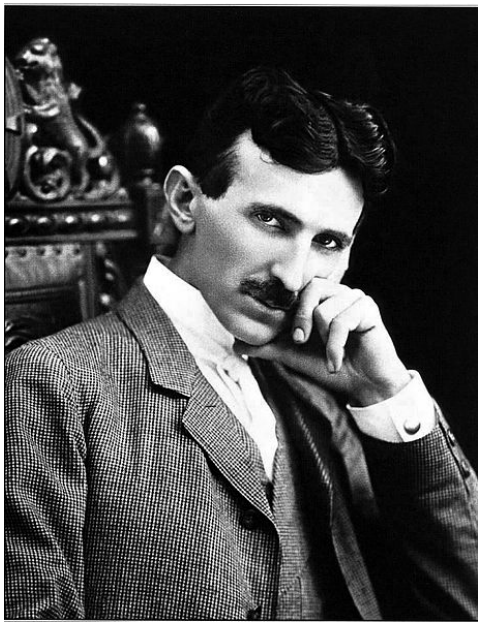
-Self-taught inventor

-Known for using keen observation and for making practical solutions for the betterment of human kind

Nikola Tesla

-University taught Mechanical & Electrical Engineering

-Known for his skills in physics and mathematics



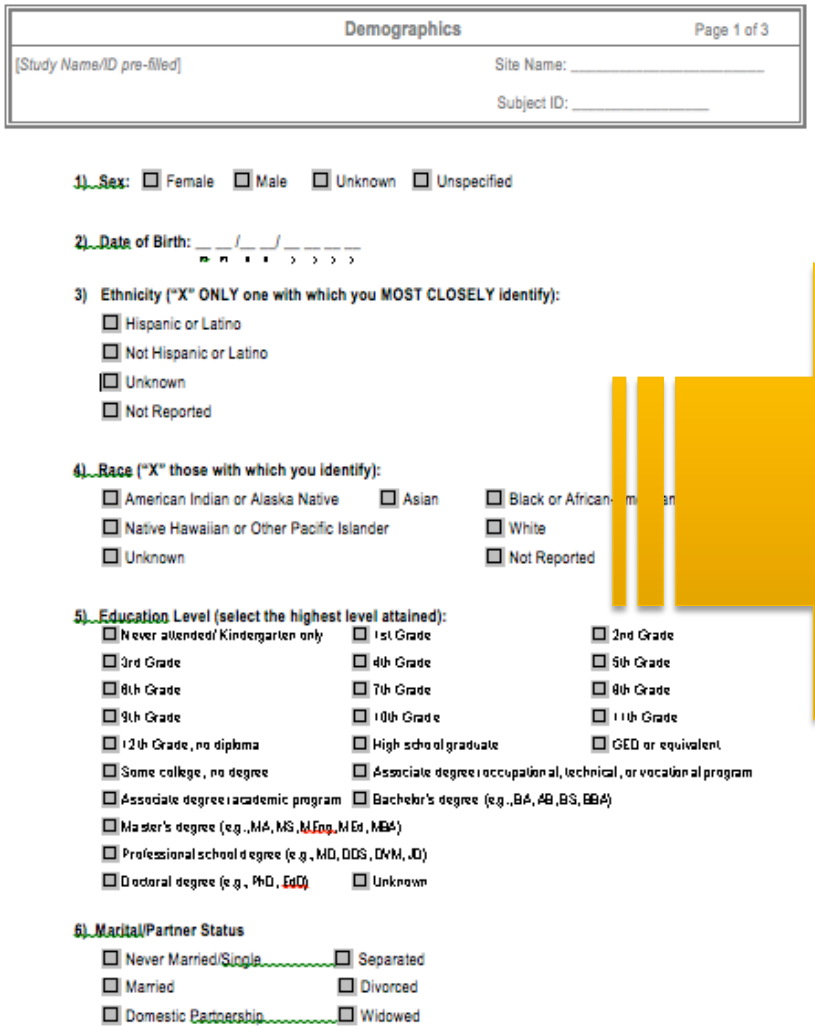
The grand idea

Volta – First battery

Edison wanted to replace gas lamps in Manhattan with Electric lights

- Worked on the problem
- Created large cache of intellectual protections (Patents)
- Hired good people (Tesla)
- Wanted to capitalize on his Patents by deploying solutions built on those concepts

The grand idea



Demographics — Page 1 of 3

[Study Name/ID pre-filled] Site Name: _____ Subject ID: _____

1) Sex: ☐ Female ☐ Male ☐ Unknown ☐ Unspecified

2) Date of Birth: __ __/__ __/__ __ __ __

3) Ethnicity ("X" ONLY one with which you MOST CLOSELY identify):
- ☐ Hispanic or Latino
- ☐ Not Hispanic or Latino
- ☐ Unknown
- ☐ Not Reported

4) Race ("X" those with which you identify):
- ☐ American Indian or Alaska Native ☐ Asian ☐ Black or African-[illegible]
- ☐ Native Hawaiian or Other Pacific Islander ☐ White
- ☐ Unknown ☐ Not Reported

5) Education Level (select the highest level attained):
- ☐ Never attended/ Kindergarten only ☐ 1st Grade ☐ 2nd Grade
- ☐ 3rd Grade ☐ 4th Grade ☐ 5th Grade
- ☐ 6th Grade ☐ 7th Grade ☐ 8th Grade
- ☐ 9th Grade ☐ 10th Grade ☐ 11th Grade
- ☐ 12th Grade, no diploma ☐ High school graduate ☐ GED or equivalent
- ☐ Some college, no degree ☐ Associate degree (occupational, technical, or vocational program)
- ☐ Associate degree (academic program) ☐ Bachelor's degree (e.g., BA, AB, BS, BBA)
- ☐ Master's degree (e.g., MA, MS, MEng, MEd, MBA)
- ☐ Professional school degree (e.g., MD, DDS, DVM, JD)
- ☐ Doctoral degree (e.g., PhD, EdD) ☐ Unknown

6) Marital/Partner Status
- ☐ Never Married/Single ☐ Separated
- ☐ Married ☐ Divorced
- ☐ Domestic Partnership ☐ Widowed

Research paper

Longitudinal change in regional brain volumes in prodromal Huntington disease

Elizabeth H Aylward,[1] Peggy C Nopoulos,[2] Christopher A Ross,[3] Douglas R Langbehn,[2] Ronald K Pierson,[2] James A Mills,[2] Hans J Johnson,[2] Vincent A Magnotta,[2] Andrew R Juhl,[2] Jane S Paulsen,[2] the PREDICT-HD Investigators and Coordinators of the Huntington Study Group

BRAIN
A JOURNAL OF NEUROLOGY

Smaller intracranial volume in prodromal Huntington's disease: evidence for abnormal neurodevelopment

Peggy C. Nopoulos,[1,2,3] Elizabeth H. Aylward,[4] Christopher A. Ross,[5] James A. Mills,[1] Douglas R. Langbehn,[1] Hans J. Johnson,[1] Vincent A. Magnotta,[1,6] Ronald K. Pierson,[1] Leigh J. Beglinger,[1] Martha A. Nance,[7] Roger A. Barker,[8] Jane S. Paulsen[1,3] and the PREDICT-HD Investigators and Coordinators of the Huntington Study Group

Diffusion Tensor Imaging in Preclinical Huntington's Disease

Vincent A. Magnotta · Jinsuh Kim · Tim Koscik · Leigh J. Beglinger · Daisy Espinso · Doug Langbehn · Peg Nopoulos · Jane S. Paulsen

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Contents lists available at ScienceDirect

Experimental Neurology

journal homepage: www.elsevier.com/locate/yexnr

Review

Functional imaging in Huntington's disease

Jane S. Paulsen *

Carver College of Medicine, The University of Iowa, Iowa City,

ELSEVIER

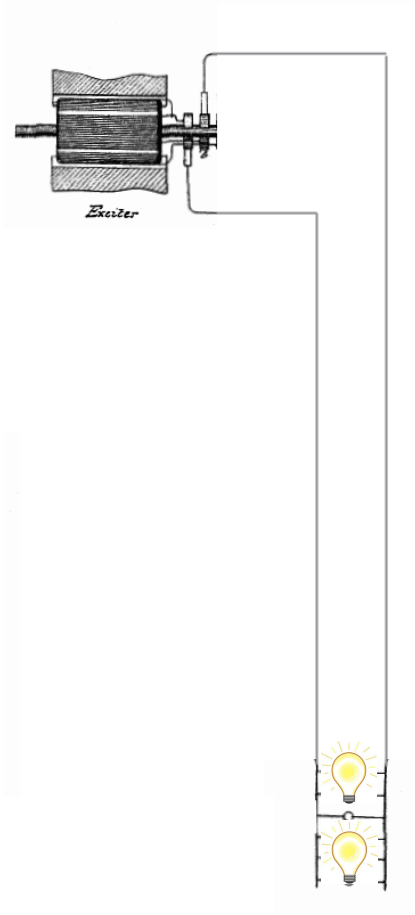
NeuroImage

www.elsevier.com/locate/ynimg
NeuroImage 31 (2006) 1075 – 1085

Evaluation of the GTRACT diffusion tensor tractography algorithm: A validation and reliability study

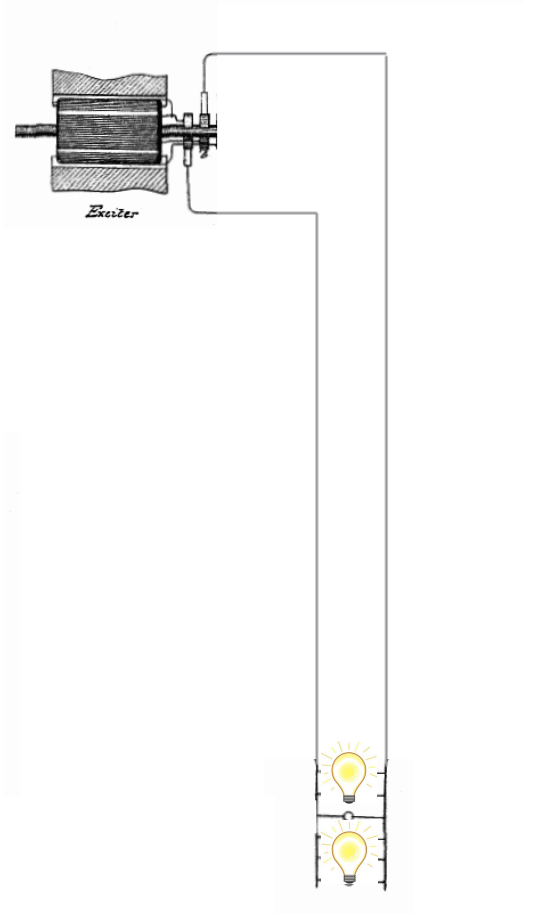
Peng Cheng,[a] Vincent A. Magnotta,[b,*] Dee Wu,[c] Peg Nopoulos,[d] David J. Moser,[d] Jane Paulsen,[d] Ricardo Jorge,[d] and Nancy C. Andreasen[d]

The controversy

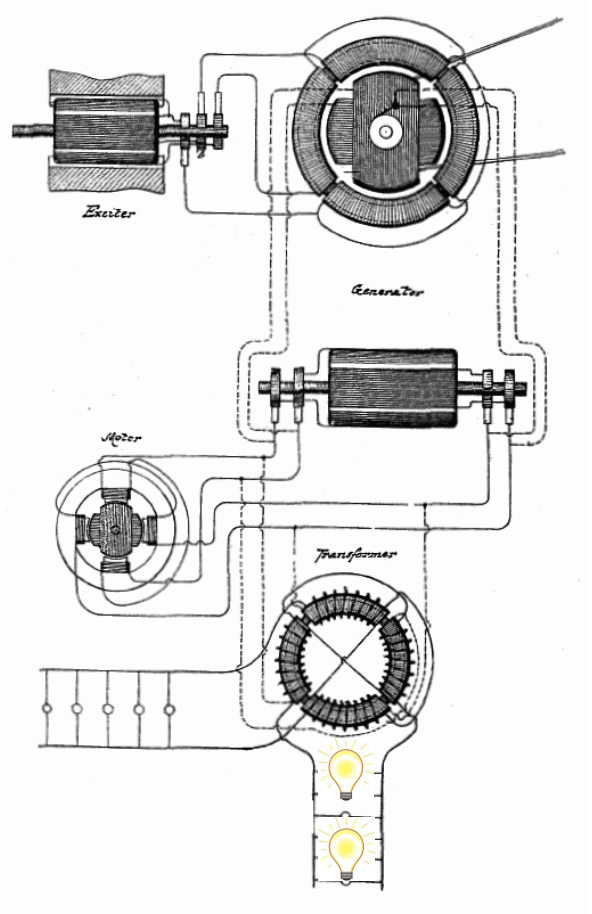


Edison's DC power distribution for incandescent lights in Manhattan

The controversy



Edison's DC power distribution for incandescent lights in Manhattan

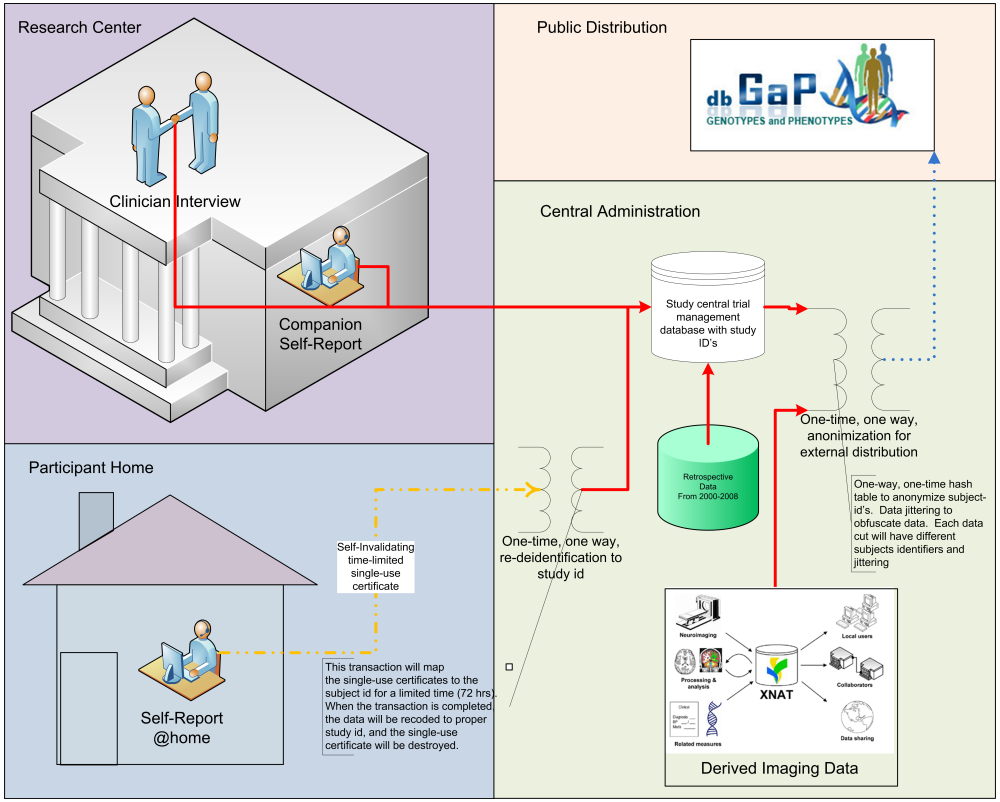


Tesla's US390721 Patent for a "Dynamo Electric Machine"

The controversy

1	AC	0.463125	0.00949066
2	BP	1.31568	0.574126
3	LE	0.88845	0.142804
4	MPJ	0.54543	0.149873
5	OC	0.474684	0.0336125
6	PC	0.718717	0.232053
7	RE	0.757446	0.0446324
8	SMV	0.892167	0.126407
9	VN4	0.431133	0.0206607

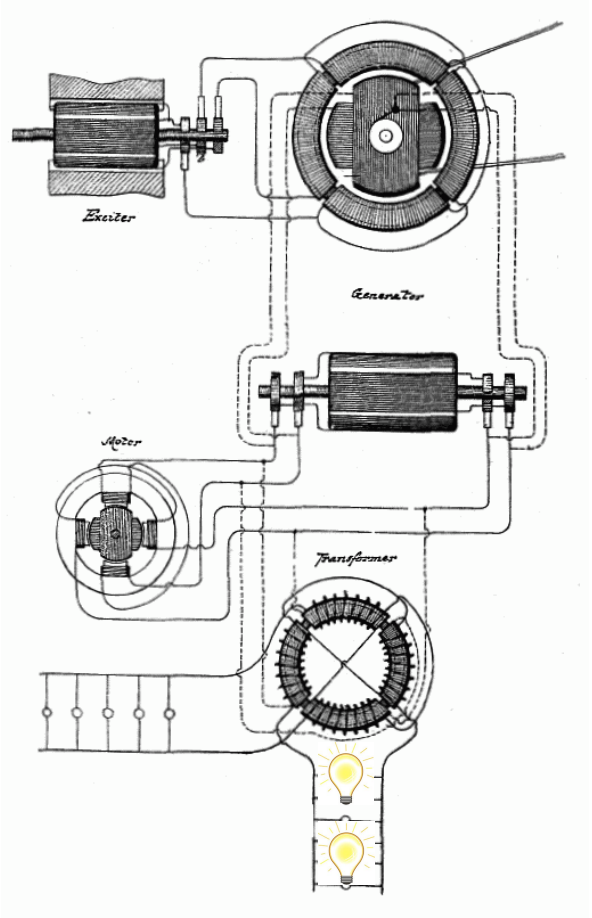
Microsoft Excel is most used!
Microsoft Access is used sometimes



This is HARD. It uses many technologies that only a few people understand, and very few understands all of them.

The tipping point

- "[Tesla's] ideas are splendid, but they are utterly impractical"** – Thomas Edison
- DC Advantages
  - Simple (The math is easy) , and practical (solid core copper)
  - It was easy to demonstrate utility
  - It was already in use in to light the streets of Manhattan



Tesla's US390721 Patent for a "Dynamo Electric Machine"

** Richard Munson, From Edison to Enron: The Business of Power and what it Means for the Future of Electricity. Page 23

The tipping point

- "[Tesla's] ideas are splendid, but they are utterly impractical"** – Thomas Edison
- DC Advantages
  - Simple (The math is easy), and practical (solid core copper)
  - It was easy to demonstrate utility
  - It was already in use in to light the streets of Manhattan
- AC Dis-advantages
  - Only a few people understand and can implement
  - The AC transformers (both to and from DC) introduce energy loss
  - Experiments in Manhattan showed that DC requires less copper in wire than AC

** Richard Munson, From Edison to Enron: The Business of Power and what it Means for the Future of Electricity. Page 23

DC is better!

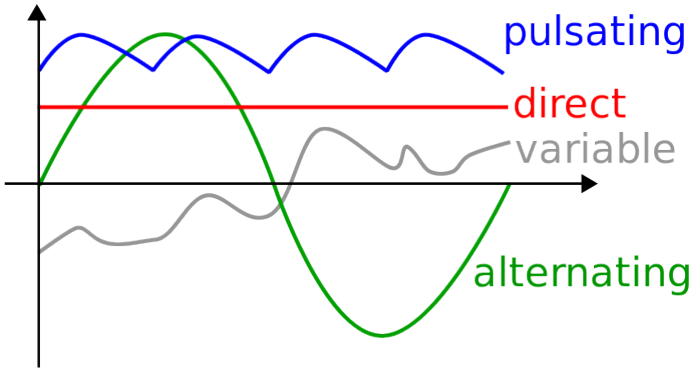
Zinc + Copper + Potatoes ➔ Light!

$$I = \frac{V}{R}$$

DC is better!

Zinc + Copper + Potatoes ➔ Light!

$$I = \frac{V}{R}$$



$$v(t) = V_{\text{peak}} \cdot \sin(\omega t)$$

$$\omega = 2\pi f$$

$$p(t) = \frac{v^2(t)}{R}$$

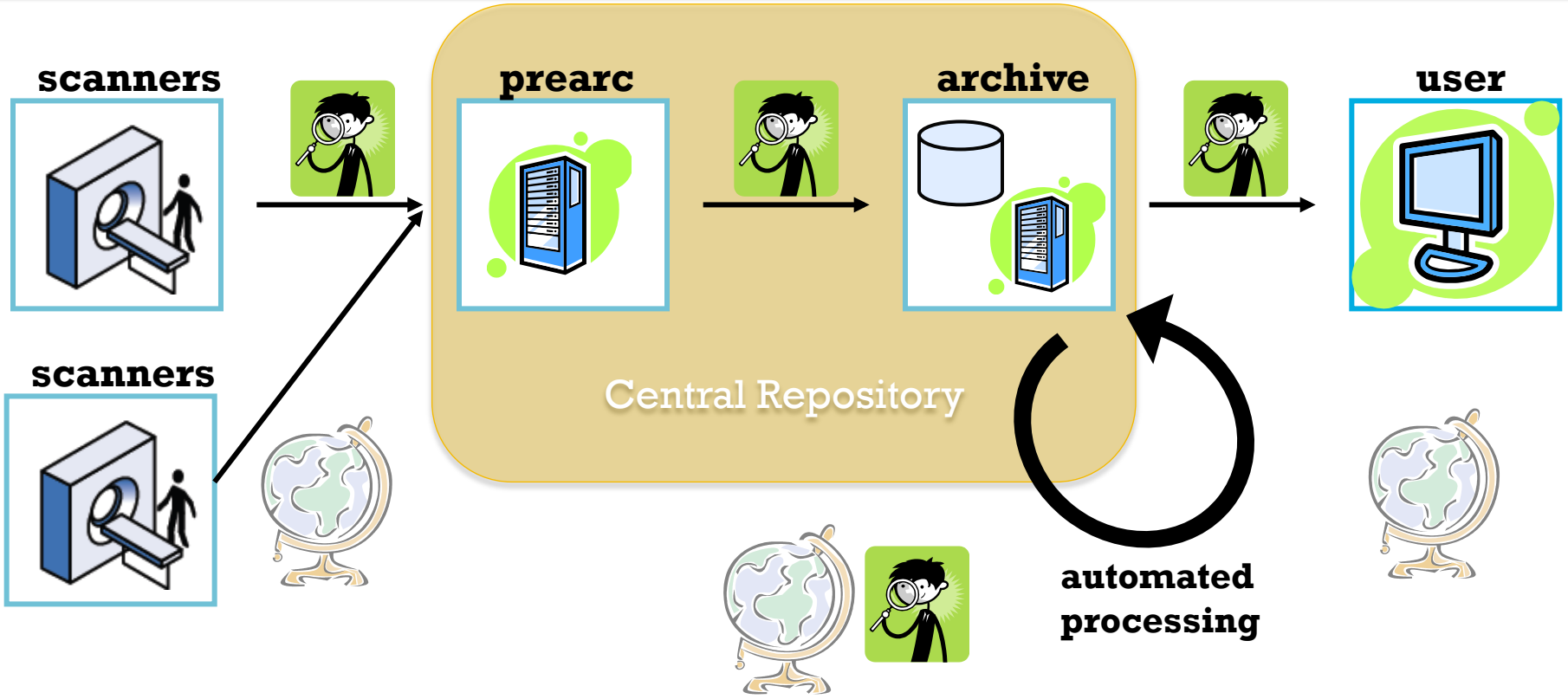
$$P_{average} = V_m I_m \cos\phi \frac{\int_0^T \sin^2 \omega t dt}{T} = \frac{V_m I_m}{2} \cos\phi$$

$$P_{\text{instantaneous}} = V_m I_m \cos\phi \sin^2 \omega t - V_m I_m \sin\phi \sin \omega t \cos \omega t$$

So why do we all use AC?

- DC power generation needs to be within 1 mile of the load.
- DC power is one size fits all, and is very inefficient to rescale to different size problems
  - Lights are low power, and would require one set of transmission lines
  - Appliances are high power, and would require separate transmission lines

So when should we consider complicated Informatics solutions?



Quality control

Prearchive
Automation

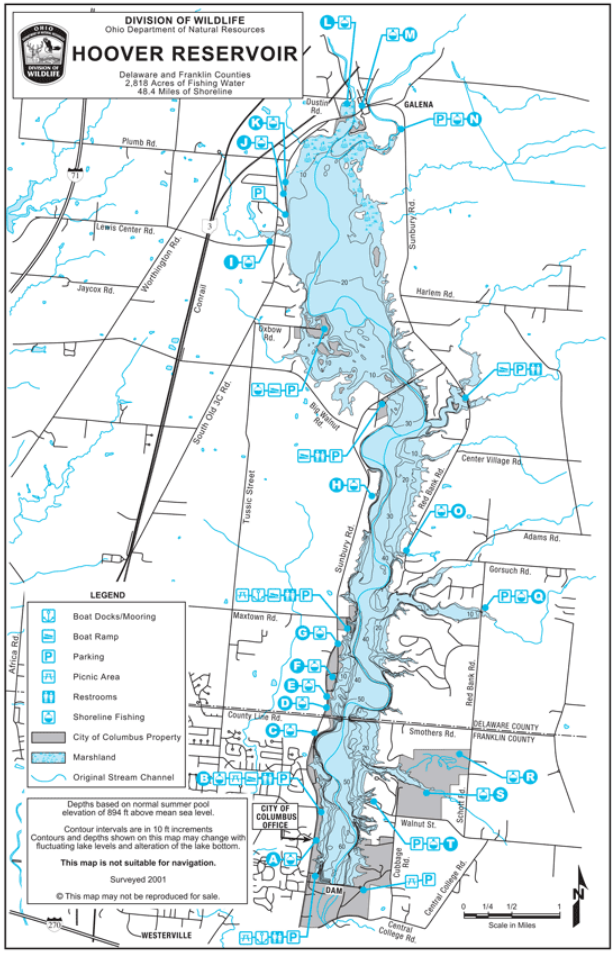
Online image viewing
Study-specific validation

Annotation
Provenance

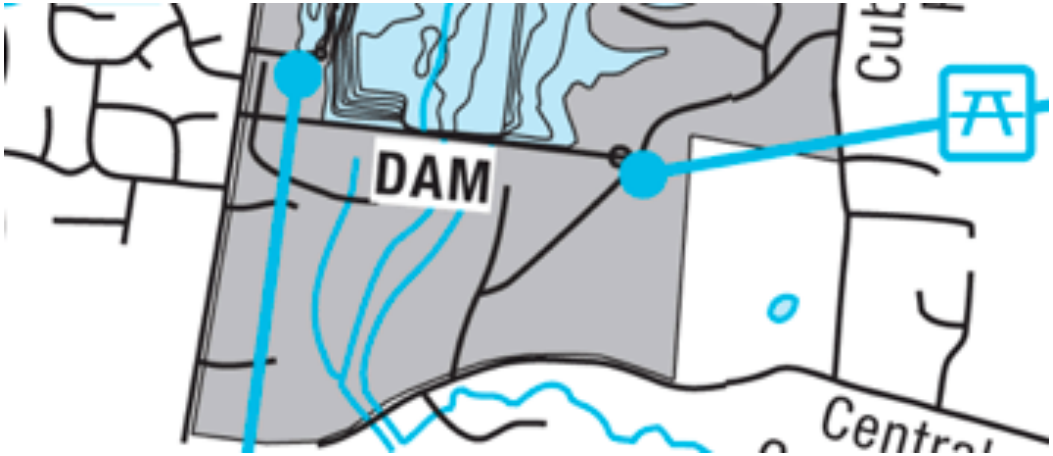
Potential vs. Kinetic energy

- Collected data has so many potential uses
  - Combine normative samples with other studies
  - Re-analyze existing data with novel methods
  - Harness the power of domain experts to fully explore details of the data
- Potential energy does no good until it is converted to Kinetic energy!

How do we store and make use of resources?



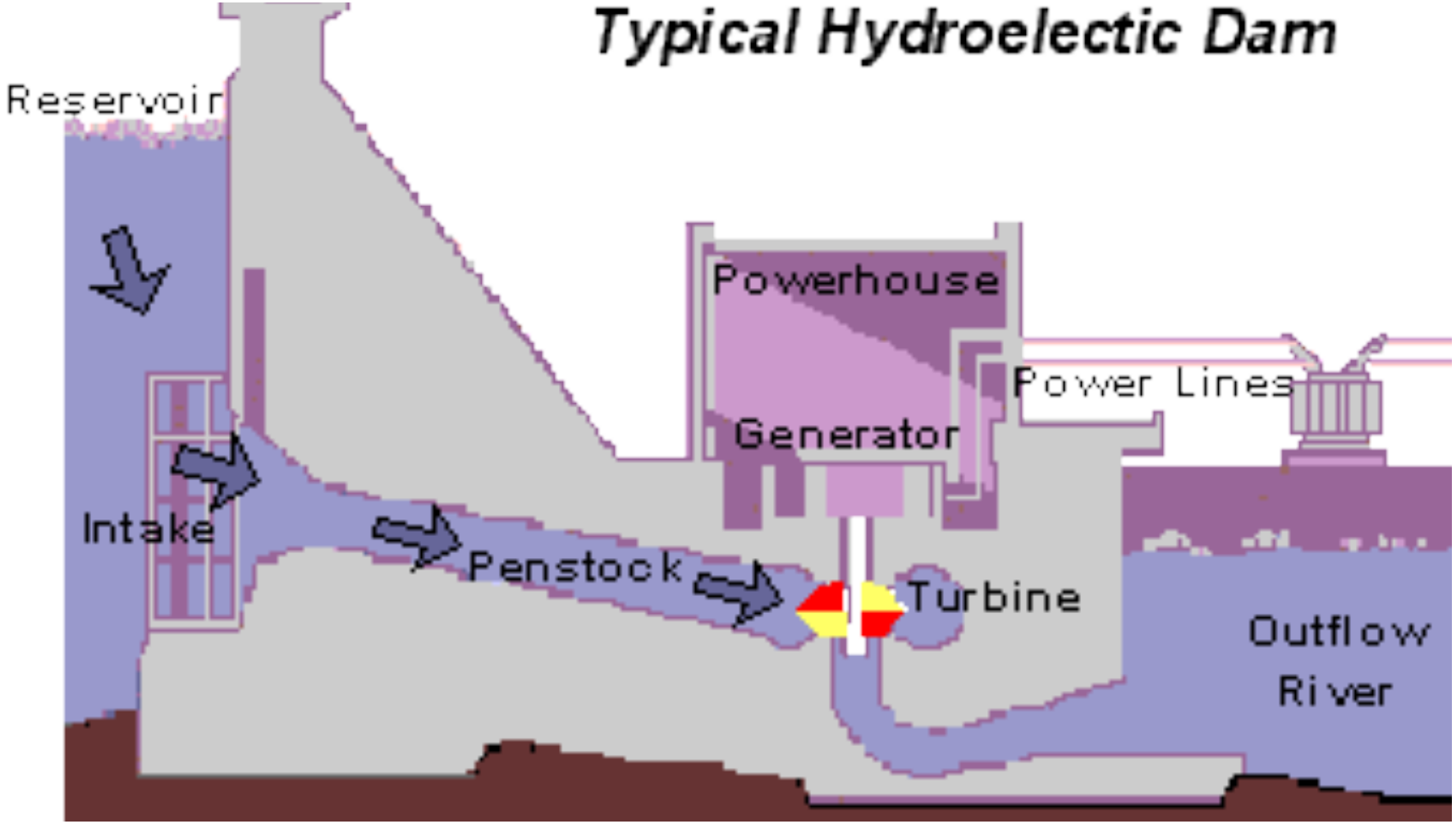
HOOVER RESERVOIR FISHING MAP Publication 5244 (R309)



How do make the most of our stored resources?

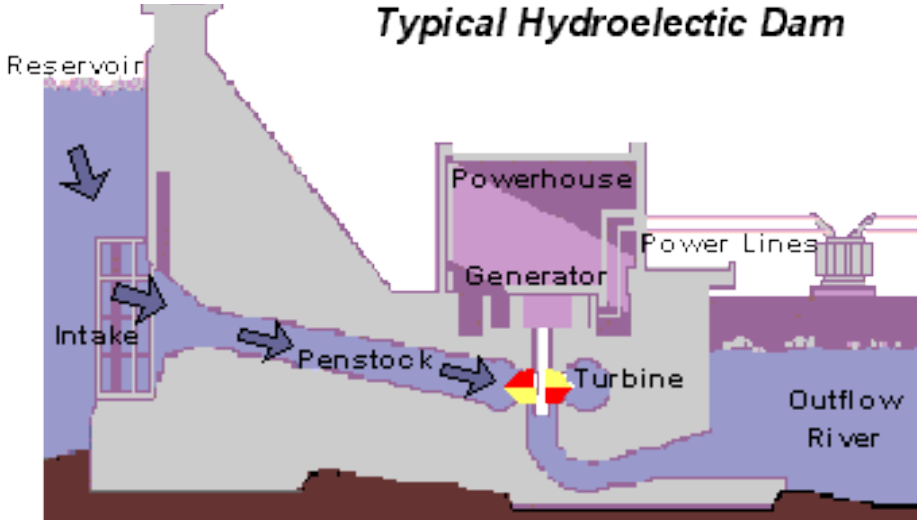
Creating single purpose local use of stored energy is not too hard.

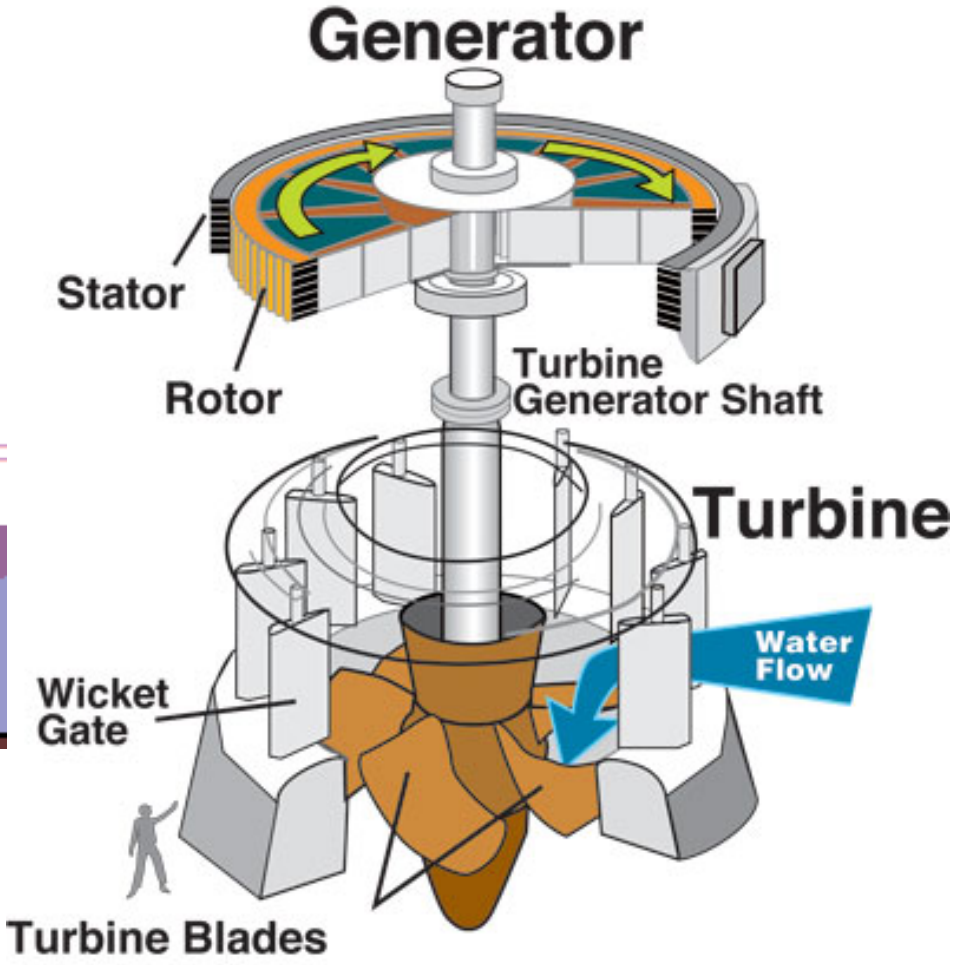
How do make the most of our stored resources?



http://ga.water.usgs.gov/edu/hyhowworks.html

How do make the most of our stored resources?





XNAT
Extensible Neuroimaging Archive Toolkit

- Completed
  - HawkID Authentication
  - 49 projects
  - 1916 subjects
  - 4241 imaging sessions
  - 2.5-Terabytes of raw image data.
  - Composite data collections shared with 17 external collaborators

User johnsonhj

Password ••••••••••

Login

Register **Forgot login or password?**

This is xnat production site. Please log in with your IOWA HawkID.

powered by XNAT

User: johnsonhj (Logout) (Edit) (Report a problem)

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  - Recent
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    - My projects
    - Other projects
- Stored Searches
- Data

Search

PREDICTHD currently contains 35 Projects, 988 Subjects, and 1739 Imaging Sessions.

Projects | Subjects | MR | PET | CT

ID | Name | Description

Keywords | Investigator | SELECT

Submit

Projects

PHD_DTI_THP
Project ID: PHD_DTI_THP
Request access to this project.

PHD-073
Project ID: PHD-073
Request access to this project.

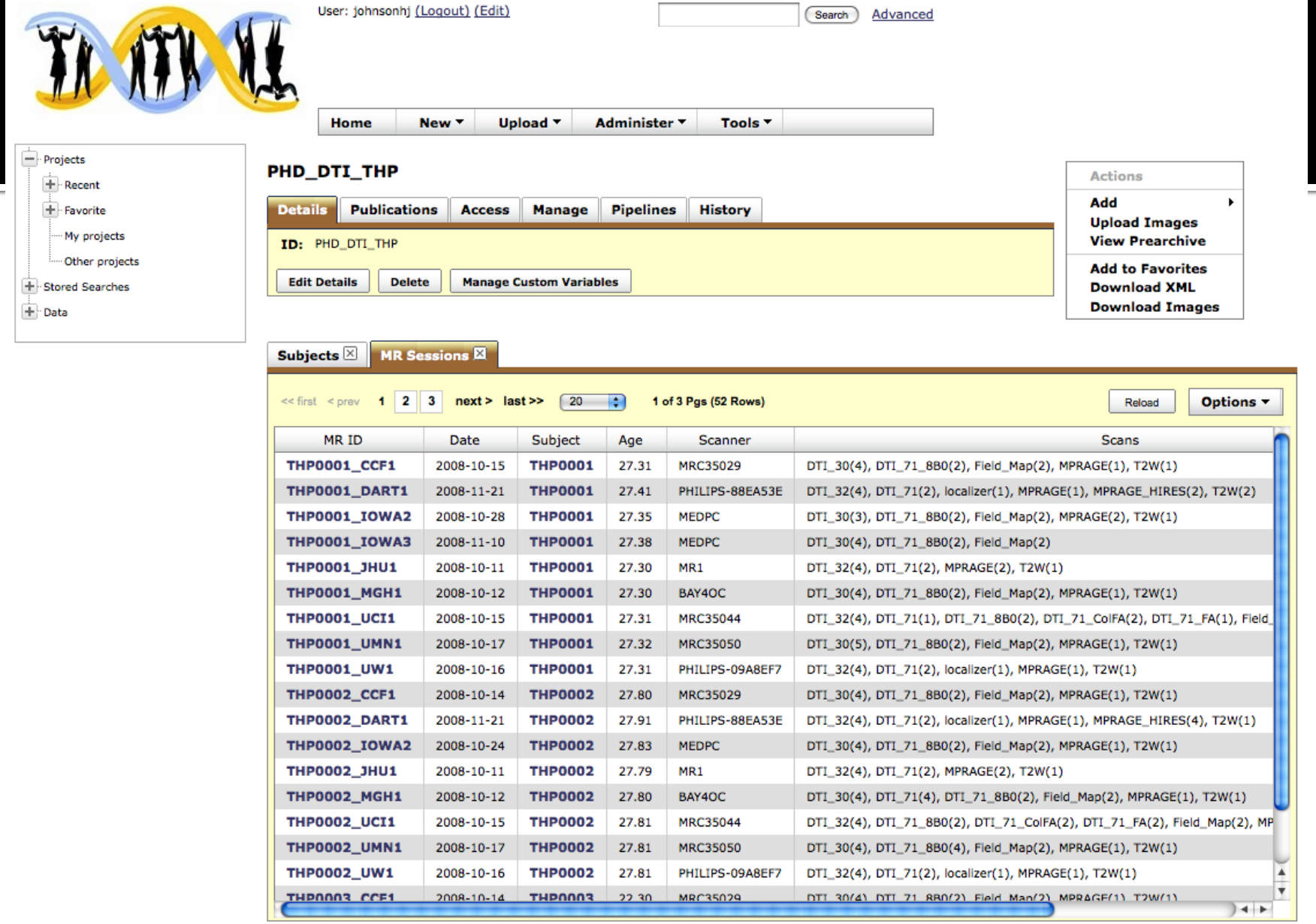
PHD-039
Project ID: PHD-039
Request access to this project.

PHD-024
Project ID: PHD-024
Request access to this project.

PHD-061
Project ID: PHD-061
Request access to this project.

Recent Data Activity

PHD-050	MR	44203	ARC
PHD-120	MR	44912	ARC
PHD-120	MR	45693	ARC
PHD-120	MR	40752	ARC
PHD-120	MR	83260	ARC
PHD-120	MR	61493	ARC
PHD-120	MR	46076	ARC
PHD-120	MR	75319	ARC
PHD-120	MR	40002	ARC
PHD-120	MR	37653	ARC
PHD-052	MR	85013	ARC
PHD-048	MR	42492	ARC
PHD-052	MR	75704	ARC
PHD-144	MR	20917	ARC
PHD-144	MR	48969	ARC
PHD-083	MR	76752	ARC
PHD-083	MR	90915	ARC
PHD-073	MR	28760	ARC
PHD-073	MR	30720	ARC



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THP0001_DART1	2008-11-21	THP0001	27.41	PHILIPS-88EA53E	DTI_32(4), DTI_71(2), localizer(1), MPRAGE(1), MPRAGE_HIRES(2), T2W(2)
THP0001_IOWA2	2008-10-28	THP0001	27.35	MEDPC	DTI_30(3), DTI_71_8B0(2), Field_Map(2), MPRAGE(2), T2W(1)
THP0001_IOWA3	2008-11-10	THP0001	27.38	MEDPC	DTI_30(4), DTI_71_8B0(2), Field_Map(2)
THP0001_JHU1	2008-10-11	THP0001	27.30	MR1	DTI_32(4), DTI_71(2), MPRAGE(2), T2W(1)
THP0001_MGH1	2008-10-12	THP0001	27.30	BAY4OC	DTI_30(4), DTI_71_8B0(2), Field_Map(2), MPRAGE(1), T2W(1)
THP0001_UCI1	2008-10-15	THP0001	27.31	MRC35044	DTI_32(4), DTI_71(1), DTI_71_8B0(2), DTI_71_ColFA(2), DTI_71_FA(1), Field_
THP0001_UMN1	2008-10-17	THP0001	27.32	MRC35050	DTI_30(5), DTI_71_8B0(2), Field_Map(2), MPRAGE(1), T2W(1)
THP0001_UW1	2008-10-16	THP0001	27.31	PHILIPS-09A8EF7	DTI_32(4), DTI_71(2), localizer(1), MPRAGE(1), T2W(1)
THP0002_CCF1	2008-10-14	THP0002	27.80	MRC35029	DTI_30(4), DTI_71_8B0(2), Field_Map(2), MPRAGE(1), T2W(1)
THP0002_DART1	2008-11-21	THP0002	27.91	PHILIPS-88EA53E	DTI_32(4), DTI_71(2), localizer(1), MPRAGE(1), MPRAGE_HIRES(4), T2W(1)
THP0002_IOWA2	2008-10-24	THP0002	27.83	MEDPC	DTI_30(4), DTI_71_8B0(2), Field_Map(2), MPRAGE(1), T2W(1)
THP0002_JHU1	2008-10-11	THP0002	27.79	MR1	DTI_32(4), DTI_71(2), MPRAGE(2), T2W(1)
THP0002_MGH1	2008-10-12	THP0002	27.80	BAY4OC	DTI_30(4), DTI_71(4), DTI_71_8B0(2), Field_Map(2), MPRAGE(1), T2W(1)
THP0002_UCI1	2008-10-15	THP0002	27.81	MRC35044	DTI_32(4), DTI_71_8B0(2), DTI_71_ColFA(2), DTI_71_FA(2), Field_Map(2), MP
THP0002_UMN1	2008-10-17	THP0002	27.81	MRC35050	DTI_30(4), DTI_71_8B0(4), Field_Map(2), MPRAGE(1), T2W(1)
THP0002_UW1	2008-10-16	THP0002	27.81	PHILIPS-09A8EF7	DTI_32(4), DTI_71(2), localizer(1), MPRAGE(1), T2W(1)
THP0003_CCF1	2008-10-14	THP0003	27.30	MRC35029	DTI_30(4), DTI_71_8B0(2), Field_Map(2), MPRAGE(1), T2W(1)

User: johnsonhj (Logout) (Edit)

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- Data

PROJECT: PHD_DTI_THP > SUBJECT:THP0001 > THP0001_MGH1

MR Session: THP0001_MGH1

Details | Projects

Accession #	PREDICTHD_E01684	**Subject:**	THP0001
Date Added	2009-10-22 19:15:18.0 (admin)	**Gender:**	Male
Date:	2008-10-12	**Handedness:**	
Time:	17:52:28	**Age:**	27.30
Operator:	swallace		
Scanner:	BAY4OC SIEMENS TrioTim		

Actions
- Edit
- View
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- Delete

Notes:

Scans

Scan	Type	Files	Note
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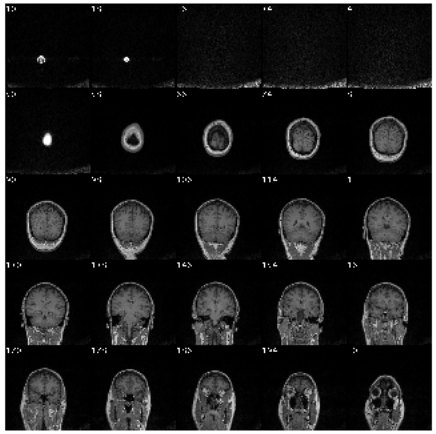
Image



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TR	2300.0
TE	2.87
TI	900.0

User: johnsonhj (Logout) (Edit)

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- Data

PROJECT: PHD_DTI_THP

Imaging Data Download

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- [ ] THP0001_IOWA3 MR
- [ ] THP0002_IOWA2 MR
- [ ] THP0003_IOWA2 MR
- [ ] THP0004_IOWA1 MR
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- [ ] THPBALL_IOWA1 MR
- [ ] THPBALL_IOWA2 MR
- [x] THP0001_CCF1 MR
- [ ] THP0002_CCF1 MR
- [ ] THP0003_CCF1 MR
- [ ] THP0004_CCF1 MR
- [ ] THP0005_CCF1 MR
- [ ] THPBALL_CCF1 MR
- [ ] THP0001_DART1 MR
- [ ] THP0002_DART1 MR
- [ ] THP0003_DART1 MR
- [ ] THP0004_DART1 MR
- [ ] THP0005_DART1 MR
- [ ] THP0001_UMN1 MR

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Raw Scans

- [x] DTI_32 (83)
- [ ] DTI_71_8B0 (76)
- [ ] Field_Map (74)
- [ ] T2W (45)
- [ ] DTI_71_FA (11)
- [ ] MPRAGE_HIRES (12)
- [ ] localizer (9)
- [ ] DTI_71 (52)
- [ ] DTI_30 (124)
- [ ] B0_MAP (1)
- [ ] MPRAGE (52)
- [ ] DTI_71_ColFA (12)

Reconstructions

Assessments

3 Select download format

- (•) Option 1: Direct download

  You will be prompted to enter a local directory to copy the data to. Then, all of the requested imaging data will be directly downloaded via a java applet into that directory.

- ( ) Option 2: Catalog XML (.xcat)

  Download an xml representation of the files. This xml can then be used by specific applications to download the data at the user's command.

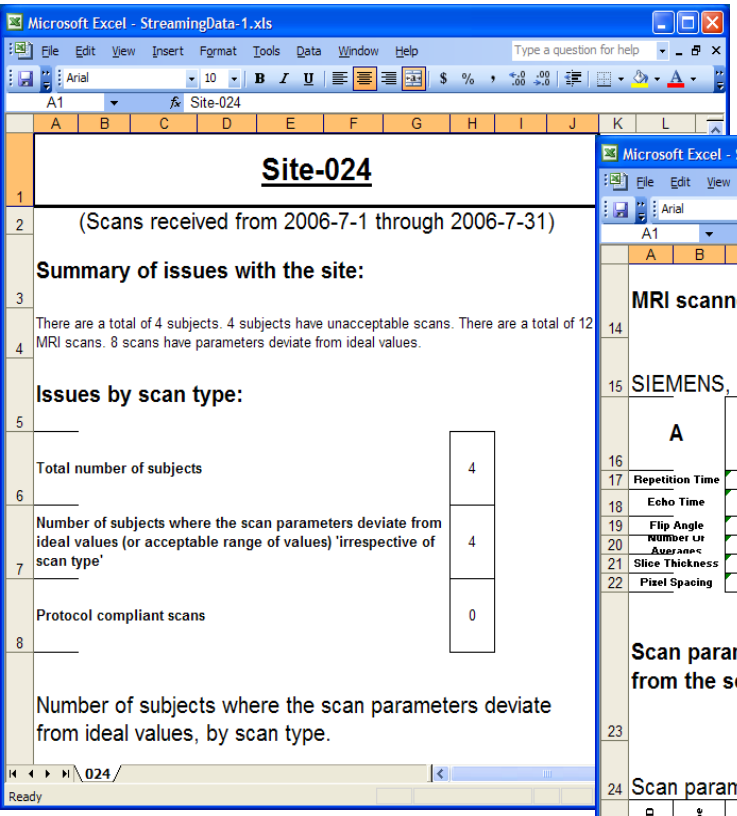
4 Submit Data Request

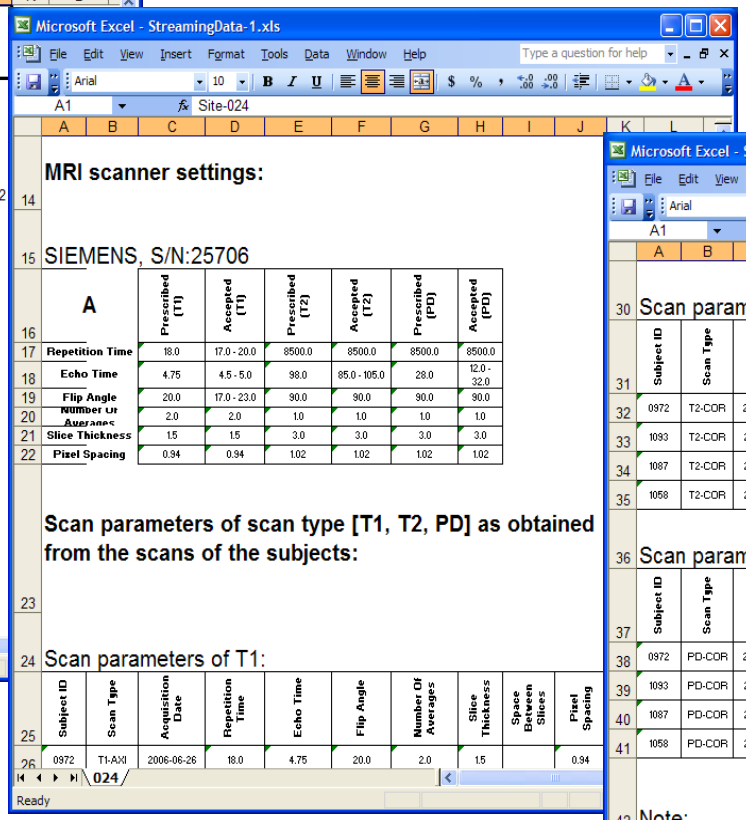
Submit

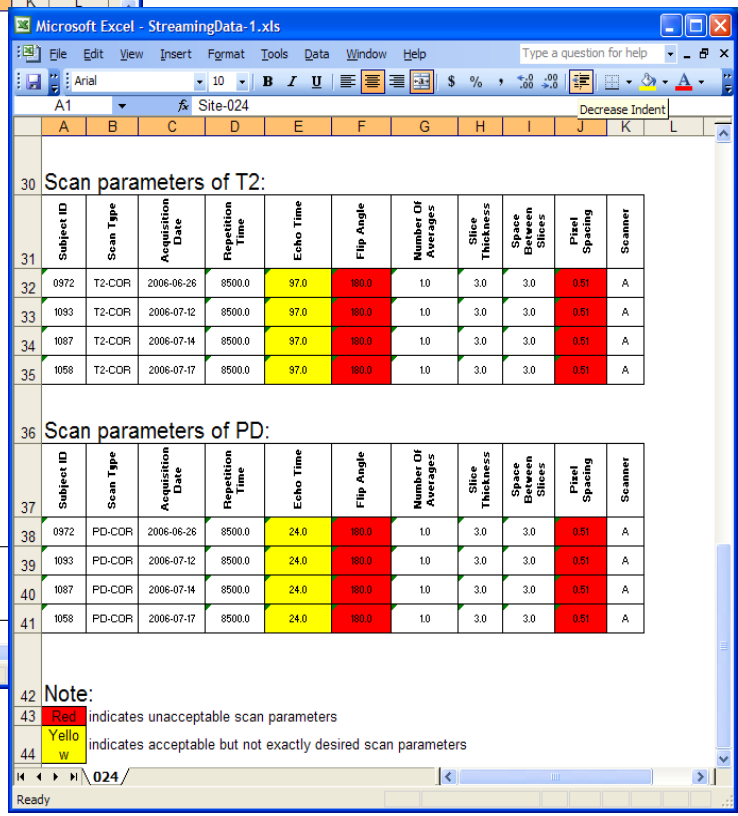
Upon page submission, the pertinent files will be reviewed and organized for download. Depending on the number of files, this may take several minutes to process.

Feedback Reports On Status

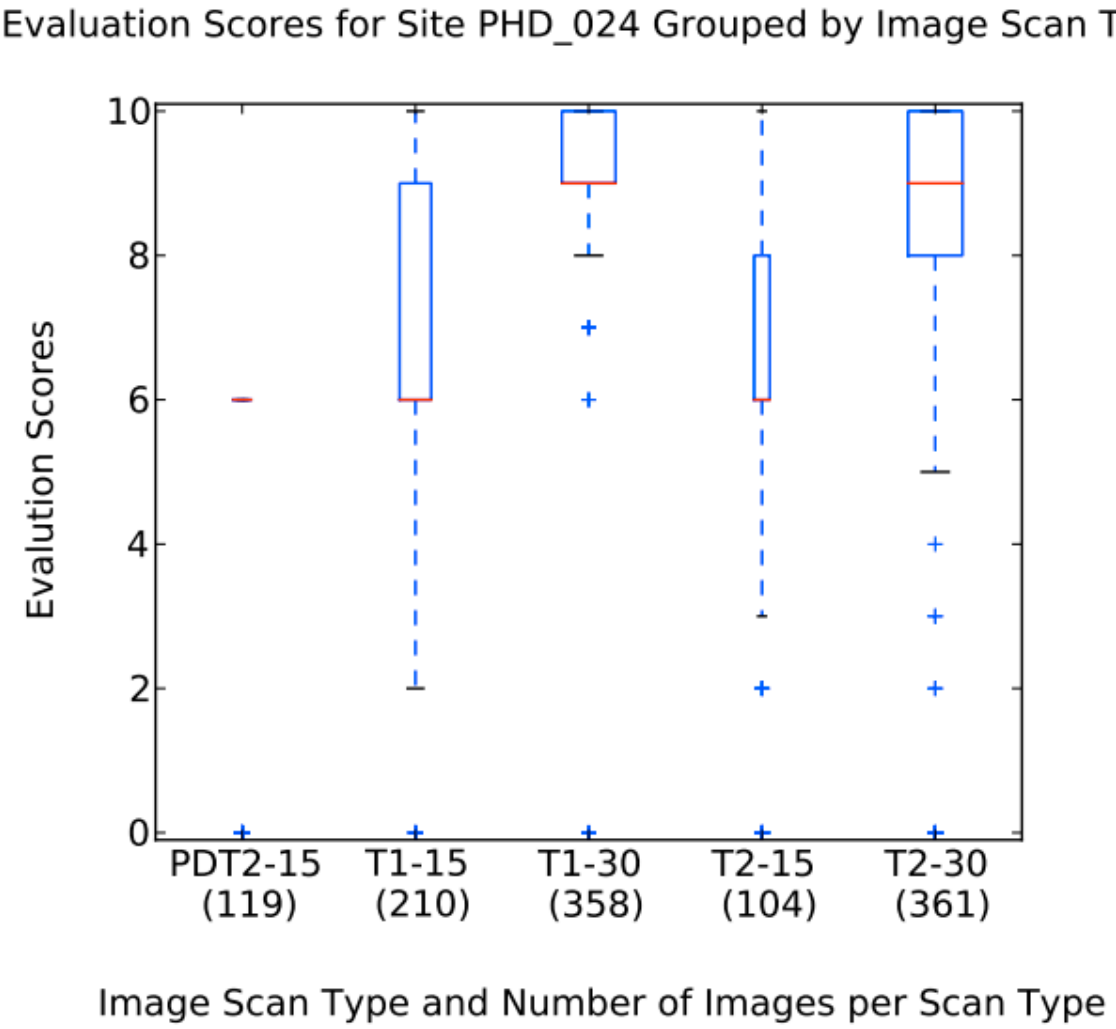
- http://www.hdni.org:8080



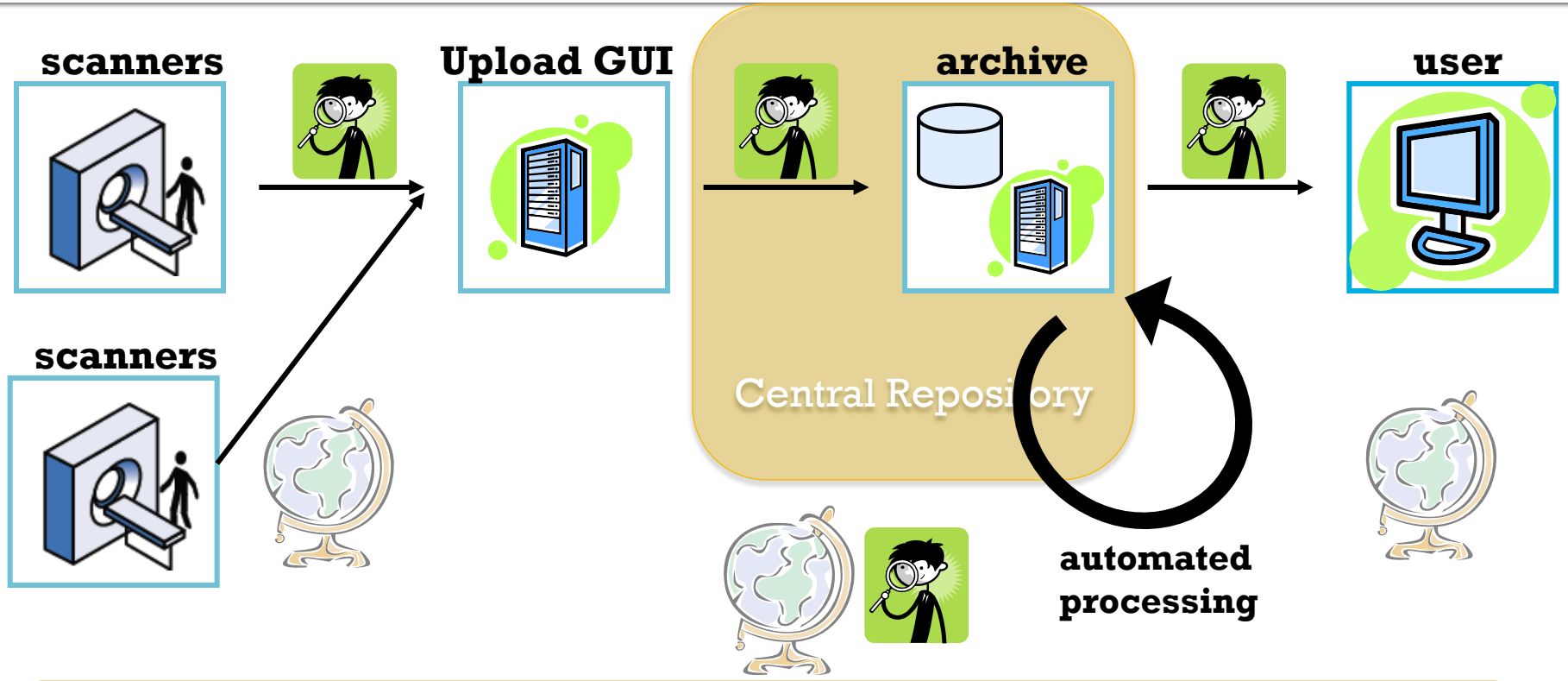




Quality of Scans



Enterprise Analysis Workflow

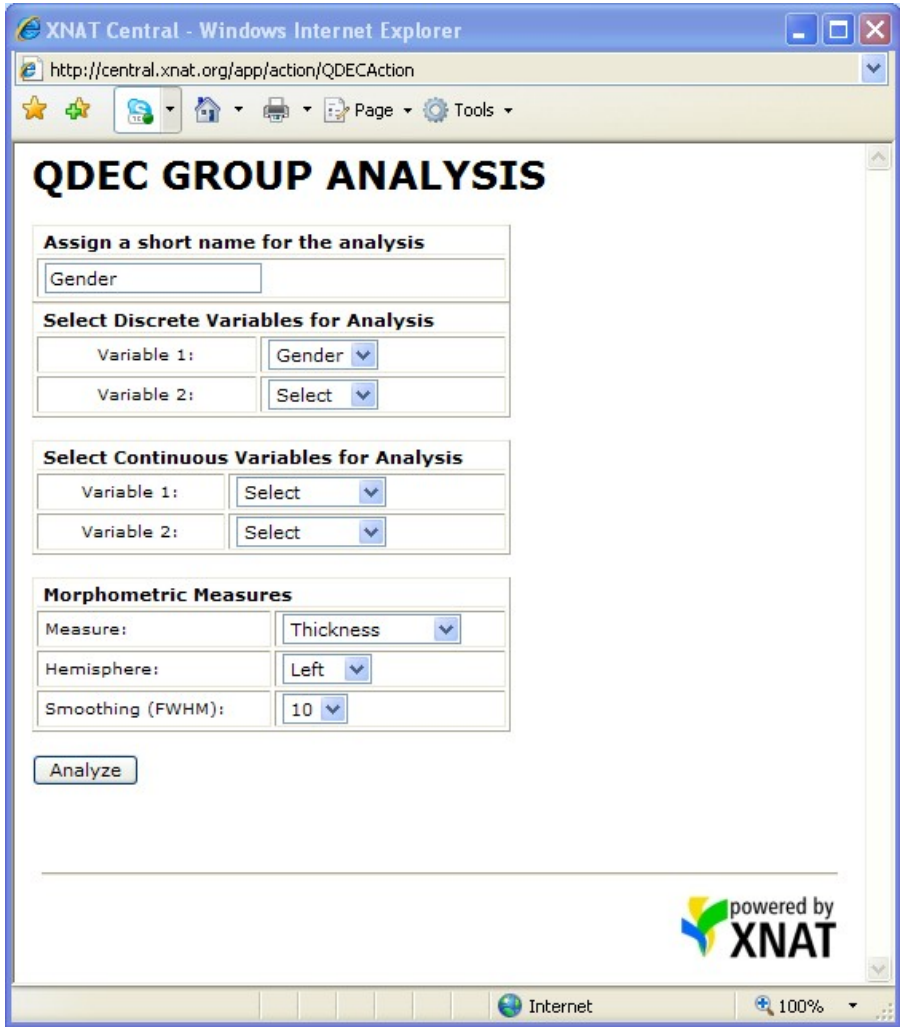


Quality control

Prearchive
Automation
Online image viewing
Study-specific validation
Annotation
Provenance

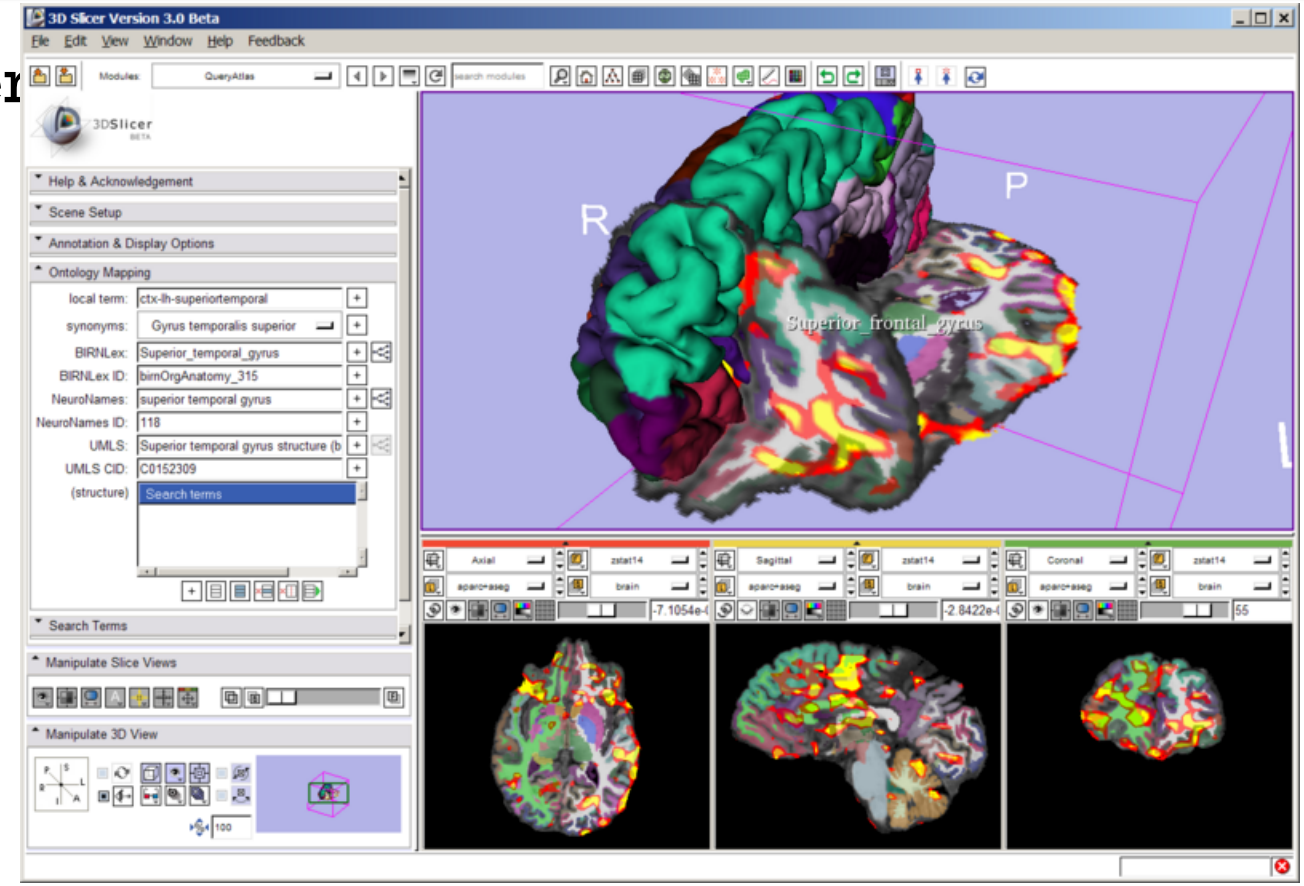
Interoperability in the field: XNAT, Freesurfer, QDEC, & Slicer

- Run Freesurfer
- Find subjects
- Run QDEC as an XNAT pipeline



Interoperability in the field: XNAT, Freesurfer, QDEC, & Slicer

- Run Freesurfer
- Find subjects
- Run QDEC
- View in slicer



Now what?

- Analyzing these large collections of data also requires great infrastructures
  - Compliant Algorithmic Libraries –ITK
  - Large-scale computation – Clusters
  - Rapid prototyping – SimpleITK
  - Workflow management – NiPype