

Erasmus MC

University Medical Center Rotterdam



Customized Pipelines for the Processing of Medical Images in Large Population Studies

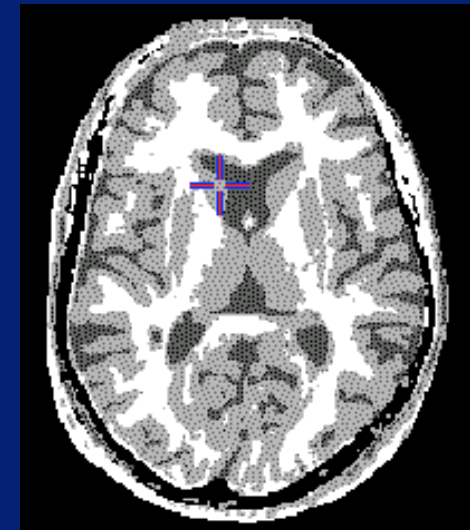
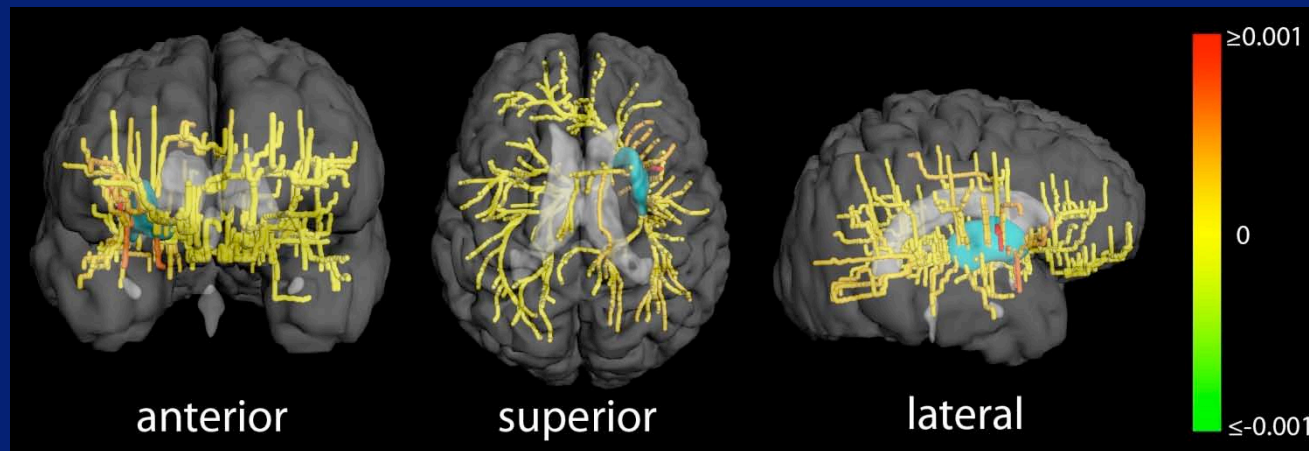
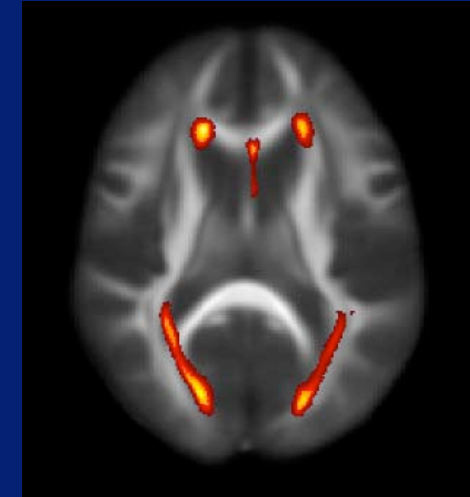
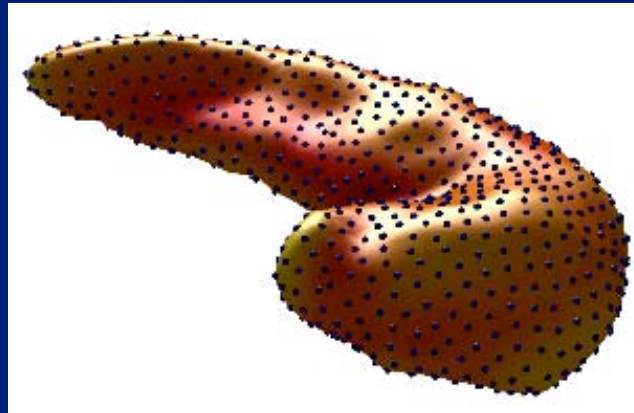
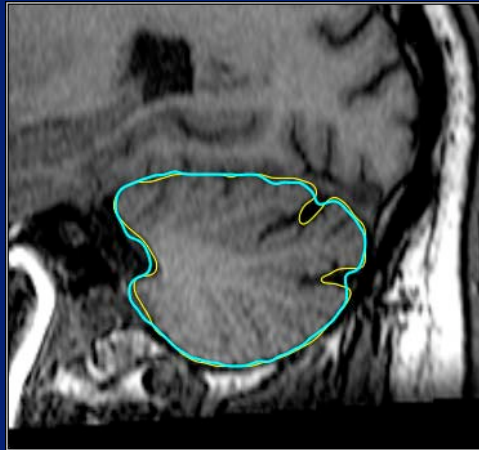
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Radiology & Medical Informatics, Erasmus MC

Biomedical Imaging Group Rotterdam

Development of robust, accurate and fully automated tools to perform measurements in MR Brain images





Two focus points:

1. Population Imaging → Understanding disease
2. Computer Assisted Diagnosis
→ EARLIER and more accurate diagnosis!

Rotterdam Study: Neurologic disease

Risk factors:

Genetic
Non-genetic

Blood pressure
Cholesterol
Diabetes mellitus
Homocysteine
Smoking
.....

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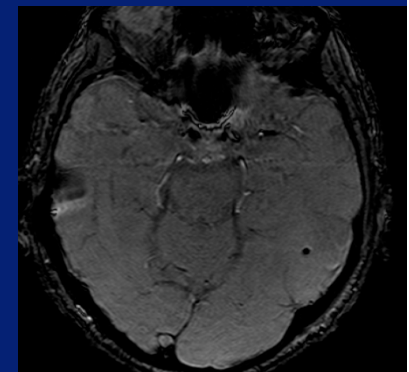
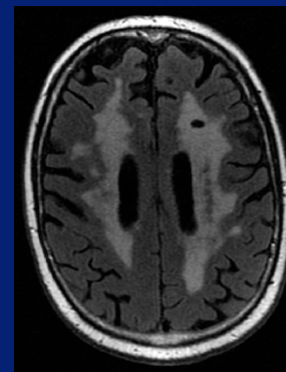
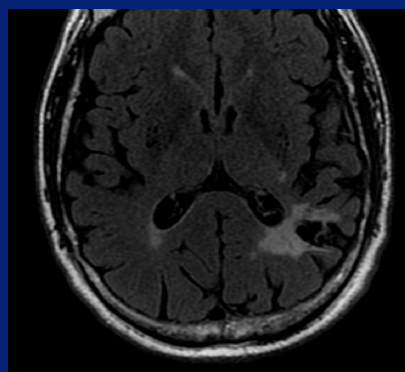
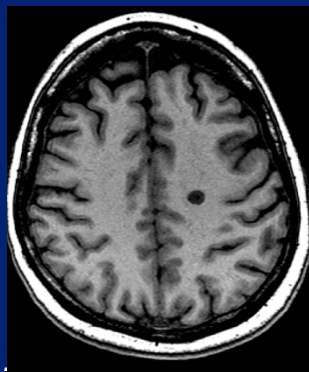
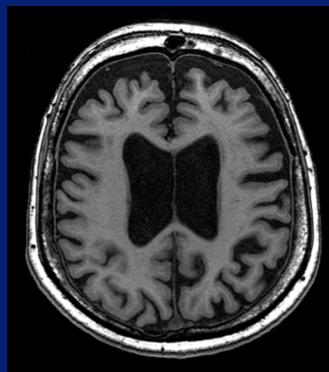
Brain changes

Atrophy
Infarcts
White matter lesions
Microbleeds
.....

?

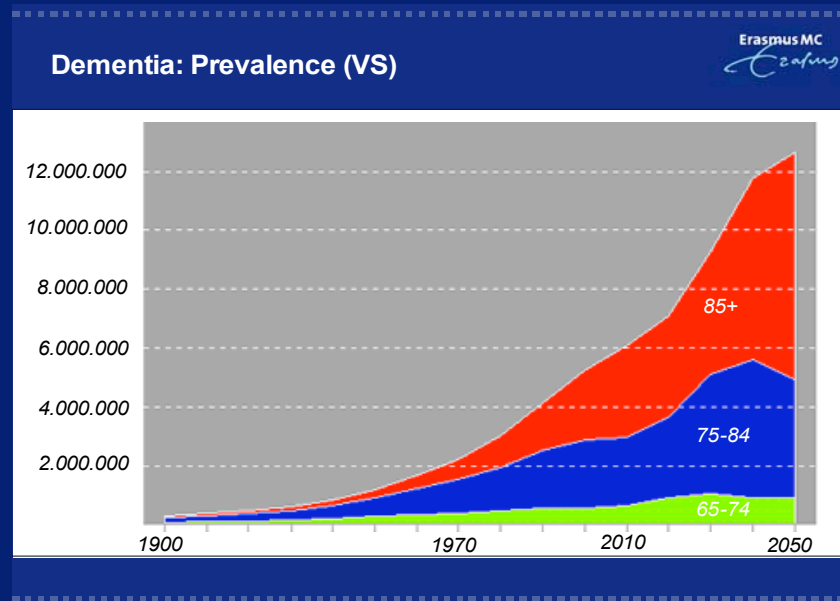
Outcome:

Stroke
Cognitive Decline
Dementia
Depression



Alzheimer's disease

- Alzheimer's disease (AD), the most common form of dementia, is one of the most devastating healthcare problems facing western society.
- In Europe, the yearly costs associated with AD is estimated to be around 400 billion Euros, exceeding the costs of heart disease, cancer, and diabetes.
- In NL, currently 1 in 60 people with AD; this will double in 2050!

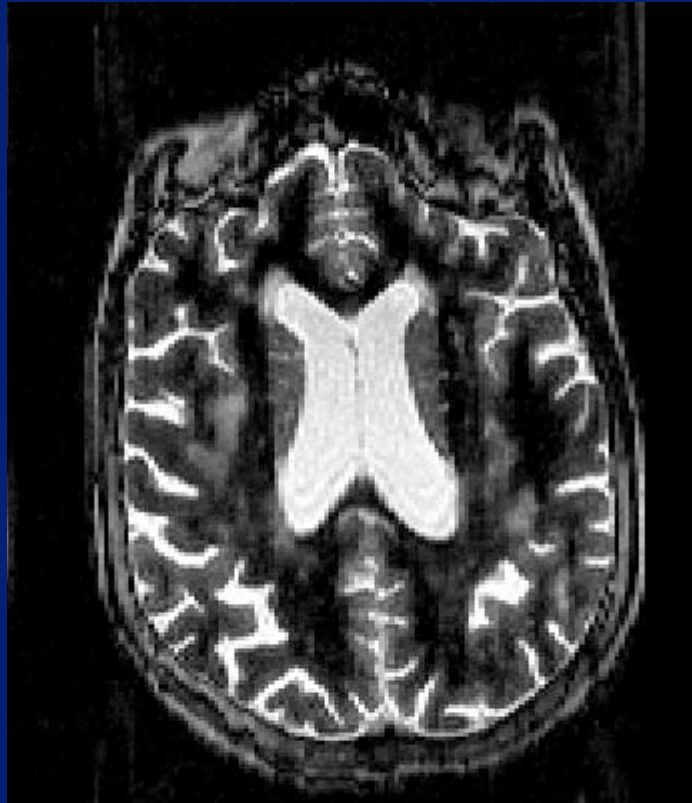


Socioeconomic impact of early diagnosis and preventive strategies

- In Alzheimer's disease, there are currently 98 molecules in pre-clinical research, and 50 phase 1 trials underway
- Current preventive therapy can delays the onset of AD symptoms (up to 3.5 years has been reported). The latter would reduce AD prevalence by 1/3.

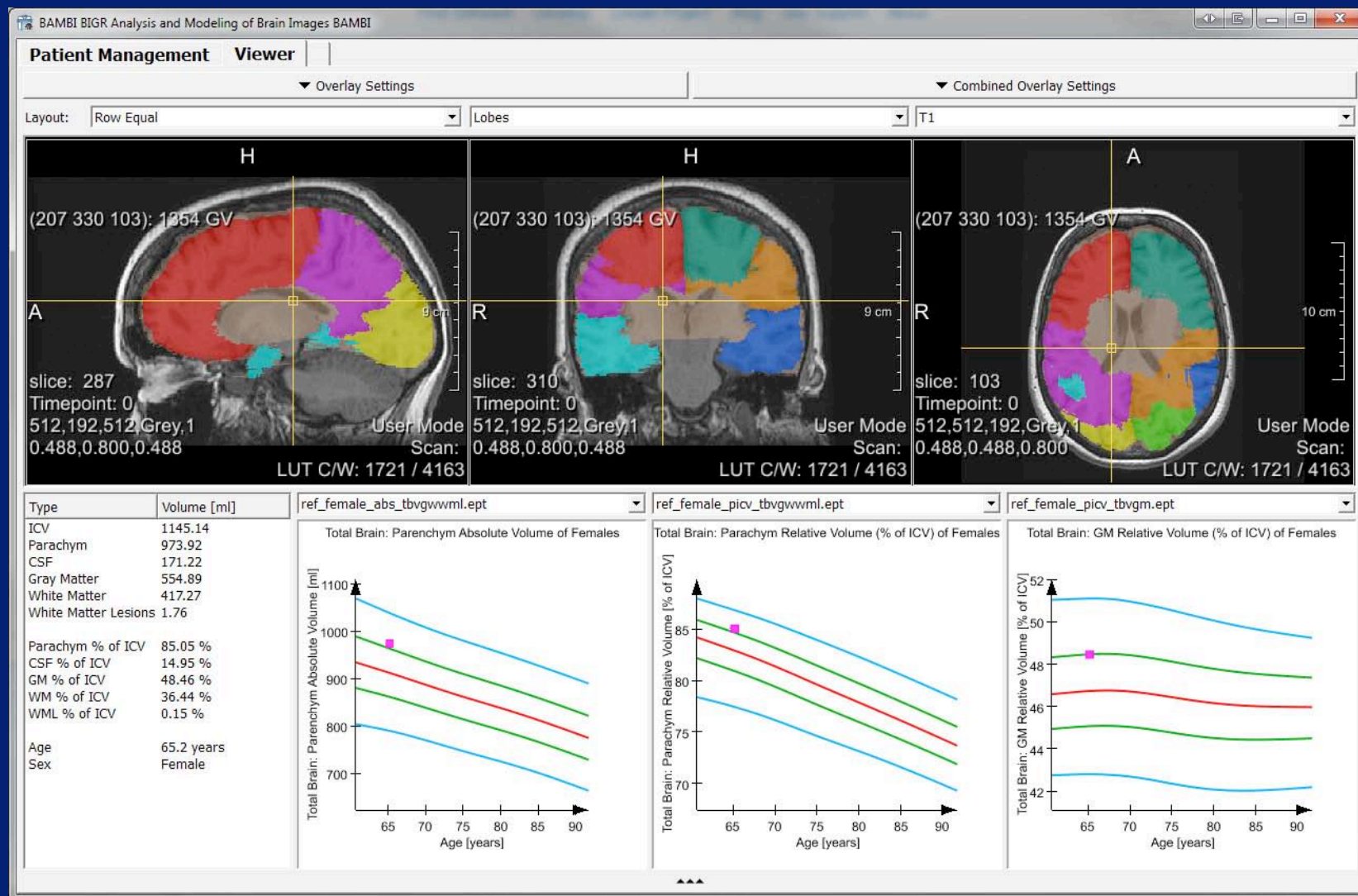
EARLY DIAGNOSIS

Critical question to be answered



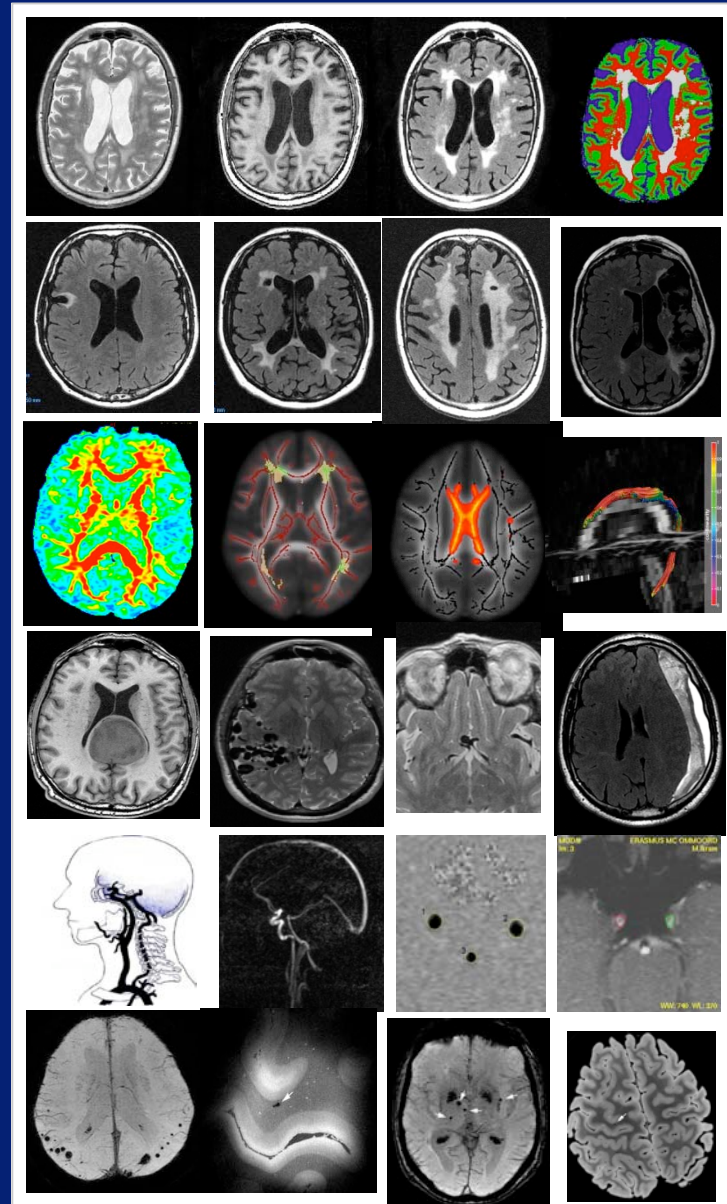
Will the owner of this brain become demented?

Relating diagnosis to reference values

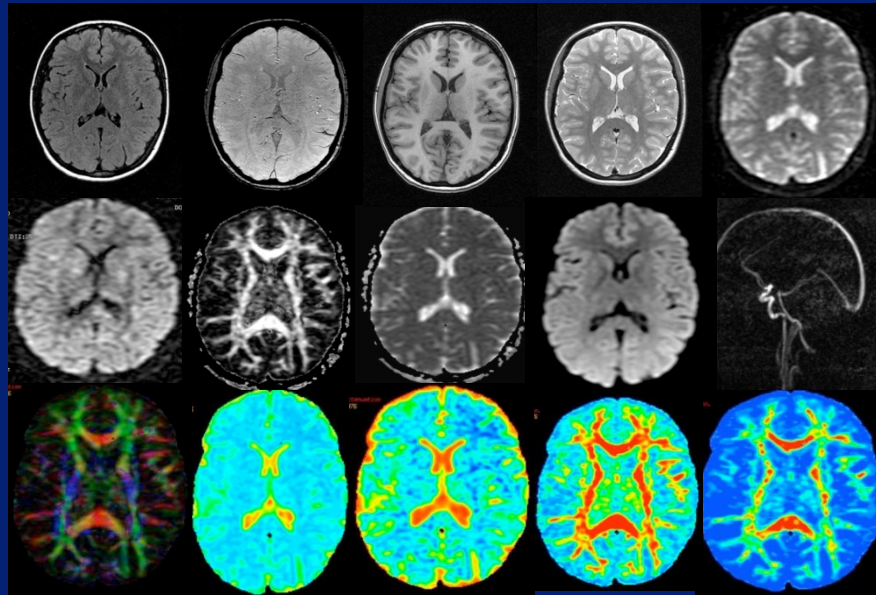


Rotterdam Scan Study (> 8000 participants)

- Tissue quantification
- Lesion assessment
- Microstructural integrity
- Incidental brain findings
- Blood flow quantification
- Cerebral microbleeds



Generating imaging biomarkers



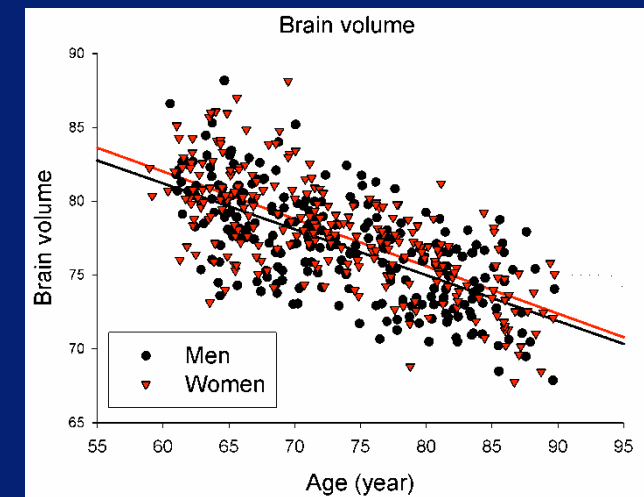
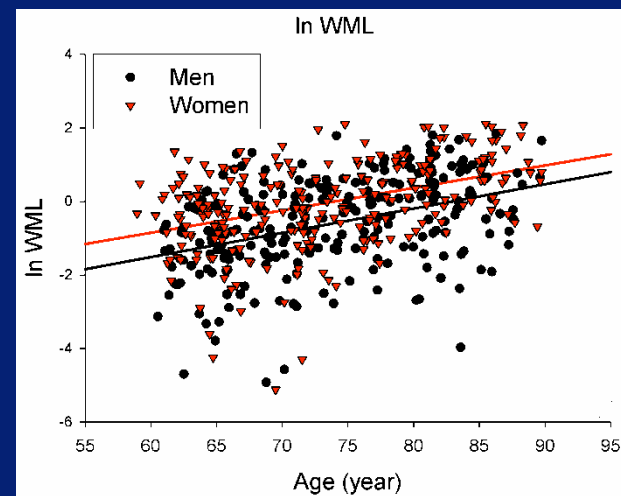
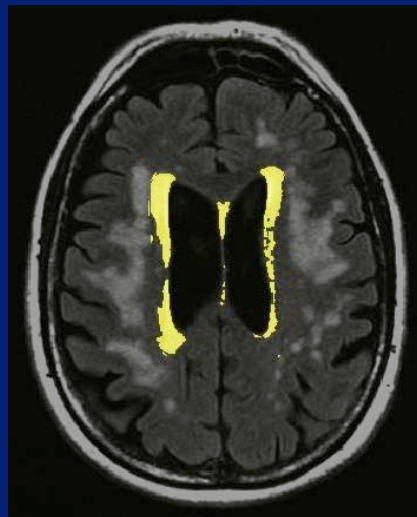
Biomarkers

0.23

183 cc

17.3% Lesion load

83.12% Connectivity
Thalamus-Cortex
Two frontal lobes



Bottom line

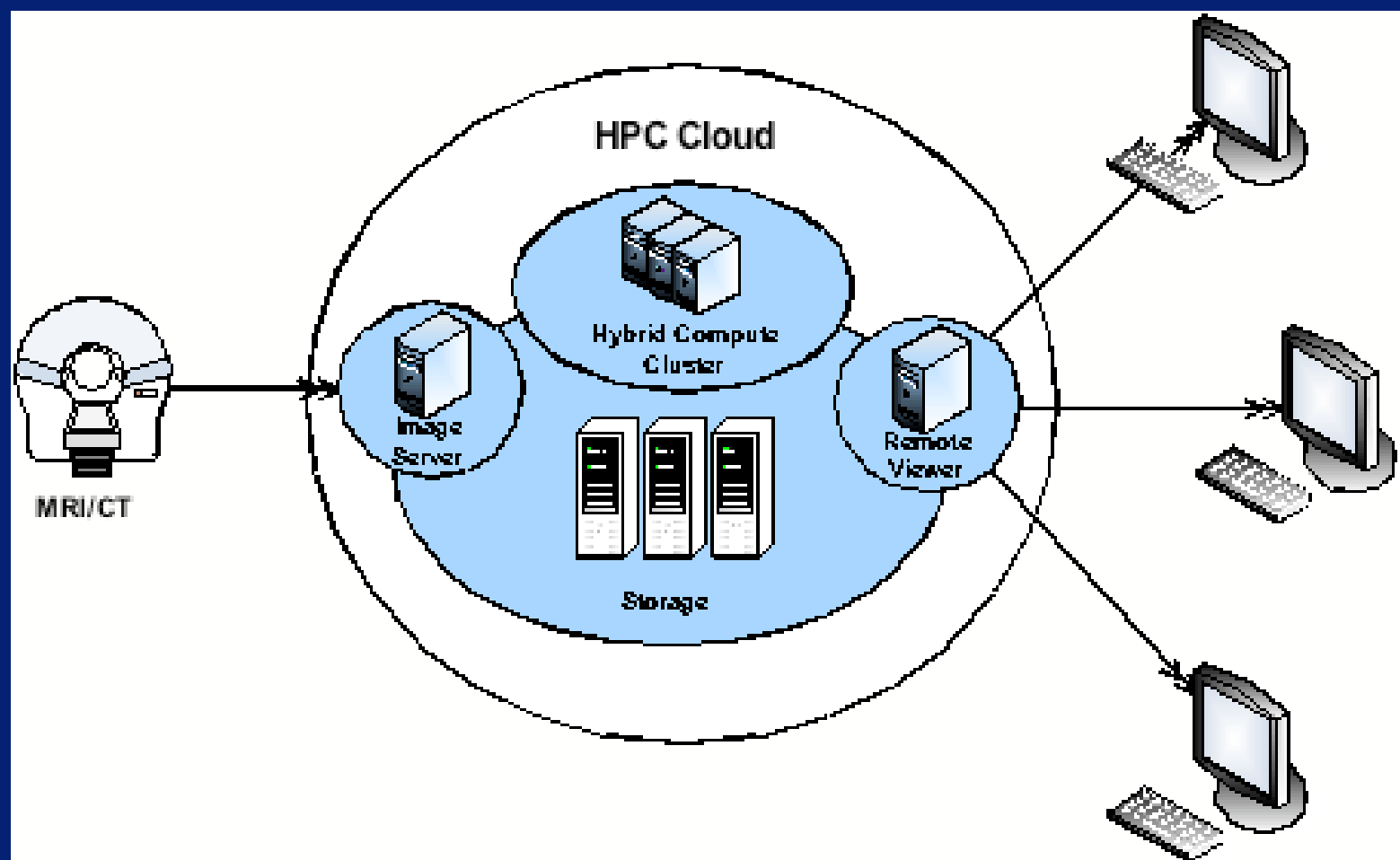
We need to scan
thousands of subjects
and analyze the scans!

Population Imaging

Current Problems in Population Imaging

- Initiatives are stuck, scaling-up is hampered
- Every institution has its own data
- Every institution has his own hardware/software infrastructure
- Data formats, scan protocols, processing and validation are not standardized!
- In practice, it's difficult to share and combine input data and numerical results
- Transfer of very large data sets is tedious
- Closed and protected hospital networks
- No high-quality IT infrastructure present
- Privacy issues

Centralized and standardized archival and processing on the HPC cloud with remote viewing, monitoring and exploration of the results

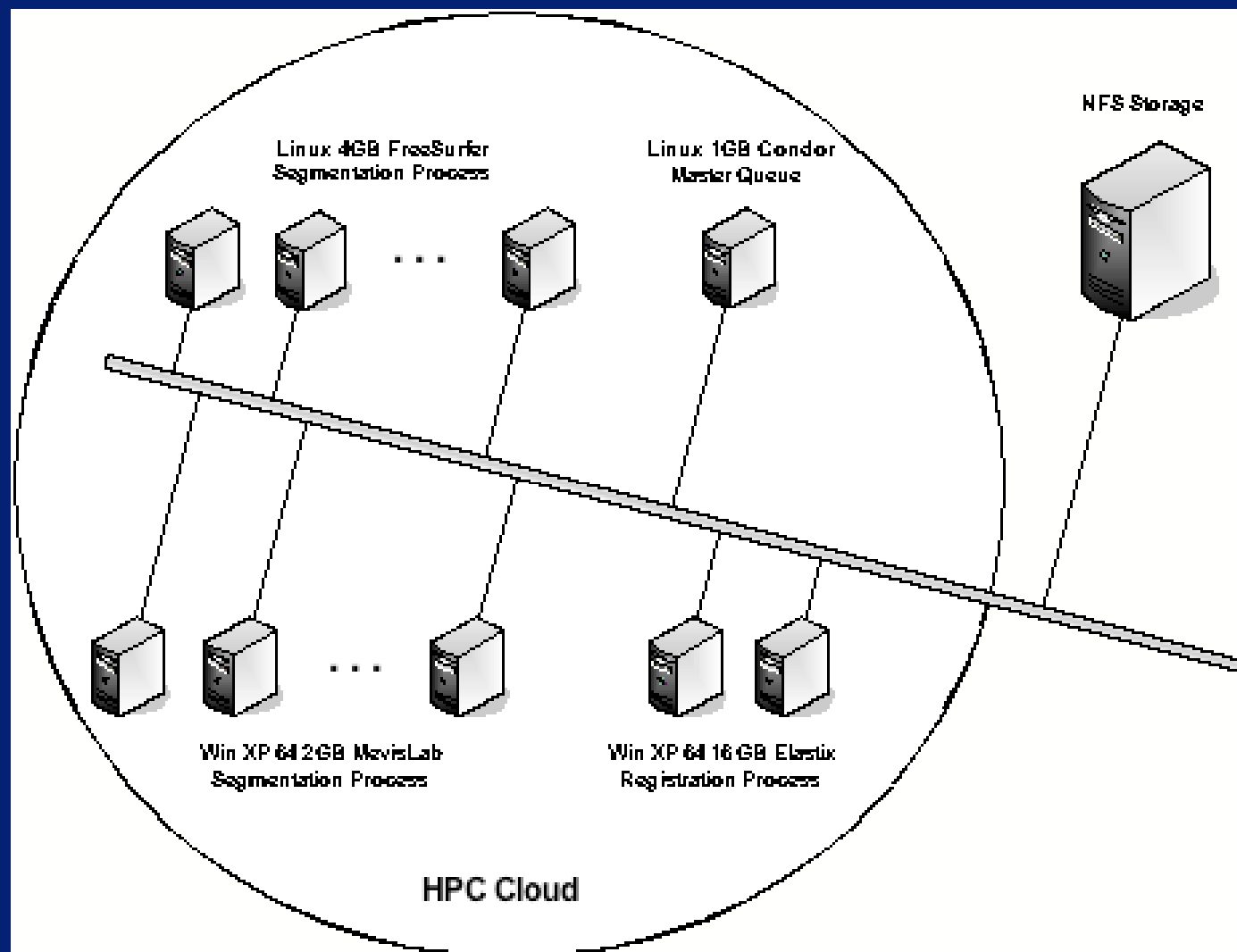


Benefits of Cloud Computing

- Create and deploy specialized Virtual Nodes on demand
 - Hardware: Memory, Cores (Multi-threading, MPI)
 - Software: OS (Linux, Windows, ...), Tools
(expertise from the pilot in 2011)
- Clone these Virtual Nodes as needed depending on IP task
 - Hybrid Cluster: Use different, tool-specific (node) images for multi-step processing (pipelines)

**Implement and deploy cluster nodes lean and mean:
Increases efficiency & flexibility!**

Hybrid Cluster Computing

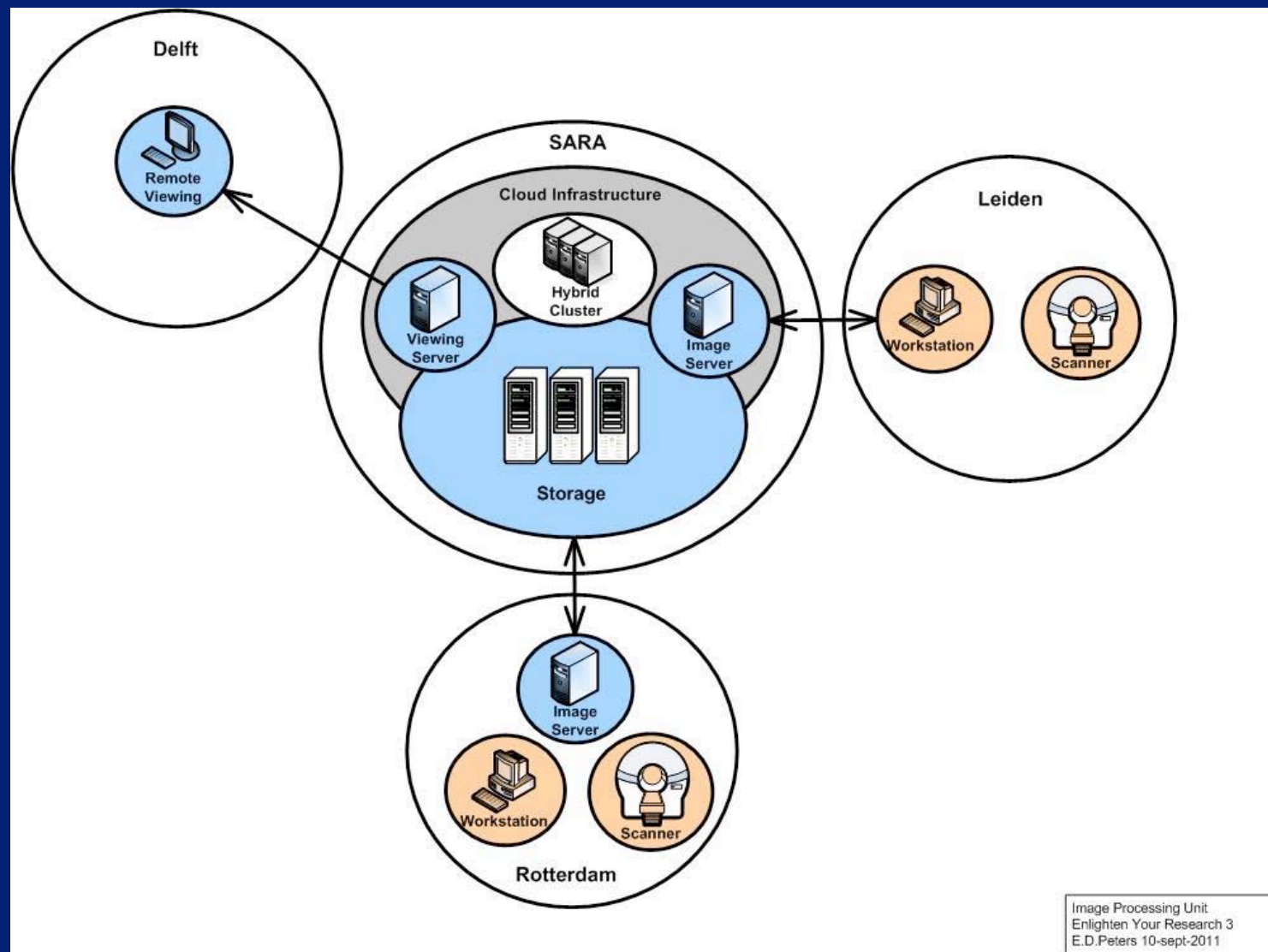


Benefits of Cloud Infrastructure

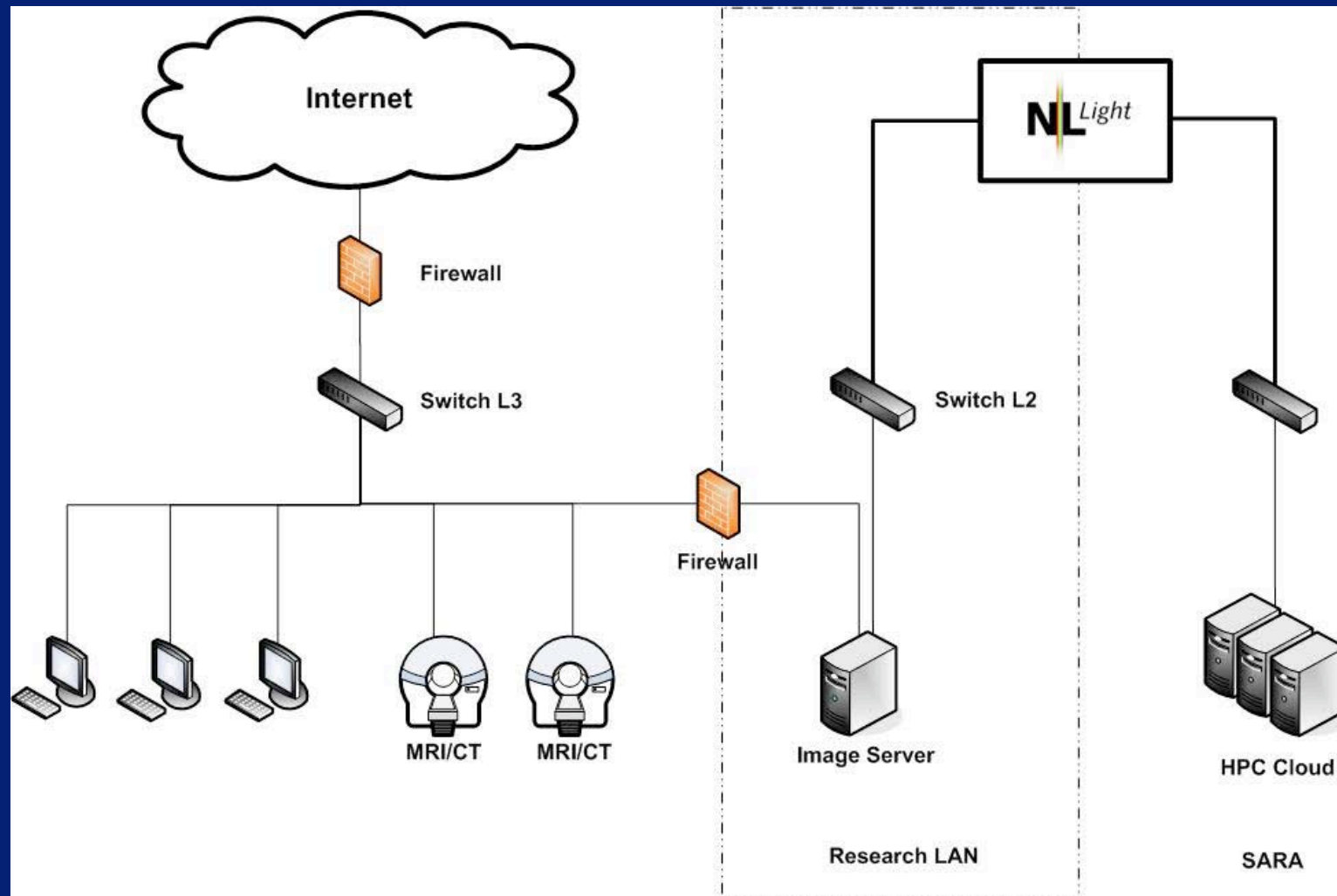
- System Memory Size
 - Very large system memory sizes possible
 - Efficient memory & CPU usage
- System Network Infrastructure
 - Advanced Integration of Storage & Computation

**To be able to run a variety of processing pipelines
in the same ‘hardware/software’ environment
means less data transfer, efficient use of resources
and in the end faster and more efficient processing**

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EYR: Light path Rotterdam, Leiden, Delft → SARA (secure & low latency)



Concluding

How are we going to use the HPC Cloud Infrastructure?

- Creating a Centralized Image Processing Unit (CIPU)

Why do we want to use the HPC Cloud Infrastructure?

- Flexibility
- Efficient use of resources
- Deploy specific nodes based on requests

How important is the HPC Cloud Infrastructure for 'our' project?

- A nice pilot to investigate centralized facilities for Population Imaging.
- Trying to have a break-through in scaling up Population Imaging!