DECIDE

Diagnostic Enhancement of Confidence by an International Distributed Environment

Project participants:

Consortium GARR (IT), CNR (IT), Consorzio COMETA (IT), Fatebenefratelli (IT), University San Raffaele (IT), University of Genoa (IT), University of Foggia (IT), Fondazione SDN (IT), MAAT France (FR), King's College (UK), Uniwersytet Warszawski (PL), Centre Hospitalier Universitaire de Toulouse (FR), Alzheimer Europe (LU)

EC Call: FP7-INFRAS-2010-2 – VRC
Contract n: RI-261593
Project type: CP-CSA
Duration: 30 months
Total budget: 3.004.531 €
EC Funding: 2.399.998 €

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on behalf of DECIDE Consortium

DECIDE:

a user friendly web-based service for early diagnosis and research on Alzheimer's disease

Why Alzheimer's disease?

Why "early diagnosis"?

Why Grid?

…before we get to the "what" and "how"

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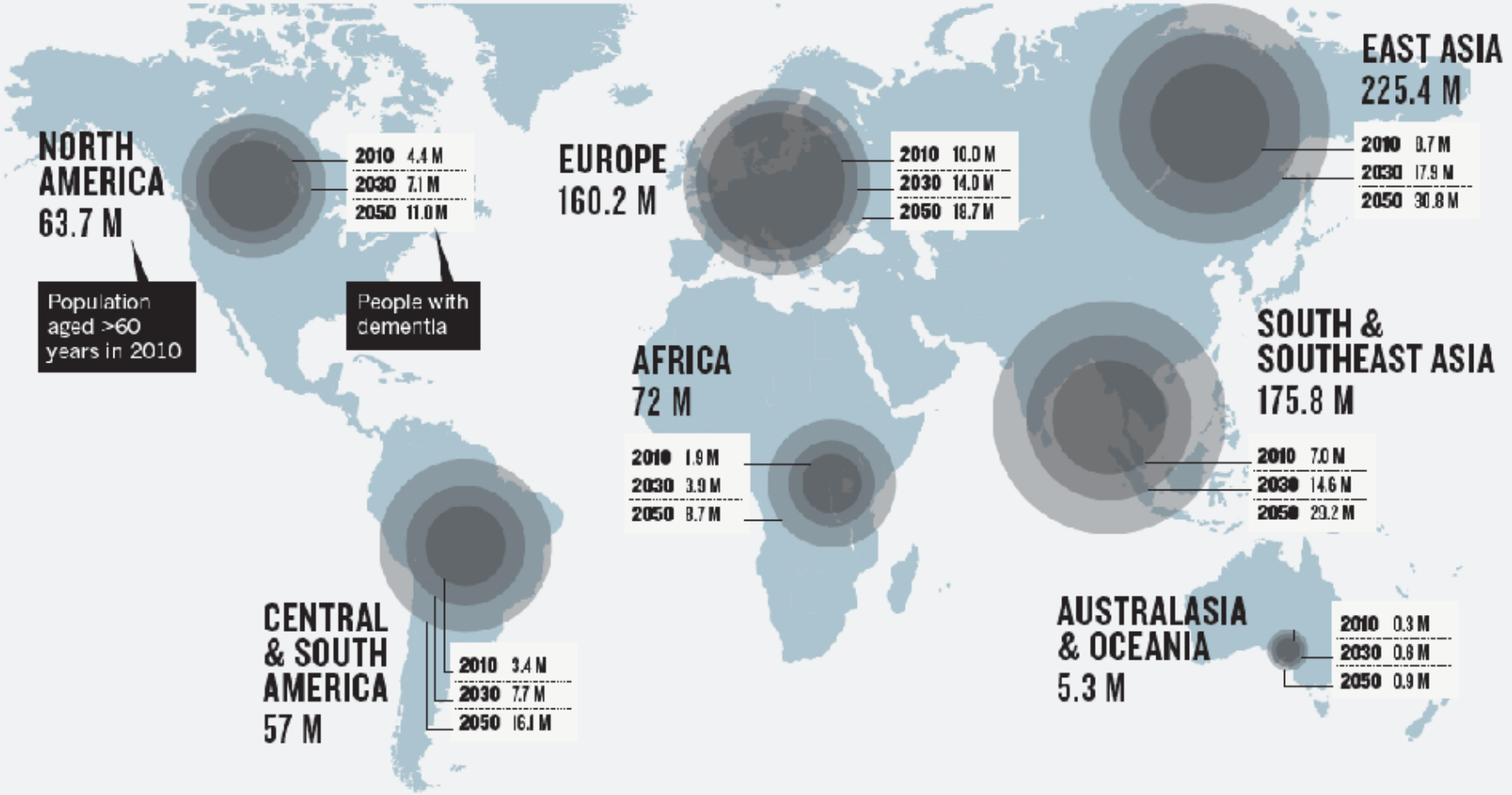
A problem for our age

BY ALISON ABBOTT

NATURE | VOL 475| 14 JULY 2011

ESTIMATED GROWTH OF DEMENTIA

The number of people with dementia will roughly double every 20 years, with the biggest increases in developing countries.



Early diagnosis of Alzheimer's disease

New diagnostic criteria were issued in 2010-2011 by European Federation of Neurological Societies and National Institute on Aging.

Major step forward: moving away from clinical symptoms, to the real underpinning of the disease.

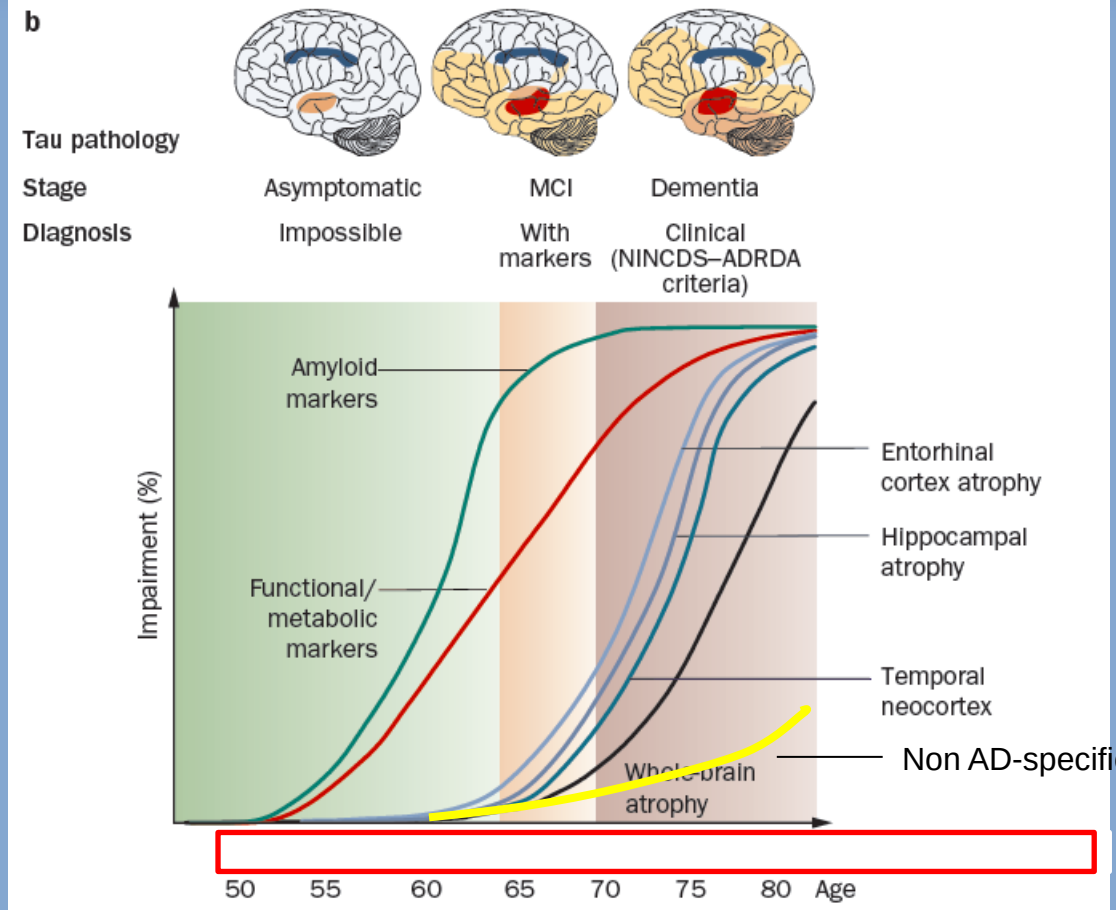


Figure 1 | Natural progression of cognitive and biological markers of Alzheimer

Frisoni et al., Nat Rev Neurol 2010

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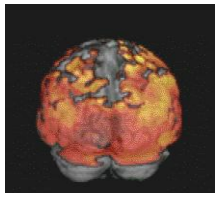
Markers of the disease

BRAIN AMYLOIDOSIS



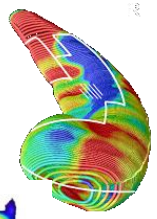
Amyloid deposits:
amyloid PET

Biochemistry:
CSF Abeta42

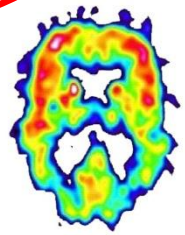
------ Offered by DECIDE

NEURODEGENERATION

Structure:
MR hippo volumetry

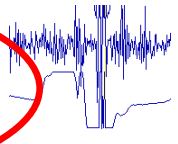


Function:
FDG PET



Biochemistry:
CSF tau

Neurophysiology:
EEG



G. Frisoni, Ospedale Fatebenefratelli, Brescia

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The Project Consortium

A **vertical approach** to e-Health, targeting the needs of neuroscientists community through the provisioning of an e-Infrastructure aimed at supporting them in the daily execution of the diagnosis

CONSORTIUM GARR - Italy
CONSORZIO COMETA – Italy

Network & GRID Layer Infrastructure Partners

CNR - Italy
UNIVERSITY OF GENOA - UNIGE Italy
UNIVERSITY OF FOGGIA - UNIFG Italy
MAAT FRANCE - maat G - France
KING'S COLLEGE – United Kingdom
UNIWERSYTET WARSZAWSKI - Poland

Application Layer Partners

IRCCS FATEBENEFRATELLI - Italy
UNIVERSITY SAN RAFFAELE - Italy
FONDAZIONE SDN - Italy
CENTRE HOSPITALIER UNIVERSITAIRE DE TOULOUSE - France
ALZHEIMER EUROPE - Luxembourg

Research & Healthcare Layer Partners

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DECIDE Objectives

- Bring to the physicians' fingertips a dedicated, powerful e-Infrastructure
  - relying on GÉANT (network), EGI (computing) and NeuGrid (inspiring idea)
- Deploy a secure and user-friendly **service for helping making early diagnosis**
  - Linking large distributed DBs of multi-modal neuro-images
  - Providing **accurate, quantitative** information
  - **Assisting** users all along the way
- To **validate** the e-Infrastructure and the service with real patient cases

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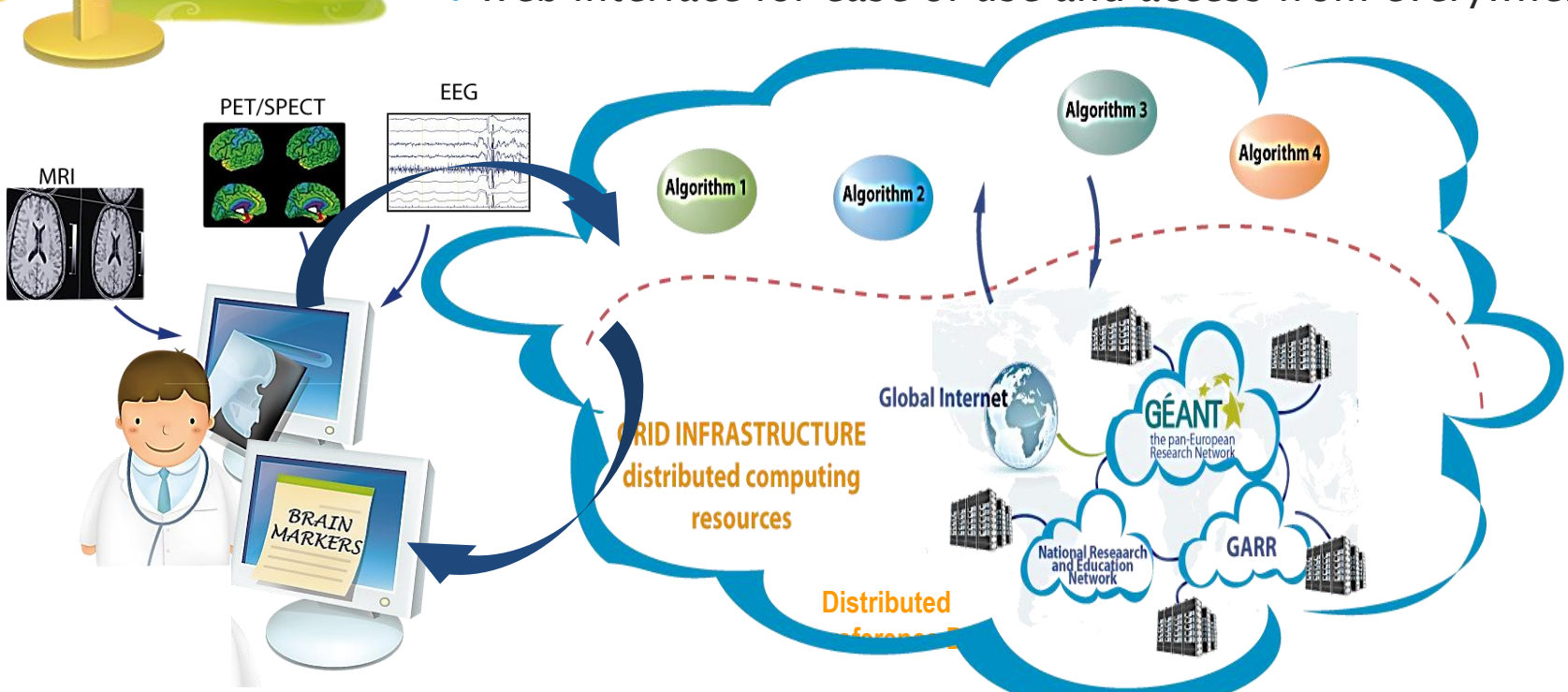
The DECIDE Service Concept

- Masking complexity from the end user
- Web interface for ease of use and access from everywhere



- Multiple **quantitative** algorithms for research and diagnosis
- Secure exploitation of large multimodal reference databases of normal subjects and patients

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Grid technology and Science Gateway

- Grid technology is used behind the scenes:
  - Fine-grained authorization control
  - Sharing of reference datasets while preserving ownership
    - "Normal" data does not leave hospital
- Grid components in use:
  - AMGA: to describe uploaded data files
  - gLibrary: for manipulation of metadata catalogue
  - SecureStorage: providing encrypted storage capabilities, with authorization control on decryption key retrieval

Question: what are EGI support plans for the above?

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DECIDE Science Gateway

- The DECIDE Science Gateway makes the Grid usable by non-ICT users
  - Standards based, modular approach
  - Supporting identity federations, for authentication: authorization handled separately
  - Based on robot certificates, no personal certificates involved
  - Simplifies job handling (no .jdl, minimized interactions) for users

DECIDE Applications

- **GridSPM:** specifically designed for SPECT and PET neurological clinical images provides an SPM analysis for the early diagnosis of Alzheimer Disease

diagnostic application

- **GridEEG:** implements EEG processing algorithms with the aim of detecting early symptoms of Alzheimer Disease and distinguishing different forms of degenerative impairment

research application

- **GridANN4AD:** concerns the analysis of PET biomarkers in Neurological and Psychiatric Disorders and provides a classification of suspected patients through an Artificial Neural Network

research application

- …two more applications being made available soon! **GridMRISeg** and **GridGDI**, both for the analysis (volumetry) of MRI images.

diagnostic application

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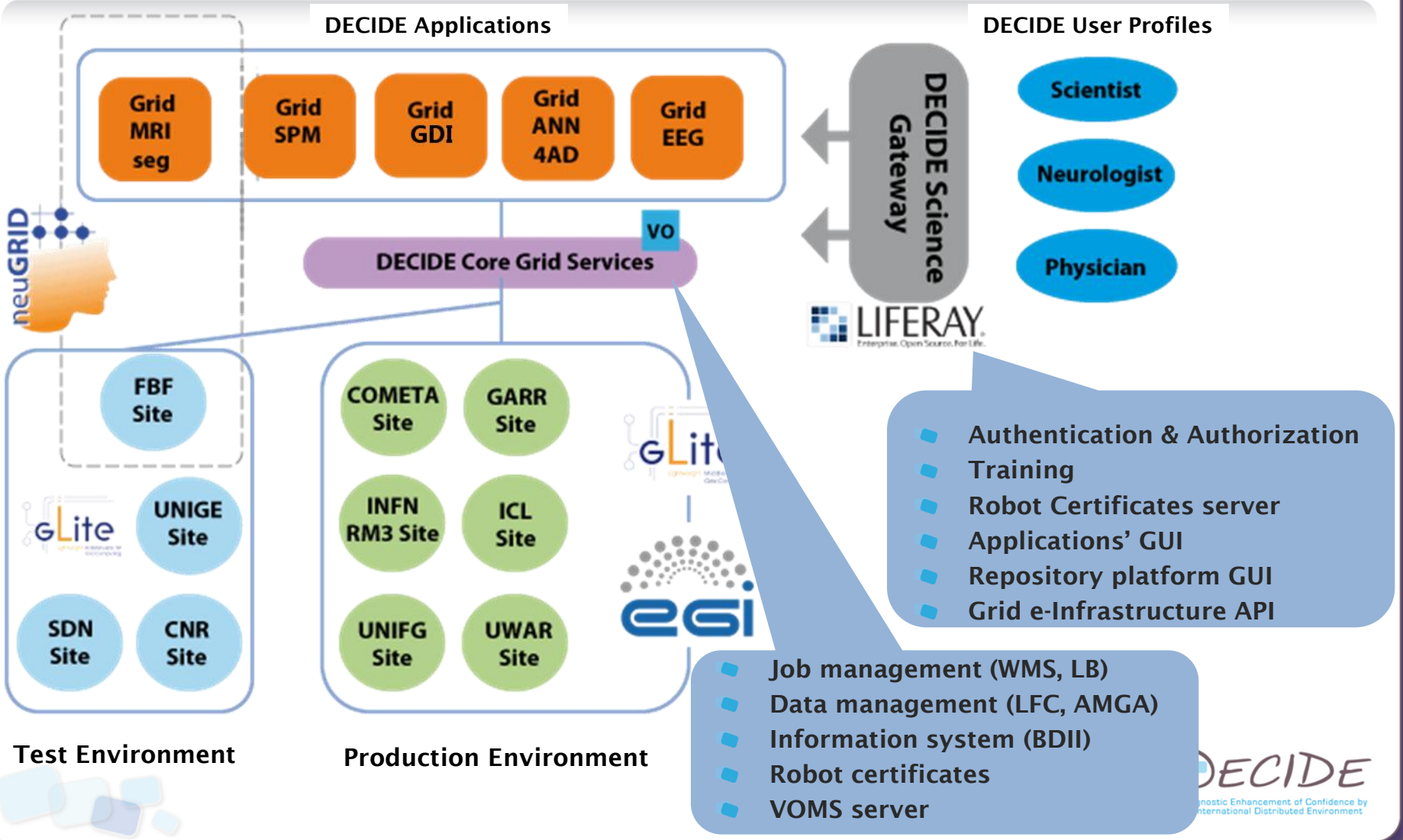
DECIDE e-Infrastructure Architecture

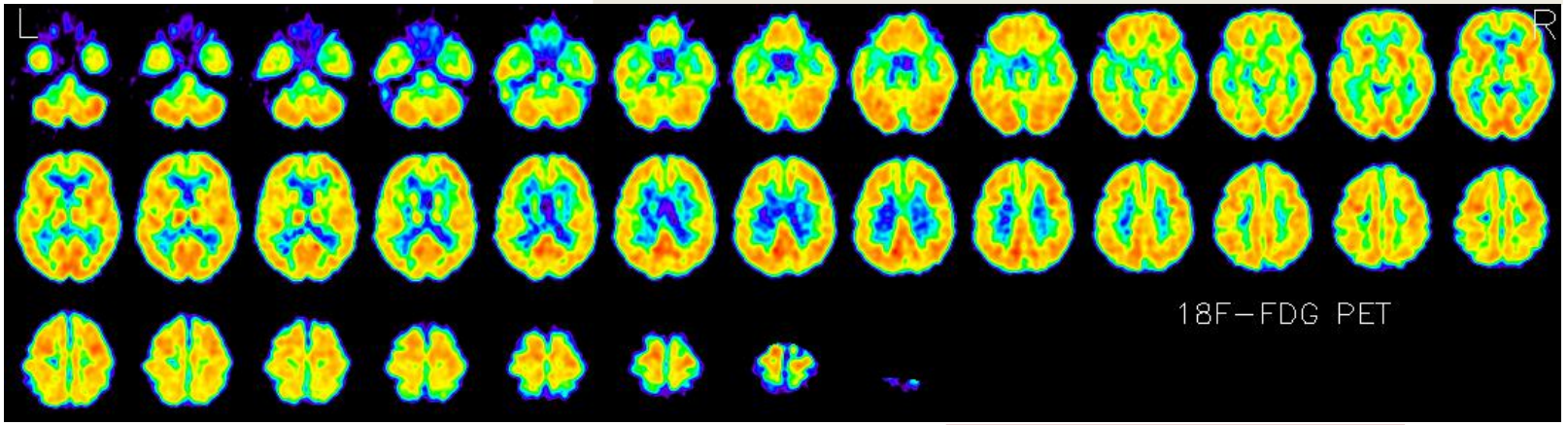


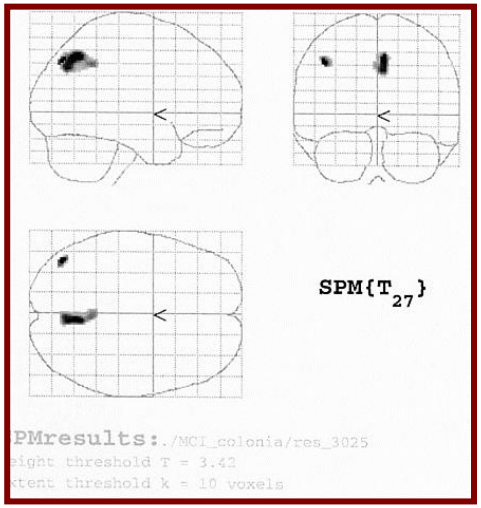
What DECIDE IS NOT and what it IS

- NOT a tool for automated diagnoses
  - It is just providing some more information to help a clinician draw a diagnosis
- NOT a tool for masses
  - Patients, as indirect beneficiaries, may be numerous, though
  - A single user may represent the nuclear imaging department of a hospital
- IS a tool for supporting clinicians during diagnostic process
  - Providing additional information to draw diagnosis: see examples in next slides

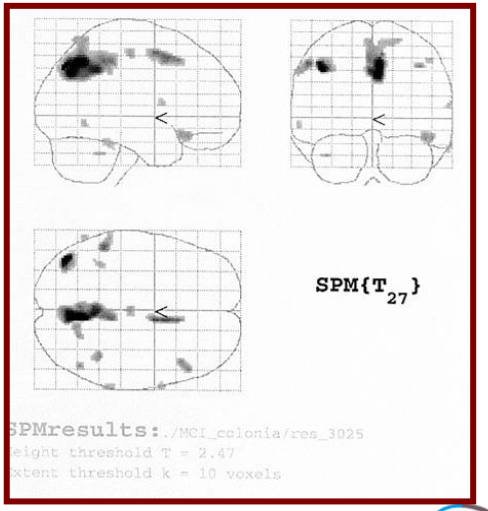
GridSPM application

aMCI ID: C03025 | Age: 82 | MMSE: 25 | CVLT: 4





p = 0.001



p = 0.01

D. Perani, Universita' Vita-Salute S. Raffaele, Milano

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GridSPM: statistical analysis of PET scans

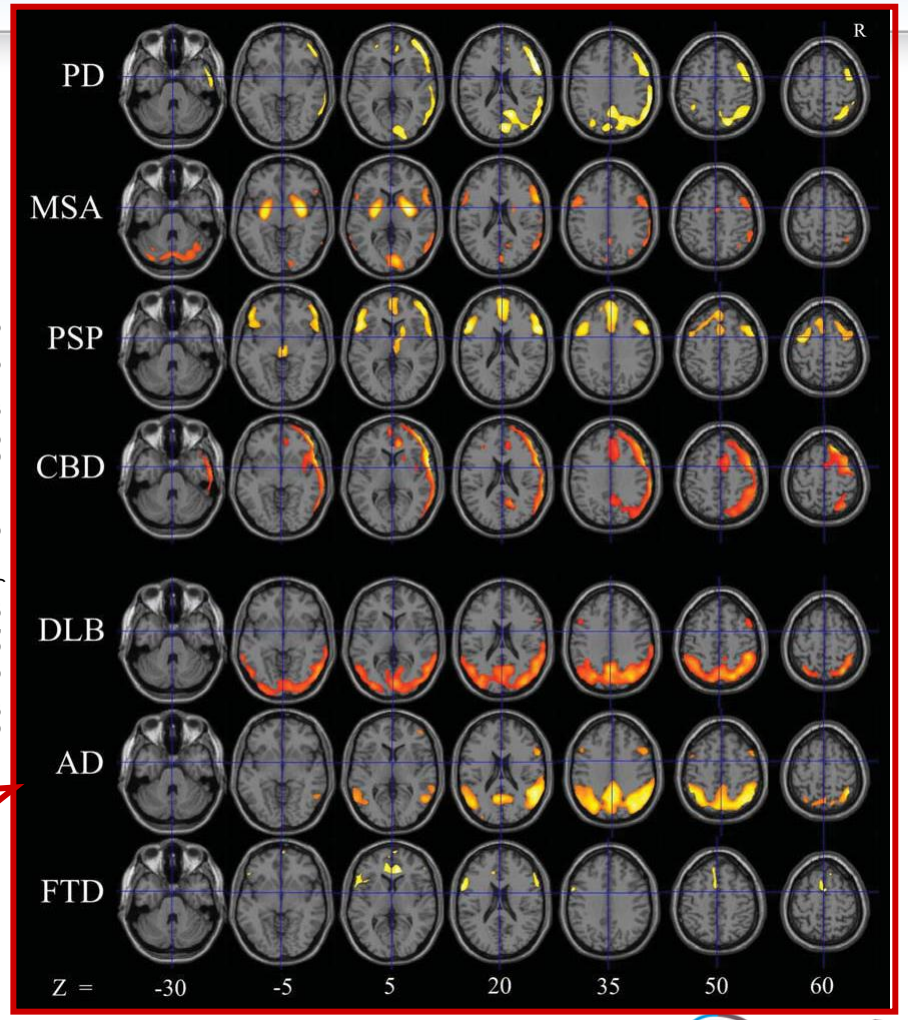
Voxel-based analysis (SPM5)

p<0.001 corrected with cluster cut-off of 20 voxels

Typical Cerebral Metabolic Patterns in Neurodegenerative Disorders

96 patients
each group vs. 18 HC

two sample *t-test*



Teune et al., Mov Disord 2010

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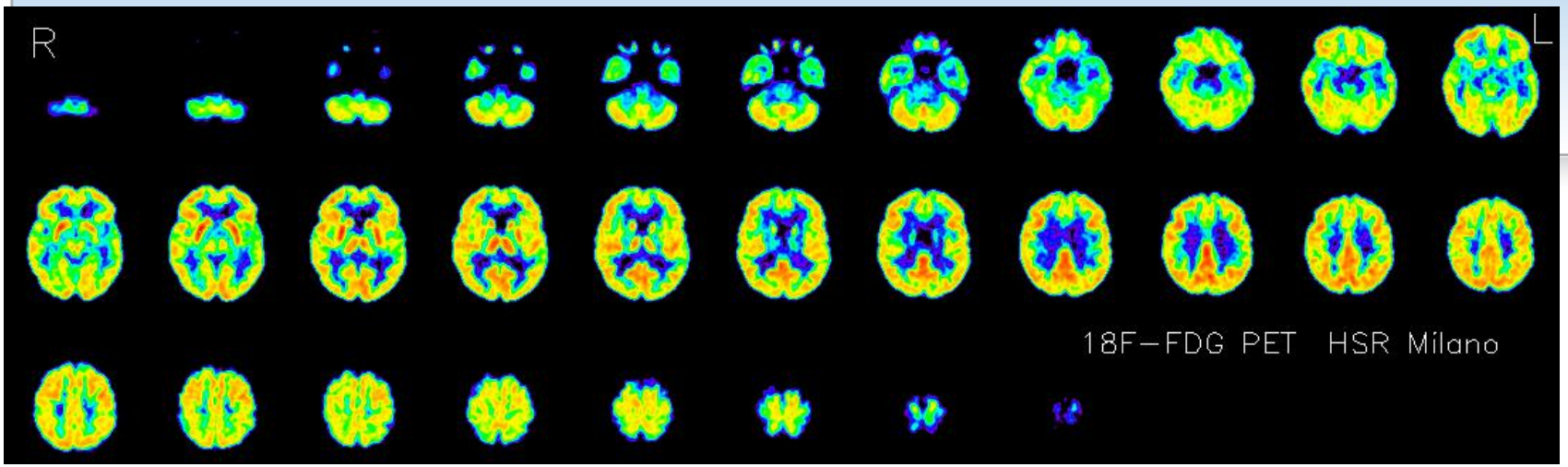
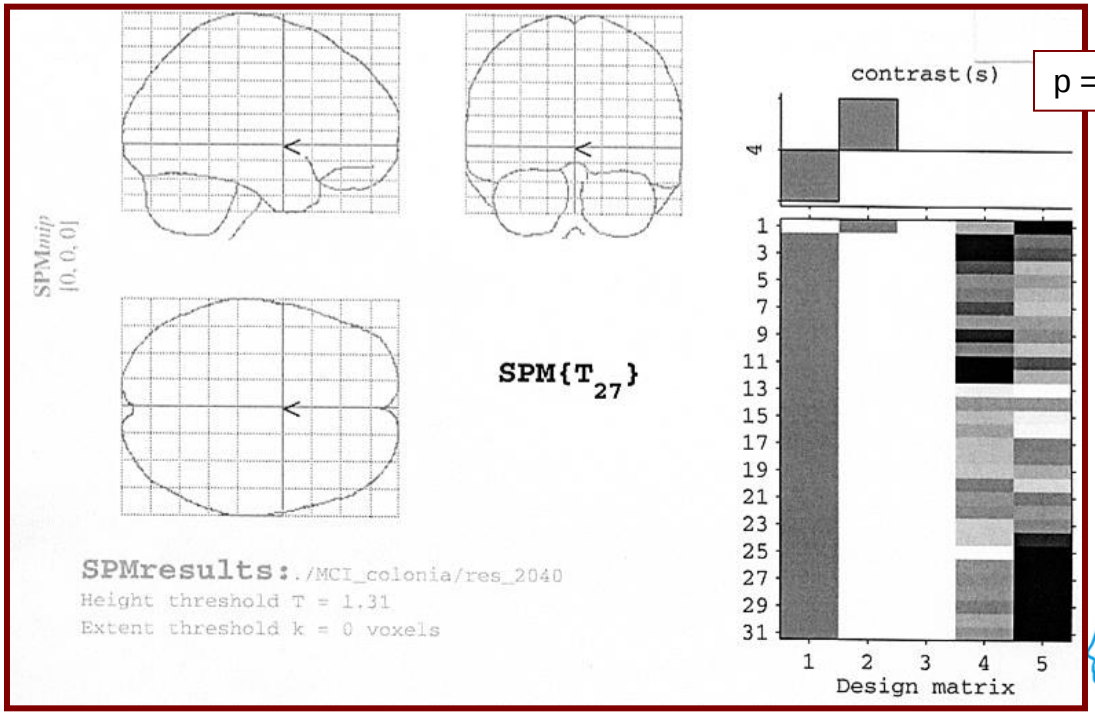
aMCI ID: C02040 | Age: 72 | MMSE: 27 | CVLT: 5



GridSPM report (negative)



p = 0.1

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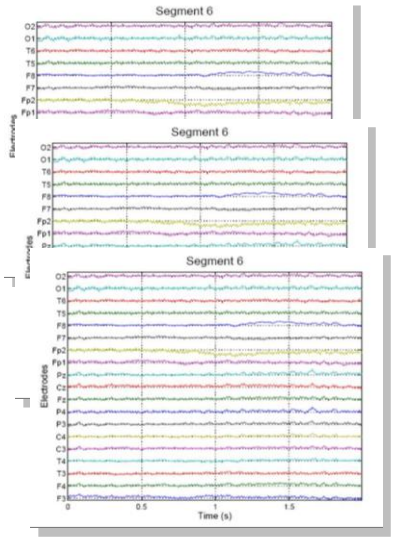
GridEEG application (1/3)

GridDATALOAD



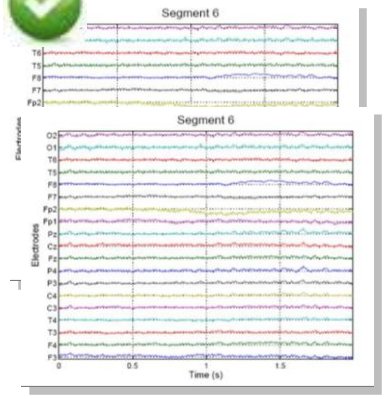
nameEEGtrials.txt

(2-sec EEG epochs in ASCII format)

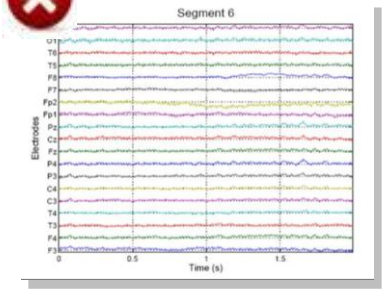
Data upload

GridEEGQUALITY

(accepting EEG epochs)

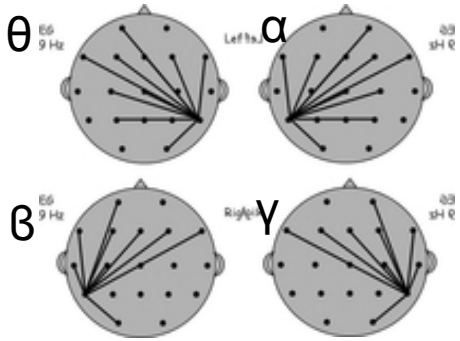


(rejecting EEG epochs)



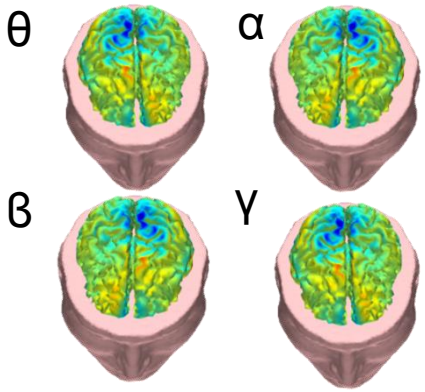
Preprocessing artifact detection

GRidDTF/COHERENCE



Model order, Frequency resolution

GRidEEGSOURCE

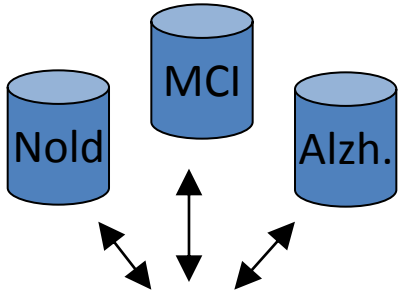


Window, Frequency resolution,…

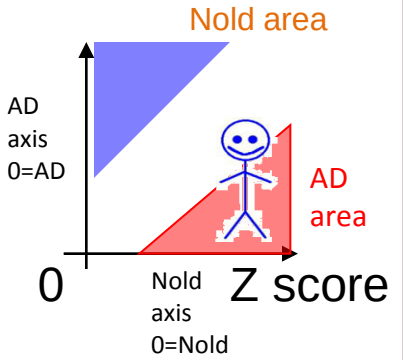
Processing & markers

GridEEGSTAT

reference EEG databases

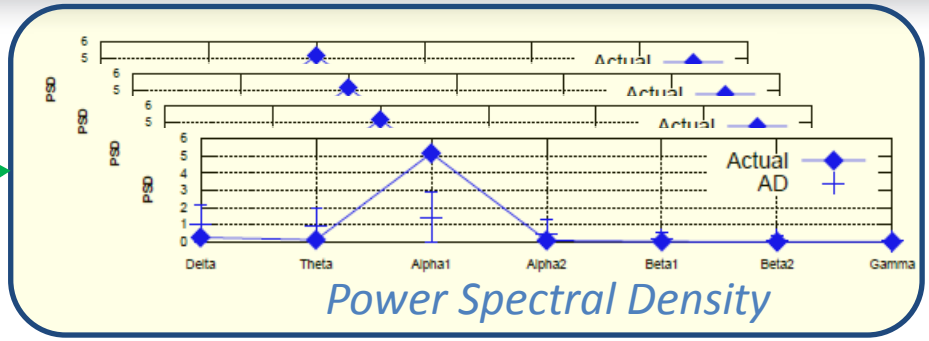


What diagnosis?

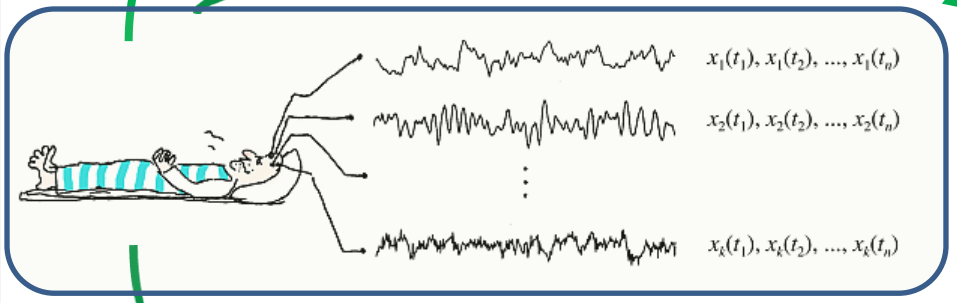


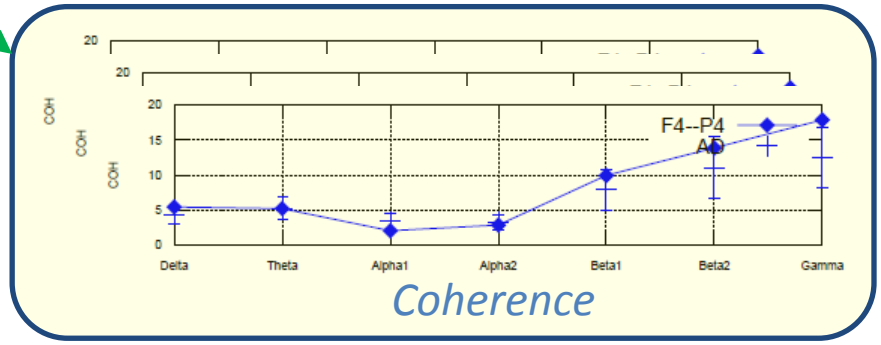
Statistics & send report

GridEEG application (2/3)

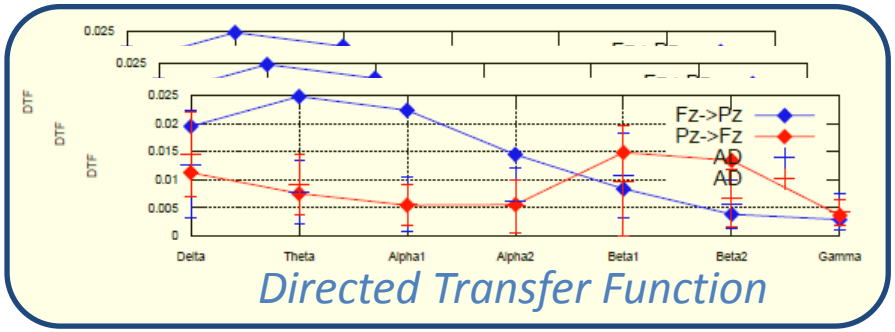


Power Spectral Density





Coherence



Directed Transfer Function

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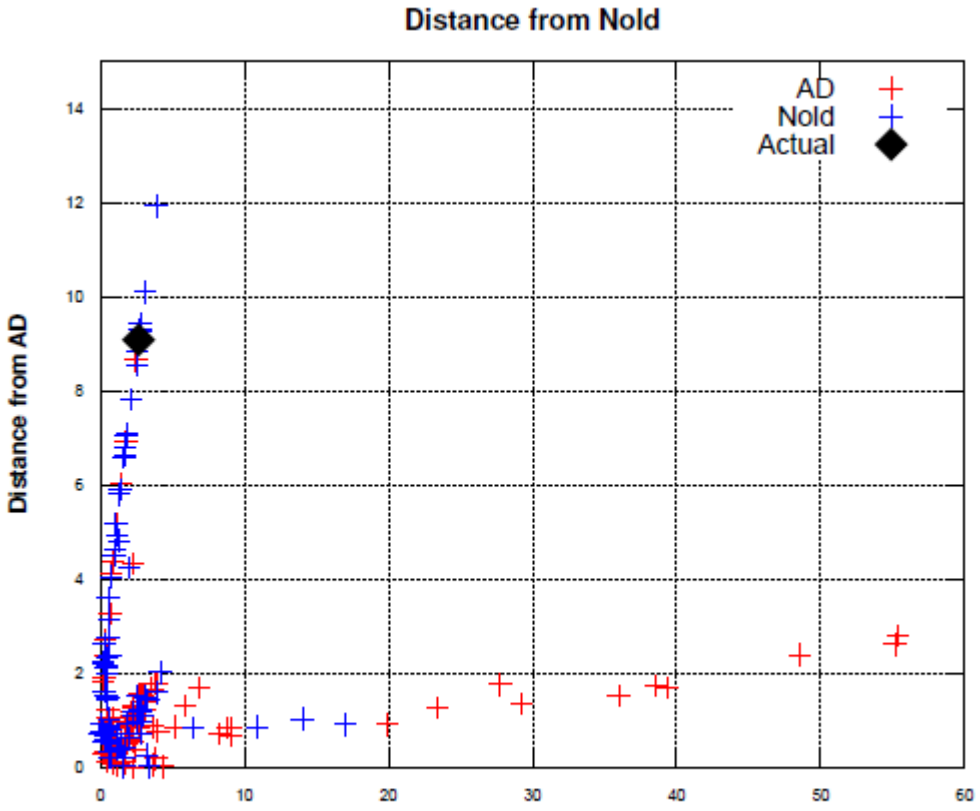
GridEEG application (3/3)

Information is combined into a "distance" from populations of normal elderly subjects and Alzheimer subjects



Scatterplot of statistical distance (Mahalanobis). Distances from the Alzheimer Diseased (AD) population are represented on Y-axis. Distances from the Healthy Elderly (Nold) population are represented on X-axis. The black diamond shows the value of the actual subject under investigation. Blue plus signs represent the values of the Nold subjects, while red plus signs represent the values of the AD patients.

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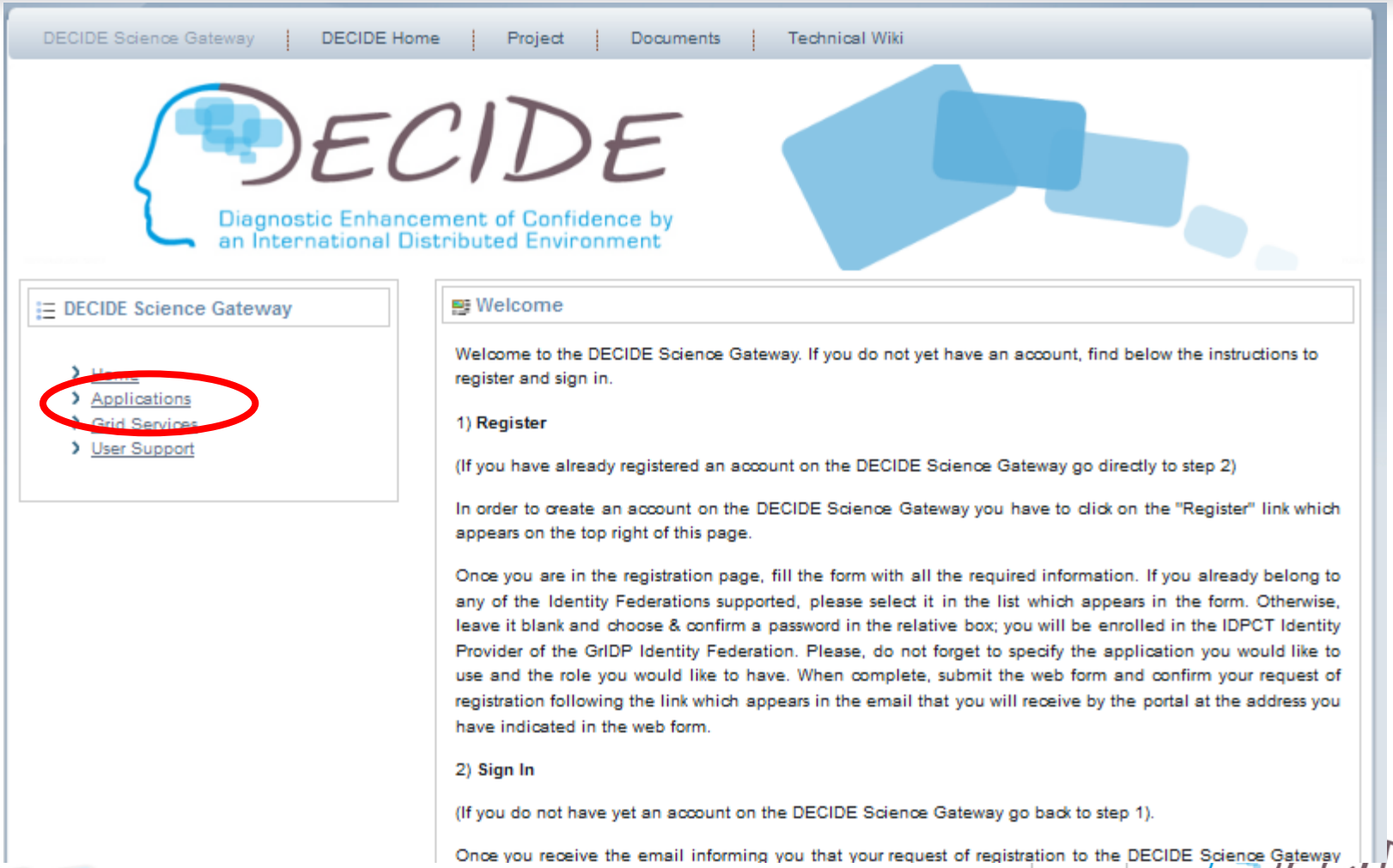
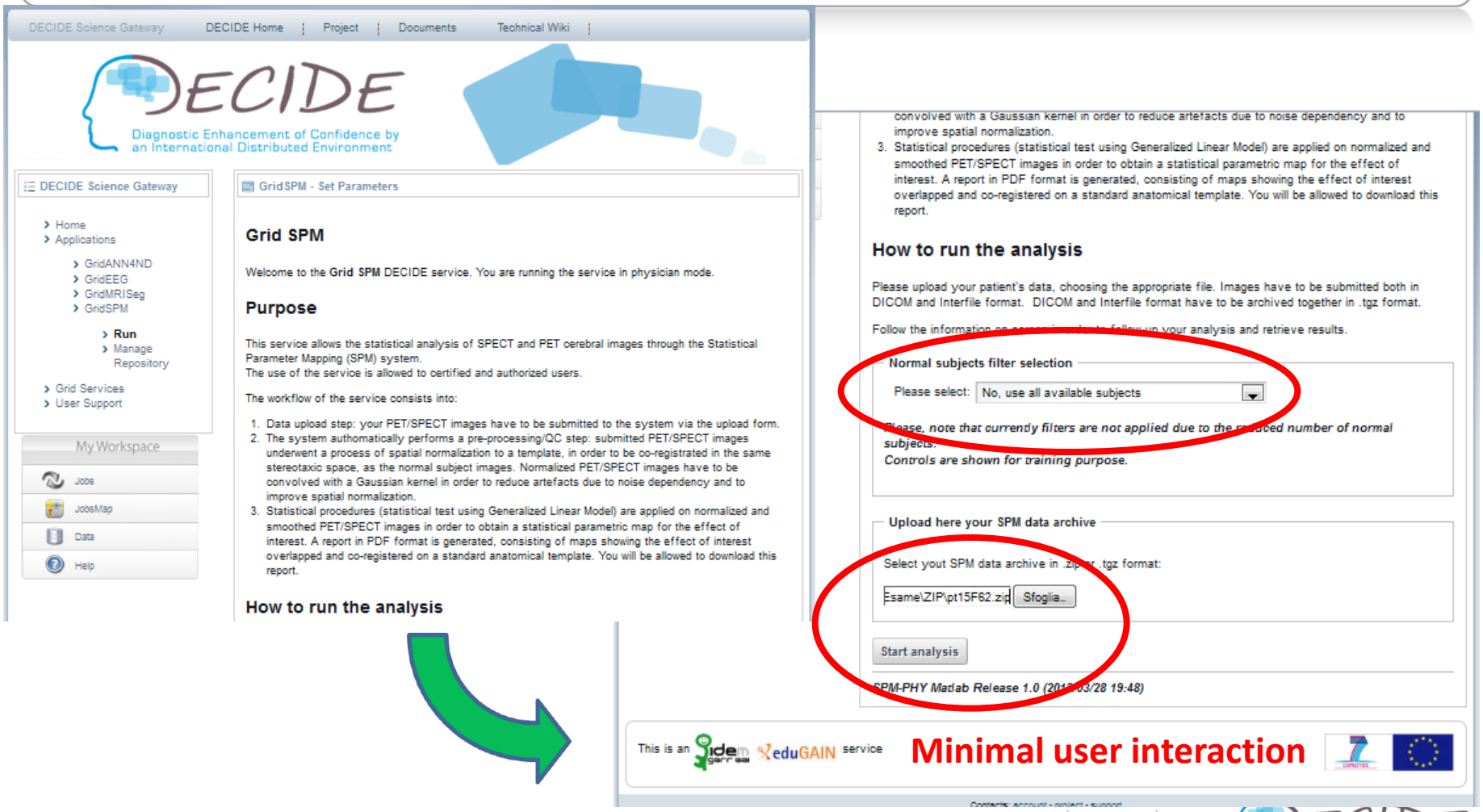
Methodology

- General philosophy: do something WITH users
  - Applications selected based on scientific relevance
  - Users involved since early phase to ensure acceptance
  - Keep clinical practice in mind: accuracy, robustness, simplicity
    - Science Gateway to make GRID usable
    - Identity Federations to avoid certificate burden, yet keeping the service secure
    - Applications carefully tuned to make them suitable to run unattended
- Hospital horizon is several years: service should be sustainable
  - Design should easily cope with technology changes

Science Gateway: login

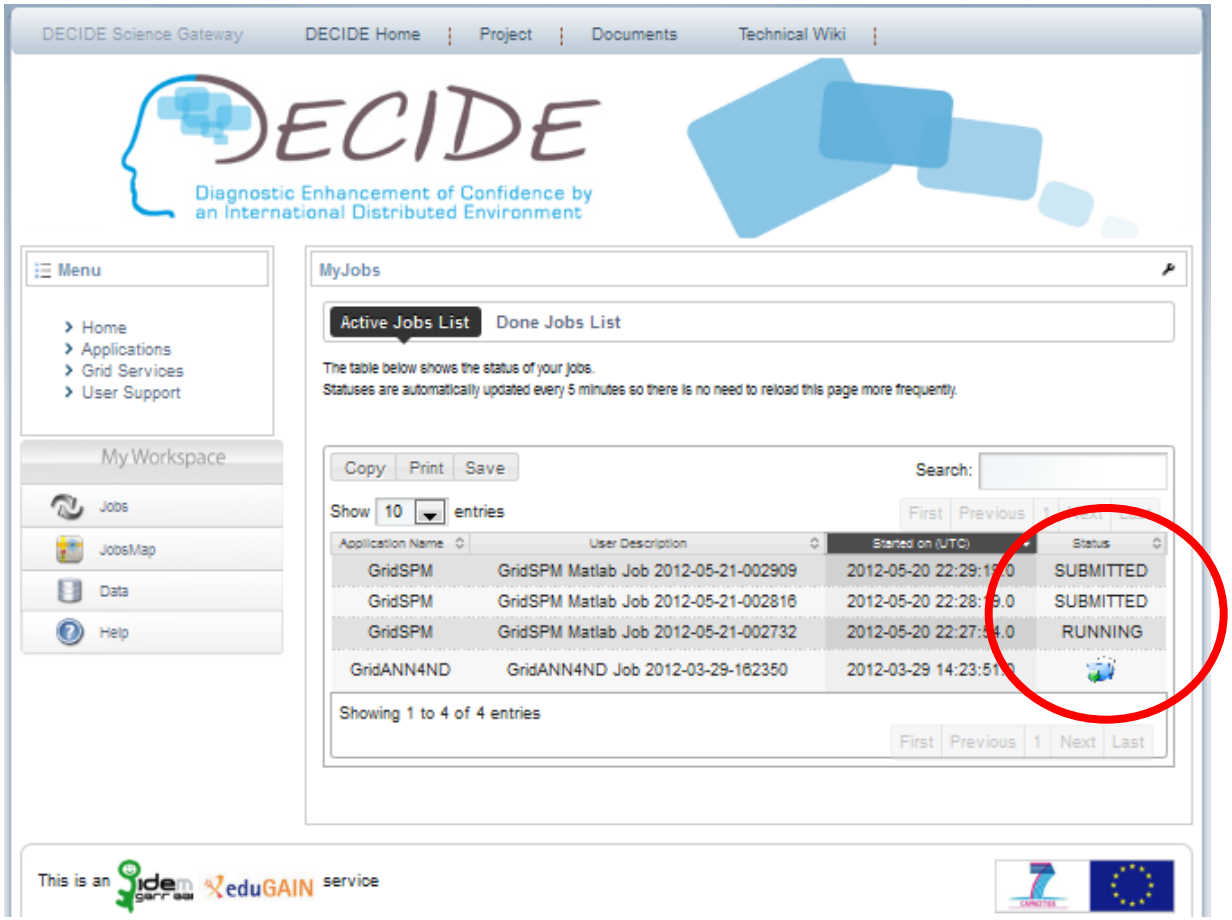


Science Gateway: applications



Science Gateway: job submit

Science Gateway: job list



User Training (1/2)

- At different levels:
  - Grid site administrators,
  - Application developers
  - “Data managers”: the “owner” of the data of a research center/hospital/clinic
  - “Neurologists”: professionals in charge of a patient, requiring a clinical test
  - “Physicians”: professionals executing the test and signing the report
  - “Scientists”: mainly researchers (can also be physicists, mathematicians, statisticians,…), who can tune some parameters for the relevant application

User Training (2/2)

- Specific for each application and for each profile
  - Science Gateway respects this and offers tailored view
- Offered as in-person training and webinar
  - Alternating, every other month
- Science Gateway users:
  - ~80 registered users
  - ~65 service users
    - 17 ANN
    - 45 EEG
    - 12 MRI
    - 15 SPM

Summarizing…

- DECIDE applications portfolio is perfectly in line with recent diagnostic guidelines on Alzheimer's disease
- DECIDE has the potential to dramatically change clinicians' daily practice, providing **secure**, **accurate**, **easy-to-use service**
  - Applications carefully tuned so they can run unattended, with minimal user interaction
  - Training programme is available,
  - Technical and clinical helpdesk are available
  - User community growing: very positive feedback
- Now dealing with sustainability and business model

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Thank you

for your kind attention!

Find more about DECIDE at www.eu-decide.eu
or contact us for questions and collaboration opportunities at
info@eu-decide.eu

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