



Neuroimaging group activity

General Status Report

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2009 review

- Intense activity
 - One paper published
 - New data analysis
 - Improved algorithms
- Stronger commitment
 - Focus on selected developments
 - New entries
 - Tighter link with our medical doctors
 - Quality feedback and collaboration from some INFN groups



Current status

- Ready to finalize our results
- Clear strategy
- Still much to do but not an impossible task
- Coordinated efforts is a requirement
- **2010 will be a pivotal year**



Reminder on our database

- ADNI db
 - Approx 1400 MRIs
 - Clinical data, follow up
- Genova (S. Martino) images
 - Approx 150 MRIs
 - Clinical data, follow up
 - PET available both locally and through EADC study
- EADC images (DESCRIPA study)
 - Approx 350 images
 - No clinical data (yet)
- Brescia images
 - Approx 300 images
 - 30 manually segmented heads



Challenges

- EADC data
 - > 2y follow up
 - Goal: Volume analysis vs Sheltens visual scale
 - **Blind analysis → significant publication (clinical)**
- Brescia (Frisoni) MRI data
 - Still on hold
 - Goal: Hippocampus segmentation (manual vs automatic)
 - Goal: Shape analysis vs clinical data
 - **Blind analysis → significant publications (technical + clinical)**
- EADC projects: NeuGRID participation / segmentation validation project
 - Pipeline Server on EGEE → **publication (technical)**
 - Hippocampi clinical validation → **significant publication (clinical)**



Important dates 2010

- HBM abstract January 22
 - Volume analysis (current)
- Neurobiology of ageing: January 31
 - Volume analysis (current)
- EADC meeting March 20
 - [Blind] Volume analysis – data exchange
- HBM conference June 24
 - Volume analysis (current/enhanced)
- MICCAI September
 - Segmentation/Enhanced Volume analysis
- EADC meeting October
 - [Blind] Segmentation shapes – data exchange

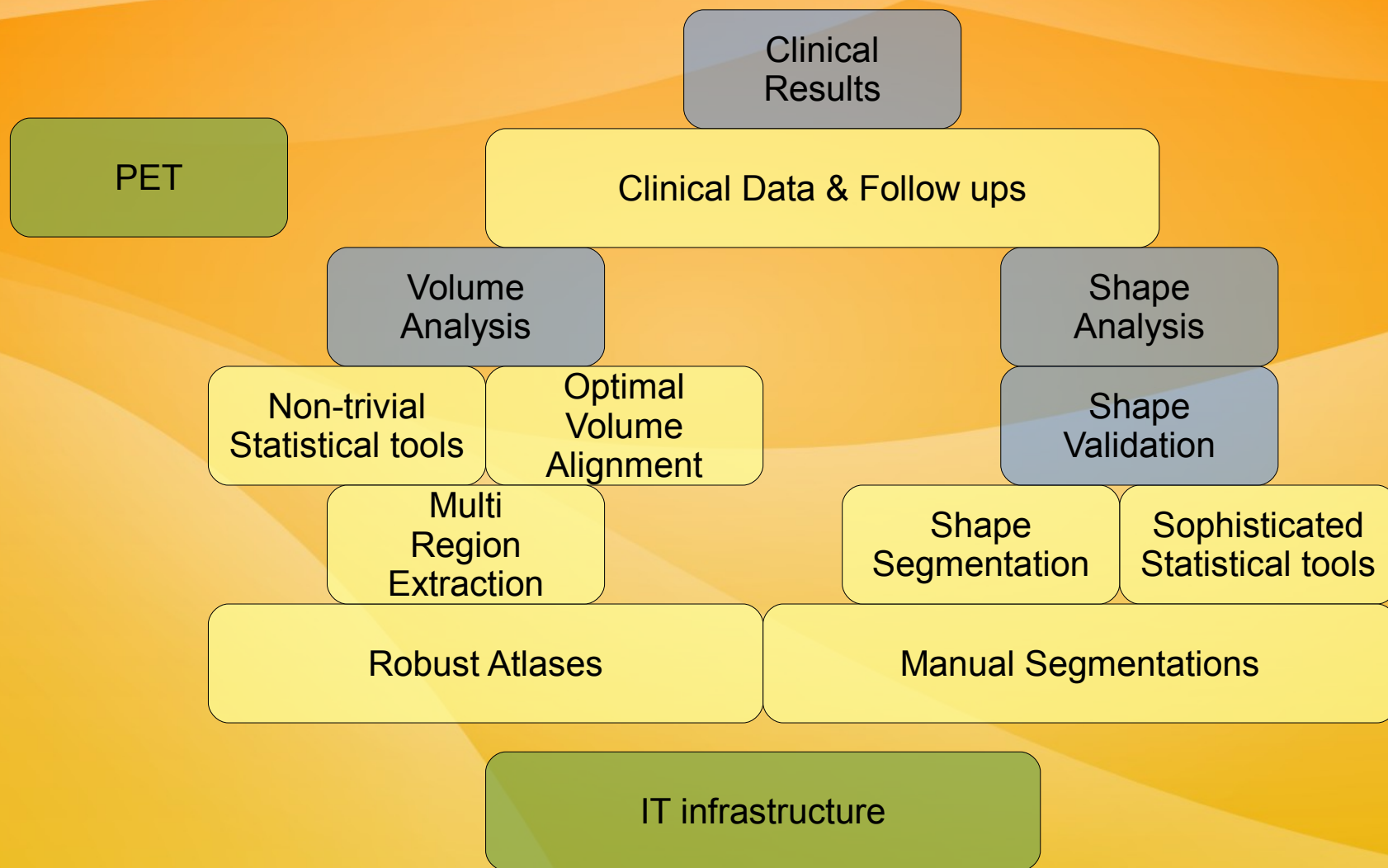


Expected submissions for 2010

- Main contributions
 - Neurobiology of ageing (beginning 2010)
 - EADC study (middle/end 2010)
 - Conferences: HBM, MICCAI, ...
 - Segmentation procedure (end 2010)
- Additional contributions
 - 1 technical paper on templates extraction algorithms (conference/journal?) [LE]
 - 1 technical paper on algorithms, performances & SunGRID (conference/journal) [GE]

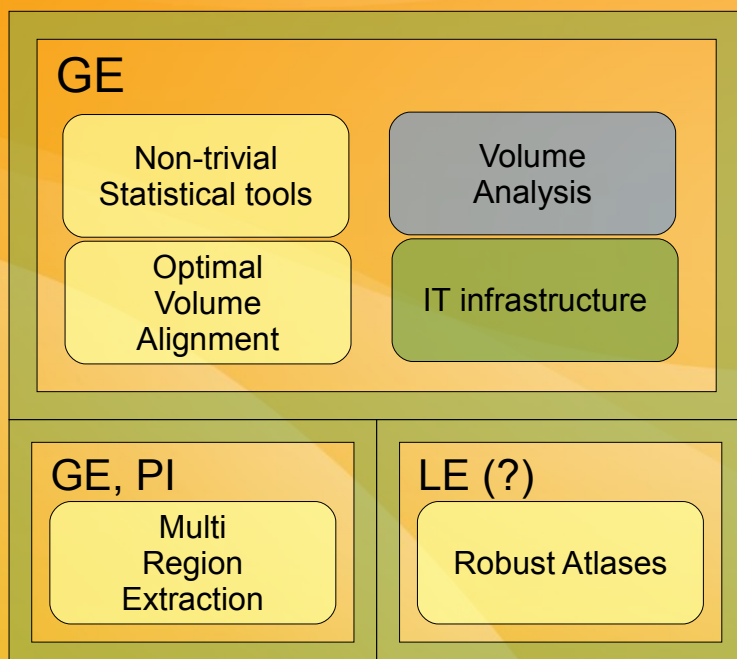


Technical review





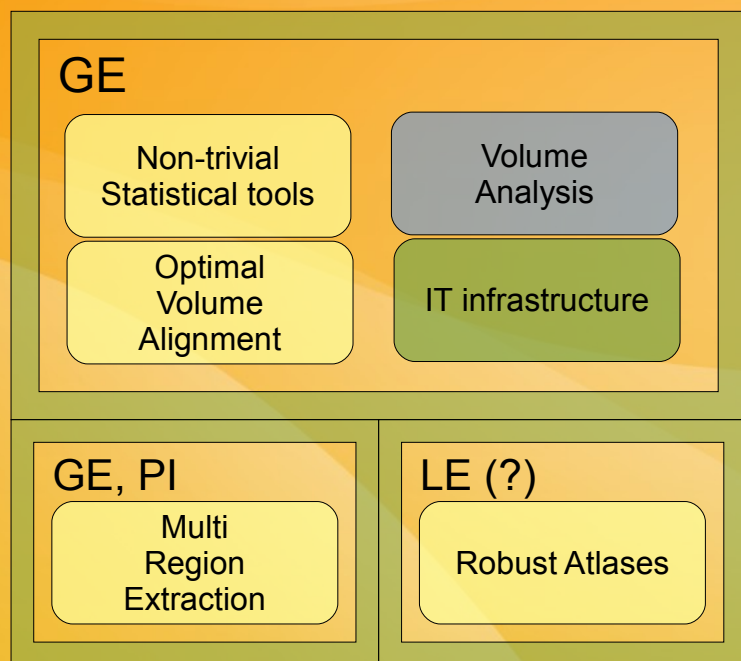
Group Review (1/2)



- Volume analysis



Group Review (1/2)



A. Chincarini, L. Rei

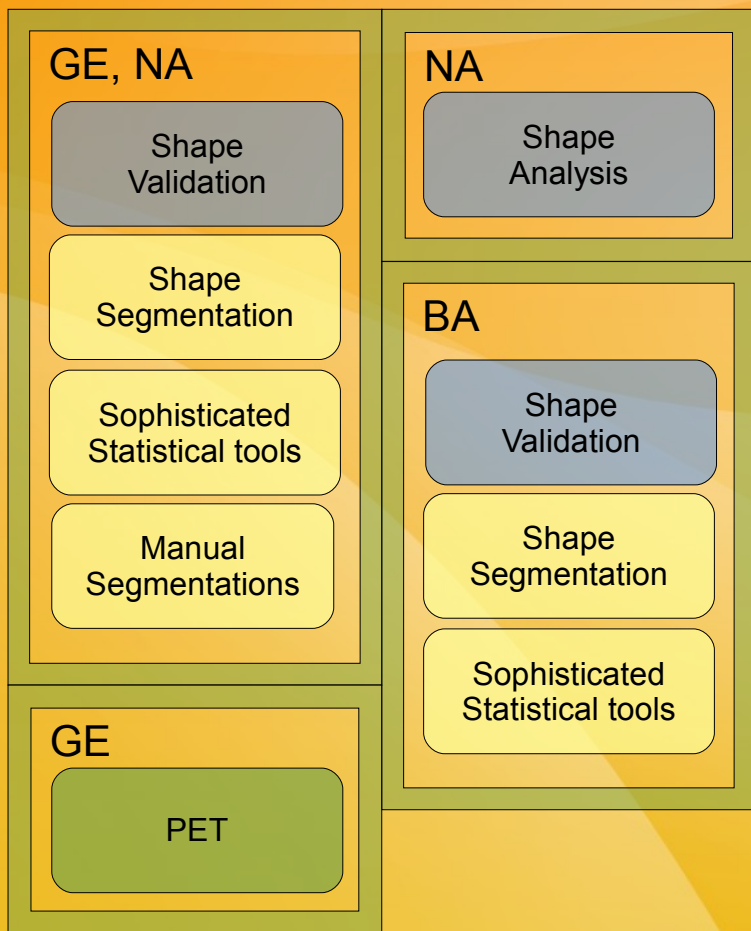
- Volume analysis

L.Rei
M.Favetta

L.Rei
A. Retico



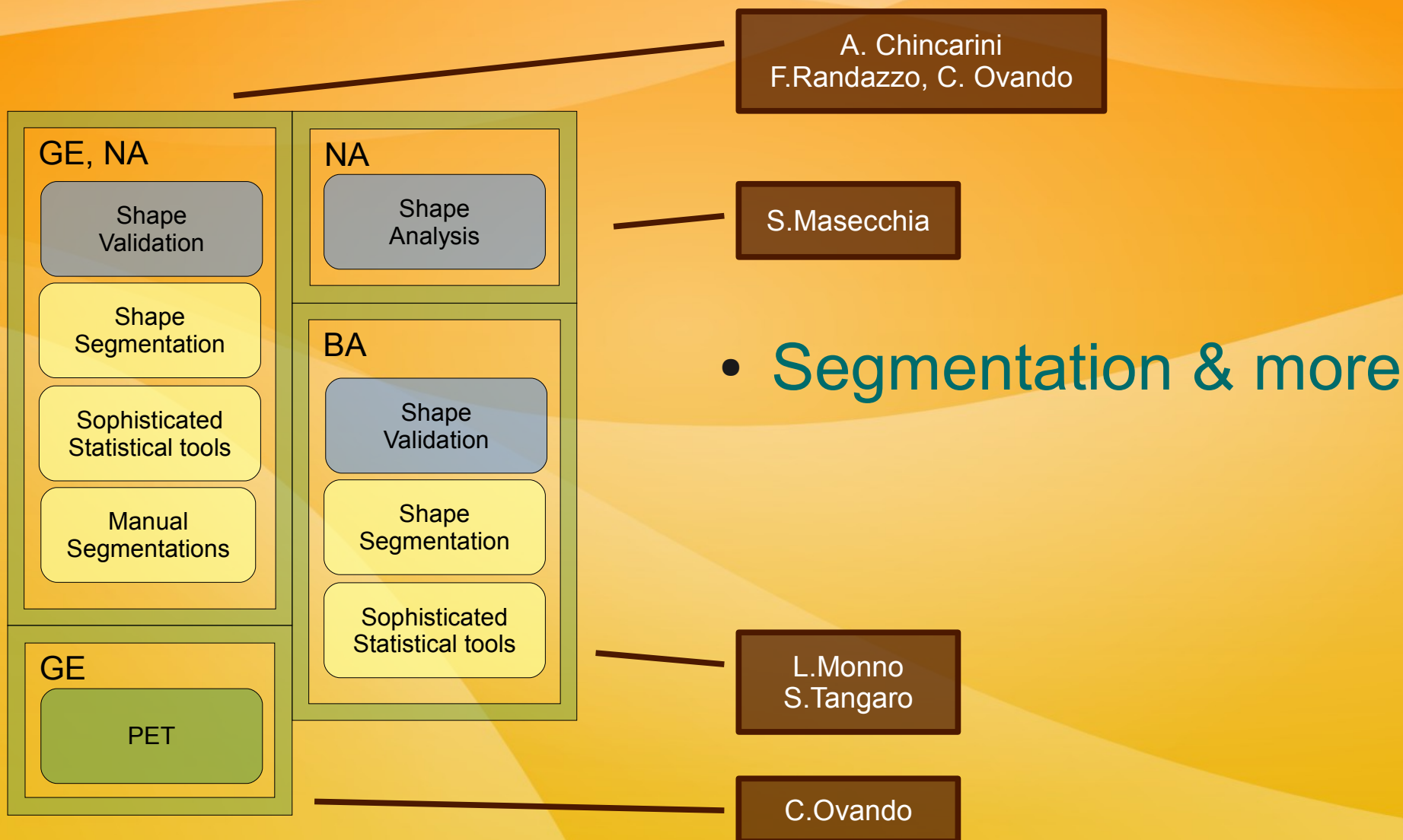
Group Review (2/2)



- Segmentation & more



Group Review (2/2)





Research guidelines (1/2)

- Volume analysis
 - Hippocampus
 - Other significant volumes (pathology dependent)
 - Time scale: 3m – 9m, 1(/ 2) clinical paper
 - Goal: clinical aid, pathology discrimination → technology transfer

- Automatic Hippocampus Segmentation
 - Algorithms can be used for other regions as well
 - Time scale: 6m / 1y, 1 technical + 1 clinical paper
 - Goal: clinical aid, early detection of Alzheimers → technology transfer



Research guidelines (2/2)

- NeuGRID / EADC segmentation challenge
 - Potential funds raiser, major algorithms validation
 - Time scale: 9m / 1y, 1+1 technical paper
 - Goal: outreach, full EADC integration → research

- MRI/PET fusion
 - Studies show remarkable improvements tapping into both MRI & PET techniques
 - Time scale: > 1y, 1 technical + 1 clinical paper
 - Goal: earlier detection, better pathology discrimination, → research



Open positions

- Major areas:
 - Segmentation (not open anymore)
 - PET/MRI fusion
 - EADC NeuGRID participation
- Minor items
 - Algorithms review & optimization
 - Other significant clinical ROIs
 - Testbed for a web portal



Neuroimaging group activity

Technical Status Report

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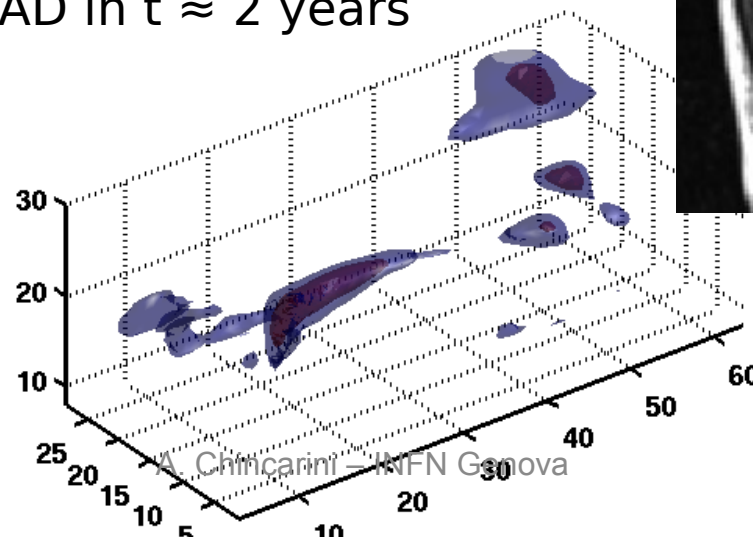
Volume analysis

- As proposed and accepted at EADC meeting (hippocampal region, likelihood ratio as statistical variable)
- Phase 1: simple correlation with Sheltens visual scale (blind, no clinical data involved)
- Phase 2: clinical data shared, follow-up prediction
- “Neurob. of Ageing” paper based on current results
- Current status:
 - completing algorithm review, new templates and improved analysis (likelihood ratio + PCA + SVM)

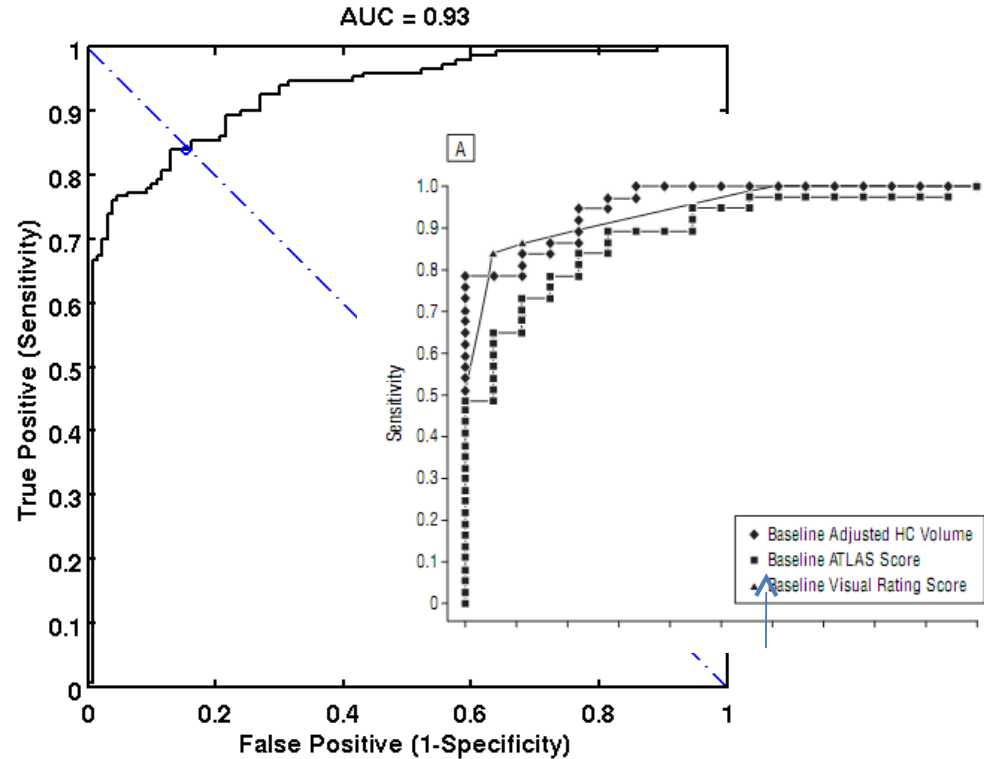
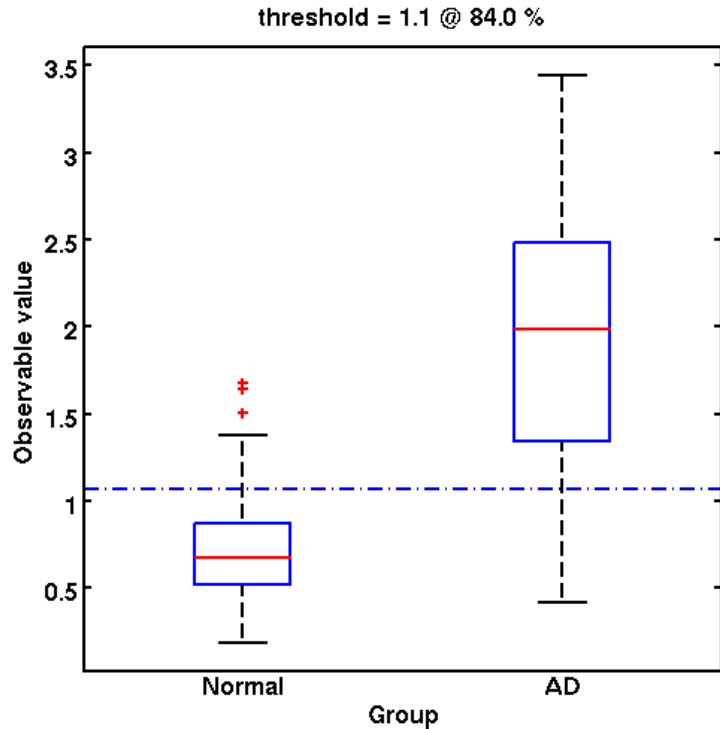
Ground for this proposal: automated analysis as a potential clinical tool

- 532 subjects
 - 130 from EADC Genoa center, Italy
 - 402 from ADNI
 - EADC-GE MCI are amnestic only
- 532 x 2 MTL volumes around the hippocampus automatically delimited and analyzed.

- 135 Normal subjects (75.5 ± 5.7) y
- 247 MCI (75.0 ± 7.0) y
 - 90 MCI converted to AD in $t \approx 2$ years
- 150 AD (76.8 ± 7.3) y



Normal subjects vs AD



“Application of Automated Medial Temporal Lobe Atrophy Scale to Alzheimer Disease” Arch Neur. 2007; 64

•Our method:

- sensitivity = specificity = 84% - MMSE score for AD: 23.2 ± 4.0

•Arch Neurog. Paper (atlas/visual/HC vol)

- sensitivity \approx specificity = 85% - MMSE score AD: 19.4 ± 4.0

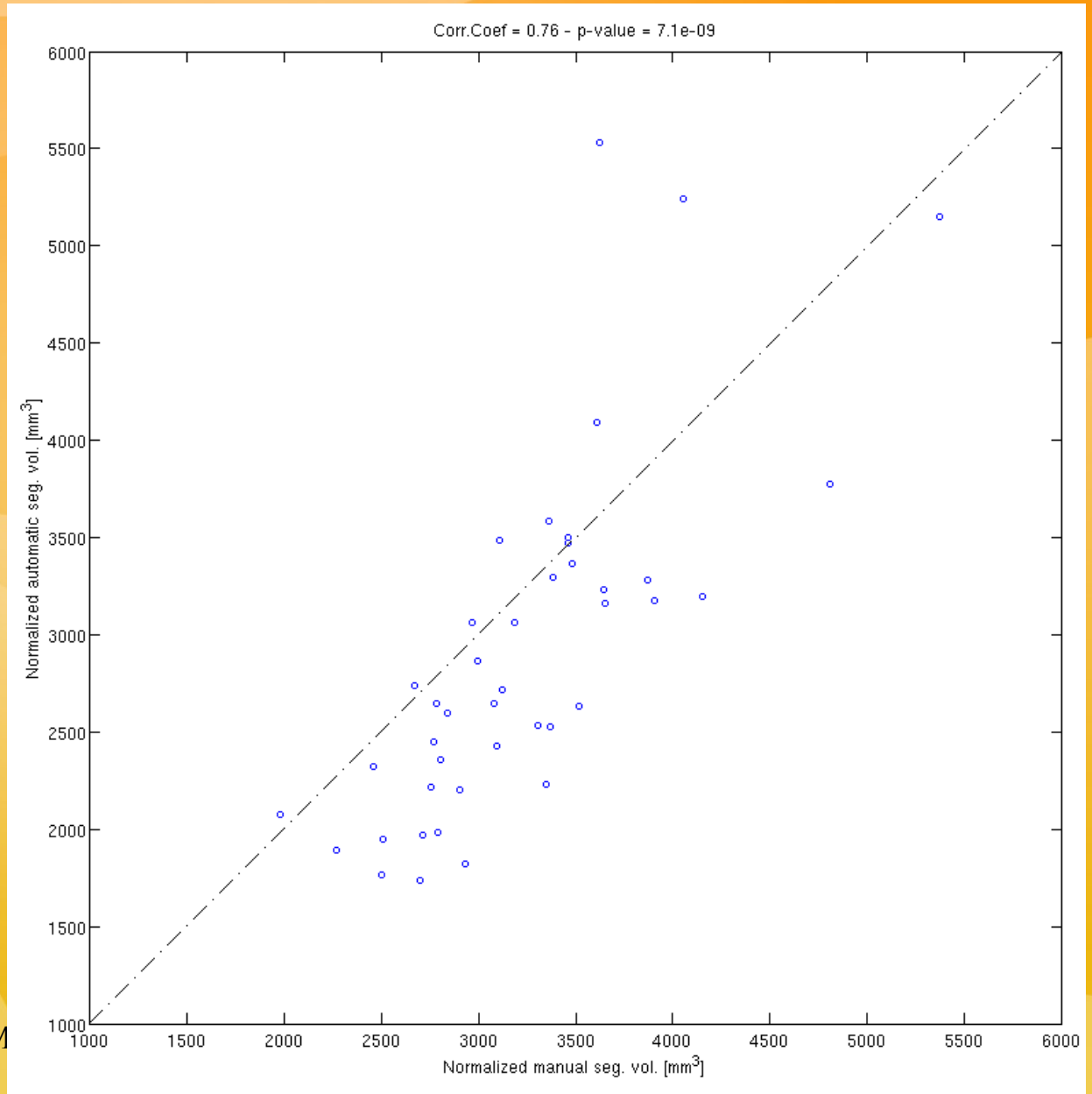
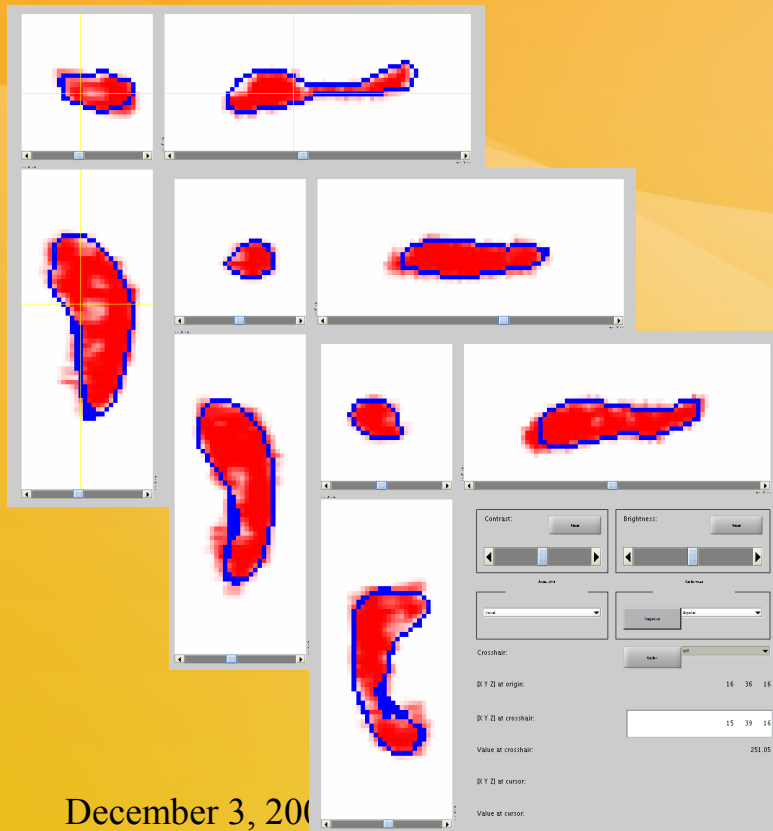


Segmentation

- Draft segmentation pipeline done.
- Uncertain training (too few hi-res manual segmentations)
- Poor correlation (approx 75% volume) with manually segmented shapes
- Segmentation algorithm is still too unstable (approx. 20% rejection rate by eye discrimination)
- Consistency filter needed to rate segmentation algorithms and pre-filter for statistic analysis
- No integrated shape analysis (yet)



Validation results (old algorithm)





Segmentation strategies

- After HBM and MICCAI, a new approach is probably needed
 - Classifiers for segmentation
 - New features included
 - box/volume independent?
- Should we keep the current template approach?
 - Yes: MICCAI segmentation challenge winners are all based on templates (atlases) + warping + statistical processing
- A combined approach may be the best choice



Neuroimaging group presentations

- Volume analysis

- ROI search with SPM (A. Retico)
- Updates on algorithms optimization, registration techniques (L. Rei)
- New, reliable, templates definition (M. Favetta)
- Ideas on volume analysis (S. Tangaro)

- Segmentation

- Innovative segmentation techniques (L. Monno)
- Shape analysis (S. Masecchia)
- Shape classifiers (F. Randazzo)

- Future developments

- Improvements on data analysis, PET (C. Ovando)



Other significant ROI

A. Retico

SPM + ADNI data

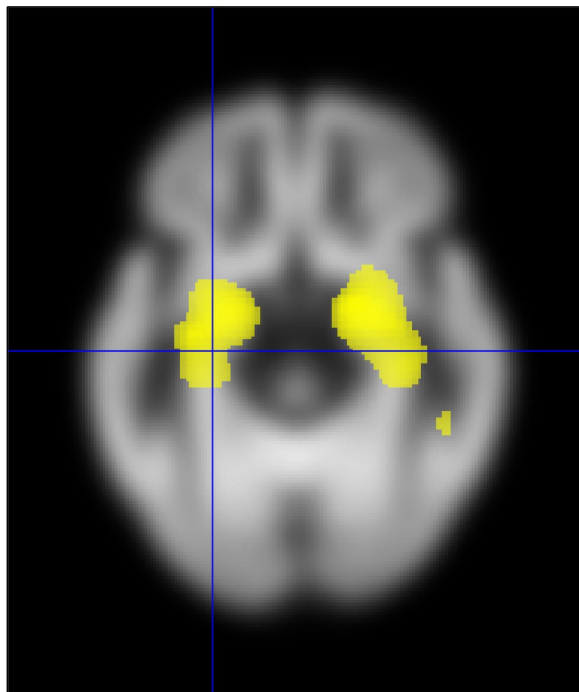
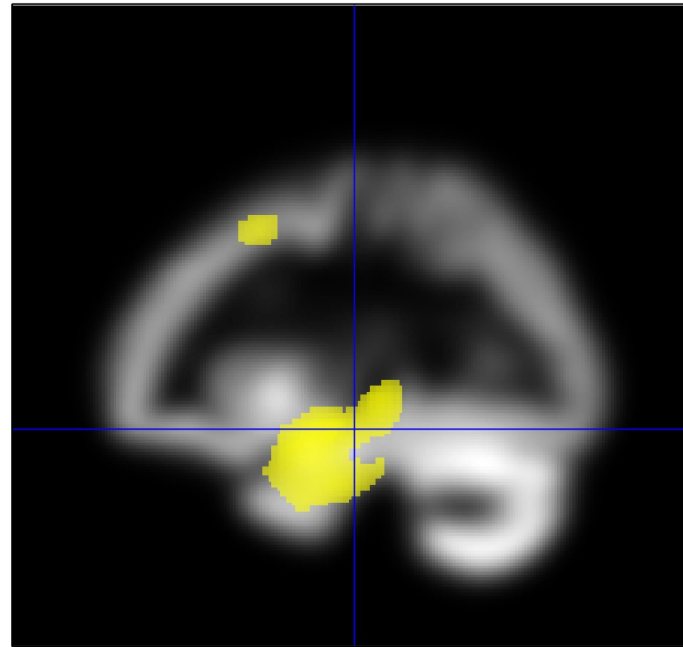
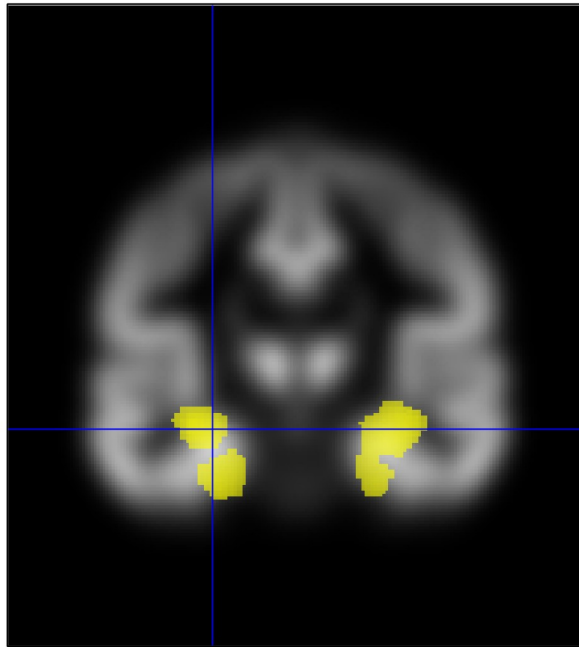
Voxel based morphometry (VBM)

- The aim of VBM is to identify differences in the local composition of brain tissues, while discounting large scale differences in gross anatomy and position.
- VBM output: a statistical parametric map (SPM) showing regions where gray matter or white matter significantly differs among groups of subjects.
- We can use VBM to identify significant local GM differences between patients affected by Alzheimer's Disease (AD), subjects diagnosed with Mild Cognitive Impairment (MCI), and Healthy Controls (HC).

DARTEL

(Diffeomorphic Anatomical Registration Through Exponentiated Lie Algebra)

- DARTEL is a tool for achieving more accurate inter-subject registration of brain images.
- The ICBM452 atlas supplied with SPM is an average of T1-weighted MRIs of normal young adult brains.
- When analyzing older or younger subjects it's better to build a population-based template.



Significant blobs
overlaid to the
smoothed averaged
GM

Conclusions

- The VBM analysis allows for the identification of brain regions where the amount of GM (or other brain segments) significantly differs among groups of subjects.
- How this analysis can interplay with the MAGIC-5 regional analysis strategy to extract a predictive clinical index for the early AD diagnosis?
 - To extract the clinical index we can try to use the significant BLOBS identified by the VBM analysis to mask the MRI images, instead of the traditional HIPPOCAMPAL BOXES.