New frontiers of human neuroimaging in Pisa: technical developments and new diagnostic methods

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Clinical impact of ultra high-field MRI 7T in **neurodegenerative disease** diagnosis

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**Parkinson disease: diagnostic role**

Standard neuroimaging techniques fail in defining normal anatomy of **Substantia Nigra** and have only a marginal role in the diagnosis of PD

SWAN UHF-MRI allowed us to define a three layered organization of SN by distinguishing **pars compacta ventralis** (SNcv) and **dorsalis** (SNcd) from **pars reticulata** (SNr).
Parkinson disease: diagnostic role

MR Imaging of the Substantia Nigra at 7 T Enables Diagnosis of Parkinson Disease

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Sensory Deprivation & GABA @ 7T scanners

FMRIB – Oxford IMAGO7 – Pisa

GABA (inhibitory neurotransmitter) decreases in the occipital cortex following short visual deprivation

A specific biomarker for adult brain plasticity, potentially important for brain repair intervention!!
FP7 funded project: TRIMAGE
“An optimized trimodality (PET/MR/EEG) imaging tool for schizophrenia”
4 years = (1 dec 2013 - 30 november 2017)

Eleven Beneficiaries (7 research institutions/4 companies)
1. UNIVERSITĂ’ DI PISA - Department of Physics
   (the Coordinator - A.Del Guerra) (UNIPI)
2. TECHNOLOGICAL EDUCATIONAL INSTITUTION OF ATHENS (TEIA)
3. FORSCHUNGSZENTRUM JUELICH GMBH (JÜLICH)
4. UNIVERSITÄTSKLINIKUM AACHEN (AACHEN)
5. KLINIKUM RECHTS DER ISAR DER TECHNISCHEN UNIVERSITAT MUNCHEN (TUM)
6. UNIVERSITÄT ZUERICH (UZH)
7. ISTITUTO NAZIONALE DI FISICA NUCLEARE (INFN)
8. Advansid SRL (Advansid)
9. WEEROC SAS (Weeroc)
10. raytest Isotopenmessgeräte GmbH (raytest)
11. RS2D (RS2D)
Rationale:
*Schizophrenia* is a severe mental disorder, which manifests early in life and causes a high social and economic burden on European societies. An imaging tool able to allow the diagnosis of schizophrenia during early development is strongly requested by the clinical community to improve the management of the disease.

Project:
TRIMAGE aims to optimize and validate an integrated diagnostic solution for simultaneous PET/MR/EEG imaging defining specific biomarkers, to give the clinicians an effective tool for the diagnosis and choice of treatment of schizophrenia and other mental health disorders.

Outcome:
The PET/MR/EEG scanner prototype will be built by the consortium and is intended for broad distribution. It will enable effective early diagnosis of schizophrenia and possibly other mental health disorders.
A closer LOOK at the instrument

Dimensional outline (left) and artistic view (right) of the dedicated brain PET/MR/EEG system (the EEG cap is not shown).

**MR (to be built)**
- 800 mm bore
- asymmetric gradient
- low field 1.5 T (non cryogenic)

**EEG (commercial)**

**PET (to be built)**
- Spatial res 2mm (DOI)
- High efficiency (14% at CFOV)
- Axial FOV= 150mm
- Transaxial FOV=110 mm radius

Cost effective  low-cost!!
Visual fMRI in 7Weeks old infants

Infant Functional Atlas is important for:
- Neurosurgery
- Brain plasticity and reorganization during development
- many other pathologies (Cerebral Palsy – PVL – Infant Hemianopia)

Optimization of MR scanning procedure for alert collaborating infants (visual stimulus, eye movement recording, holding crib...)

For making these recordings routinely in neuro-radiological centers it would be important to use a vertical MR scan.

INFANT ATLAS:
-  $\chi=5$, $\psi=-30$, $\zeta=-11$, $\zeta=13$ are the distance (mm) from the AC point in the $x,y,z$ directions

A well-established cortical network of Visual selectivity by 7 weeks of age