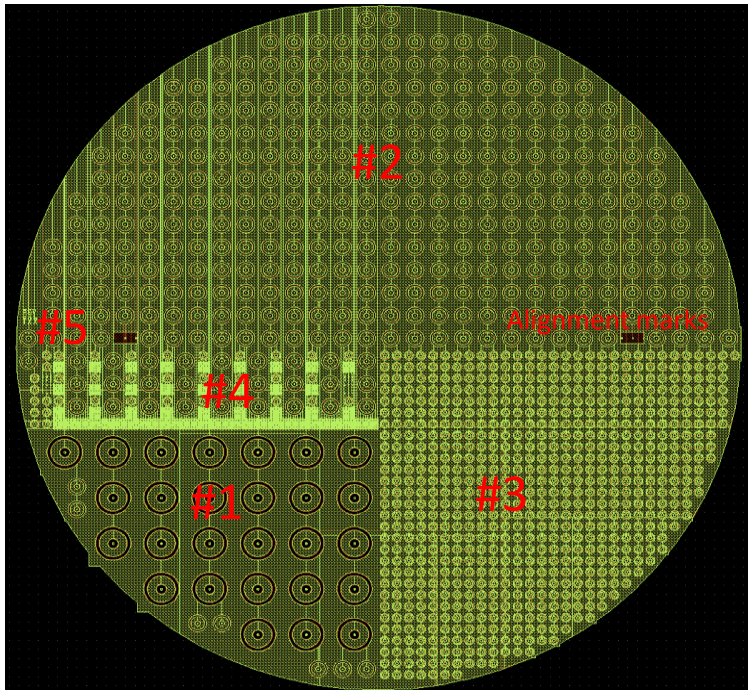


Development of Radiation Hard
Semiconductor Devices for Tracking
Detectors in Future Collider
Experiments

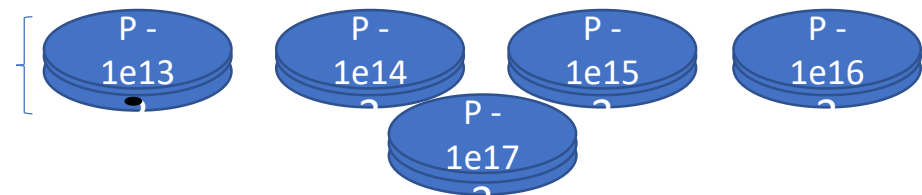
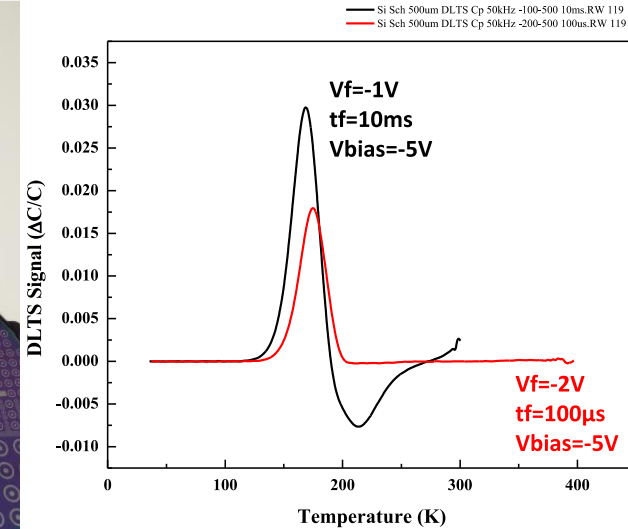
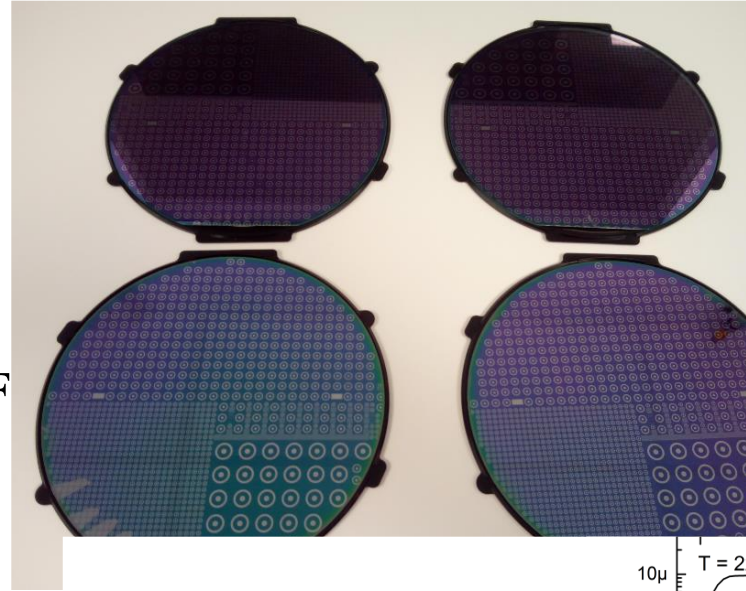
Thomas Koffas

R&D Examples – Material Defects

Radiation Damage of Epitaxial p-type Si – Schottky Diodes + pn Junctions

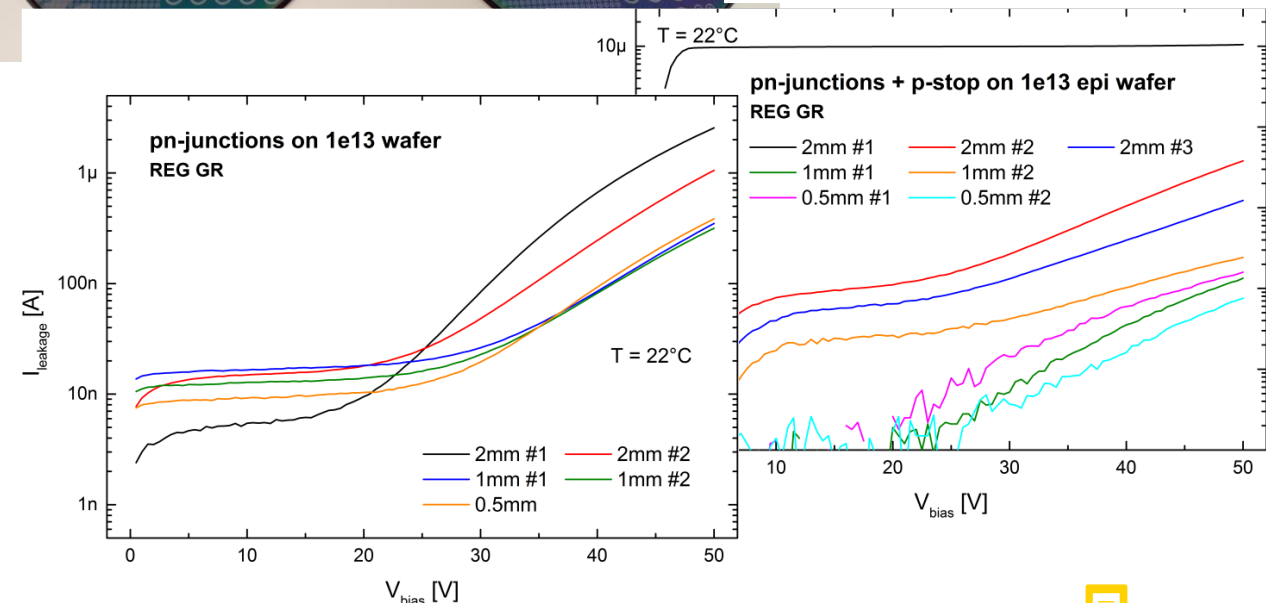


RAL/ITAC
→
Carleton/CUMFF

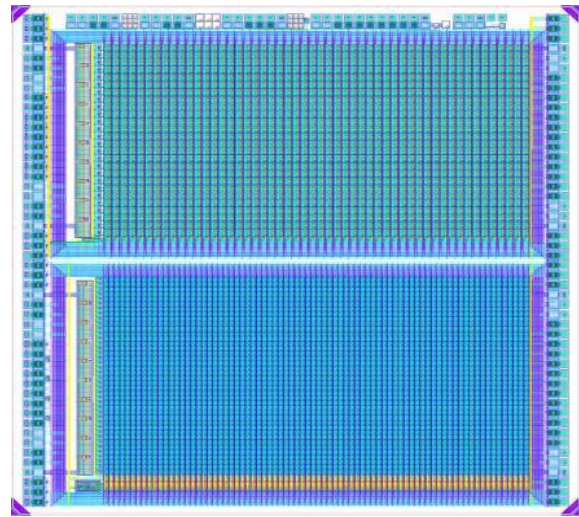


Si wafers (6 inches) of different epitaxial doping levels each

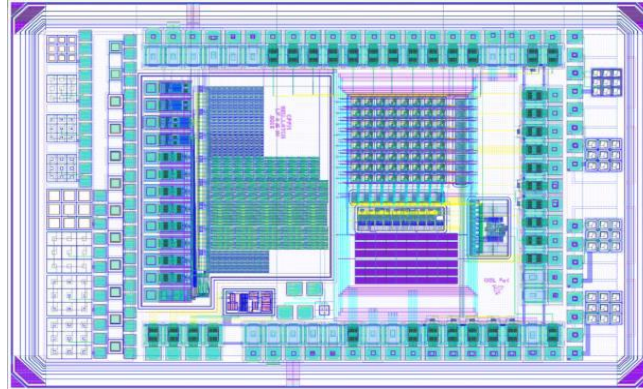
- P type doped with different **epitaxial** doping levels
- 10 Wafers /each doping type



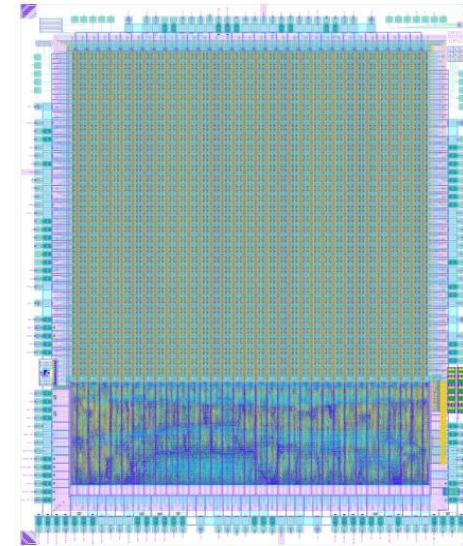
R&D Examples – New Structures/D-MAPs



RD50-MPW1



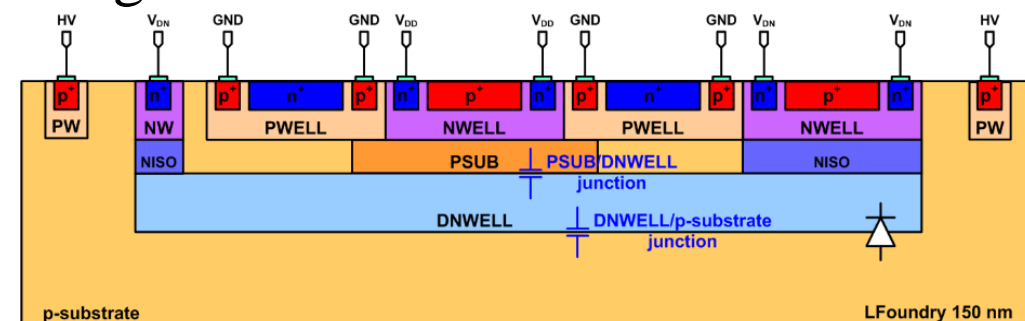
RD50-MPW2



RD50-MPW3



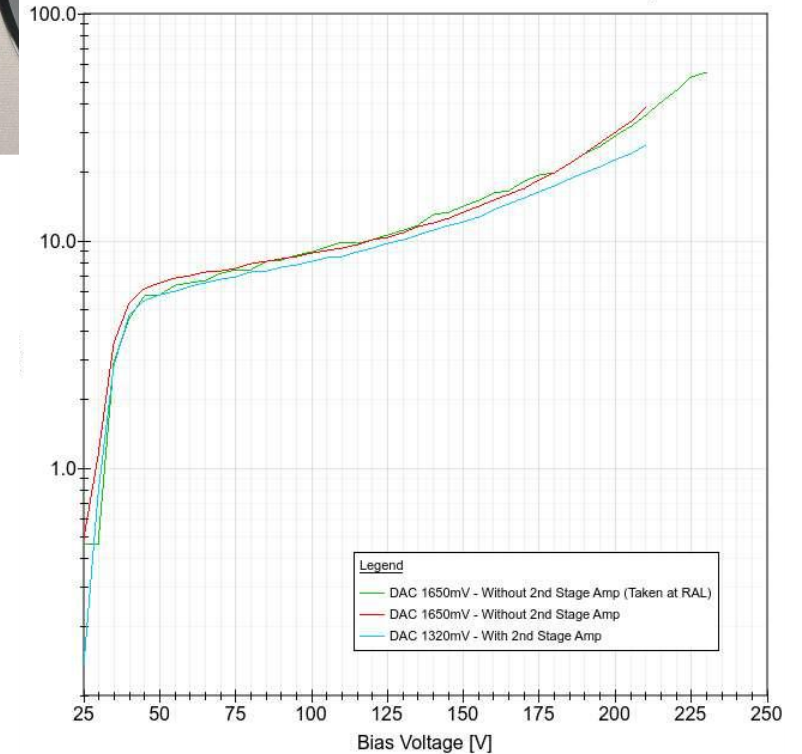
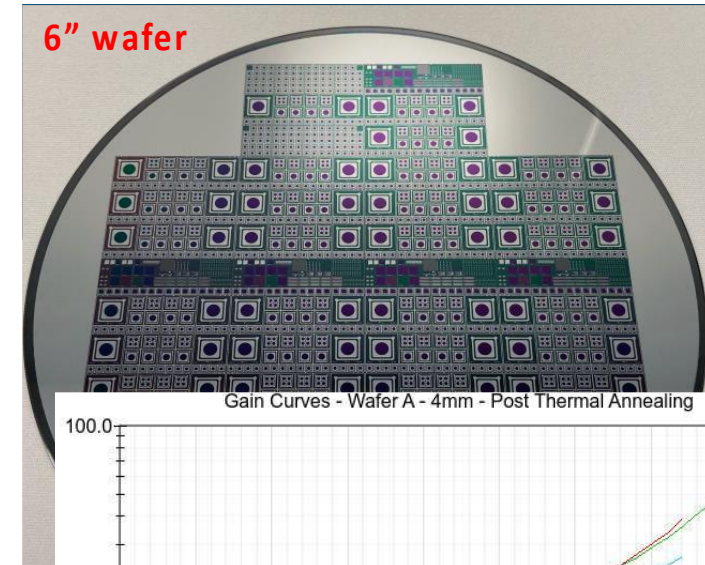
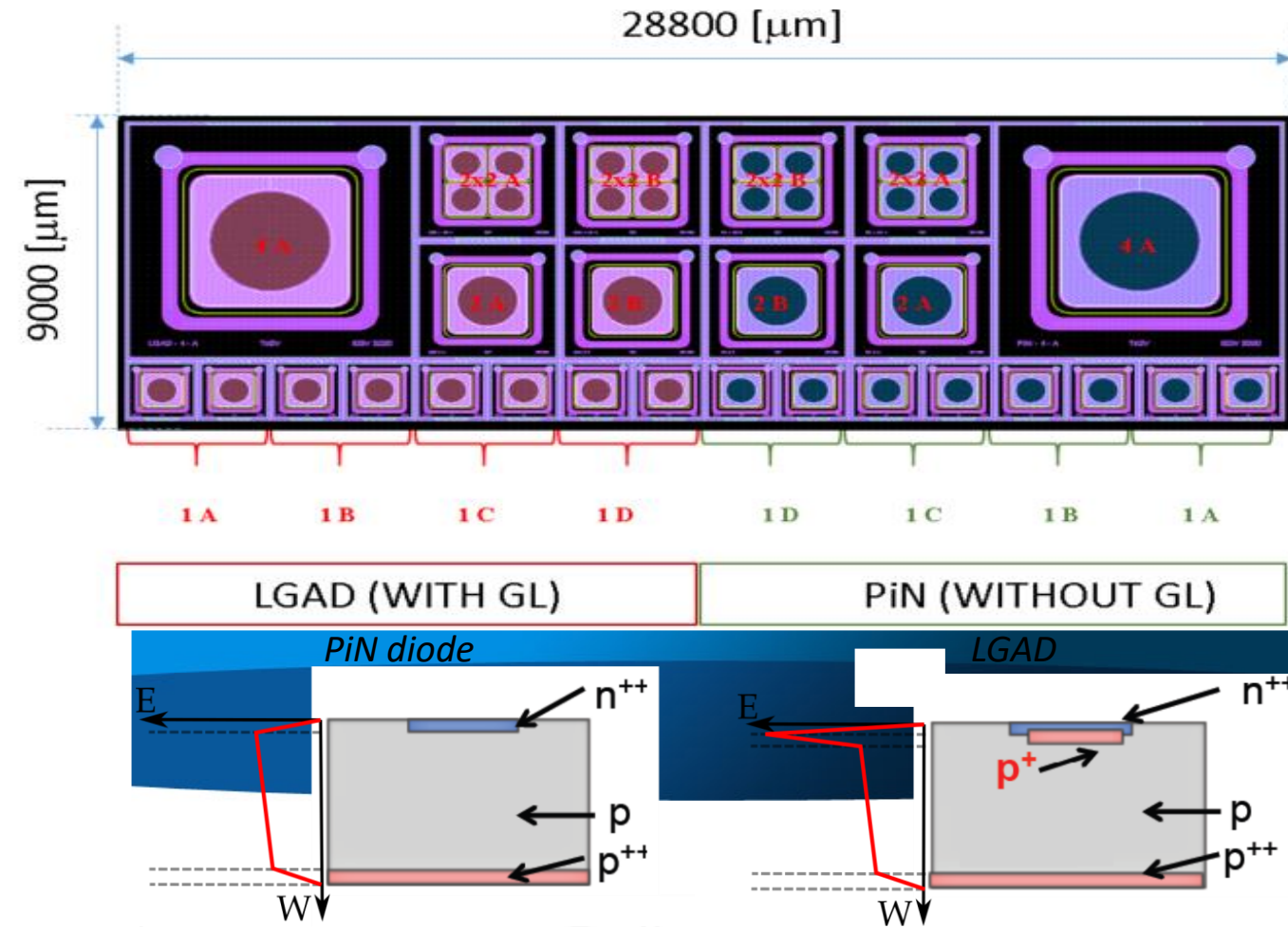
- 3 Depleted Monolithic Active Pixels Sensors (DMAPs) designed
 - Submission dates in timeline, chip delivery ~0.5 – 1 year later
- All in LFoundry 150nm process
- High resistivity substrates (up to ~2 kOhm/cm)



R&D Examples – New Structures/LGADs

Study radiation effect on Gain Layer (GL) charge amplification

- LGAD and PiN diodes share the same layouts (4mm, 2mm, 1mm)
- Three different gain layer doses and energy
- Fabrication completed at Teledyne-e2v (UK)

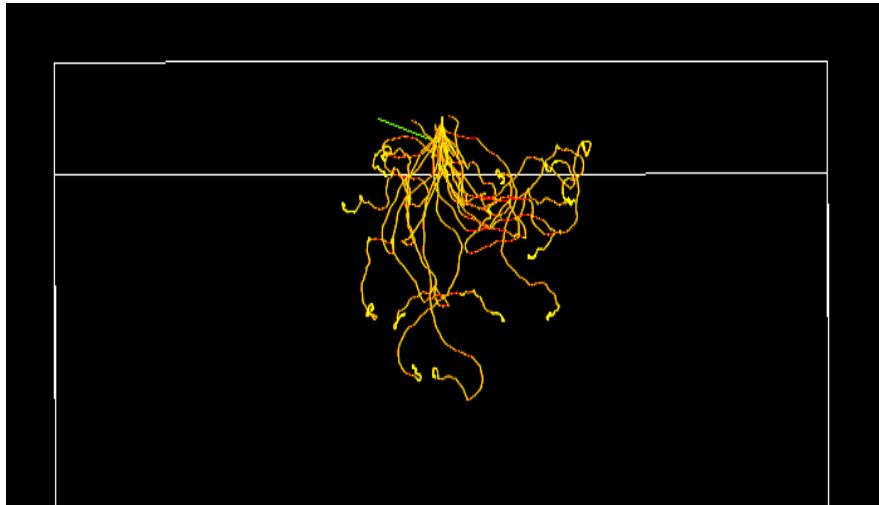


R&D Examples – New Materials

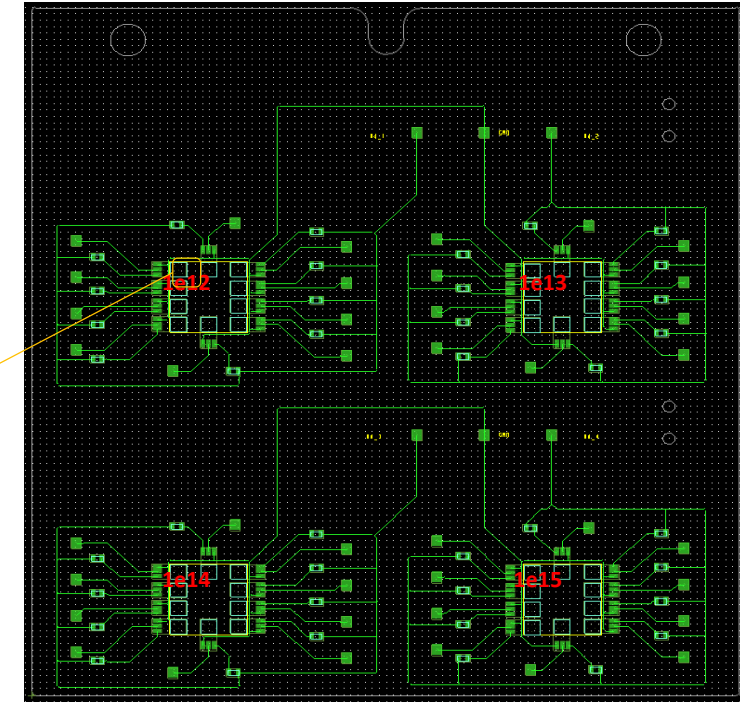
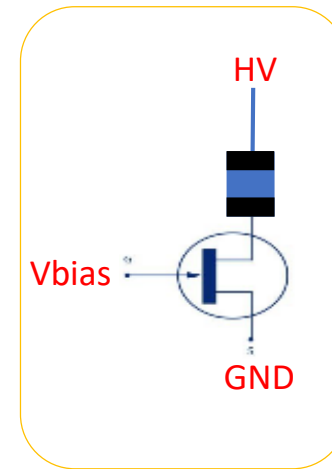
NRC GaN Fabrication Process Radiation Hardness

Modified GaN HEMT structure as rad-hard sensor for ionizing radiation

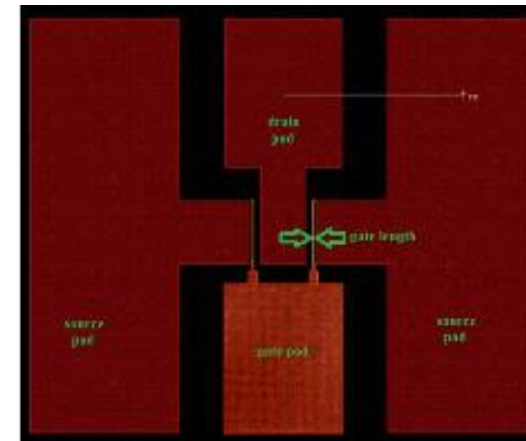
- GEANT4 simulations of 500 keV normally incident β -particles on a GaN slab demonstrate sufficient energy deposition for detection



- TCAD simulations being performed on the modified GaN HEMT to investigate if gain can be achieved in a similar manner to that of LGADs
- Aim to irradiate some GaN HEMTs fabricated by NRC with 26MeV p up to fluences of 10^{15} [cm²] (TID around 230Mrad [GaN]) to compare with previously irradiated Panasonic GanFETs used in Strips ITK



PCB holding up to 40 NRC 1x2 mm² GaN devices, divided into 4 blocks. Each block of 10 devices receives a different p fluence, up to $1e15$ [cm⁻²]



NRC 1x2 mm² GaN HEMT layout
Each 1x2 mm² chip contains 4 HEMTs, differing in gate length

R&D Framework – CERN Collaborations

The RD50 Collaboration



An international collaboration that aims to provide radiation-hard semiconductor devices for future colliders

New!



- ***63 institutes, 370 members***

- 50 European institutes
- 8 North American institutes
- 2 Asian institutes
- 1 Middle East institute

