

Underground physics

APPEC towards Horizon2020 meeting
DESY Zeuthen, Berlin, November 4-5, 2013

Laura Baudis
University of Zurich



**Universität
Zürich**^{UZH}

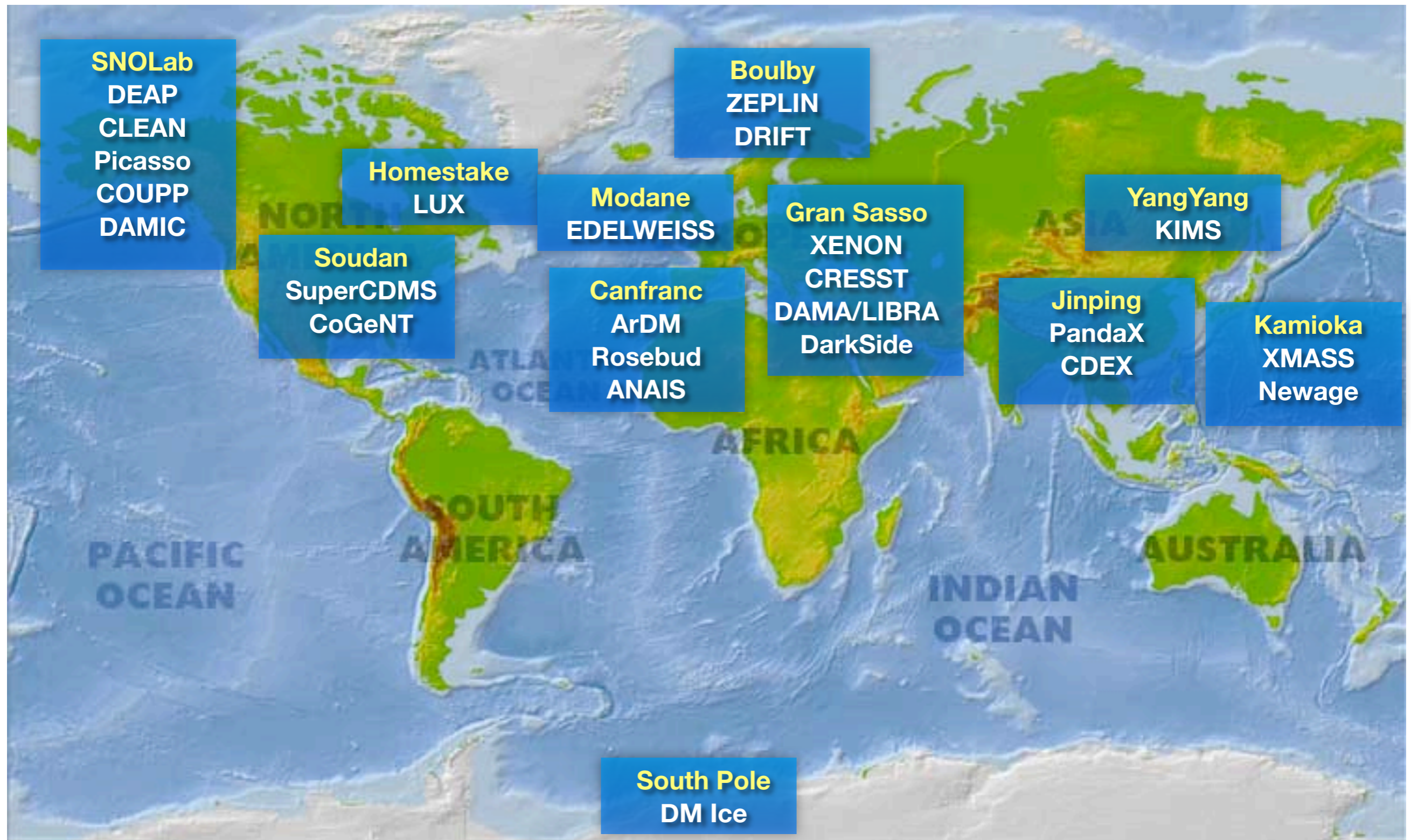
Topics of discussion

- Underground laboratories
- Dark matter experiments
- Double beta decay searches

Glossary

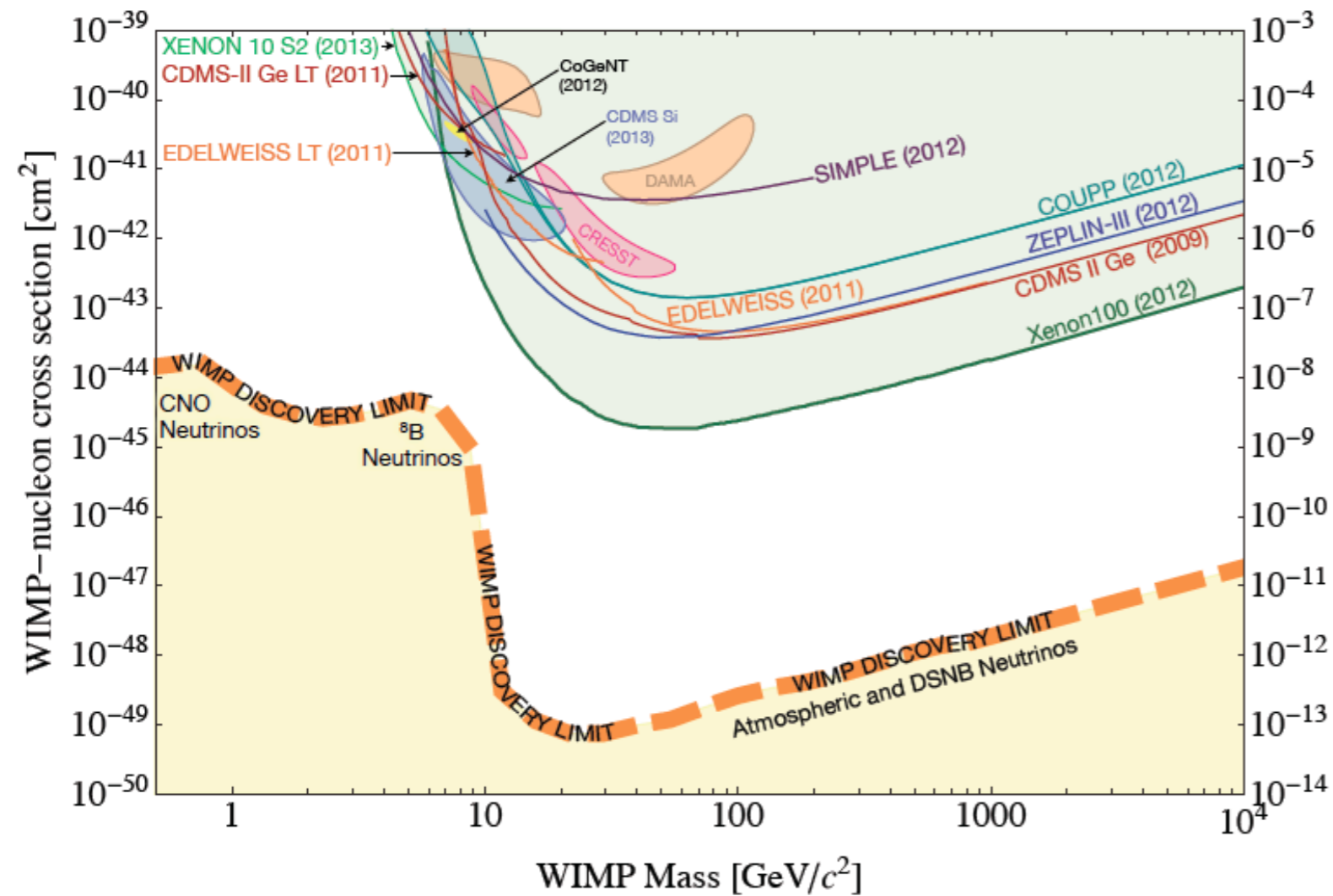
- **MSCA:** Marie Skłodowska-Curie actions
- **FETs:** future and emerging technologies
- **RI:** research infrastructure
- **ERC:** European Research Council
- **SMEs:** Small and Medium-Sized Enterprises
- **ESFRI:** European Strategy Forum on Research Infrastructure
- **LEIT:** Leadership in Enabling and Industrial Technologies
- **I3:** Integrated infrastructure (example, old ILIAS)
- **PP:** priority program

WIMP detectors, world wide

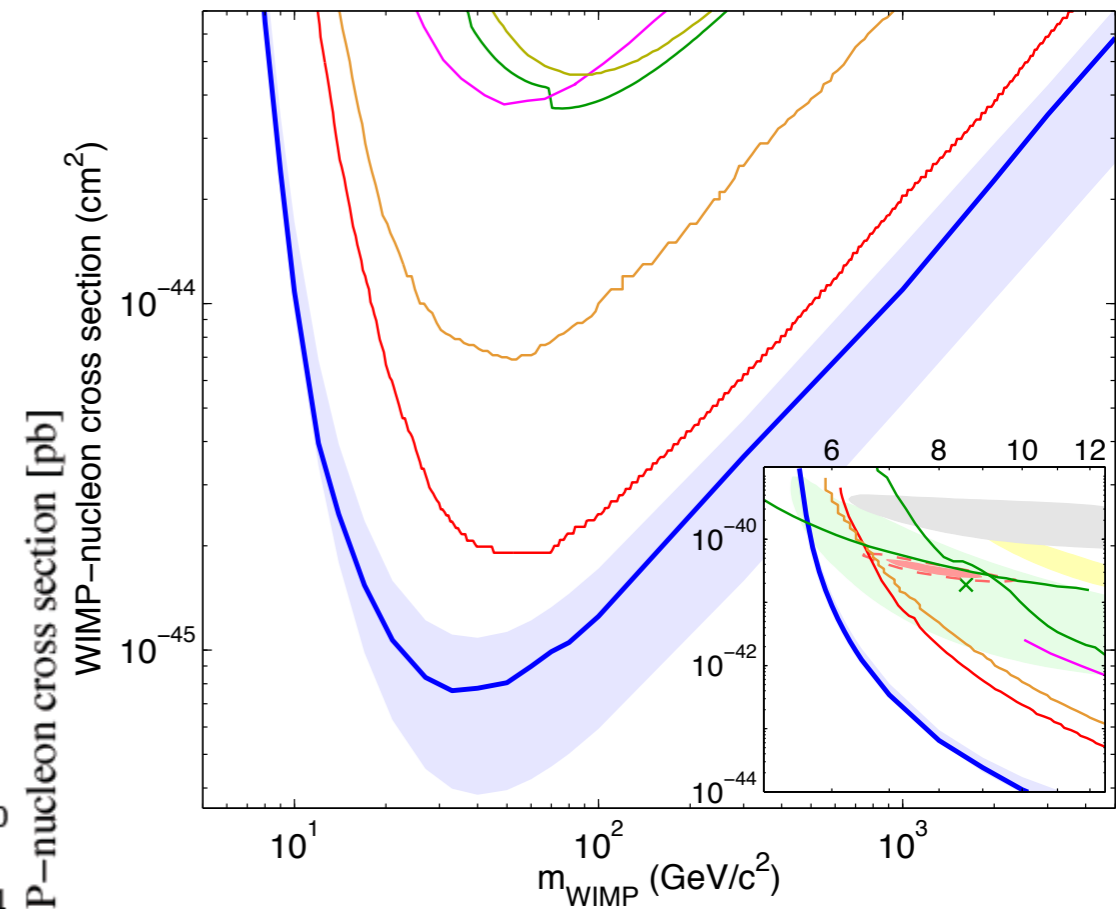


WIMP parameter space

Overview of results before Oct 30, 2013 and neutrino backgrounds



LUX result, Oct 30, 2013



Dark matter experiments with strong European involvement

- Bolometers:

- ➔ current: CRESST, EDELWEISS

- ➔ future: EURECA (proposal, CDR), discussions with SuperCDMS towards > 100 kg

- Noble liquids:

- ➔ current: ArDM, DarkSide-50, XENON100, and XENON1T (in construction)

- ➔ future: DarkSide5t (proposal), XENONnT (n=5-7, proposal), DARWIN (design study, funded by ASPERA)

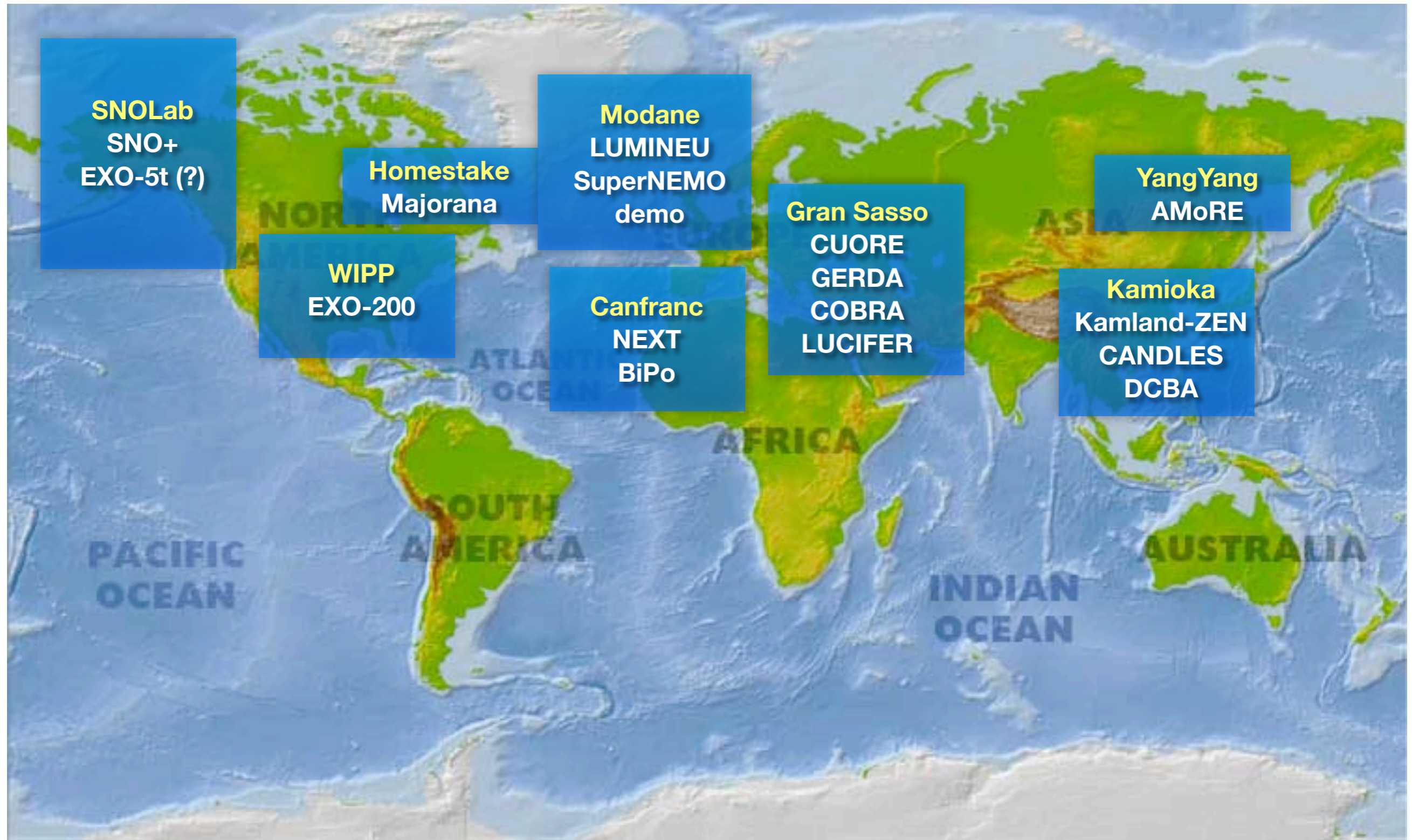
- Room temperature crystals:

- ➔ DAMA/LIBRA, ANAIS (in construction)

- Directional: R&D, large detector(s) (1 ton CF₄ at 50 torr for 1e-46 cm² ~ 16 x16 x16 m³) once there is a clear discovery

- ➔ DMTPC, DRIFT, MiMAC

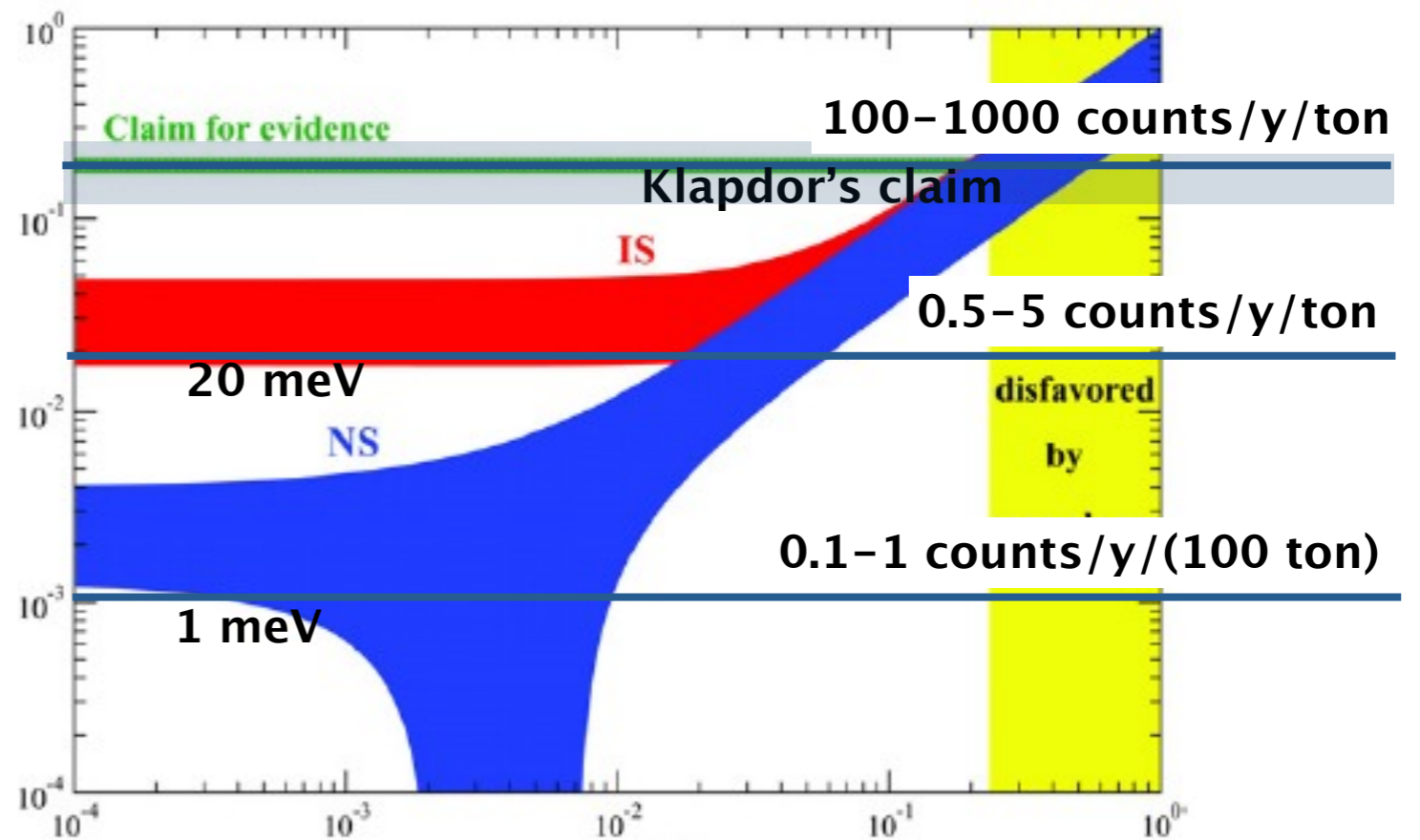
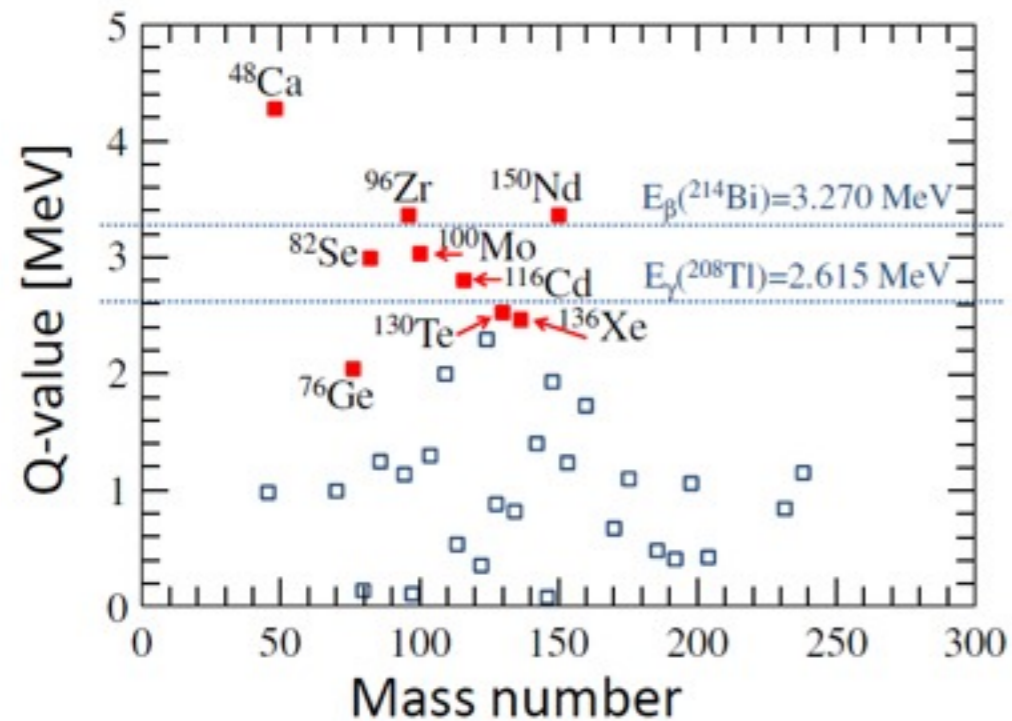
Double beta detectors, world wide



Double beta decay: isotopes and reach

Primary goal of searches: test the nature of neutrinos (Majorana vs. Dirac)

Could also deliver information on effective Majorana neutrino mass



Figures by A. Giuliani, Oct 2013

Double beta experiments with strong European involvements

- Crystals/calorimeters:
 - ➔ CUORE: ^{130}Te in TeO_2
 - ➔ GERDA: ^{76}Ge in HPGe (MoU with Majorana for larger, ≥ 100 kg, experiment), **SILENT study funded by ASPERA**
 - ➔ LUCIFER: ^{82}Se , in ZnSe -> ERC funding
 - ➔ LUMINEU: ^{100}Mo in ZnMoO_4
 - ➔ COBRA: ^{130}Te , ^{116}Cd in CdZnTe
- Noble gases (tracker + calorimeter):
 - ➔ NEXT: ^{136}Xe HP gas -> ERC funding
- Think foil/tracker
 - ➔ SuperNEMO demo: ^{82}Se , or ^{150}Nd , or ^{48}Ca as thin foils
- Scintillator: SNO+: ^{130}Te loaded in scintillator; Borexino loaded with ^{136}Xe (?)

Some common issues in direct dark matter and double beta decay searches

- Low radioactivity tracing
- Materials of extreme radiopurity
- Photodetectors
- Cryogenic detectors, bolometers
- Underground infrastructures
- Gas/liquid purification techniques
- Enrichment/depletion processes

Questions we were asked to consider

1) Will we do a MSCA and of which type (ITN, COFUND, RISE) and which perimeter?

ITN underground lab; possibly ITN on dark matter, ITN on double beta decay

2) Can we propose a design study (for a “world class research infrastructure”, INFRADEV 1-2014)?

Large noble liquid detector: but as a multi-purpose facility (dark matter, solar neutrinos, solar axions, double beta, other?) -> does it qualify as an ESFRI?

3) Is there a present/future ESFRI link?existing PP, implementation?

Underground lab proposal for 2016 roadmap

4) Can we propose an I3 beyond GW, UL

Dark matter/double beta decay synergies

5) Can we participate in an RI cluster?

No

Questions we were asked to consider

6) Can we bid to an e-infrastructure? (calls 1 and 9)

No

7) Can we apply for FETs, LEITs, societal challenge R&D?

Any ideas?

8) What are the global aspects of our research?

NFRASUPP-6 – 2014 – INTERNATIONAL COOPERATION FOR RESEARCH, INFRASTRUCTURES (7 M)

9) What are the R&D themes that an ERANET+ could support?

Dark matter, double beta decay, synergies (our suggestions)

ITN UG lab proposal

- Deadline is April 2014
- 4 underground labs (Boulby, Canfranc, Gran Sasso, Modane)
 - ➔ + other full partners (proposals to be submitted to the lab directors + Ino)
 - ➔ + associate partners
 - ➔ + industrial partners
- Immediate actions:
 - ➔ invite colleagues to submit proposals
 - ➔ prepare document to send around to the community next week

Existing dark matter + neutrino ITN

www.invisibles.eu

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neutrinos, dark matter & dark energy physics

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THE NETWORK

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Invisibles is a new European ITN project (FP7-PEOPLE-2011-ITN, PITN-GA-2011-289442-INVISIBLES (April 2012-March 2016)), which focuses on Neutrino and Dark Matter phenomenology and their connection. Experimental and theoretical aspects are also encompassed. The network involves nodes in seven European countries and its associated partners extend to seven non-European countries.