

FUTURE OF ASTROPARTICLE PHYSICS AT INFN



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PEOPLE & MONEY

- 750 physicists / 540 FTEs
- 12 MEuro/year (+ EGO + KM3Net +)
- large and motivated community

A LOT OF CARE IN TELLING THE FUTURE

- Nature goes by its roads, we have some problem in identifying the right ones

ASPERA ROAD MAP 2008



Magnificent Seven



On 29 September 2008, ASPERA published the **European roadmap for astroparticle physics**, presenting the seven large infrastructures expected to address some of the most exciting questions about the Universe such as: What is dark matter? What is the origin of cosmic rays? What is the role of violent cosmic processes? Can we detect gravitational waves?

This ambitious programme of the "Magnificent Seven" astroparticle physics large projects will gather European countries to open new exciting windows to the Universe. Most of these projects are currently under design study or preparatory phase.

- **CTA** is a large array of Cherenkov Telescopes for detection of cosmic high-energy gamma rays
- **KM3NeT** is a cubic kilometre-scale neutrino telescope to be built in the Mediterranean Sea
- **EURECA** is a large-scale dark matter detector
- The **Einstein Telescope** is a third-generation underground gravitational antenna
- **LAGUNA** is a very large volume deep underground neutrino observatory
- The Pierre Auger Observatory is an existing infrastructure to be extended with a North site
- A ton-scale detector for the determination of the fundamental nature and mass of neutrinos is envisaged beyond the current projects.

STATUS AFTER 6 YEARS

- CTA: not started yet
- KM3Net: new terminology - Phase 1.5 - far behind ICECUBE
- EURECA: what is it ? We know XENON1T- Dark Side- LUX
- Einstein Telescope: we better observe GW with Virgo/LIGO first
- LAGUNA: unclear, community is focusing on LBNE, HyperK
- Pierre Auger Obs: no North Side, change of mission ?
- A ton scale detector for DBD: several options, no clear way

INFN PORTFOLIO

- CUORE for DBD (not yet started) and GERDA (taking data)
- DAMA (adding statistics to claim), Dark Side for Dark Matter (starting), XENON1T (in preparation)
- VIRGO (done) and Advanced VIRGO (in construction)
- Pierre Auger (thinking to an upgrade)
- MAGIC (taking data)
- AMS (taking data) , PAMELA, AGILE, FERMI
- KM3Net at Capo Passero (taking shape)

CONSIDERATIONS

- CMB missing
- Dark Energy missing
- Neutrinos beside DBD need a program
- Dark Matter too much 'WIMP' oriented

WHAT NEXT

In view of the complex landscape we have to confront, INFN has recently started a process to identify the most important research themes that we should focus on amongst those that in this moment do not receive enough attention (people, funding).

Astroparticle physics is a sector that is at the center of attention.



7-8 APRILE 2014

ANGELICUM

what NEXT?

INFN
Istituto Nazionale
di Fisica Nucleare

Alla vigilia degli importanti input sperimentali che arriveranno da LHC a più alta energia e dai nuovi esperimenti sulla materia oscura, l'INFN si interroga sulle possibili strade da prendere per la ricerca di nuova fisica oltre il Modello Standard.

L'incontro è aperto a tutta la nostra comunità INFN, per dare anche il tuo contributo iscriviti dal sito www.infn.it

Angelicum Congress Centre - Aula Magna
Largo Angelicum, 1 Roma

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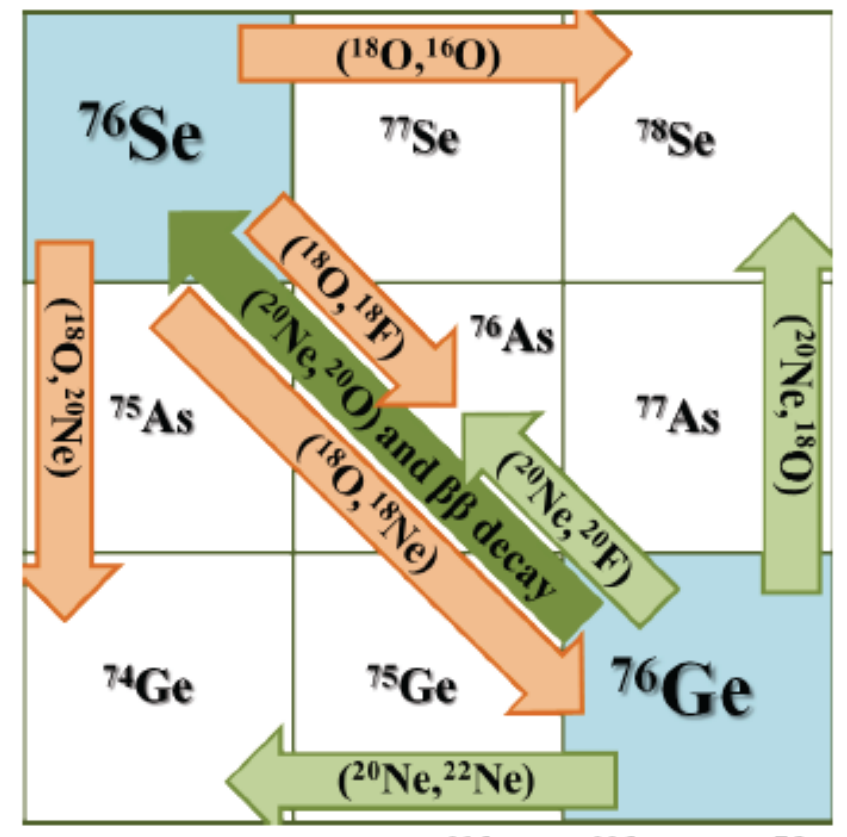
NEUTRINOS

- Sterile neutrinos : clean the field from the 'LBNE's effect - **ICARUS at FNAL SBL and SOX at LNGS**
- Mass hierarchy: **JUNO**
- CP violation: **LBNE with LAr**
- DBD at 0 background : **vigorous R&D**
- Absolute mass: **HOLMES (ERC)**
- Relic neutrinos: ?

THE GHOSTS OF DBD

- Nuclear Matrix Elements
- Renormalization of g_A

NUMEN

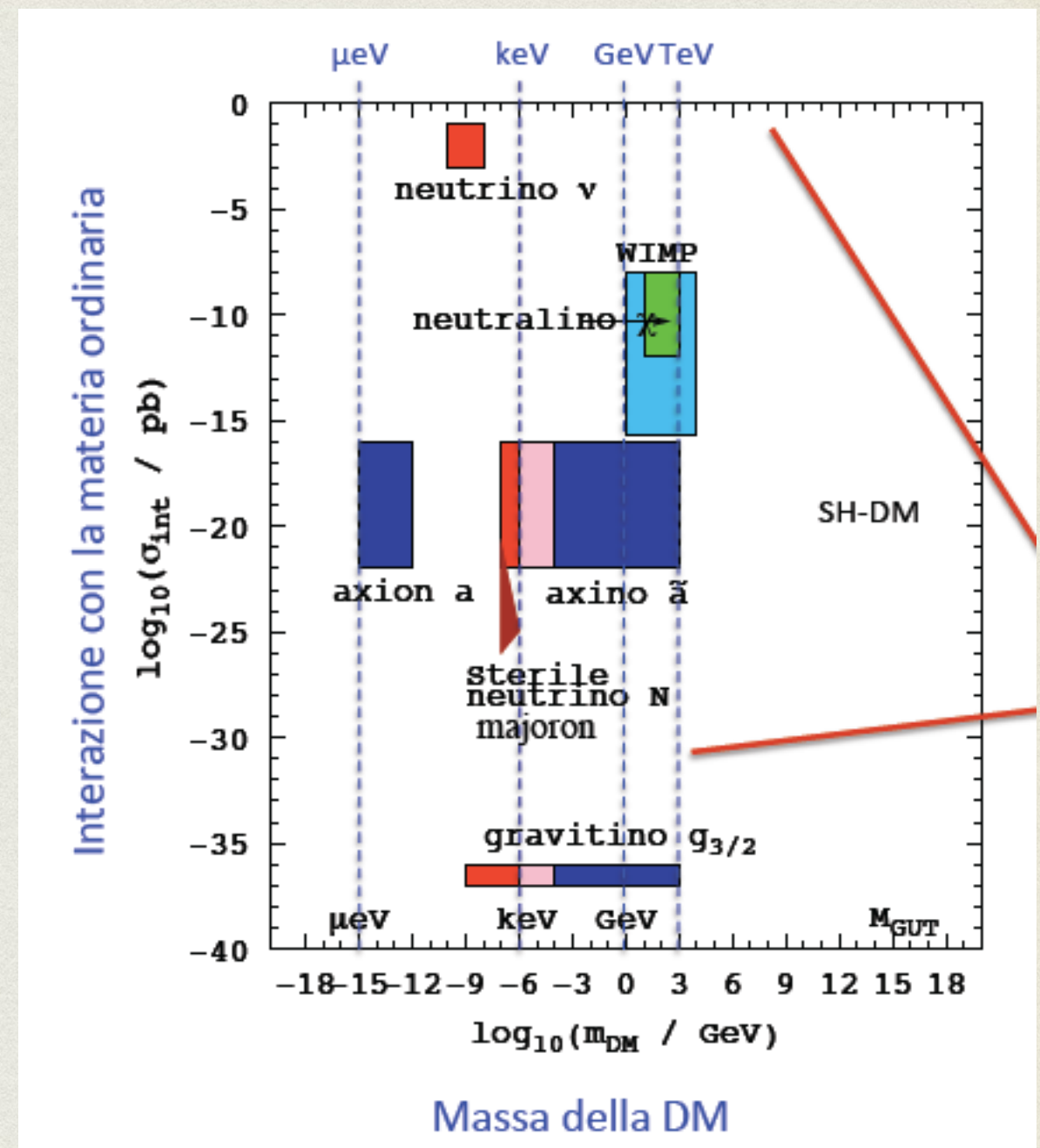


Determining the Nuclear Matrix Elements of Neutrinoless Double Beta Decays by Heavy-Ion Double Charge Exchange Reactions

It will require a substantial and expensive upgrade of the **LNS** cyclotron

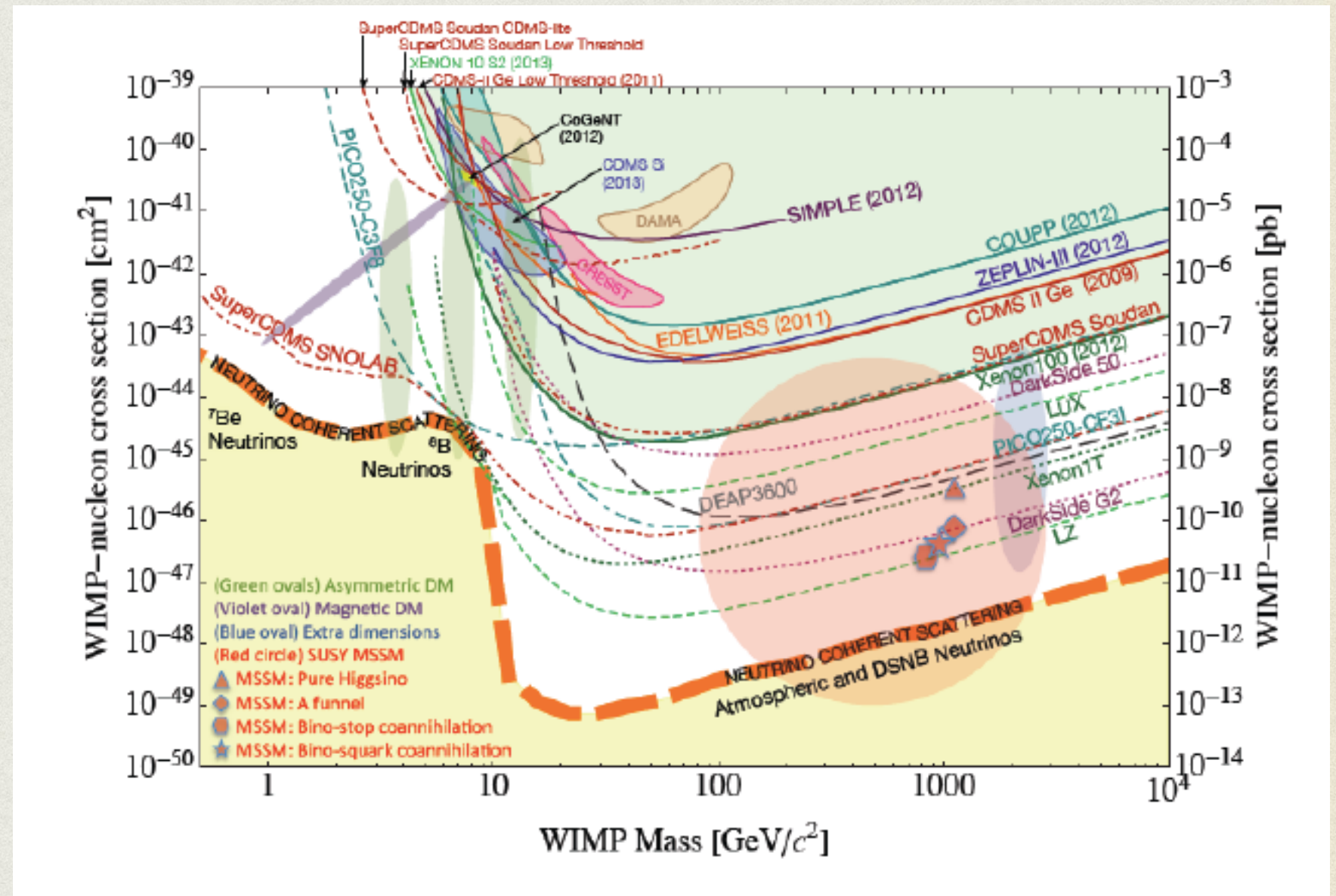
DARK MATTER

- the link LHC - Dark Matter-
WIMP's it is not in great
shape
- we have to broaden the search



FINISH WIMP

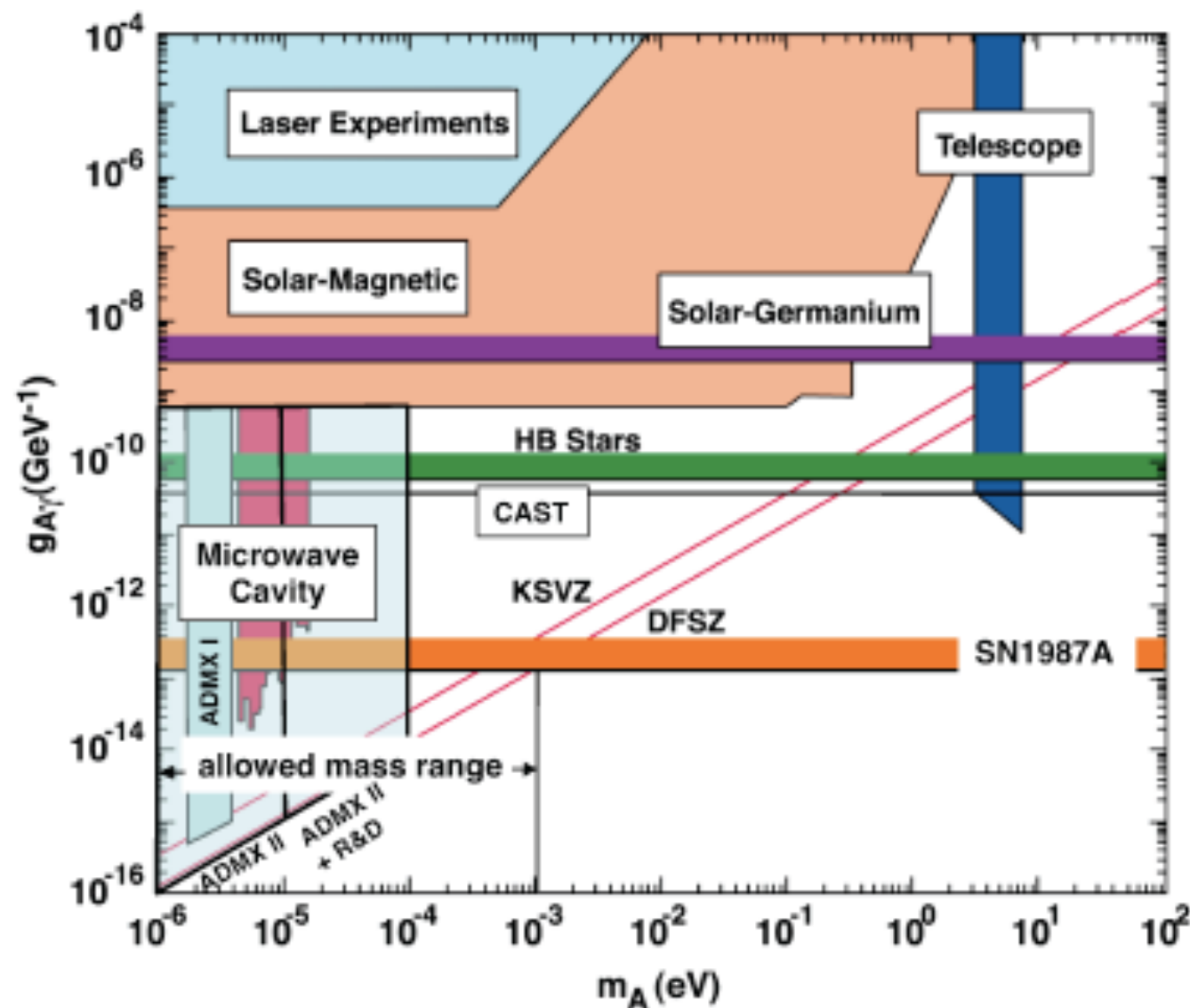
- do better at low mass
- get to neutrino limit



AND DO NOT FORGET CRYSTALS

- Check DAMA with NaI (two proposals for LNGS with possibility of follow up in South hemisphere (either South Pole or Australia))
- Improve wrt. KIMS with CsI at low temperature (IHEP) at LNGS

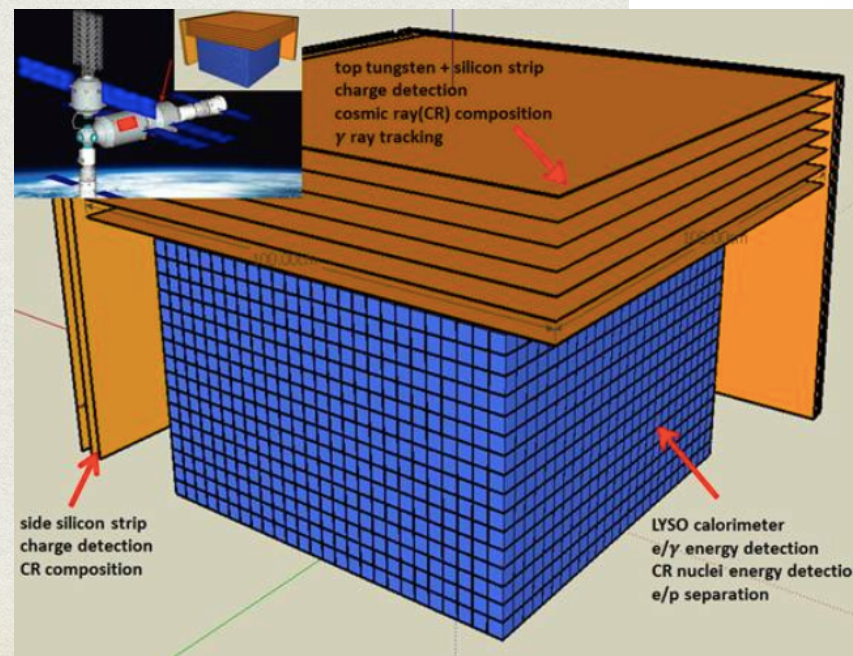
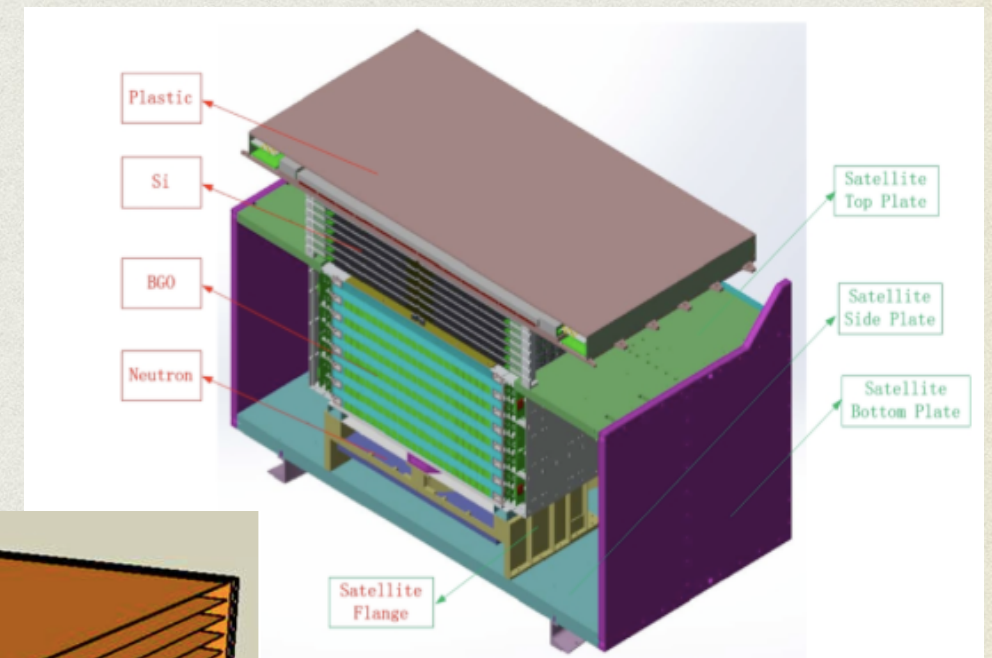
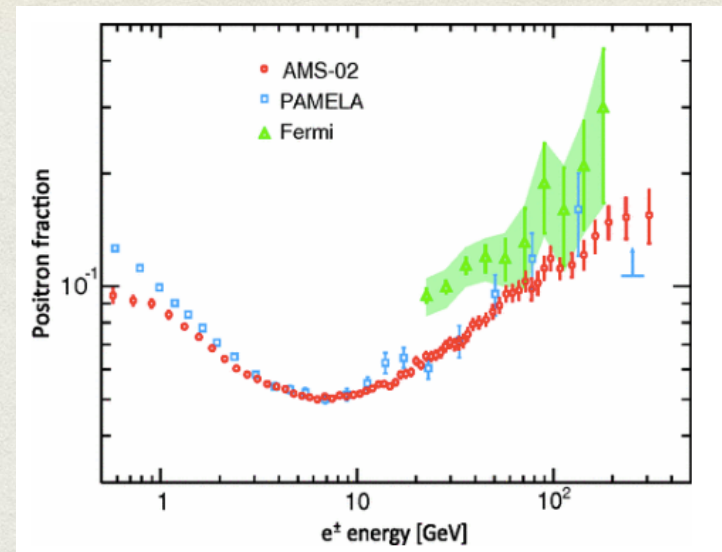
OPEN AXION SEARCH



start an R&D for some innovative and technologically advanced detector.

KEEP GOING TO SPACE

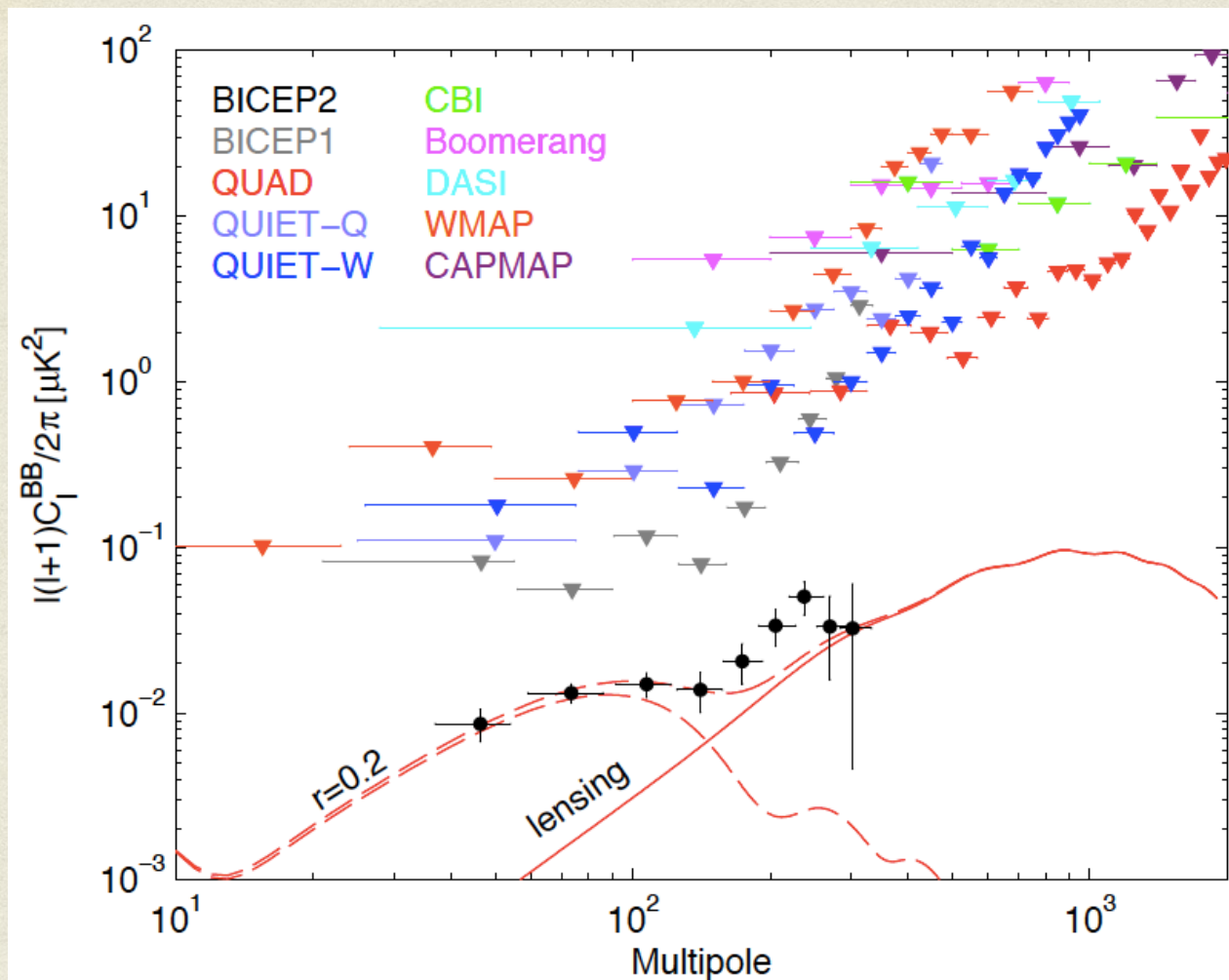
- beside AMS
- jump on DAMPE (GAMMA400 ?)
- and think to HERD



COSMIC RAYS

- **Photons**: trying to organize a participation in CTA together with INAF and discuss LHASSO
- **Charged**: evaluating the potential of Auger upgrade
- **Neutrinos**: operate and evaluate Phase 1.5 of KM3Net, then ?

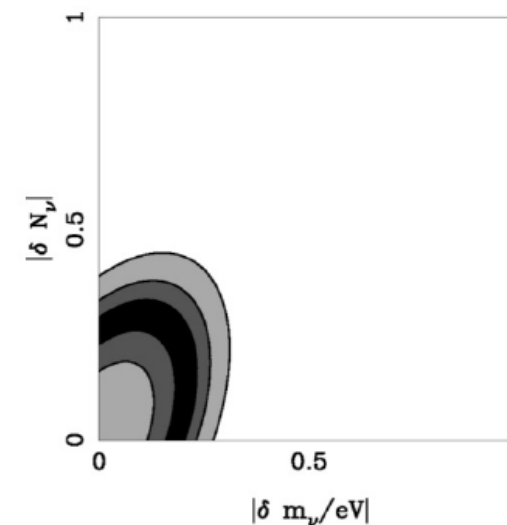
SOMETHING WE HAVE TO DO ABOUT



Primordial GW

Neutrino Physics

Neutrino physics from
cosmology: forecasts



Planck+Euclid
Kitching et al., 2008

$\Delta m_\nu \sim 0.03 \text{ eV}$ and $\Delta N_\nu \sim 0.08$

GRAVITATIONAL WAVES

- VIRGO for discovery
- Einstein Telescope at the stage of study
- Lisa Pathfinder as a step to eLisa

CONCLUSION

- INFN intends to substantially invest in Astroparticle Physics
- However we have to look critically at the results obtained so far and carefully evaluate the perspectives
- Analytical continuation might not be the best strategy
- DBD, DM, GW are clearly our main targets