

Astroparticle Physics in the Netherlands

compilation by the CAN

Astroparticle physics strategy forming

- National Strategy to be aligned with European Strategy
-> APPEC roadmap ([town meeting last week](#))
- Discussion and common strategy required to focus for best impact
-> Community input/involvement essential
- Alignment with Nikhef and Astronomy strategies

Science questions (in last strategy report)

What is the origin of the highest energy particles in the Universe?

What is the nature of spacetime?

What is the nature of dark matter?

What is the nature of the large-scale structure of the Universe?

What is the structure of the physics beyond the Standard Model?

Large Infrastructures

Structural investments needed

- Permanent Committee for Large Scientific Infrastructures (~40M€/year), >10M€ / proposal
2 slots / 2 years for particle physics & astronomy & astroparticle physics
- NWO-XL / Zwaartekracht / (ERC)
 - Science
- Nationale Groeifonds -> Einstein Telescope (42M€ + 870M€ earmarked)
 - Economy driven, regional impact
- Membership costs

Cosmic Rays: AugerPrime 2022-203(5?)

Composition at the highest energies

Air shower physics

Improve sensitivity for neutrinos and gammas



Cosmic Rays: Next Generation Observatory

At least an order of magnitude larger than Auger

4-pi observatory

Multi Messenger observatory

R&D is happening now (necessary)

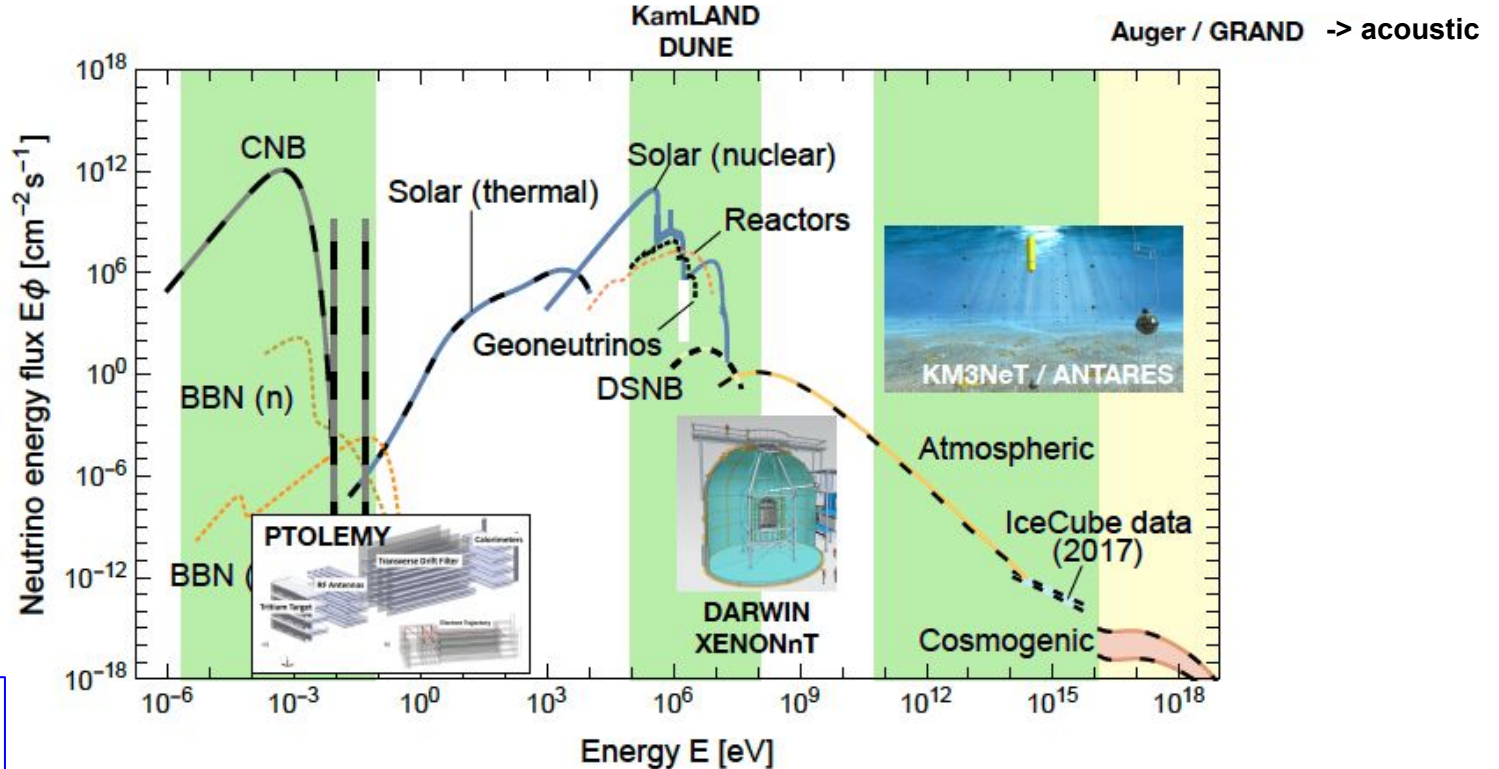
Main contenders in the Dutch landscape:

GRAND (radio detection, 200,000 km² spread over the world)

GCOS (particle/radio/fluorescence, 40,000 km²)

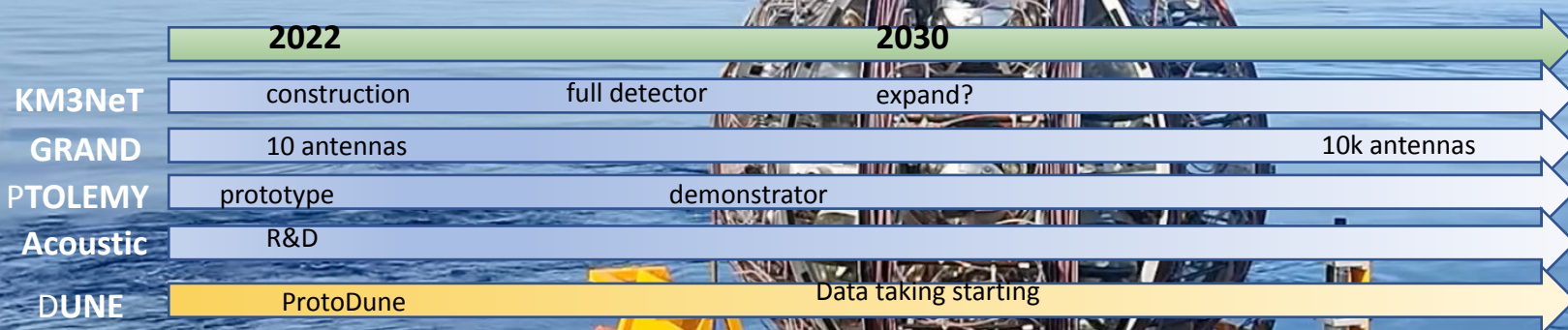


Neutrinos



Shown by
S. Ando
APP meeting 2021

Neutrino experiments



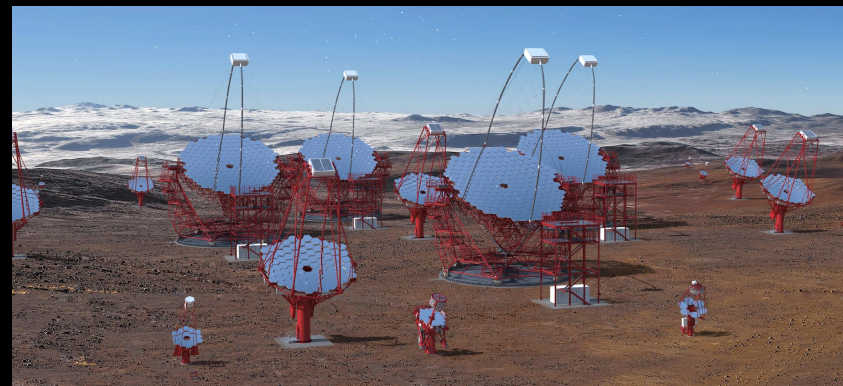
- Cosmic neutrino sources
 - > probing cosmic ray origin & Production & acceleration mechanisms
- Neutrino properties
- Beyond-the-standard model probes

NL Gamma rays: short term future

- Participate in the construction phase by contributing to the SST Camera production
- Participate in the early science phases: out of commissioning and key science projects
- This phase is covered by NWO-G and NOVA investments
- Goal: make NL ready for participating in early science
 - funding for PhD students/postdocs
 - participating in H.E.S.S. (Vink & Vecchi are members)

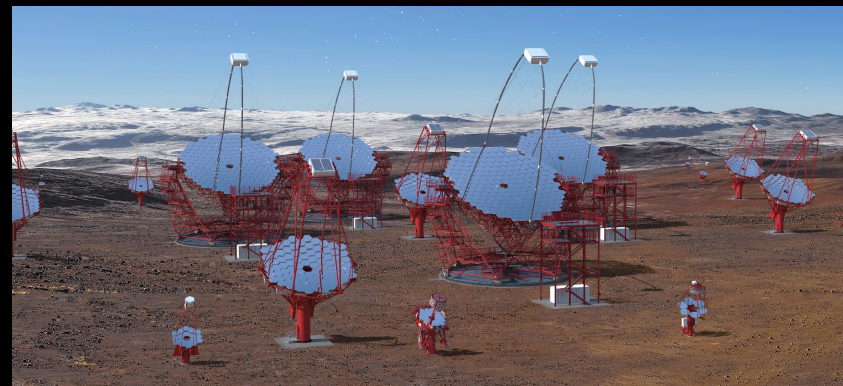
NL Gamma rays: long term future

- For being a full member:
 - Either: become full ERIC member
 - Or: negotiate a 3rd party agreement
- Requirements (to be negotiated!):
 - Contributing to operation costs (3M€/yr): NL 40k€-200k€ for 5 to 10 yr?
 - Extra IKC/cash?
- Parallel:
 - widen the science community in the Netherlands
 - obtain funding for long term science harvesting
 - explore better the synergies with KM3NeT and other fields

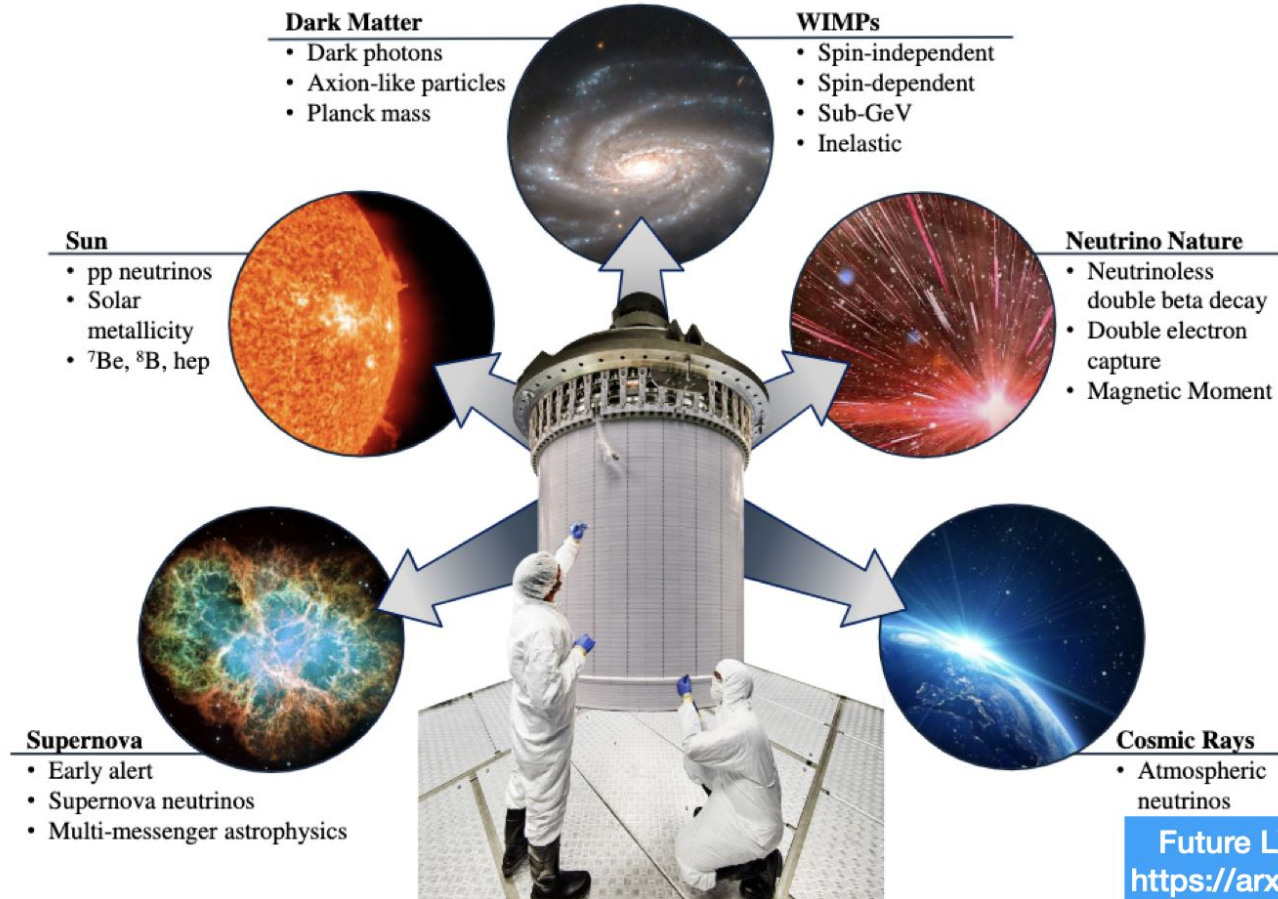


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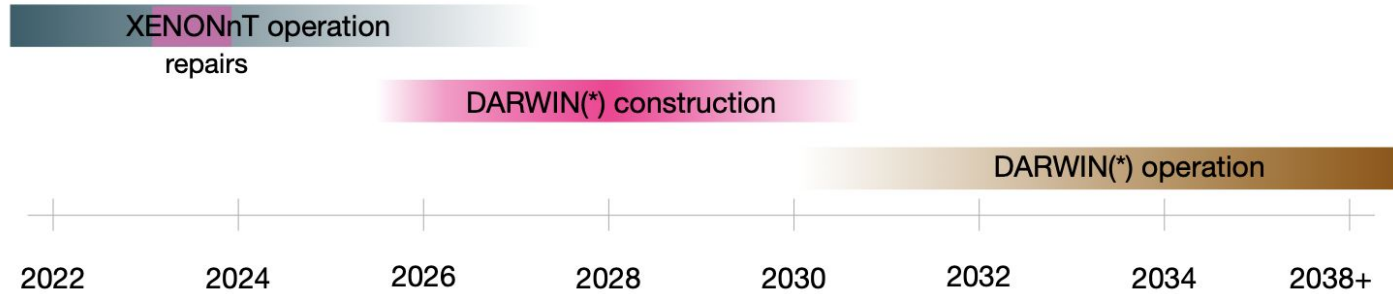
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Large sensitive mass, low energy threshold, low background: DARWIN: a multi-purpose underground observatory



XENON and DARWIN timelines

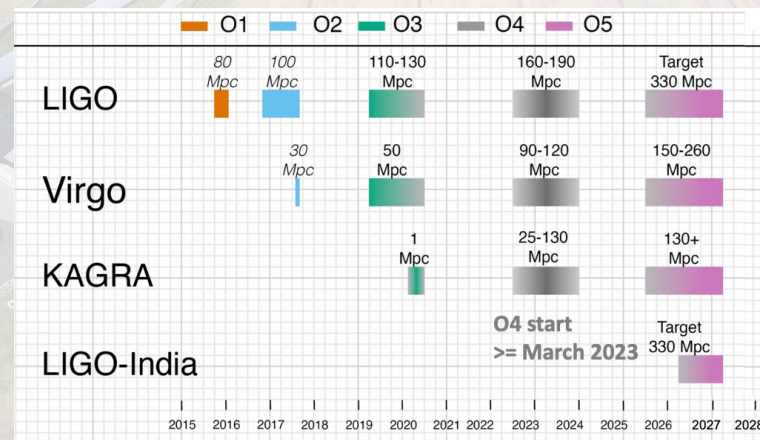
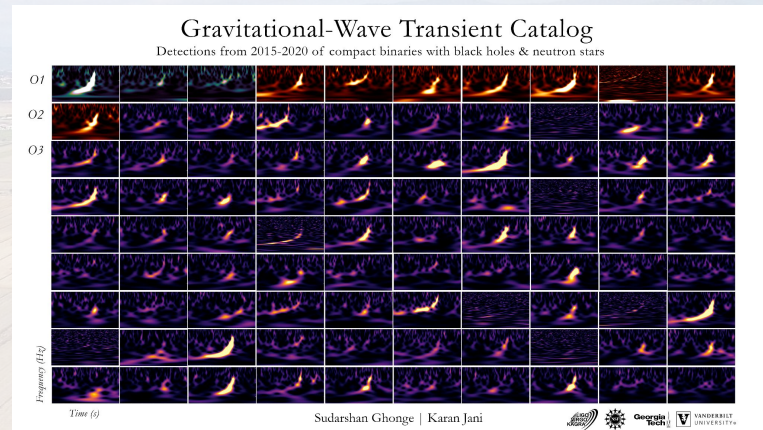


(*) DXLZ joint collaboration detector, may get new name

Gravitational Waves (I)

Virgo (& LIGO) are the **workhorses & goldmines** of GW observation for the next 10+ year:

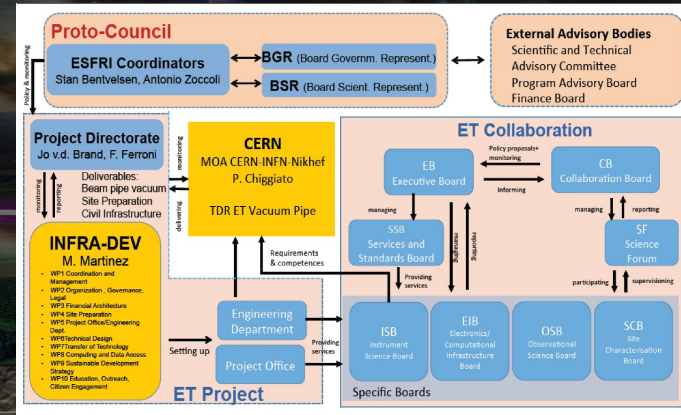
- **NL with strong track record in instrument science and observational science.**
- Nikhef recently officially joined EGO as third partner (next to INFN and CNRS).
- Alternating observation runs and detector upgrades.
- **Next run (O4) will start in spring 2023 and we expect to triple the number of observations.**
- **Research Infrastructure (RI) proposal submitted to NWO for 21-22 round to support Virgo upgrades**



Gravitational Waves (II)

Einstein Telescope as the future of GW observation for most of the 21st century!

- Admitted to ESFRI roadmap in 2021.
- **Efforts coordinated by INFN and Nikhef.** Setting up structures, project office, connection to CERN etc
- **South of Netherlands (with neighbouring countries) explored as one possible location.**
- Dutch government recently announced 42 MEuro for preparing a bidbook for hosting ET in NL + earmarked 870 MEuro for construction of civil infrastructure.
- Strong ecosystem developing with various projects (Dutch Black Hole Consortium, ETpathfinder, E-TEST, ET-Technology, ET2SMEs, personal grants from ERC/NWO etc)





Gravitational Waves (III)

LISA will fly at ca 2035!

- **Fully complementary, but synergistic to groundbased GW detectors** (e.g. supermassive BH vs stellar mass BH).
- **NL involved in instrumentation** (e.g. quadrant diodes, mechanics etc) and **observational science!**
- **Roadmap application submitted.**

GW (groundbased & spacebased) projects and communities: Loads of synergies with neighbouring communities, e.g. astronomy, astroparticle, nuclear physics, fundamental physics ...

Computing

- Experiments with increasing data volumes / processing needs, theory supported with sophisticated simulations
 - > Role of computing increasing
- Open Data (FAIR) required
- New opportunities with new hardwares & AI
 - > take advantage of HEP experience
 - > structural embedding in (APP specific) education?
 - > more closely connect to computing / (industry)?
- APPEC supporting ESCAPE follow-up
 - > concretely tailored to actual multi-messenger needs

Other opportunities?

- New technologies developing
(e.g. atom interferometry for gravitational waves,
quantum gravity lab experiments?)
- Opportunities for Dutch contributions?