

Nikhef

Nikhef physics programme



C³ workshop

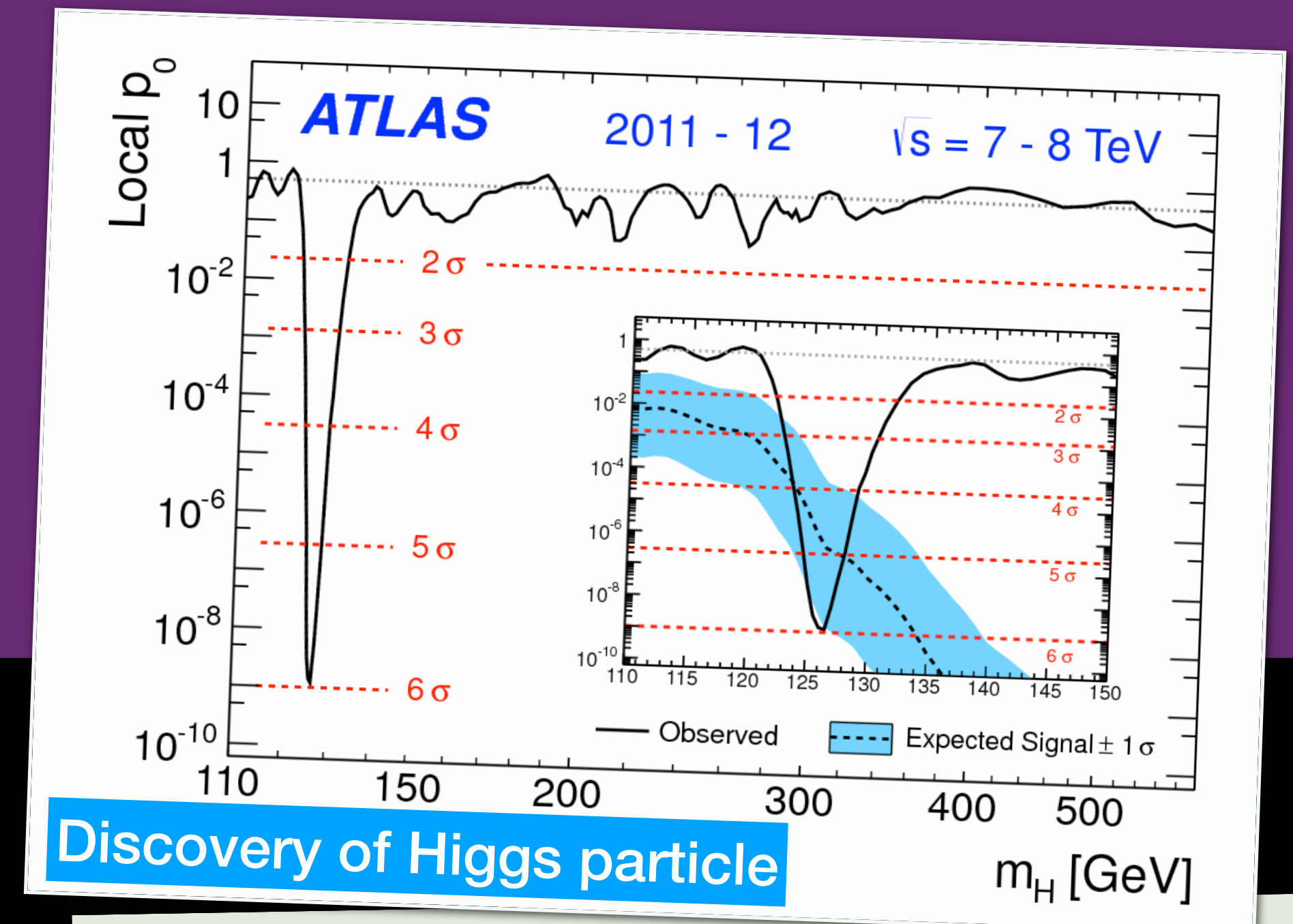
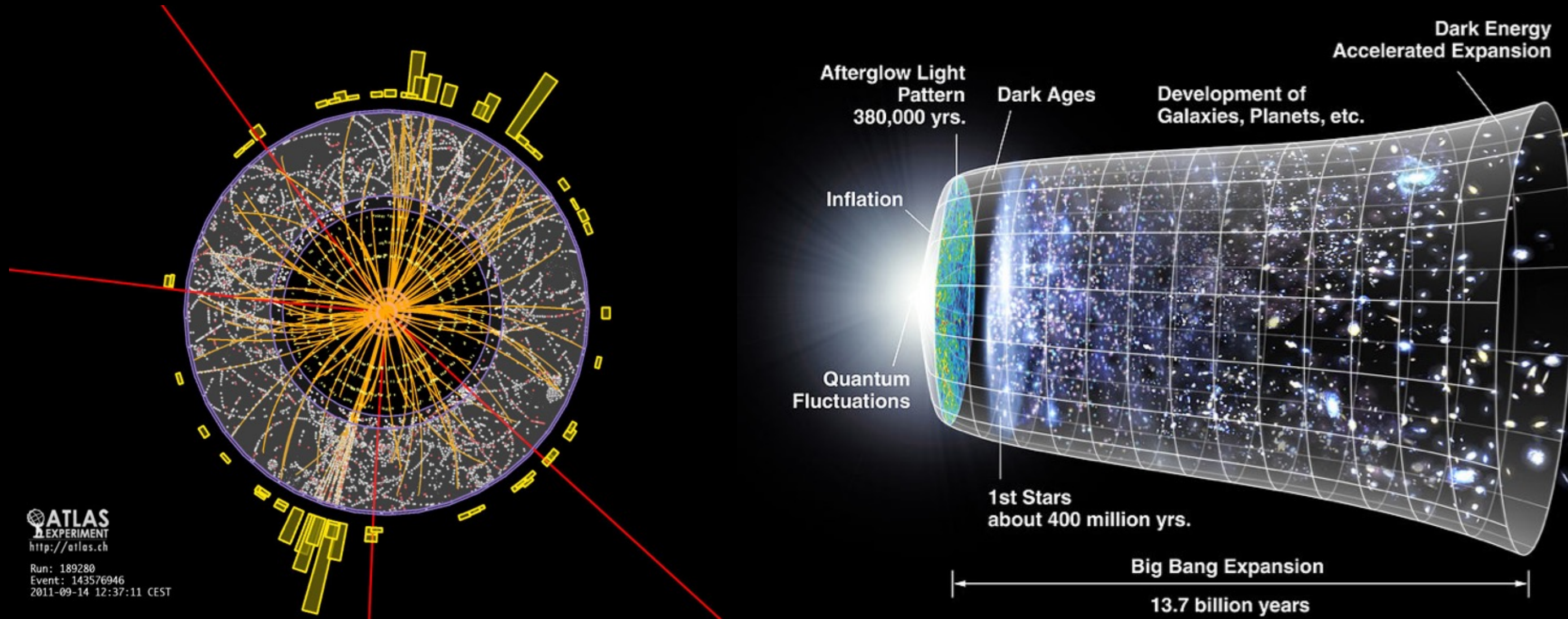
Cool Copper Collider

7-8 October 2024 at Nikhef in Amsterdam

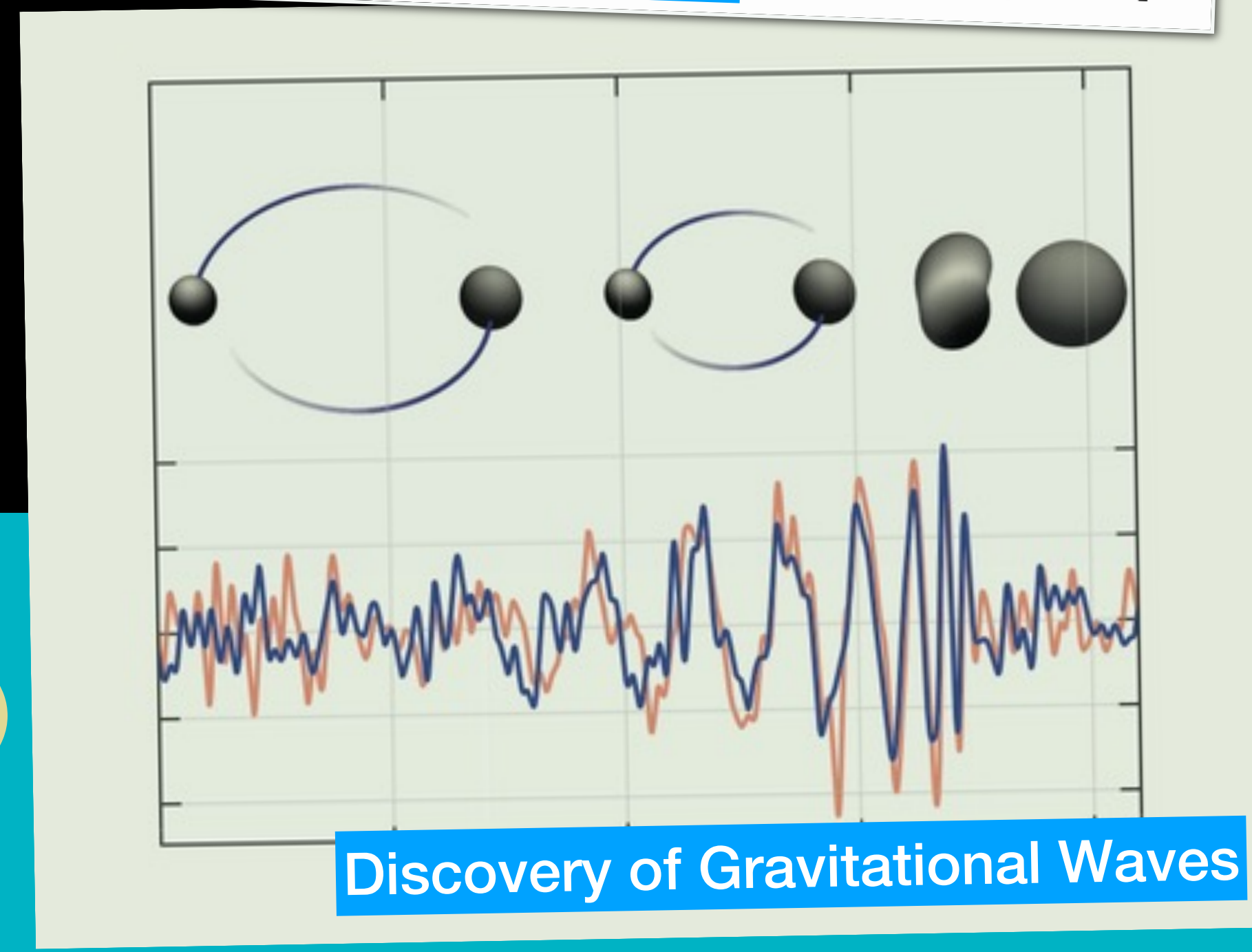


Dutch institute with 6 University partners

Study the interaction and structure of all elementary particles and fields



Discovery of Higgs particle



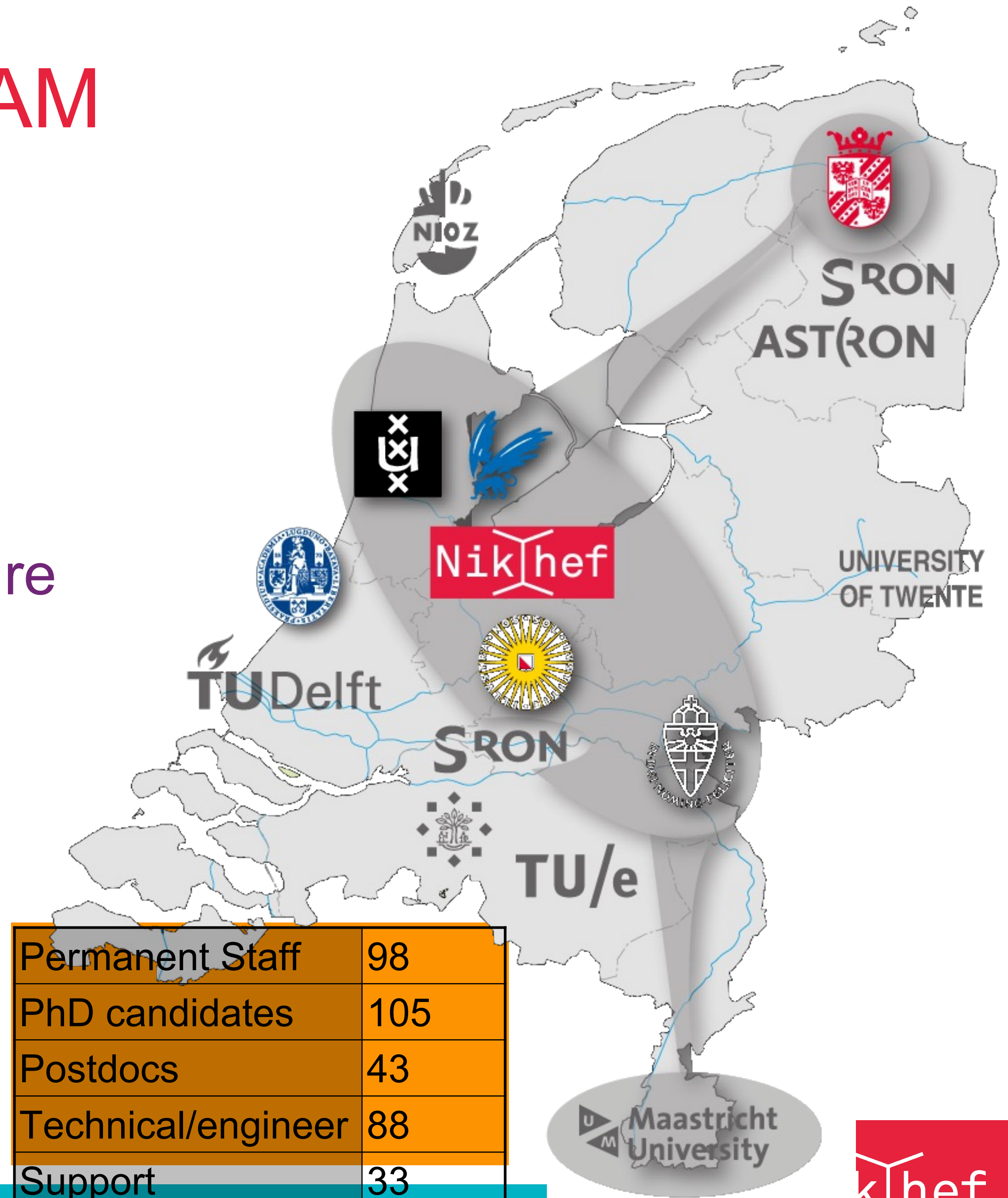
- Collider physics (i.e. CERN)
- Astroparticle physics – (e.g. Einstein Telescope)

Knowledge and technology transfer

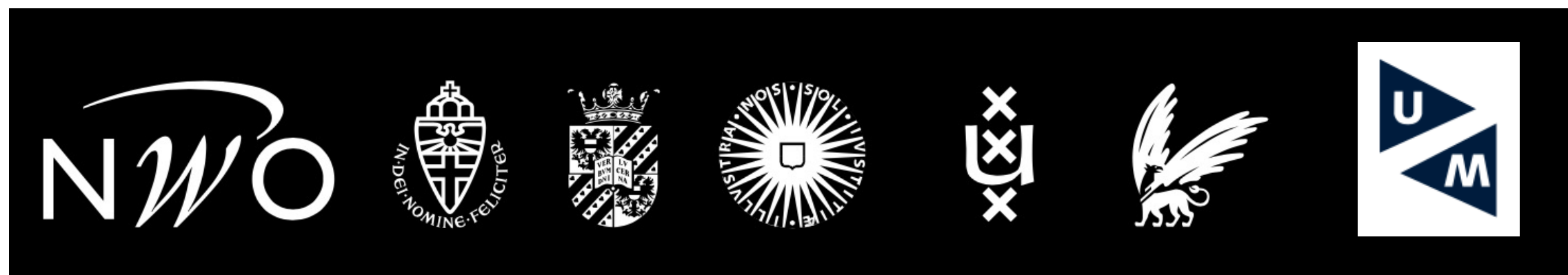
NATIONAL SCIENCE PROGRAM

NWO institute and University partners

- University partners in key positions
 - Leaders of the scientific programs
 - Comply to the Nikhef National strategy
- Added value Nikhef institute infrastructure
 - Technical competence and support
 - Large computing infrastructure
 - Long term strategy & commitment
- Focus and mass in world-top expts



Permanent Staff	98
PhD candidates	105
Postdocs	43
Technical/engineer	88
Support	33



SCIENTIFIC PORTFOLIO NIKHEF

Nikhef contains 11 program lines, with large scientific overlap

- Particle physics
 - Accelerator Physics at the LHC: ***ATLAS, LHCb, ALICE***
 - ***Electron EDM***
- Astroparticle physics
 - ***Neutrino Physics, Dark Matter, UHECR***
 - ***Gravitational Waves***
- Enabling programs
 - ***Theory, detector R&D, Physics Data Processing (PDP)***

In addition Nikhef houses three workshops

- ***Mechanics, Electronics, Computing***
- Support



PORTFOLIO NIKHEF

P: Program leader
 D: Deputy program leader
 x : Staff scientist(s)

	ATLAS	LHCb	ALICE	Neutrino Physics	Dark Matter	Cosmic ray	electron EDM	Gravitational Waves	Theory	R&D	PDP
NWO-i	P x	D x	x	P x	x	x		x	P x	P x	P x
UvA	x			D x	P x			x	x	x	
VU		P x						D x	x		
UU			P&D x					D x			
RUG		x					P x		x		
RU	P x					P x		x	x		
UM		x						P x			x

TECHNICAL WORKSHOPS

Mechanical Technology

- Well-equipped workshop
- Design and build detectors

Electronics Technology

- Data acquisition systems
- Analogue and digital (chip) design

Computing Technology

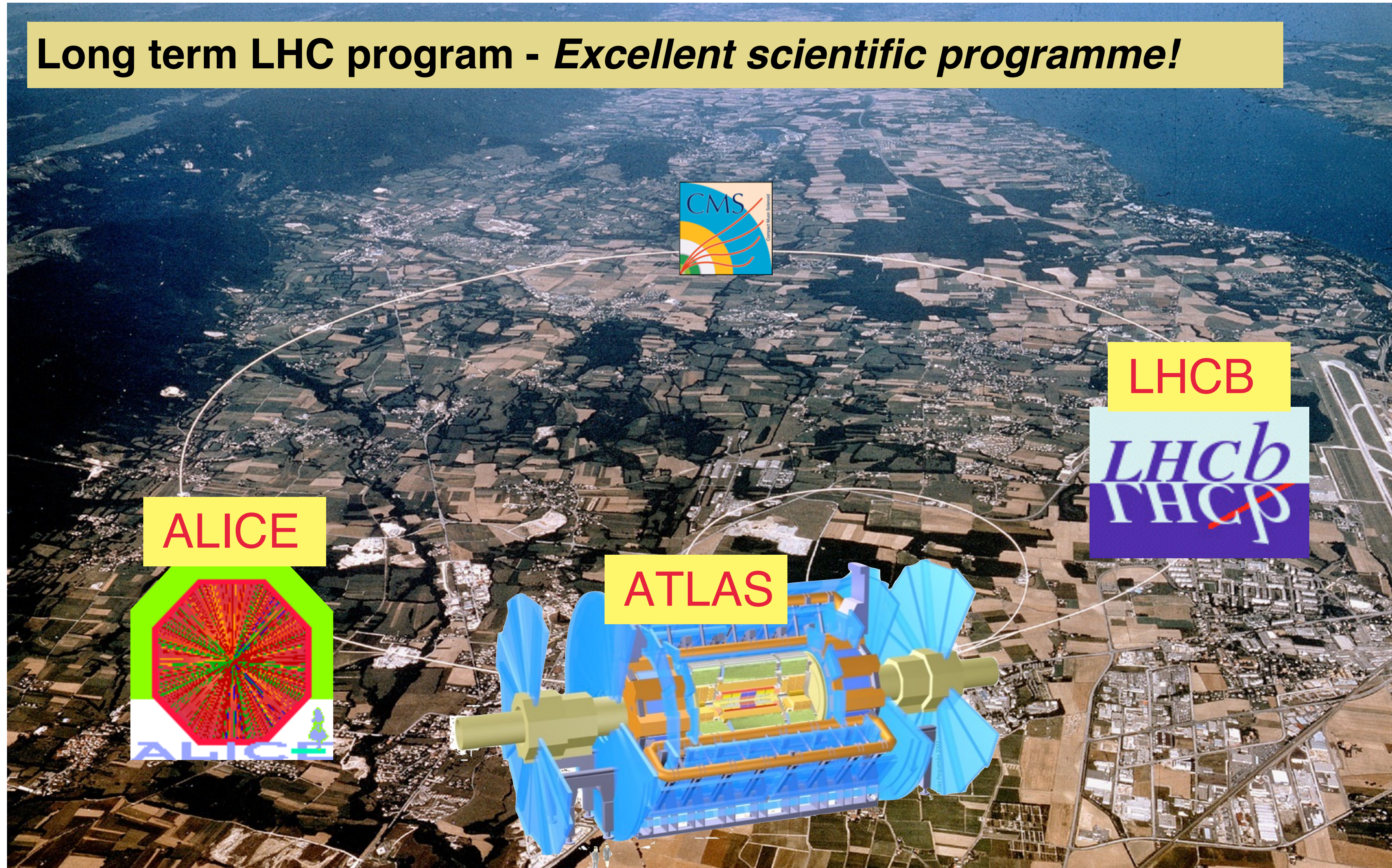
- Embedded software and controls
- Physics Data Processing
- Tier-1 computing centre



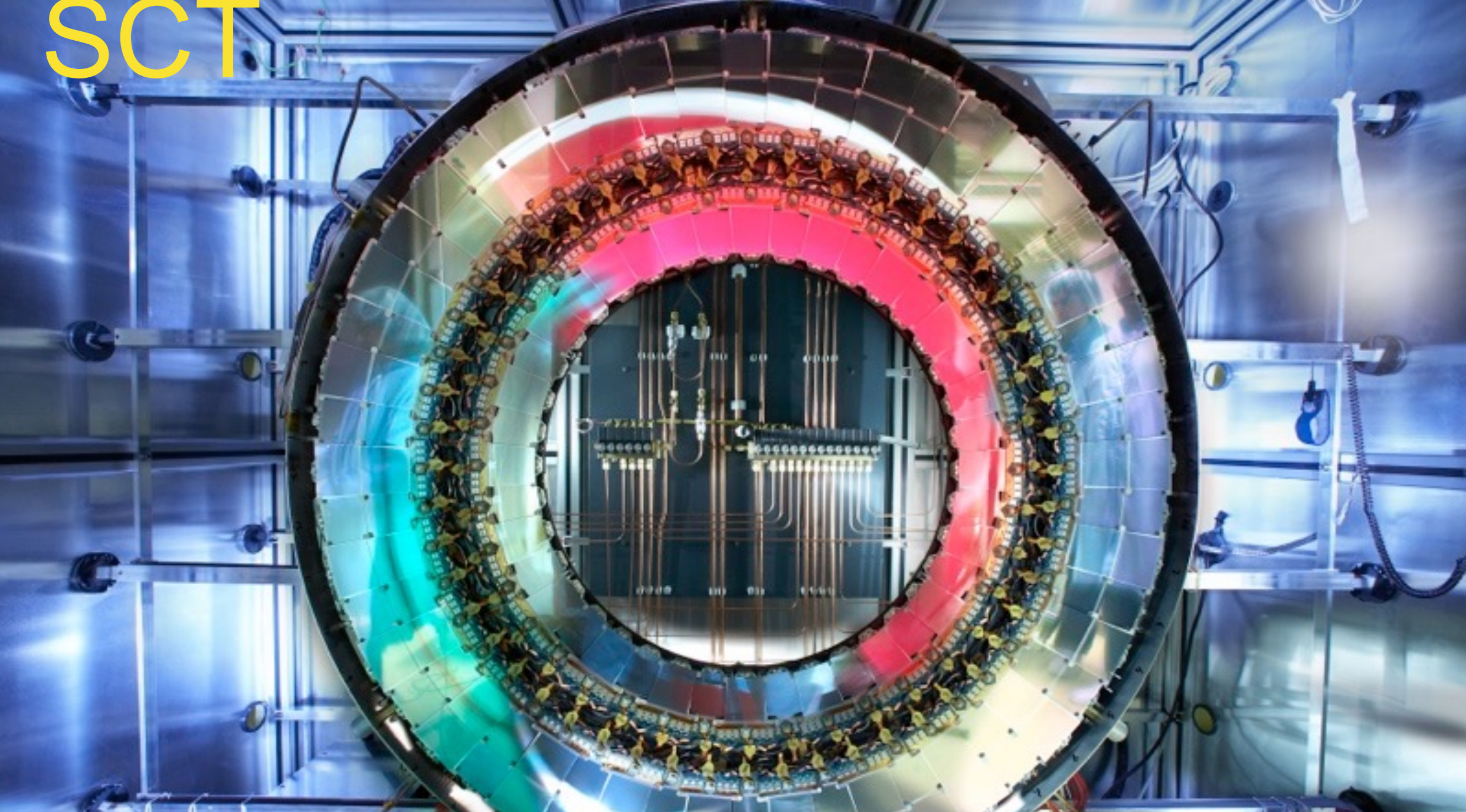
CERN PROGRAMME - DUTCH INVOLVEMENT

- **ATLAS**
 - Higgs physics
 - New particles beyond the Standard Model
- **LHCb**
 - Rare decays
 - Matter-anti-matter differences
- **ALICE**
 - Plasma of quarks and gluons
 - Phase transitions

Long term LHC program - *Excellent scientific programme!*

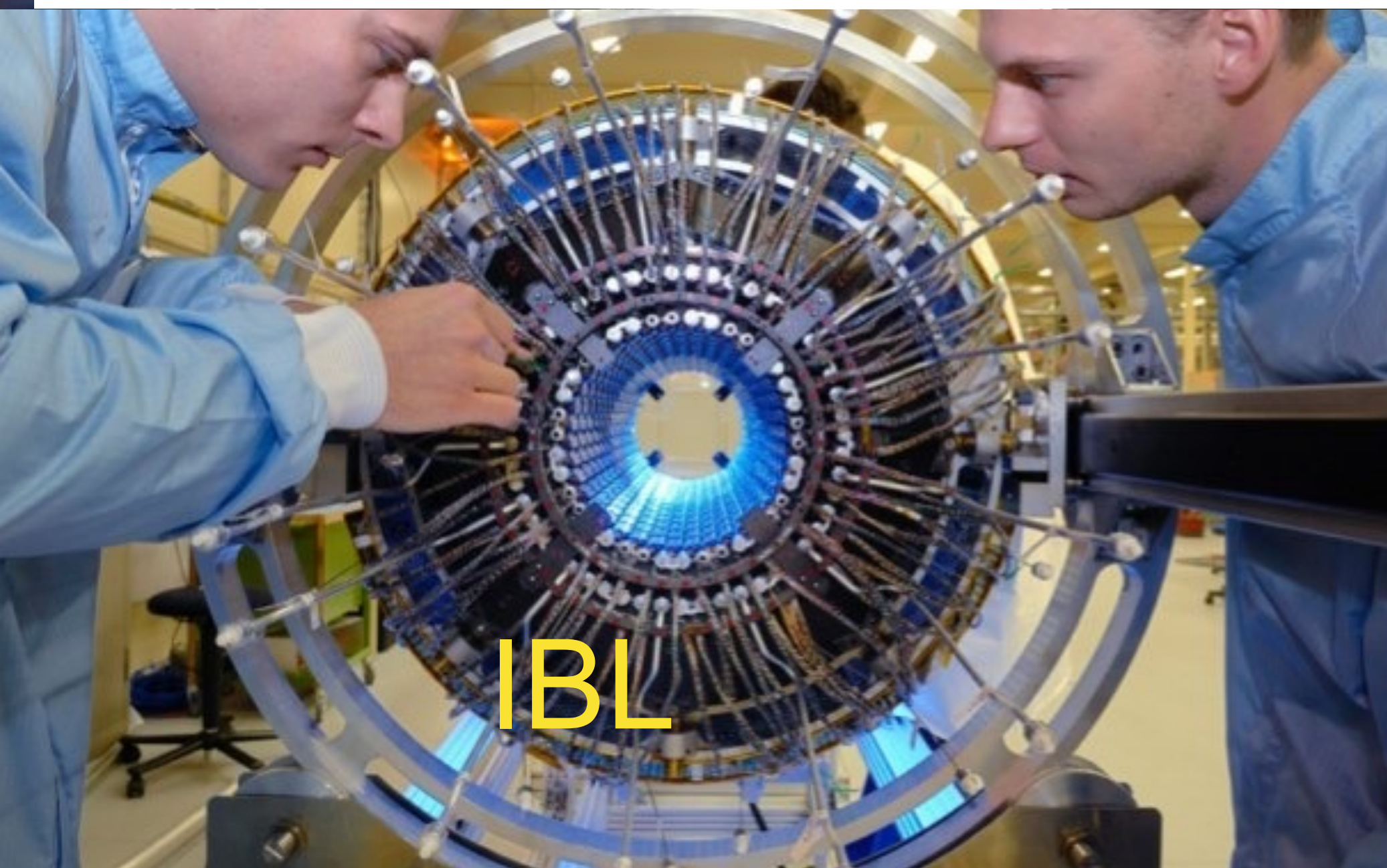


SCT

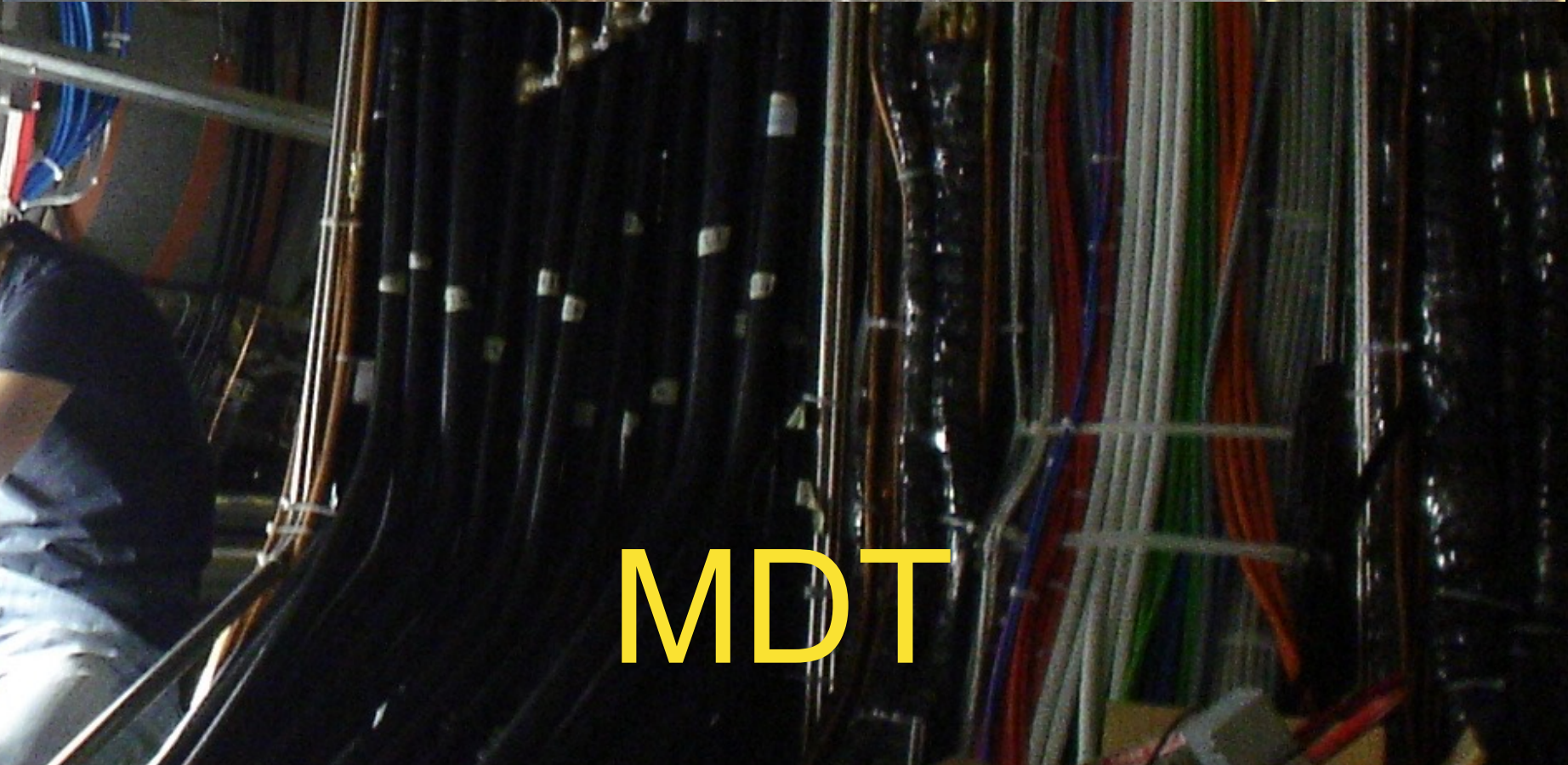
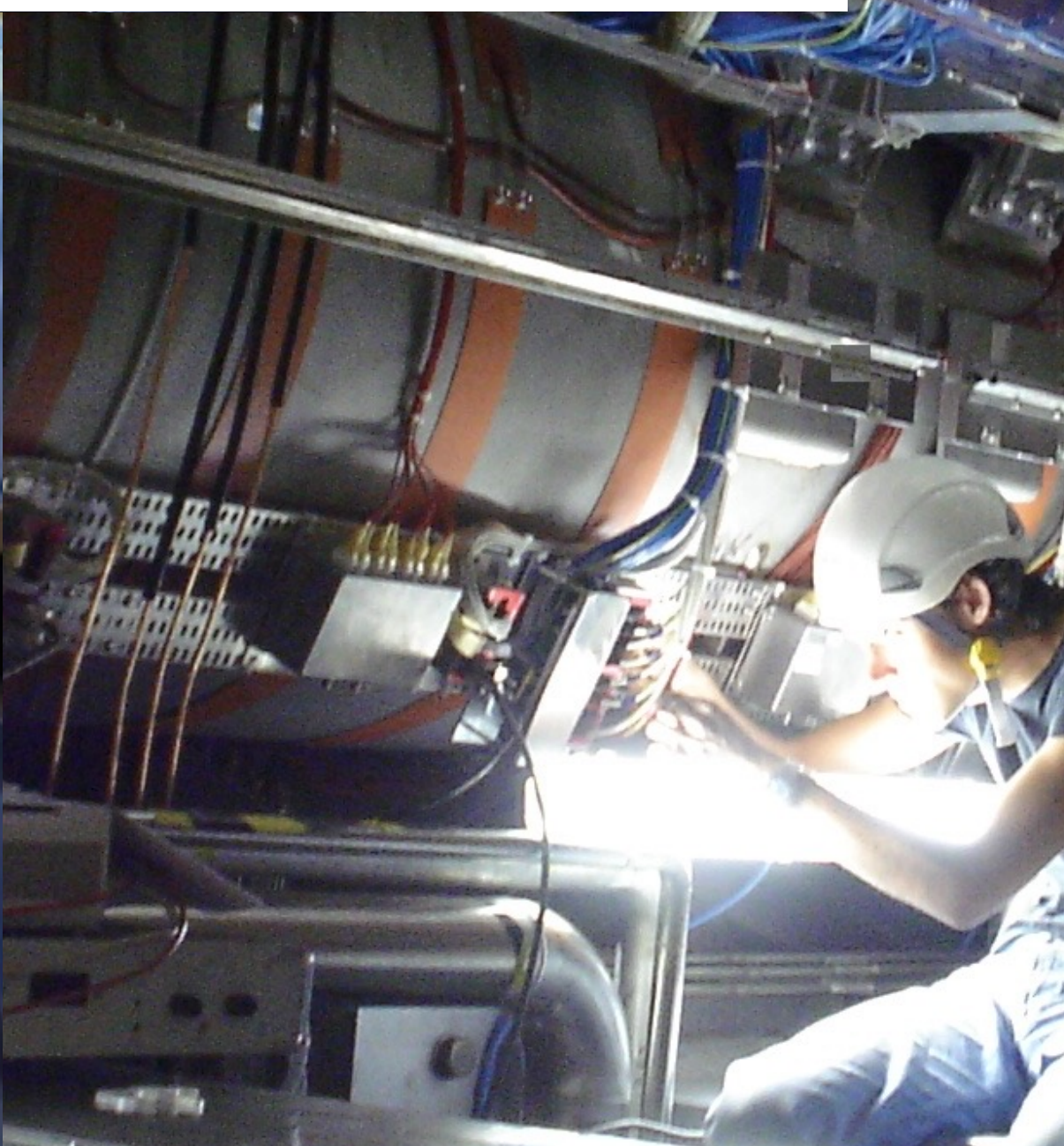


MAGNETS

DUTCH INVOLVEMENT IN ATLAS



IBL



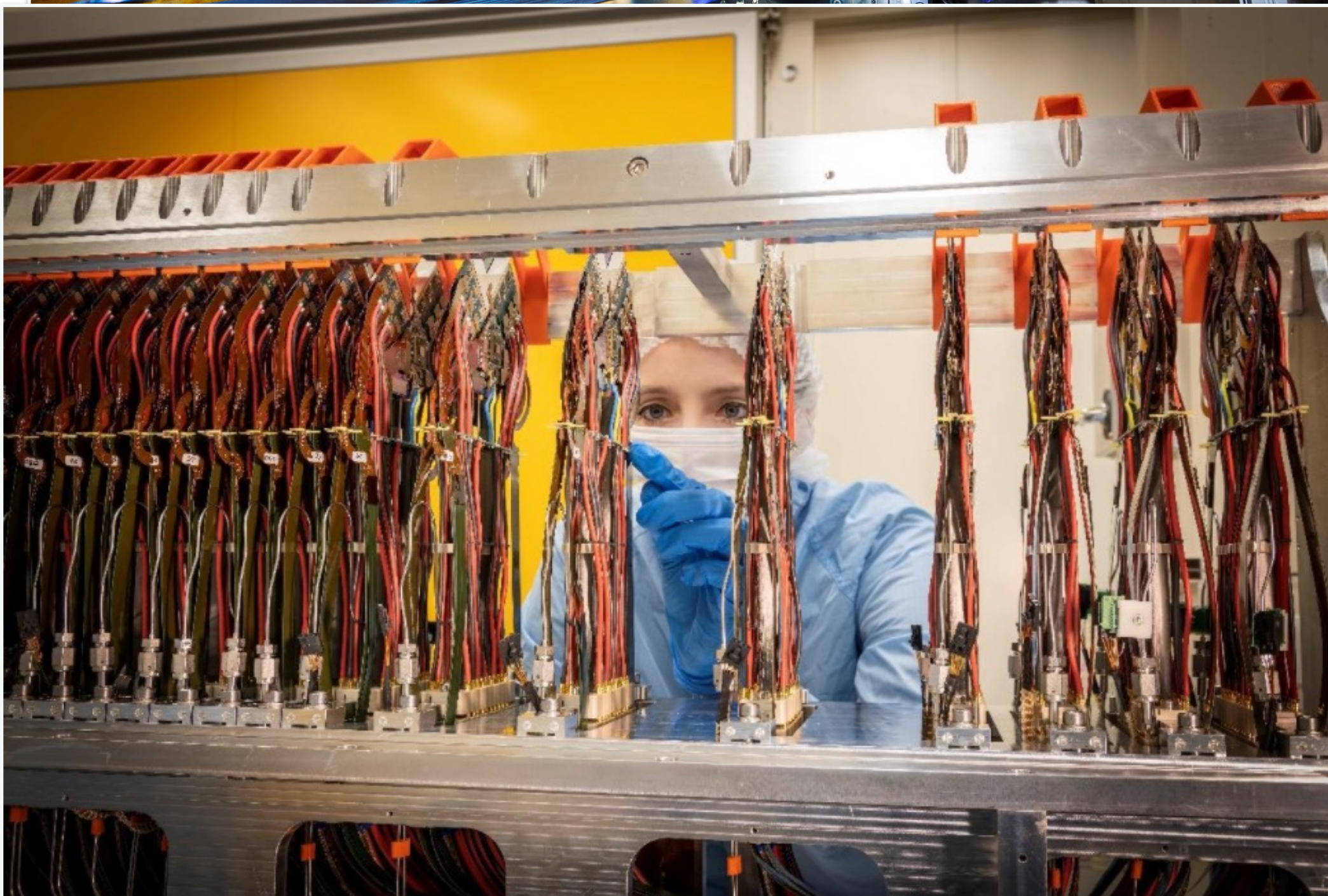
MDT

LHCB UPGRADES

VELO RF box, modules

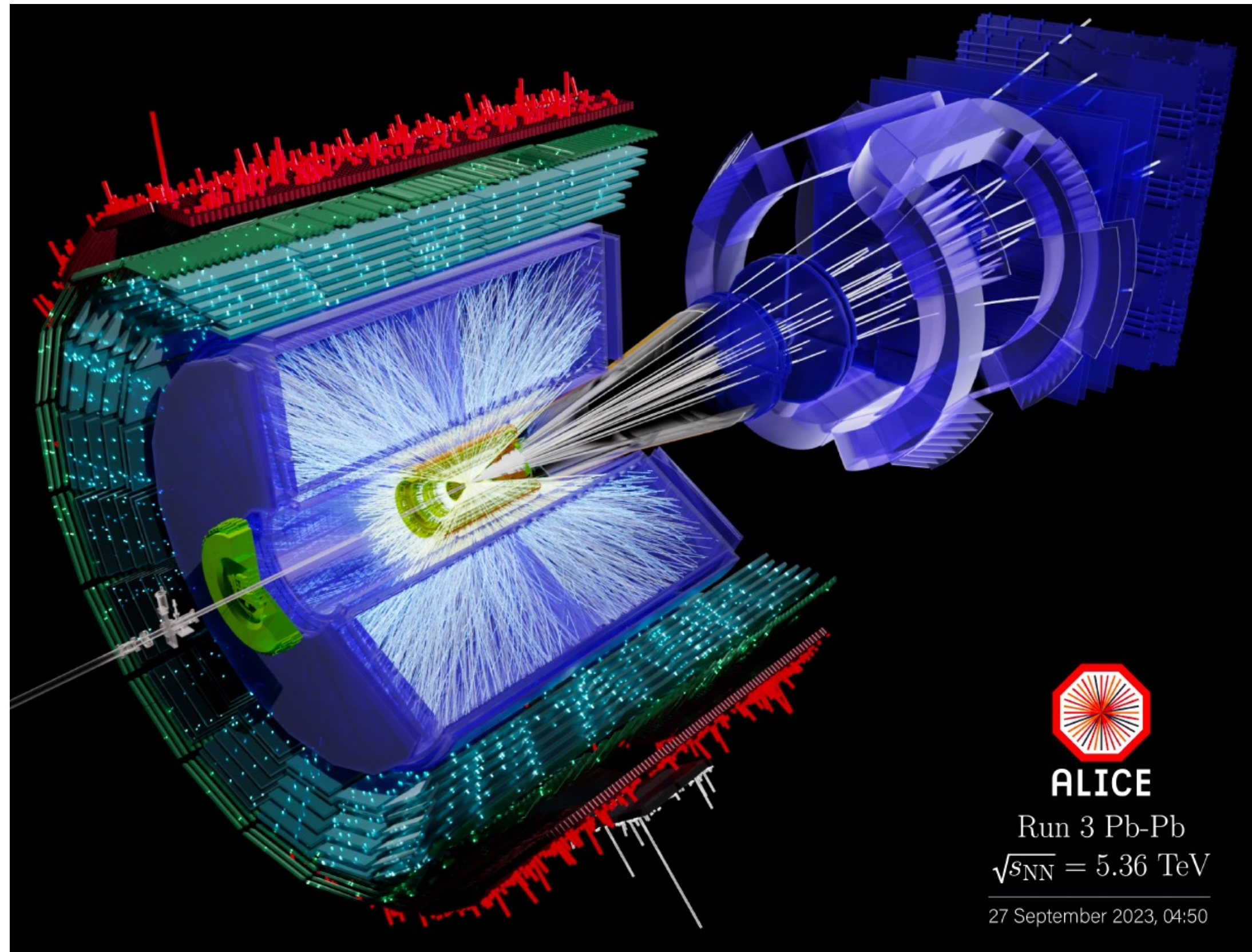
SciFi tracker

High Level Trigger



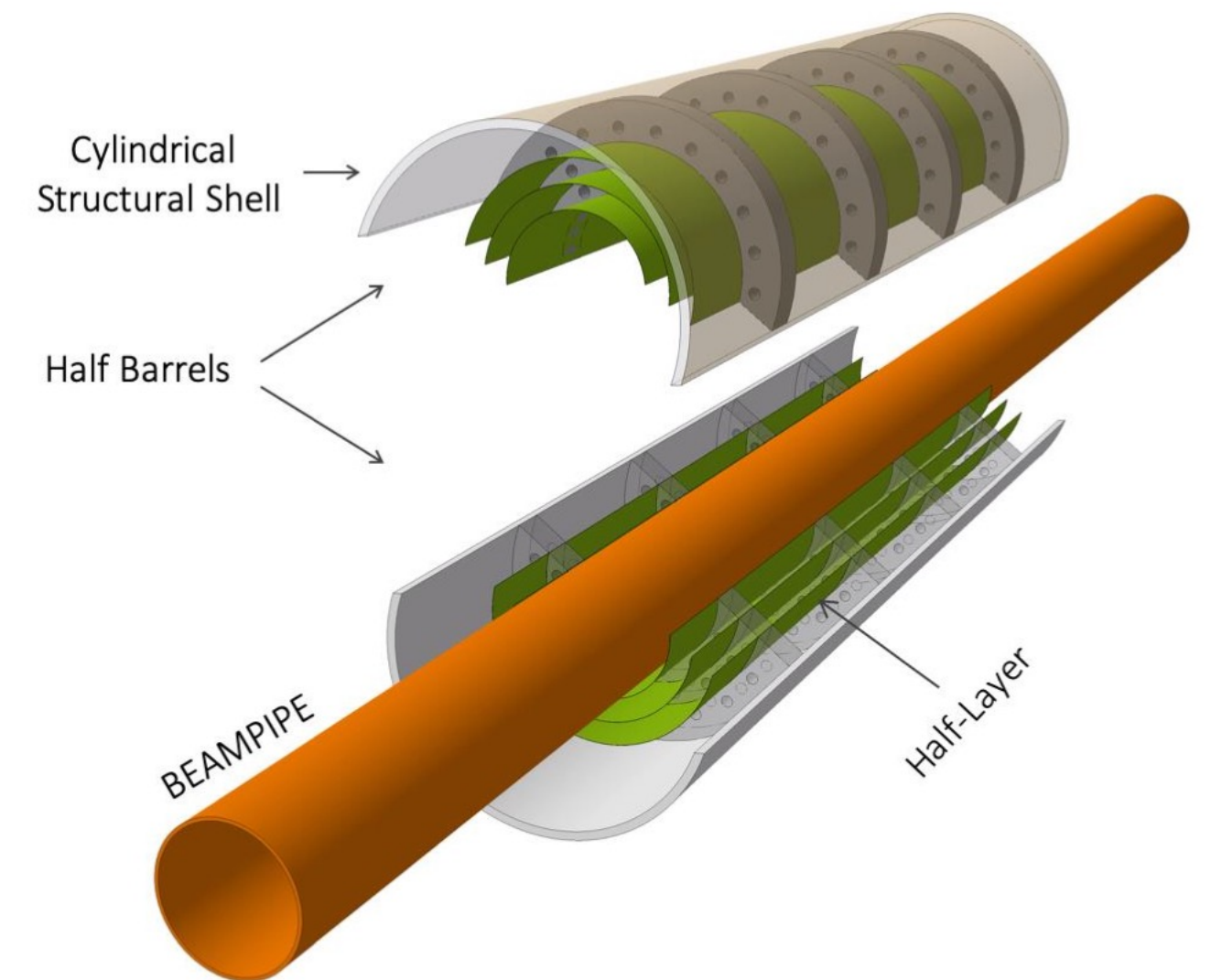
ALICE

Heavy ion collisions and QCD

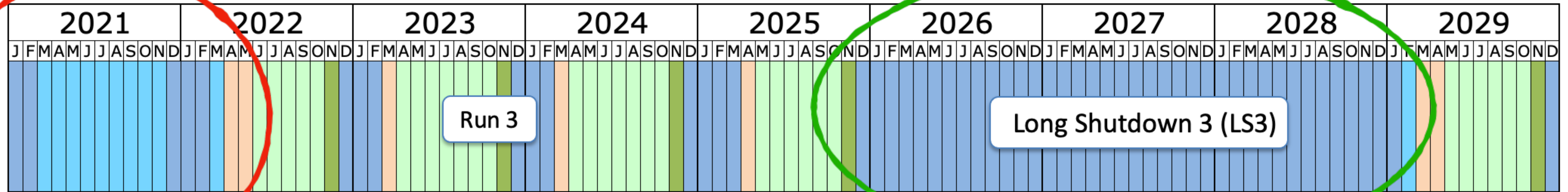


ITS2 upgrade (LS2): Monolithic Active Pixel Sensors

ITS3 upgrade (LS3): ultra-light large-area sensors



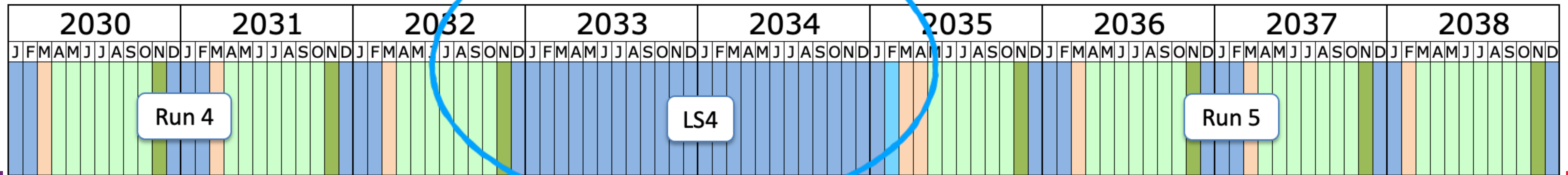
LONG TERM LHC AGENDA FOR NIKHEF



LHCb: RF box, VELO modules, SciFi tracker, HLT/GPU
 ALICE: ITS-2 Alpine modules
 ATLAS: NSW - services

ATLAS: ITk endcaps, FELIX TDAQ
 LHCb: 4d fast timing R&D
 ALICE: ITS-3 design

In line with ESPPU: ambitions on 4d fast timing tracking, R&D started
 Joint efforts for ITS-3 (ALICE), HGTD (ATLAS), VELO-3 (LHCb)



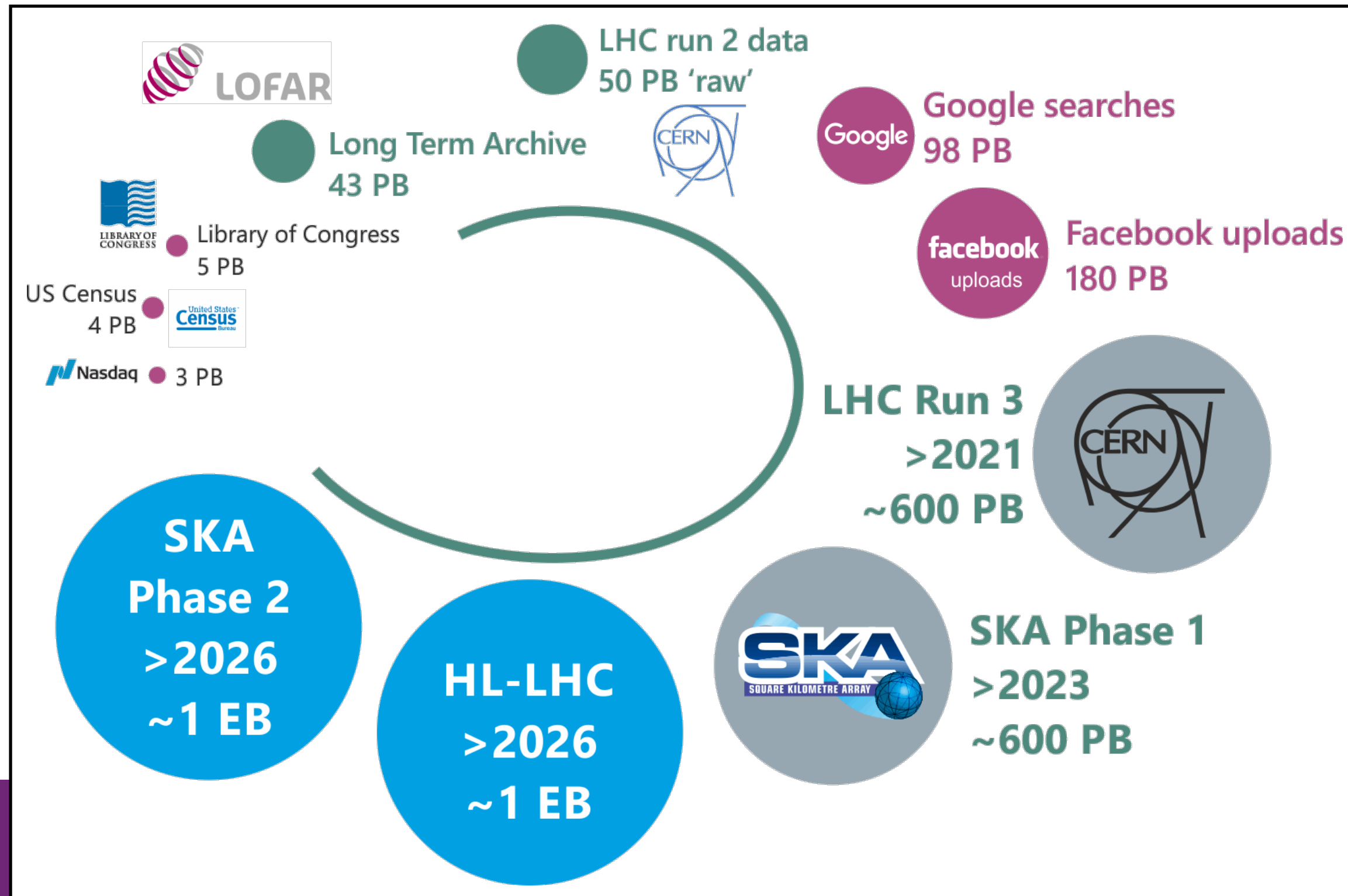
Last updated: January 2022

COMPUTING RESOURCES

Nikhef/SURF provides a Tier-1 computing centre

- Funding secured for period 2021-2025
- National Roadmap - joint together with astronomy
 - CERN Tier-1, SKA, KM3NeT, ET

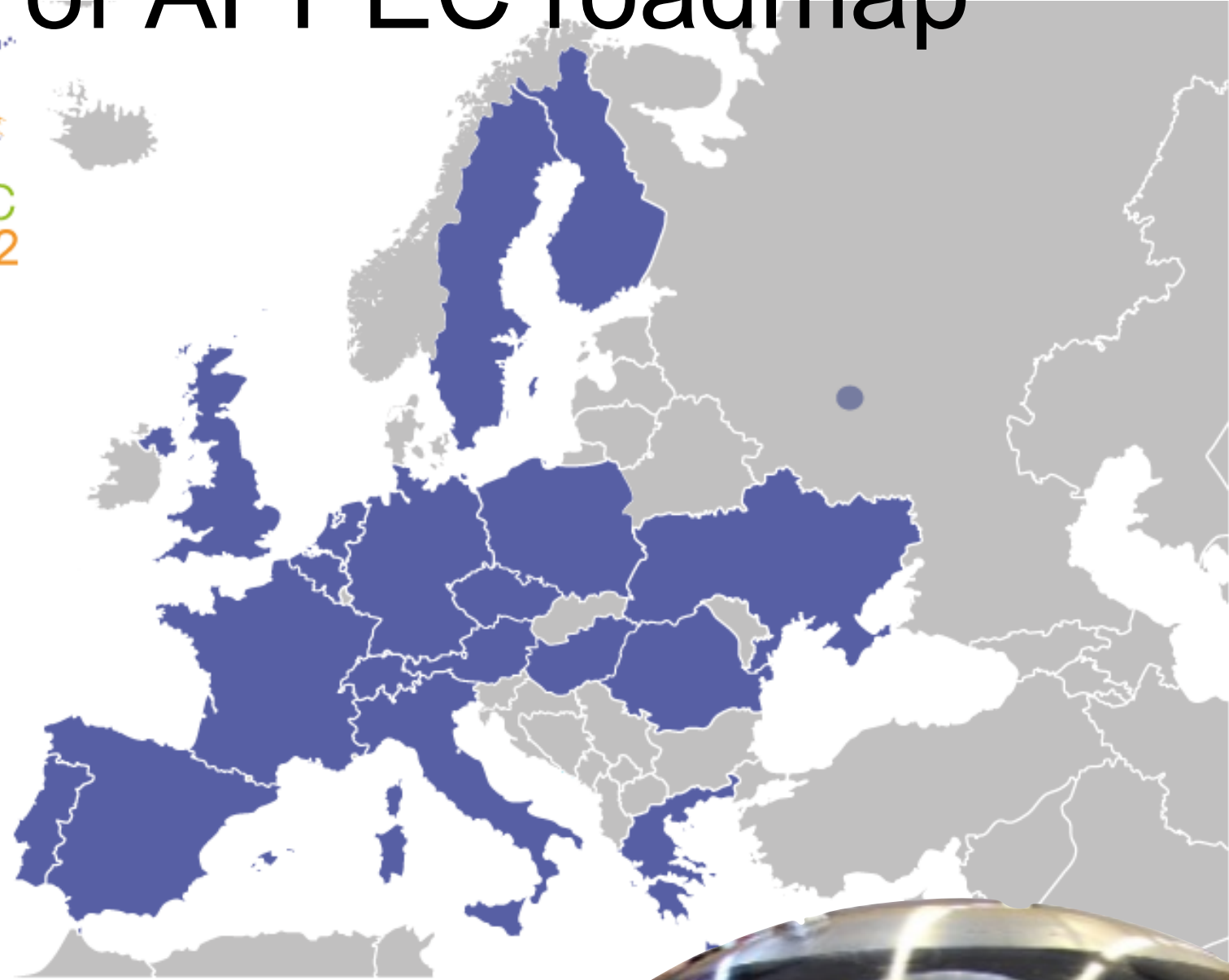
Part of EOSC/ESCAPE



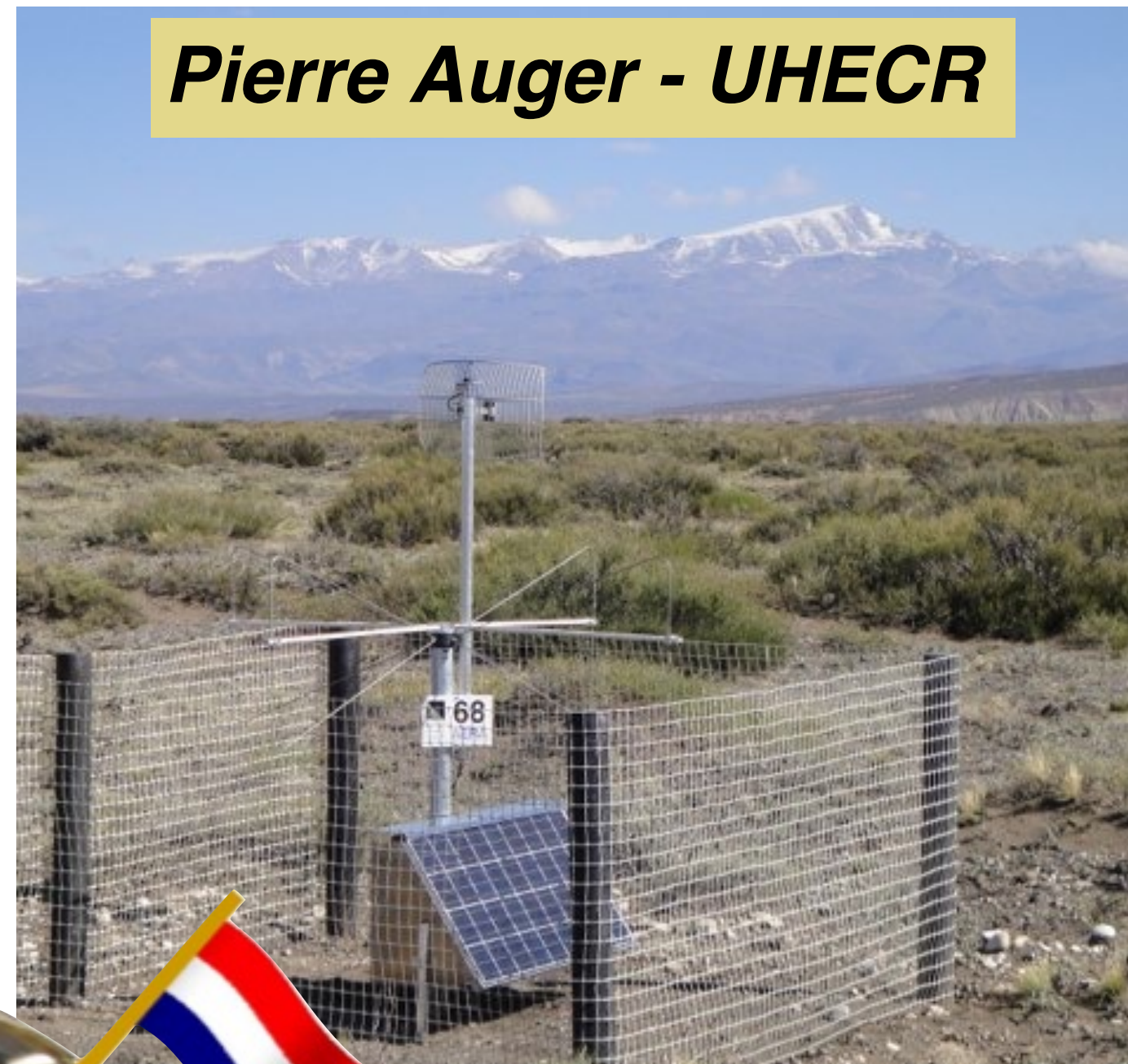
supported by SURF, coordinating the Dutch National e-Infrastructure

ASTROPARTICLE PORTFOLIO @ NIKHEF

Priorities of APPEC roadmap



Pierre Auger - UHECR



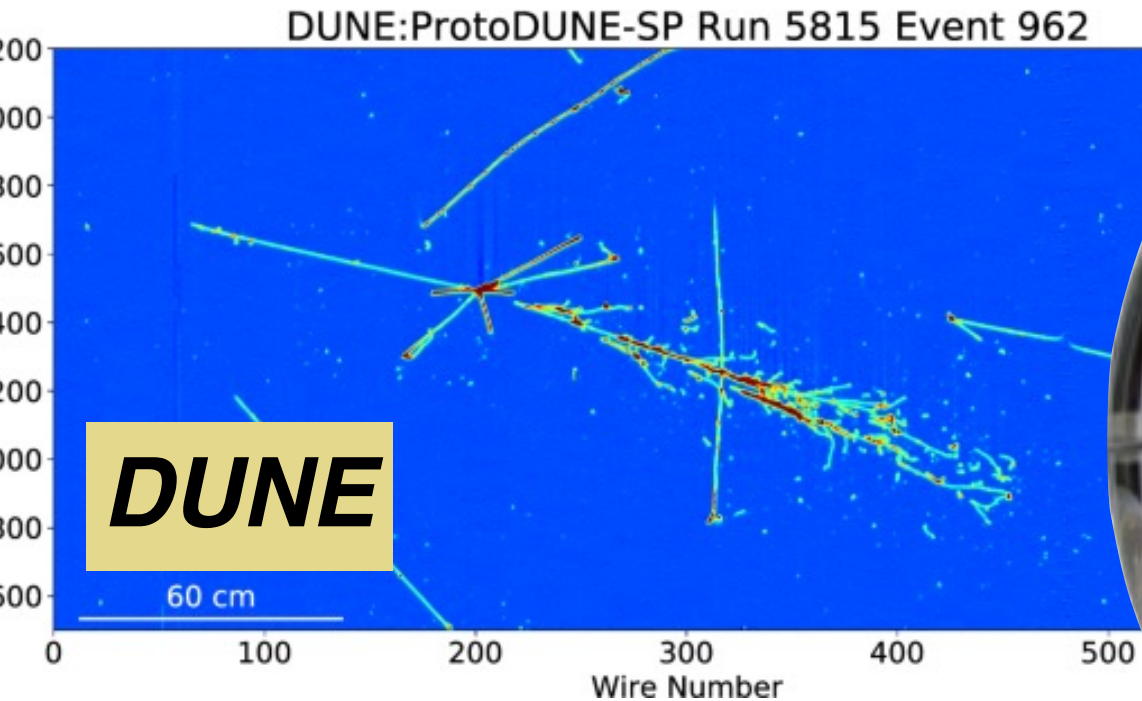
XENONnT - Dark Matter



Gravitational Waves



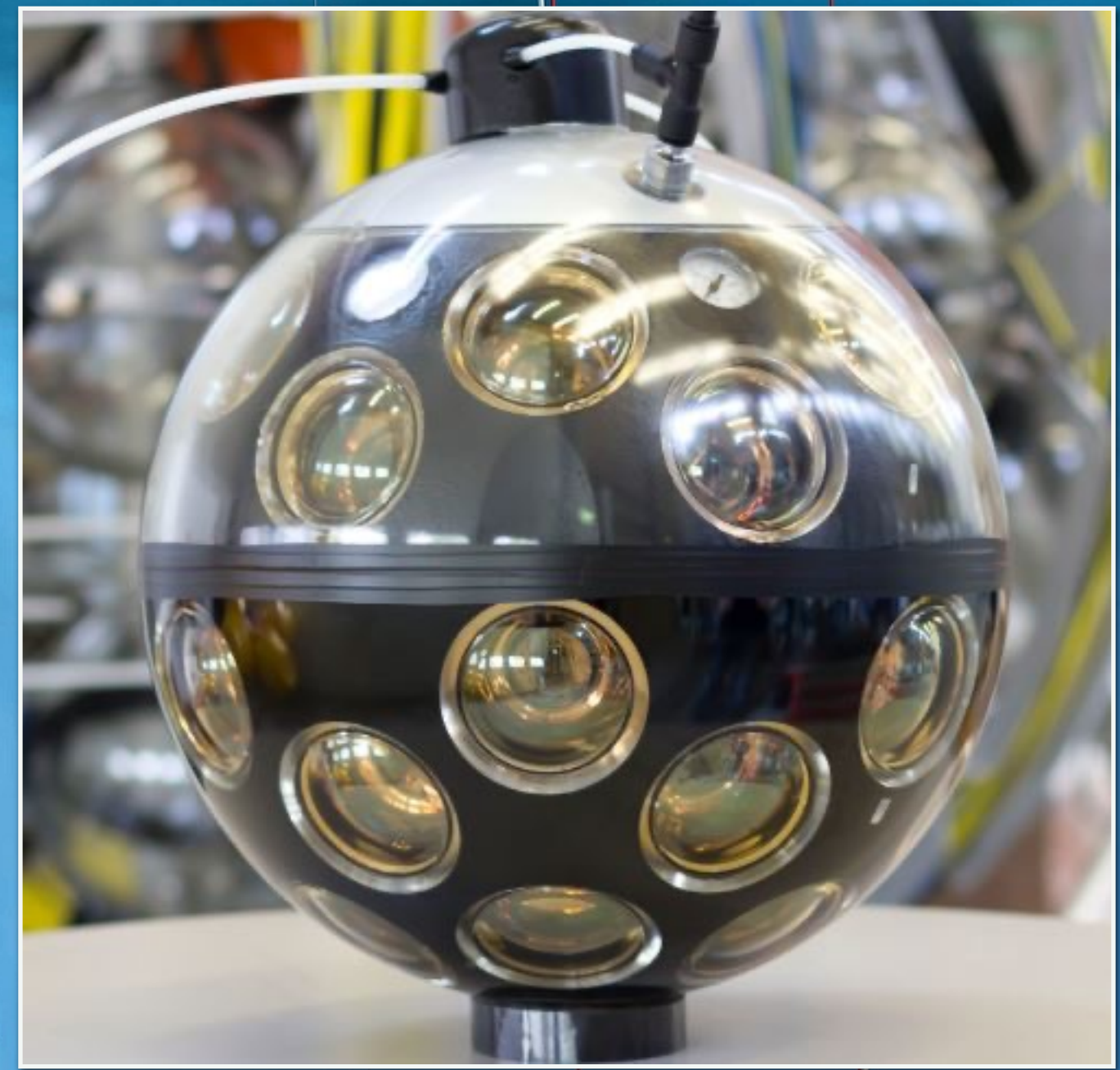
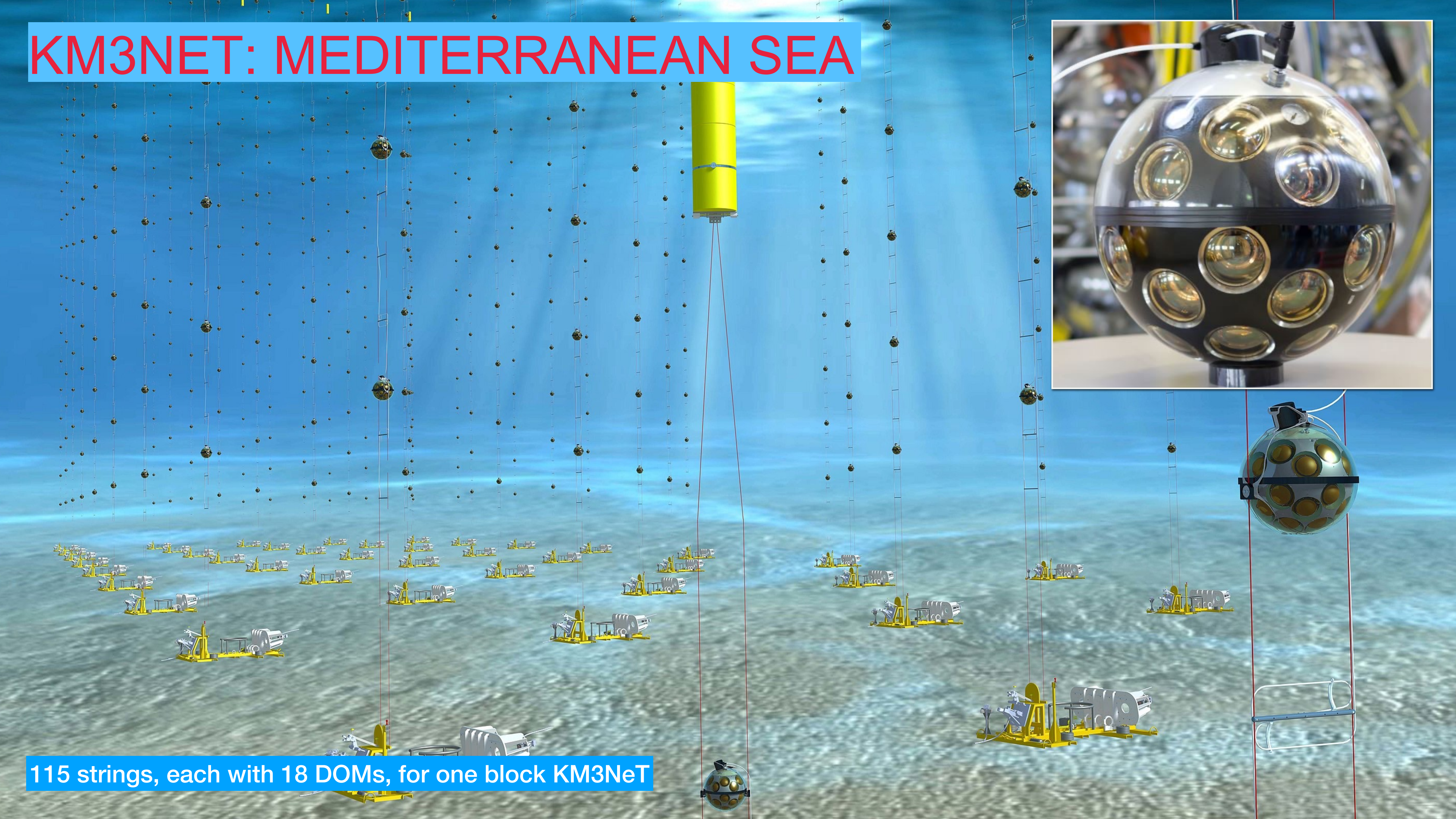
DUNE:ProtoDUNE-SP Run 5815 Event 962



KM3NeT - neutrino telescope



KM3NET: MEDITERRANEAN SEA



115 strings, each with 18 DOMs, for one block KM3NeT

KM3NET - A NEUTRINO TELESCOPE

Two blocks: ORCA (France, Toulon) and ARCA (Italy, Sicily)

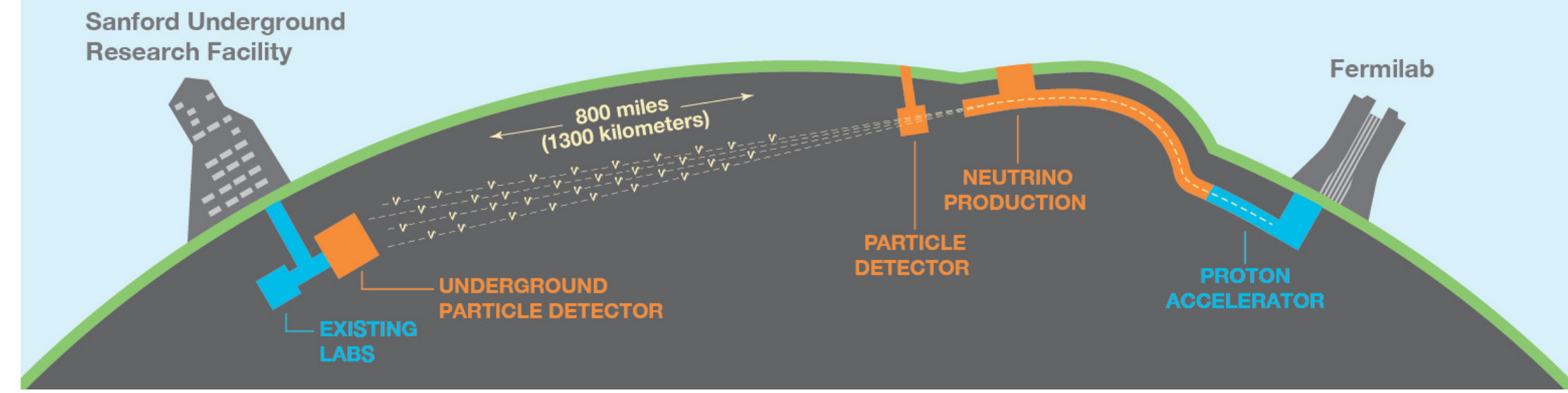
- Both sites use same technology, largely developed at Nikhef
 - International infrastructure where Nikhef involvement is largest
 - Dutch contribution funded by the National Roadmap (2018)
- Currently construction of the infrastructure
 - NL, France, Italy as main partners



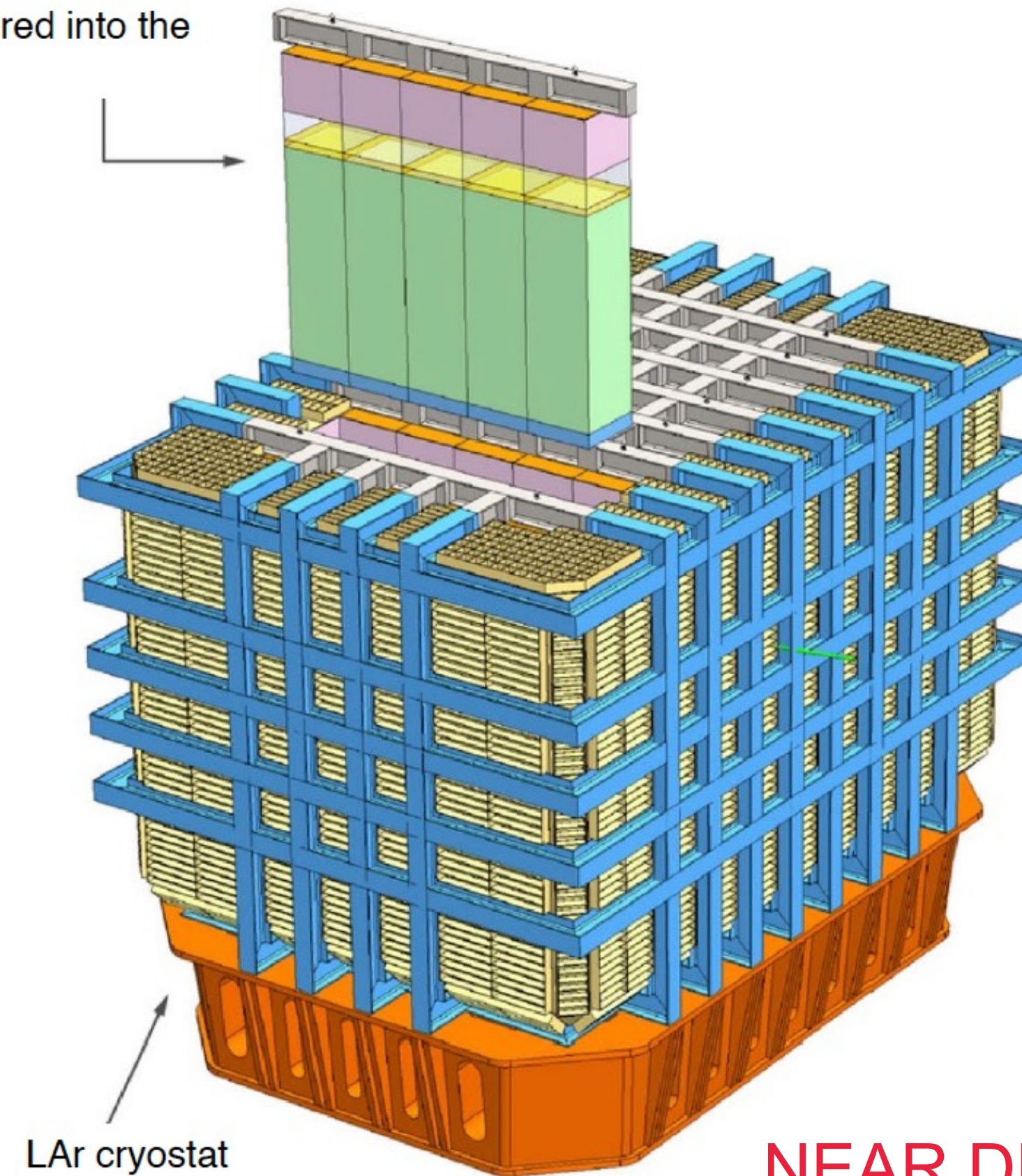
DUNE

ProtoDUNE DAQ and analysis
Computing
Near Detector LAr light readout

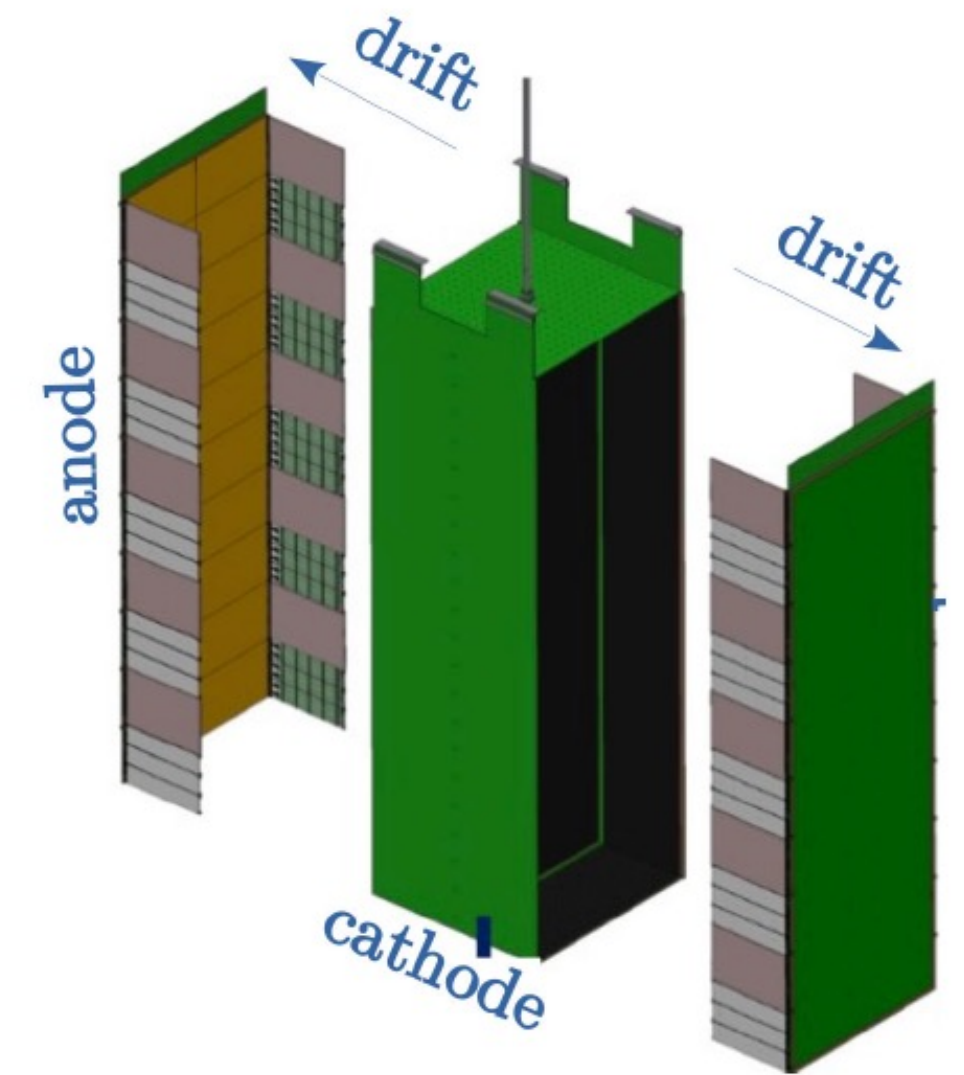
NEUTRINO OSCILLATIONS, CP-VIOLATION



Row of detector modules being lowered into the cryostat.



Exploded view of a module



LAr cryostat prototype at CERN (ProtoDUNE)

PROTODUNE

NEAR DETECTOR LIQUID ARGON

DARK MATTER

LOCAL R&D LAB

two-neutrino double electron capture in ^{124}Xe

$$T_{1/2} = (1.8 \pm 0.5) \times 10^{22} \text{ year}$$



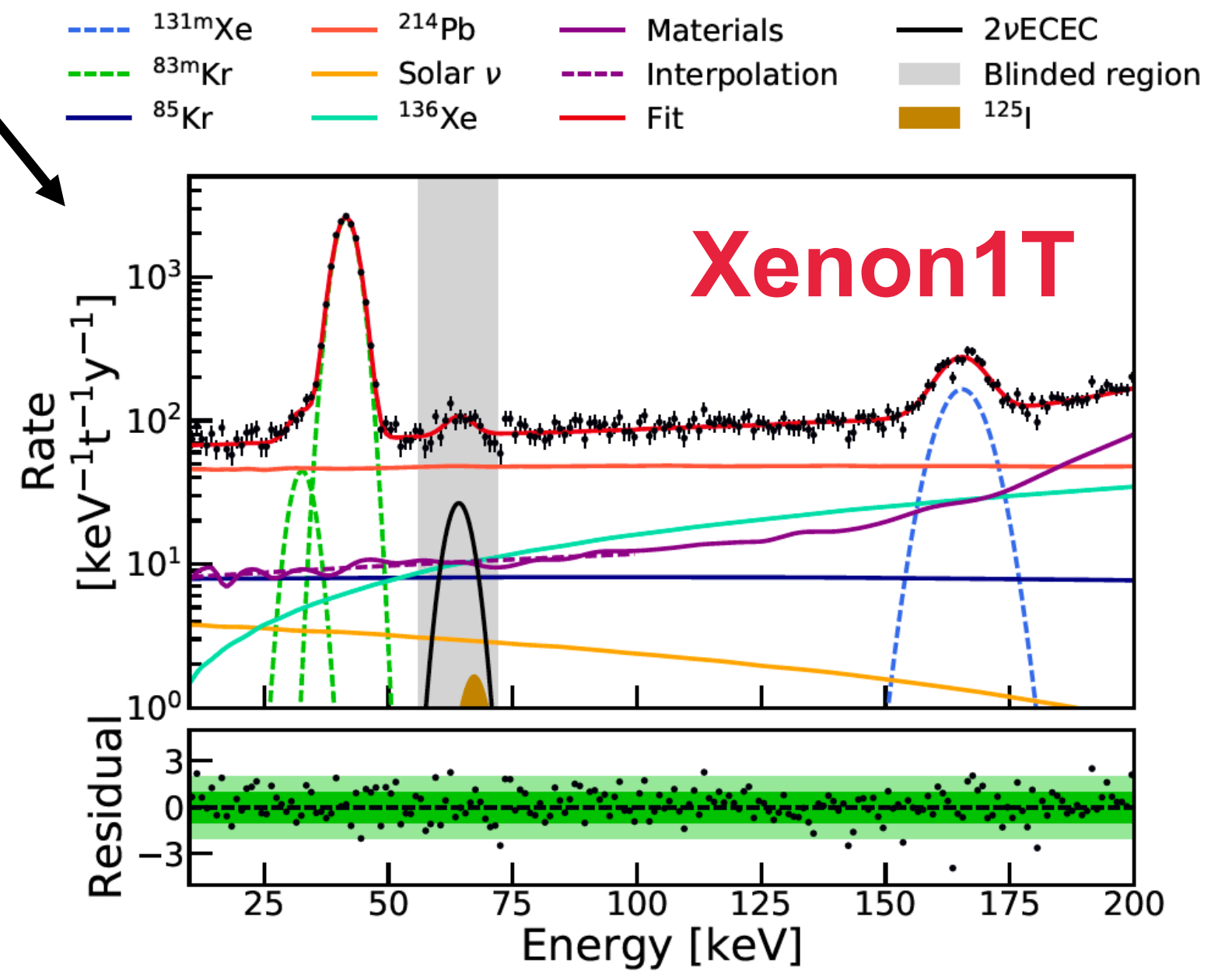
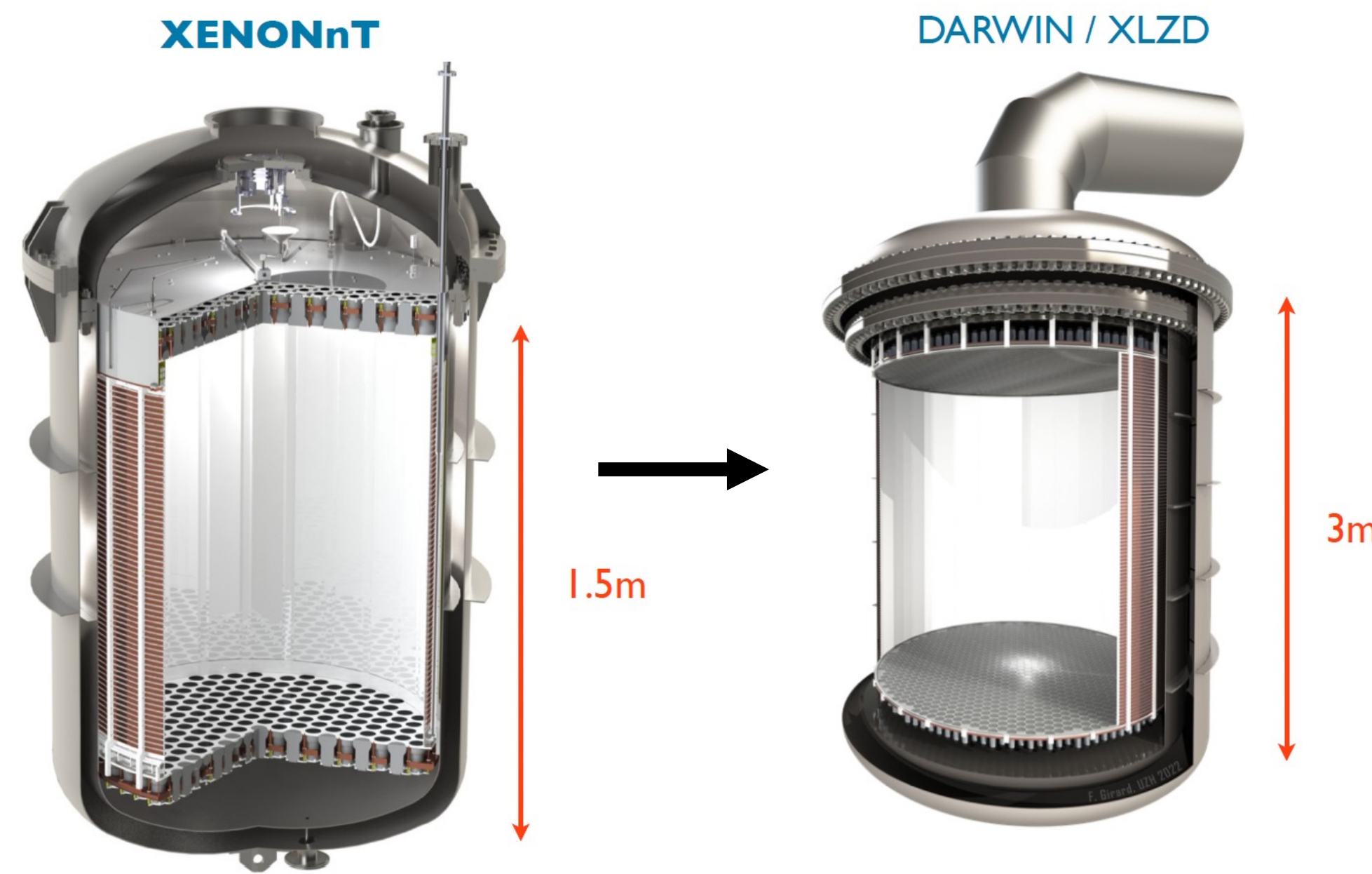
Xenon100

Xenon1T

XenonNT

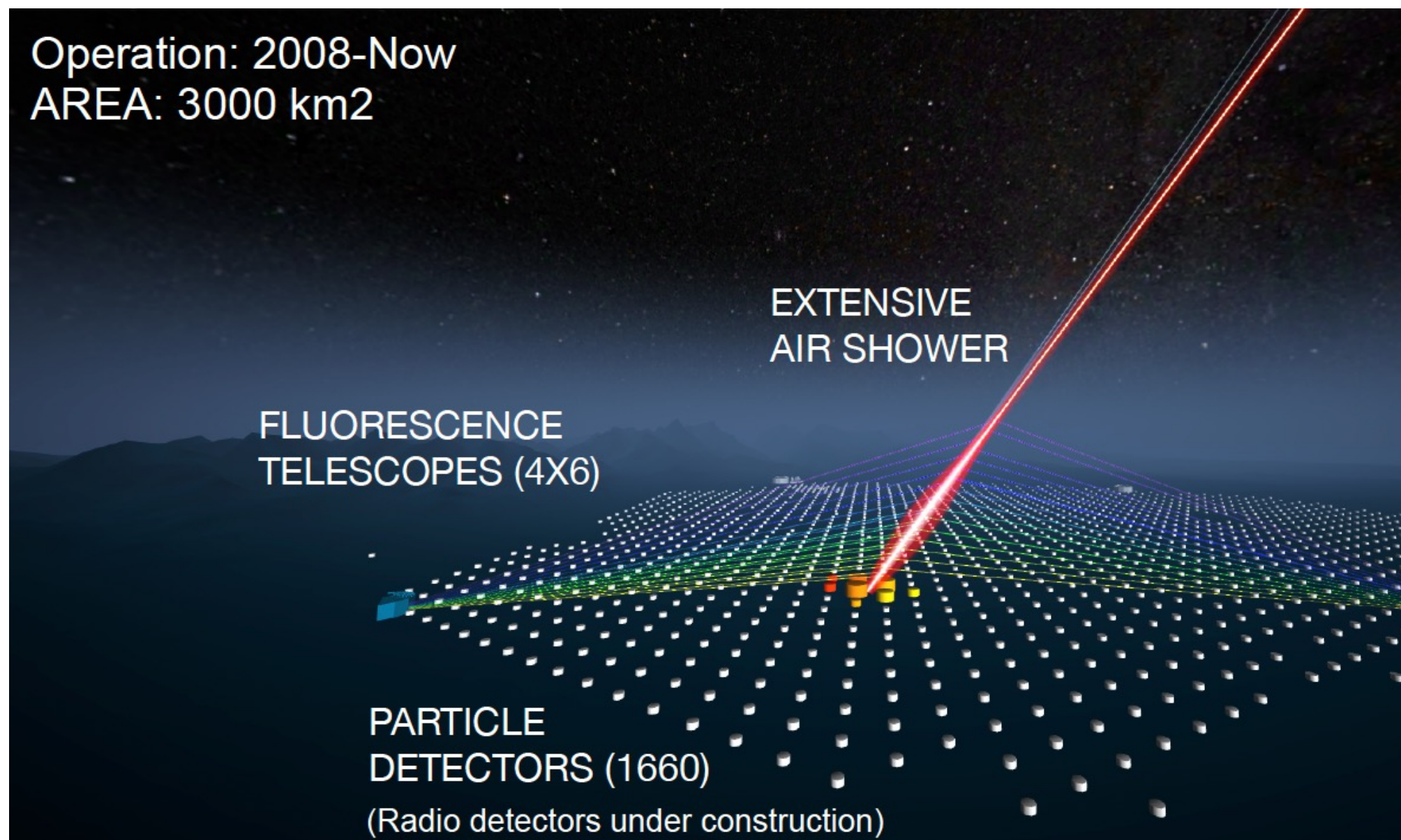


XLZD/DARWIN

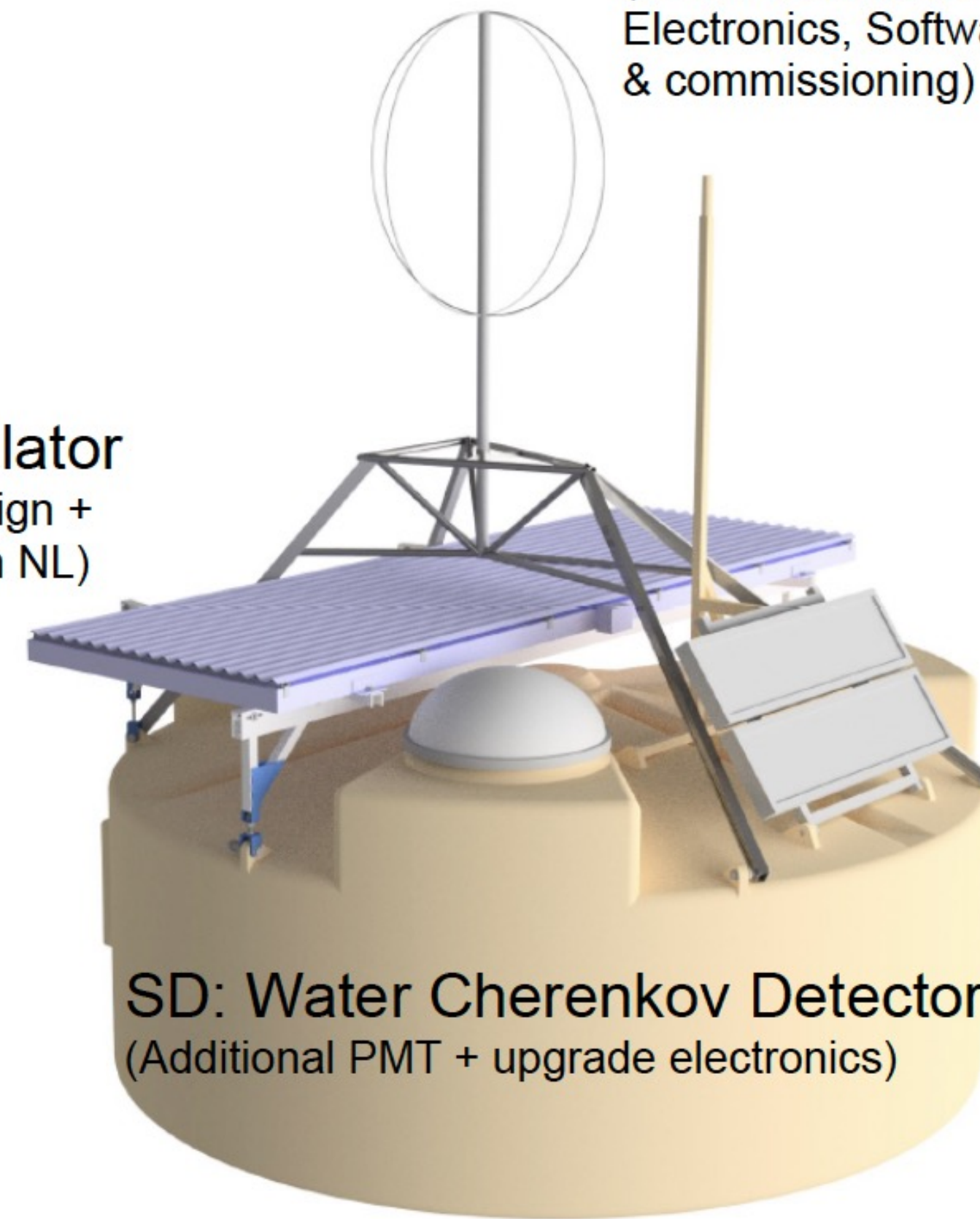


UHE COSMIC RAYS

Pierre Auger Observatory



SSD: Scintillator
(Mechanical design +
12% produced in NL)



RD: Radio Antenna
(Dutch Contribution: Mechanics,
Electronics, Software, Calibration
& commissioning)



SD: Water Cherenkov Detector
(Additional PMT + upgrade electronics)

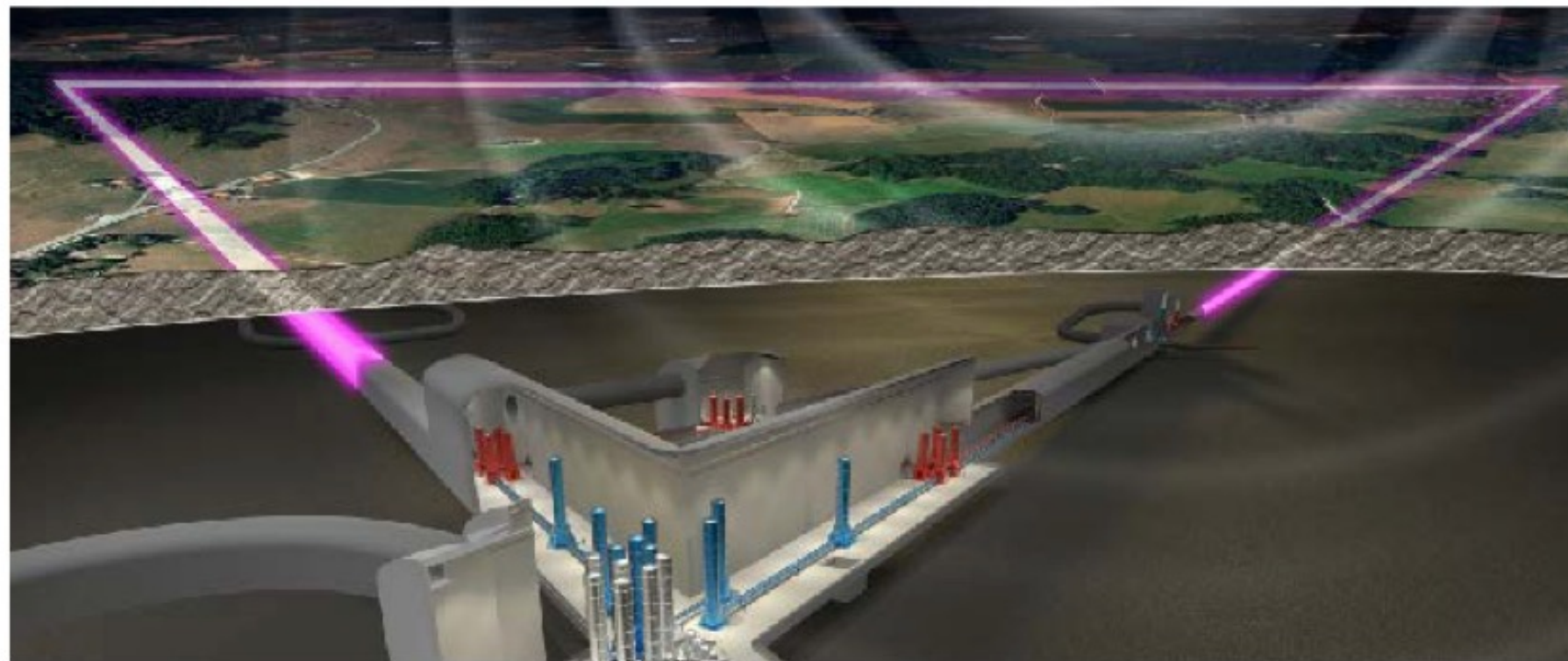
Still unknown: composition and sources
Future ambitions: radio detection, also neutrinos



GROUND BASED GW PROJECTS

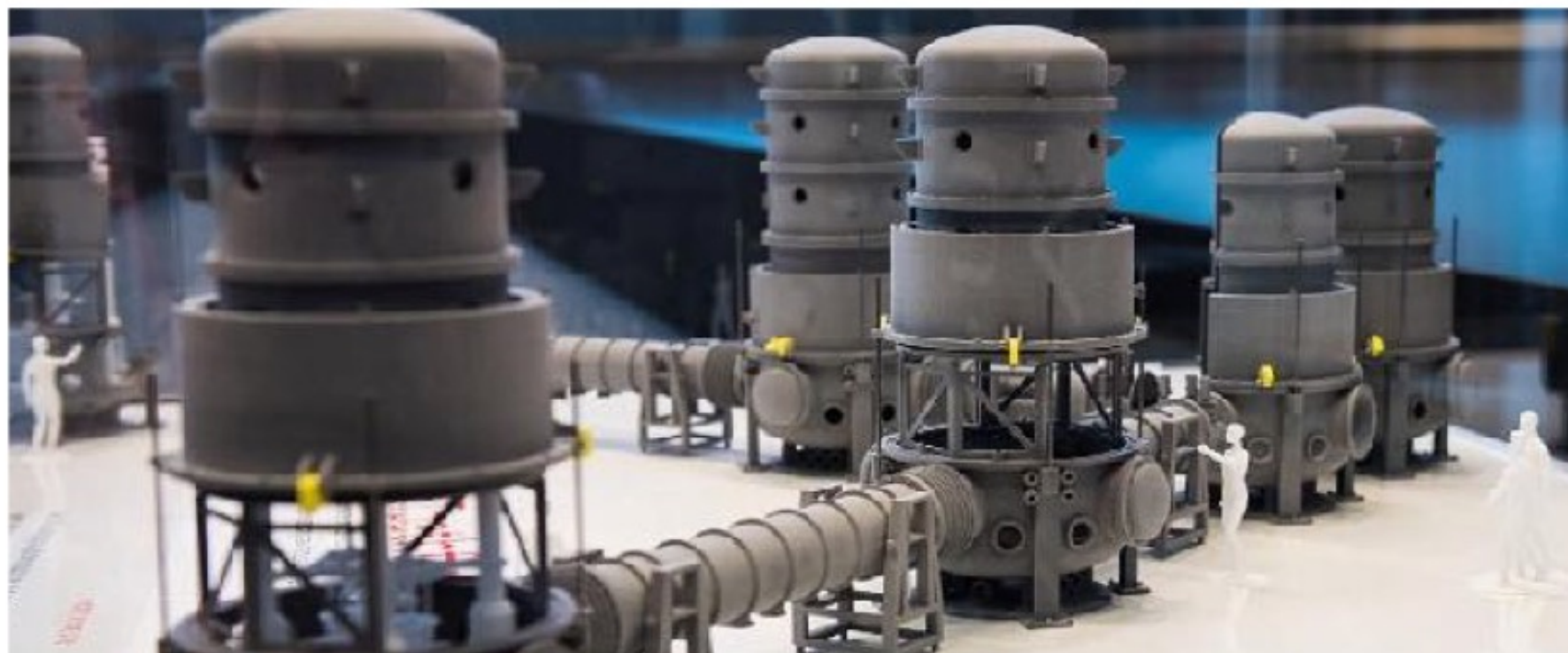
Virgo:

- Currently running together with LIGO
- Nikhef installed e.g. frequency-dependent squeezing system



Einstein Telescope:

- Plan for future observatory in Europe
- Prepare for a bid in the Euregio-Meuse-Rhine



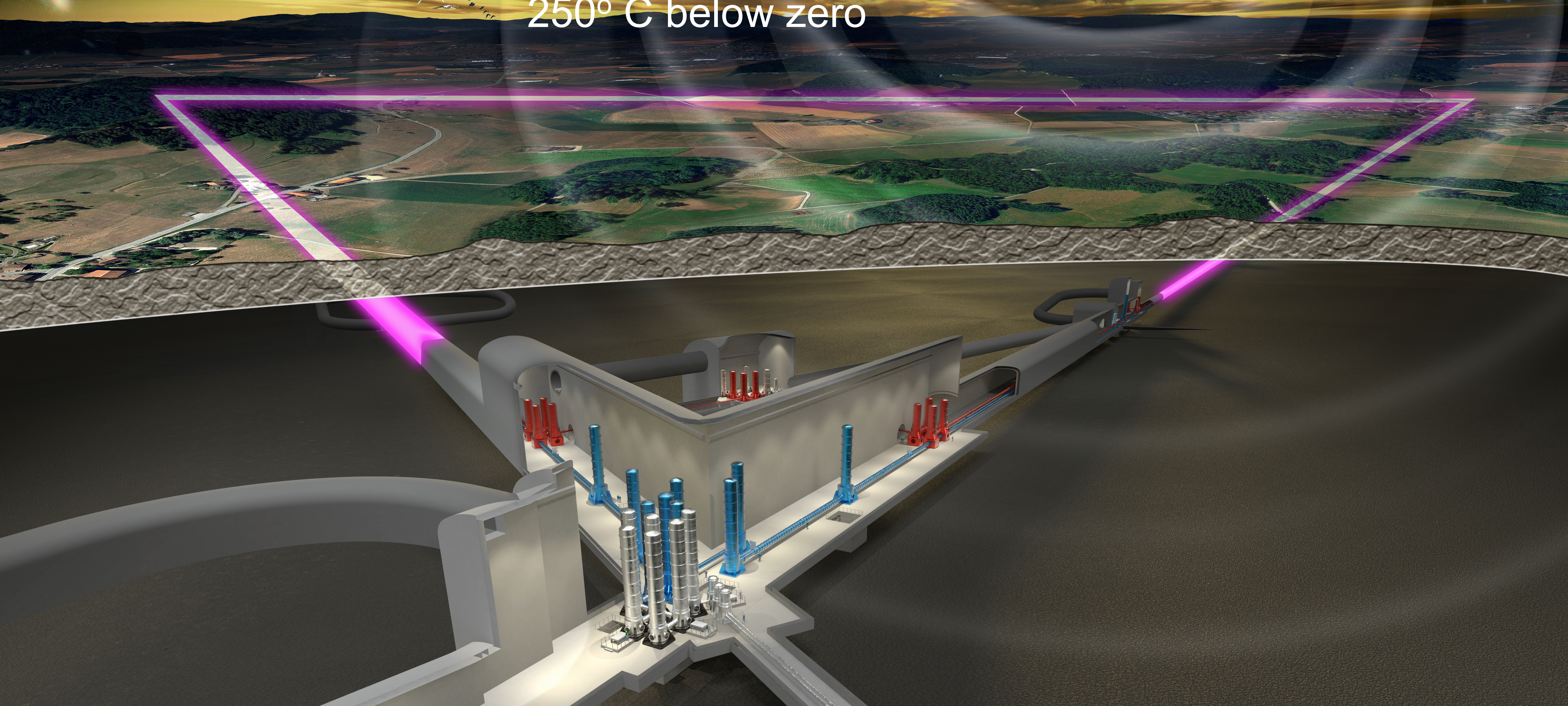
ETpathfinder:

- 10m scale prototype interferometer
- Testbed for future GW technologies

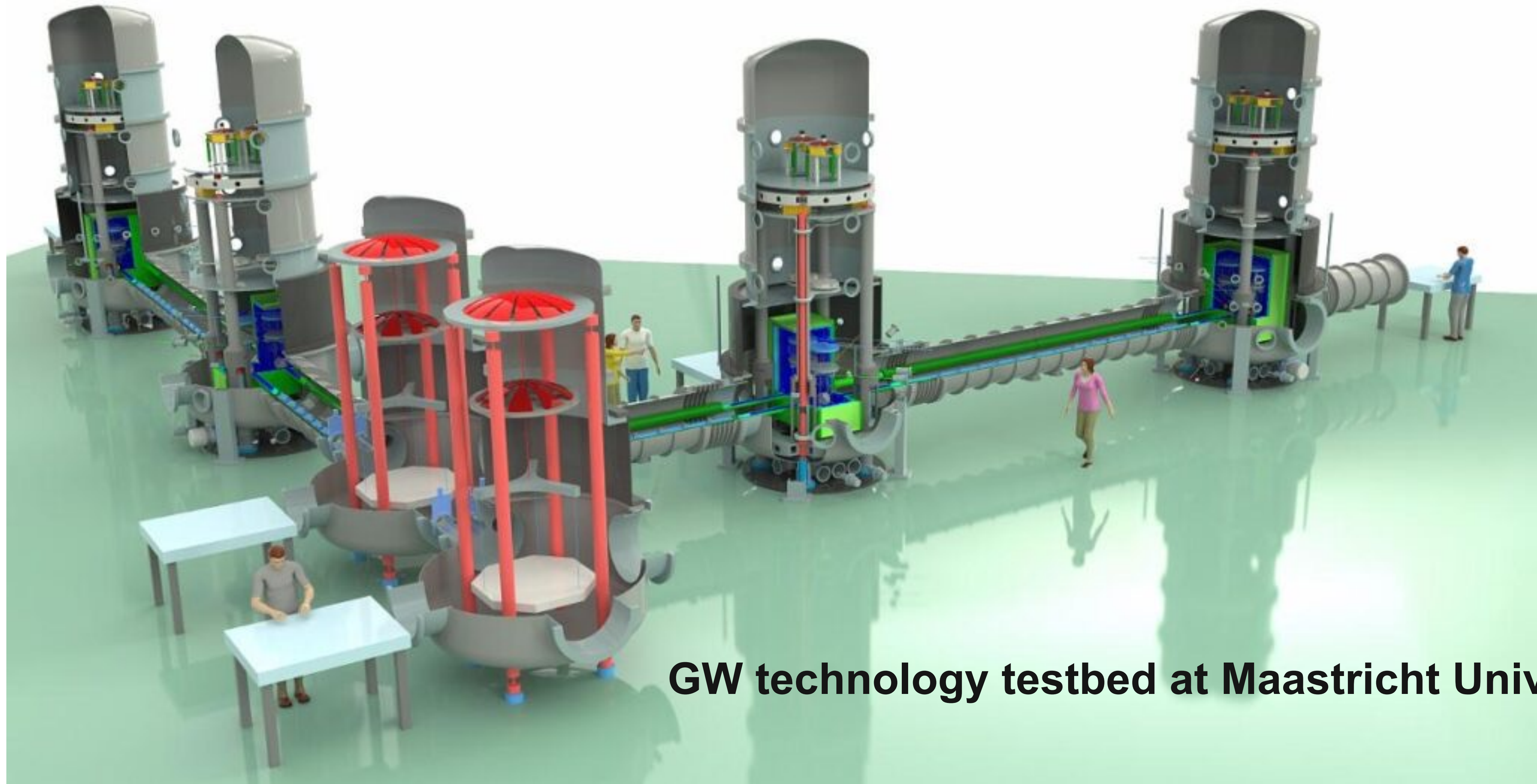
Einstein Telescope European Project

10 km long arms
underground
250° C below zero

>100.000 observations/
year from whole universe



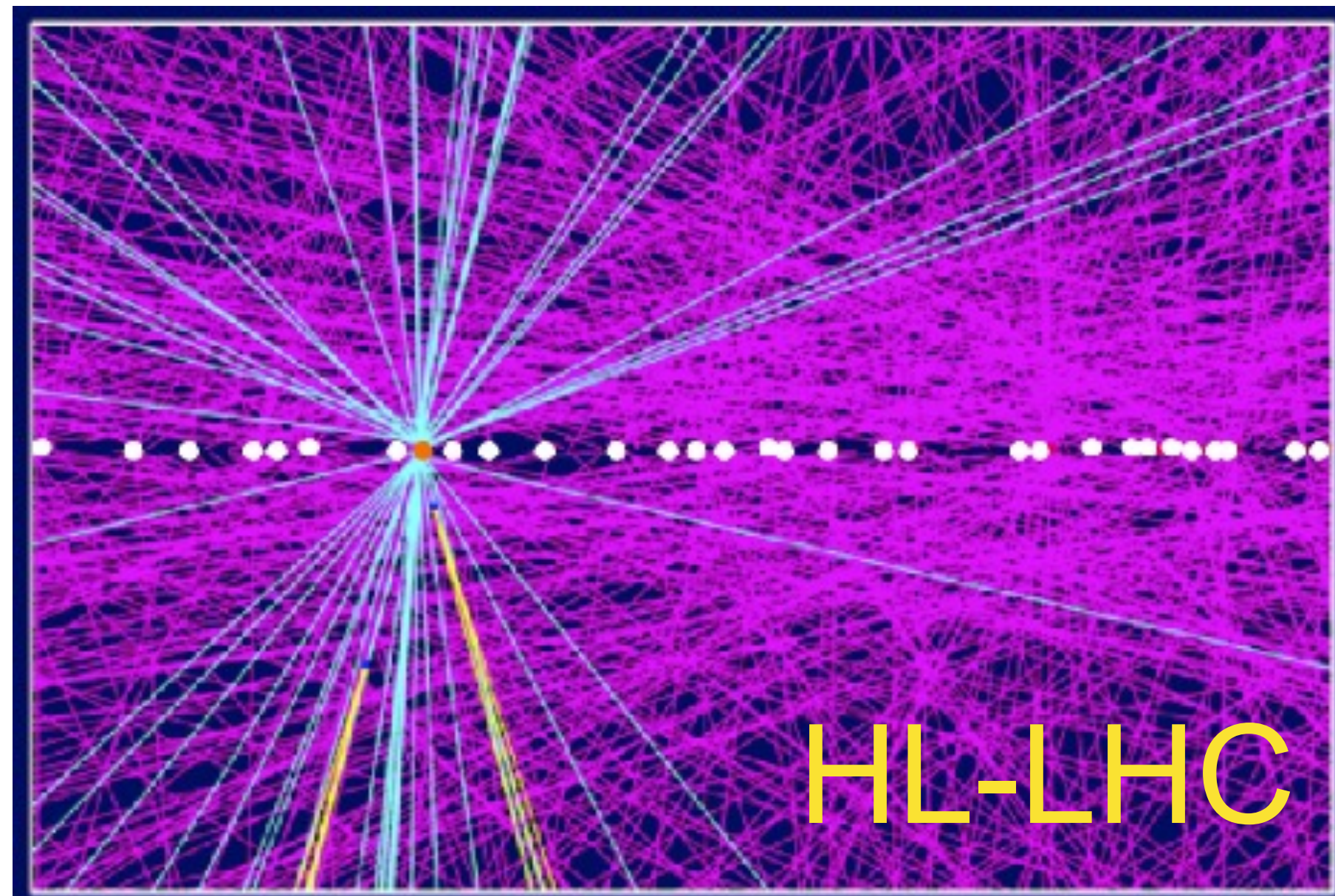
ET PATHFINDER



GW technology testbed at Maastricht University

DETECTOR R&D

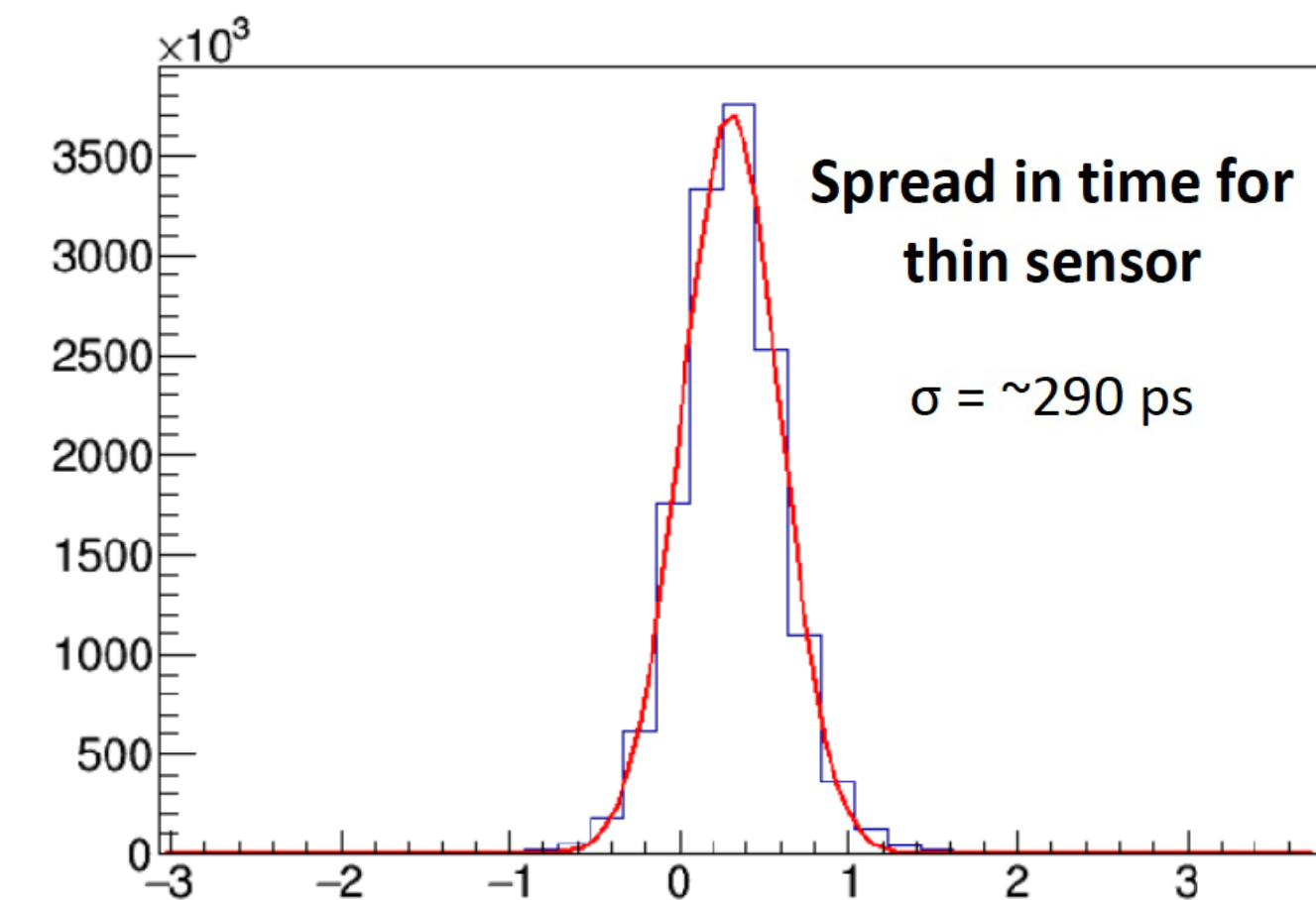
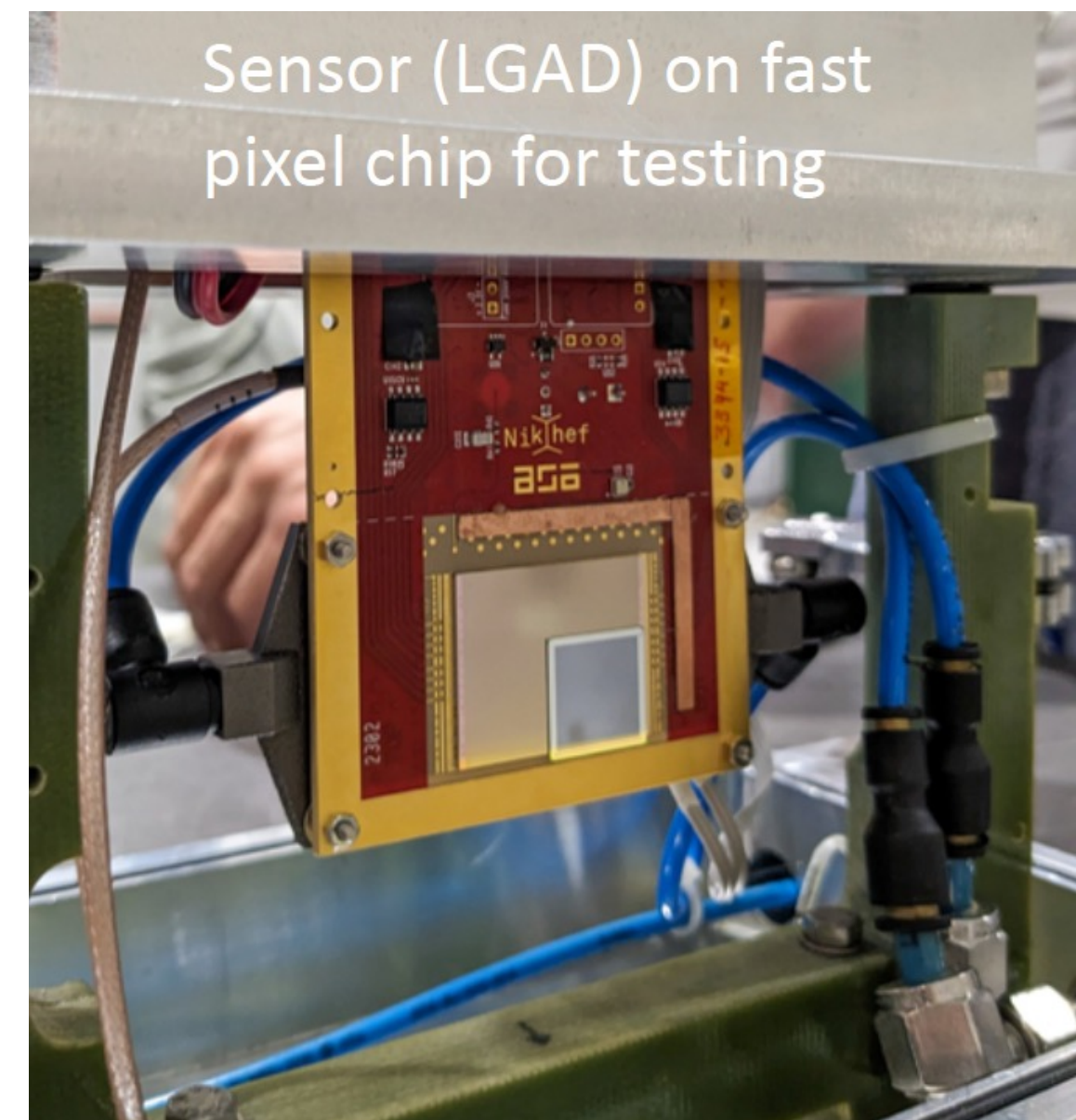
- Gravitational waves
- Fast and smart pixels for LHC experiments upgrades



4D-tracking
=
3D + time

Earlier work: GRIDPIX, focussed on ILD detector at ILC:

pixel readout of a TPC, with electron multiplication



CONCLUSION AND SUMMARY

- Nikhef coordinates Dutch activities in experimental particle and astroparticle physics
- Rich portfolio at LHC, and in astroparticle physics
- Preparing for Einstein Telescope
- Detector R&D, computing, theory division
- Supported by strong engineering and workshop facilities
- Preparing our input to the European Strategy discussion