Institut national de physique nucléaire et de physique des particules

www.in2p3.fr

Joint FKPPL and TYL/FJPPL Workshop

Seogwipo City, Jeju Island, Korea

May 8th, 2019

IN2P3

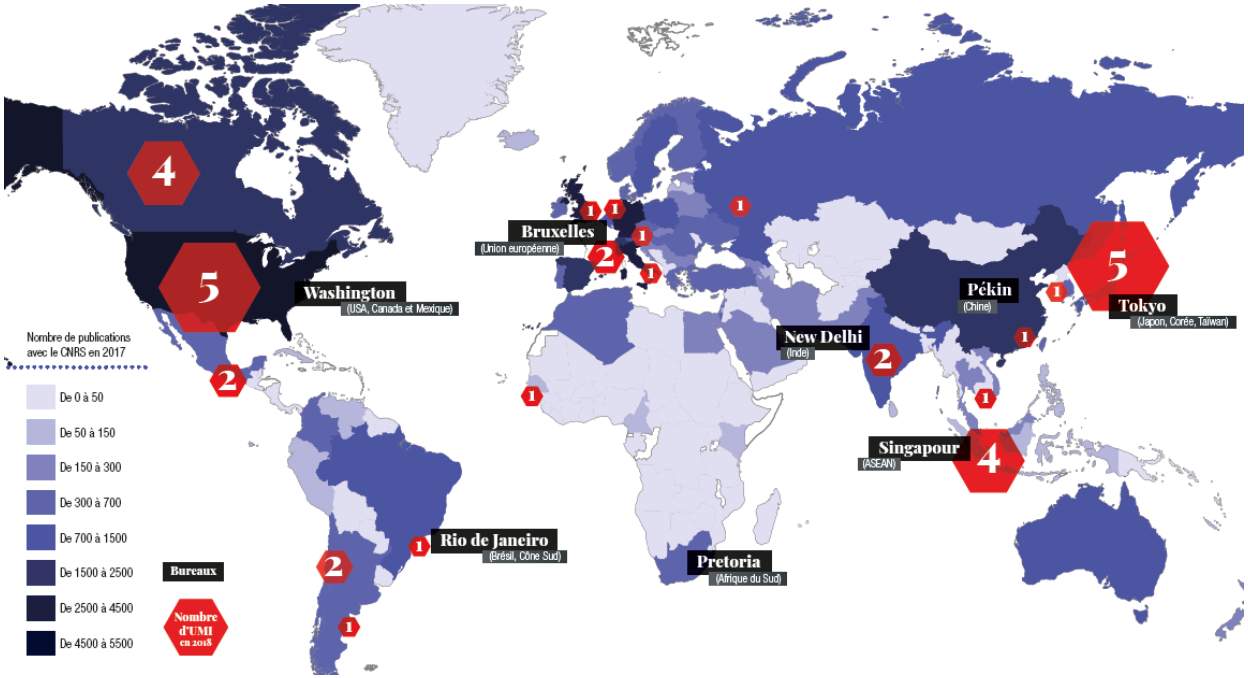
Laurent Vacavant

IN2P3 : a CNRS institute

- **CNRS:** a 32 000-strong workforce, incl. 24 600 permanent staff
  - 11 200 researchers
  - 13 400 engineers, technicians and administrative staff
- 2017 budget : 3.5 G€ (2.7 G€ state subsidy + 780 k€ self-generated income)
- Over 1 000 research units and 100 service units

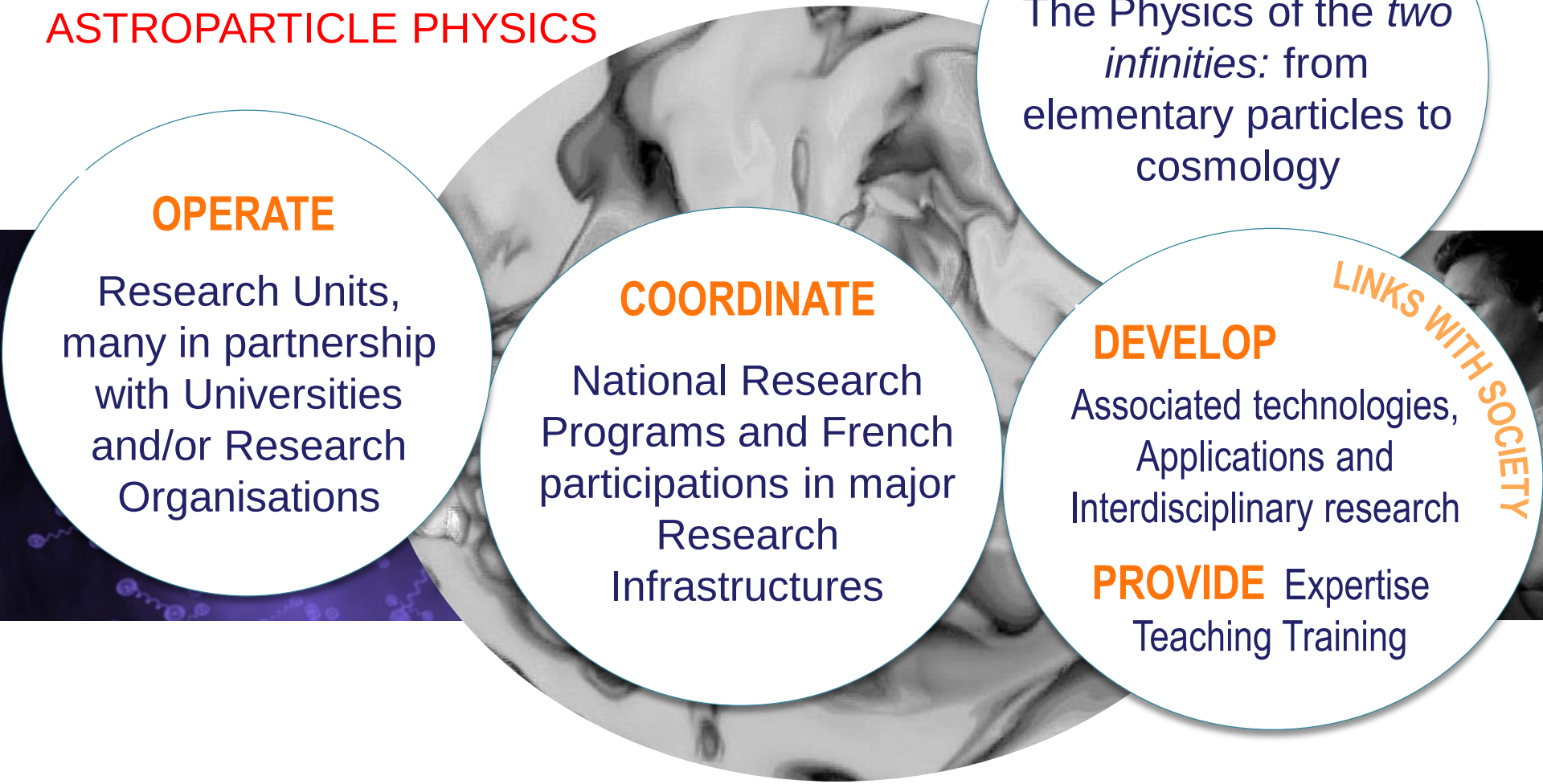
Depuis 80 ans, nos connaissances bâtissent de nouveaux mondes

- **95% of research** carried out in partnership with universities, national, European and international Institutes, and private companies, within **joint research units** (UMR)
- More than 50 000 publications/year (Scopus), incl. 60% co-signed with a foreign laboratory



IN2P3 : a national institute

MISSION : COORDINATE RESEARCH IN THE FIELDS OF NUCLEAR, PARTICLE and ASTROPARTICLE PHYSICS



EXPLORE

The Physics of the *two infinities:* from elementary particles to cosmology

OPERATE

Research Units, many in partnership with Universities and/or Research Organisations

COORDINATE

National Research Programs and French participations in major Research Infrastructures

DEVELOP

Associated technologies, Applications and Interdisciplinary research

PROVIDE Expertise Teaching Training

LINKS WITH SOCIETY

Research Areas @ IN2P3

Particles & hadronic physics

Matter's most elementary constituents and fundamental interactions

Nuclear physics & Applications

Structure of nuclear matter, nuclear energy and medical applications

Astroparticle physics and Cosmology

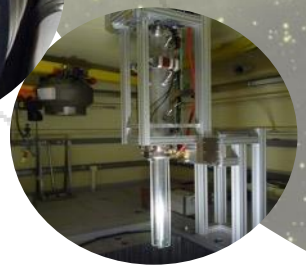
Universe's composition and behaviour

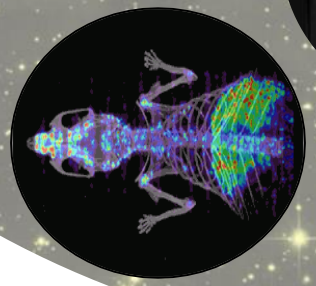
Computing & Data

Data Science and Computing research

Accelerator & Technology

Major R&D domains





IN2P3 : 5 Major Research Areas - 25 Research Units

Particles and hadronic physics
Matter's most elementary constituents and fundamental interactions

Nuclear physics and Applications
Structure of nuclear matter, nuclear energy and medical applications

Astroparticle physics and Cosmology
Universe's composition and behaviour

Accelerators & Technologies
Major R&D domains

Computing and Data
Data Science and Computing research

1000 CNRS and University researchers,
1500 engineers, technicians and administrative staff
700 postdocs and Ph.D students

25 laboratories and technical support labs
18 joint with Universities,
2 with CEA, 1 with Italy*
8 interdisciplinary accelerator based platforms

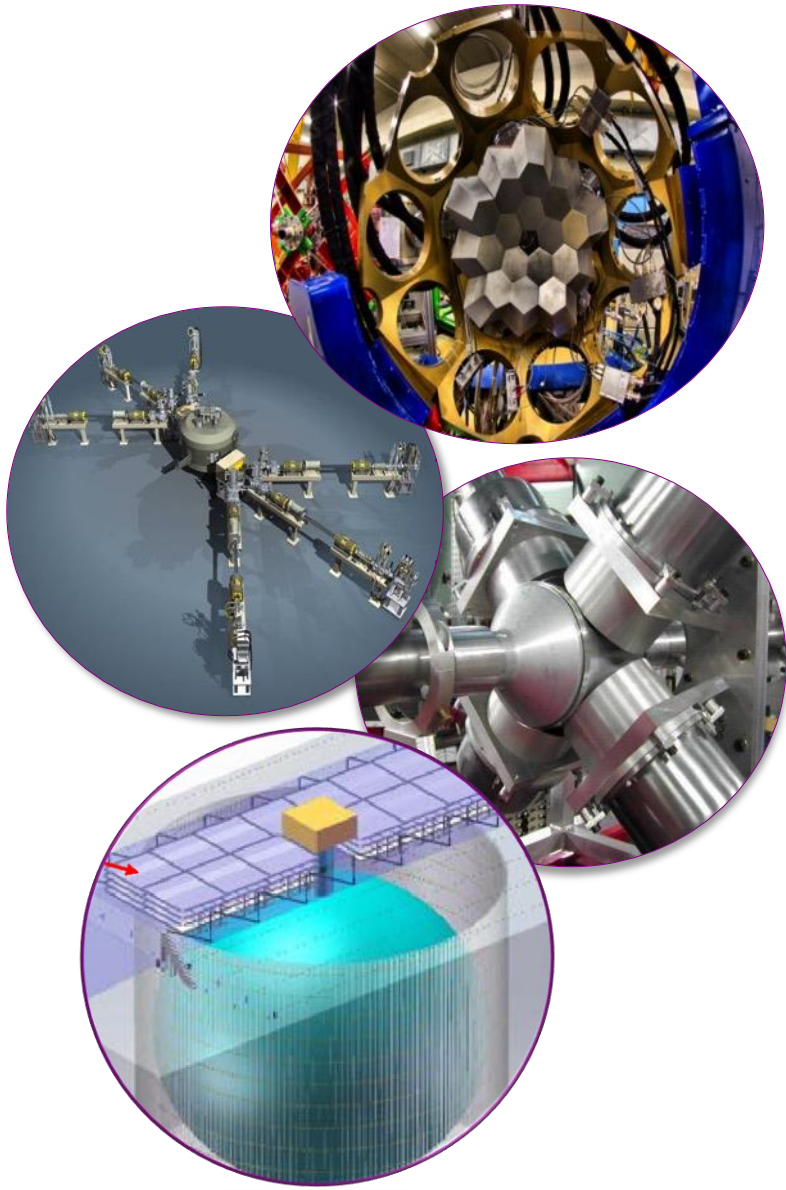
30 major research programs (TGIR/IR)
50 International collaborative research agreements

* EGO and CNRS participations in CERN, FAIR and CTA

IN2P3 : a “distributed” laboratory

Nuclear physics & its applications

- Nuclear physics and astrophysics
  - Study of exotic nuclei
  - Study of the nucleon structure
- Reactor based neutrino physics
  - Double-Chooz, JUNO
  - Sterile neutrinos : STEREO, Solid
- Applications for
  - Health and life-science
    (Radiotherapy, radioisotopes, dosimeters, imaging technics, simulations)
  - Nuclear Energy
    (ADS transmutation, studies for Thorium-cycle)
  - Radiochemistry
  - Cosmic ray tomography



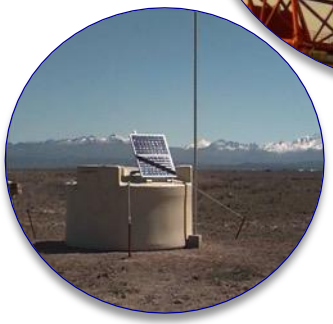
Astro-particles & cosmology

High-energy gamma rays
- HESS
- Fermi-LAT
- CTA
- HARPO
- SVOM

High-energy cosmic rays
- AMS
- Auger Prime
- EUSO

Gravitational Waves
- Virgo
- LISA / LISA Pathfinder

Non-accelerator neutrinos
- KM3NeT
- SUPERNEMO
- SuperKamiokande
- LUMINEU



Direct dark matter detection
- Edelweiss
- XENON
- DAMIC
- DARKSIDE
- MIMAC

Inflation and CMB
- QUBIC
- NIKA
- PLANCK

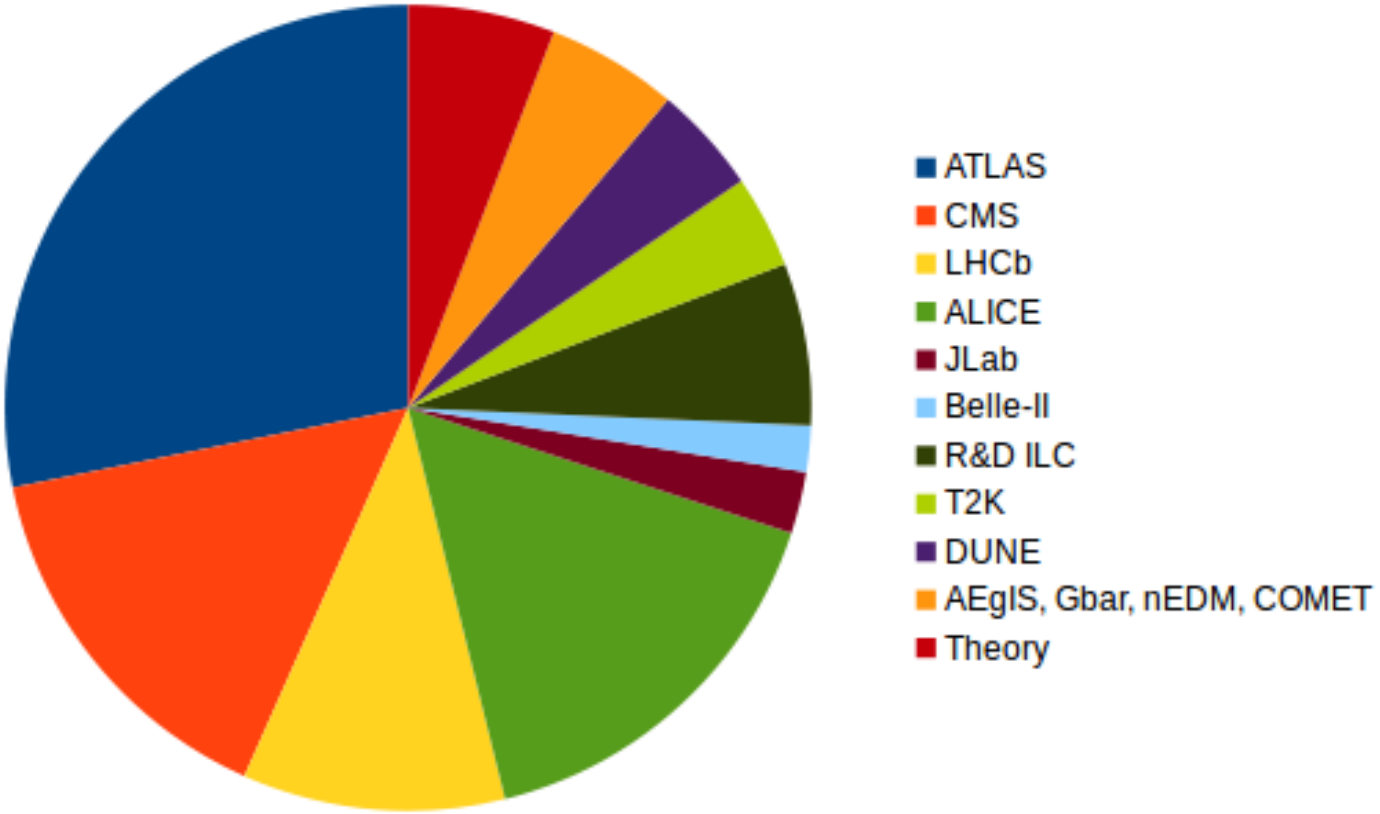
Dark Energy
- LSST
- DESI
- SDSS/BOSS/eBOSS
- EUCLID

Particle & hadronic physics

- Participation in all 4 major LHC experiments :
  - Physics of and beyond the standard model
  - B-physics and fundamental symmetries
  - Heavy-Ion physics
- Participation to Belle-II:
  - B-physics at an e^+e^- collider
- Hadronic physics
  - J-Lab and Hades/GSI
- Participation in precision physics experiments
  - nEDM (PSI), GRANIT (ILL), Comet (J-Parc), AEgIS & Gbar (CERN)
- Accelerator based neutrino physics
  - T2K, DUNE (ProtoDUNE-DP, WA105)
- Detector R&D for ILC:
  - CALICE (SiW and SDHCAL), CMOS technology for micro-vertex

Particle & hadronic physics

Permanent researchers: ~ 230 CNRS +100 from universities



+ PhD students: ~ 190
+ post-docs: ~ 120

(NB: some limited double counting)

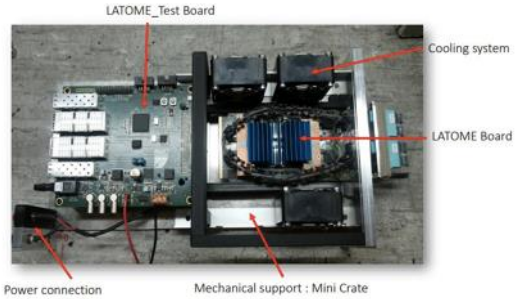
LHC phase 1 upgrades

CMS (finished in 2017)

New pixel detector : DAQ
L1 ECAL trigger
Tracker CO_2 cooling

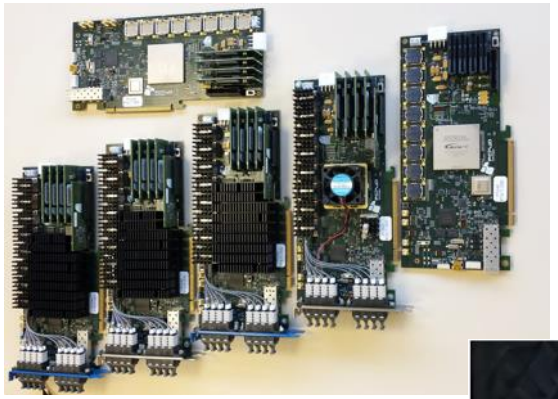
ATLAS

Pixel Inner Barrel Layer (2014)
Liquid argon calorimeter:
electronics



LHCb

Calorimeter electronics
Scintillating Fiber tracker
DAQ system



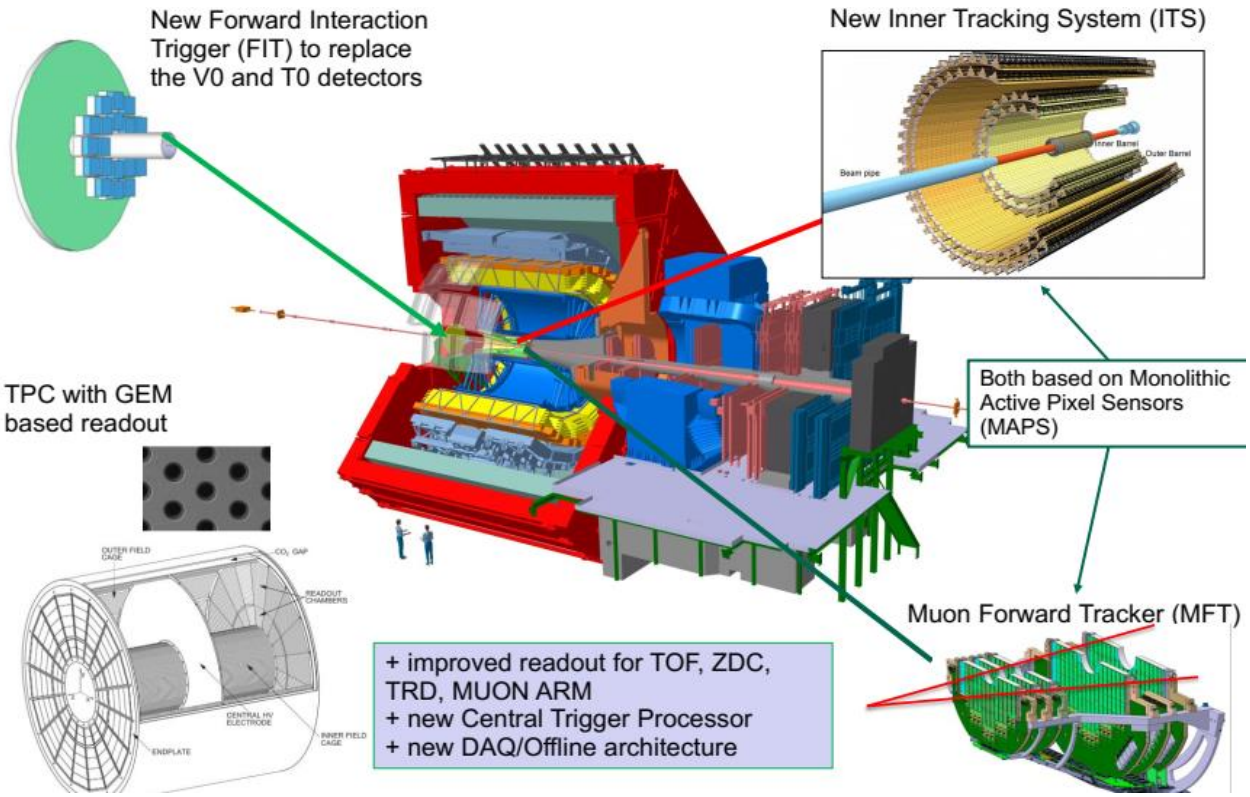
ALICE

Muon System
Inner Tracking System
Muon Forward Tracker

Phase 1 upgrades for ALICE

Involvements in the major upgrades for ALICE

- Contribution to design of the ALPIDE pixel chip
- ITS: production of 400 modules
- MID: production of FE cards FEERIC
- MUTRK: production of (200k) DualSampa cards and large PCBs
- MFT: co-management with CEA of the full project



LHC phase 2 upgrades

France contribution to ATLAS & CMS upgrades for the HL-LHC were approved In 2017:

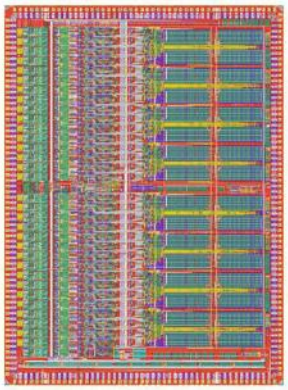
140 M€ investment over 10 years for IN2P3

- ATLAS
  - Inner Tracker: sensors, electronics, track trigger, mechanics
  - Liquid argon calorimeter: electronics
  - Tile calorimeter: electronics and HV
  - High Granularity Timing Detector
- CMS
  - Tracker: electronics, endcap mechanics & cooling, DAQ
  - High Granularity Calorimeter: electronics, mechanics, trigger
  - RPC Muon Chambers: electronics

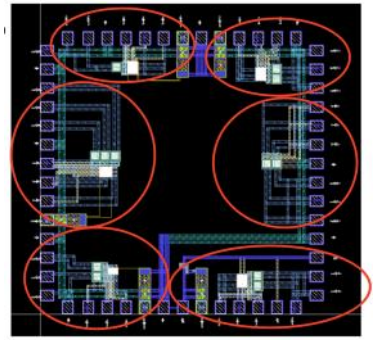
- R&D: strong contribution to micro-electronic (ASICs design)

TSMC 130 nm

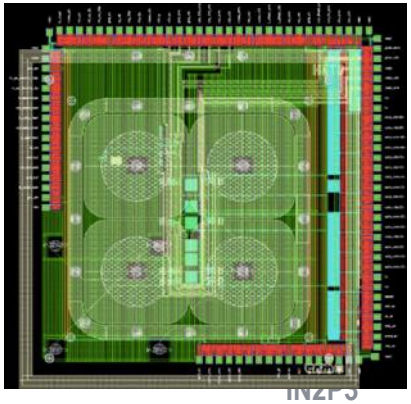
HGROC
CMS HGCAL



LAUROC
ATLAS LAr



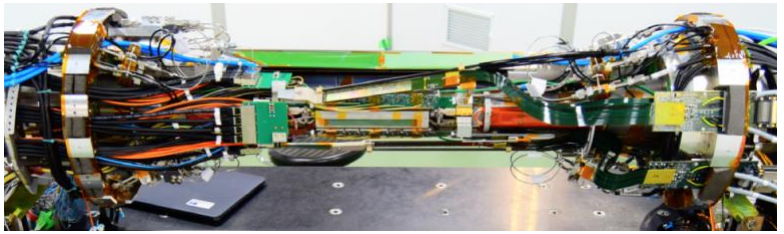
ALTIROC
ATLAS HGTD



TSMC 65 nm

CIC
CMS tracker

Belle-II @ KEK



Involvement since 2017

- Interest for Kπ(π)γ modes (charged and neutral)
- Contributions:
  - ARICH: commissioning, redesign cooling
  - PLUME: beam background characterization (BEAST)

Growing interest

- CPPM team now joining IPHC and LAL
- new hires, ~18 persons by end of 2019

Considerations for strengthening contributions

- IN2P3 considers being a Raw-Data-Center (10% of data)
  → building on the expertise of CC-IN2P3 in Lyon (TA BaBar, T1 LHC, Tokyo T2, synergy with DIRAC & CPPM)
- proposal of PCIe40 cards (à la LHCb with strong support) for the DAQ upgrade
- strong interest for a vertex detector upgrade based on CMOS

Conclusion

FKPPL:

- created in 2008
- 15 institutions/universities from the Republic of Korea
- 9 labs from IN2P3 (and corresponding universities) participating (+INP, CEA)

Toshiko Yuasa Lab / FJPPL:

- created in 2006
- KEK (inter-university) in Japan
- 16 labs from IN2P3 (and corresponding universities, +CEA) participating

Strong interest from IN2P3 to pursue both adventures:

- Very fruitful collaborations, as we will hear more about during this workshop
- CNRS collaborative instruments have changed though
- need to reformulate a bit once the LIAs end

Many thanks to the organizers of this joint workshop !

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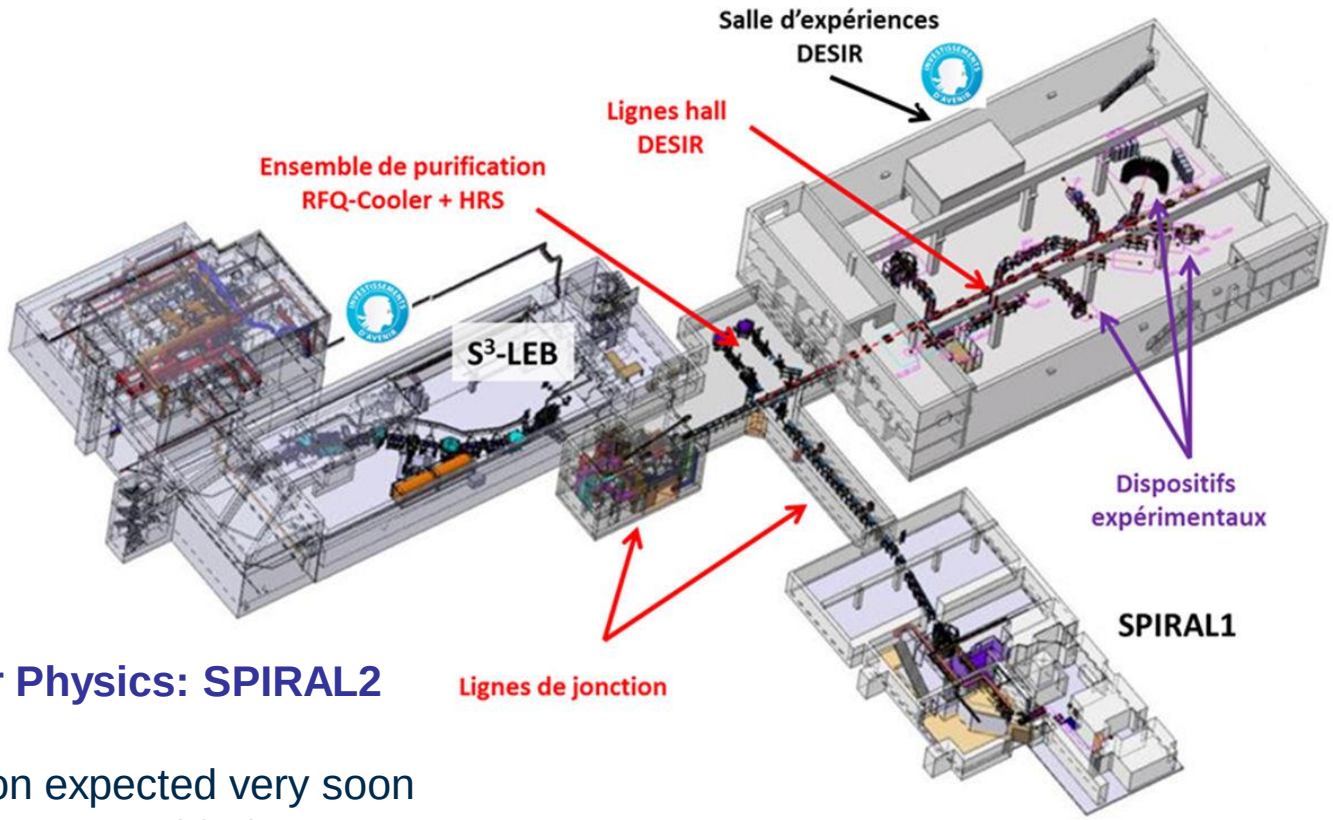
Merci de votre attention !

Nuclear Physics @ GANIL



Highest priority in Nuclear Physics: SPIRAL2

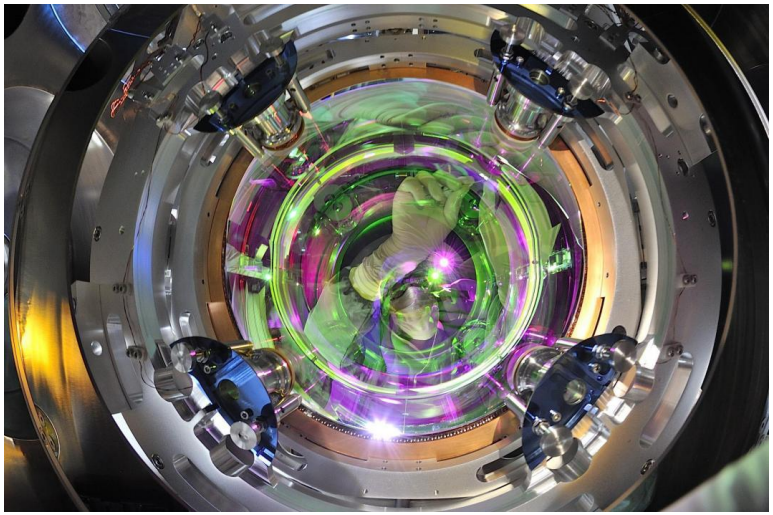
- LINAC: ASN authorization expected very soon
  => RF commissioning : summer 2019
  => Beam commissioning: fall 2019 and first beam to NFS in 2020

- Spectrometer S3: start-up in 2021/2022

- DESIR : start-up in 2024/2025

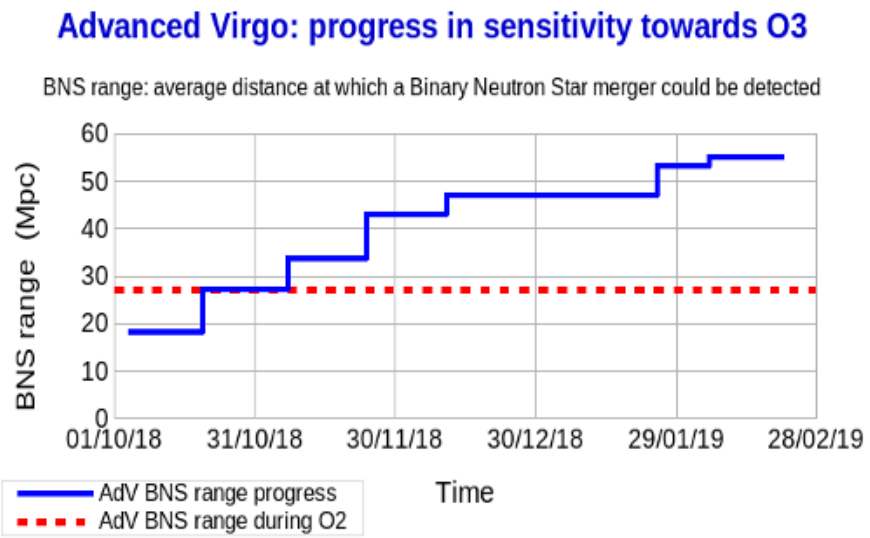
Gravitational Waves: Virgo

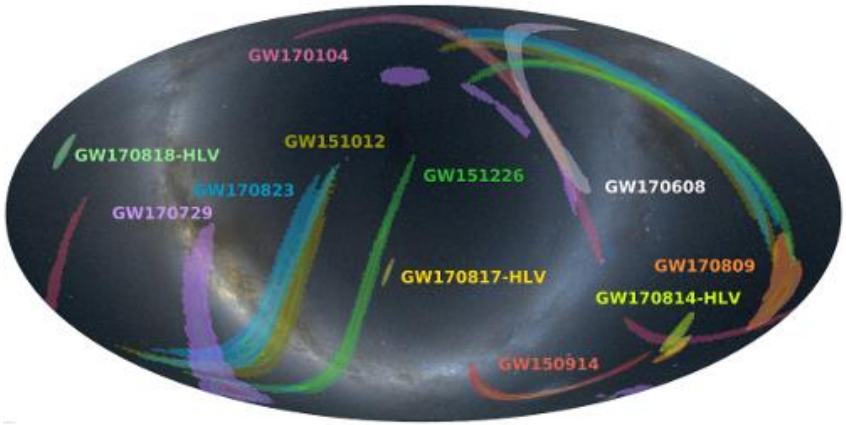
Virgo and LIGO mirrors :
Polishing and coating coated at LMA (Lyon)



April 1st : Start of New observing period (run O3) of Virgo and LIGO which will last 1 year:

- Virgo sensitivity improved by a factor of 2 (8 in volume)
- Expecting several observations per week: merger of 2 black holes, of black hole-neutron star
- Strong links between nuclear physics and astrophysics





Dark energy: LSST

Dark energy: LSST

- IN2P3 is involved in the construction
- CCIN2P3: computing center with all LSST data
- Physics program within the DESC collaboration

Filter Autochanger

Filter loader on transport cart

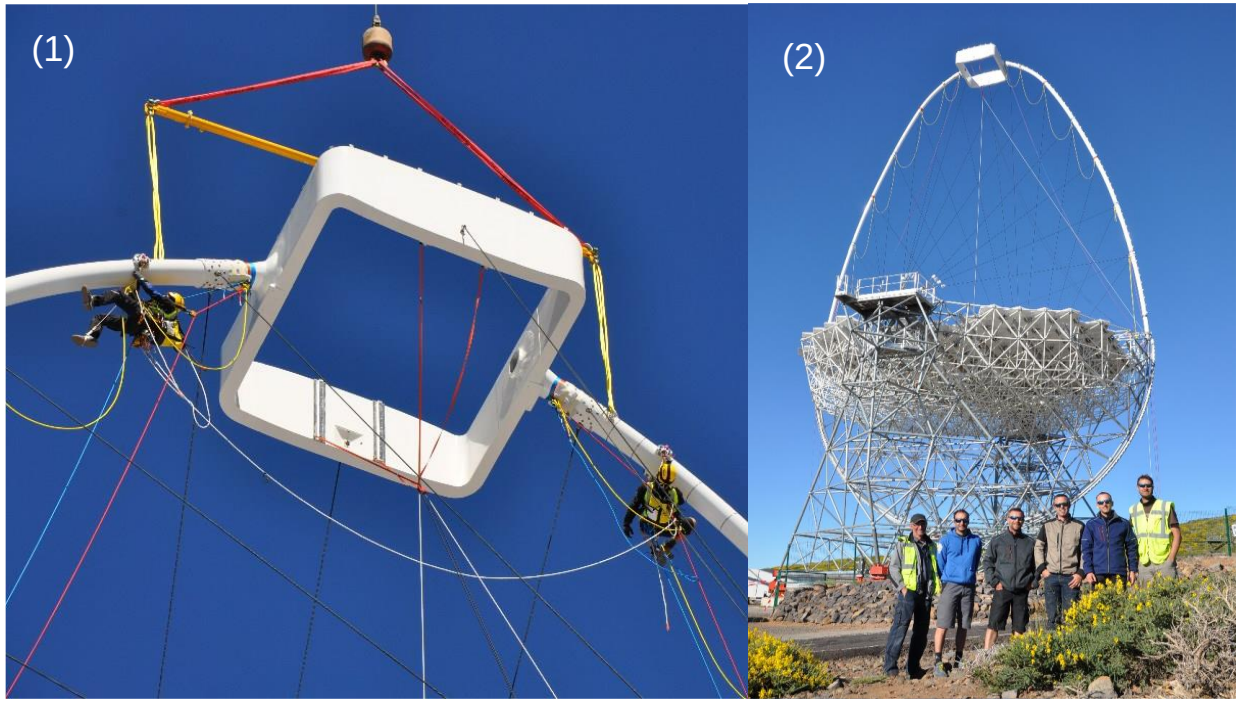
5 Filter capacity carousel

High energy gamma ray: CTA

CTA : Next project for high energy gamma ray studies

- 2017: one of the 2 new fundings (with HL-LHC) for Very Large Research Infrastructure approved in France
- IN2P3 contributions to LST-1 and NectarCAM

Design, construction and assembly of LST: October 2018



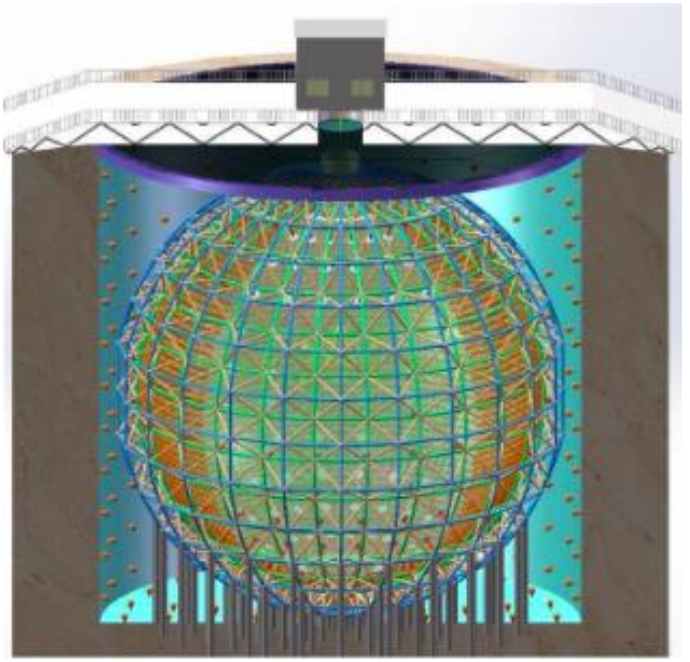
JUNO International collaboration
70 institutes, 17 countries

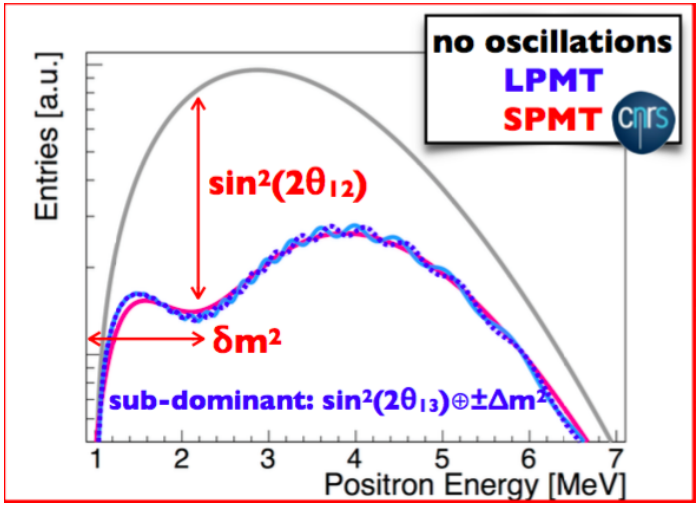
- since 2018 : JUNO is a research infrastucture on the Fench roadmap

- Target Tracker Opéra
- SPMT électronique (27kvoies)

- 2020 : SPMT installation
- 2021 : TT installation

- Positively evaluated by IN2P3 Scientific Council in June 2018

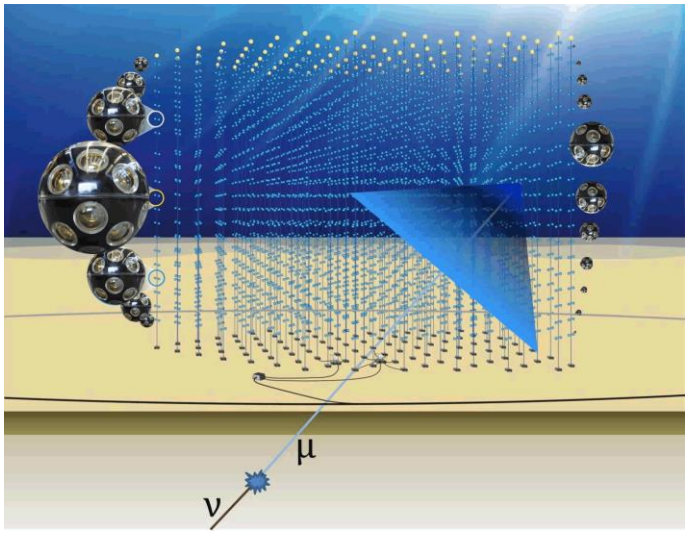




Neutrino Physics : KM3NeT

ORCA : Oscillation Research with Cosmics in the Abyss, 40 km off-shore of Toulon

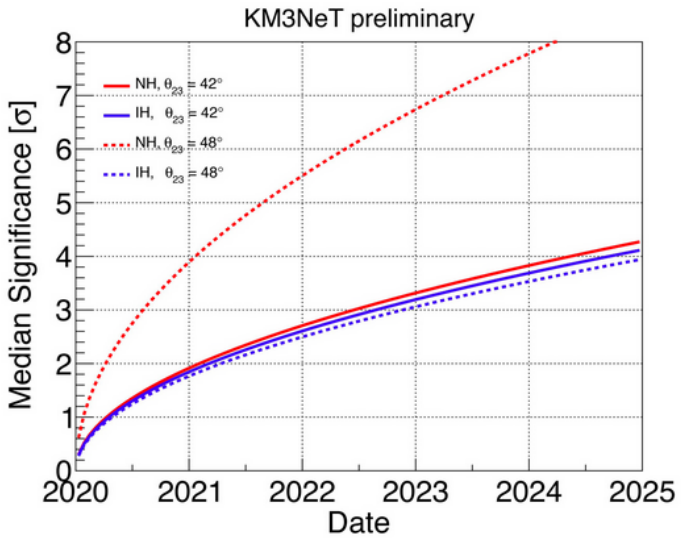
- Dense array of detection unit to study neutrino oscillation parameters and in particular to determine the neutrino mass hierarchy



- Digital Optical Modules (DOM) :
- Detection Unit: 18 DOMs vertically arranged and connected by an electro-optical cable

- Prototype array: 6 detection units
- Final array: 115 detection units

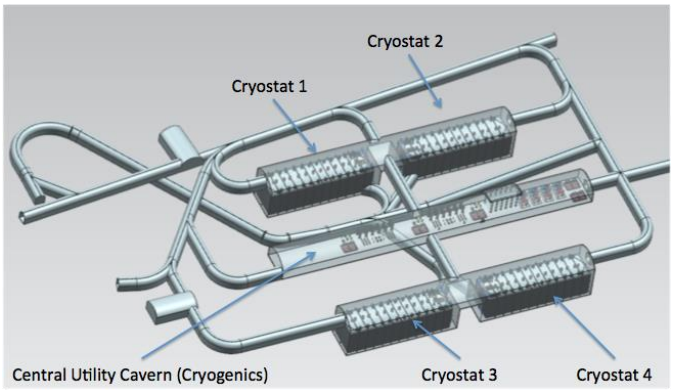
First detection unit successfully deployed in March 2019

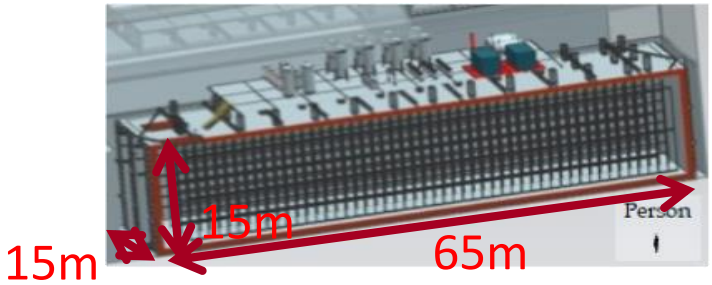


Neutrino Physics : DUNE

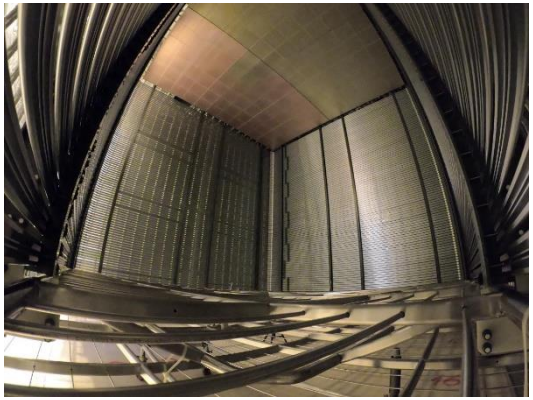
- R&D at IN2P3 since 2006 on **Liquid Argon Dual Phase TPC**
- Contribution to far site detector: electronic, DAQ, mechanics
- Contribution to the PIP-II accelerator construction

Neutrino platform at CERN





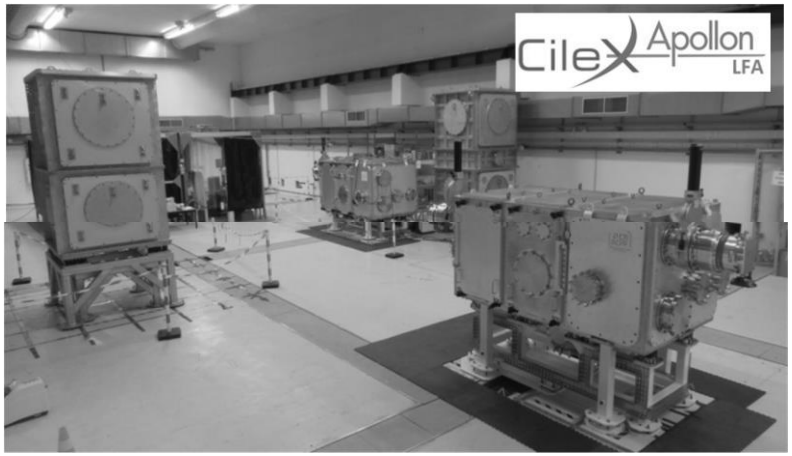
Proto-DUNE-Dual Phase: ready for LAr filling



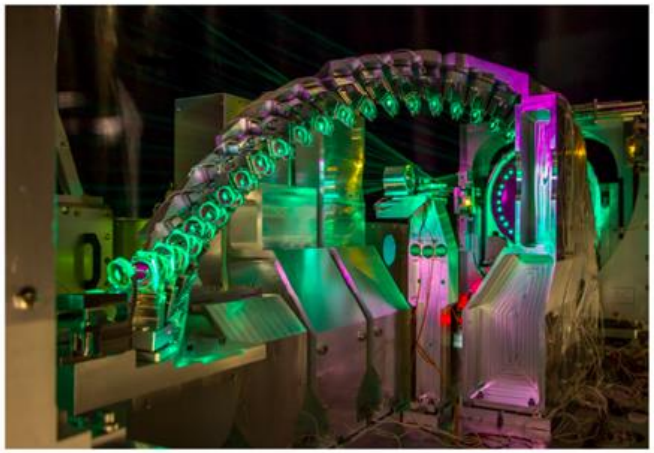
Accelerators

First cryomodule delivered to ESS in 2018

R&D on laser-plasma acceleration



Circulateur Laser pour ELI-NP

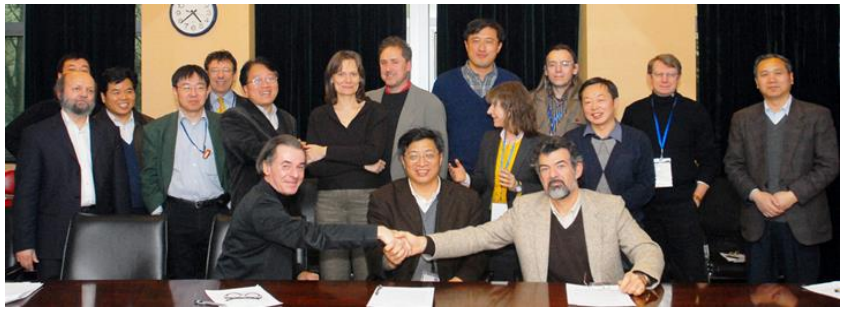


THOMX: compact & intense photon source

FCPPL

Directors: CHEN Gang (IHEP), Eric Kajfasz (IN2P3-CNRS)

- Created in 2007, renewed in 2011, 2015
- Goal: strengthen and structure France-China collaboration in particle physics and associated fields
- Partners France : CNRS, CEA, 12 Universities and Engineers Schools
  China: CAS, 6 Universities
- Topics:
  - Particle physics at CERN, neutrino physics, astroparticle experiments, theory
  - Associated technologies: detectors, accelerators



LIA renewal – 2019: to be discussed this week

Project of an International Joint Laboratory located in Beijing

- Enhanced collaboration on new projects
- JUNO (neutrino physics), underground experiments
- R&D on detectors, accelerators, magnets

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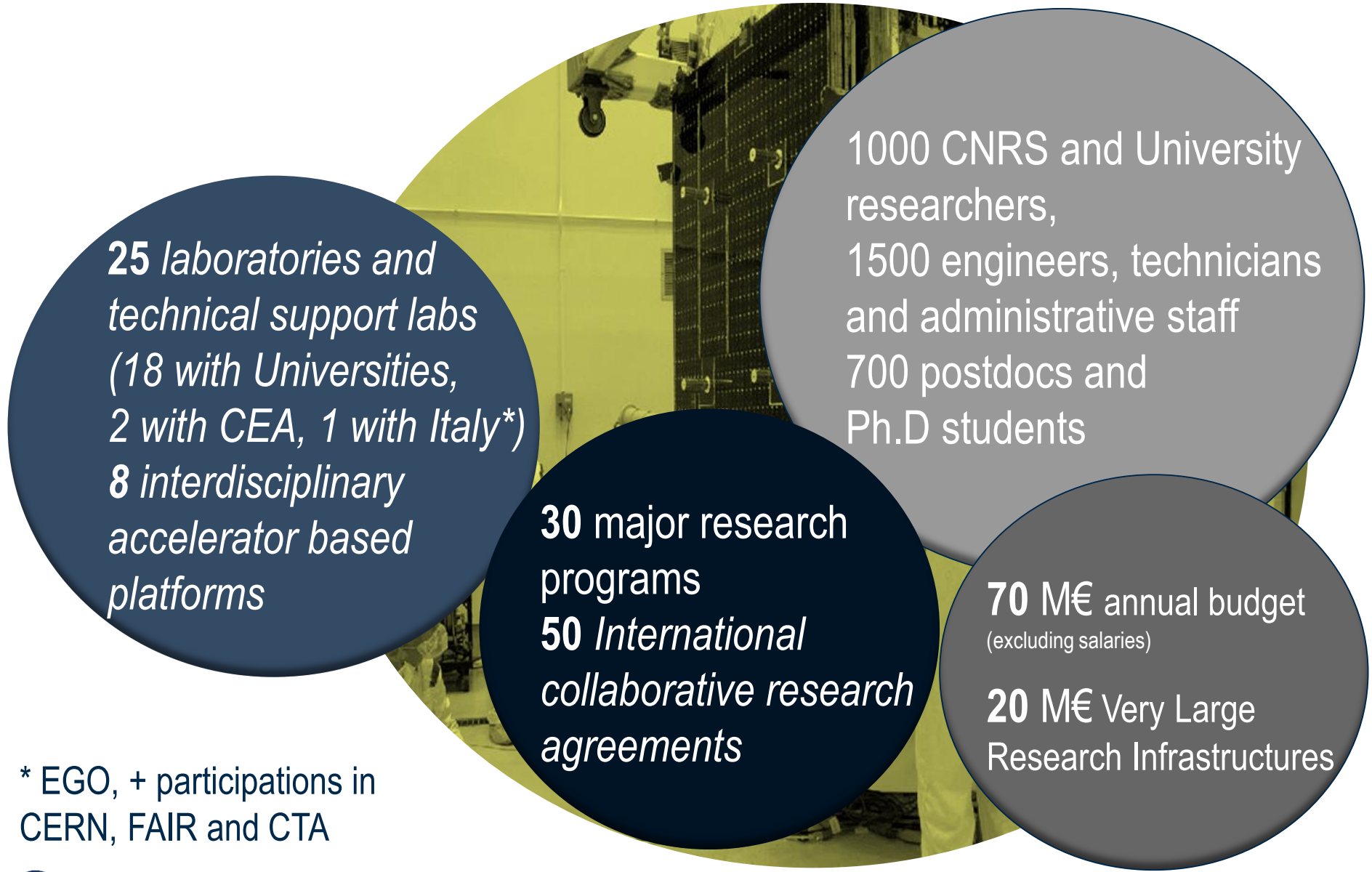
Merci de votre attention !

Key Figures



25 *laboratories and technical support labs (18 with Universities, 2 with CEA, 1 with Italy*)*
8 *interdisciplinary accelerator based platforms*

1000 CNRS and University researchers,
1500 engineers, technicians and administrative staff
700 postdocs and Ph.D students

30 major research programs
50 *International collaborative research agreements*

70 M€ annual budget
(excluding salaries)

20 M€ Very Large Research Infrastructures

* EGO, + participations in CERN, FAIR and CTA

Research infrastructures in France

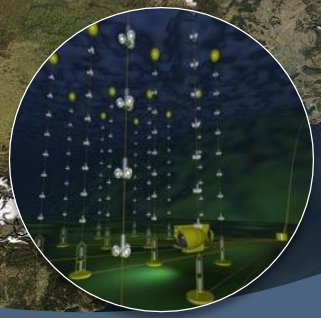
GANIL /Spiral2

IPNO/
Alto

LNCA/
DChooz

ILL / Stereo

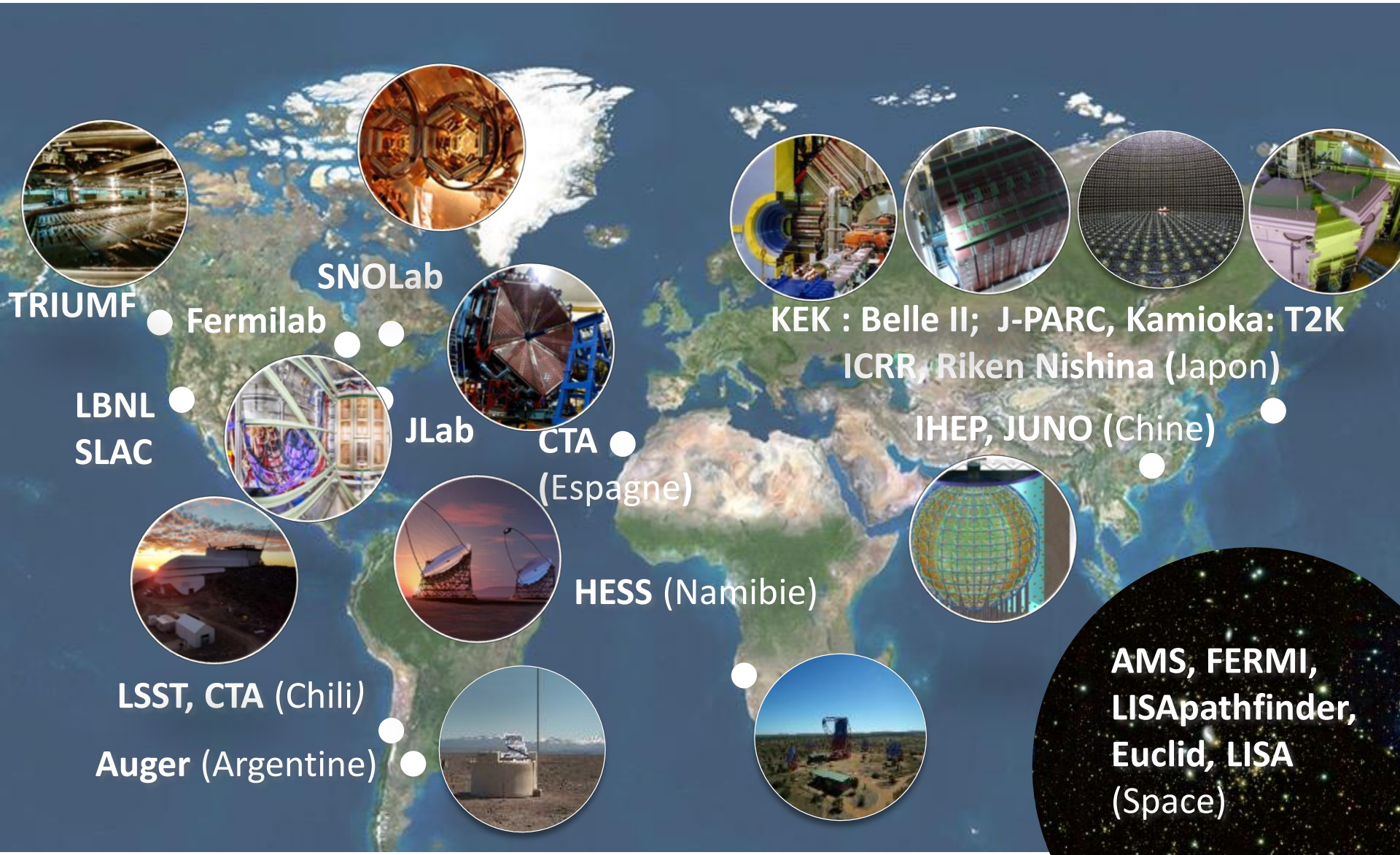
LSM / Edelweiss, SuperNemo



CPPM / Antares, KM3NET

European Research Infrastructures

International Research Infrastructures



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