



Institut national de physique nucléaire et de physique des particules

www.in2p3.fr

A composite image showing particle tracks on the left and a colorful cosmic nebula on the right. The tracks are thin lines of various colors (blue, orange, yellow) radiating from a central point. The nebula is a large, multi-colored cloud of gas and dust in shades of purple, pink, and green.

Sonder les infinis : des particules au cosmos

EIC User Group Meeting, Paris

July 22th, 2019

IN2P3

Patrice Verdier



IN2P3 : a national institute

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

OPERATE

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

COORDINATE

National Research
Programs and French
participations in major
Research
Infrastructures

EXPLORE

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

DEVELOP

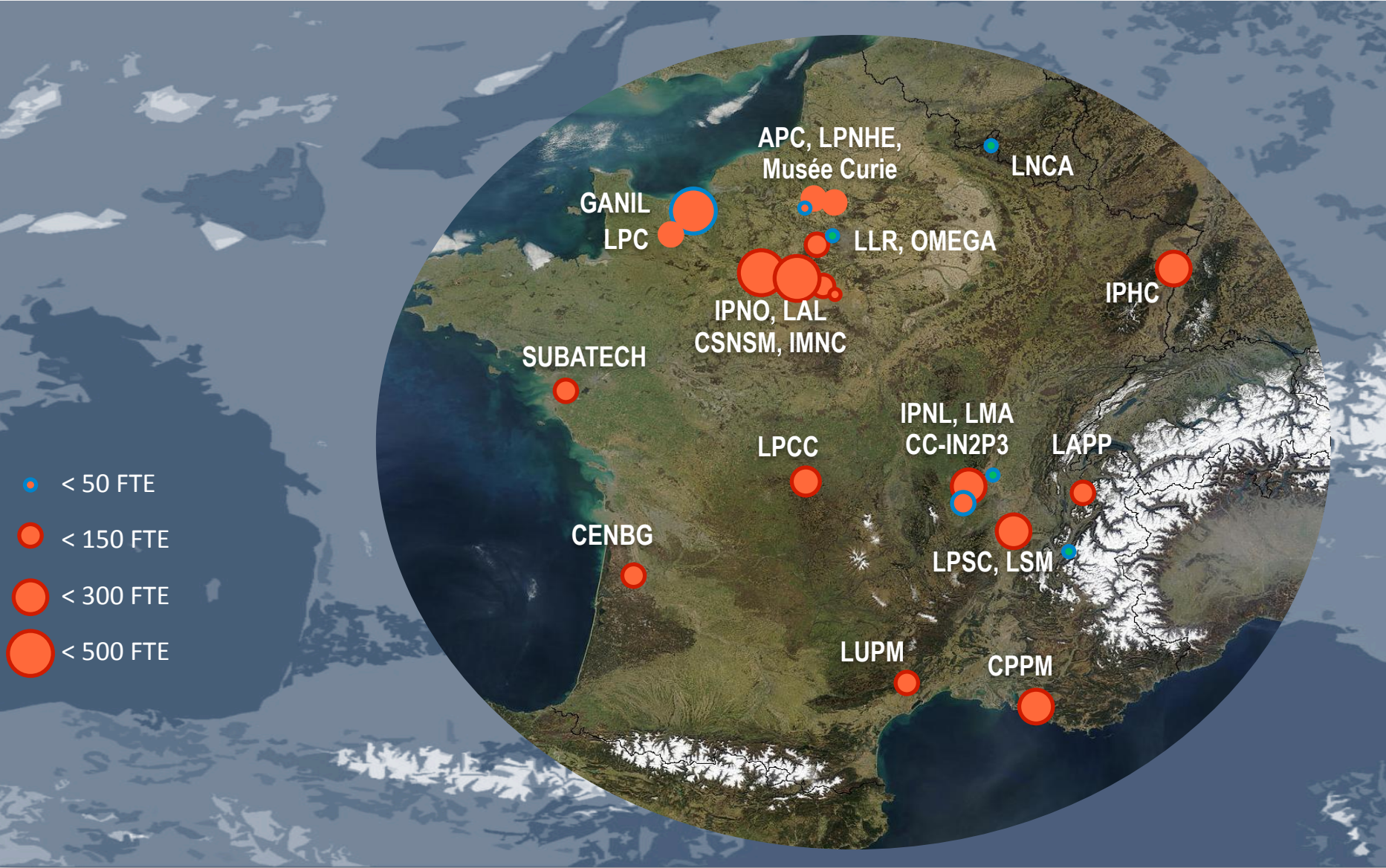
Associated technologies,
Applications and
Interdisciplinary research

PROVIDE Expertise
Teaching Training

LINKS WITH SOCIETY



IN2P3 : A “distributed” laboratory



IN2P3 : A “distributed” laboratory





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

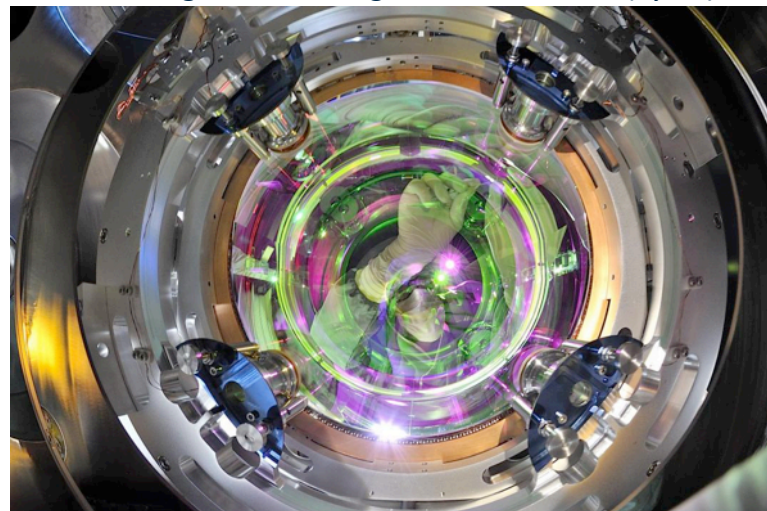
* EGO and CNRS participations in CERN, FAIR and CTA



Gravitational Waves: Virgo



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

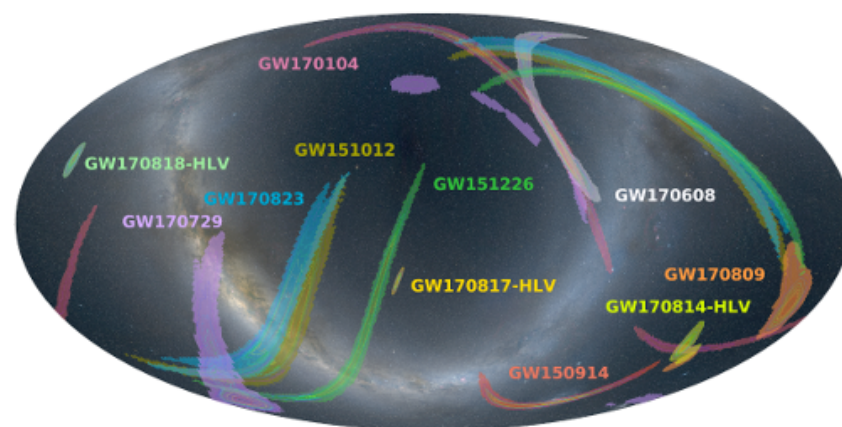
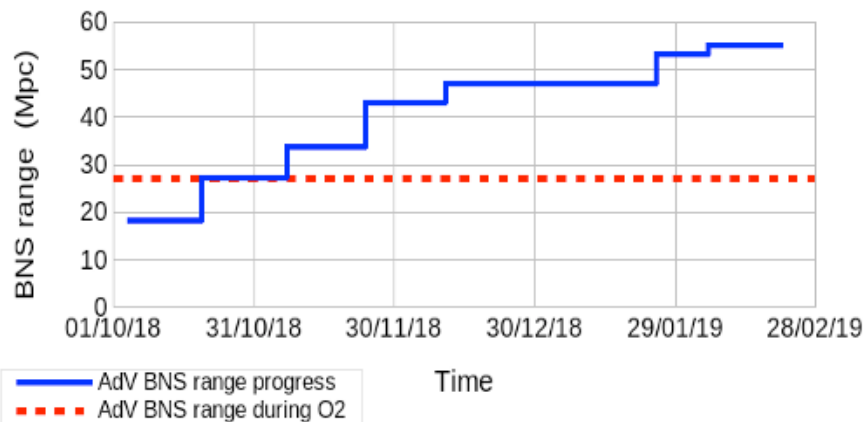


April 1st : Start of New observing period (run O3) of Virgo and LIGO which will last 1 year:

- 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

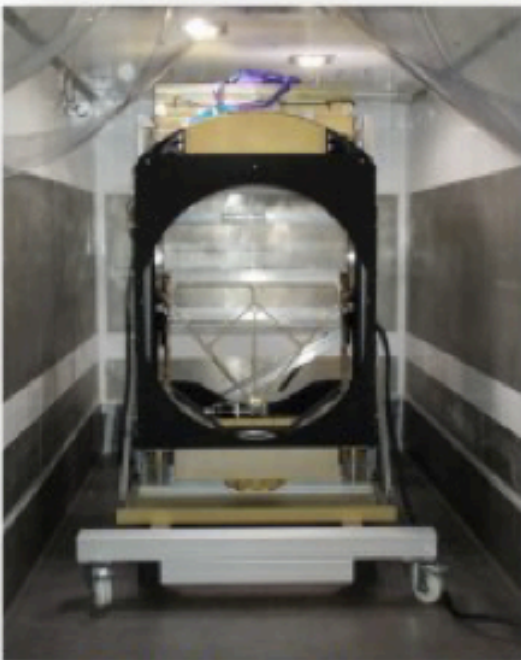
Advanced Virgo: progress in sensitivity towards O3

BNS range: average distance at which a Binary Neutron Star merger could be detected



Dark energy: LSST

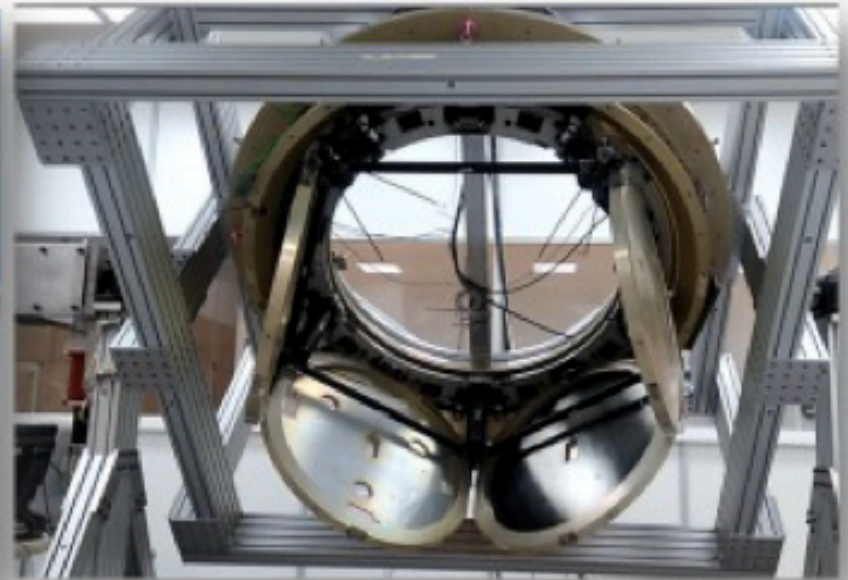
- IN2P3 is involved in the construction
- CCIN2P3: computing center with all LSST data
- Physics program within the DESC collaboration



Filter Autochanger



**Filter loader on
transport cart**



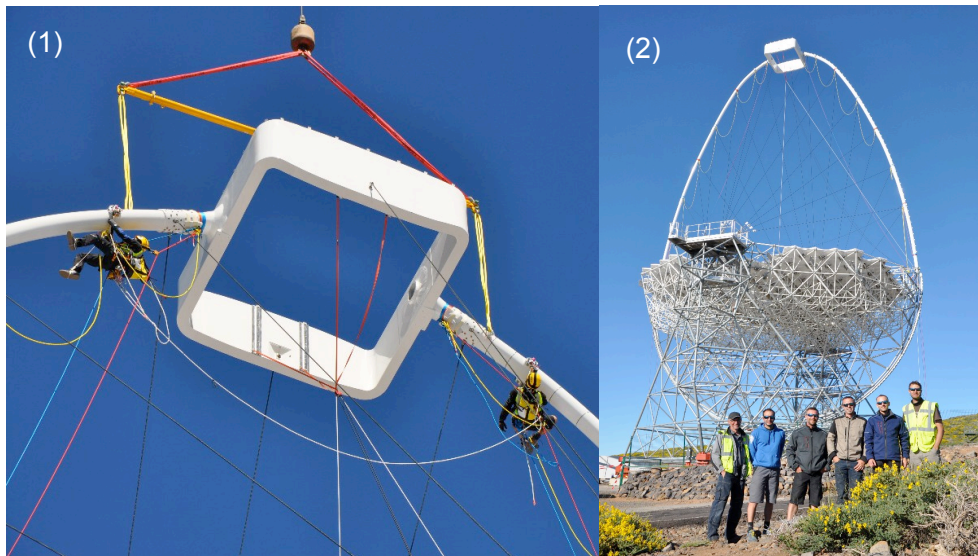
5 Filter capacity carousel

High energy gamma ray: CTA

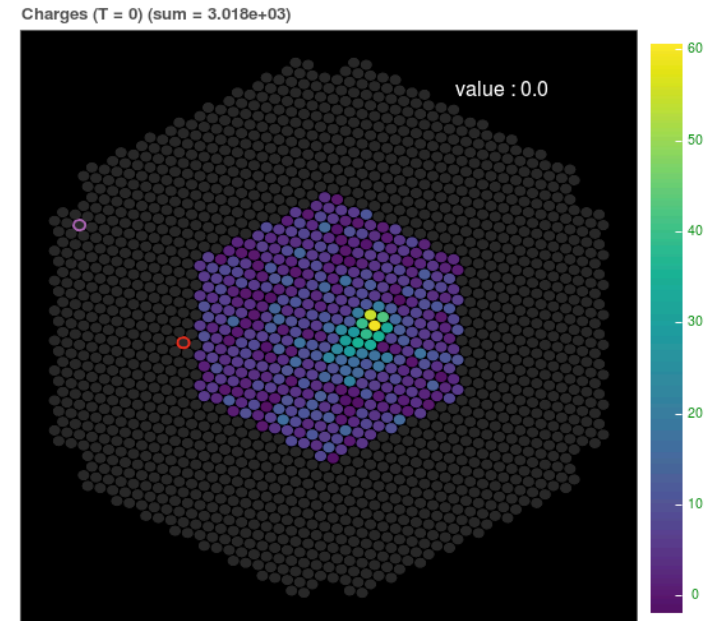
CTA : Next project for high energy gamma ray studies

- 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



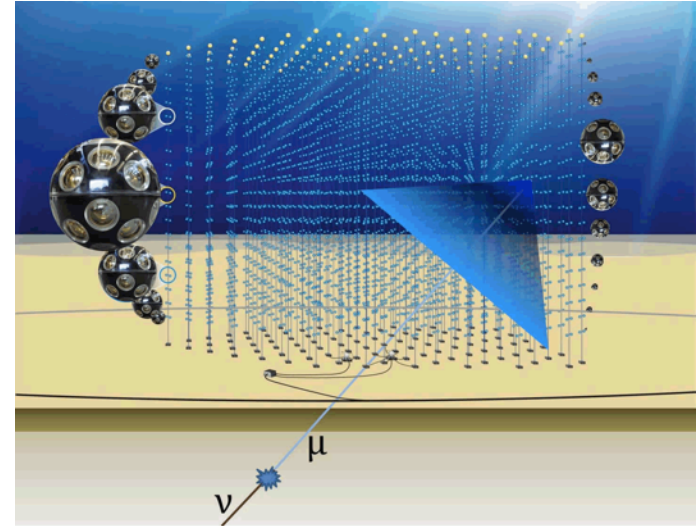
NectarCAM First light: may 2019



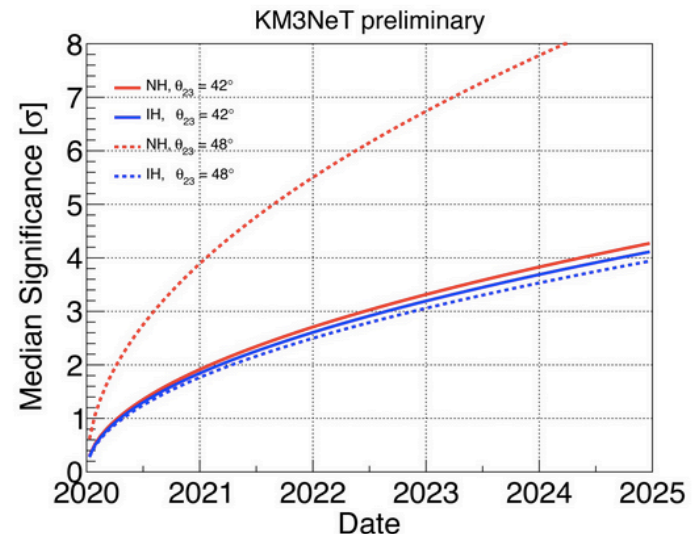
Neutrino Physics : KM3NeT

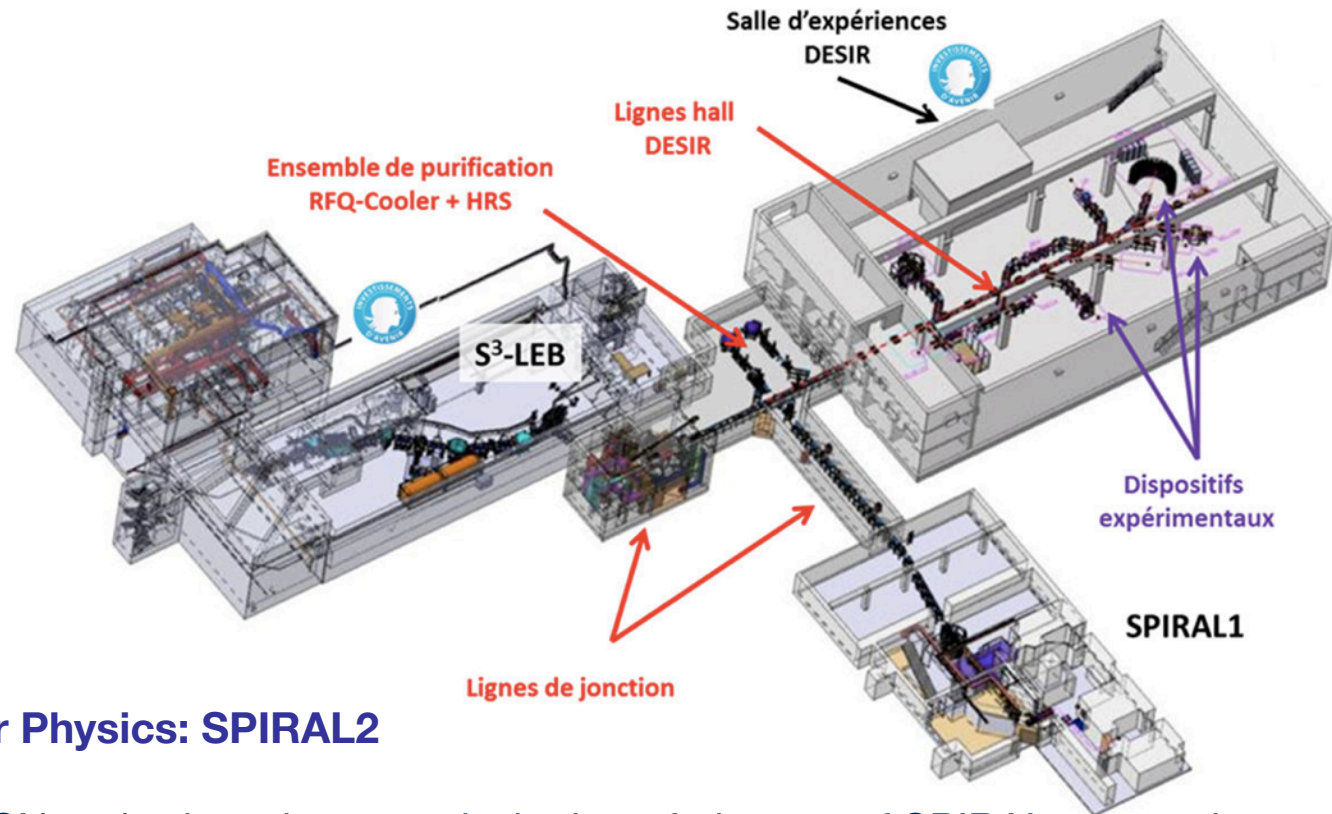
ORCA : Oscillation Research with Cosmics in the Abyss, 40 km off-shore of Toulon

- 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





Highest priority in Nuclear Physics: SPIRAL2

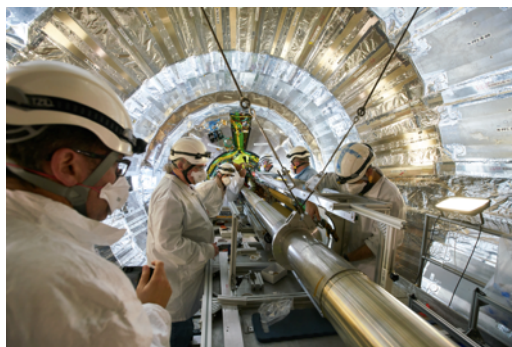
- LINAC: 3 weeks ago, ASN authorizes the commissioning of phase 1 of SPIRAL2 extension
=> RF commissioning : summer 2019
=> Beam commissioning: fall 2019 and first beam to NFS in 2020
- Spectrometer S3: start-up in 2021/2022
- DESIR : start-up in 2024/2025

LHC phase 1 upgrades



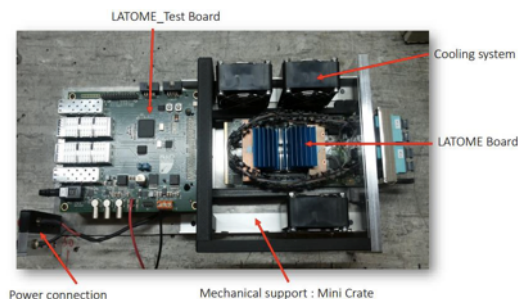
CMS (finished in 2017)

New pixel detector : DAQ
L1 ECAL trigger
Tracker CO₂ 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

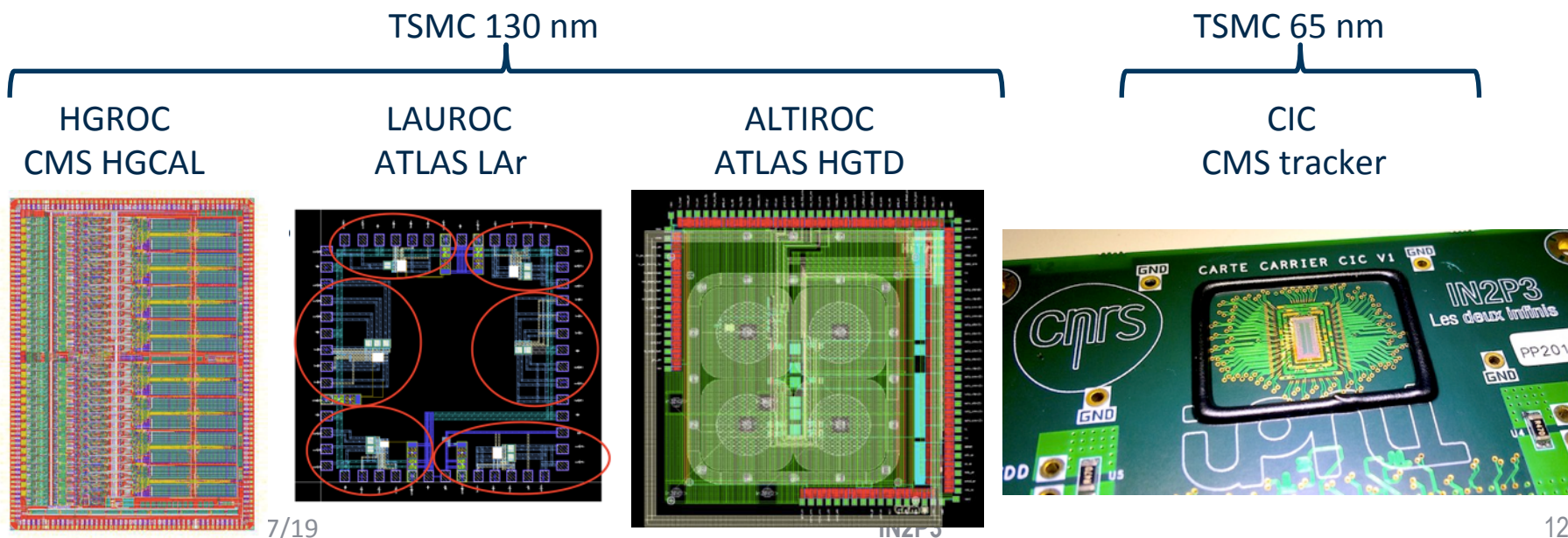
LHC phase 2 upgrades

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)



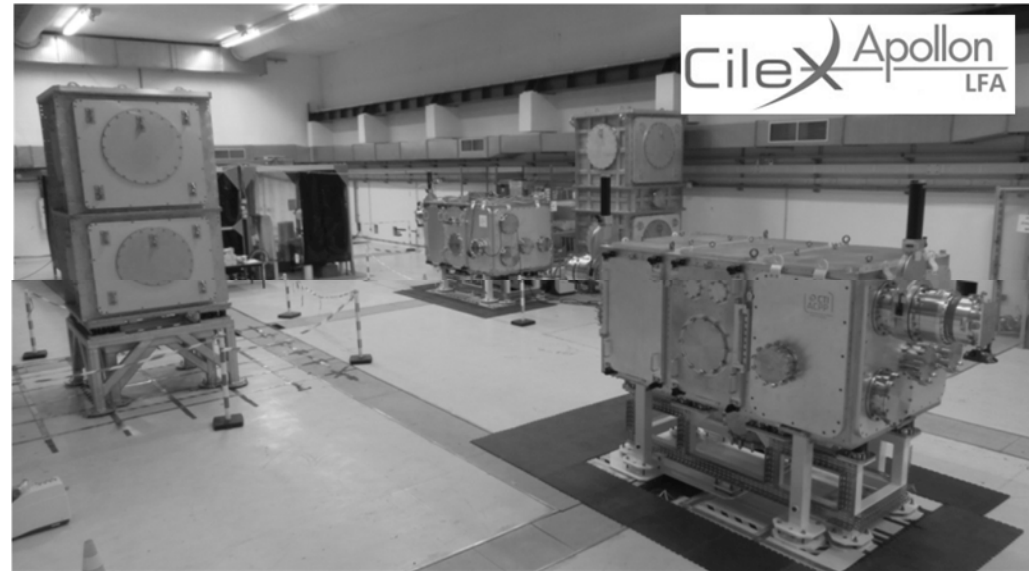


Accelerators

First cryomodule delivered to ESS in 2018



R&D on laser-plasma acceleration



THOMX: compact & intense photon source

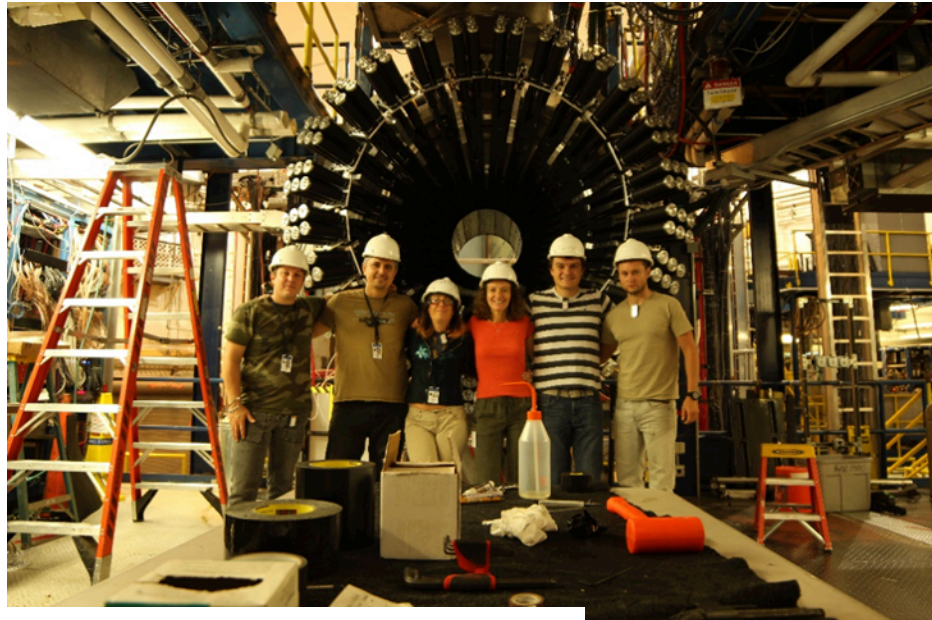




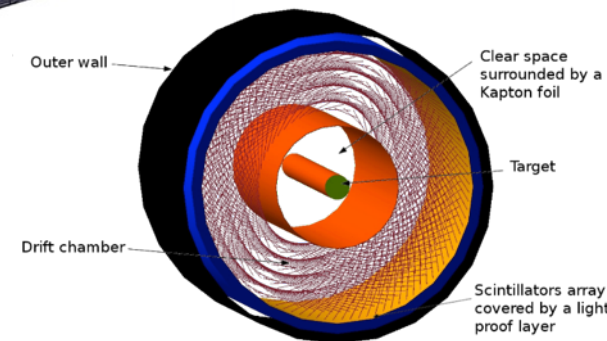
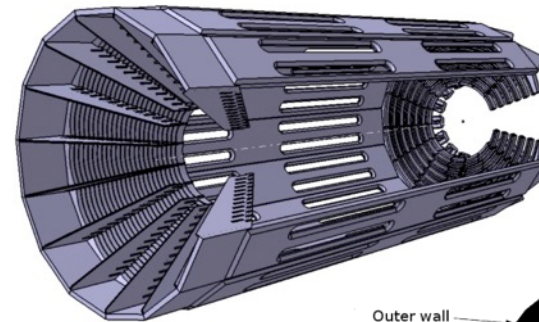
Hadronic Physics at J-Lab

Recent contributions to J-Lab physics program by IPNO team

- Central neutron detector for CLAS12
- Calorimeter NPS
- Polarized Electrons for Polarized Positrons
- Heavy Photon Search



- A Low Energy Recoil Tracker
Funded by ERC : Raphael Dupré

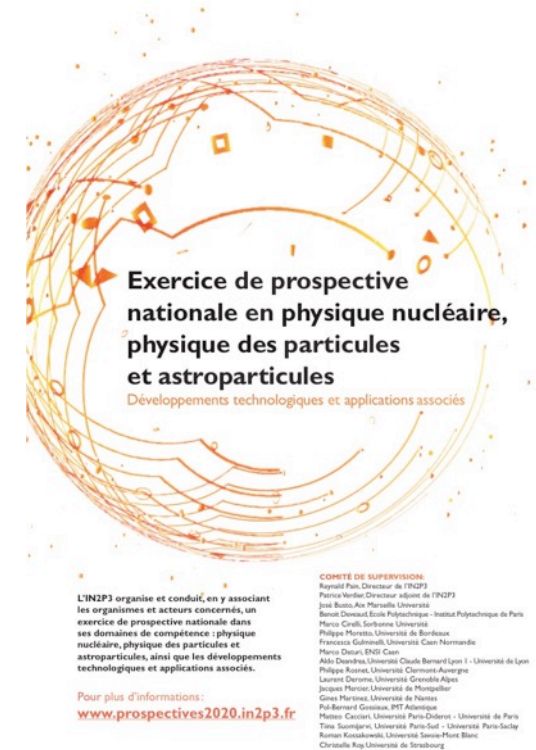


Most IN2P3 efforts in hadronic physics are currently focused on the heavy ion program at CERN :

- ALICE and its upgrades (Muons, ITS, MFT)
 - CMS Heavy Ions
 - LHCb Heavy Ions
- ⇒ Phase 1 upgrade during LS2 in 2019-2020

Longer term future of heavy ion program at CERN is also discussed within the ESPP process
=> conclusion expected during spring 2020

French strategy in nuclear physics, particle Physics and astroparticles :
conclusion and roadmap by the end of 2020



At this early stage, there is a strong scientific interest for EIC physics program

IN2P3 contributions to experiments in the US:
Jefferson-Lab, Phenix & STAR @ BNL, Nuclear Physics @ Argonne
Babar @ SLAC, DØ & DUNE at Fermilab, LSST, ...



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Sonder les infinis : des particules au cosmos

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

30 major research programs
50 International collaborative research agreements

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

70 M€ annual budget (excluding salaries)

20 M€ Very Large Research Infrastructures

* EGO, + participations in CERN, FAIR and CTA

Research Areas

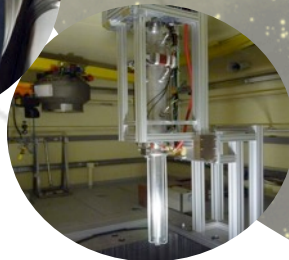
Particles & hadronic physics

Matter's most elementary constituents and fundamental interactions



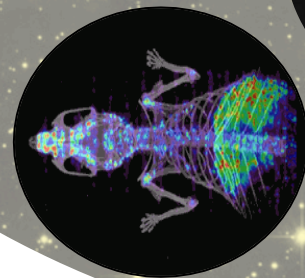
Nuclear physics & Applications

Structure of nuclear matter, nuclear energy and medical applications



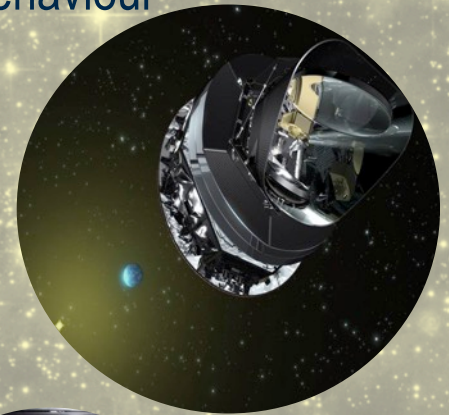
Accelerator & Technology

Major R&D domains



Astroparticle physics and Cosmology

Universe's composition and behaviour

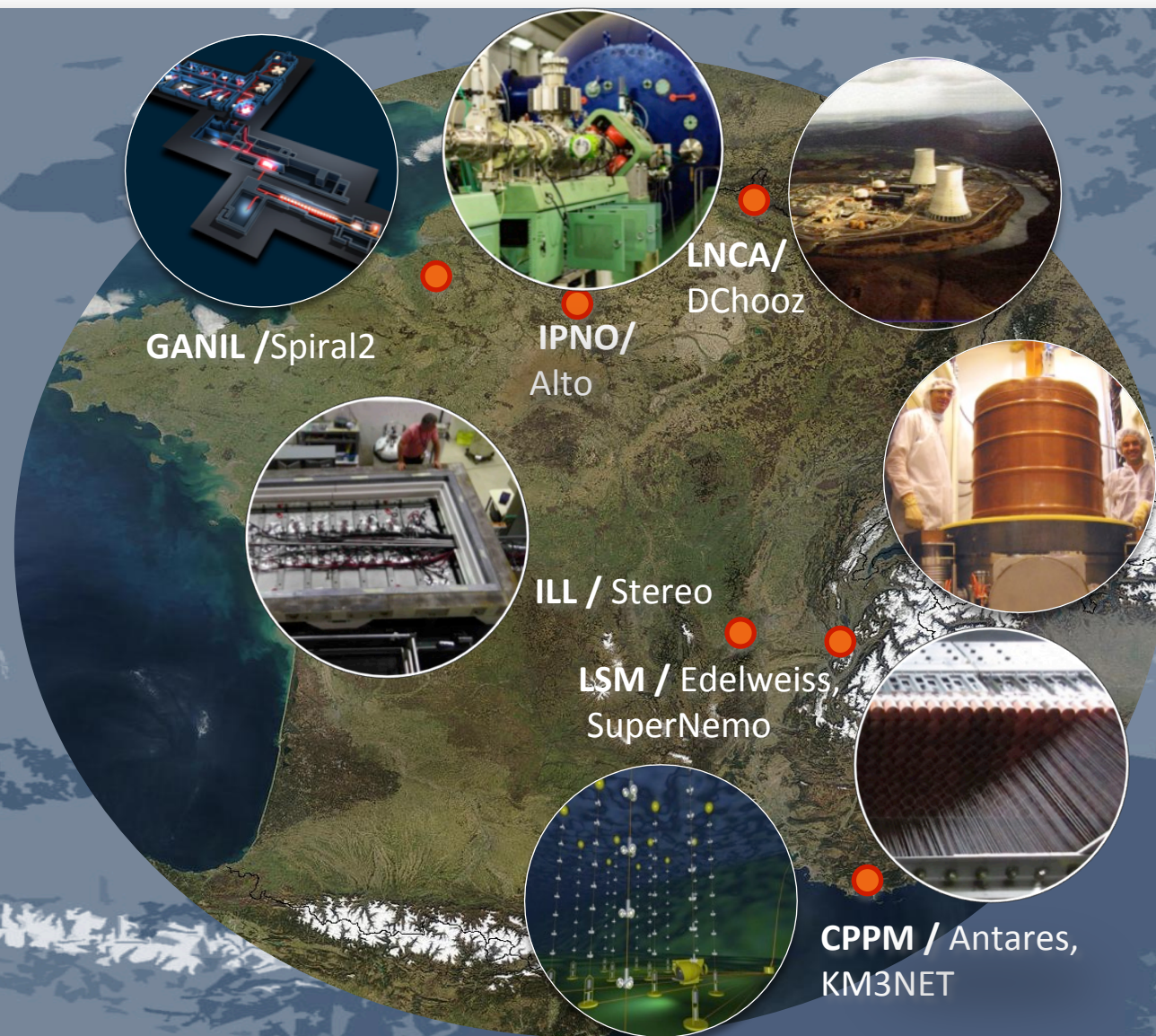


Computing & Data

Data Science and Computing research



Research infrastructures in France



European Research Infrastructures



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International Research Infrastructures

