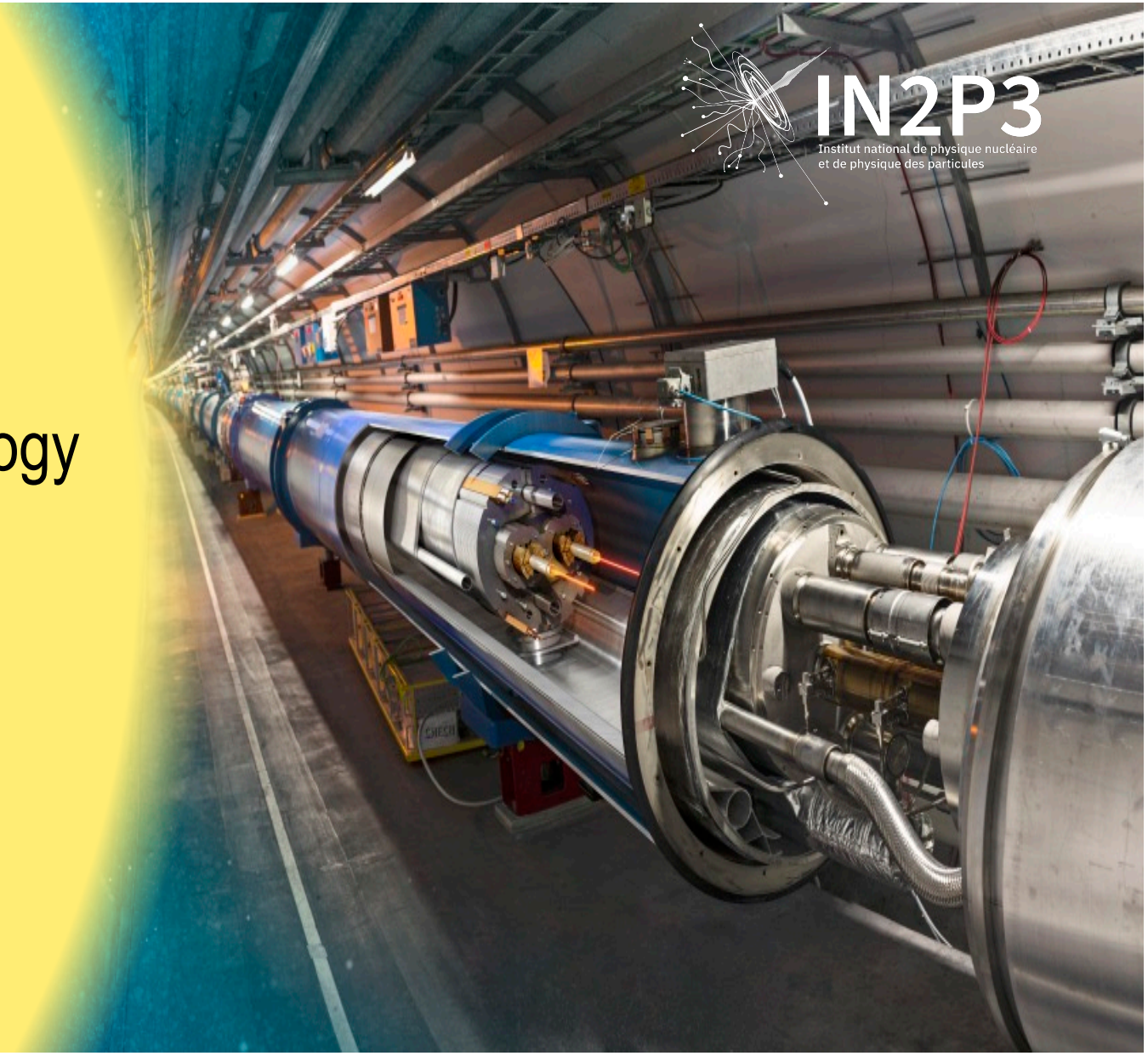
cnrs NUCLÉAIRE & PARTICULES



Accelerators and Technology at IN2P3

CNRS Workshop at TRIUMF
23-APR-2026

Arnaud Lucotte
Scientific Director for Accelerators and Technology

Accelerator Science & Technology at IN2P3

Strategy

Objectives, organization and funding

Scientific Objectives Roadmap

- Particle Physics : FCC-ee (CERN), PIP-II/DUNE (FNAL), PERLE (Orsay), BELLE2 (SuperKEK)
- Nuclear & Hadronic Physics : ESS (Lund), NFS, S3 and DESIR (GANIL), *EIC (BNL)**
- Applied Physics : Nuclear energy (MYRRHA), Materials (industry), Health (beam/flash, radionuclides)

Steering and Organization

- Federate the accelerator community of researchers, engineers : GDR, discipline-based networks
- Strengthen core disciplines through targeted permanent position recruitment policy
- Develop dedicated infrastructures and platforms for accelerator R&D's and related fields
- Structure projects and R&D activities within dedicated National Research Programs
- Foster exploratory R&D activities in specific frameworks

Funding Resources

- Ministry DGRI / establish National Large Research Infrastructure (IR/IRI*) : GANIL, ESS, DUNE/PIP-II, …
- National Research Agency / equipement of excellence : DESIR/S^3, PACIFICS, NEWGAIN, ThomX…
- NRA + Region / laboratory of Excellence with universities : CPER, LaBEX…
- CNRS / ERC-like initiative for prototyping : 3M€ grant for « high-risk » project
- EU / Projects with European infrastructures : INFRATECH (R&D), INFRADEV (TNA) + ERC/EIC

Accelerator Science : Organization and Landscape

IN2P3
Research Programs

4 Research Programs
- 20 Master Projets
  - ~ 150 FTE / operation
  - ~ 160 FTE / construction R&D
- Annual Budget
  - ~ 30 M€ -- operation
  - ~ 40 M€ -- construction R&D

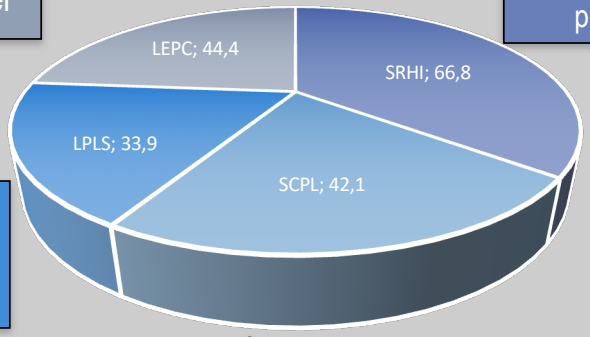
National Infrastructures
- GANIL / Caen
- LMA, CC-IN2P3 / Lyon
- LSM / Modane
- Omega / Palaiseau
- LSPM / Marseille

Accelerator Infrastructures
- IJCLab / Orsay
- LPSC / Grenoble
- IP2I / Bordeaux
- IPHC / Strasbourg

2 National Networks
- GDR « Accelerators »
- GDR « Instrumentation

LEPC
Leptonic Collider

Personnel (FTE)



SRHI
Stable & Radioactive Heavy-Ions production & acceleration

LPLS
Laser Plasma & Light Sources

SCPL
Superconducting RF Cavities & Proton Linac

among which about 50 Fixed Term contracts + 20 PhD's

Central follow-up and steering by Scientific Director and Technical Director
- In a real dialog with Lab Directors (typically monthly)
- Regular visit to research teams AND support departments
- Annual Review of projects

Organization of career foresight initiatives related to accelerator science
- Tracking and evolution of technical competencies and emerging expertise
- Multi-year recruitement strategy : fixed terms and permanent positions

Specific support for academic training via internships and PhD research
- Link to doctoral schools and support to international school (JUAS)
- Specific (limited) funding from IN2P3

National Infrastructures at IN2P3

IN2P3
National Infrastructures

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  - ~ 160 FTE / construction/R&D
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Accelerator-based infrastructures at IN2P3

IN2P3
Accelerator infrastructures

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IJCLab's SupraTECH

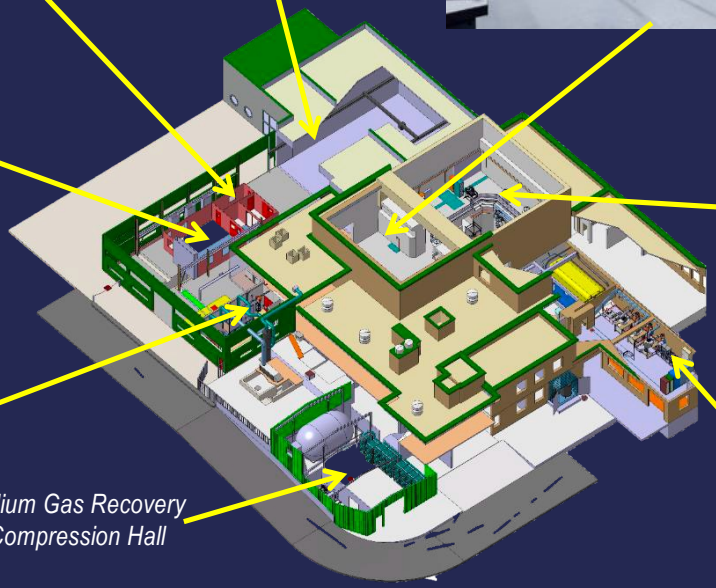
IJCLab

SupraTECH Facility

Cavity and Cryomodule Assembly Clean Room

Cryomodule Assembly Hall

High Temp. Vacuum Furnace



Cryomodule Testing Hall

Chemical Treatment Hall

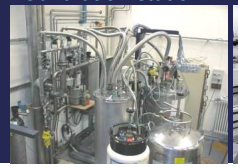
Helium Gas Recovery & Compression Hall

RF Power Sourc
352 MHz Klystro

He Liquefier

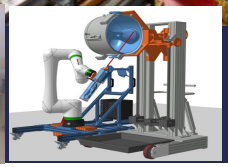
Vert Cryostat Testing Hall

T Calibration station



RF Condition. Clean Room

Coupler Clean Room



IJCLab's *Vacuum & Surface* Platform

IJCLab
Vacuum and Surface Platform

Plateform "Vacuum & Surface" : *surface analysis and ultrahigh vacuum studies of material for accelerators technologies*

Since 2024

Equipments and expertise, techniques

Structures / Topography / Composition

- X-ray Diffractometer (DRX)
- Secondary Ion Mass Spectrometer (SIMS)
- Confocal Microscope
- Scanning Electron Microscope (SEM)+ Energy dispersive X-ray spectroscopy (EDS) + Electron Back scattered Diffraction(EBSD)
- X-ray Photoelectron Spectroscopy (XPS)

Techniques

Mass Spectrometry
Degassing rate meast.
Second. e- yied meast (SEY)
Molecular Desorption

Target Analyses

Material studies, Multi-layers, thin films, doping, Coating (SIS,…) chemical treatment,
…

Accelerator Community as a National Network

IN2P3
Community

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SCIPAC
Science for Particle Accelerators

Heavy Ion Accelerators	❑ R&D SPIRAL2 DESIR, NEWGAIN, S3 et ALTO ❑ Ion sources (GANIL/ALTO, ECR, FEBIAD, res. laser, ...) ❑ Target-Source Ensemble (targets, ovens…) ❑ Beam lines, RFQ, ion traps …
Hadron Beams Accelerators	❑ SuperConducting R&D (cavities/CM, multipactor…) ❑ RF Structures (RFQ, couplers, HOM, FRT) ❑ Dynamic vacuum & materials (ch. And temp. treatment) ❑ Beam dynamics, design and reliability (AI)
Electron Accelerators	❑ Beam dynamics ❑ Positron Sources ❑ Nanometric beam handling & stabilisation ❑ Luminometry ❑ Compton production Gammas, polarimetry ❑ Photogun, injectors
Laser Plasma Acceleration	❑ Laser Plasma Acceleration : multi-staging, plasma cell, ❑ Simulations ❑ Beam Diagnostics & instrumentation
Transversal expertise	❑ Magnets ❑ Supraconducting high gradient Magnets ❑ Calculation and simulations ❑ Diagnostics, instrumentation ❑ Artificial Intelligence, retroaction loop, etc… ❑ Vacuum and matérials ❑ Laser & optics

About 250 engineers and researchers (CEA+CNRS)

Research Programme

Superconducting Proton Linac

SuperConducting Proton Linac

SCPL
Hadron Accelerators

Scientific Objectives

Design and build Superconducting Accelerators operating in high-gradient high Q_0 RF mode
- Studies of materials, multi-layer coatings, thin films, doping, chemical & thermal surface treatments
- Studies of field emission mechanisms, mitigation of the multi-pacting effect, including simulations

Design and build accelerator systems for high-intensity hadron beams
- Reliability studies, online monitoring (AI), control of cryogenic distributions, etc.

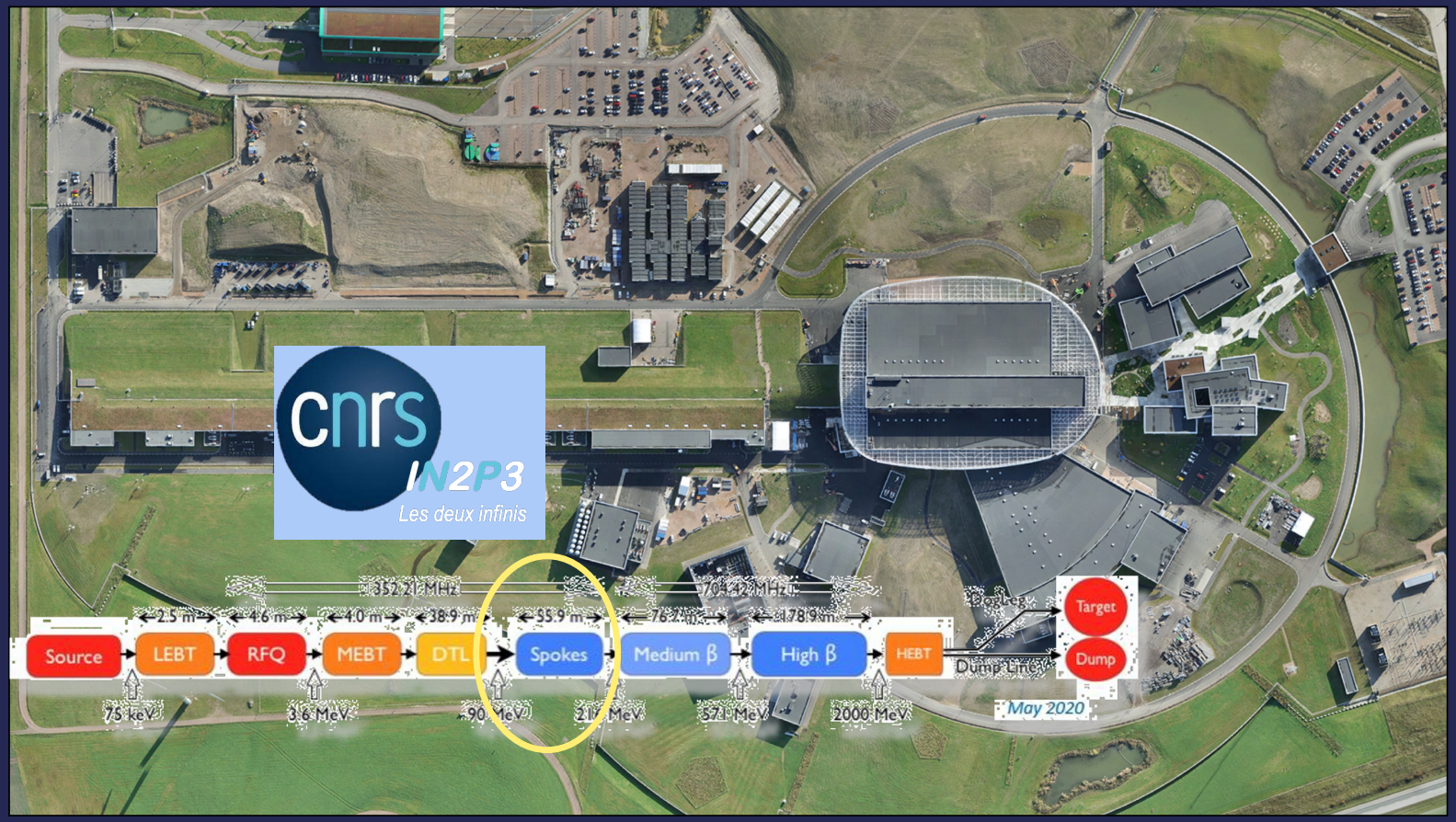
Structuration and Organization

Construction, Operation and Qualification Projects
- ESS @ Lund — *IJCLab*
- MYRRHA @ Mol — *IJCLab, LPSC, IPHC*
- PIP-II in LBNF-DUNE @ FNAL — *IJCLab*

R&D projects : SRF from materials to processes
- Innovative Heat treatment/thermal doping (SRF-Heloise)
- Metallographic polishing (SRF-PACCAS)
- Anti-multipacting coatings and characterization (SRF-MULTIPAC) — IJCLab, LPSC
- Cavity decontamination using plasma cleaning (SRF-DECAP)
- Alternative high-Tc SC materials, thick-layers, multi-layers (SRF-SURICAT)

European Spallation Source (ESS)

ESS
Superconducting
Proton LInac



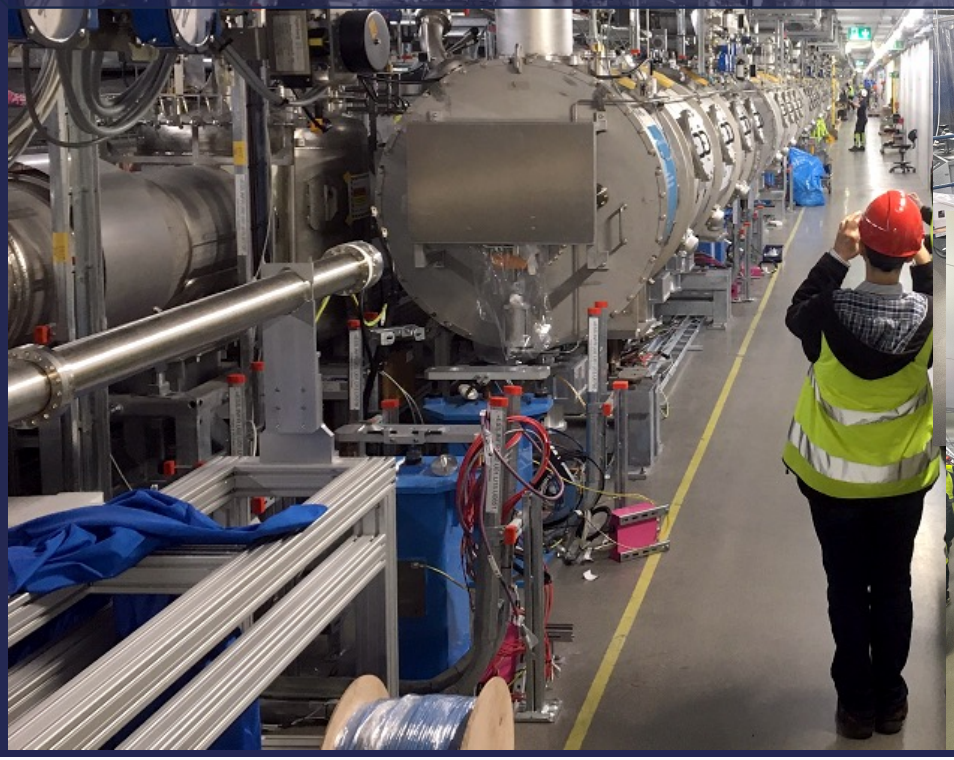
IN2P3 contribution to ESS

Construction of Low Beta Spoke Section @ ESS

Conception, design, fabrication, validation & installation

- First CM connected in JUL-2023
- 13 CM connected in summer-2024

Projects funded by Ministry (21 M€)



ESS

Superconducting
Proton LInac

IN2P3 contribution to ESS

ESS
Superconducting
Proton LInac

King Carl XVI and the french president in the ESS tunnel @ Lund on 31-JAN-2024…

IN2P3 contribution to ESS

ESS
Superconducting
Proton LInac

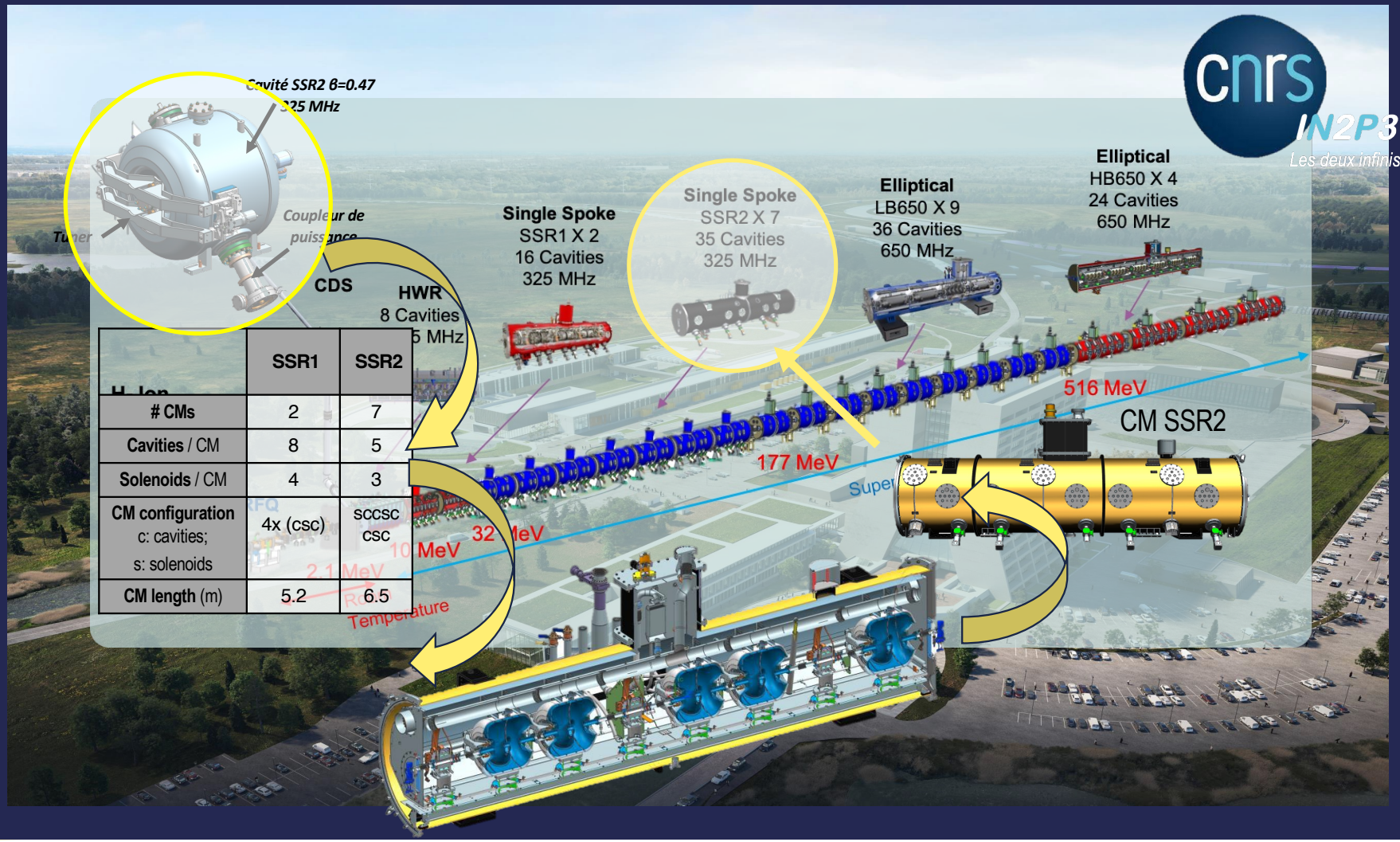
King Carl XVI and the french president in the ESS tunnel @ Lund on 31-JAN-2024…

Collective Medal of CNRS - 2025 to the incredible team…

Proton Improvement Plan (PIP II)

PIP II

Superconducting RF & Proton LInac



	SSR1	SSR2
# CMs	2	7
Cavities / CM	8	5
Solenoids / CM	4	3
CM configuration c: cavities; s: solenoids	4x (csc)	sccsc csc
CM length (m)	5.2	6.5

IN2P3 Contribution to PIP II

PIP II
IN2P3 contribution

PHASE-1 : Prototyping of SRF components (2018-2025)

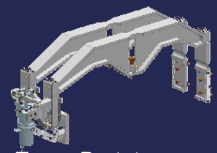
Cavities : 6 units
- ❖ Follow-up & validation of fabrication procedures with industrials (w/ FNAL)
- ❖ Preparation of dressed cavities @ IJCLab
- ❖ Qualification of cavities with vertical cryostat
- ❖ Re-conditionning : chemical and thermal treatments, HPR cleaning

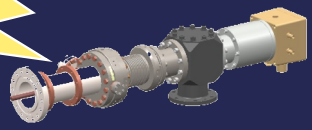
Tuners : 5 units
- ❖ Qualification of 4 tuners in Vertical Cryostat

Power Couplers : 4 units
- ❖ Test, qualification and delivery to FNAL

Phase-1 completed


Cavity Prototype

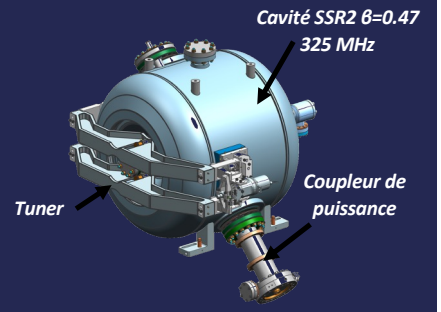

Tuner Prototype


Coupler prototype

PHASE-2 : Test and Qualification of series (2026-2028)

Qualification of 33 dressed cavities
- ❖ Tests of 33 dressed SSR2 cavities in cryostat (5x6 CM + 3 spares)
- ❖ Fabrication follow-up with industrial, reception and re-conditionning
- ❖ Tests and validation of 33 units in Vertical Cryostat
- ❖ Re-conditionning as necessary (< 25% max of cavities)

Vertical Cryostat Tests in SupraTECH
- ❖ Upgrade of CV1250 on top of CV 800

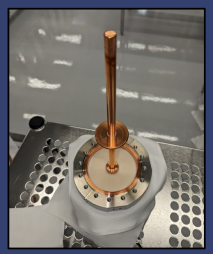
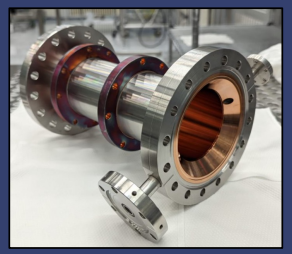
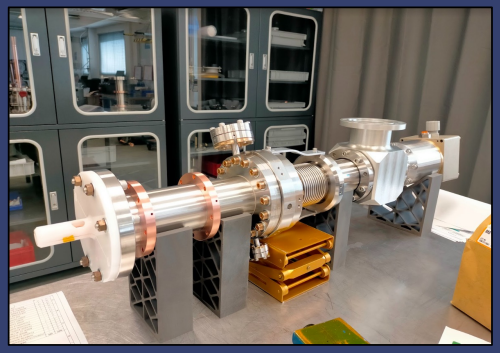


Phase-1 : Prototyping and Validation

PIP II
Phase-1 contribution

POWER COUPLERS

- FDR in 2020
- Order of 4 units in 2021
- Redesign, broken pieces and refabrication in 2022
- Reception of couplers in 2023
- Validation of all units in 2024

TUNERS

- FDR in 2019
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CAVITIES

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- Lessons learnt : a long process…
  Reconditionning for all 6 cavities need
  - Joint development of cobot HPR
  - Plasma processing technique
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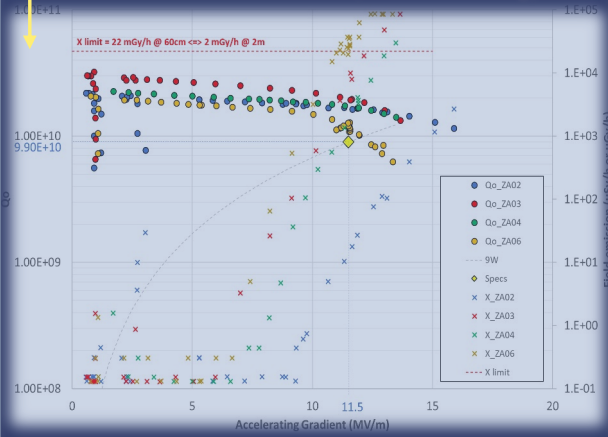

Phase 1 : Prototyping and Validation

PIP II
Phase 1 contribution

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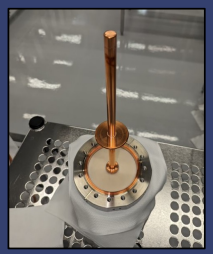
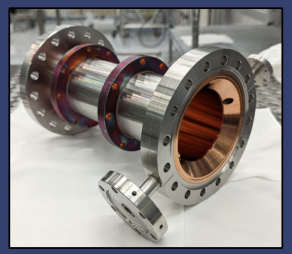
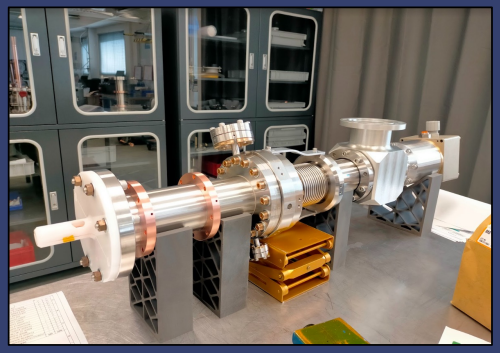

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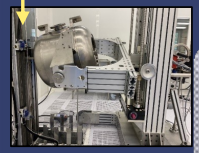
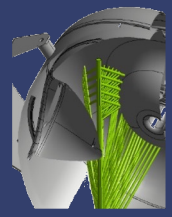
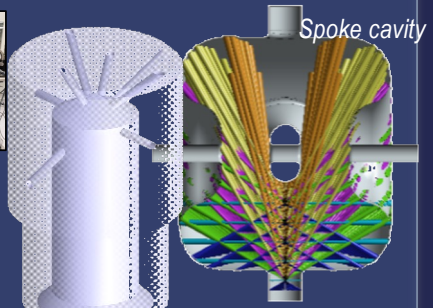

Phase 1 : Prototyping and Validation

PIP II
Phase 1 contribution

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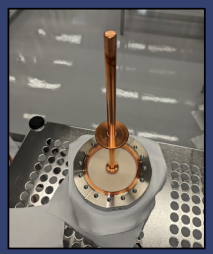
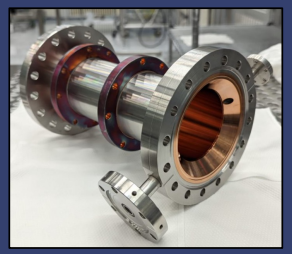
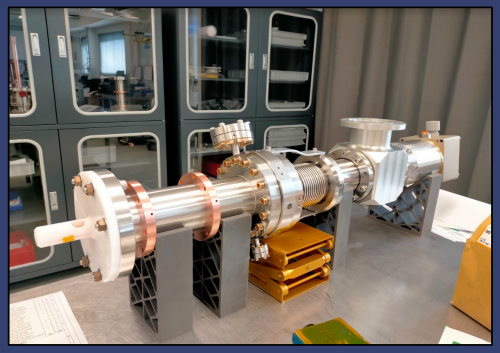

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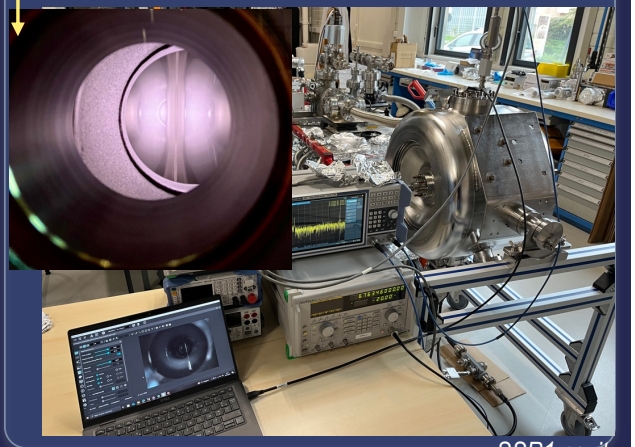


SSR1 cavity

Research Programme

Stable & Radioactive Heavy Ions

Stable & Radioactive Heavy Ions (SRHI)

SRHI
Stable and Radioactive Heavy Ion beams

Scientific Objectives

Design and build stable and radioactive ion sources, target-source ensembles
Design, optimize, build accelerating, selecting, transporting beams

Structuration and Organization

Construction, Operation and Qualification Projects

- SPIRAL2-S^3
- SPIRAL2-DESIR
- SPIRAL2-NEWGAIN

IJCLab, IP2I, LP2IB, LPC, LPSC, IPHC

R&D projects for « stable ions »

- ECR ion sources, high-frequency sources (60 GHz), ECR plasma simulation (ECRIPAC) — *LPSC*
- Metallic Ion Beam production (inductive and resistive high-temperature ovens) — *IPHC, GANIL*

R&D projects for « radioactive ions »

- UC_2 Uranium-Carbyde targets for fission @ ALTO (STUC) — *IJCLab*
- Target-Source assembly / Fusion-Evaporation (TULIP) — *GANIL*
- FEBIAD and Nier-Bernas ion sources for GANIL & ALTO — *IJCLab, GANIL*
- Resonant Laser Ionization Spectroscopy at ALTO & GANIL (RIALTO, GISELE) — *LPSC, GANIL*
- Charge Breeding Decontamination (C.BREEDER)

Nuclear Physics at GANIL National Infrastructure

GANIL
ESFRI Landmark Infrastructure

See Herve's talk

Strategy 2025-2035 : a major program of Accelerator construction & upgrade

Strong support from ministry, region, university

SPIRAL2 Program

- Project S^3 – Superconducting Spectrometer Separator (24,3 M€)
- Project DESIR – Decay Excitation Storage of Radioactive Ions (39,5 M€)
- Project NEWGAIN – New Ganil Injector (25,3 M€)

Cyclotron Renovation Program

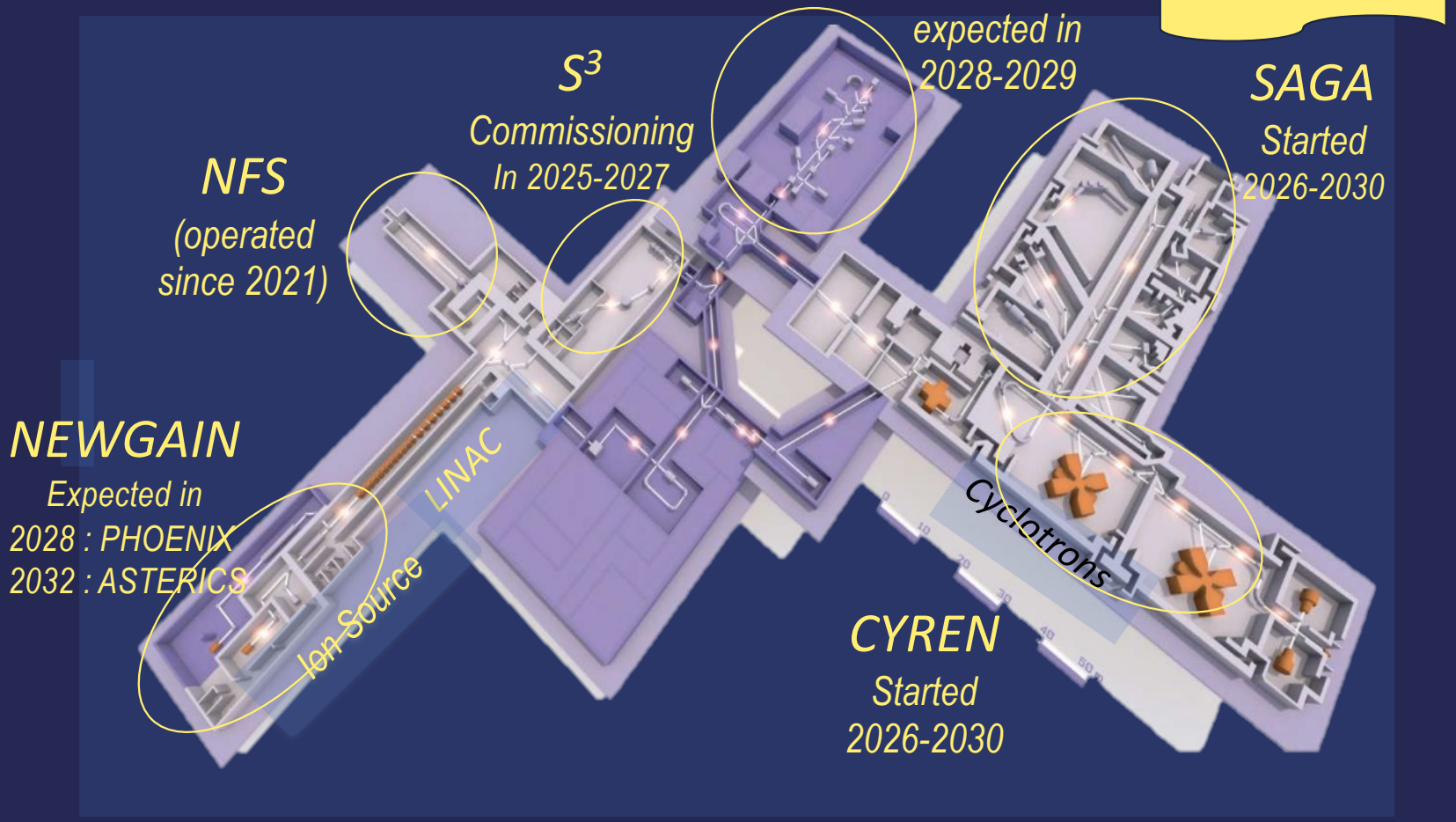
- Project CYREN – Cyclotron Rennovation (30 M€)

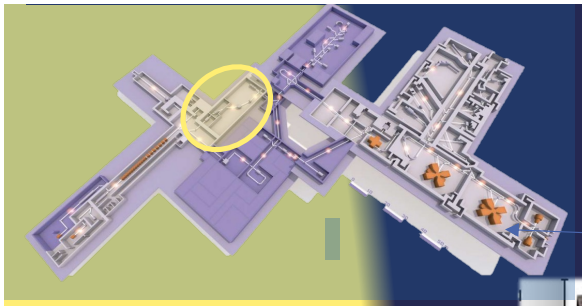
Development of Irradiation capabilities for spatial applications & industry

- Project SAGA – x5 times for spatial and x2,5 time for fondamental physics (40 M€)

Nuclear Physics at GANIL National Infrastructure

GANIL
ESFRI Landmark Infrastructure





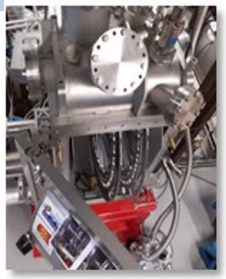
Superconducting Separator Spectrometer (S^3)

S^3

Stable and Radioactive Heavy Ion beams

See Herve's talk

Target system

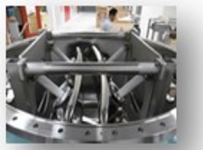


High power rotating targets

3 × M-dipoles

Large H & V gaps

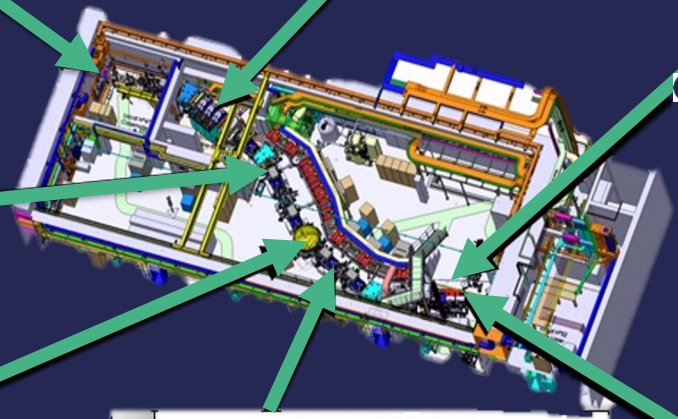
E-Dipole



20 cm gap & +/- 300 kV
Open slit in the anode

Dispersive zone

Open RT magnet & beam dump & Movable fingers



SC Multipoles

SMT, PSS, Coldbox & LTC

Infra / Interface

LEB

LEB @ LPC & GISELE Laser Lab

SIRIUS

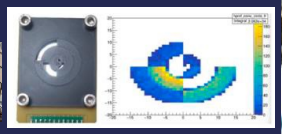
DSSD, SSD, FEE/BEE, DAQ & Diagbox

DESIR : accelerator and beam lines equipments…

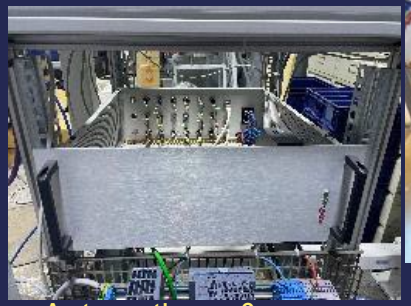
DESIR

Stable and Radioactive
Heavy Ion beams

Transport Beam Line



Beam Diagnostics

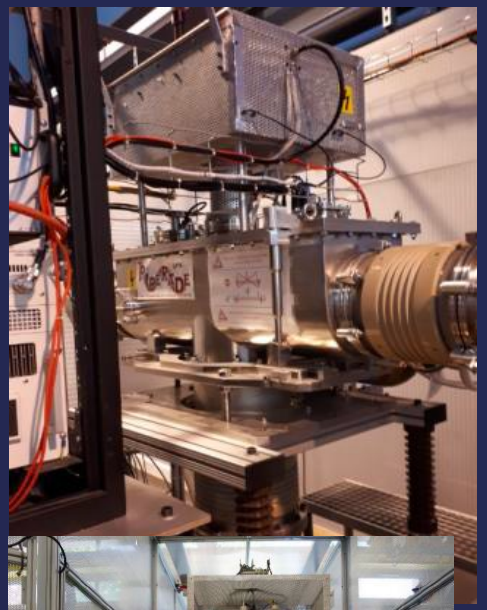


Automatisme &
contrôle-commande

Identification Stations

High resolution Spectrometer

General Purpose Ion Buncher:



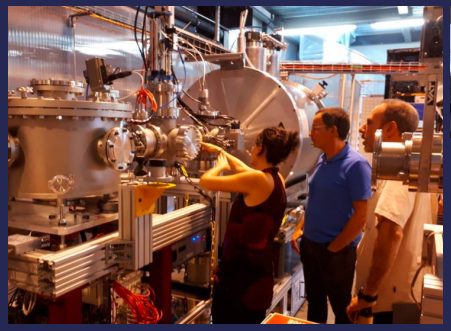
RFQ-cooler

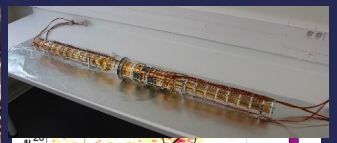
DESIR : Ion beam selection

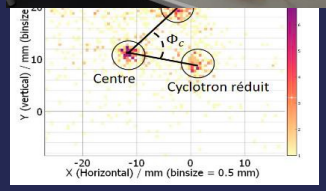
DESIR

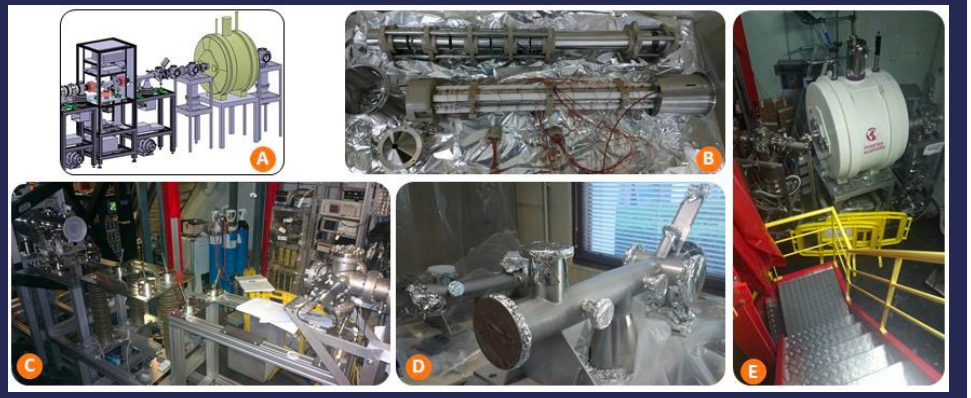
Stable and Radioactive Heavy Ion beams

PIPERADE / PI-ICR



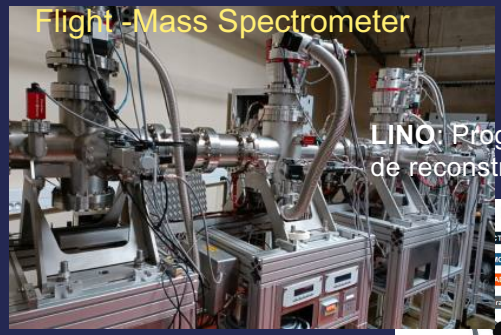




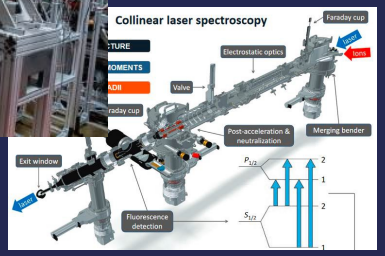


MLL Trap

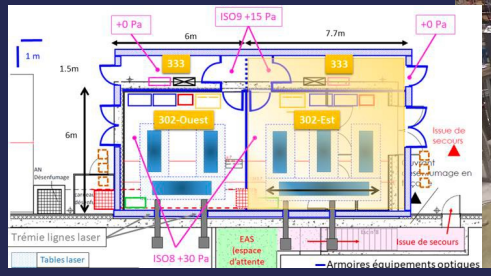
Multi-Reflexion Time Of Flight -Mass Spectrometer



LINO: Programme en cours de reconstruction (IJCLab)



Resonant Laser ionization install.



MORA

Research Programme

Light Sources & Laser Plasma

Light Sources and Laser Plasma Acceleration

LSLP
Light sources & Laser Plasma Acceleration

Scientific Objectives

Design accelerators for the production of intense photon beams

- High-intensity light sources : X-ray Inverse Compton Demonstrator, optical cavities, laser etc…

Explore and study the potential of *laser-plasma* acceleration

- Electron acceleration: Plasma cell optimisation, injector, stability and reproducibility, disagnostics, Simulations, Beam transport, *Multi-staging*
- Ion acceleration: Gas jets for laser-driven ion acceleration, characterization, simulations

Structuration and Organization

Construction, Operation and Qualification Projects

- THOM-X
- GammaFactory

IJCLab

R&D's Projects

- PALLAS – LPA injector @ LaserIX
- ALP-e – LPA @ Apollon and simulation
- TWAC – R&D on THz dielectric acceleration

IJCLab, LLR, LP2IB

Thom X : a high intensity Inverse Compton X-source

ThomX
Light Source & Laser Plasma Acceleration

Demonstrator for a compact X-source

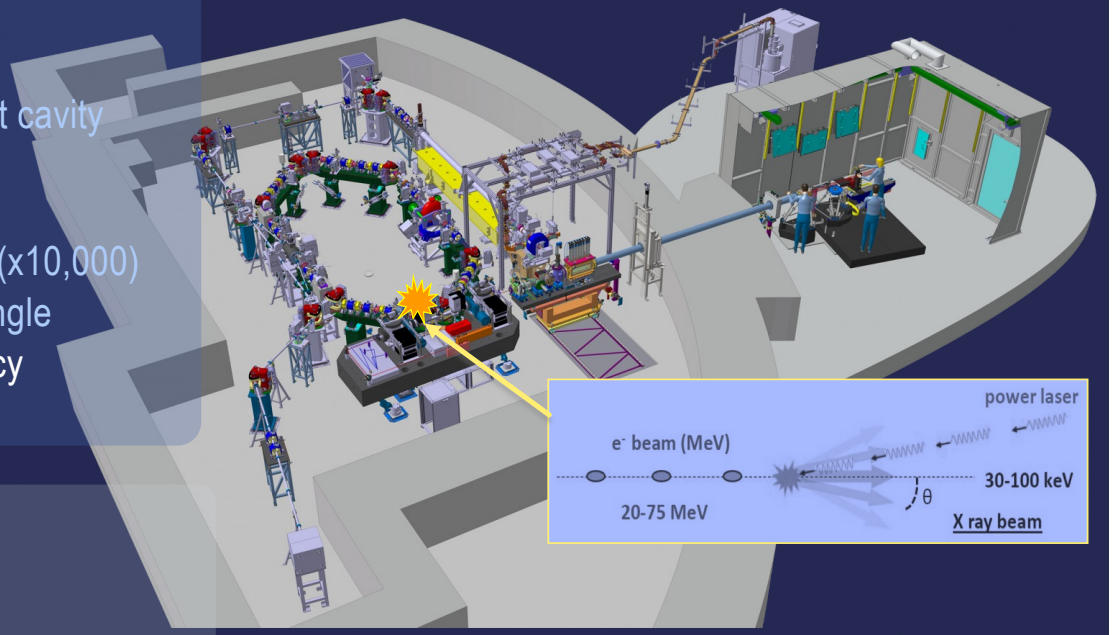
Baseline initial Design Parameters

- Compact equipements area : 100 m²
  e-accelerated and stored in a 18-m ring
  laser pulse accumulated in Fabry-Perrot cavity
- Electron bunch : 50-70 MeV, 1 nC
- Laser pulse : 1030 nm, 21 mJ,
- Cavity accumulation : 70 W → 700 kW (x10,000)
- Beam crossing : every 60 ns with 2° angle

Project funded by National Research Agency

- 11 M€ overall, 10-years

PHYS. REV. ACCEL. BEAMS 28, 023401 (2025)



Status of the project

Installation completed and operationnal

Commissioning ongoing :

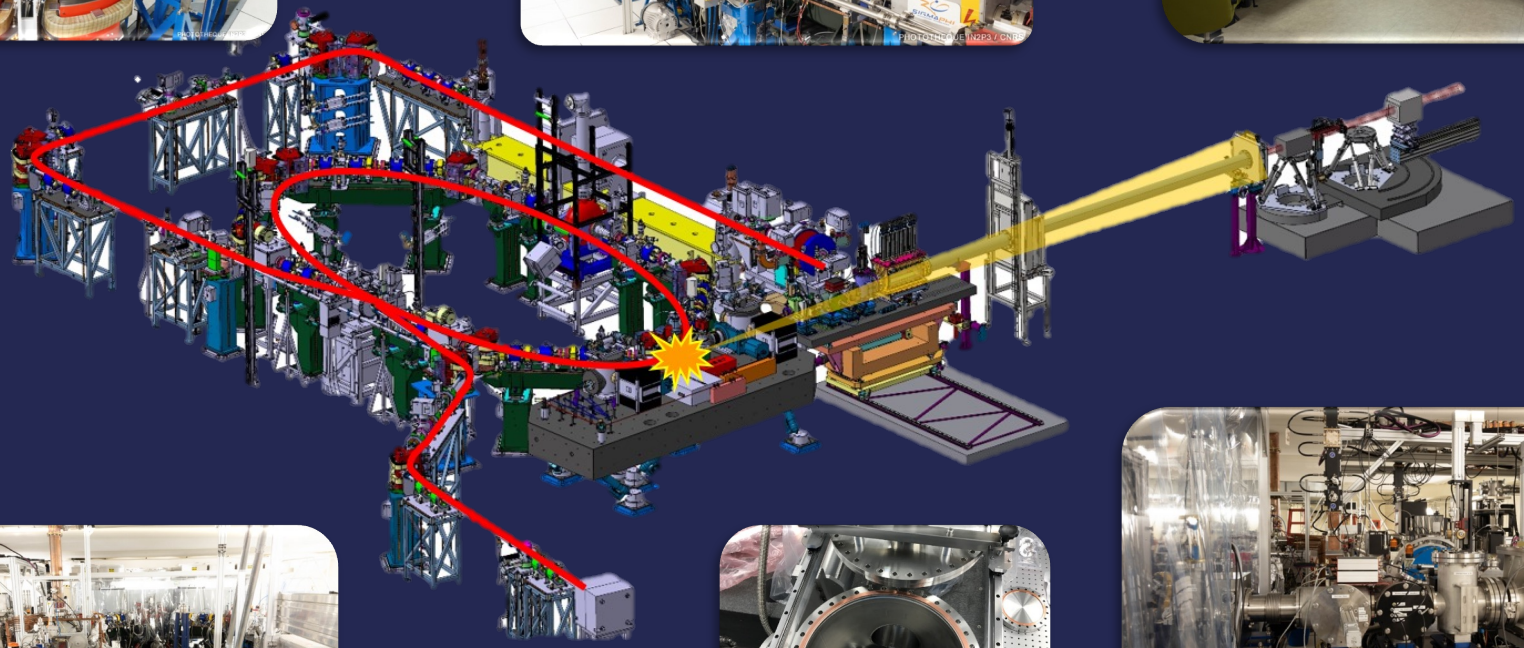
- Correction of the orbit length
- Stabilization of the beam transport
- Optimization (flux/spectrum/beam-size) ongoing
- Commissioning of the X-ray beam analysis devices

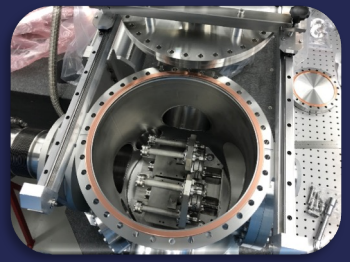
Achieved flux of 10^{10} X-ray/s

Thom X : Source-X compacte par Compton Inverse

ThomX

Light Source & Laser Plasma Acceleration





The EU context for Laser-Plasma WakeField Acceleration

EuPRAXIA
Light Source & Laser Plasma Acceleration

The EuPRAXIA Program

EuPRAXIA aims at the construction of two EU Research Infrastructures

- *electron-beam* driven plasma wakefield acceleration (INFN, Frascatti)
- *laser-based* plasma wakefield acceleration (ELI, Tcheque Rep.)

The program fosters the activities of about 10 *national nodes* contributing to the LPA research and developments

Strategy on Laser Plasma Acceleration

LPA
Light Source & Laser Plasma Acceleration

PALLAS experiment (IJCLab, CNRS)

- Laser–plasma injector 10 Hz, 150 MeV
- Advanced laser driver control: reliability and automated control via machine-learning
- Plasma-target development: high-quality, high-repetition rate electron-beam production
- Beam transport, diagnostics and optimization multi-staging: compact transport, RF

LAPLACE experiment (LOA, CNRS)

- High Rate : 100 Hz, 1J, 25 fs
- High Energy : 6J, 30 fs, 1 Hz
- Deepen laser–plasma source physics
- Applications: strong-field QED studies, radiobiology, non-destructive testing, ultrafast imaging
- Design industrial prototypes: high-repetition lasers, advanced diagnostics, plasma–laser feedback loops…

CNRS National Roadmap (2025-2030)

National Prospectives from the LPA community available

- R&D phase with both LAPLACE (HR and HE) and PALLAS (cell, beam-transport)
- Integration of PALLAS efforts in LAPLACE-HE for multi-staging validation
- CNRS Roadmap to be integrated as a *national-node* in EuPRAXIA framework (in discussion)

Key CNRS laboratories

- IJCLab, LLR, LOA, LULI, LPGP

French industrial partners

- Thales, Amplitude, ImagineOptic, SourceLab, PHASICS, FastLite, FemtoEasy…

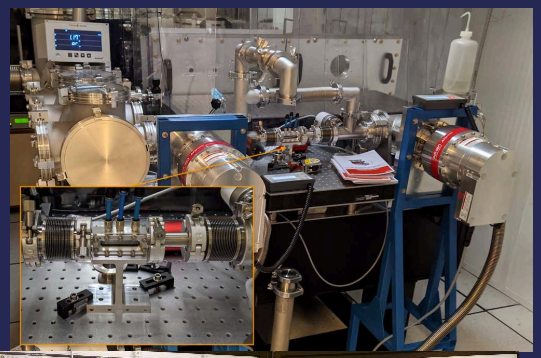
PALLAS Project

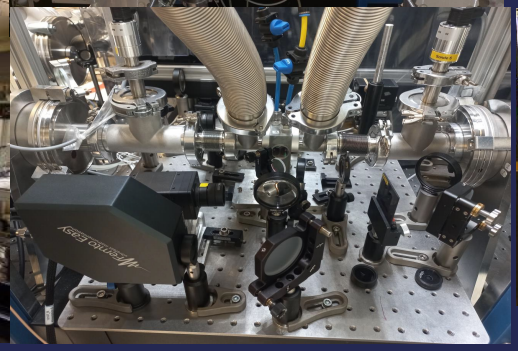
The PALLAS Experiment @ IJCLab

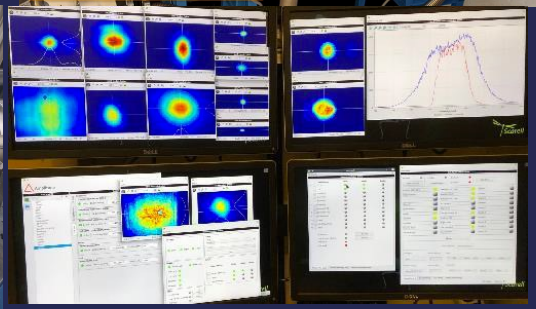
PALLAS
Light Source & Laser Plasma Acceleration

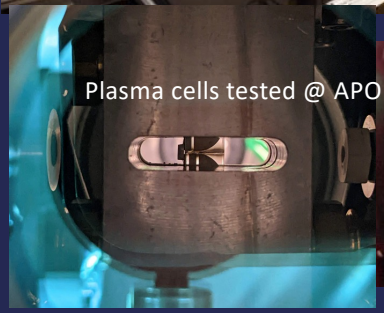

PMultibeam platform LaseriX @ Orsay

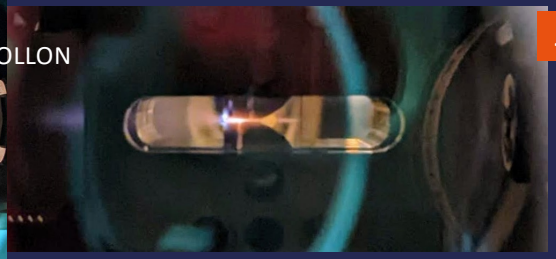

Test bench for plasma cells



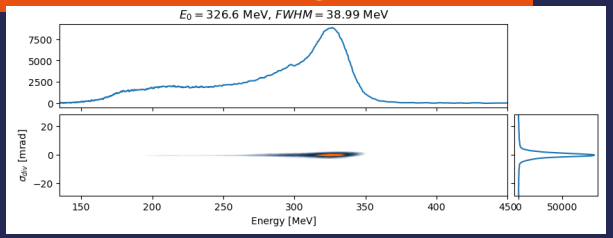



Laser Monitoring & Control


Plasma cells tested @ APOLLON



...first accelerated électrons @ APOLLON



Research Programme

Lepton Colliders

Future Lepton Colliders (LEPC)

LEPC
Lepton Colliders

Scientific Objectives

Futur Collider at CERN

Preparing for a french contribution to the next collider at CERN

- FCC ee : SRF elements, beam-dynamics, nano-beam stabilization, positron sources, polarimetry,
- PERLE : High power Energy Recovery Linac demonstrator

Structuration and Organization

Project PERLE
- Construction of a High Power ERL demonstrator

IJCLab, LPSC, IPHC

Project FCC-ee : SRF 800 MHz
- Conception and development of 800 MHz SRF components
- Test-bench facility for the cryomodules validation

IJCLab, LPSC, IPHC

Project FCC-ee : R&D on beam production and controls
- Production and stabilization of nanobeams, control and positioning
- High-intensity positron sources
- Compton Laser polarimetry
- Machine Detector Interface (MDI) HTS quadrupoles

IJCLab, LPSC, IPHC, LAPP, GANIL

Project EIC-accelerator (in discussion)
- Design, Construction of SRF cryomodules for the RCS

IJCLab,

PERLE : high current Energy Recovery Linac

PERLE
Lepton Colliders

PERLE Design (250-500 MeV)

Initial Scheme with 2 SC LINACs

- 4 x 5-cell 801.58 MHz LINAC SC CM
- Based on ESS elliptic design

Maximal Beam Energy 500 MeV

- 3 arcs of re-circulation (160 MeV/turn)
- Average beam current : 20 mA
- Power : 10 MW

Status of the Experiment

Funding for 1-SC Linac, 1 turn ERL @ 80% complete

- European ***INFRATECH iSAS (5M€)*** CM design & HOM
- CNRS Funding ***:*** *3,5M€ (ERL4ALL, national program)*
- IN2P3 Funding : 1,2 M€
- Regional Funding ***:*** *2 M€*

2SC Linac, Multi-turn option not funded

- Open to contributions from international partners

Collaboration PERLE

International members

- CERN
- ESS Lund
- ESS Bilbao
- Jefferson Lab, Cornell
- Liverpool, STFC
- Univ. Palestine

PERLE : The Injector

PERLE
Lepton Collider

HV system

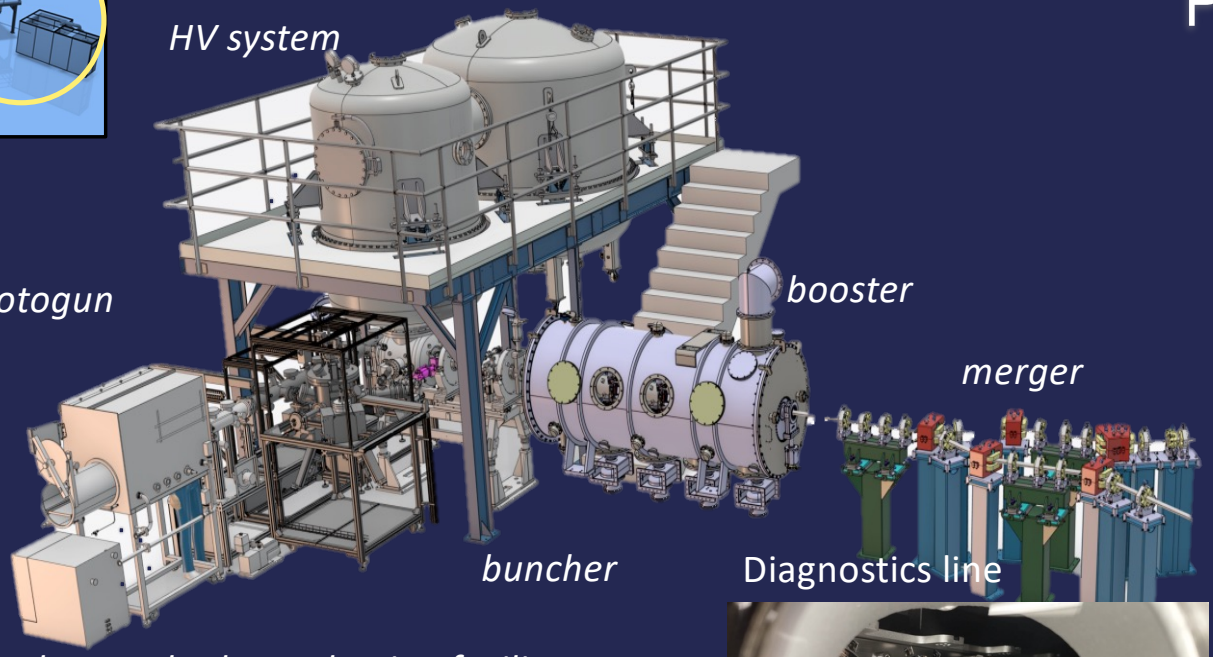
DC photogun

booster

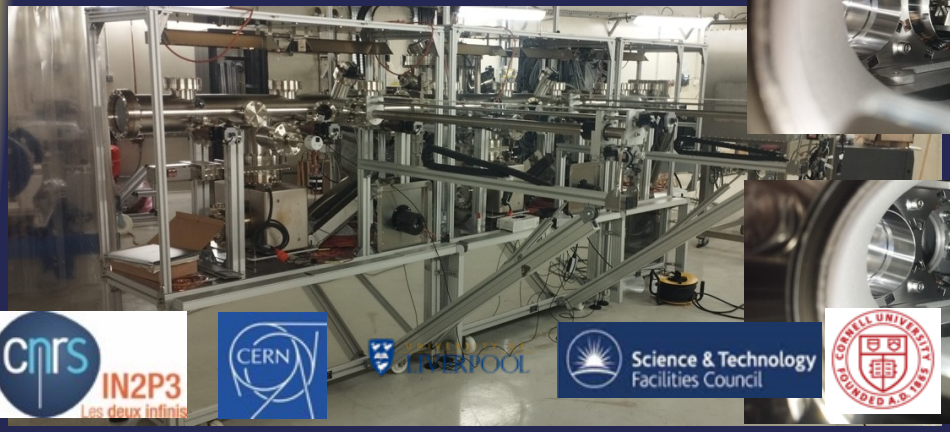
merger

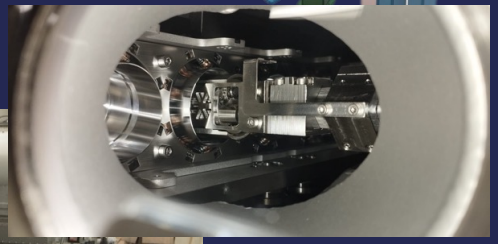
buncher

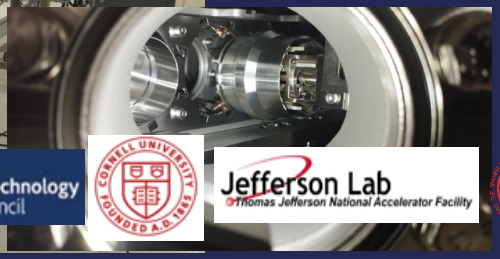
Diagnostics line



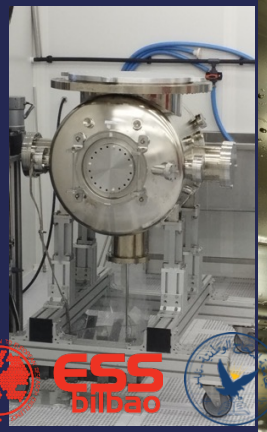
Photocathode production facility



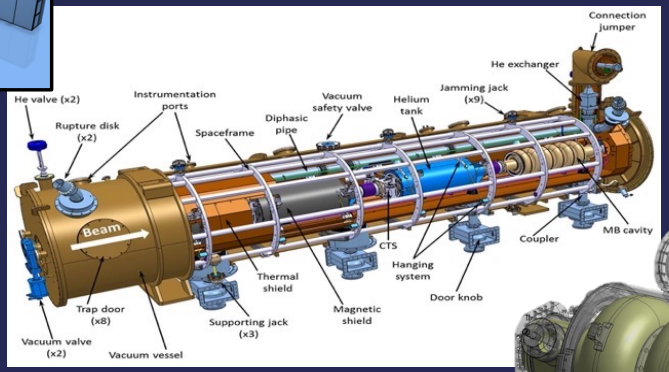


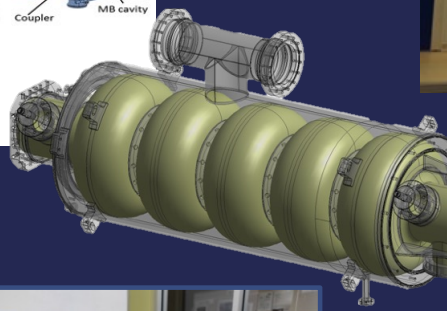


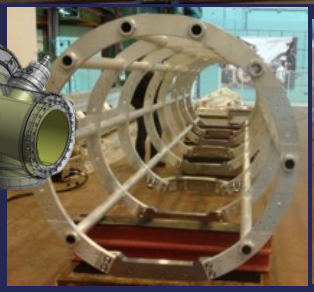
Gun chamber HPR cleaning
in clean room



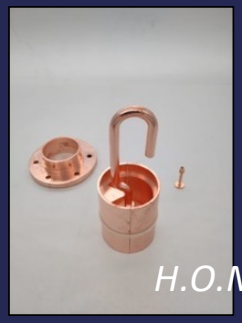
PERLE : the LINAC

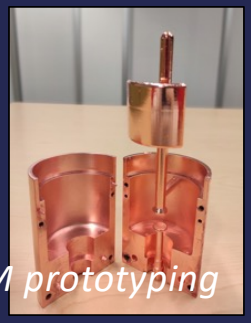




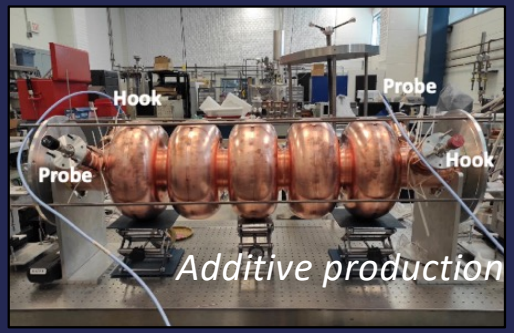


PERLE
Lepton Collider

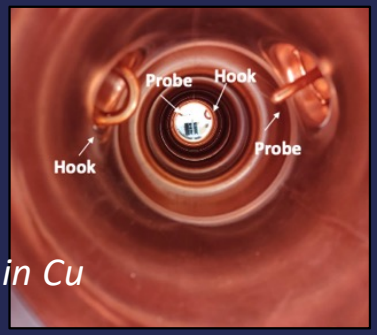


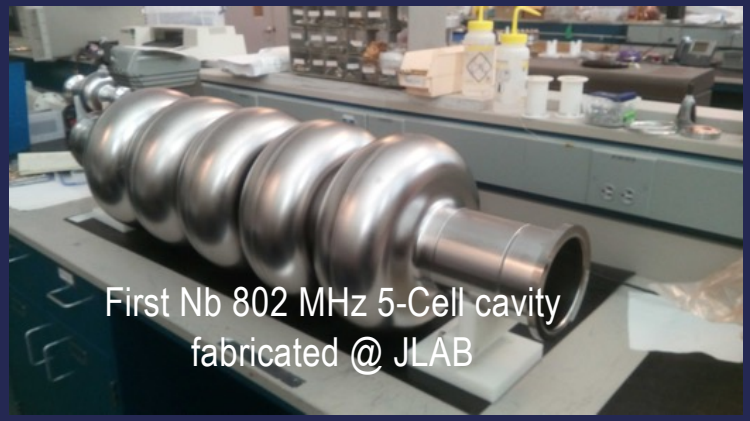


H.O.M prototyping



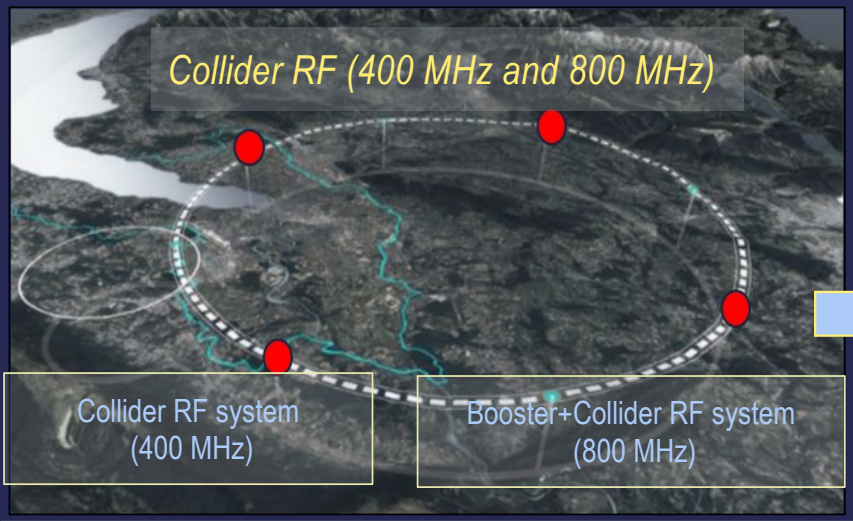
Additive production in Cu



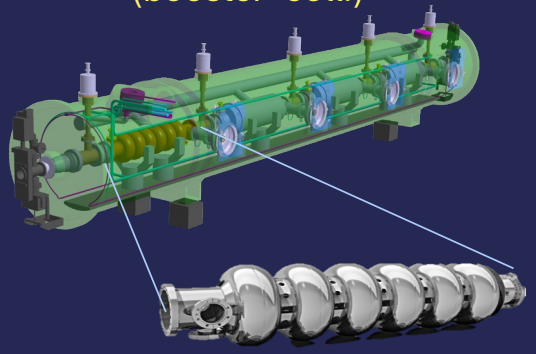


IN2P3 planned contribution to FCCee : SRF @ 800MHz

FCC-ee
Lepton Collider



x 28 (phase-1) + 186 (phase-tt)
(booster+coll.)



e-e+ →ttbar

FCC SuperConducting 800 MHz RF : Cavities

- Design and optimization of cavities, couplers and cryomodules
  - Currently at TRL-4
- 5-cell: TRL-4 (JLab, IJCLab) — 30 MV/m achieved on single-cell
- 6-cell: TRL-5 (IJCLab, CERN) — 22.5 MV/m achieved on single-cell
  - Goal: TRL-7, including cryomodule testing

FCC SuperConducting 800 MHz RF : CryoModules

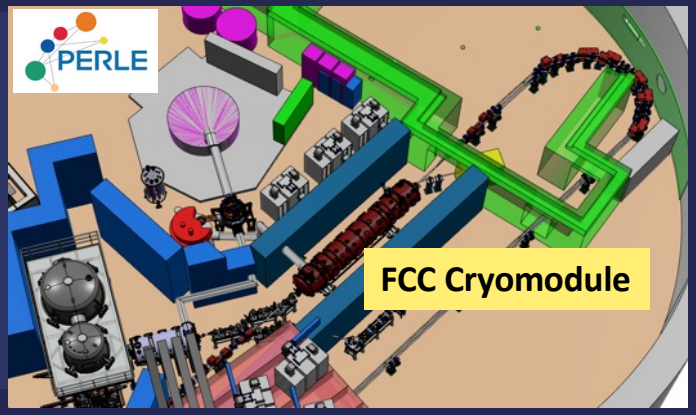
- 4 x 6-cell Cryomodules design studies started with CERN
- Cryomodules assembling & Test in Vertical Cryostat foreseen at SupraTECH

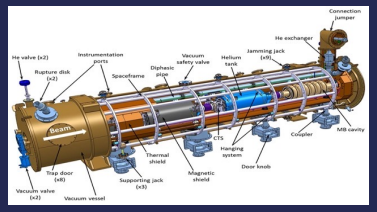
IN2P3 planned contribution to FCCee : synergy w/ PERLE

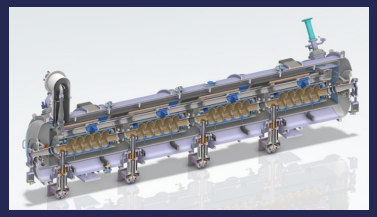
FCC-ee
Lepton Collider

Synergy on many key-technological topics

- HOM couplers and Power couplers (within ISAS)
- Beam line absorbers
- SRF cavities (test in Vertical Cryostat)
- Cryomodule design
- RF amplifiers
- (Cobot for clean room preparation)




ESS elliptical cryomodule


PERLE cryomodule


FCC 800 MHz cryomodule

PERLE as a beam test facility for FCCee

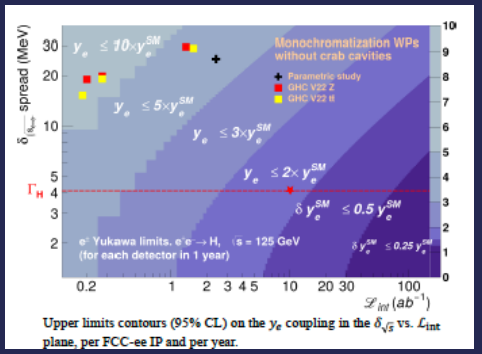
- 801.58 MHz SRF systems: → FCC freq (R&D on cavity, RF sources, LLRF...)
- Multi-turn ERL : → test with beam of damping systems (HOM, Absorbers)
- 250 MeV, ~ 82 MeV /Linac: → challenging high E_{acc}=22.4 MV/m @ high $Q_o > 3^{10}$
- 500 pc bunch charge @ 40 MHz => 20 mA: → high current
- Cryo temp. 1.8K to 2K → optimizing the operating temperature

IN2P3 planned contributions to FCC ee : Beam Developments

FCC-ee
Lepton Collider

High performance beam and ML developments

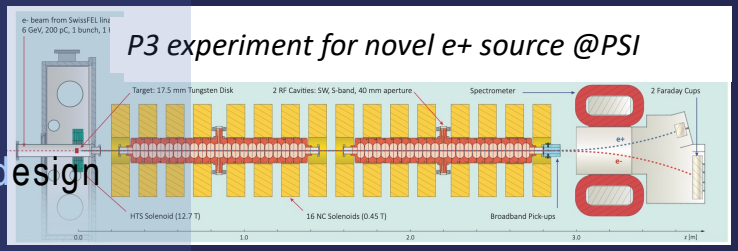
- Design and and performance optimization
  - high-intensity novel e+ sources
  - Interaction Region for nanobeam sizes and high-energy resolution collision schemes
  - high-energy booster
- Development of laser-based polarimetry tools



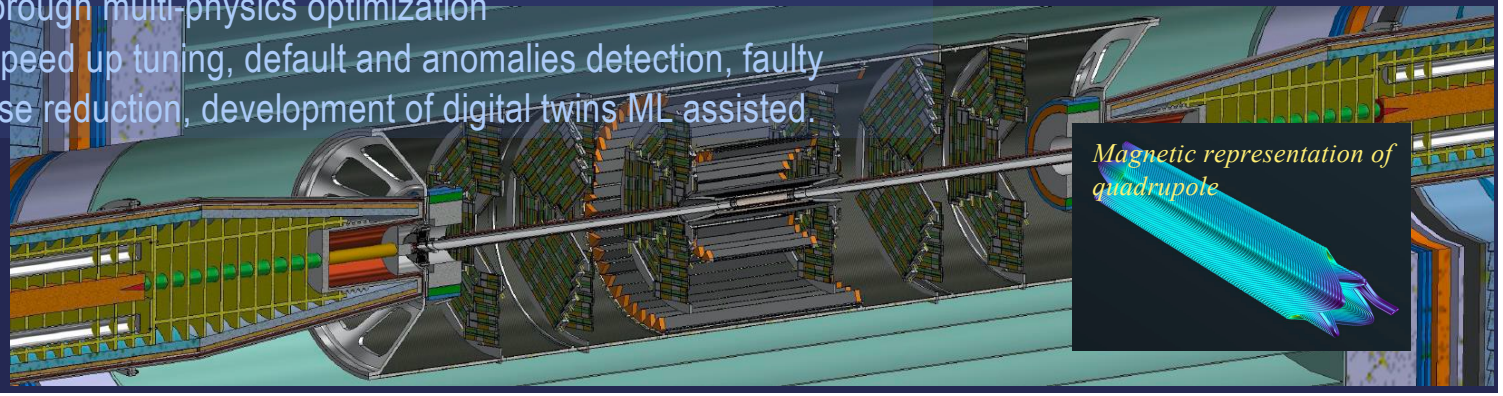
Upper limits contours (95% CL) on the y_e coupling in the $\delta_{\sqrt{s}}$ vs. $\mathcal{L}_{int}$ plane, per FCC-ee IP and per year.

Lines of research with embeded AI for

- Modelling: optimization of optics (linear and non-linear) design including errors, tolerance calculation
- Technology: optimization of design devices (SC magnets, RF cavities, e+ targets,..) thorough multi-physics optimization
- Operation: speed up tuning, default and anomalies detection, faulty recovery, noise reduction, development of digital twins ML assisted.



P3 experiment for novel e+ source @PSI



Conclusion

Accelerator Science & Technology at IN2P3

A strategy based on our main Involvements *for our fields*

- Stable and radioactive ion beams production for GANIL projects
- Superconducting RF cavities & associated components, cryomodules
  - ***Growing importance of our implication on Future CERN*** electron machines with synergetic high power ERL construction in Orsay…

A strategy based on large international cooperations

- Collaboration agreements with CERN, FNAL, KEK, Jefferson Lab, ESS, STFC, PSI,…
- And of course, a long history of collaboration with TRIUMF
  - Today on SRF developments – see Camille's talk
  - …

We eagerly anticipate deepening our collaboration through this International Research Laboratory !

BACK-UP

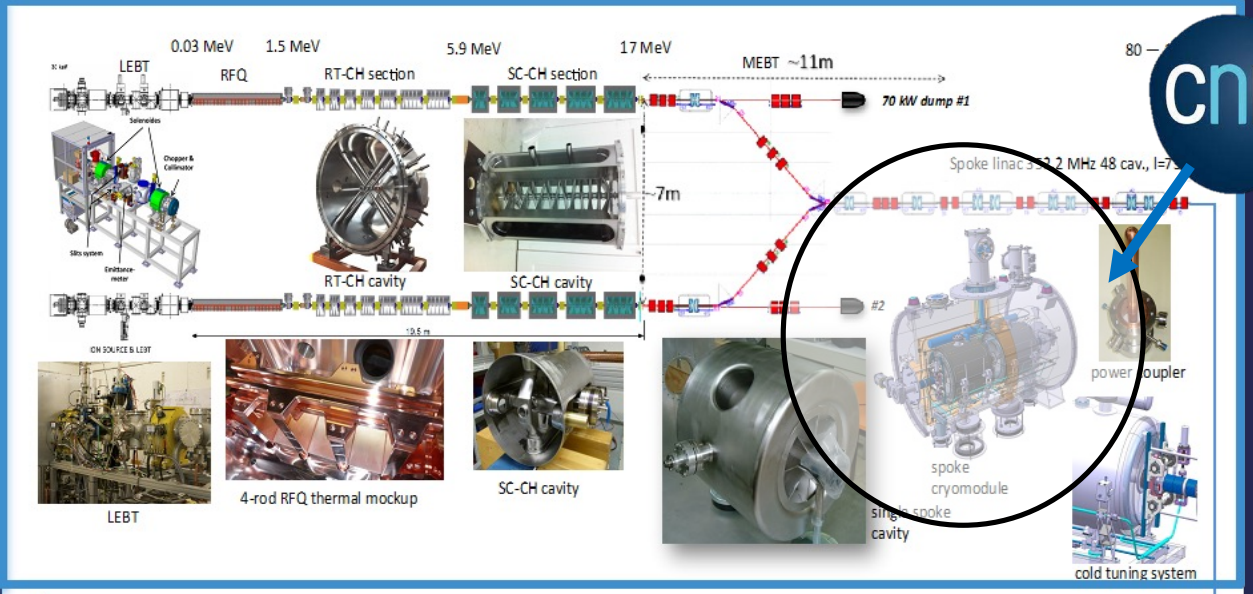
IN2P3 and ADS : MYRRHA and MINERVA

MYRRHA

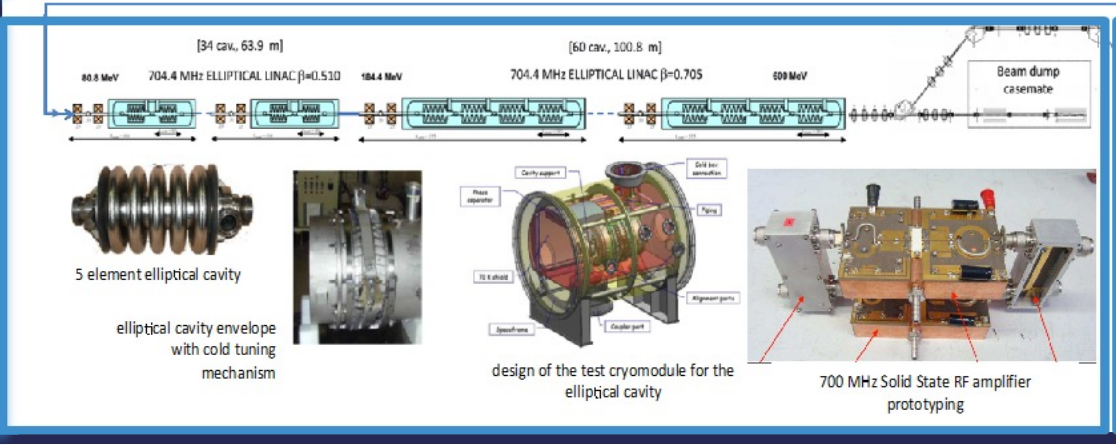
Superconducting

Proton Linac

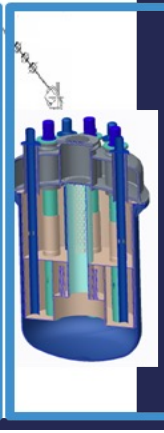
Phase 1 – 100 MeV



Phase 2 – 600 MeV



Phase 3 – Reactor



IN2P3 in Accelerator Driven System : MYRRHA

MYRRHA
Superconducting Proton Linac

ADS : A long history at IN2P3 with Reactor Physics teams

- Construction of the proton source (Generator of Intense Pulsed Neutrons)
- Beam dynamics for MEBT3 & HEBT / LPSC, IJCLab, IPHC
- HEBT Beam position Monitor (IJCLab)
- Beam Profile Monitor (LPSC)
- LLRF system for RFQ injector (IJCLab)
- Cryogenic valve box, cryomodule vessel (IJCLab)
- RF power amplifier (SCK), LLRF (IJCLab)

Implications in MINERVA to be completed in 2027-28

MINERVA 100 MeV : Pre-series Design and Prototyping

Test & Validation of SRF components @ IJCLab

- Qualification of 6 pre-series cavities at 2K
- Assembly and integration, test and RF characterization, possible re-conditioning

Cold Tuning System : 6 units

- Assembly and integration into the Cold Tuning System text box
- Qualification tests of CTS at 77K

Power Couplers : 6 units

- Design and supply of conditioning cavities, cleaning and assembly, baking of the couplers
- Conditioning at 80 KW

IN2P3 planned contribution to EIC

EIC
Lepton Collider

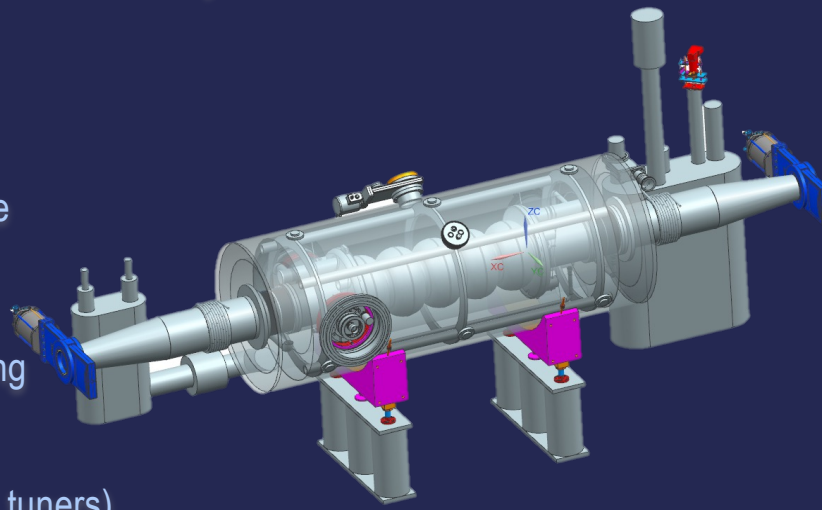
Contribution to EIC accelerator construction : RCS Cryomodules

Phase 1 (2026 to mid-2028)

- Design of the cryomodule and valve box
- Tooling design and procurement
- Design and preparation of Supratech test infrastructure

Phase 2 (mid-2027 to mid-2031)

- Procurement of 2 complete cryomodules
- Coordination and follow-up of component manufacturing
- Cryomodule assembly at IJCLab
- Cryogenic and RF performance validation at 2 K
- Qualification of critical components (cavities, couplers, tuners)
- Shipment to BNL after acceptance



EIC Electron Injector Design & Cost Review,

Project submitted to ministry
as a new « large research infrastructure »
in the National Roadmap
(decision expected end of 2026 / beg. 2027)