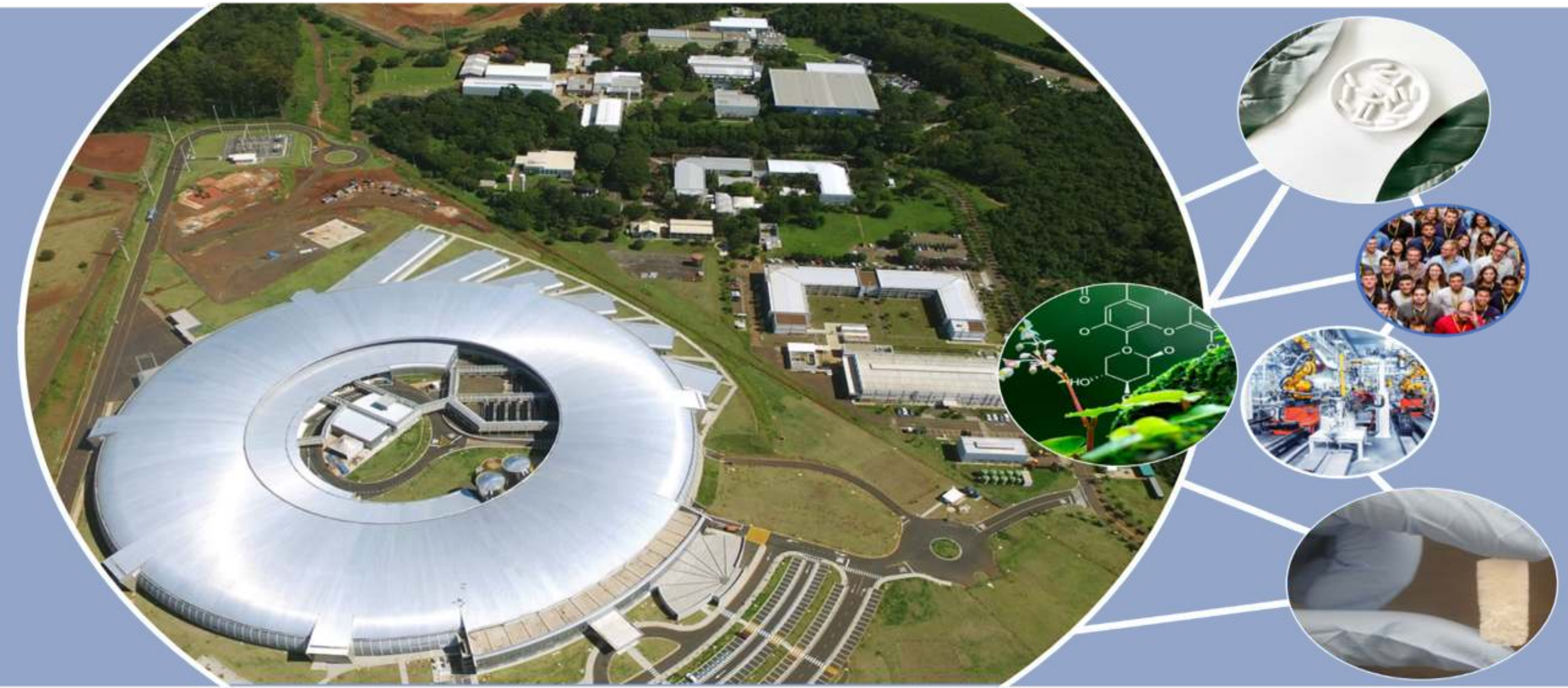
CNPEM – Brazilian Research Center in Energy and Materials



Antonio José Roque da Silva
Director General - CNPEM
jose.roque@cnpem.br

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GOVERNO DO BRASIL DO LADO DO POVO BRASILEIRO

SIRIUS I Brazilian Synchrotron Light Laboratory (LNLS)

General Directorate

Brazilian Biorenewables National Laboratory (LNBR)

Brazilian Biosciences National Laboratory (LNBio)

Engineering and Instrumentation Laboratories

Brazilian Nanotechnology National Laboratory (LNNano)

Human Resources

Emplyees – 1.250
Students, PosDocs– 250
Trainess – 150
Outsourced Personnel - 250

TOTAL I 1.900

Ilum School of Sciences

CNPEM is a private, non-profit organization overseen by the Brazilian Ministry of Science, Technology, and Innovation (MCTI)

CNPEM Campus

Important Turning Point in the Brazilian Science - “Big facility”, in house development

A pioneering lab in Brazil

First synchrotron light source in the southern hemisphere

Around 85% built in house

Built between 1987-1997

Training of human resources

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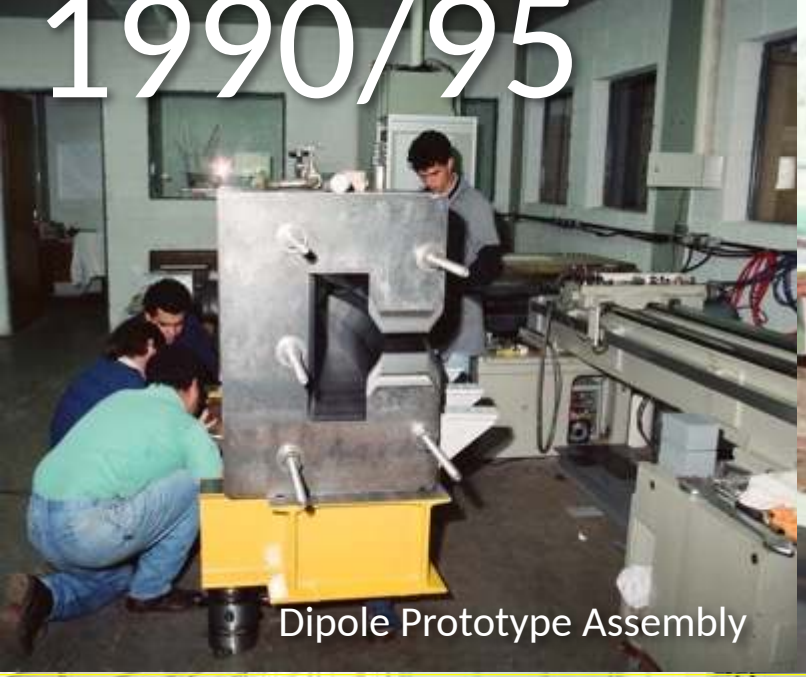
1990/95

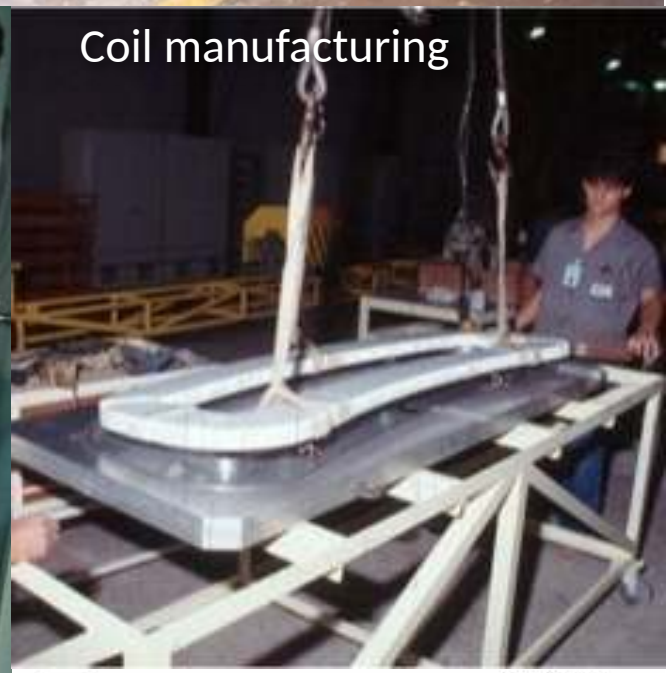


Dipole Prototype Assembly

Magnets production

1/12 storage ring

Vacuum Chamber Prototype Assembly



Coil manufacturing

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But not competitive at an international level...

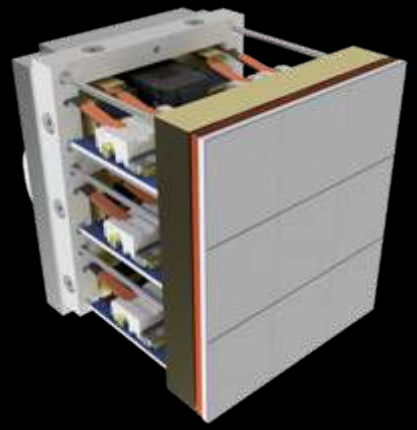
Sirius – a competitive synchrotron light source – 4th generation

Technology development highlights

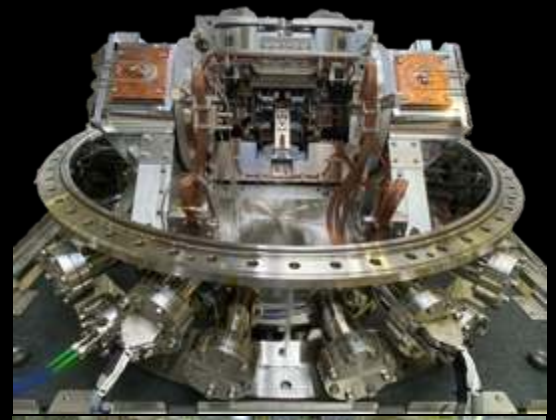
Magnets

Delta Undulator

X-Ray detectors



X-Ray monochromators

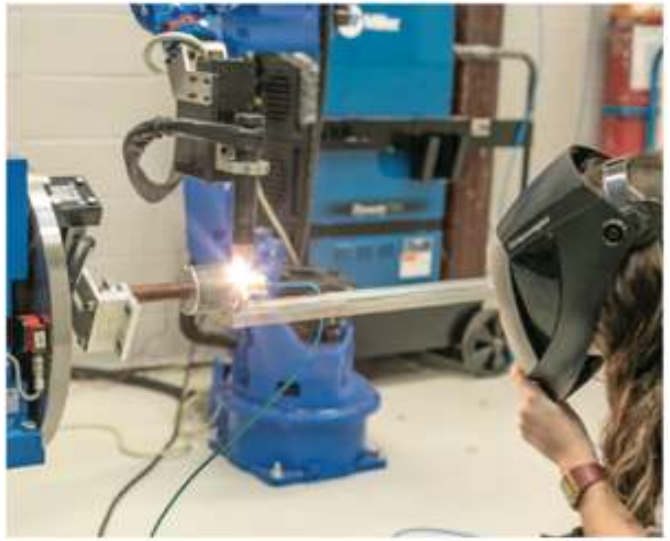


Vacuum chambers (NEG Coating)

NEG Coating

Cu/Ag alloy chamber

Termomecanica



Cu welding

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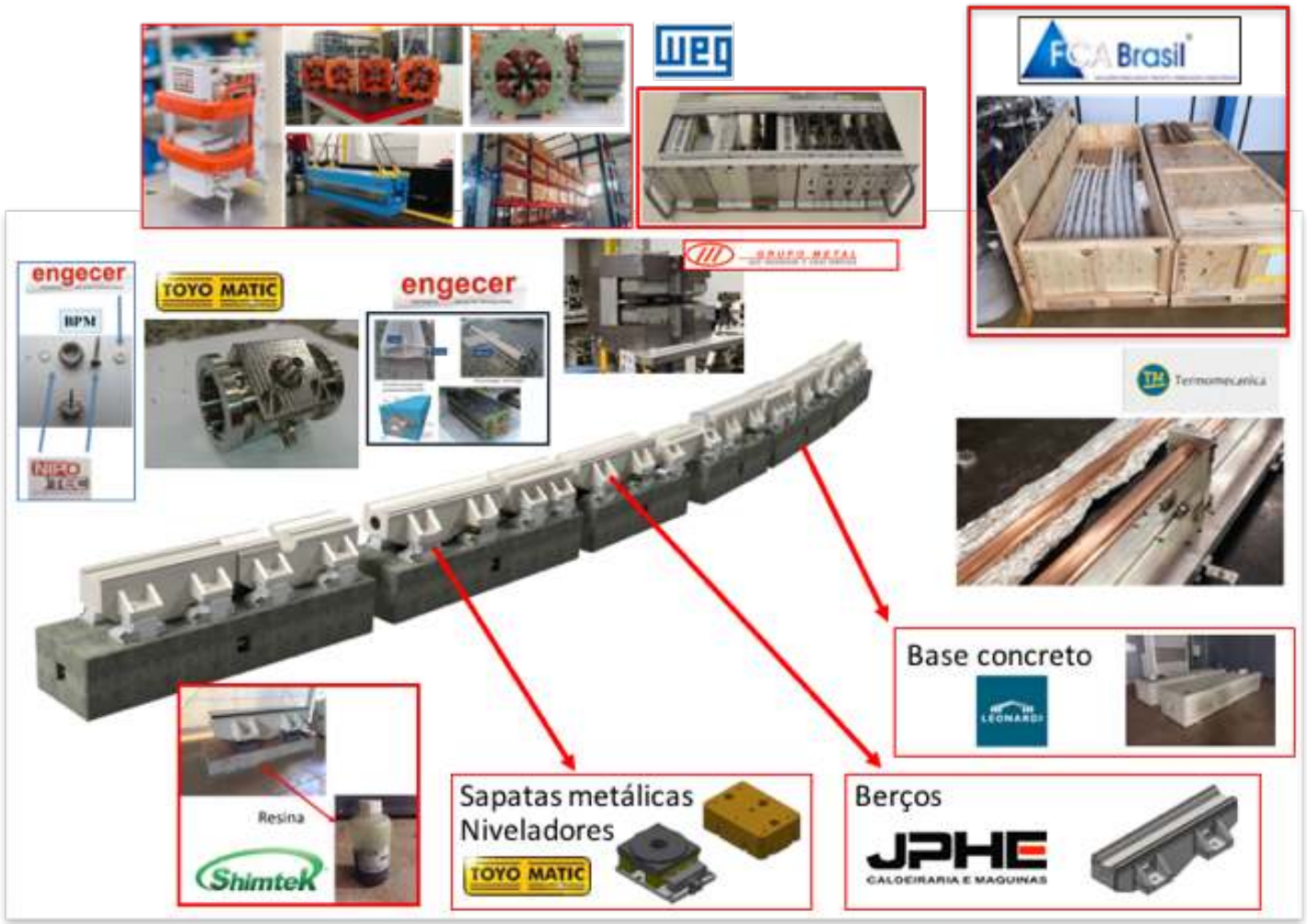
Sirius: CNPEM and Brazilian Industry Collaboration

Interaction with innovative Brazilian companies in product/process/production developments for Sirius



BIOTEC

FCA Brasil

Agreement between PITEC and CNPEM advances the development of state-of-the-art technology

THANKS TO THE INVOLVEMENT OF THE BRAZILIAN COMPANIES, THE PROJECT ACHIEVED A > 80% INDEX OF NATIONALIZATION

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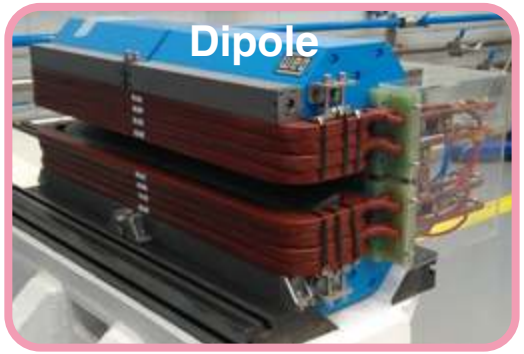
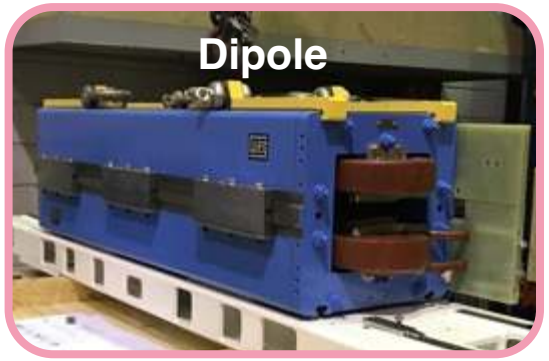
Magnets Development Timeline

Santa Cândida (1987)

UVX

2ª Generation
1997-2019

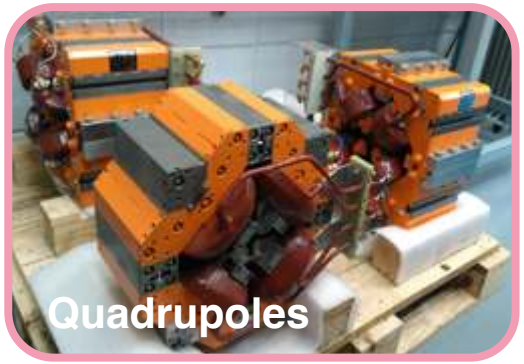




Sirius

4ª Generation
2020-In operation

?



Success case: Magnets for Sirius

1036 eletromagnets

- 257 in the Booster Ring
- 782 in the Storage Ring

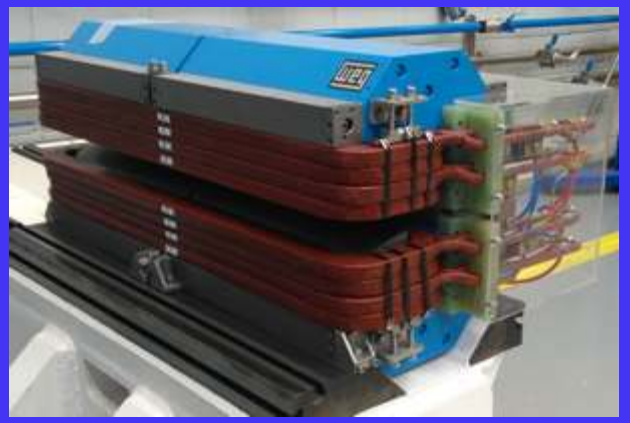
Divided into:

- Corrector
- Quadrupoles
- Sextupoles
- Dipoles

Success case: Magnets for Sirius

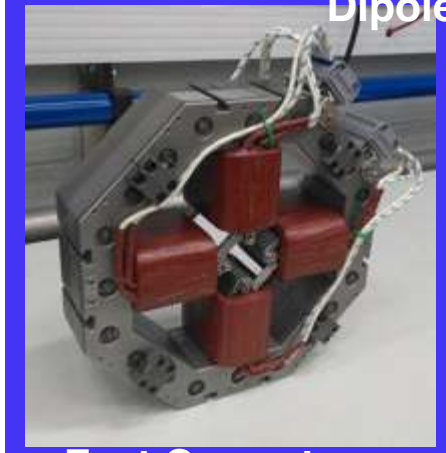
WEG manufactured the Sirius accelerator electromagnets, a **non-standard, high-precision product for the company**.

More than 1,000 magnets were built and installed.



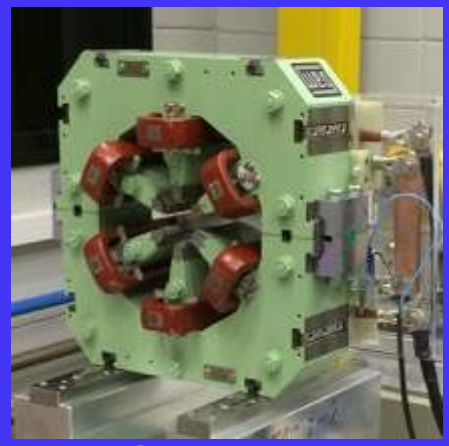
Storage Ring Electromagnetic Dipole

Booster Dipole



Fast Corrector

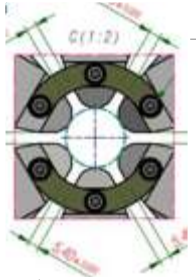
Quadrupoles



Sextupole

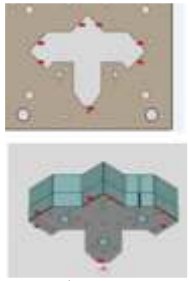
Sirius Magnets Development Proces

Sirius Electromagnets → External Manufacturer (WEG)



Design

- Simulation, mechanical design and project specification



Prototype

- Validate design/simulations
- Develop process

Pilot Batch

- Adjust design/product

Serial Batch

- Serial production at scale

Validation

- Magnetic measurements
- Metrology

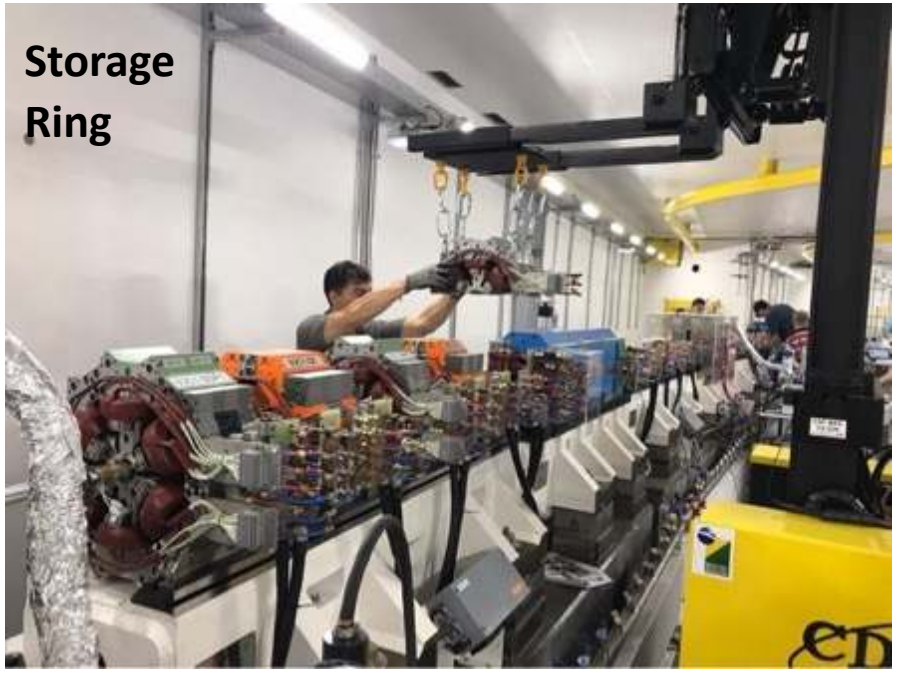
Magnets for Sirius

WEG - Jaraguá do Sul, SC, Brazil

Special room for magnets´ assembly at WEG

Booster

Storage Ring



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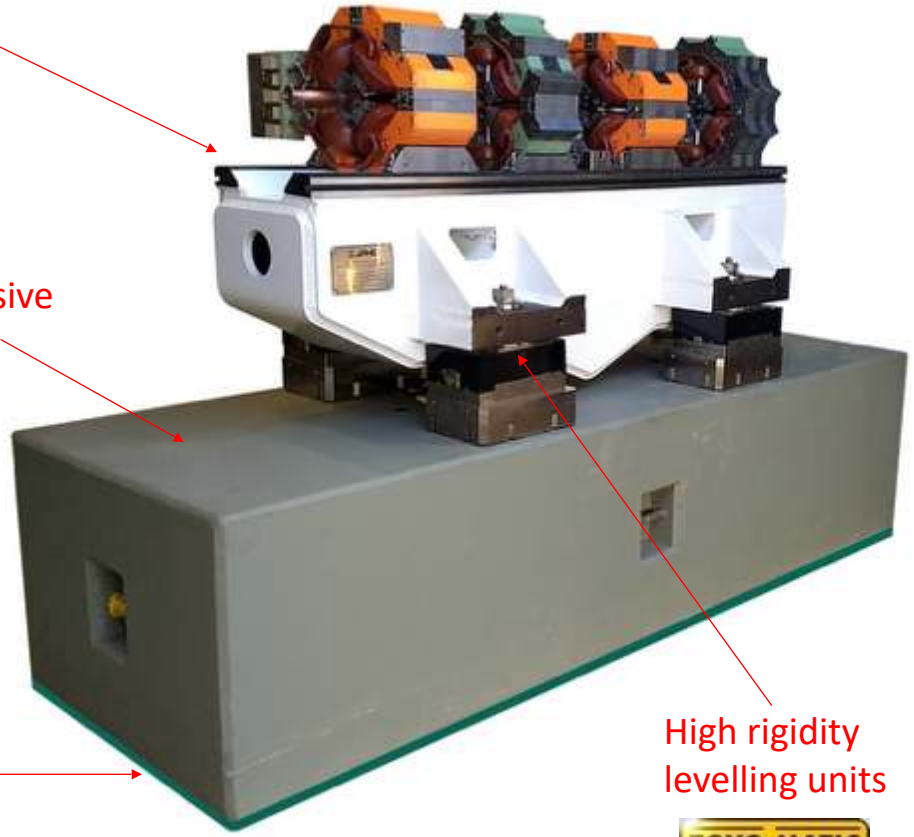
High Stability Girder

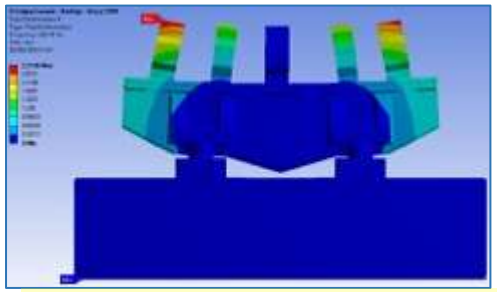
10 micrometer flatness girder

100 MPa compressive strength concrete

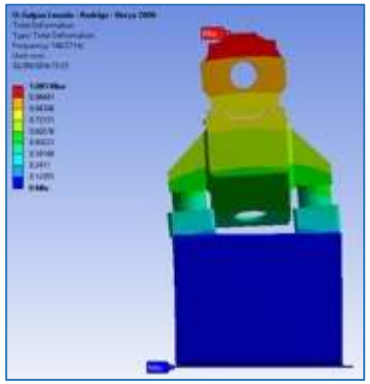
5 GPa compressive strength resin



High rigidity levelling units



V 1st mode: 268 Hz



H 1st mode: 152 Hz

Multipole Magnets aligned by mechanical definition using reference surfaces of magnets and girder

CERN Cooperation and Opportunities in Brazil

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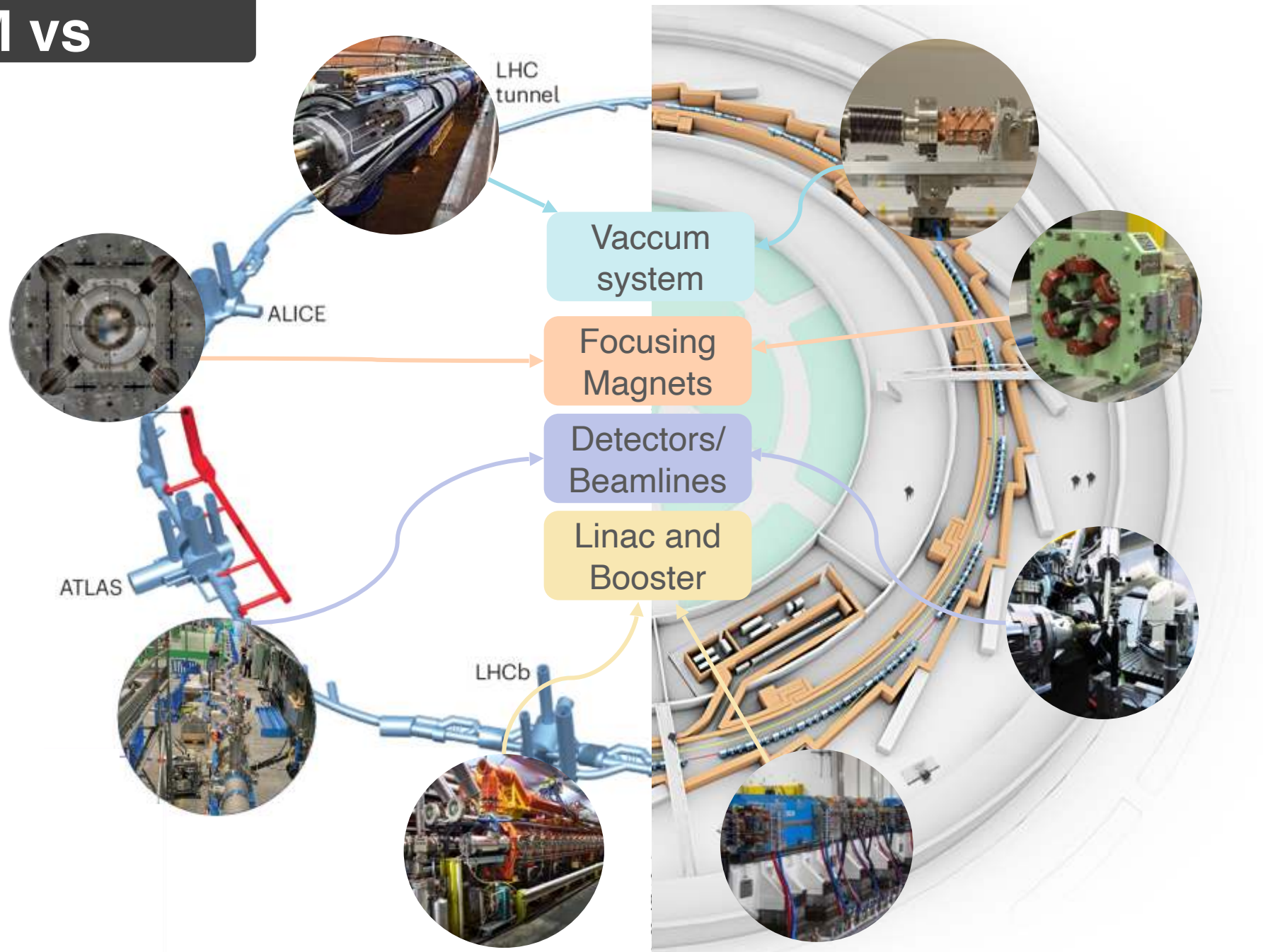
CNPEM vs CERN

SIRIUS vs LHC

CNPEM CERN

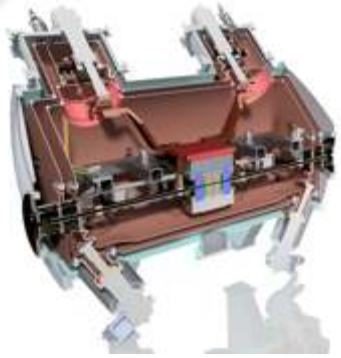
	Goals	What they are	What they accelerate	Accelerator dimensions
SIRIUS CNPEM Campinas, Brazil	Materials science, nanotechnology, biotechnology, physics, environmental sciences, and others.	Synchrotron Light Source	Electrons	518 meters, ground level
LHC CERN Genebra, Switzerland	Particle physics, studies about the origin of the universe, matter and antimatter. The Higgs boson was discovered at	Particle Collider	Protons	26,700 meters, underground

CNPEM vs

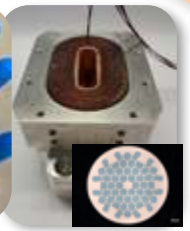

LHC tunnel
ALICE
ATLAS
LHCb
Vaccum system
Focusing Magnets
Detectors/ Beamlines
Linac and Booster

CNPEM & CERN Agreement

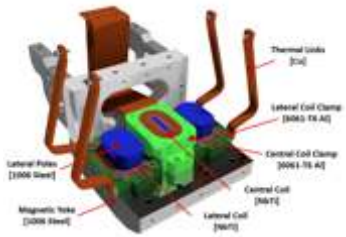
Scientific agreement between CNPEM and CERN signed in Dec 2020, sharing across any area of mutual interest, with emphasis on **accelerator technologies, magnets, and superconducting materials.**



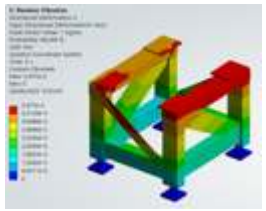
Vertical Cryostat for Cryogenic Temperature Testing



Prototyping and manufacturing of the coils



Mounting and Supporting Device



Prototypes of the quench protection system and power supply

Superconducting Wavelength Shifter (SWLS)

Ongoing development of a >6 T superconducting magnet to be installed in one of the straight sections of Sirius. Our developments cover electromagnetic design, coil manufacturing, mechanical design, cryogenic design, design and construction of new power supplies and quench protection.

Radiofrequency Quadrupole (RFQ) Cavity

The effort includes in-house design and fabrication of the RFQ accelerating cavity, the development of a custom vacuum-sealing solution tailored to the system, and the integration of all subsystems into a robust, clinically oriented platform.

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Associate Member State of CERN

- Since March 2024, Brazil is an **Associate Member State of CERN**, the first in South America.

- Brazil is an Associate Member of CERN, unlocking access for Brazilian companies, now **eligible to bid for CERN contracts.**

- CNPEM supports the Industrial Liaison Officer - ILO

activities

Procurement and Industrial Services Group

Who to Contact in Your Country

Brazil

Rafael Navarro

Organization
CNPEM

Address
Polo II de Alta Tecnologia - R. Giuseppe Máximo Scolfaro, 10000 - Campinas - SP, 13083-100, Brazil

Telephone
+5511972814717

Email
rfabran@gmail.com

Industrial Liaison Officers (ILO's) are appointed by CERN's Member States to facilitate the flow of communication between CERN and its suppliers. ILO's can provide advice on the opportunities available for doing business with CERN and the support available to firms in their local regions.

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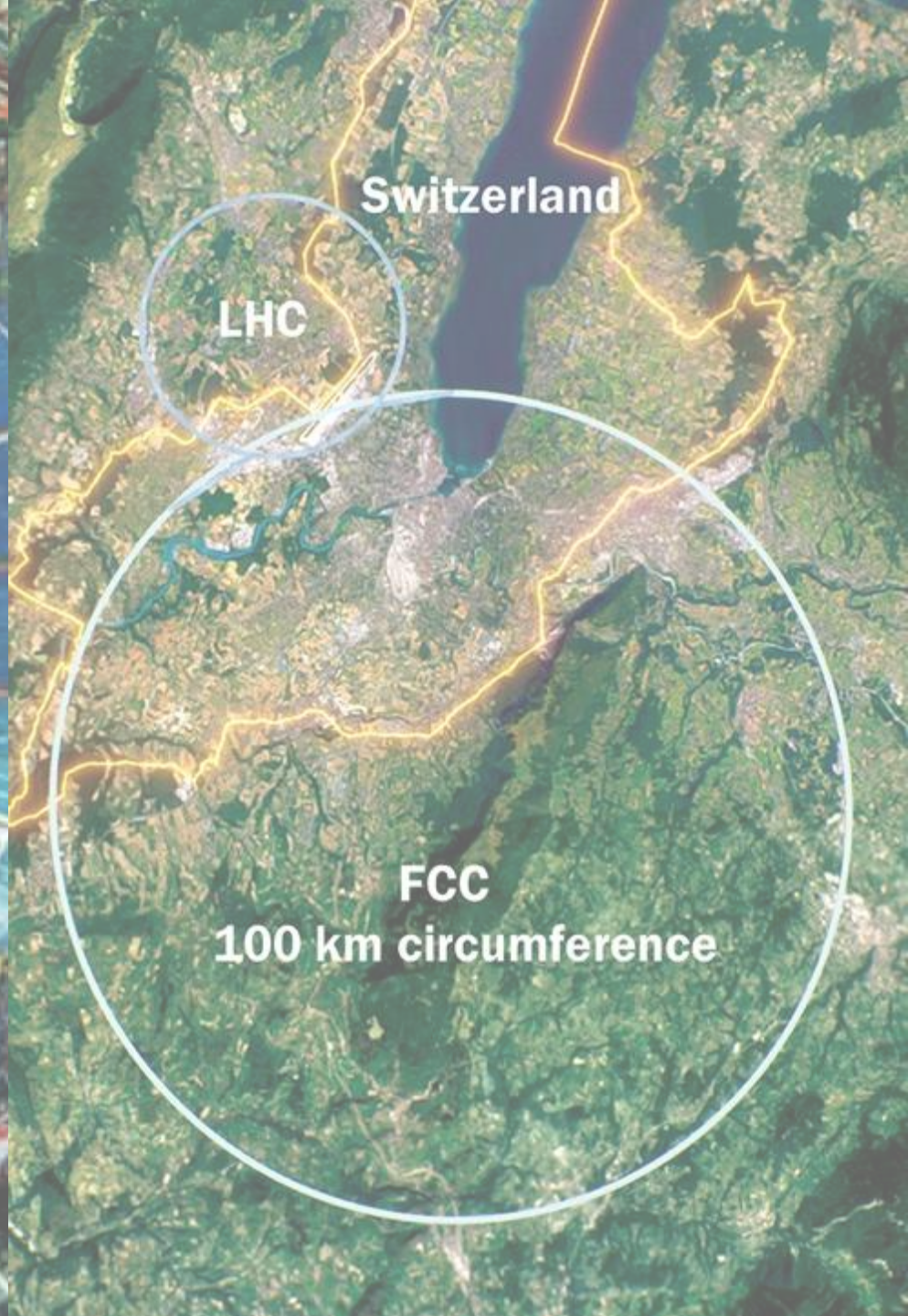
Partnering with CNPEM

How CNPEM de-risks:

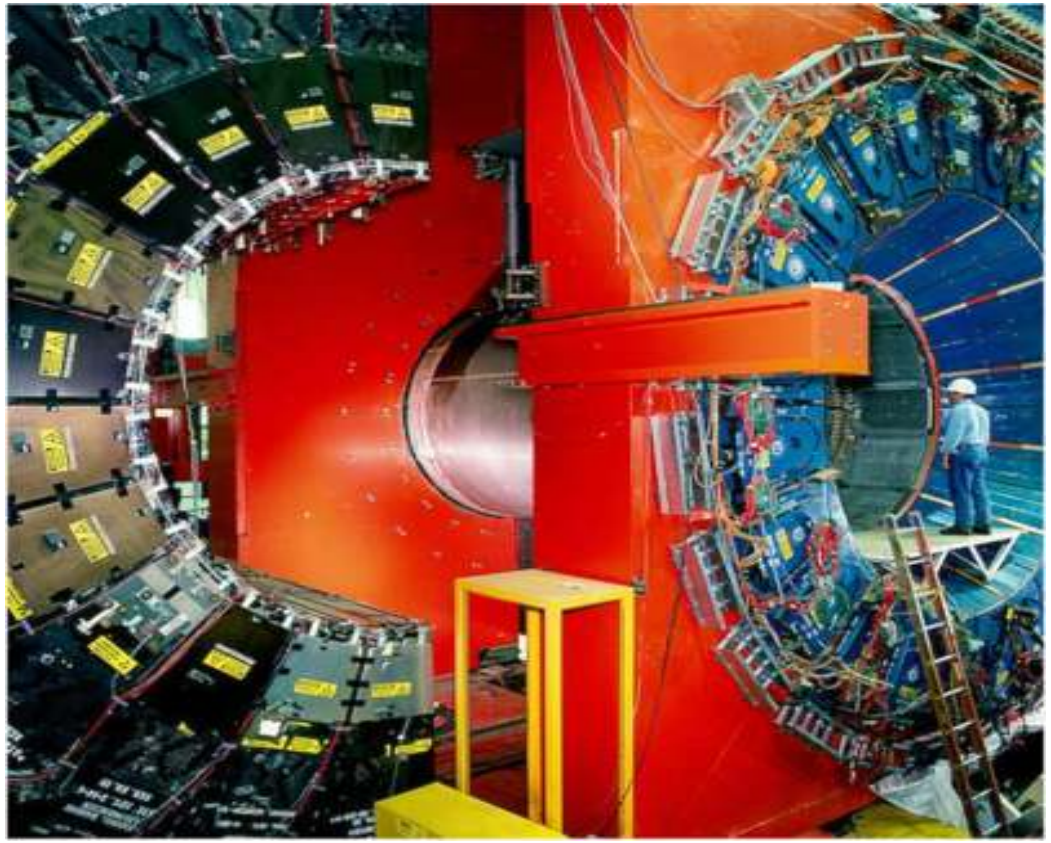
- CNPEM operates as a private, non-profit research ICT**, supervised and financed by MCTI,** with open, multi-user facilities and engineering and scientific teams that **co-develop solutions with companies and other ICT´s**.
- Accredited **EMBRAPII Unit** since 2014, enabling agile contracting and non-reimbursable co-funding for corporate RD&I projects.
- **Co-development, prototyping, and qualification** using CNPEM **infrastructure and expertise**. Innovation support covers **tech transfer/licensing**, advanced **technology services**, **scale-up**, and a Deeptech **acceleration program**.

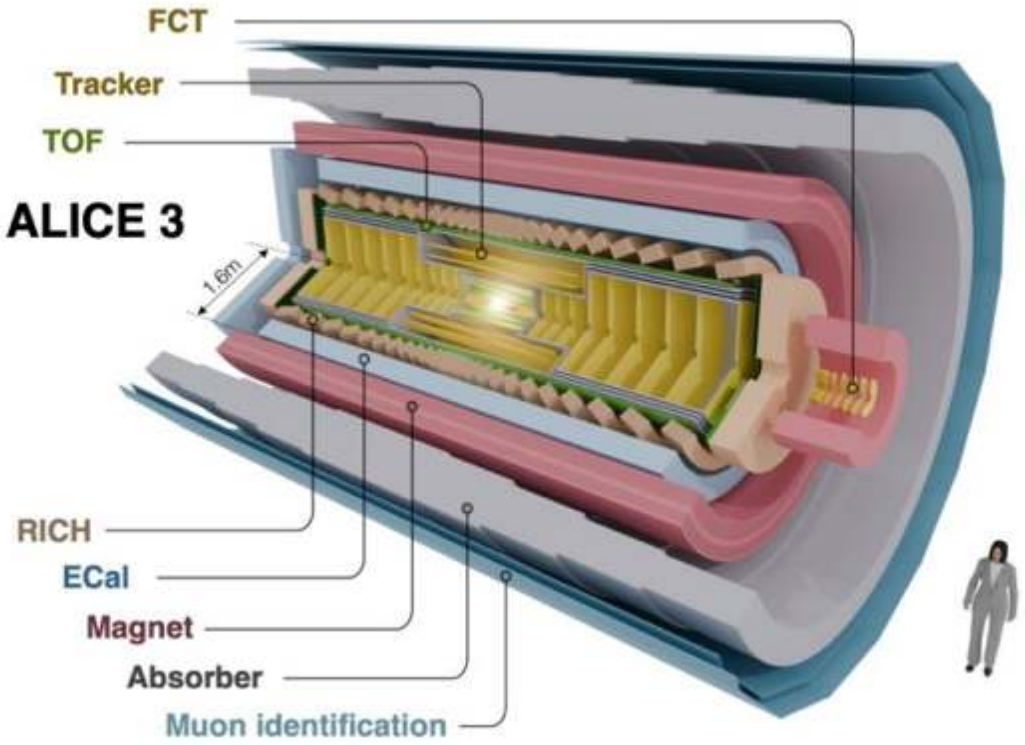
CERN's Next Big Projects



ALICE Detector

ALICE (A Large Ion Collider Experiment) is **one of CERN's major experiments** dedicated to the study of heavy ion collisions. Installation of the new ALICE detector is targeted for the LS4 period, with commissioning around 2034.





A new **superconducting detector magnet** is required for ALICE 3, with design and industrialization currently under study.

The plan involves **developing and producing the magnet in Brazil**, engaging **national companies** with coordinated support from **Brazilian funding agencies**.

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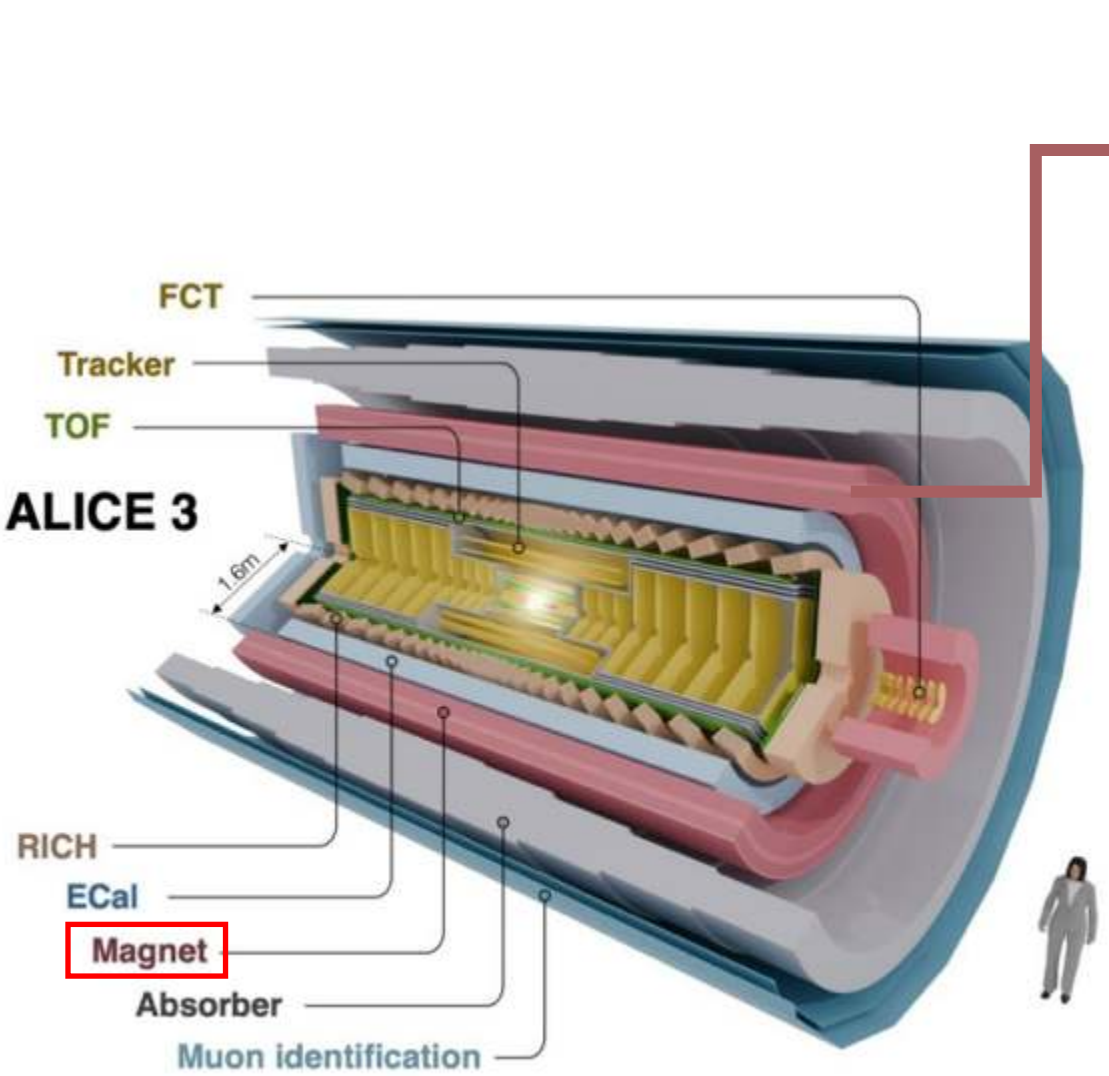
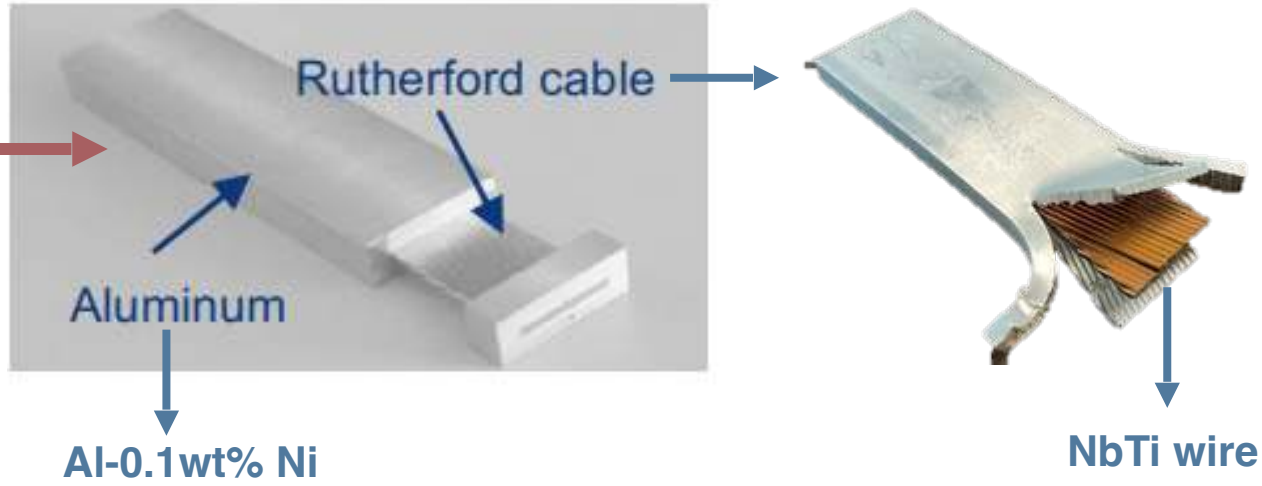
ALICE Magnet





Challenges:

- **Rutherford-type Cu/NbTi cable co-extruded with aluminium**: the conductor that generates the field in superconducting regime and is relevant well beyond ALICE to other CERN detectors and large magnets.
- **High-purity Al-0.1 wt% Ni**: qualified aluminum-alloy supply and processing capabilities remain limited, creating room for Brazilian producers and processors to qualify alloys and extrusion routes to CERN standards.

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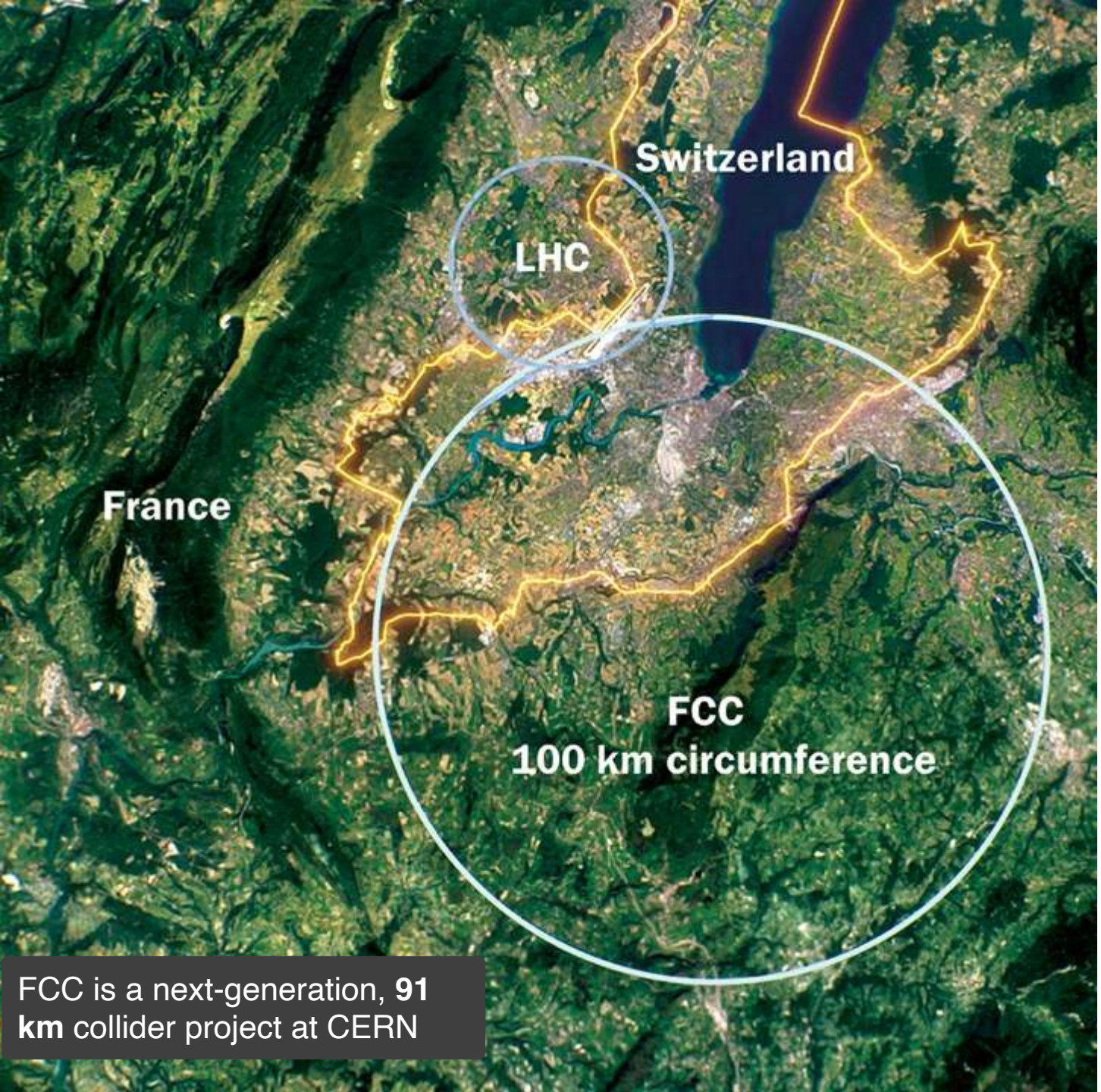

FCC is a next-generation, **91 km** collider project at CERN

FCC

- Two stages
  - FCC-ee (precision measurements) about 15 years from the late 2040s
  - FCC-hh (high energy) about 25 years from the 2070s
- The FCC team is conducting the **feasibility analysis** and advancing the **conceptual design**.
- The **large scale** and duration of FCC open **unprecedented opportunities for Brazilian companies** across magnets, cryogenics, vacuum, power systems, precision mechanics, and controls.

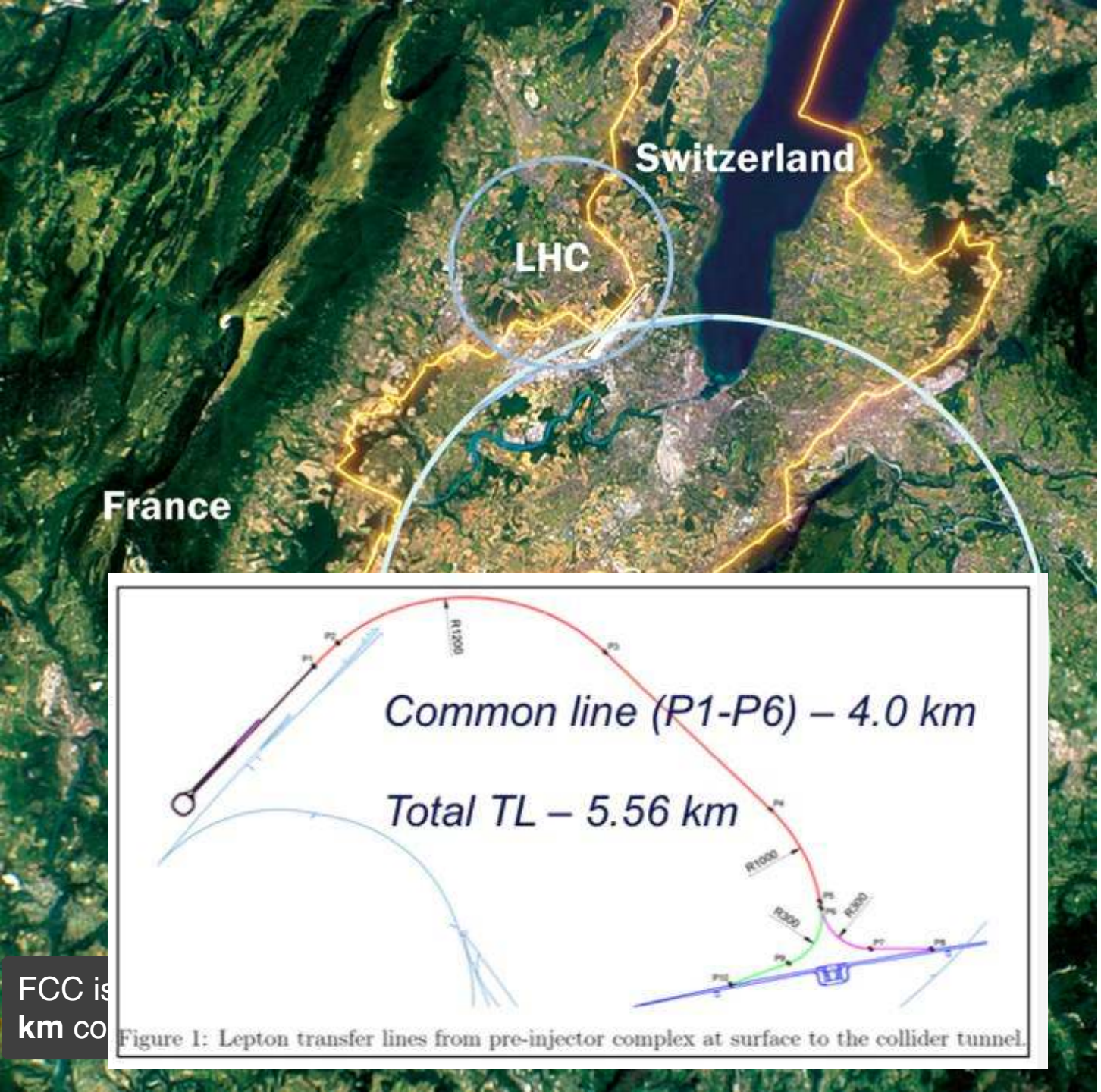

Figure 1: Lepton transfer lines from pre-injector complex at surface to the collider tunnel.

FCC is
km co

FCC

- Two stages
  - FCC-ee (precision measurements) about 15 years from the late 2040s
  - FCC-hh (high energy) about 25 years from the 2070s
- The FCC team is conducting the **feasibility analysis** and advancing the **conceptual design**.
- The **large scale** and duration of FCC open **unprecedented opportunities for Brazilian companies** across magnets, cryogenics, vacuum, power systems, precision mechanics, and controls.

- **In particular, the transfer lines will require a large number of high-quality dipoles, quadrupoles and correctors.**

Reference: *Future Circular Collider Feasibility Study Report, March 2025*

	Unit	Quadrupoles	Dipoles	Correctors
Total number		338	286x6=1716	224
# magnets in common line		162	192x6=1152	108
Length	m	1	1	tbd

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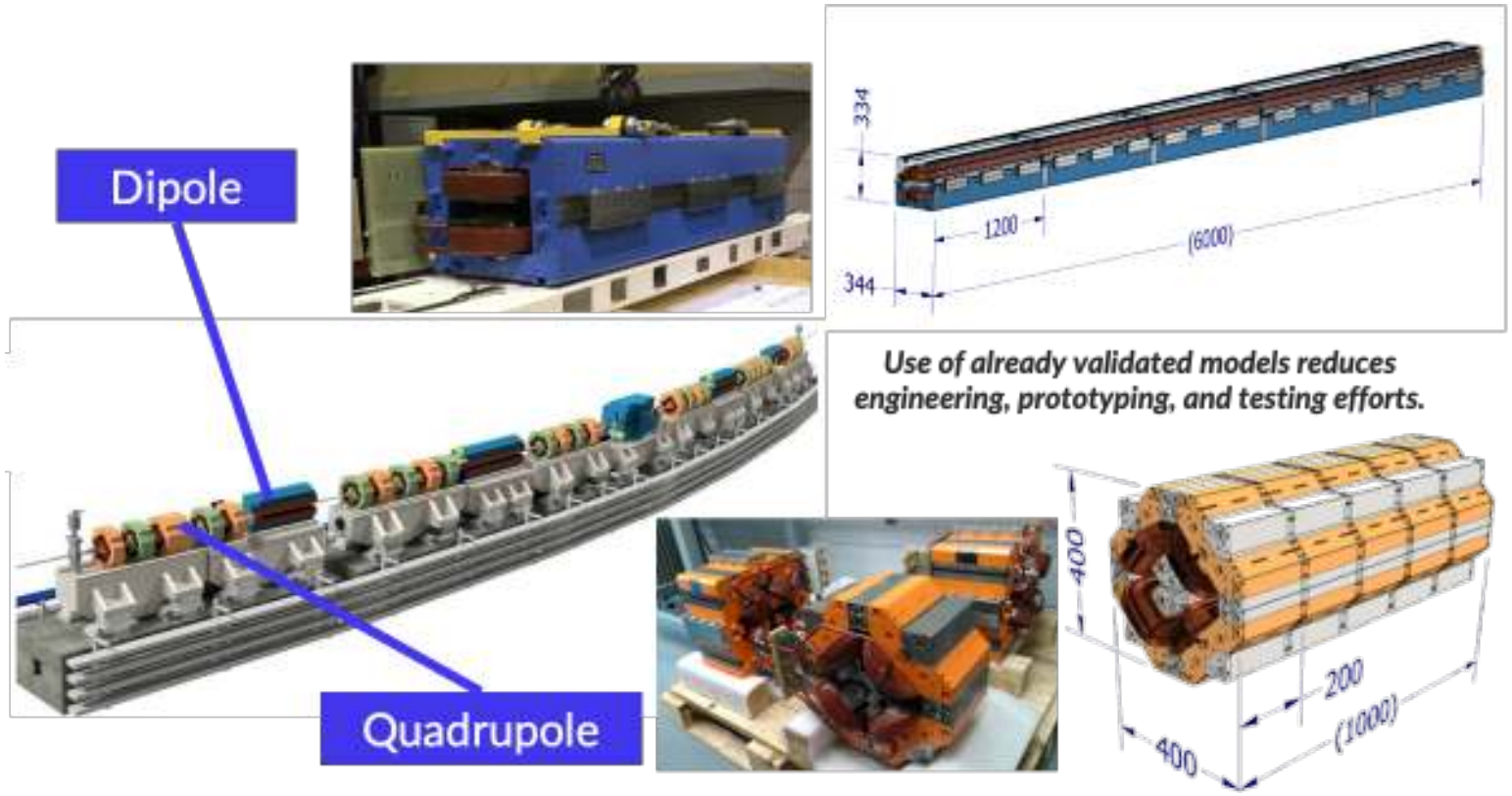
CNPEM's Proposal for FCC-ee Transfer Line

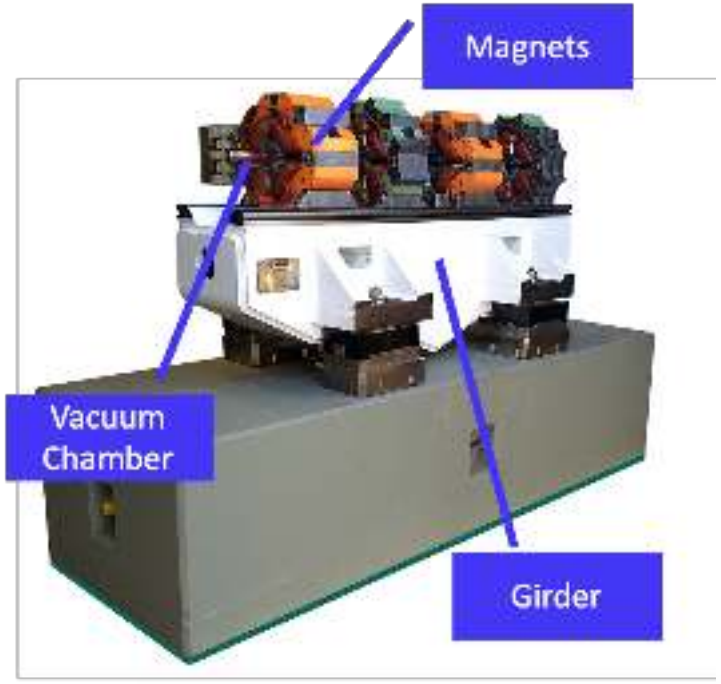
The proposal centers on **adapting the existing Sirius magnets for the FCC project**, leveraging models already produced and validated.

Minor modifications have to be implemented to ensure full compatibility with FCC-CERN specifications, aligning performance parameters and engineering requirements.

Key advantages include a significant **reduction in development effort**.

This approach **accelerates delivery timelines** and streamlines project execution for FCC-CERN.





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Thank you

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