

Overview of HEP Activities in Portugal

FCC Portugal Engagement Meeting




Ricardo Gonalo – UC / LIP

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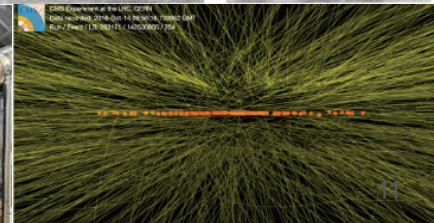
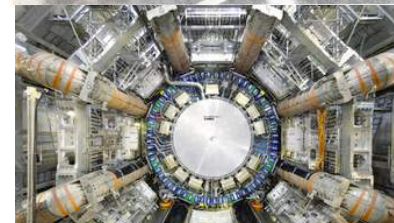
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COIMBRA

Outlook

- Portuguese HEP community
 - Portugal and the FCC
 - Experiments
 - Detector R&D
 - Theory and phenomenology
 - A little about LIP
 - Priorities and conclusions
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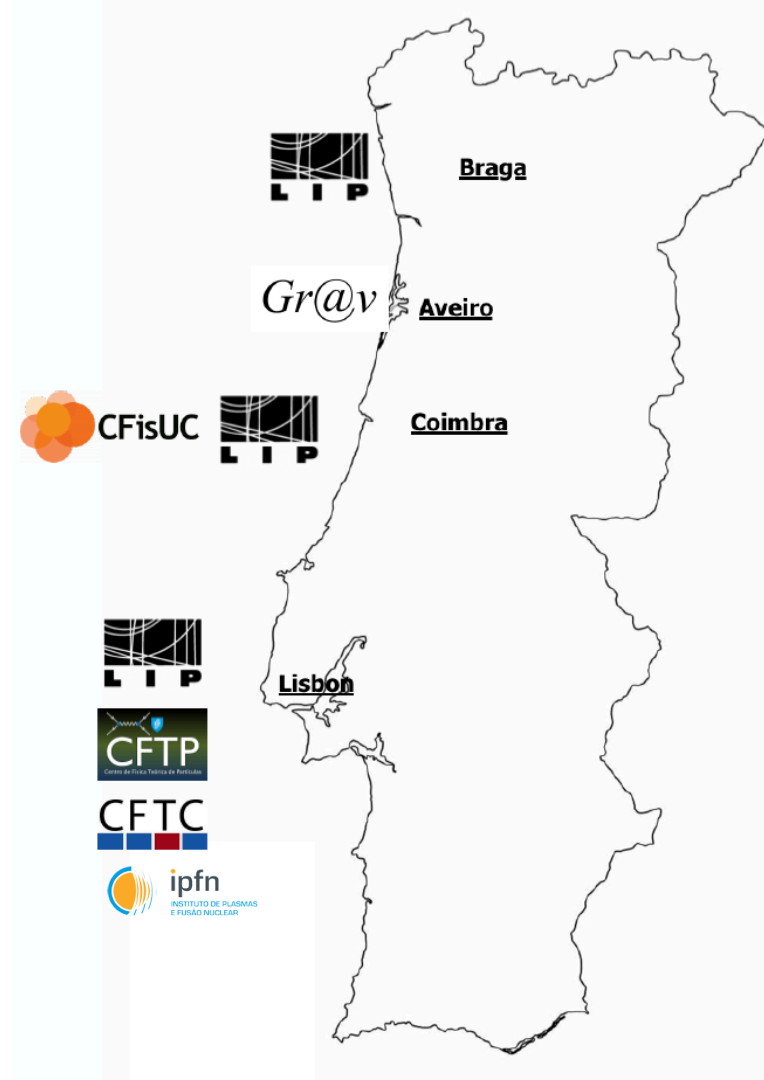
Portugal and CERN

- Portugal joined CERN in 1986
- Participated in the last 35 years of CERN's life:
 - Fixed target, LEP, LHC, HL-LHC, R&D, Theory
 - But also Training programs, ECFA, EPPCN, etc
- Want to participate in its future!

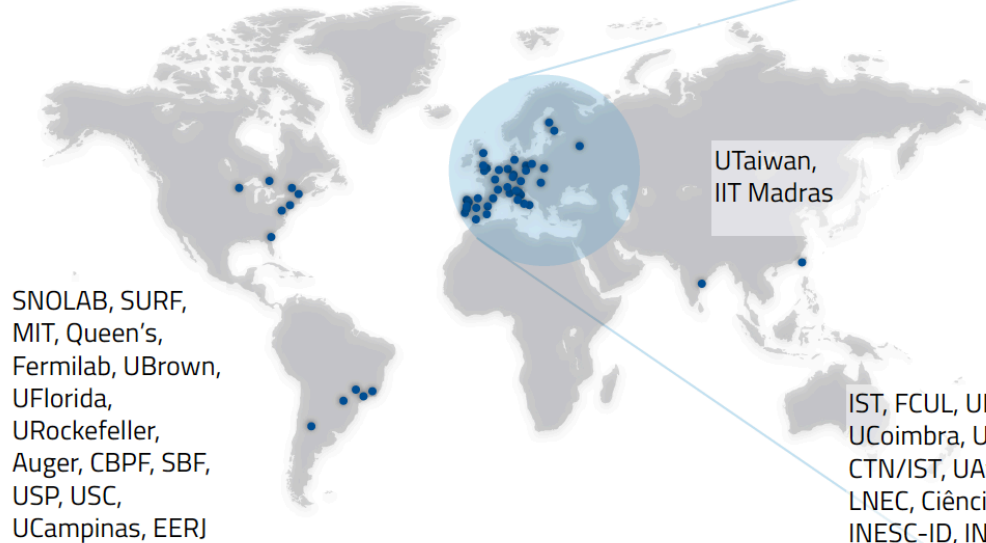


Portuguese HEP Community

- Around 350 people in Portuguese institutions
 - ~150 postgraduate students
- >100 CERN users
 - ~1/2 in LHC experiments
 - ~1/3 in Isolde
- Activity on:
 - **Experimental** particle physics (LIP)
 - **Detector** development for HEP and other (LIP, CFisUC)
 - **Grid/HTC computing** (LIP, FCCN)
 - Particle **theory and phenomenology** (LIP, CFTP, CFTC, CFisUC, Gr@v)
 - Plasma **wakefield** acceleration (IPFN)
- Close connection to universities in Lisbon, Coimbra, Minho
 - Also connections to several technology-based Portuguese companies working with CERN



Connections worldwide



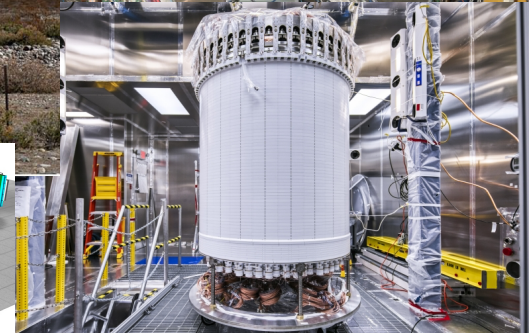
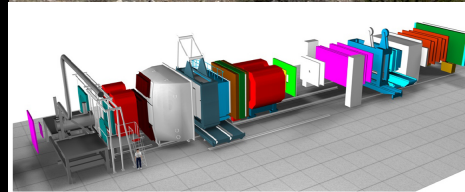
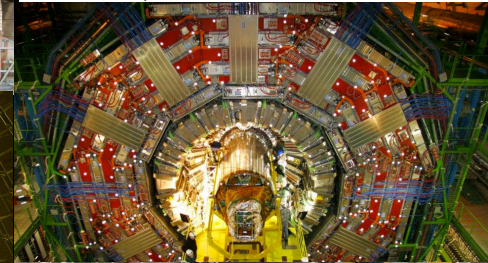
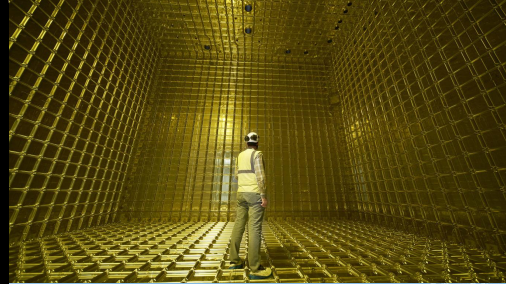
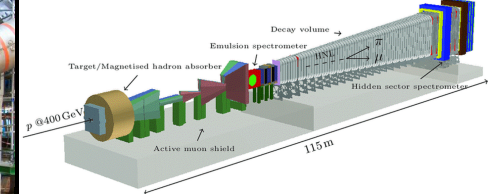
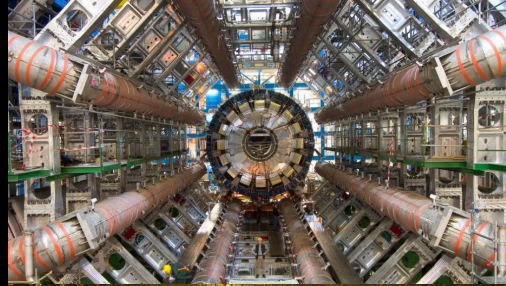
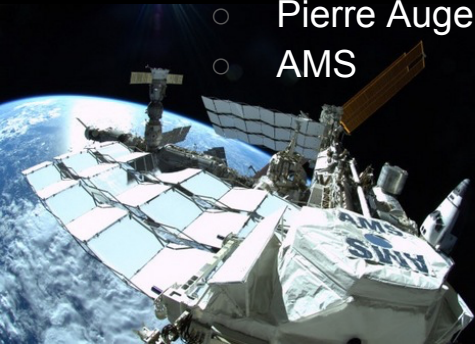
CERN, ESA, EGI, DESY,
HIP Helsinki, MEPhi,
Imperial College, USurrey,
UOxford, TUDresden,
LMU Munich,
HephyViena,
TUDortmund, IPPP, LPC,
TUDelft, GSI, Humboldt,
KIT, CEA, CESNET, PSI,
Clermont-Ferrand,
CYFRONET, PSNC,
Utrecht

IST, FCUL, ULisboa,
UCoimbra, UMinho,
CTN/IST, UAveiro, ICNAS,
LNEC, Ciência Viva, IBEB,
INESC-ID, INESC-TECH,
UBI, UÉvora, SPF,
ISEC/IPC, LIBPhys, BioSI,
CCMAR, ISEC, UPorto,
IMM, IGC, PORBIODATA,
FCT/FCCN

CSIC, IFCA, UPV, CESGA, BIFI, UAM, PIC,
Lifewatch ESFRI, UGranada, USC/IGFAE,
INFN, INAF, UFerrara, UTorino, UPadova,
UPisa, Udine, PoliMilano, PoliBari, LLR

Experiments

- At CERN:
 - LHC: ATLAS, CMS
 - Fixed target: COMPASS/AMBER, ISOLDE, SHIP/SND
- At GSI-Darmstadt: HADES
- Neutrino: SNO+, DUNE
- Dark matter: LUX, LZ
- Cosmic ray:
 - Pierre Auger Observatory
 - AMS



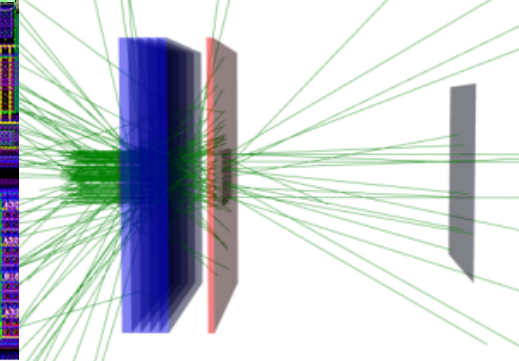
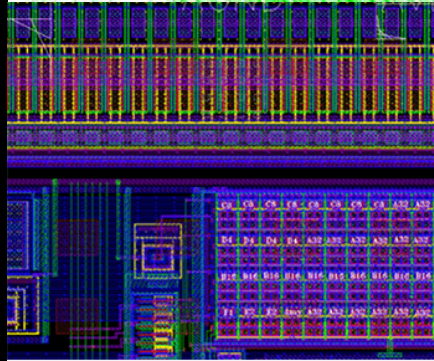
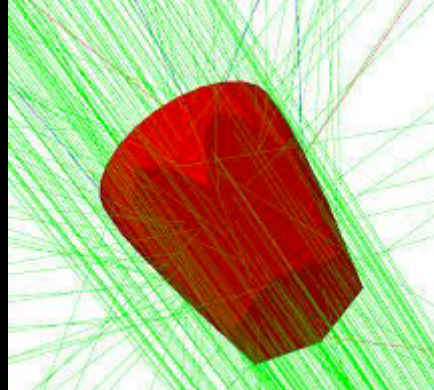
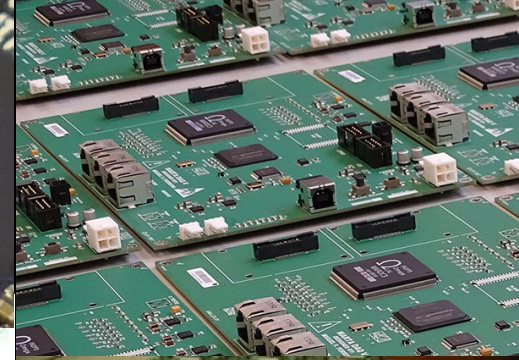
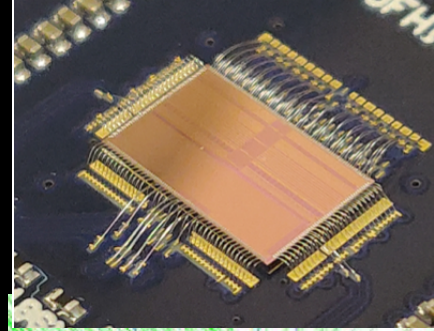
Detector development

- History of gaseous, noble liquid and scintillating detector development
- Contributions include e.g. ATLAS hadronic calorimeter and HADES time of flight detector
- Allowed to branch out into medical imaging instrumentation R&D, environmental monitoring, national security, and space applications



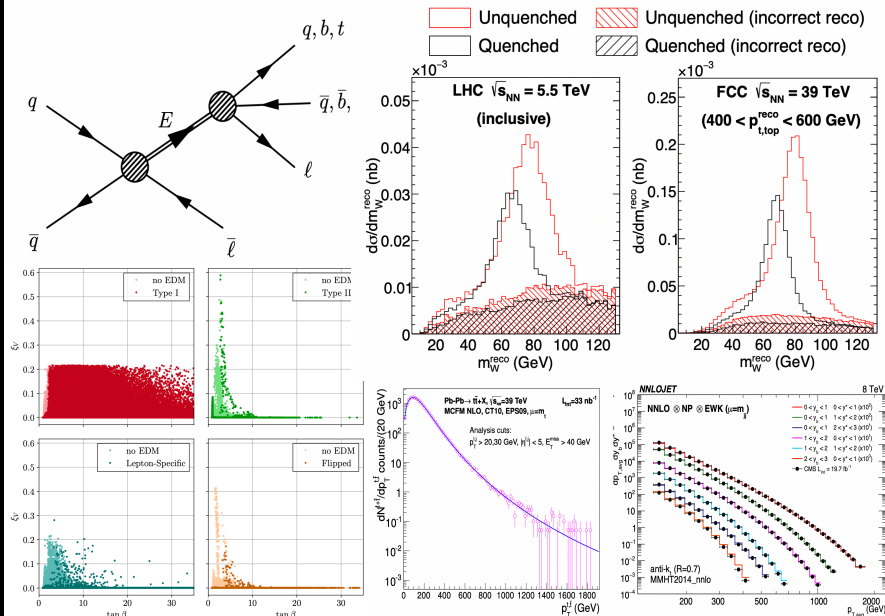
Electronics, simulation

- Also history in readout electronics for HEP
- Examples are synchronization board for CMS ECAL, or low power consumption front-end cards for Auger detector stations
- Competences in detector simulation with many applications from HEP to medical physics and space

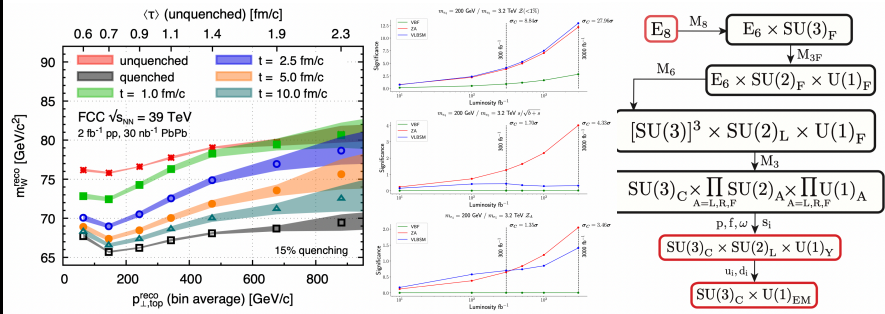


Theory and phenomenology

- Multi-Higgs models
- CP violation
- Flavour and BSM
- Effective field theory for searches
- Quark-gluon plasma
- Jets and QCD
- Hadronic cascade modelling
- Experimental observables for CP violation in Higgs sector
- Etc...
- Close links and fruitful exchange with experimental community

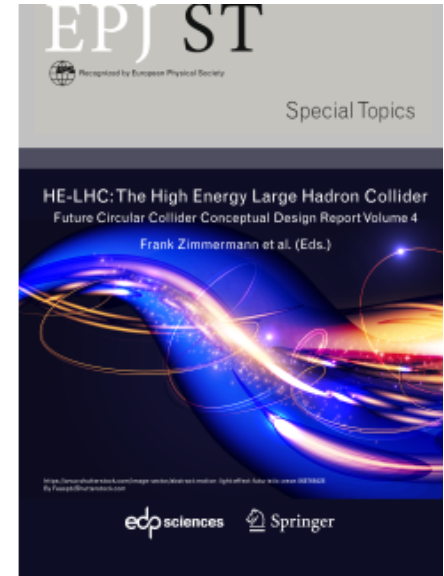
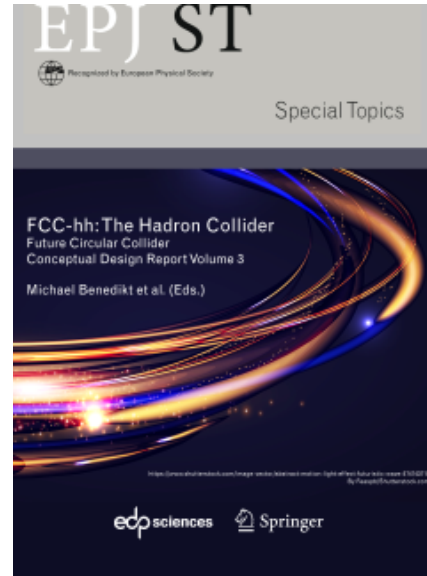


$$V = m_{11}^2 |\Phi_1|^2 + m_{22}^2 |\Phi_2|^2 - \left(m_{12}^2 \Phi_1^\dagger \Phi_2 + h.c. \right) + \frac{\lambda_1}{2} (\Phi_1^\dagger \Phi_1)^2 + \frac{\lambda_2}{2} (\Phi_2^\dagger \Phi_2)^2 + \lambda_3 (\Phi_1^\dagger \Phi_1) (\Phi_2^\dagger \Phi_2) + \lambda_4 (\Phi_1^\dagger \Phi_2) (\Phi_2^\dagger \Phi_1) + \left[\frac{\lambda_5}{2} (\Phi_1^\dagger \Phi_2)^2 + h.c. \right].$$



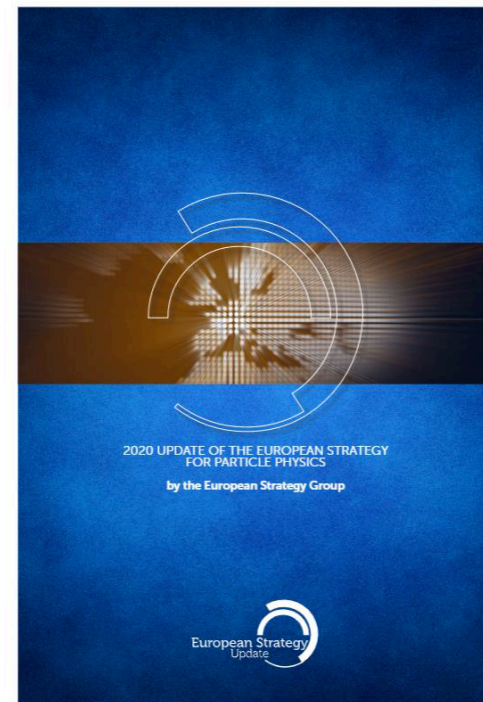
Portugal and the FCC

- Several contributions to the FCC Conceptual Design Report
 - Physics: Top, Higgs, Heavy Ion, etc – both theoretical explorations and feasibility studies
 - Detector design and studies
- Most contributors from
 - LHC experimental groups
 - LHC-related theory interests
 - These are the core of people here today



Portugal and the European Strategy for Particle Physics

- Contributed to the 2020 ESPP with local consultation
 - View that next major collider should be based at CERN
- Aligned with priorities set out by ESPP:
 1. Full physics exploitation of the LHC and HL-LHC
 2. Next priority is a e^+e^- “**Higgs factory**”
 3. Increased R&D on enabling accelerator technologies:
 4. Support neutrino projects in US and Japan
 5. Support high-impact scientific diversity programme complementary to high-energy colliders
- First strategy document approved at a special Restricted Session of CERN Council in **Lisbon, 14 July 2006**



Portugal and the FCC

- Public and scientific sessions organized following the 2020 update of the European Particle Physics Strategy



<https://indico.lip.pt/event/738/>

at IST, Lisbon
10 am, Sept. 28th Grande Auditório

PARTICLE PHYSICS
for the future of Europe

Related areas in Portugal and the role of CERN
in the future of European Science

<https://indico.lip.pt/event/748/>

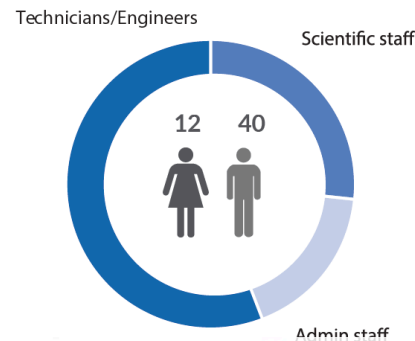
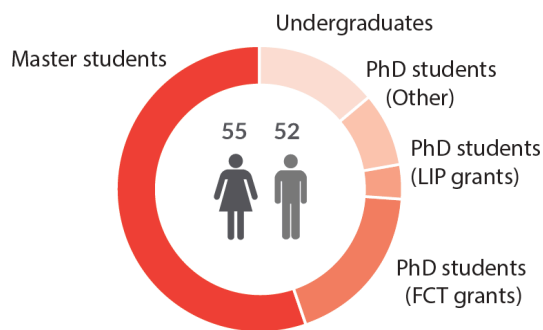
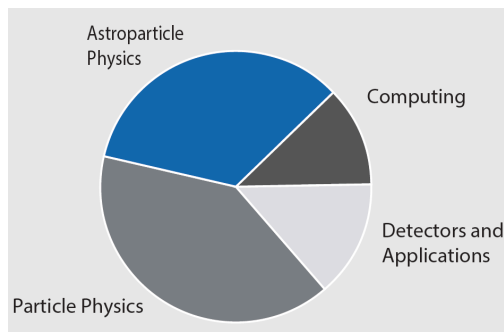
Organising Committee
Pedro Abreu (IST/LIP)
Gustavo Castelo-Branco (IST/CFTP)
Nuno Castro (UM/LIP)
Patrícia Conde (IST/LIP)
João Correia (C2TN/DECN/IST)
Michele Gallinaro (LIP/IST)
Ricardo Gonçalves (UC/LIP)
Brigitte Hiller (UC/CFisUC)
José Maneira (LIP)
Orlando Oliveira (UC/CFisUC)
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João P. Silva (IST/CFTP)
João Varela (IST/LIP)
Pedro Vaz (IST/C2TN)

European Strategy Update logo, LIP logo, and logos for INSTITUTO DE FÍSICA DE LISBOA, TÉCNICO LISBOA, and Santander Universidades.

<https://indico.lip.pt/event/748/>

A bit about LIP

- Concentrates experimental work in HEP in Portugal
- 243 members: 102 researchers, 107 students, 52 staff (~1/4 researchers)



Activity at LIP

4 pillars:

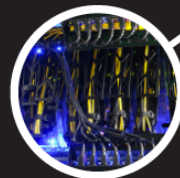
- Particle and astroparticle physics research
- Development of new instruments and methods
 - Detectors for experiments, health care, space, national security
- Computing
 - Supports scientific activity at LIP
 - Provides backbone of national scientific computing network with important impact across disciplines
- Outreach, advanced training, knowledge transfer
 - Essential to boost efforts of other areas in answering societal challenges
- Competence centers in
 - Monitoring and control
 - Simulation and machine learning



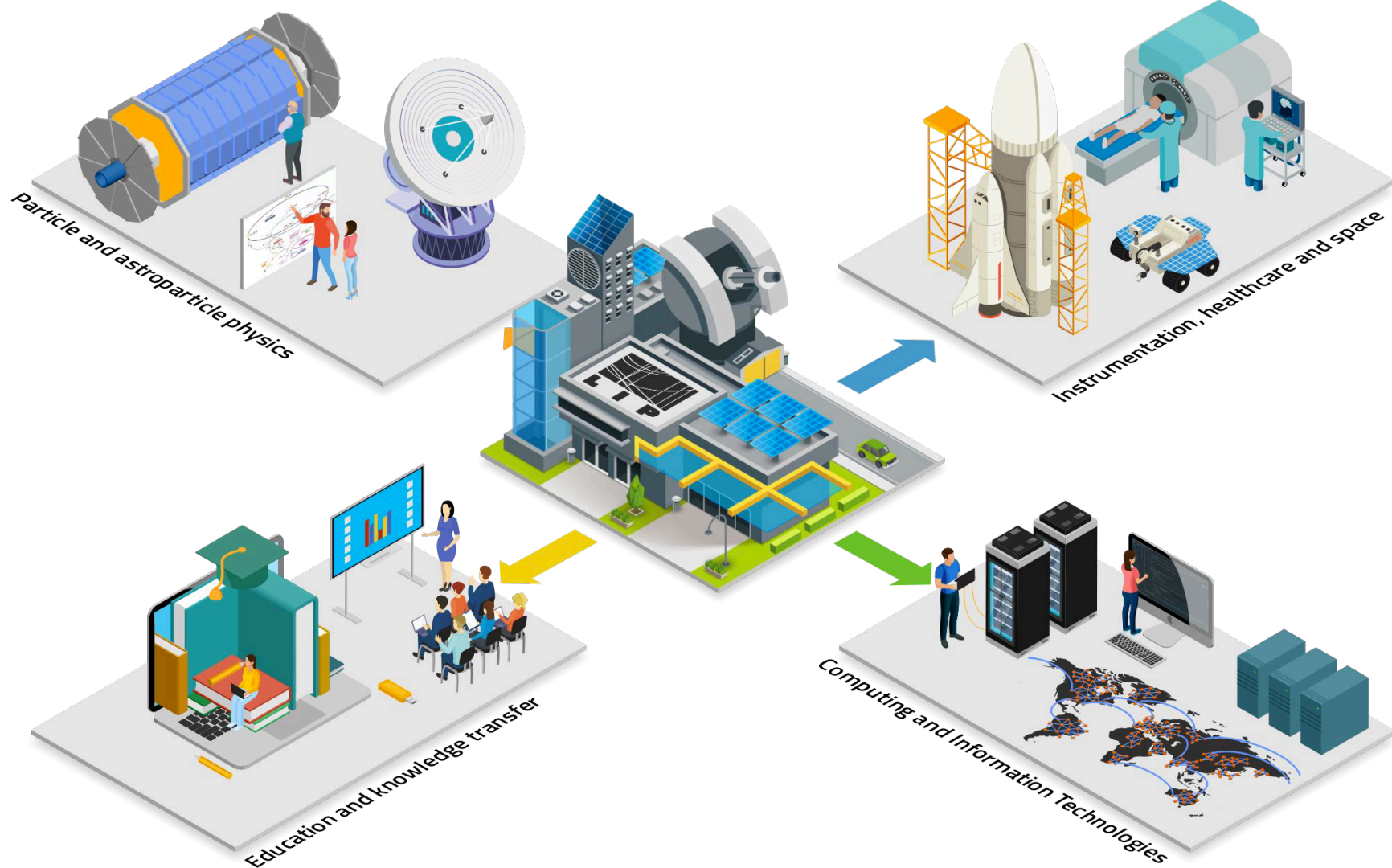
Phenomenology and
Experimental particle
and astroparticle
physics



Development of
new instruments
and methods

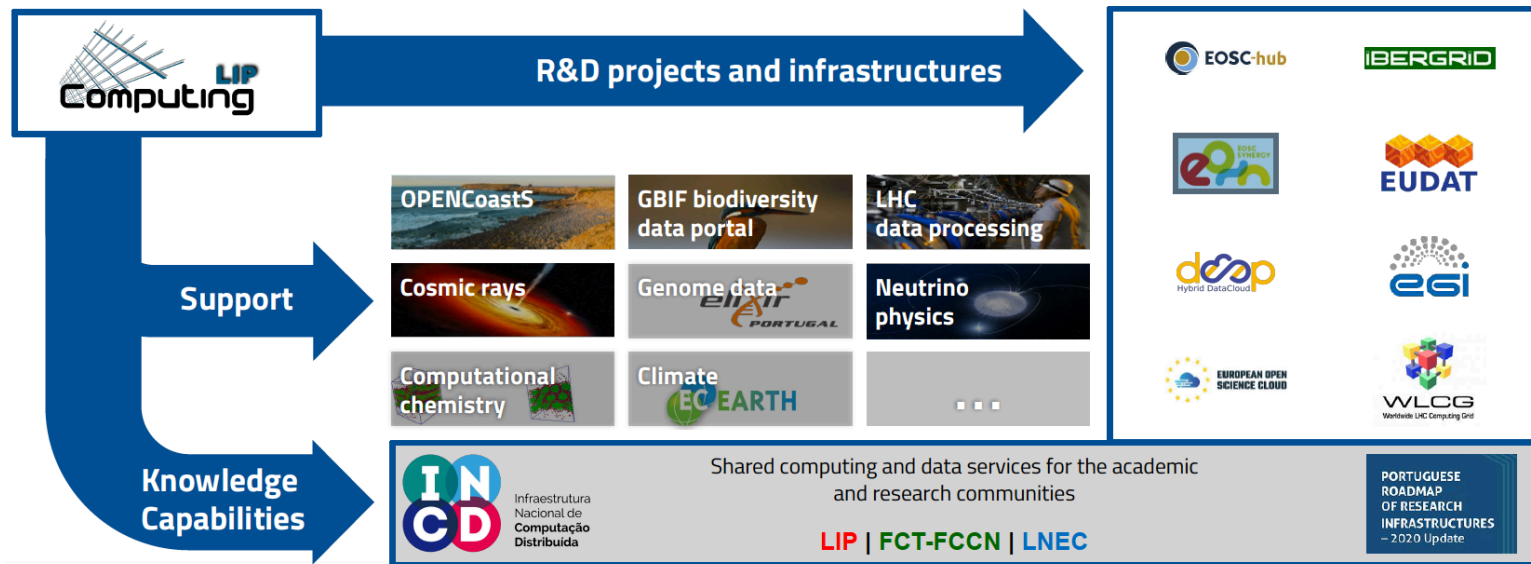


Computing



Computing

- Both infrastructure management and R&D
- Computing challenges posed by research in particle physics – huge requirements already from HL-LHC
- Extension to other domains across the public and private sectors

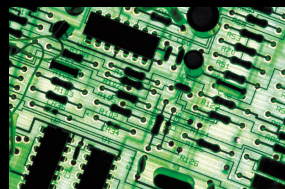


Infrastructures

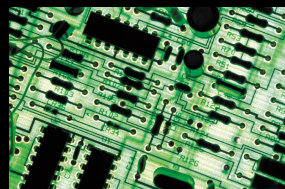
- Laboratory of Optics and Scintillating Materials – scintillating detectors
- Detector Laboratory – mostly gaseous detector
- Precision mechanical workshop
- Cosmic-ray electronics Laboratory – mostly front-end readout electronics
- TagusLIP Laboratory – electronics including front-end ASIC for HEP and PET



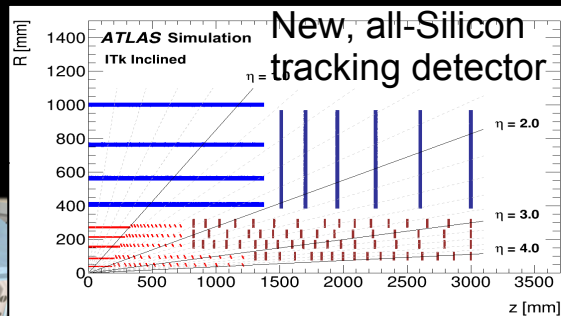
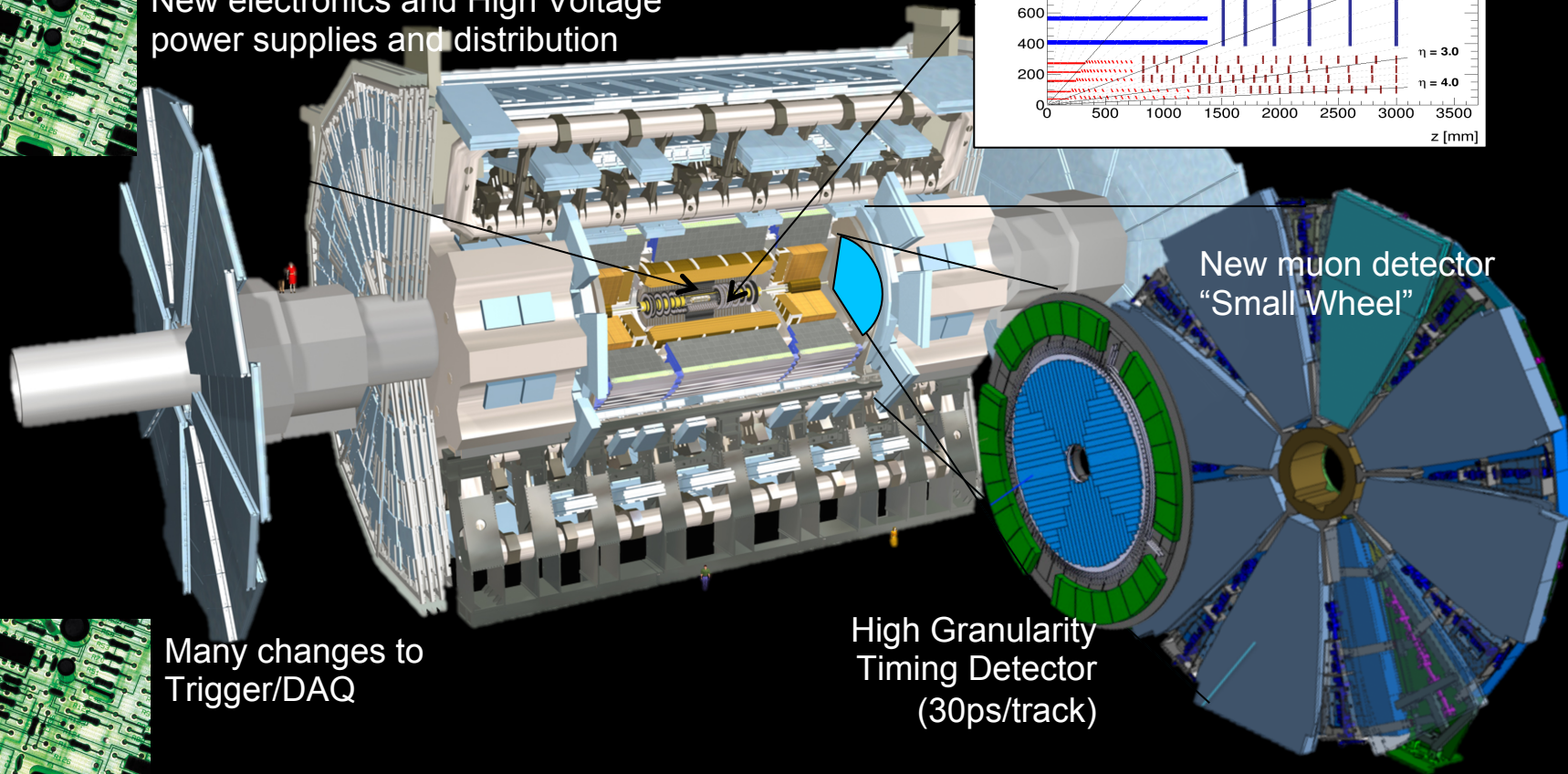
HL-LHC Upgrade



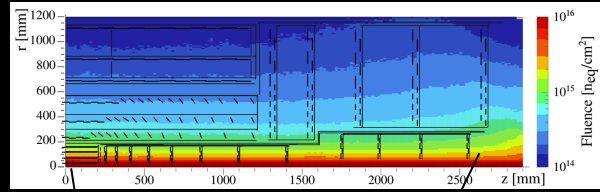
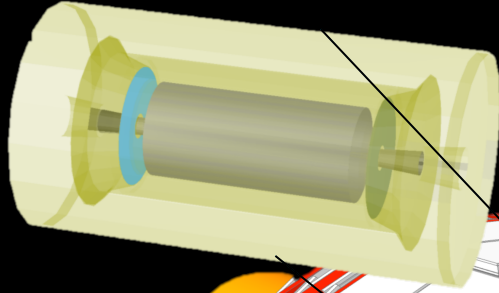
New electronics and High Voltage power supplies and distribution



Many changes to Trigger/DAQ



New MIP Timing Detector
(Barrel & Endcap)



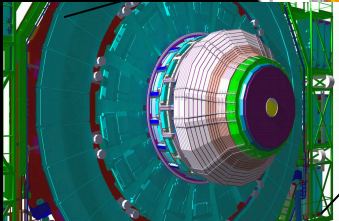
Replacement of
tracking detector

New electronics for
muon chamber
operation

Hardware to reconstruct
charged tracks (trigger)

New electronics for
calorimeter readout

New High
Granularity
Calorimeter



“The next accelerator and the next focus for particle physics must be in Europe. That is the only way to ensure that the best people will continue to come to Europe.”

José Mariano Gago, Special Restricted Session of the CERN Council,
1st European Strategy for Particle Physics, Lisbon, 14 July 2006



Conclusions

- We are a lively HEP community with a diverse set of activities and interests
 - Also R&D on plasma wakefield acceleration
- Most people interested in FCC come from LHC experiments and related theory
- LHC and HL-LHC are main priorities, but interest in FCC is growing
 - Relevant funded R&D project will start soon – on rad-hard plastic scintillator development
- See following talks by:
 - Michele Gallinaro on current LHC activities
 - João Pires with overview of theory work
 - Rute Pedro on perspective detector developments

Status of Global FCC Collaboration



Thank you!



LET'S INSPIRE PEOPLE



Outreach&Training

- Masterclasses, public events, visits to schools, CERN Portuguese language teachers school, engineers training programme, summer internships, etc

