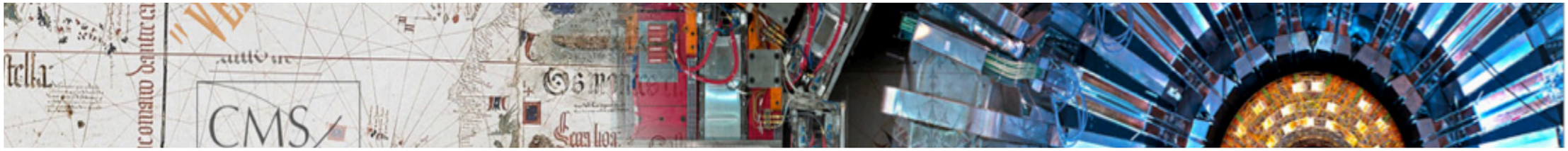


The CMS GROUP

OVERVIEW
2018+2019

JORNADAS LIP | BRAGA, FEB. 15TH, 2020

Bruno Alves, Mariana Araújo, Diogo Bastos, Pedrame Bargassa, Pietro Faccioli, Michele Gallinaro, Jonathan Hollar, **Nuno Leonardo**, Beatriz Lopes, Eliza Melo, Tahereh Niknejad, Ozlem Ozcelik, João Seixas, José Silva, Júlia Silva, Ksenia Shchelina, Giles Strong, Alex Toldayev, João Varela

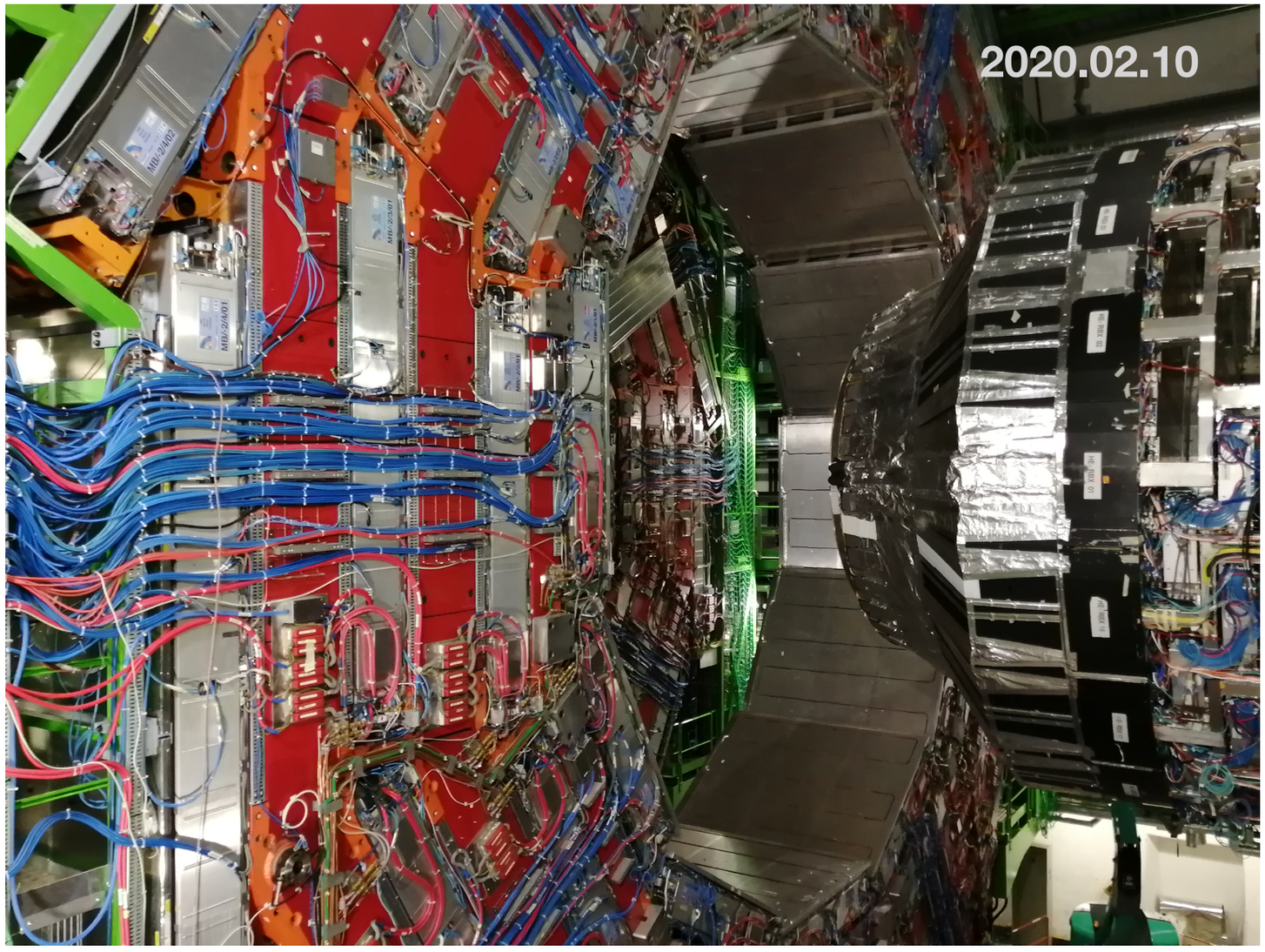
Collaborators: K.-F.Chen, A.David, S.Fonseca, C.Lourenço, C.Silva, P.Silva

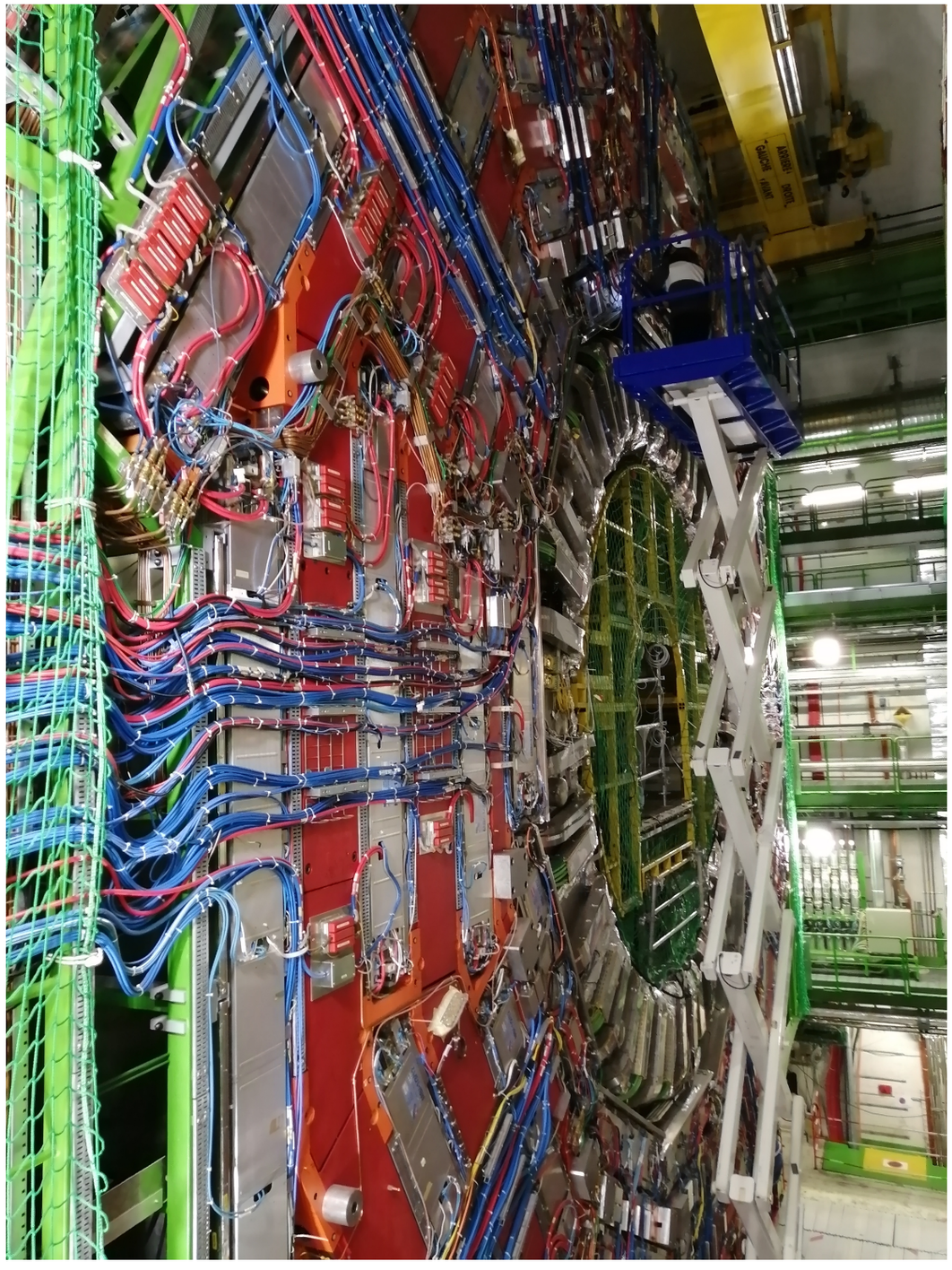
Internship students (2018-2019): M. Afonso, F. Albergaria, T.Alvim, M.Bengala, H.Borges, T.Cabos, V.Cardoso, R.Cipriano, G.Crupi, A.Faria, J.F.Gonçalves, J.P.Gonçalves, A.Gaspar, M. Guerreiro, B.Lopes, J.Lourenço, A.Mosso, J.Neves, A.Oudot, A.Pardal, N.Rebelo, R.Santo, L.Sintra, G.Vília, J.Vital

FCT Fundação para a Ciência e a Tecnologia

CERN/FIS-PAR/0006/2017 | IF/01454/2013/CP1172/CT0003 | IF/00772/2014/CP1248/CT0002 | AMVA4NewPhysics-675440

The CMS Detector today





How our detector looked liked earlier this week.

The CMS Detector tomorrow

Trigger/HLT/DAQ

- Track information in L1-Trigger
- L1-Trigger: 12.5 ms latency – output 750 kHz
- HLT output 7.5 kHz

Barrel ECAL/HCAL

- Replace FE/BE electronics
- Lower ECAL operating temp. (8 °C)

Muon Systems

- Replace DT & CSC FE/BE Electronics
- Complete RPC coverage in region 1.5<h<2.4
- Muon tagging 2.4<h<3

New Endcap Calorimeters

- Rad. tolerant – high granularity
- 3D capable

Precision Proton Spectrometer | PPS

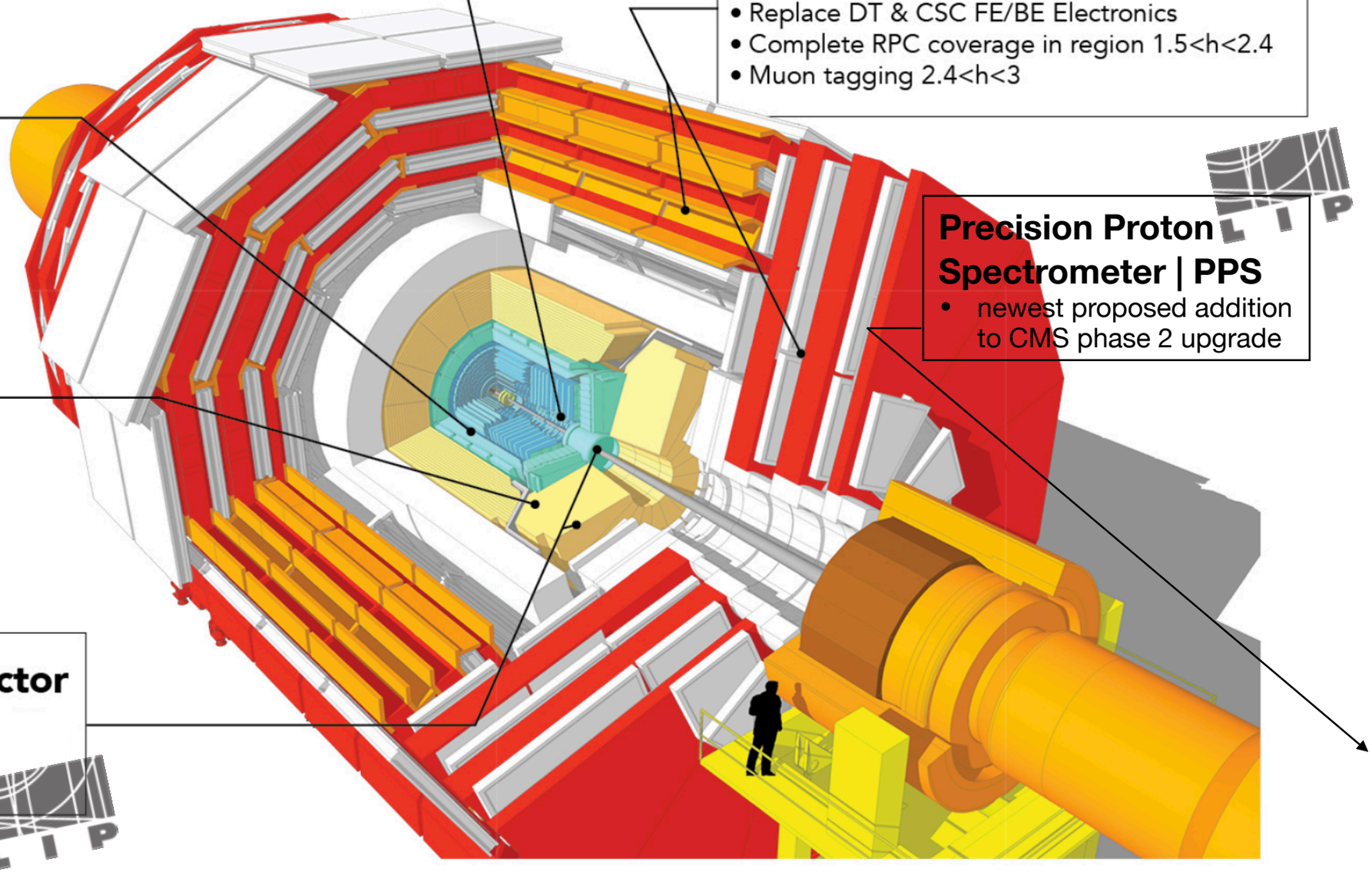
- newest proposed addition to CMS phase 2 upgrade

New Tracker

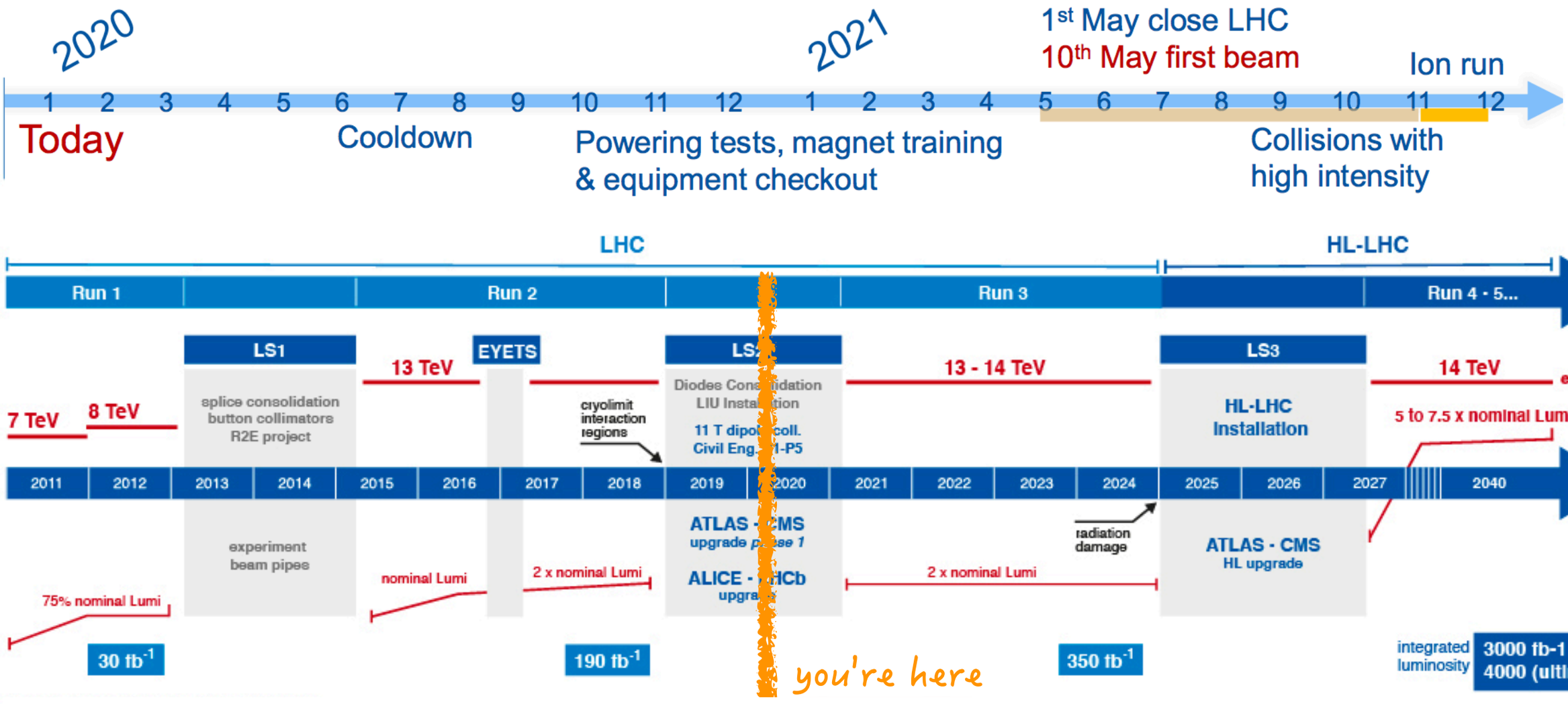
- Rad. tolerant – high granularity – significant less material
- 40 MHz selective readout (pT>2 GeV) in Outer Tracker for L1 -Trigger
- Extended coverage to h=4

MIP Precision Timing Detector

- Barrel: Crystal +SiPM
- Endcap: Low Gain Avalanche Diodes



The LHC schedule



Updates to schedule (being refined):

- LS2 extended by 2+ months
- 2021: reduced pp run (8-20/fb); 1month PbPb run
- energy (13 vs 14TeV) to be decided early 2021, desirably constant for entire run
- Run3 extended by 1 year; LS3 to start 2025

Group activities

- **Physics exploration of LHC data**
  - pp & PbPb — Run2 (&Run1) datasets
  - precision measurements & searches for rare processes
  - Higgs, Top, B, Quarkonia, EWK, SUSY, Dark Matter, QCD, QGP
  - HL-LHC projections: Heavy Flavour & Higgs (input for ESPPU)
- **Detector maintenance & operation**
  - PPS
  - ECAL
  - Computing
- **Detector upgrade** (HL-LHC)
  - MTD
  - ECAL, HGCAL
- **Training & Outreach**
  - @CERN, @LIP, @IST

➡ PPS talk by **Jonathan**

➡ MTD talk by **Tahereh**

Physics analysis highlights

- **Higgs**
  - HH→bbττ, H→ττ, H→Qɣ
- **top/EWK**
  - tt→bblτ, W→τ/μ (LFU); pp→pptt, ppWW

➡ top talk by Alex

- **SUSY/DM**
  - stop→bffχ (4-body); pp→H+MET

➡ SUSY talk by Diogo

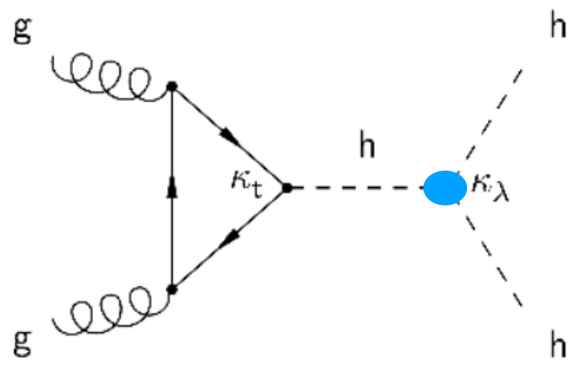
- **Quarkonia**
  - P-wave polarizations, $\chi_c \rightarrow \psi\gamma$
- **B physics**
  - B production&properties; B→μμ
- **Heavy ions**
  - B hadrons as QGP probes, B→ψX

search: HH production

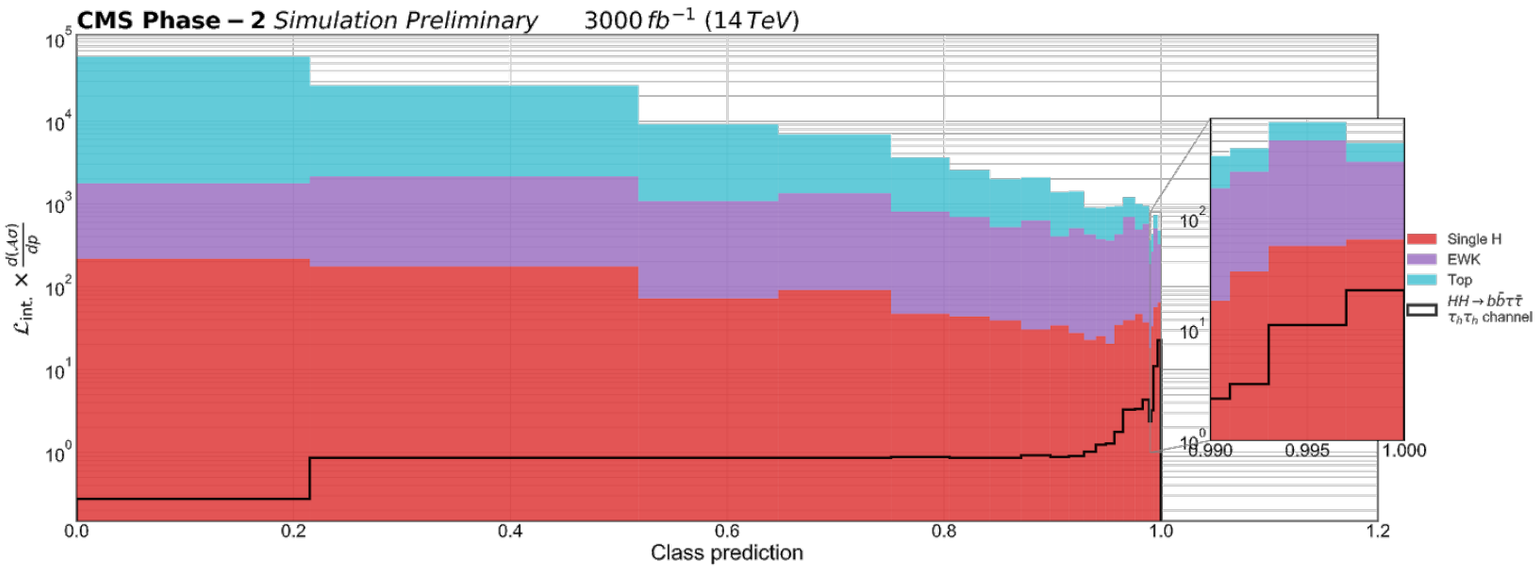
G.Strong, M.Gallinaro, M.Bengala, R.Santo

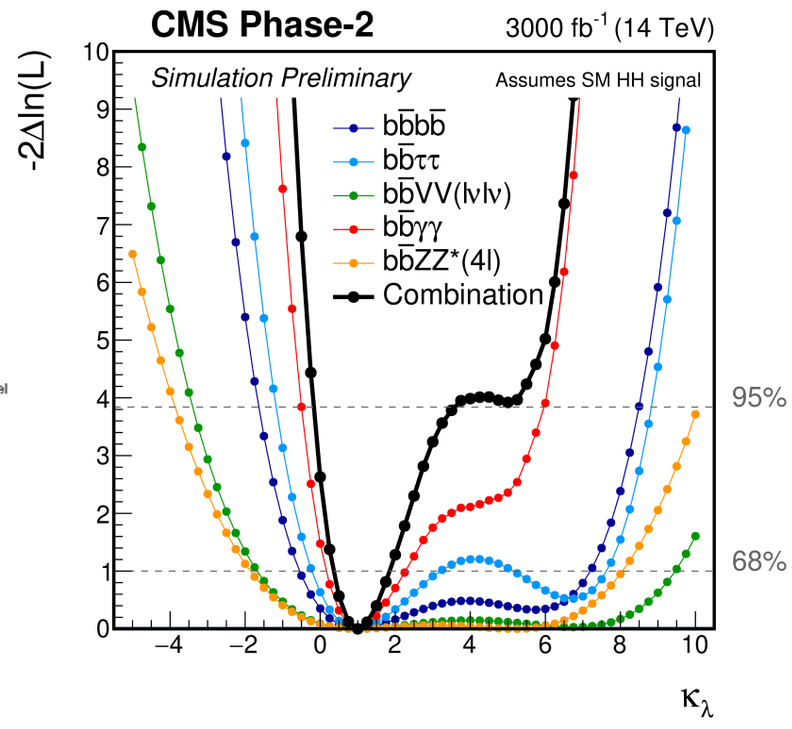
- probe the Higgs self-coupling
- search for HH→bbττ using full Run2 data
- sensitivity improvement w/ advanced deep learning
- delivered sensitivity study for HL-LHC

HH current Run2: 10xSM
expect HL-LHC: 3σ



CYRM-2019-007.221





Higgs ML challenge paper

G.Strong, arXiv:2002.01427
Matches performance of winning solution but with large reduction in train and inference time, and hardware requirements

LUMIN

PyTorch wrapper for HEP

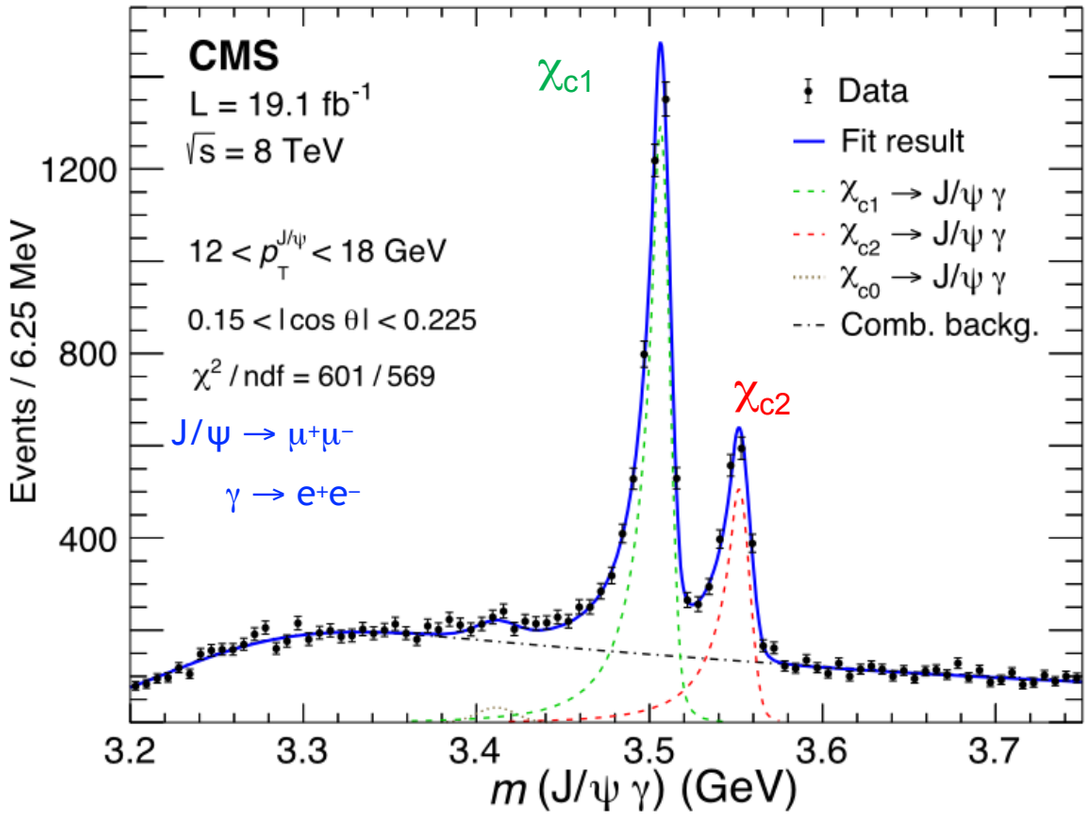
lumin.readthedocs.io

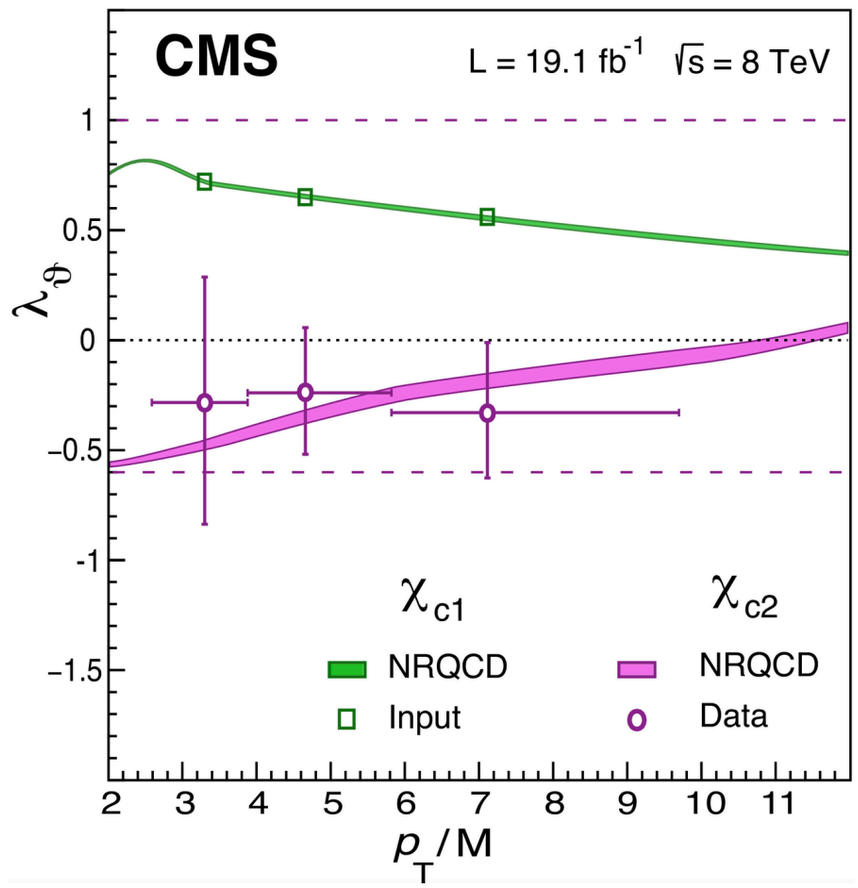
measurement: χ_c polarisation

M.Araújo, P.Faccioli, J.Seixas

- first measurements of P-wave quarkonium polarisations: χ_{c2}/χ_{c1} ratios
- yield first significant departure from unpolarized production scenario previously established for S-wave quarkonia: $\psi(nS)$, $\Upsilon(nS)$

arxiv:1912.07706 (PRL)





Signals reconstructed as $\chi_c \rightarrow J/\psi\ \gamma \rightarrow \mu\mu\ ee$ with photon conversions to e+e- pairs in tracker.

Polarisation extracted following proposed method:

P. Faccioli et al., PRD 83 (2011) 096001

$$W(\theta) = 1 + \lambda_\theta \cos^2\theta$$

study muon emission angle θ in J/Ψ rest frame

training & outreach

Researchers take CMS shifts LIP room @IST

(ECAL, Muon, Computing)

Undergraduate student chats

A última tomada de dados do LHC Run2

A experiência CMS na sala LIP@IST

20/11/2018

O quê: turnos de tomada de dados de CMS no LHC

Quando: 19-25/11(evento especial 20/11 às 15:00-18:00)

Onde: Sala LIP no IST (à entrada do edifício de Matemática/Física)

Porquê agora: próxima oportunidade só daqui a 2 anos!

Certifying CMS data quality from the LIP ROC at IST

The LHC provides CMS with millions of collisions each second, and a wealth of physics data is obtained from the proton-proton interactions. Before the data is made available for physics analyses, however, it needs to be ensured that all relevant CMS sub-detectors were performing optimally during the data

High school student visits @CERN

MSc theses

CERN-THESIS-2018-274
https://cds.cern.ch/record/2649927
Defense: May 2018

CERN-THESIS-2019-256
https://cds.cern.ch/record/2705630
Defense: October 2019

CERN-THESIS-2019-280
https://cds.cern.ch/record/2708053
Defense: December 2019

TÉCNICO LISBOA

TÉCNICO LISBOA

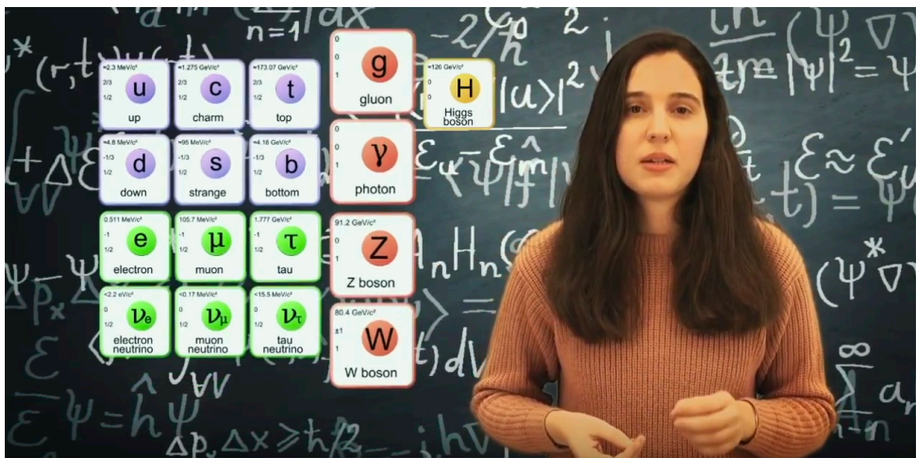
TÉCNICO LISBOA

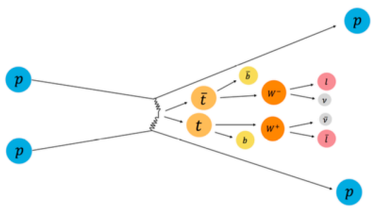
Measurement of b-quark fragmentation fraction ratios at the CMS experiment: a key ingredient for the $B_s^0 \to \mu^+\mu^-$ rare decay analysis

Bruno Afonso Fontana Santos Alves

Probing the quark gluon plasma medium through B meson production measurements in PbPb collisions at the LHC

Júlia Manuela Cardoso Silva





Search for exclusively produced top quark pairs at the LHC

Beatriz Ribeiro Lopes