CMS status
IGFAE retreat

X. Cid Vidal (IGFAE)

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INSTITUTO GALEGO
DE FÍSICA
DE ALTAS ENERXÍAS

USC UNIVERSIDADE DE SANTIAGO DE COMPOSTELA
MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES
AGENCIA ESTATAL DE INVESTIGACIÓN
EXCELENCIA MARÍA DE MAEZTU 2024-2029
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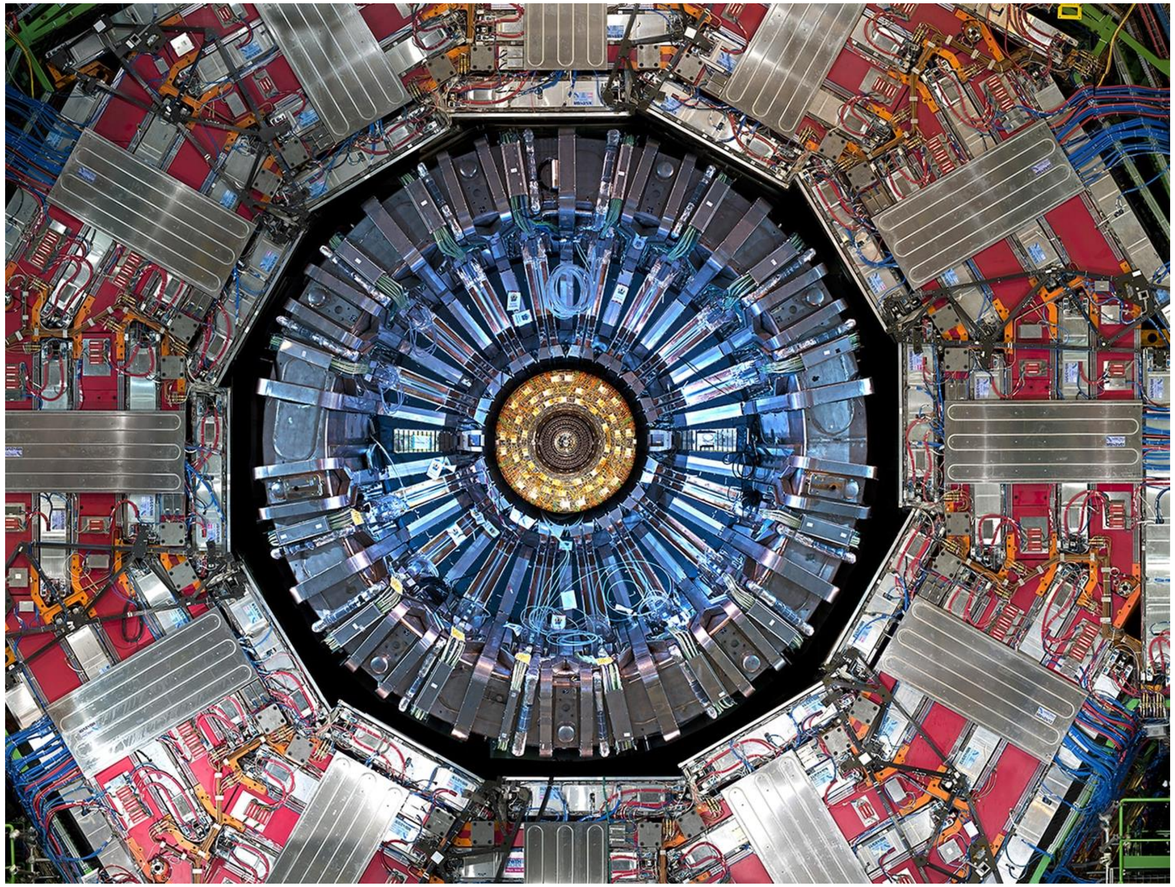
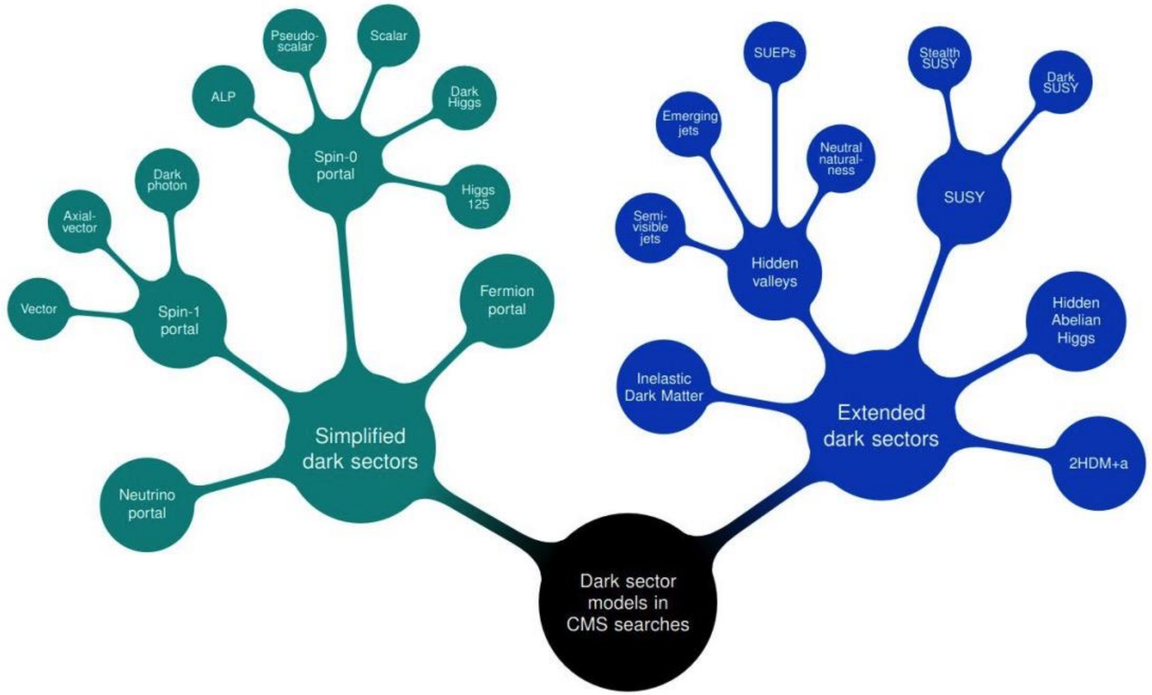
The CMS Experiment at CERN (I)

- **Compact Muon Solenoid (CMS),** one of two general-purpose detectors at the LHC, collecting data since 2010
  - 21 m long, 15 m diameter, **14,000 tonnes.** Heaviest particle detector ever built!
- **Higgs boson discovery** co-announced with ATLAS on **4 July 2012**, completing the Standard Model of Particle Physics
  - Awarded the Nobel Prize in Physics 2013 (Higgs & Englert)
- **Global collaboration**. ~6,200 physicists from **240+ institutions** in 65+ countries



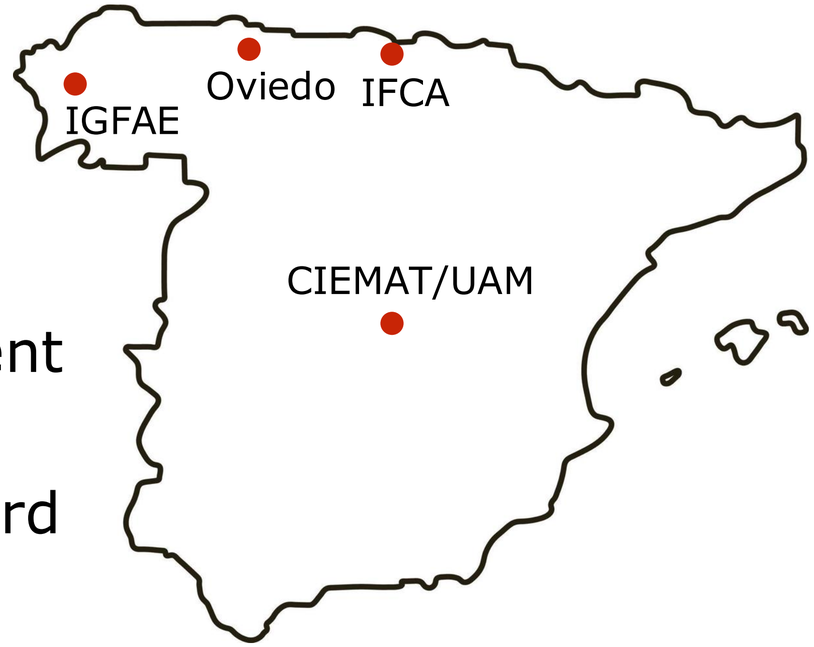
The CMS Experiment at CERN (II)

- **Superconducting solenoid magnet, 3.8 Tesla**, the most powerful superconducting magnet ever operated in a collider experiment
- **Data collected**, Run 2 (2016–2018): **150 fb^{-1}** at 13 TeV; Run 3 ongoing at record **13.6 TeV (~500 fb^{-1} collected in total)**
- **Rich physics programme,** precision SM measurements (including Higgs), SUSY, dark sector searches, heavy-ion physics
- Detector to be upgraded during LS3 (phase-2 upgrade) **will take data during Run 4 and 5** (till the 2040s). Move to a pile-up of ~200, big technological challenge



Application history

- **First local discussions started in early 2025, support from IGFAE,** opportunity to diversify activities of the institute.
  - Guarantee LHC activities beyond the 2040s (LHCb HL-LHC upgrade still under discussion, will hopefully happen too!)
- Discussions taking place at Spanish level since early 2025 too. **Support from all Spanish groups**
- Visit to IGFAE from CMS management in fall 2025, went very well!
- Presented IGFAE application in CMS Collaboration Board in Feb 26. Approved just a couple of weeks later
- **Funding**: Discussed with FPA-AEI coordinator (Pilar) too
  - Will apply for new national funding (Generación de conocimiento) application submitted by late 2026
  - Xunta de Galicia groups grant including CMS already



+ technical institutes in Aragon, Andalucia, Catalonia

The IGFAE CMS team

R. Soto Rey
MSc student

(PhD from September)

M. Pereira Martínez
PhD student

Soumya Dansana
Postdoc (from September)

Position got 16 excellent applications!

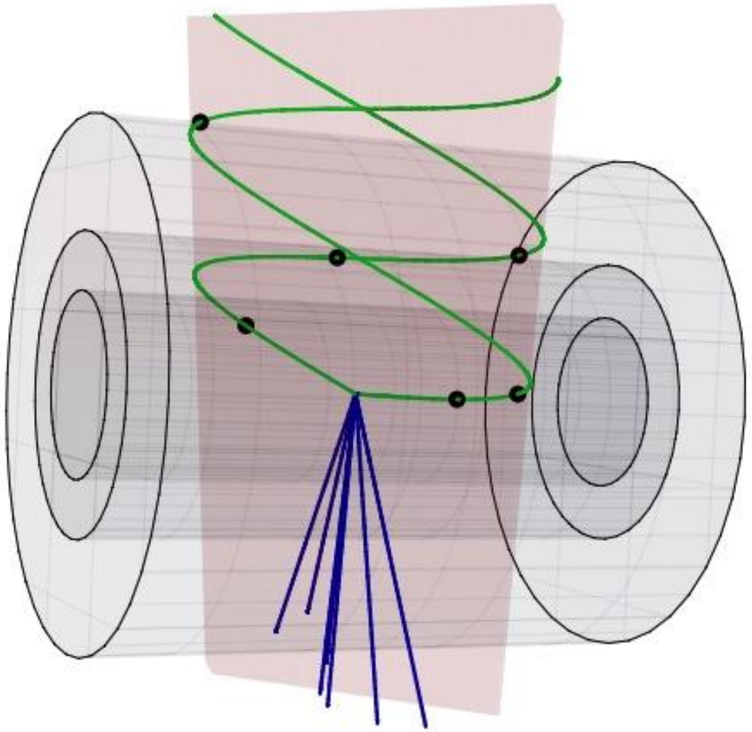
X. Cid Vidal
Associate Professor USC

+ multiple ongoing/future confirmed applications: ATRAE, TalentGal, LaCaixa, MSCA PF, Juan de la Cierva

Physics Program

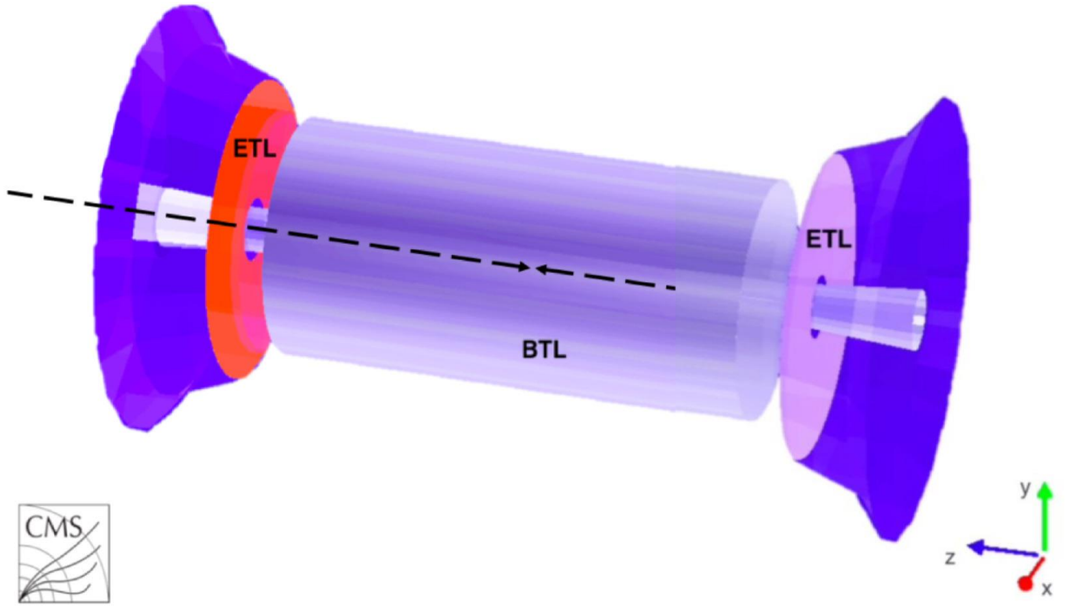
- **Long-Lived Particles (LLPs) & Dark Sectors**: Main motivation is to pursue searches for new physics via displaced signatures and unconventional topologies like quirks.

- **Examples of ongoing analyses:**
  - ttbar ALP associated production: ALPs decaying to dielectrons → access very light ALPs. Also, synergy with other very light dielectron analyses: TM, X17,...
  - Search for semivisible and emerging jets using anomaly-detection techniques, with graph autoencoders.
- Also, interest in strange-flavor physics or heavy-ion physics (ATRAE application)



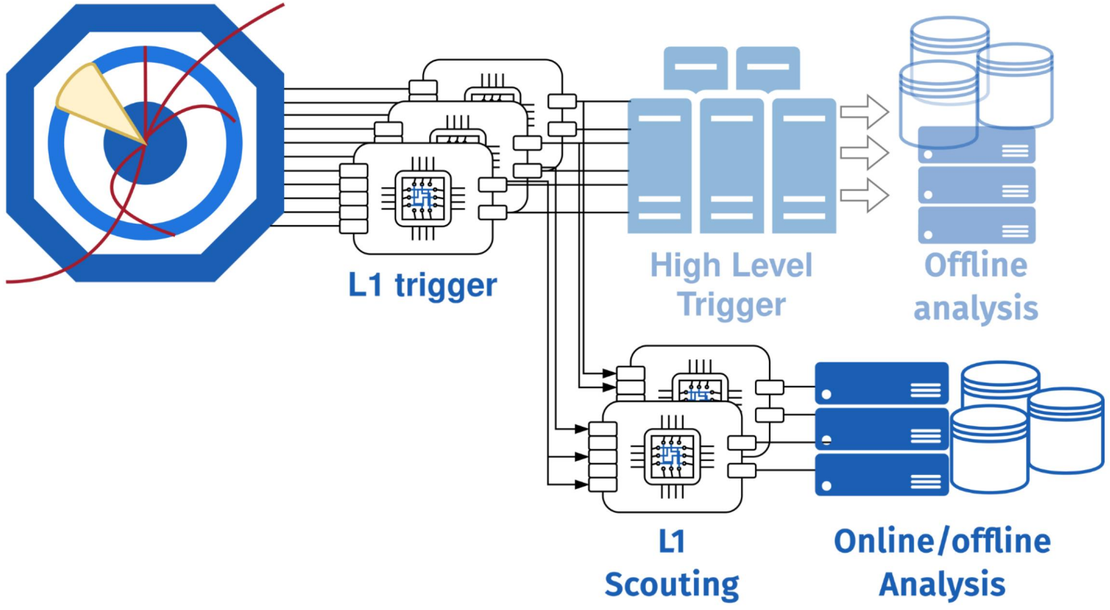
MIP Timing Detector (MTD)

- **Involvement in MTD**: Primary upgrade focus to enhance LLP sensitivity through 4D reconstruction and precise timing
  - *Software & Performance*: Focusing on the commissioning, reconstruction software, and performance characterization of the MTD, leveraging previous work in, e.g., CODEX-β
  - *Hardware*: Collaboration with IFCA (Cantabria), we'll help them with ETL assembly (LGADs)



Real-Time Analysis & L1 Scouting

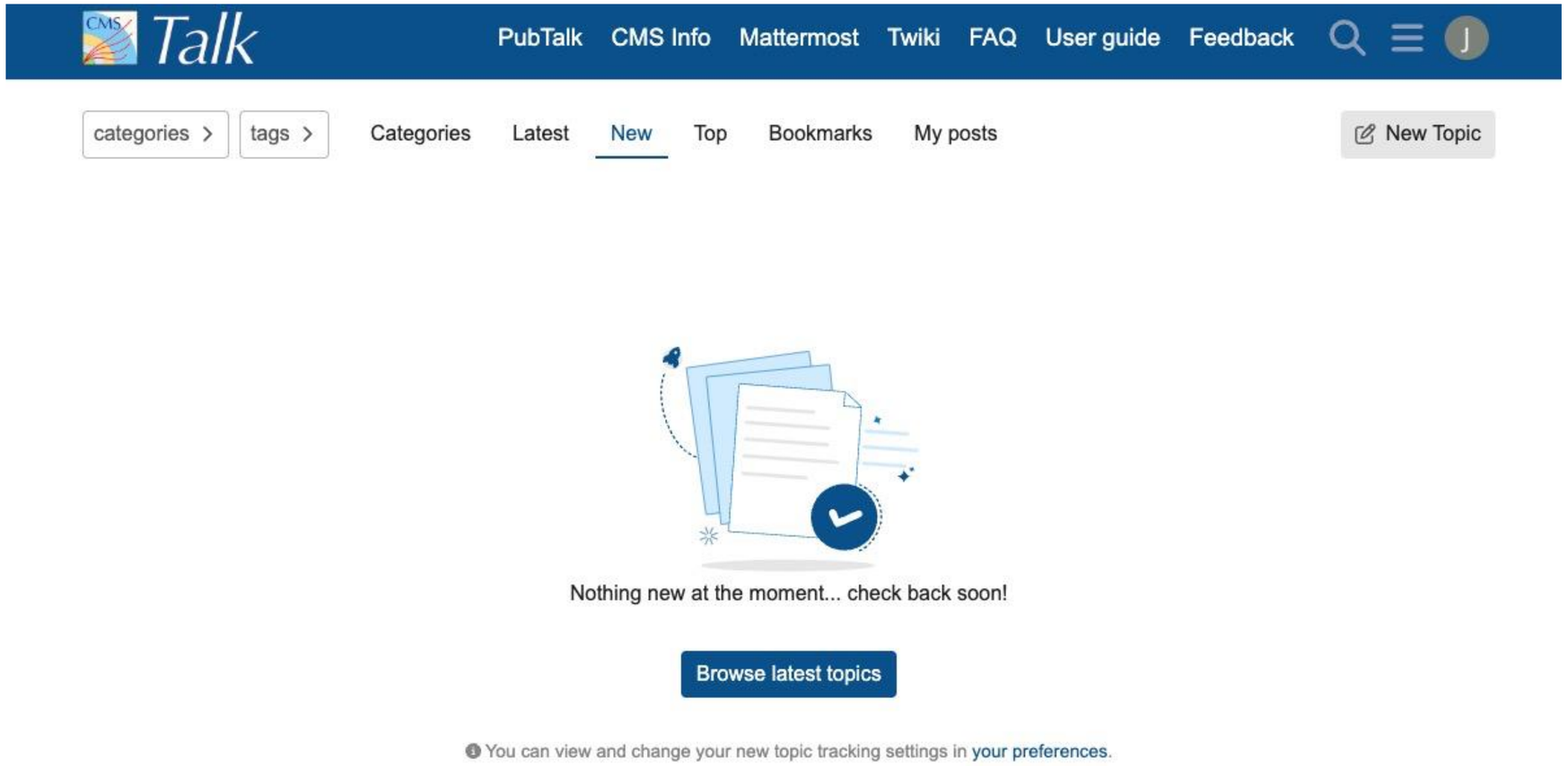
- **L1 Scouting for LLPs**: Study possibility to use L1 Scouting for real-time LLP detection, capturing signatures that fail standard trigger thresholds.
- **Trigger & Computing Expertise**: Porting algorithms from CPU to GPU frameworks, utilizing experience gained from LHCb's real-time computing environment.
- **Deployment & Commissioning**: Direct involvement in the software deployment, data validation, and commissioning phases of Scouting activities.



- **Anomaly Searches**: Exploring ML-driven anomaly detection as a natural extension of real-time data processing

...and more

- **Service & Outreach**: Commitment to CMS communication by helping maintain the CMSTalk and CMSPub pages



Conclusions

- **IGFAE formally joined CMS in February 2026**. ~1 year of groundwork, full backing from all Spanish CMS groups and CMS management
- **A new group is taking shape + funding pipeline is strong!** Multiple applications in preparation or submitted
- **Physics focus: LLPs and Dark Sectors:** ALP searches (ttbar associated production), semivisible/emerging jets with graph autoencoders; synergy with LHCb + CODEX-b LLP expertise
- **Strong technical programme**: MTD commissioning & software (CODEX-β expertise), ETL hardware assembly with IFCA + Trigger (CPU→GPU)
- **Exciting times ahead**! Physics, service and outreach from day one, with potential to grow!

Discussion