ESR9: Real-time analysis for Dark Photons search in LHCb and smart vehicles

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SMARTHEP

ESR9: Real-time analysis for Dark Photons search in LHCb and smart vehicles

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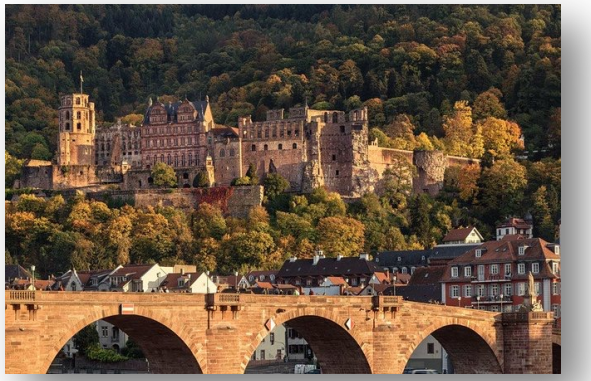
Personal and Academic interests

Personal interests

- I am from Ecuador.
- Born in a small town called Ambato near Quito.
- My major hobbies are:
  - ❖ Climbing (“cordillera de los Andes”)
  - ❖ Chess (chess.com user: carlos_cocha)
  - ❖ Football
  - ❖ Judo (begginer)
  - ❖ Enjoying Germany (castles, sausages, bread, beer, bureaucracy ...)
- Looking forward to expand my network within LHCb and the SMARTHEP project.

Ambato city and Chimborazo mountain (closest point to sun)

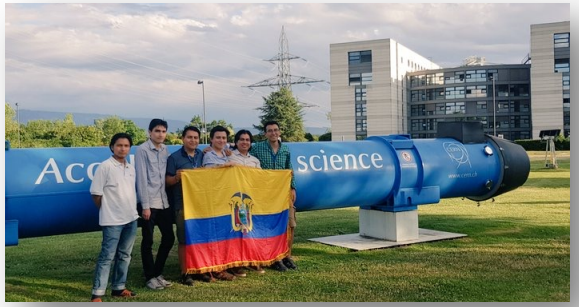


Heidelberg

Quito, latitude 0°0′0″

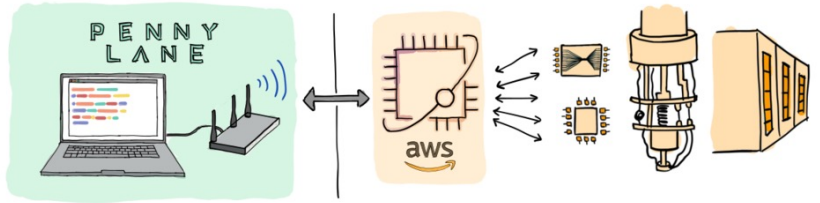
Academic interests

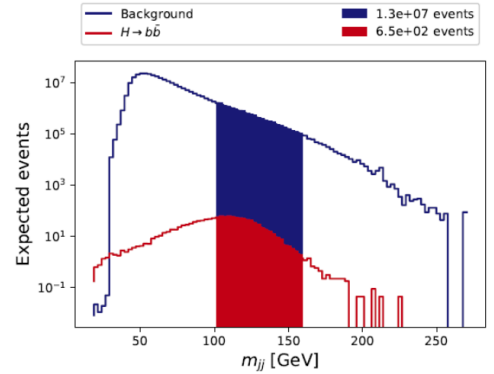
CMS cavern, 2019



Ecuadorian community at CERN

- My passion for **HEP** started in 2019 (CERN Summer Program).
- My **computing** skills were boosted during my master (Universtity of Padova):
  - ❖ Thesis: *b*- and *c*-jets identification with **quantum ML** algorithms for the Higgs search at LHCb.





  - ❖ Internships: PRACE Summer of **HPC** about the use of hybrid computing architectures in HEP.
- Excited to contribute within an LHC experiment and learn from particle physics and RTA experts.
- Acquire all the possible knowledge to become an active member in this field.

Project Description

Real-time analysis for Dark Photons search in LHCb and smart vehicles

Model

- Dark photon can kinetically mix with the SM photon
- Extend the SM by a new 'dark' gauge group $U(1)'$:

$$\mathcal{L} \supset -\frac{1}{4}F'_{\mu\nu}F'^{\mu\nu} + \frac{1}{2}\boldsymbol{m}^2_{A'}A'_\mu A'^\mu + \boldsymbol{\epsilon} e A'_\mu J^\mu_{EM}$$

$\boldsymbol{m}_{A'}$: dark photon mass $\boldsymbol{\epsilon}$: kinetic-mixing parameter

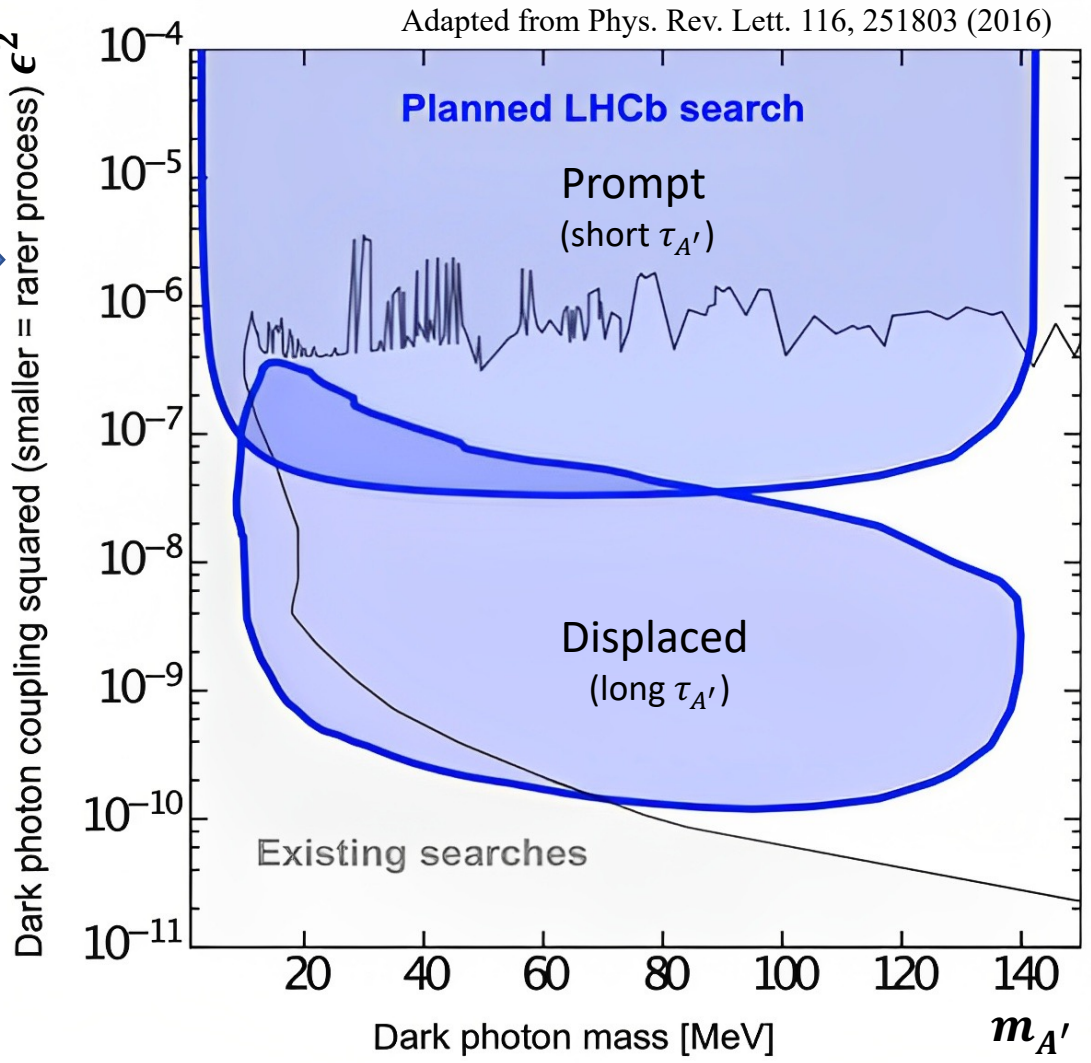
Rare charm decay

$$D^{*0} \to D^0 \boldsymbol{A'}, \qquad A' \to e^+e^-$$

- $m_{A'} \in [2m_e, \Delta m_D]$
- Displaced search: $\epsilon^2 \in [10^{-10}, 10^{-6}]$
- Prompt search: $\epsilon^2 \in [10^{-7}, 10^{-4}]$
- Production rate: ~ 5 kHz

Goal

Develop an advanced RTA-based analysis to efficiently select decays involving di-electron vertices with **low invariant mass** for the dark photon $\boldsymbol{A'}$ search.



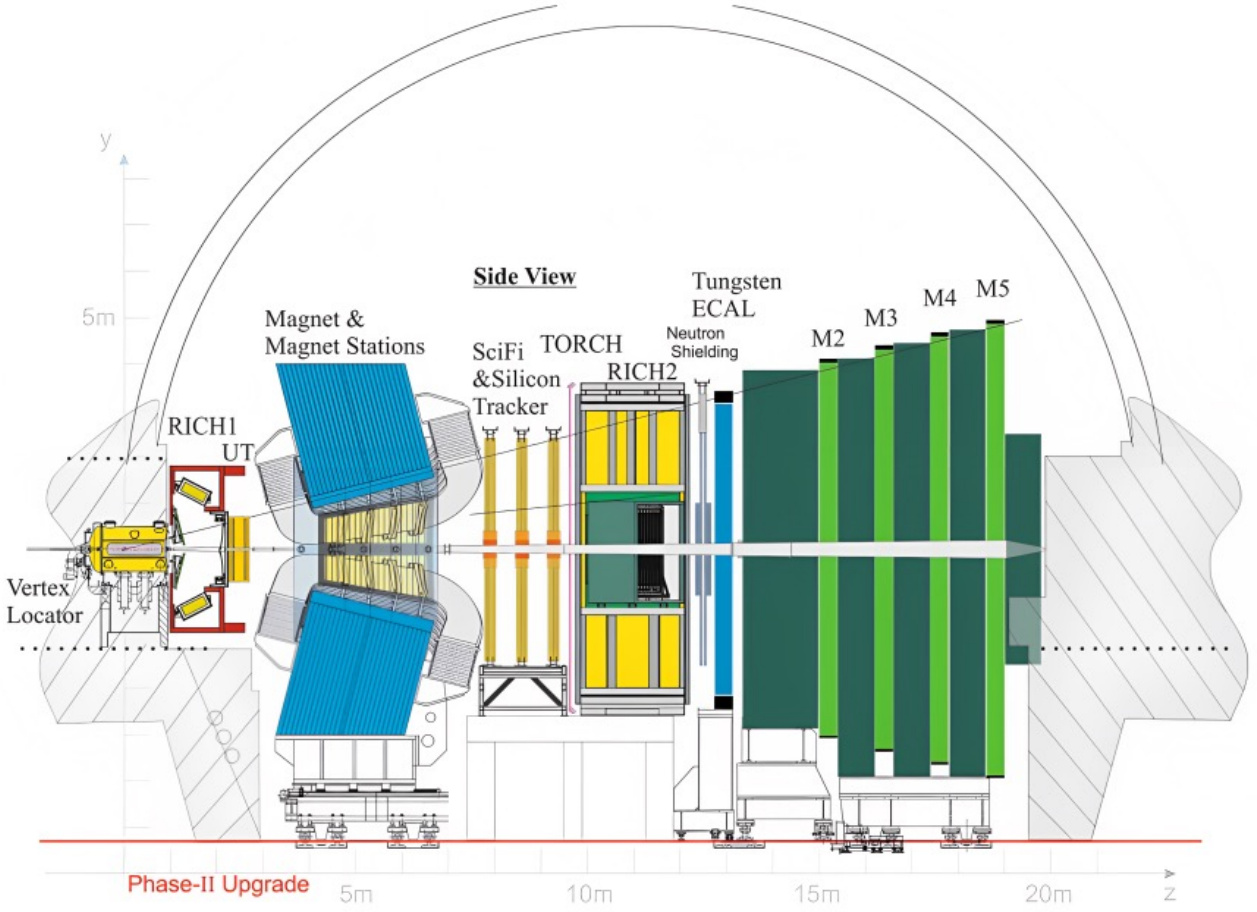
Real-time analysis for Dark Photons search in LHCb and smart vehicles

Tools

- LHCb detector: excellent SV resolution and PID
- LHCb trigger: select soft final states
- Advanced ML algorithms: electron classification.

Secondments

- **IGFAE at University of Santiago de Compostela:** training in highly parallel architectures (GPUs) for the LHCb online reconstruction.
- **TU Dortmund:** developing RTA electron classification with experts and PhD students.
- **VERIZON:** training in ML models based on streams of data.

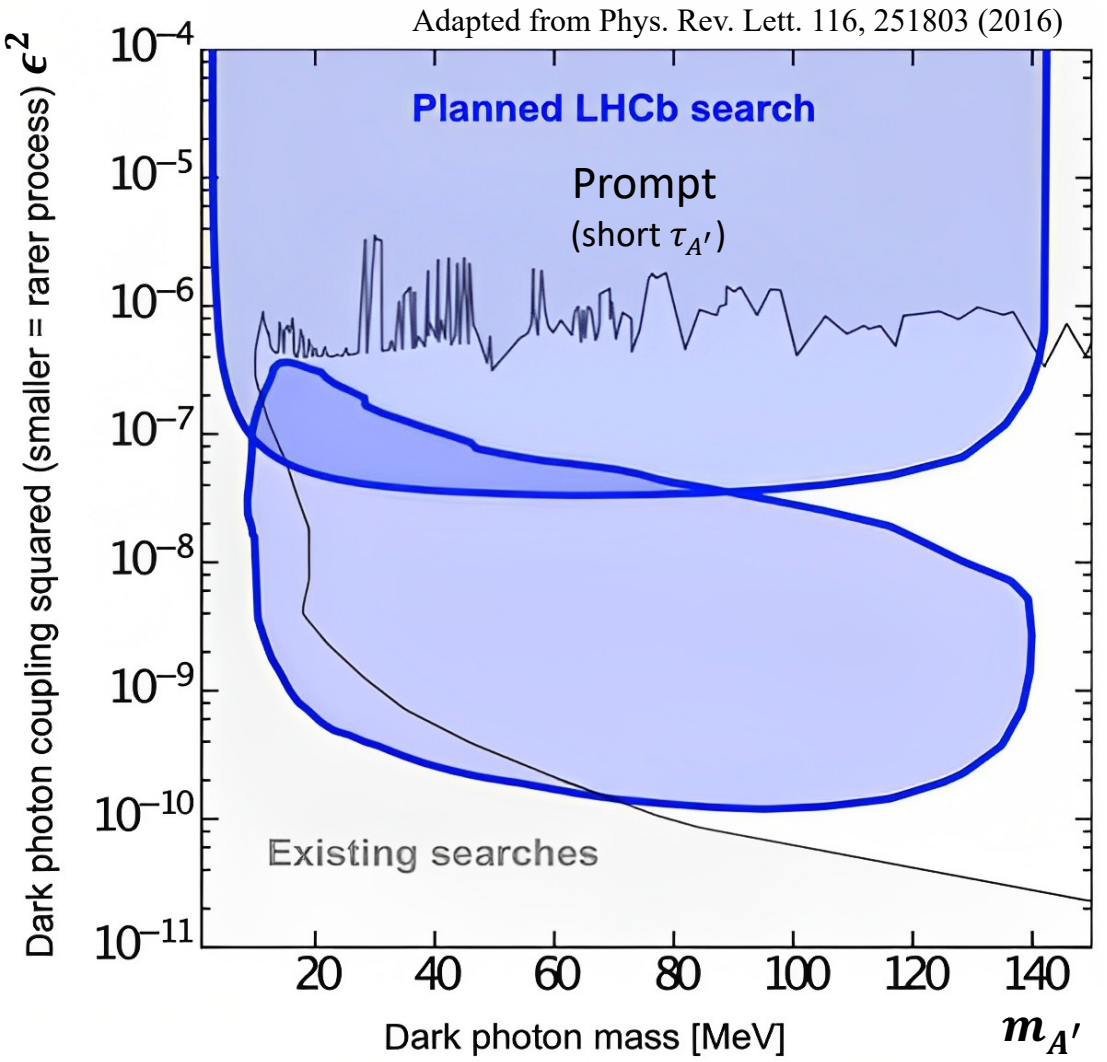


Real-time analysis for Dark Photons search in LHCb and smart vehicles

Let's start with the **prompt** search:

	To-do list	
1	Literature (theoretical and experimental) review	√
2	Development of a HLT2 trigger line	
	Learn about upgraded LHCb trigger software development	√
	Produce Run-III MC for the signal: $D^{*0} \to (D^0 \to K^-\pi^+)e^+e^-$	√
	Write the trigger line	√
	Optimize the trigger selection efficiency and rates	
3	Deploy the trigger line by the end of the commissioning	
4	Assess trigger performance with early real data	

To be continued …



Thanks

Back-up

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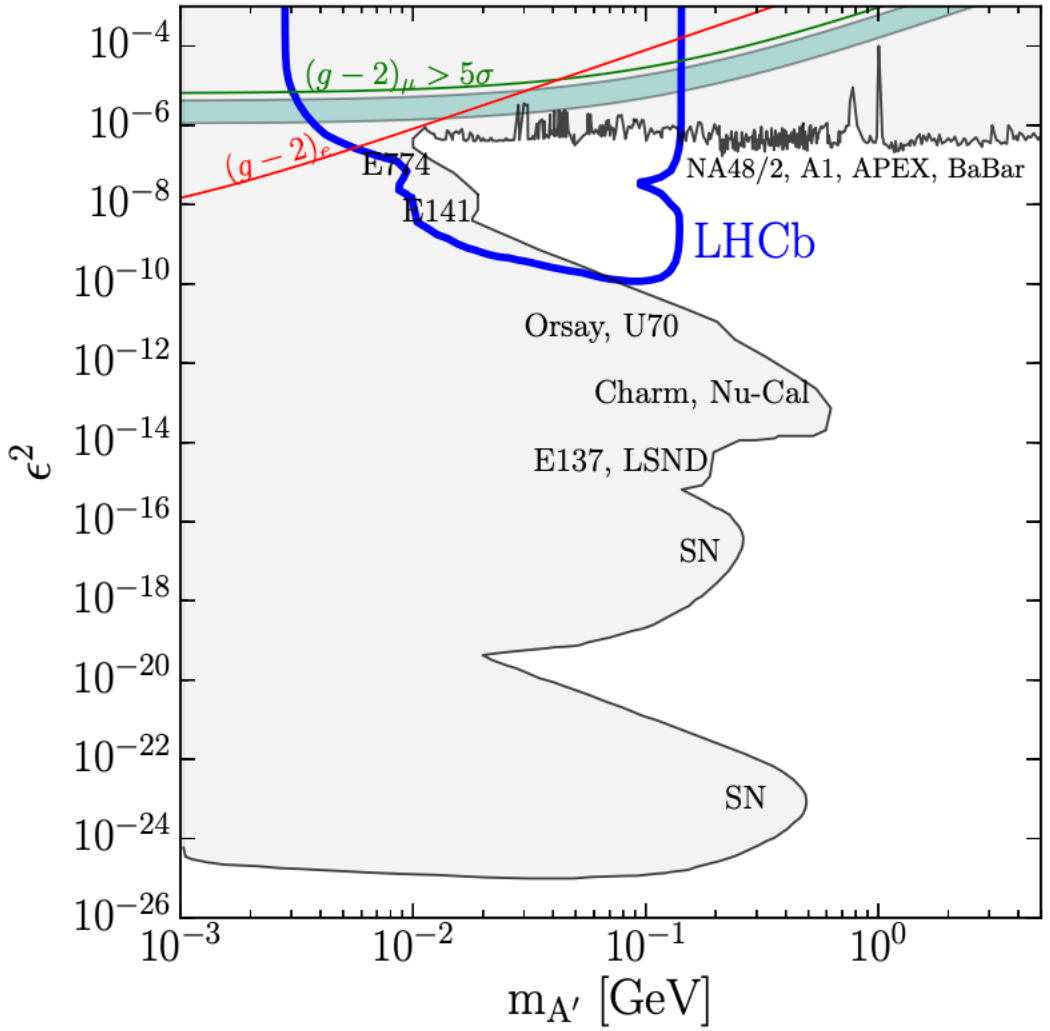

Adapted from Phys. Rev. Lett. 116, 251803 (2016)