Paving the Way to New Discoveries in Particle Physics

Feb 1, 2026, 5:00 PM → Feb 6, 2026, 12:00 PM US/Mountain

Flug Forum (Aspen Center for Physics)

Giulia Zanderighi (Max Planck Society (DE)), Greg Landsberg (Brown University (US)), Marcela Carena Lopez, Matthias Neubert (Johannes Gutenberg University Mainz)

Description

Confirmed speakers, please apply for the conference directly with the Aspen Ceneter of Physics using the following link:

https://aspenphys.org/winter-conferences/#event5895

This will secure your housing and must be done by October 15, 2025 to guarantee a room in Aspen Meadows.

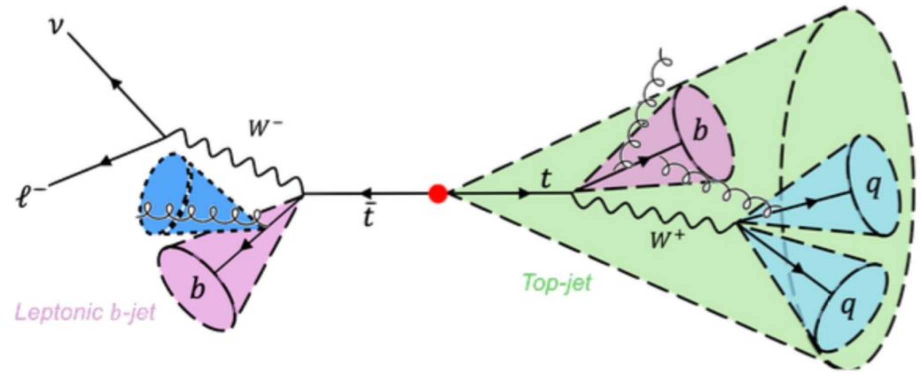
Phys. Lett. B 867 (2025) 139608

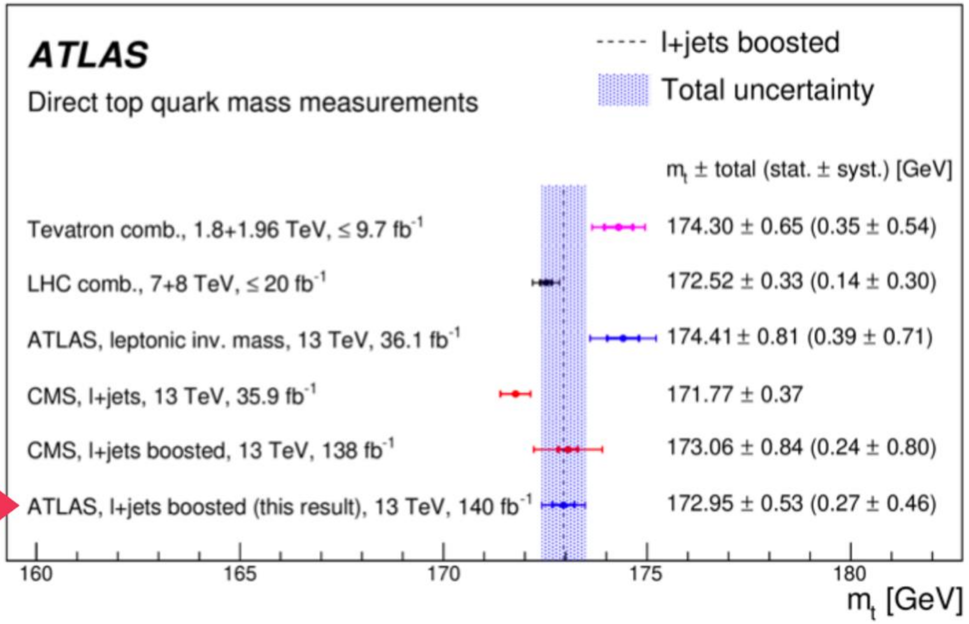
BOOSTED TOP MASS

- First ATLAS measurement of top quark mass using boosted tops

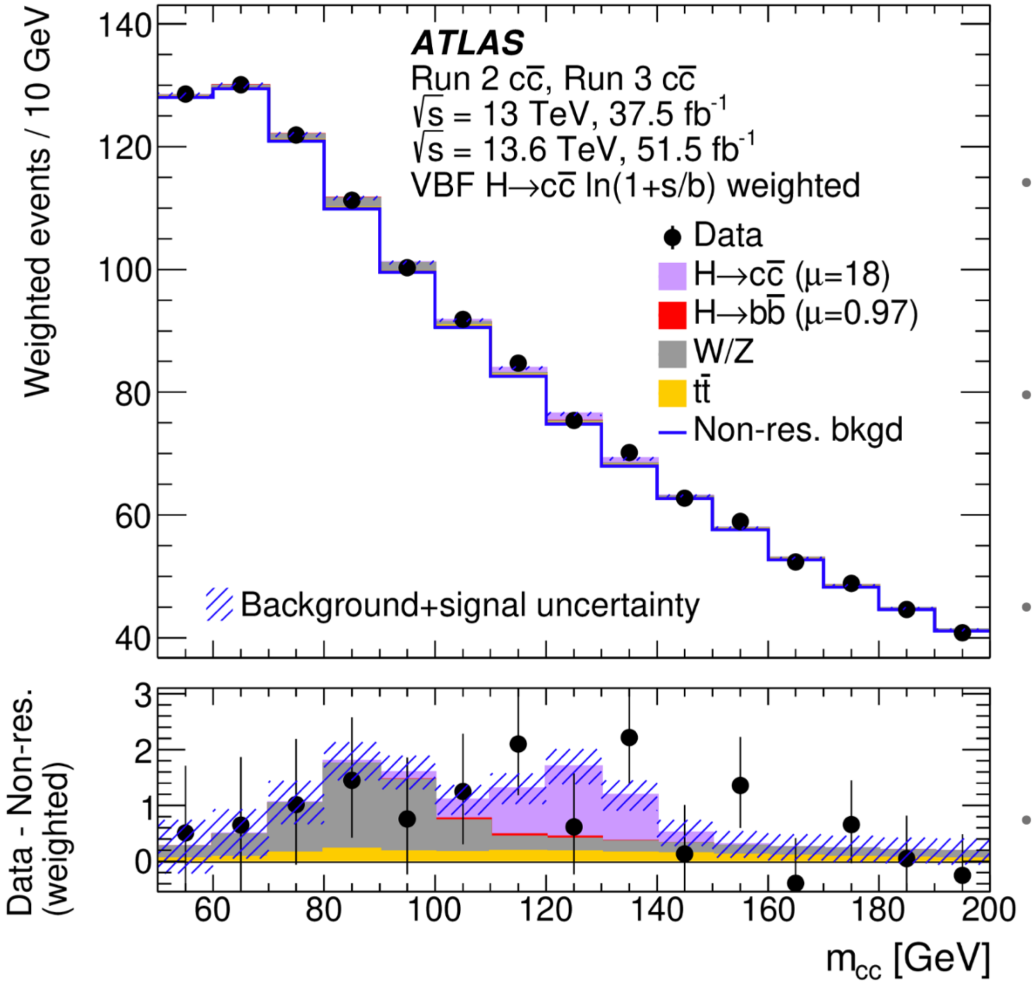
$$m_t = 172.95 \pm 0.53 \text{ GeV}$$

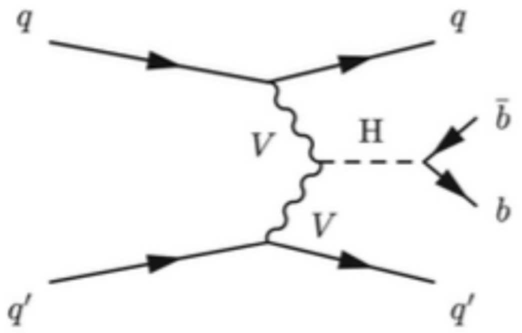
- Most precise ATLAS measurement in a single channel
- High precision due to reduced jet energy scale and recoil uncertainties, improved flavor response uncertainty





VECTOR BOSON FUSION H → cc & bb





- Challenging hadronic final state; new inclusive vector-boson fusion trigger developed for Run 3
- Improvement in multivariate techniques & use of new flavor identification algorithm (GN2)
- H→cc signal strength 18 +/- 13
  H→bb signal strength 0.97 +0.57/-0.50
- Combining with Run 2 H→bb, obs (exp) significance of 3.2 (3.6) σ

arXiv.2511.21911

HIGGS PRODUCTION –TTH(→CC)

Florencia Canelli

Run 2

First search for H→cc in ttH production. Performed **simultaneously with ttH(H→bb)** in the three mutually exclusive channels with 0 to 2 leptons.

Trades rate for **top-tagging and flavor information** in an extremely challenging heavy-flavor environment, rather than relying on clean leptonic VH signatures.

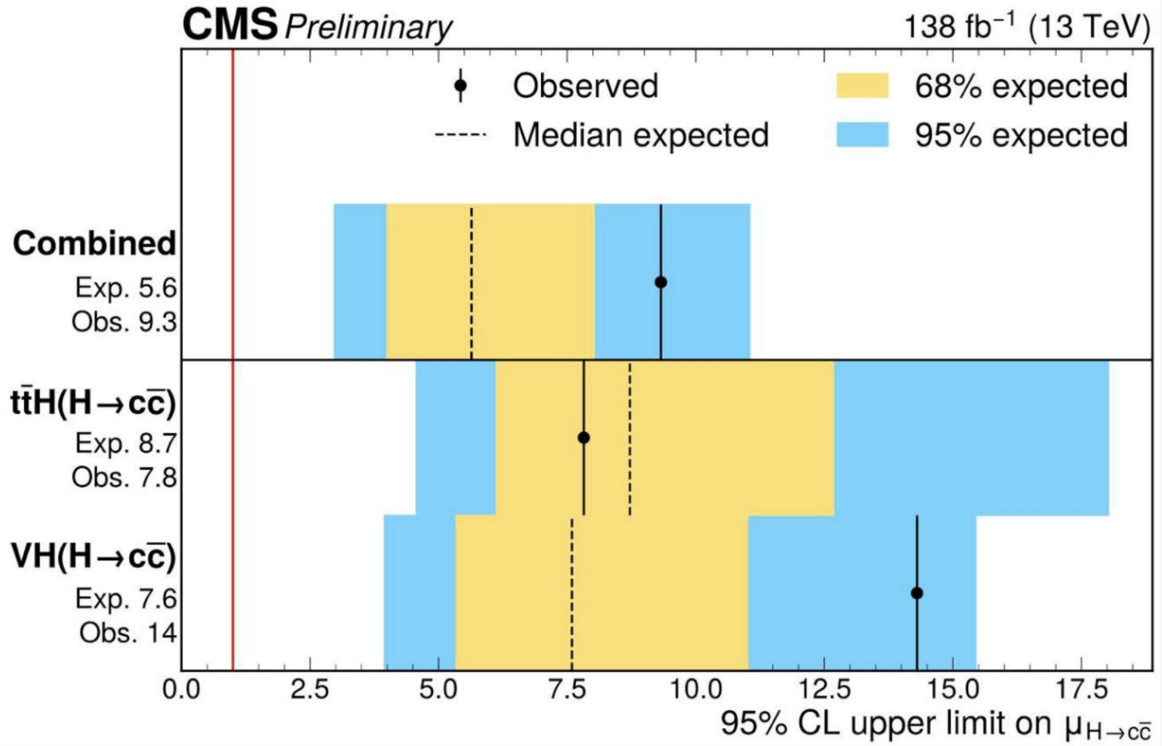
Uses ParticleNet for *b vs c vs light* jet discrimination and Particle Transformer ML algorithm for full event classification.

When combined with VH(→cc) results ➔ most stringent constraint on the charm Yukawa coupling to date

$|\kappa_c| < 3.5$ at 95% CL

Simultaneous probe of the charm and bottom quark Yukawa couplings.

$\mu(ttH, H\to bb) = 0.91^{+0.26}_{-0.22}$
4.4σ observed significance



$\mu(ttH, H\to cc) = -1.6 \pm 4.5$ (stat-dominated)

Opens possibility of **$\mu(ttH+VH, H\to cc) < O(1)$** with HL-LHC.

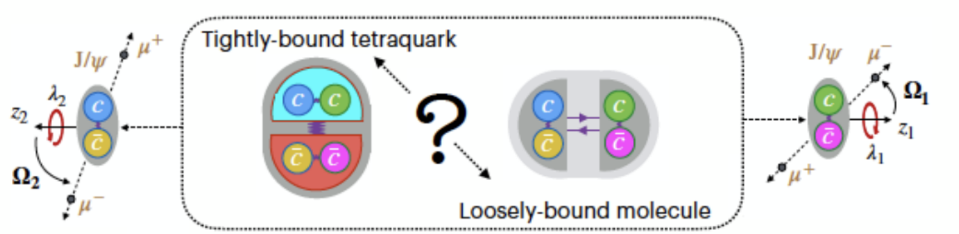
QUANTUM STATES OF ALL-CHARM TETRAQUARKS

Run 2 & Run 3

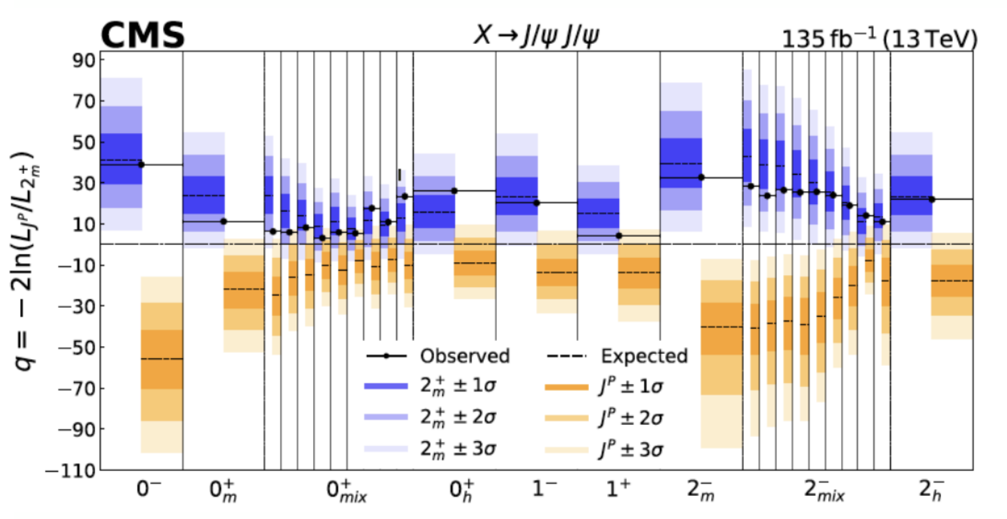
Observation of 3 X states in the J/ψ J/ψ final state
→ The 3 X particles form a family of cccc states with the same quantum numbers.

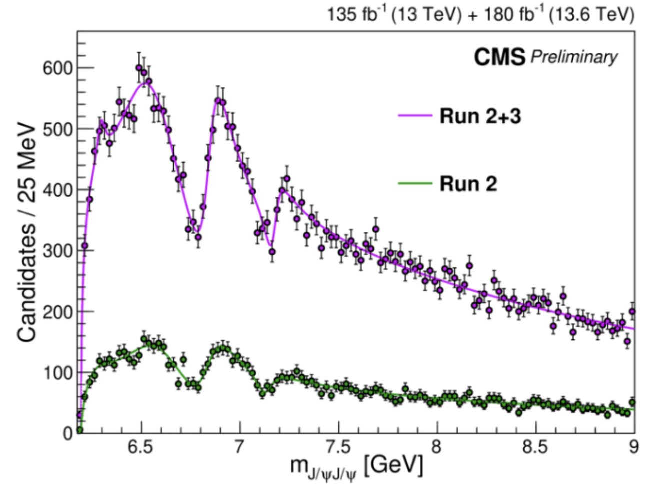
First determination of the **spin and parity** of the all-charm tetraquark family using Run 2 data.

Use a **full angular analysis** of the four-muon final state, and **simultaneous testing of all plausible JPC hypotheses**.



J^{CP} can be inferred from the polarizations of the mesons
→ angular distributions of the decay muons





CMS-PAS-BPH-24-003, to be submitted

Run-3 data confirm family structure and interference. Brings 3.6x more data.

The quantum numbers are consistent with **JPC=2++**, while lower-spin hypotheses are excluded.

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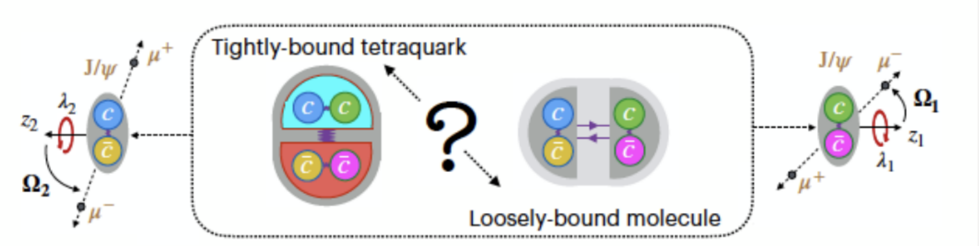
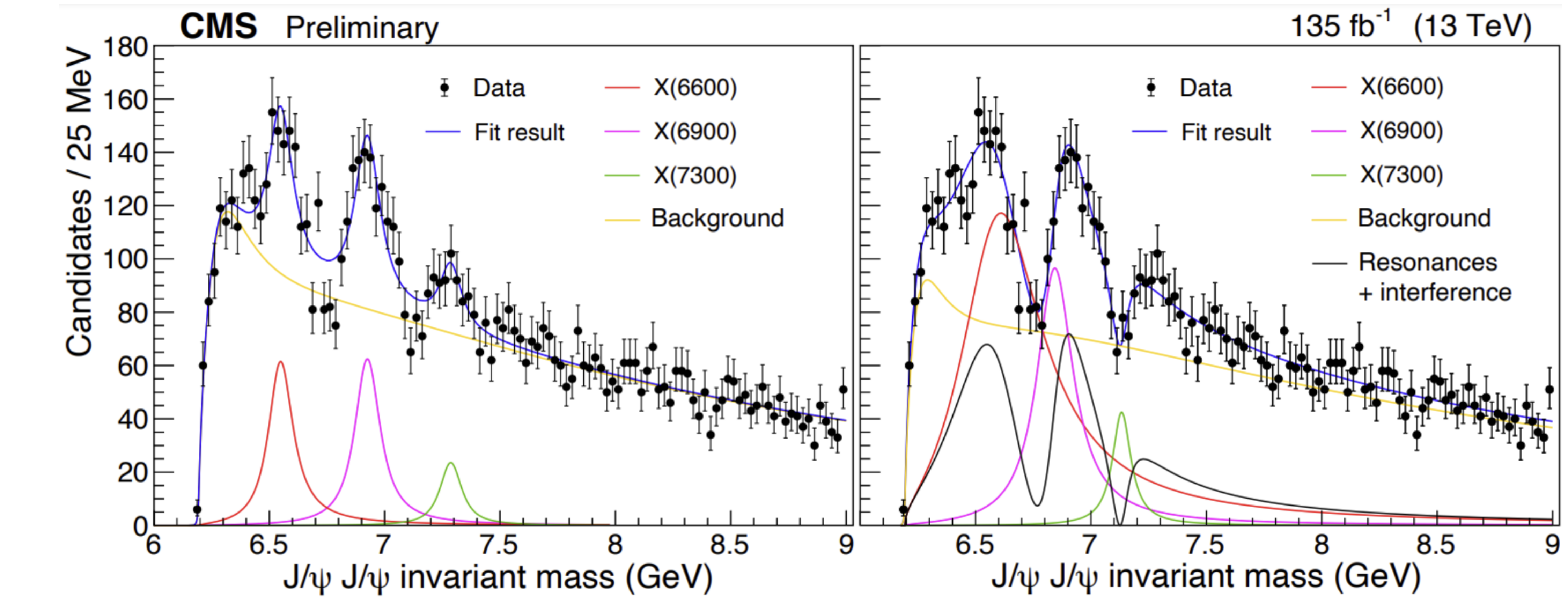
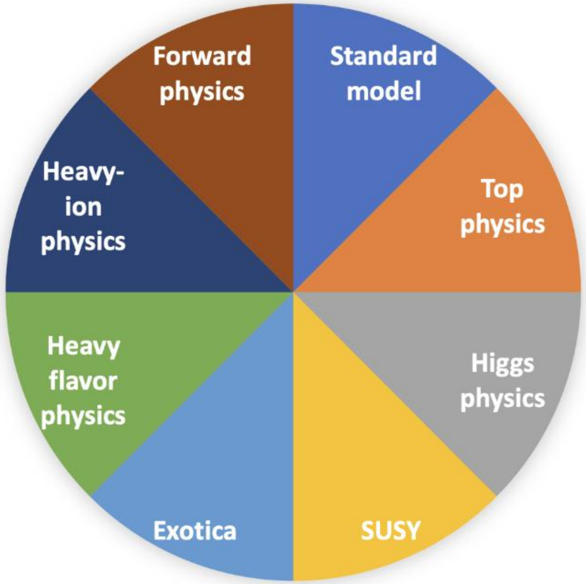


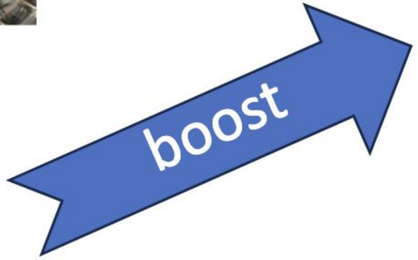
First determination of the **spin and parity** of the all-charm

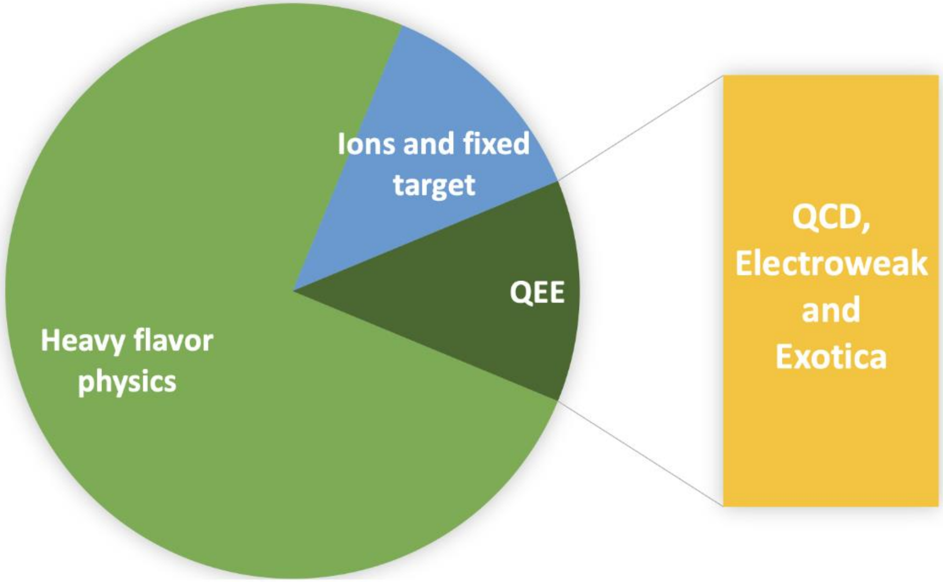


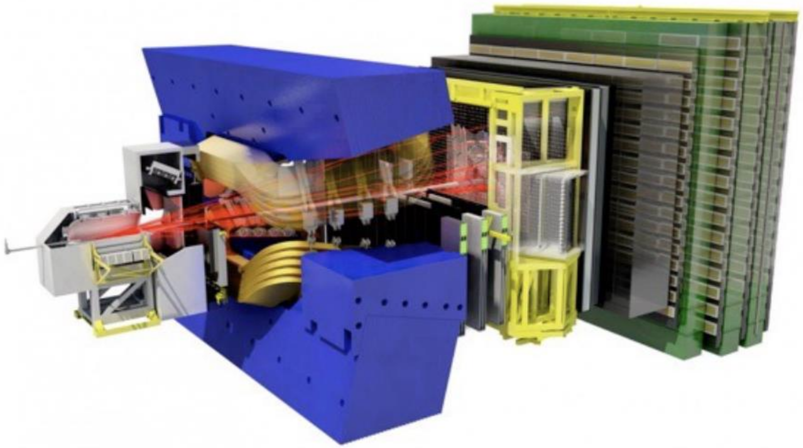
Lesya Shchutska

LHCb: LHC beauty experiment and general-purpose detector in the forward region

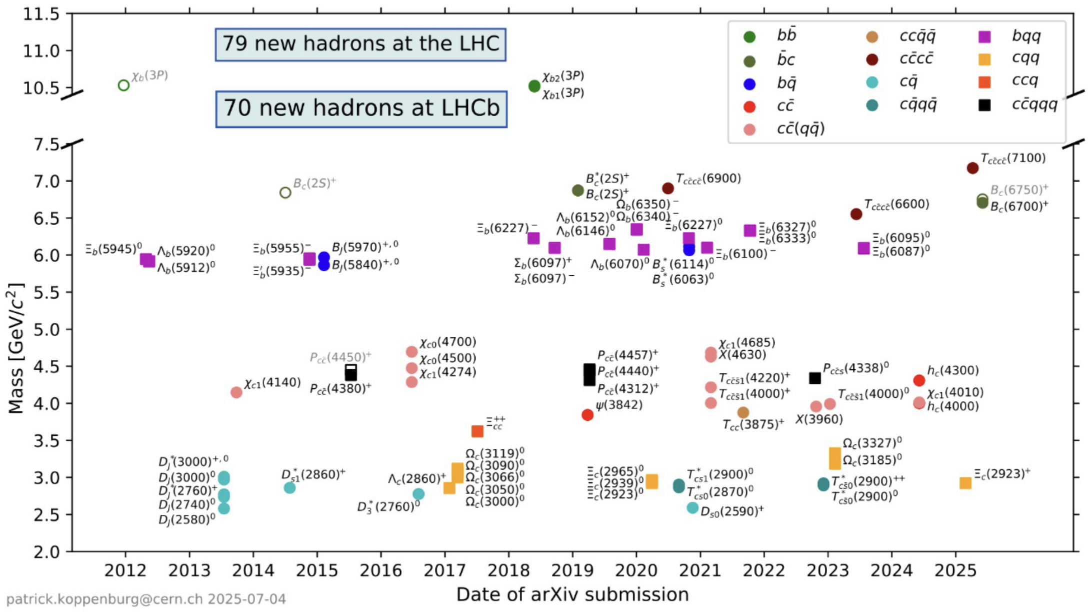








Particles discoveries: foundation of our field

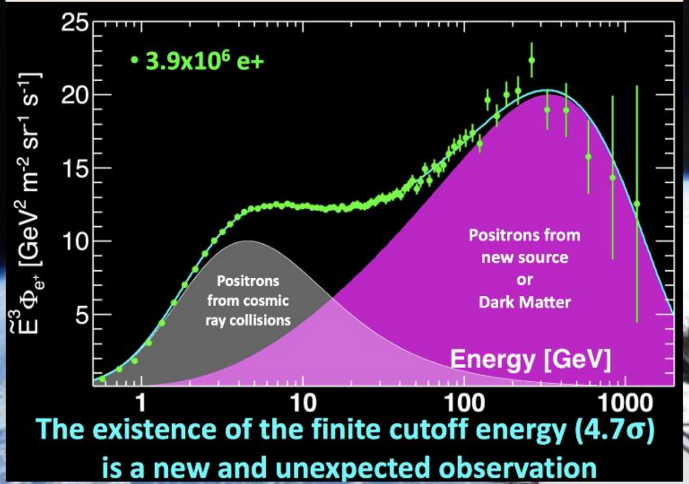


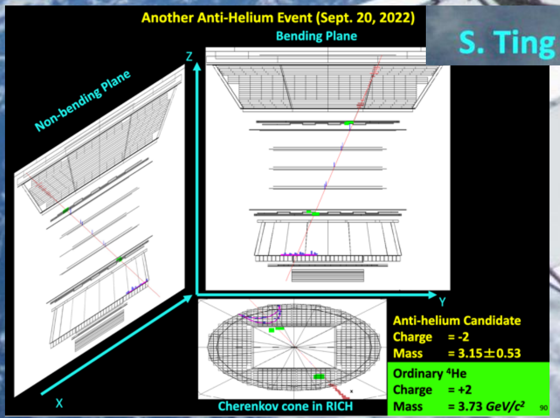
or 0.06 new hadrons per author in LHCb
and 0.002 per author in ATLAS+CMS

- discovery of new fundamental particles now is non-trivial:
  - the safest bet on a dark dark matter candidate
- many unseen hadrons out there
  - conventional and exotic
- interpretation of the nature of exotic hadrons is still debated!

Discovery happening in space?

Long-standing positron excess



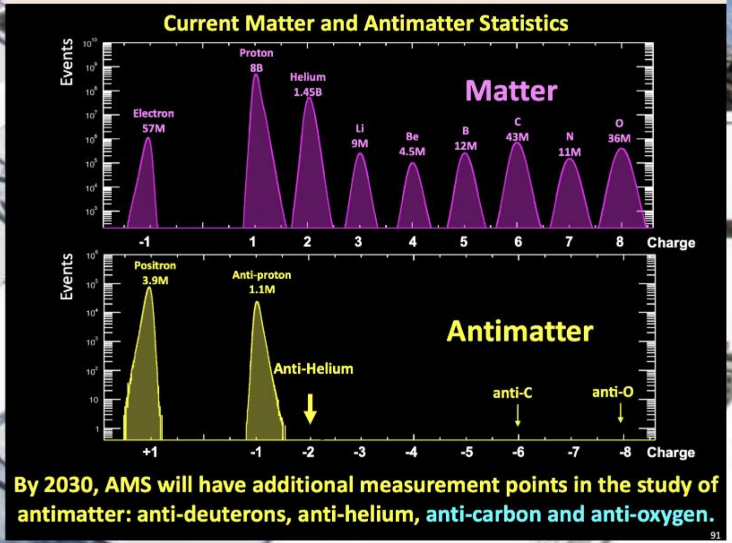


S. Ting

- Astrophysical antihelium production is expected to be negligible
  → Smoking gun for new physics?
- but the DM explanation is also difficult
- Attempts for new production sources in $\chi\chi \to b\bar{b}$

with predicted $\mathcal{B}(\overline{\Lambda}_b^0 \to {}^3\overline{He}X) \sim 3\times10^{-6}$ (PRL 126 (2021) 10)

Handful of anti-Helium events?

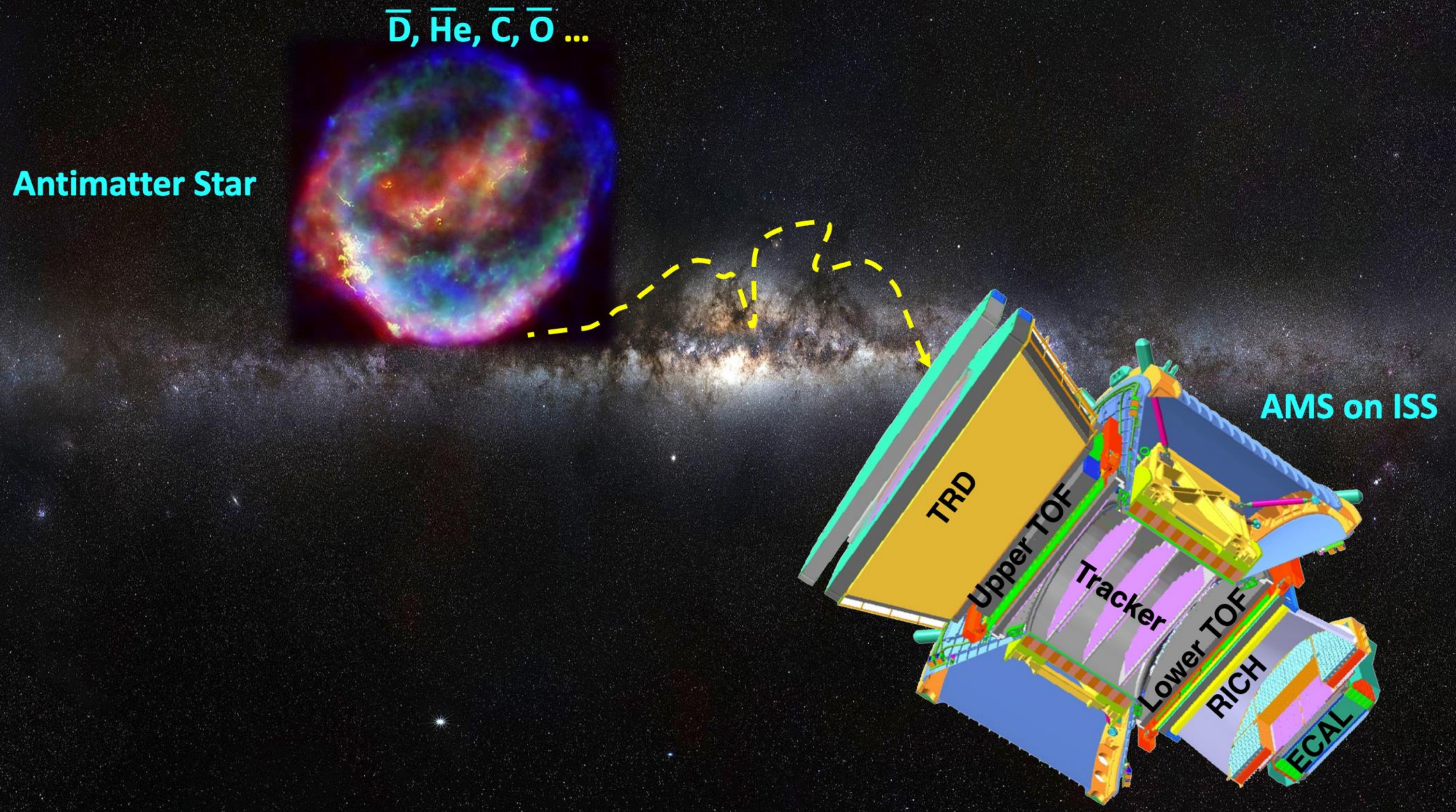


S. Ting, CERN colloquium 2023

Latest AMS Results on Heavy Antimatter

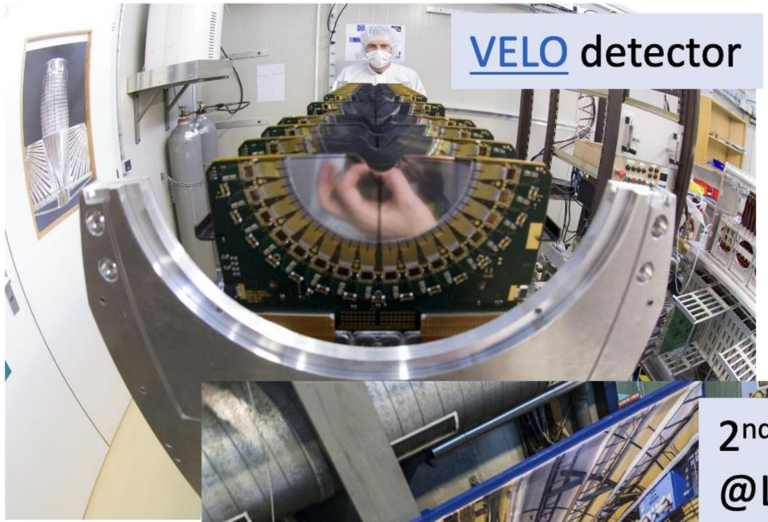
S. Ting

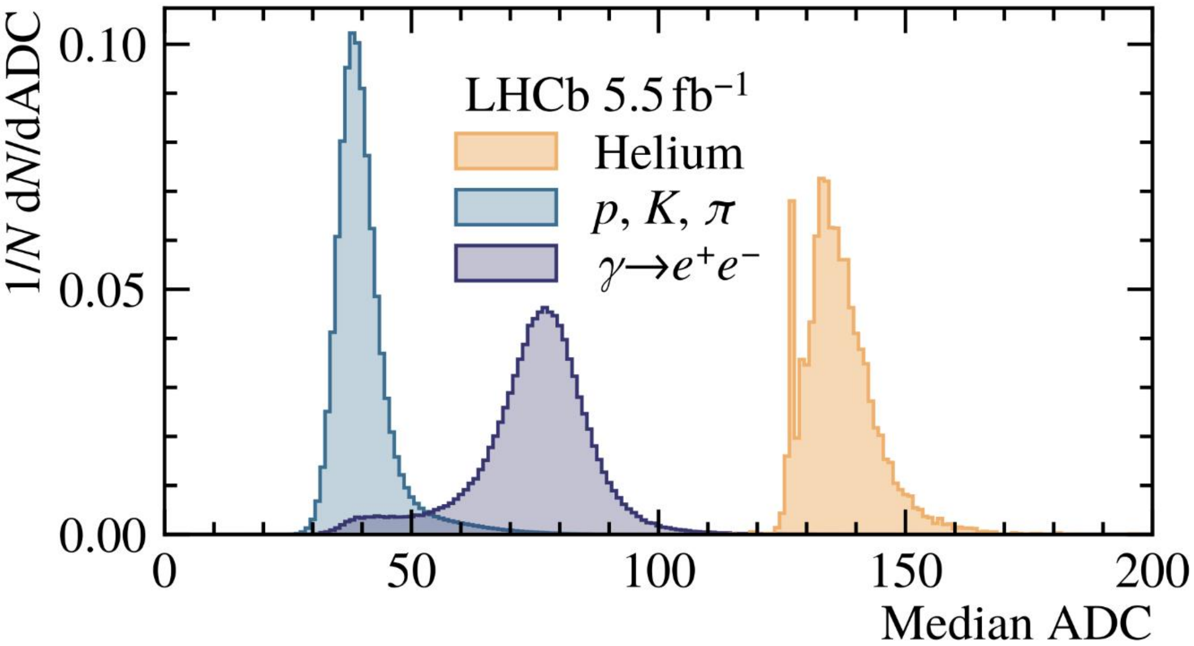
Matter is defined by its mass *M* and charge *Z*.
Antimatter has the same mass *M* but opposite charge –*Z*.



AMS is a unique antimatter spectrometer in space

VeLo: performance beyond design goals



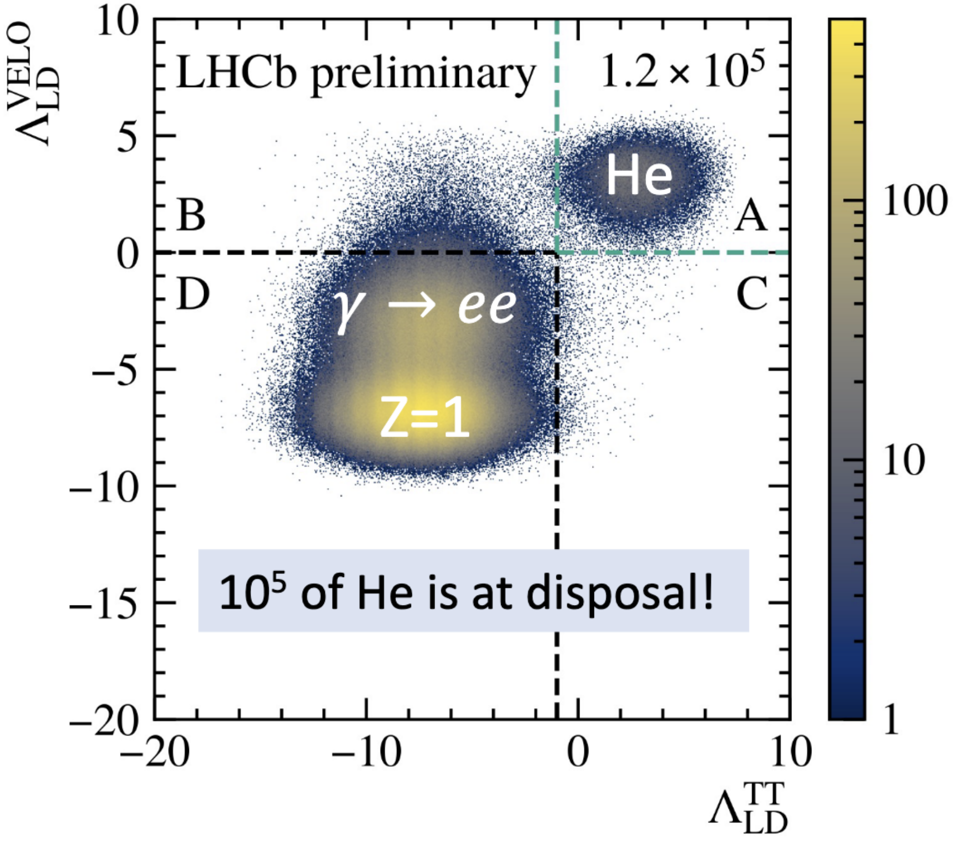


Median ADC of all VELO clusters in a track:
→ clear separation in charge:

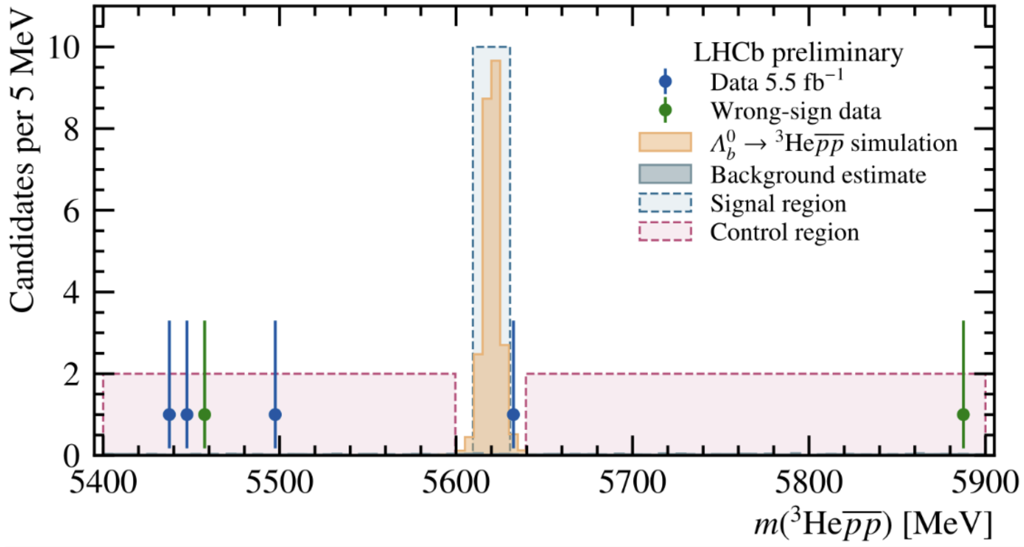
- 1^2 : all charge-1 particles
- 1^2+1^2: photon conversions with 2 tracks together
- 2^2: Helium

JINST 19 (2024) P02010

Paving the way across the fields: antihelium production and astroparticles



10^5 of He is at disposal!

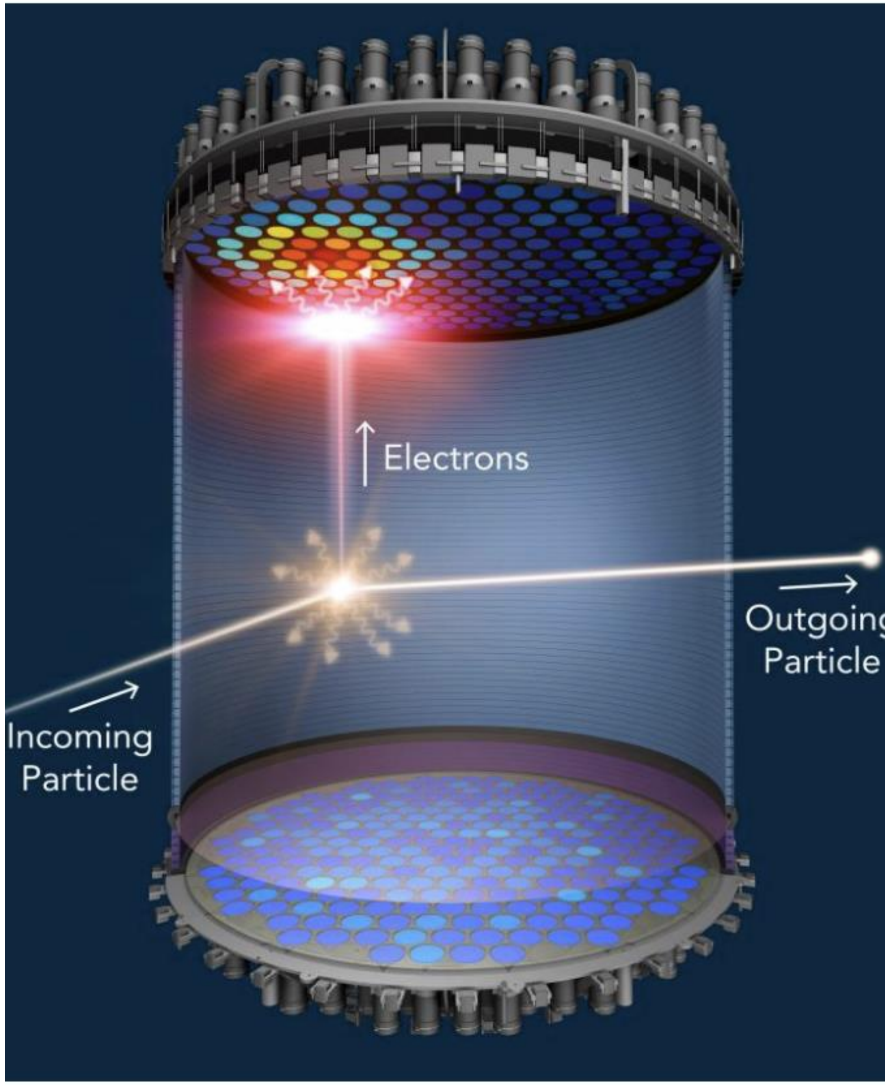


$\mathcal{B}\left(\overline{\Lambda}_b^0 \to {}^3\overline{He}X\right) < 6.3\times10^{-8}$ at 90% CL

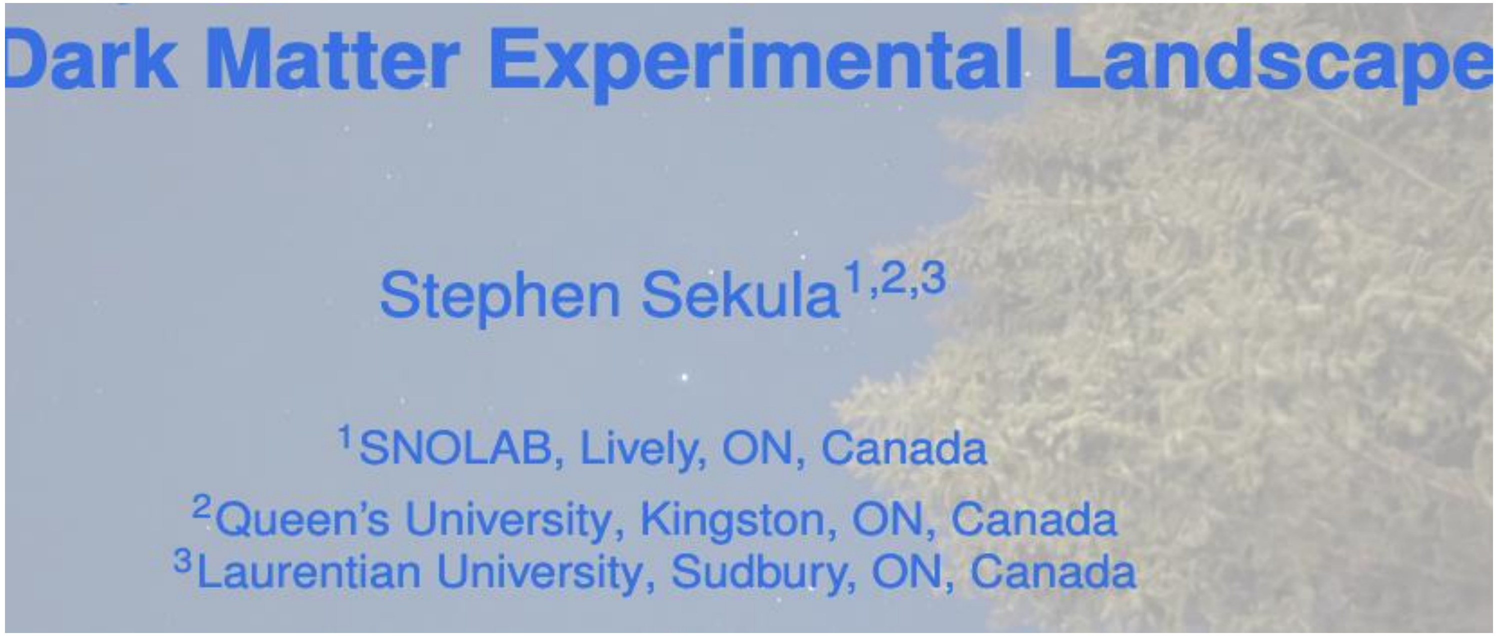
- excludes largest theoretically predicted value
- leaves room for $(d,p) \to {}^3He\gamma$ coalescence

NB: preliminary result!
More thorough investigation
of this unique data sample is ongoing

LHCb-CONF-2024-005



LZ concept (graphic from SLAC)



Gas: NEWS-G;

Liquid/Argon: DarkSide-50, DEAP-3600;

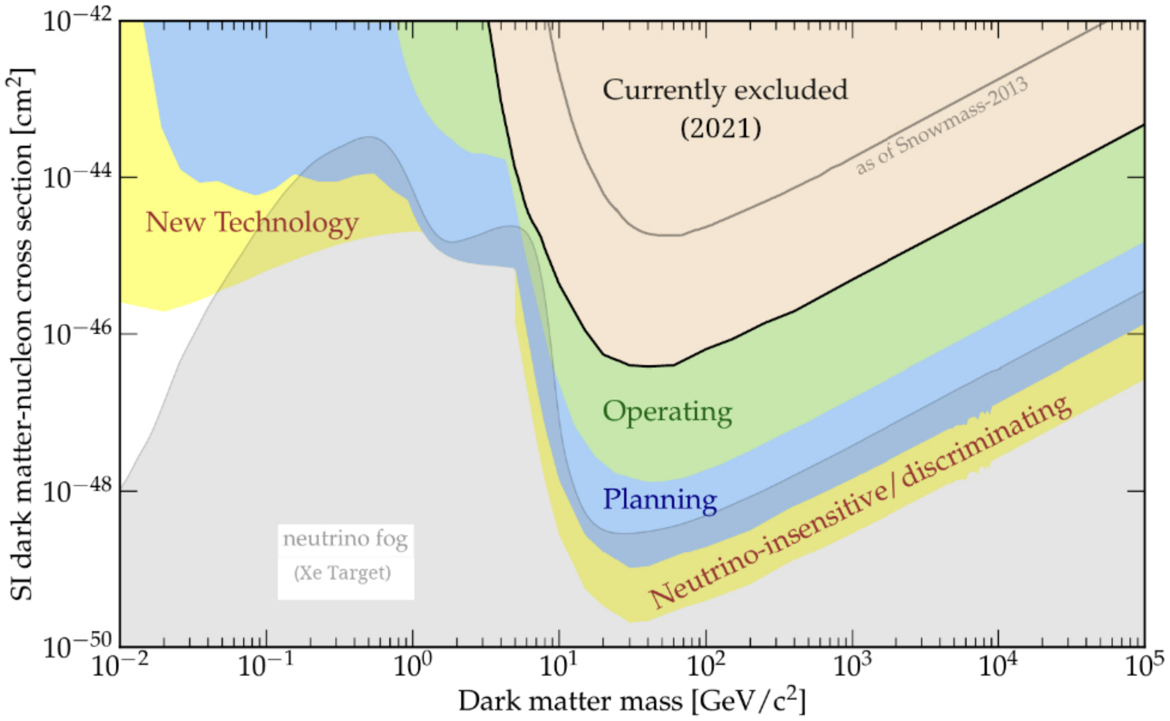
Liquid/Superheated: PICO-40L, SBC;

Liquid/Xenon: LZ, PandaX-4T, XENONnT;

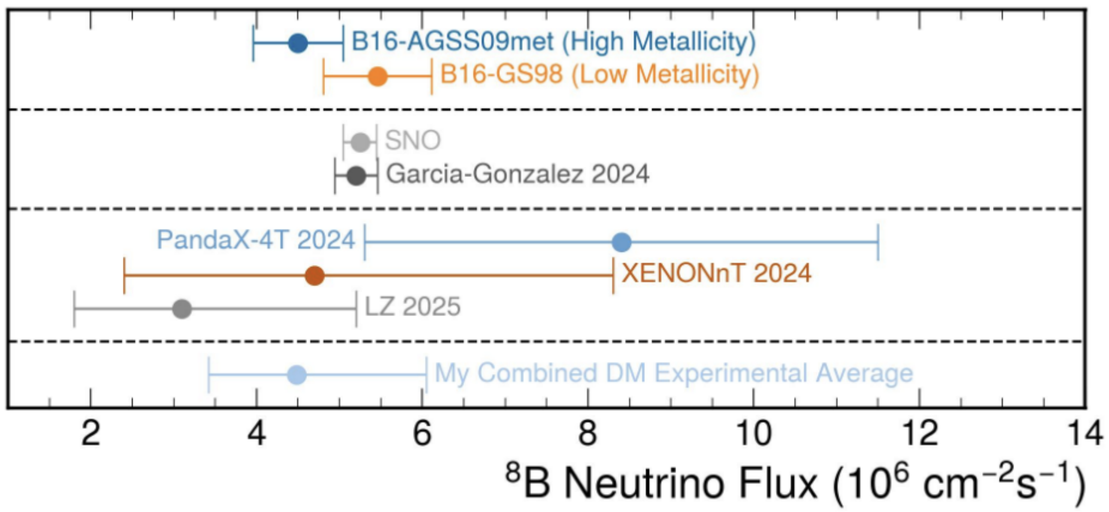
Solid/Crystal: ANAIS, COSINE-100, DAMA/LIBRA, SABRE, SuperCDMS-SNOLAB;

Solid/CCD: DAMIC, DAMIC-M, SENSEI.

We must confront neutrino physics



In 2021–2022 [13], "Operating" experiments included LZ, XENONnT, PandaX-4T, SuperCDMS-SNOLAB, and the Scintillating Bubble Chamber. "Planned" were SuperCDMS, DarkSide-LowMass, SBC, a 1000 tonne-year liquid Xe detector, and ARGO.



^{8}B CEνNS theory predictions (low- and high-metallicity stars) [14], SNO [15] and multi-experiment combined measurements [16], DM experiment measurements [17, 18, 12], and a naive combination of DM experiments. LZ rejects the 0-CEνNS hypothesis at 4.5σ.

We are in an era where these instruments are absolutely confirmed to be weakly interacting (somewhat) massive particle detectors.