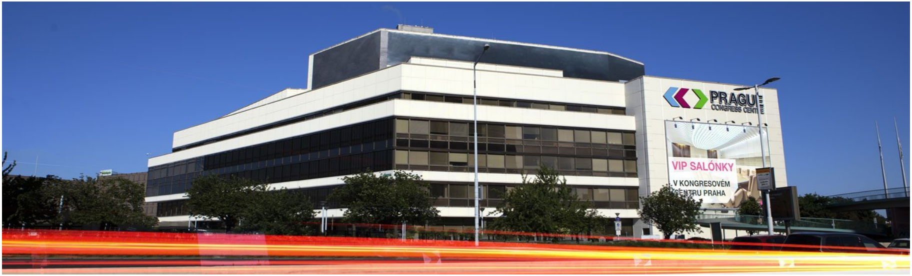
Report from the ICHEP-2024
42^{nd} International Conference on High Energy Physics,
17 - 24 July 2024, Prague, Czech Republic

Grzegorz Grzelak

Faculty of Physics
University of Warsaw

High Energy Physics Seminar, 4-OCT-2024

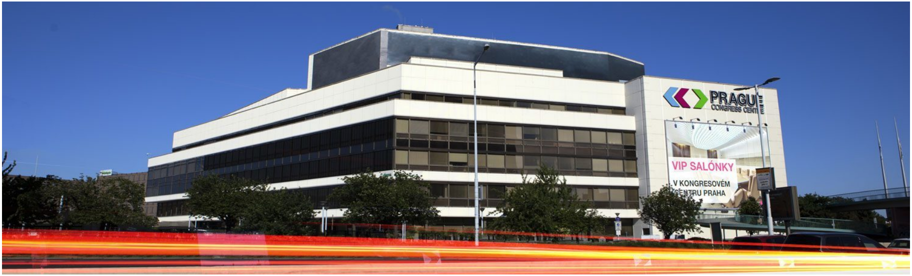
Congress Centre at Prague



- Capacity: up to 9,300 participants in more than 50 halls and meeting rooms
- originally: the Palace of Culture, communist party conventions: 1981 - 1989
- reconstruction in January 2018

- ICHEP-2024: 1400 participants from 55 countries,
- about 1000 lectures, 18 blocks of parallel sessions
- **excellent organization !**

Congress Centre at Prague: upon the Vyšehrad Hill



Congress Centre at Prague: interiors

Congress Centre at Prague: interiors ... and the Zeitgeist

Outline

- Present: LHC Era (Higgs, AI)
- Future collider(s) (on Earth)
- In Space: AMS-02 (+LHCb)
- In Mind: New ideas (see also backup plots)

- **01. Higgs Physics**
- 02. Neutrino Physics
- 03. Beyond the Standard Model
- **04. Top Quark and Electroweak Physics**
- 05. Quark and Lepton Flavor Physics
- 06. Strong Interactions and Hadron Physics
- 07. Heavy Ions
- **08. Astro-particle Physics and Cosmology**
- 09. Dark Matter Detection
- 10. Formal Theory
- **11. Accelerator: Physics, Performance, and R&D for Future Facilities**
- 12. Operation, Performance and Upgrade (incl. HL-LHC) of Present Detectors
- **13. Detectors for Future Facilities, R&D, Novel Techniques** ($\rightarrow$ backup plots)
- 14. Computing, AI and Data Handling

Parallel Sessions (cont.)

- 15. Education and Outreach
- 16. Equity, Diversity and Inclusion
- 17. Technology Applications and Industrial Opportunities
- **18. Sustainability (accelerators, detectors, computing)**

This is a new session in ICHEP2024. Nowadays, the need for sustainability impacts any human activity. This session will discuss the sustainability of fundamental high-energy particle research. Visionary contributions that would help set the direction of the field for decades to come are welcome.

→ for example: carbon footprint in HEP

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Dear Grzegorz Grzelak
For your information:
your jobs for user grzelak and group HERA on NAF @ DESY
in the past seven days
accounted for 79.5942 hours in 105 different jobs
equivalent to 2.27412 kWh power consumption
equivalent to 1.10295 kg CO2 production according
to the usual conversion factor from UBA
equivalent to CO2 production of driving 7.55444 km
in an average fossile fuel powered VW Golf
```

Raymond Volkas

The General Framework

Raymond Volkas

Two main outcomes of the LHC: The discovery of the Higgs boson and nothing else (so far)!

$$\mathcal{L} = -\frac{1}{4} F_{\mu\nu} F^{\mu\nu} + i \bar{\psi} \not{D} \psi + h.c.$$

Simplicity, governed by symmetries only 3 (EW) and 2 (QCD) parameters!

$$+ \bar{\psi}_i y_{ij} \psi_j \phi + h.c. + \frac{c_{ij}}{\Lambda} L_i L_j H H \ ?$$

$$+ |D_\mu \phi|^2 - V(\phi) + \Lambda^4 \ ?$$

Not governed by symmetries and with **26 parameters set by "hand" of experiments!**

Open problems

Hierarchies

- Gauge Hierarchy and Naturalness
- Flavour hierarchy including neutrino masses

The strong CP problem

$$\theta \frac{\alpha_s}{8\pi} F^A_{\mu\nu} \tilde{F}^{A\mu\nu} \qquad \theta < 10^{-10}$$

From neutron electric dipole moment

The existence of Dark Matter (new field?)

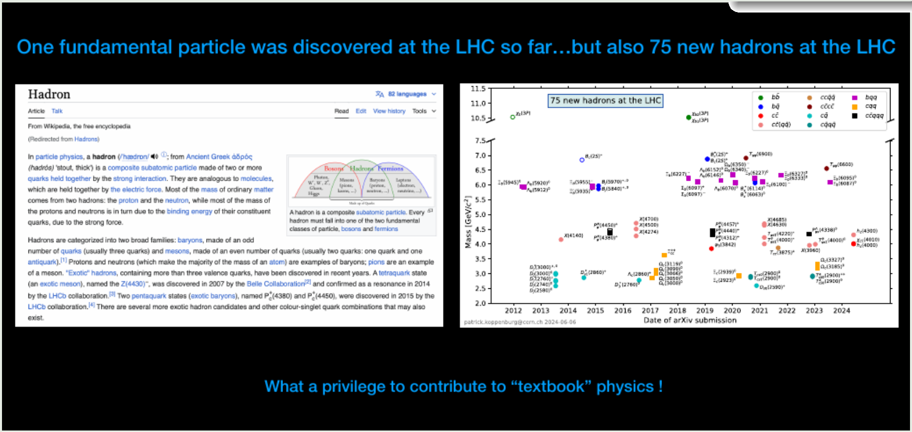
The nature of Dark energy

Open questions

- What is the origin of the asymmetry between matter and anti-matter in the universe?
- What are the properties of QCD confinement?
- Why do electrons have precisely the same charge as the protons?

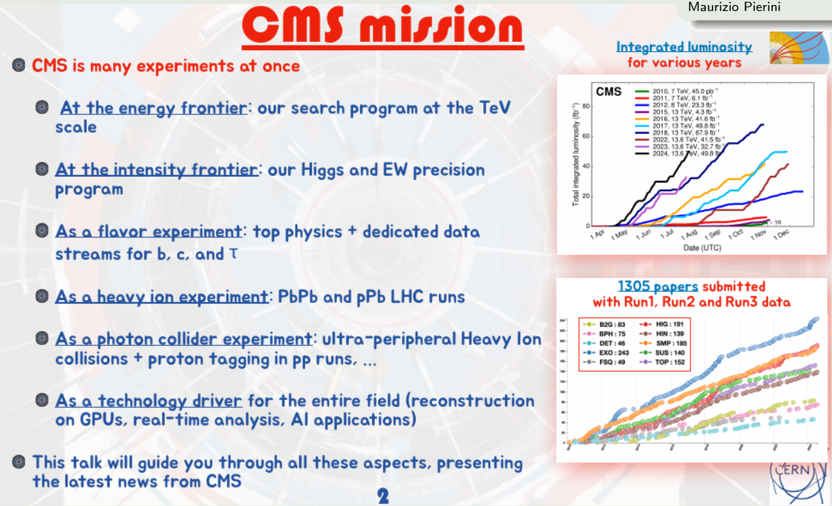
Strong statement, contested in many talks

Yasmine Amhis



LHC(b) contribution to "textbooks" physics,
accumulating data on precise hadron spectroscopy (→ non-pQCD)

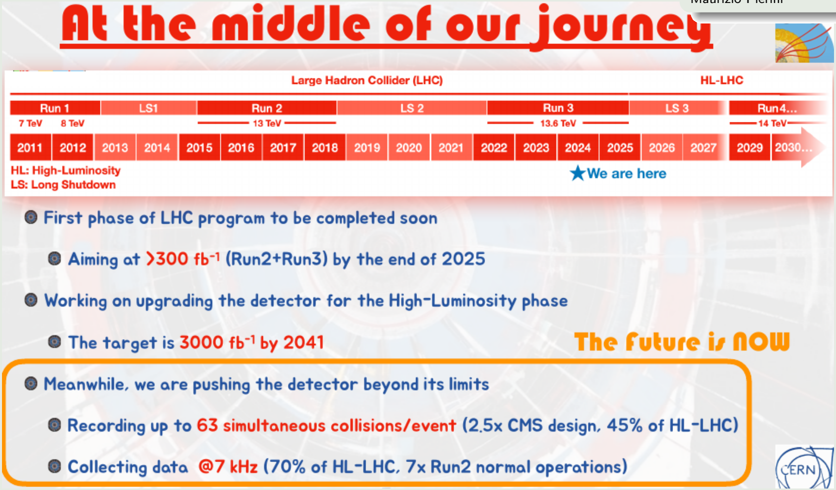
Maurizio Pierini



Impressive number of results (all LHC experiments)

LHC time table

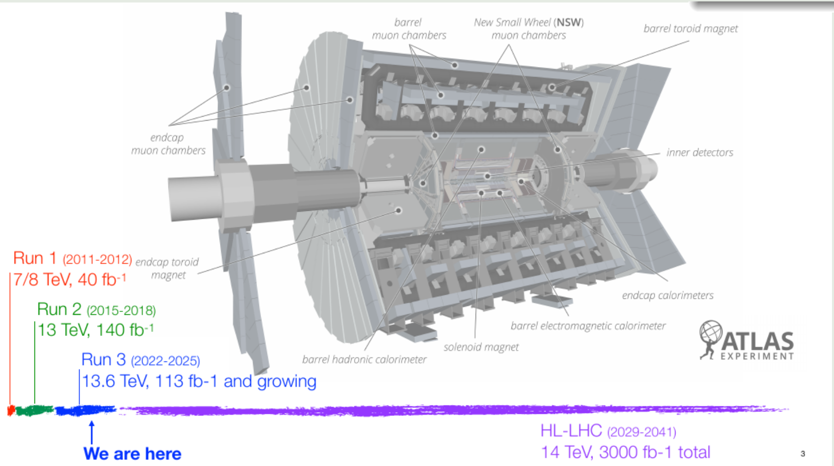
Maurizio Pierini



LHC is already running with 45% of HL-LHC !

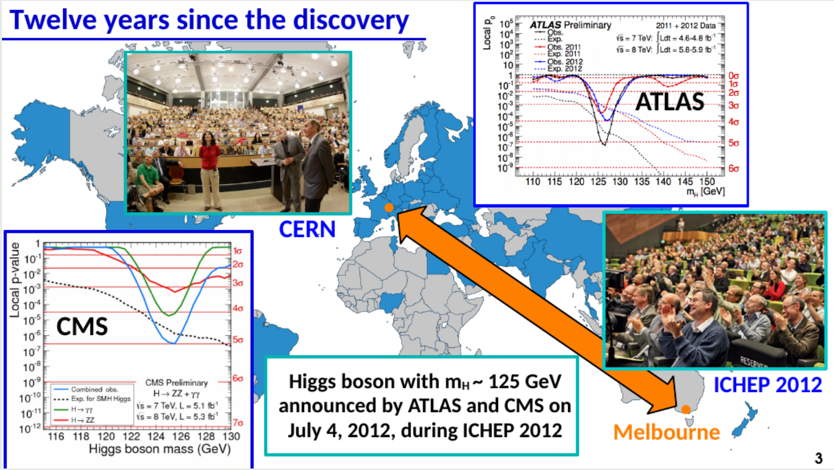
LHC time table

Monica Dunford



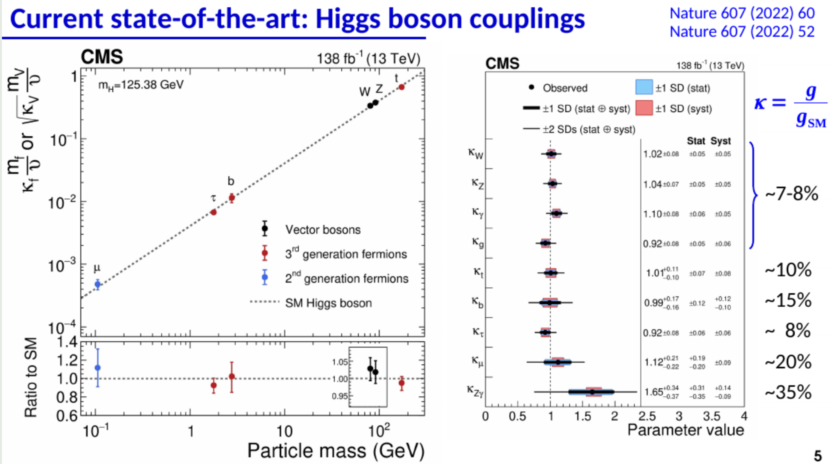
Much more data still to come

Nicolas Berger



ICHEP-2012 at Melbourne: Higgs announced by ATLAS and CMS

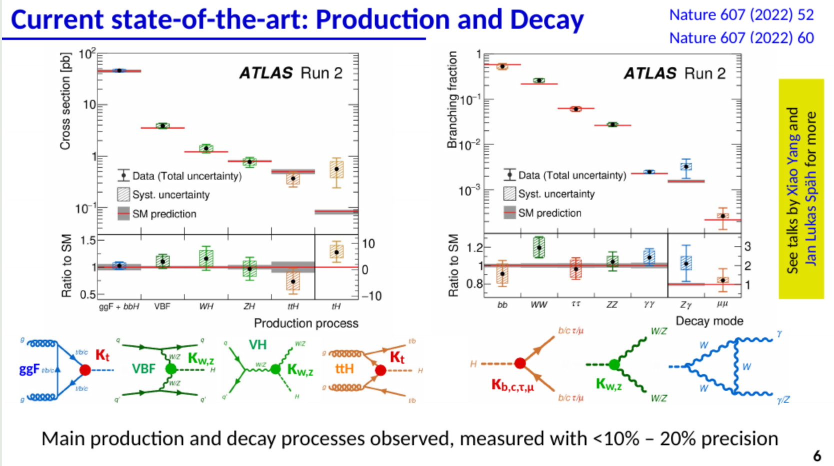
Nicolas Berger



Higgs boson couplings, scaling with particle mass

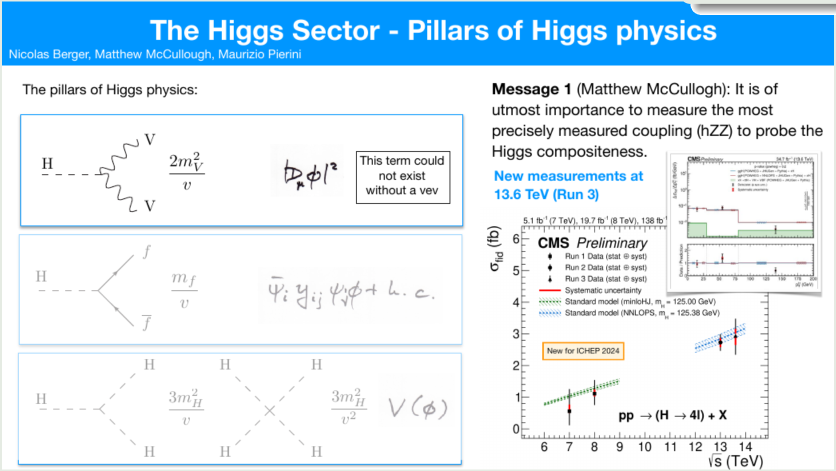
Higgs production and decay ("A portrait of the Higgs boson...by ALTAS")

Nicolas Berger



Higgs boson production xsections and decay BR, agreement with SM

Marumi Kado



Higgs physics pillars, couplings to Vector Bosons, hZZ: window to Higgs compositness

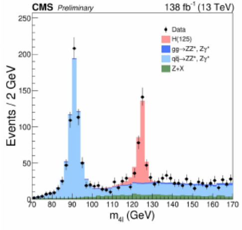
Nicolas Berger

Current state-of-the-art: Mass

CMS: using **H→ZZ*→4l** : CMS-PAS-HIG-21-019

m_H = 125.08 ± 0.10 (stat) ± 0.05 (syst) GeV

Most precise single measurement (< 1 ‰)



ATLAS: combining H→4l + H→γγ : Phys. Lett. B 843 (2023) 137880, Phys. Lett. B 847 (2023) 138315

m_H = 125.11 ± 0.11 GeV (syst: 0.09 GeV)

Most precise measurement to date

H→γγ mass resolution systematics reduced by a factor 4 !

JINST 19 (2024) P02009

See taks by Camila Pazos, Léo Boudet, Badder Marzocchi and Federica Primavera for details

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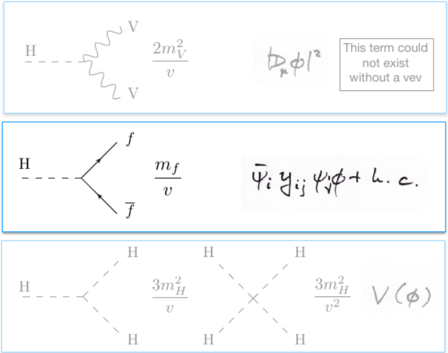
Most precise measurement to date ($H \to 4l$, $H \to 2\gamma$)

Marumi Kado

The Higgs Sector - Pillars of Higgs physics

Nicolas Berger, Matthew McCullough

The pillars of Higgs physics:



	Current	HL-LHC	FCC (ee)
$\kappa_{W,Z}$	6%	1.5%, 1.7 %	0.4%, 0.2 %

	Current	HL-LHC	FCC (ee)	FCC (hh)
κ_t	11%	3.4%	-	1%
κ_b	11%	3.7%	0.7%	-
κ_τ	8%	1.9%	0.7%	-
κ_μ	20%	4.3%	8.9%*	

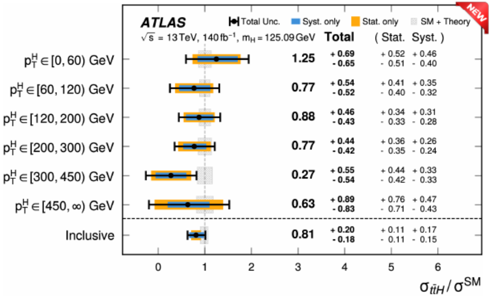
Higgs physics pillars, coupling to fermions (3^{rd} and 2^{nd} generation)

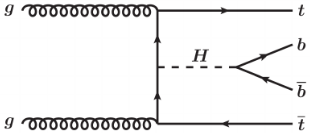
ATLAS: ttH production, $H \to bb$

Monica Dunford

arXiv:2407.10904

Precision Higgs - ttH to bb





Total uncertainty reduced by factor of ~2, 4.6 σ observed

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Towards HL-LHC, 4.6 σ visible, very complex final state, $tt + bb$ bkg. (ML !)

Marumi Kado

Top Yukawa Coupling at the LHC

Nicolas Berger, Matthew McCullough, Monica Dunford, Francesco di Bello

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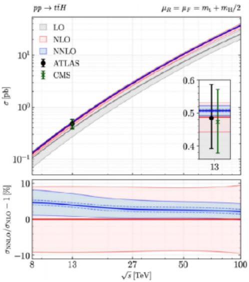
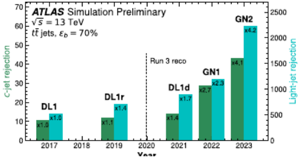
Recent example from Mathew (ttH)



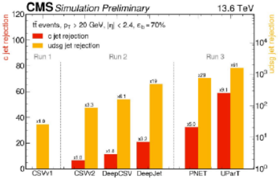
Message 2 (again) (Matthew McCullough):
Precision in Higgs physics is key.

ttH from ATLAS

AI in HEP reconstruction has a significant impact!



The most shown plot at this conference!



There are 4 b-quark jets in the ttH(bb) event topology!

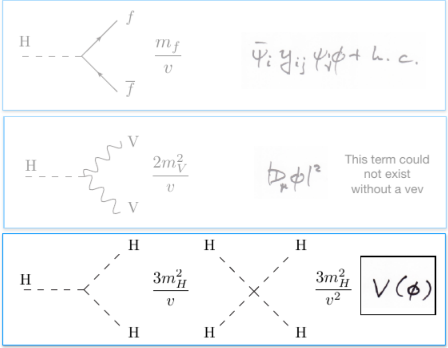
Higgs physics pillars, ttH Yukawa coupling, $H \to bb$

Marumi Kado

The Higgs boson self coupling!

Nicolas Berger, Matthew McCullough

The pillars of Higgs physics:



Despite the fact that in "Vanilla SUSY and vanilla composite models it is difficult to have large deviations in trilinear w.r.t. vector boson coupling"

Matthew McCullogh

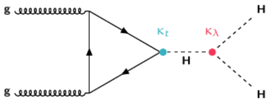
Message 3 (Matthew McCullogh - as well as Georg Weiglein in parallel session): Large trilinear deviations are possible while deviations of the Higgs to Z coupling remain small.

"Arguably the most important of them all!"

Higgs physics pillars, self couplings

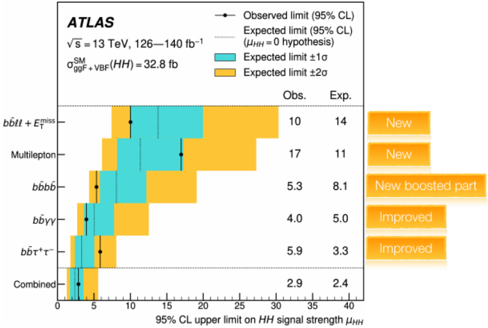
Monica Dunford

Di-higgs production



Best expected sensitivity on HH cross section, self-coupling, κλ

$$\mu_{HH} = 0.5^{+0.9}_{-0.8}(\text{stat.})^{+0.7}_{-0.6}(\text{syst.})$$



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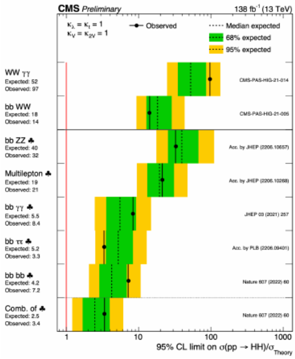
Towards HL-LHC, process is visible already now

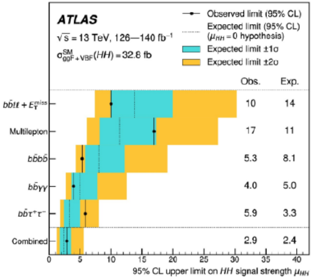
Marumi Kado

Higgs Self Coupling and HH Production

Nicolas Berger, Matthew McCullough

"Arguably the most important of them all!"





Observed limits start deviating from expectation!!

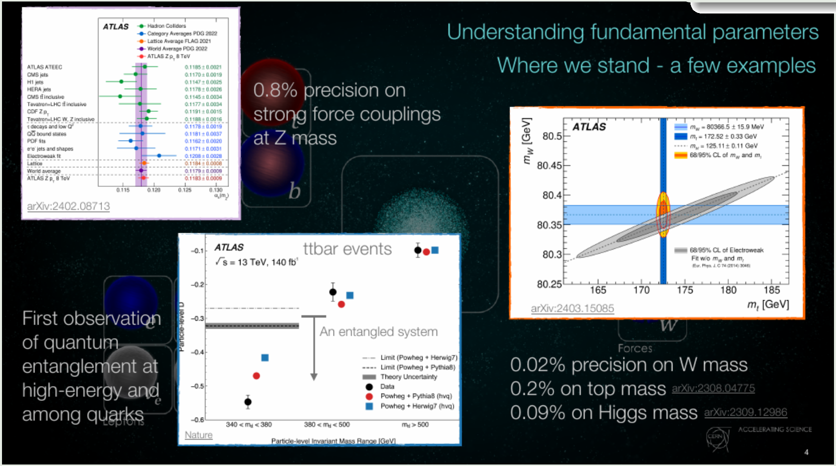
Both experiments have ~1σ sensitivity to a signal (Obs. ATLAS 0.4σ and CMS ~1σ) with Run 2!!

Naive comb. ATLAS-CMS sensitivity with Run 3 close 2.5 σ with improvements (and as much data as possible) **aim at 3σ**

Looking for tension...

ATLAS precision measurements: overview

Monica Dunford



Sub-percentage precision of many measurements.

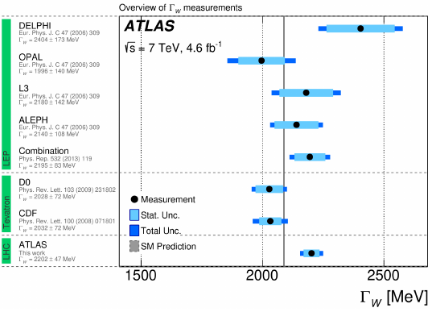
ATLAS precision measurements: W width

Monica Dunford

arXiv:2403.15085

Properties of the W boson

- First measurement of the W width at the LHC, together with an improved W mass
- Largest systematics from the calibration, the theoretical modeling and the parton density functions



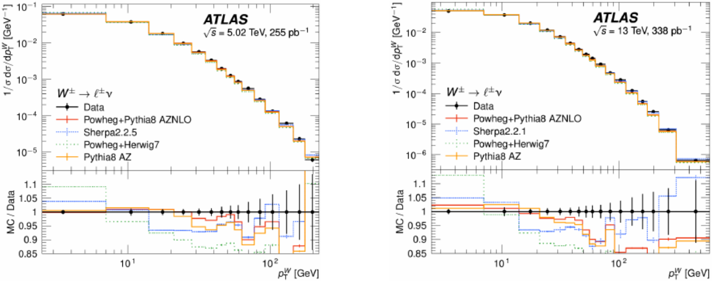
Best world value.

ATLAS precision measurements: W width, fits to W p_T distribution

Monica Dunford

Where can we go - improved modeling

- Dedicated measurements under optimal running conditions can play a key role to improve these limitations



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Experimental data better then theoretical modeling.

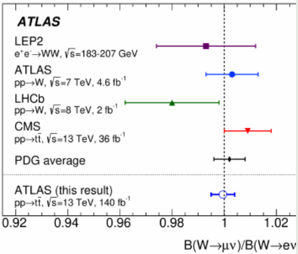
Monica Dunford

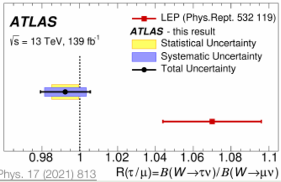
Lepton universality in W decays

- Exploits clean W bosons from top-pair decays
- Higher precision than current world average

$$R_W^{\mu/e} = 0.9995 \pm 0.0045$$

- This adds to a previous result with taus, solving a decade old puzzle from LEP





Nature Phys. 17 (2021) 813

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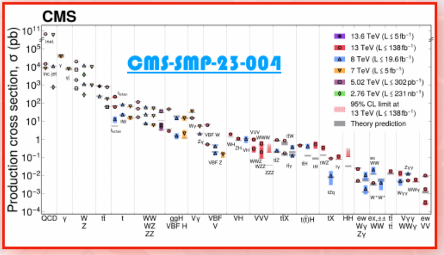
$R_W^{\mu/e}$ - better then world average so far. $R_W^{\tau/\mu}$ - consistent with 1.0.

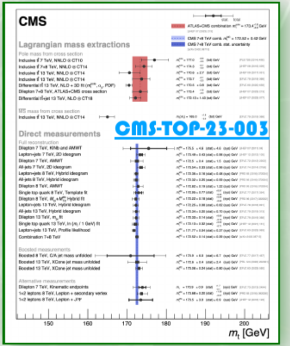
CMS precision measurements

Maurizio Pierini

CMS as a precision physics experiment

- Since Run1, carrying out a fully comprehensive measurement program, to improve our understanding of the SM
- Spanned 14 orders of magnitude in cross sections, going from abundant QCD processes to rare multi boson production
- Measuring fundamental parameters of the Standard Model with multiple techniques at unprecedented precision





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Agreement with SM

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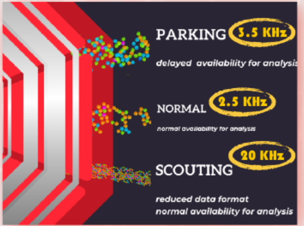
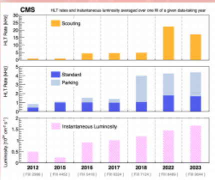
Rethinking Data Taking Strategy

CMS-EXO-23-007

- LHC high-intensity challenge: retain sensitivity to high rate processes (e.g., low p_T) w/o compromising high-p_T core program. Two solutions:
  - (Since 2011) Scouting Stream to work around trigger constraints: store 10 kB of HLT reco objets rather than the full RAW event (~1 MB)
  - (Since 2012) Parking Stream to work around computing constraints: store extra data on tape and reco them when extra computing resources are available
- For Run3, we pushed this effort to maximum capacity
  - Scouting now covers ~20 kHz out of ~100 kHz of incoming rate (at maximum of available online CPU power)
  - Promoted Parking program to default (not just last-year-of-run effort)
- Big benefits to our core physics program (Higgs physics, searches, etc.) and beyond-core areas (e.g., flavor)





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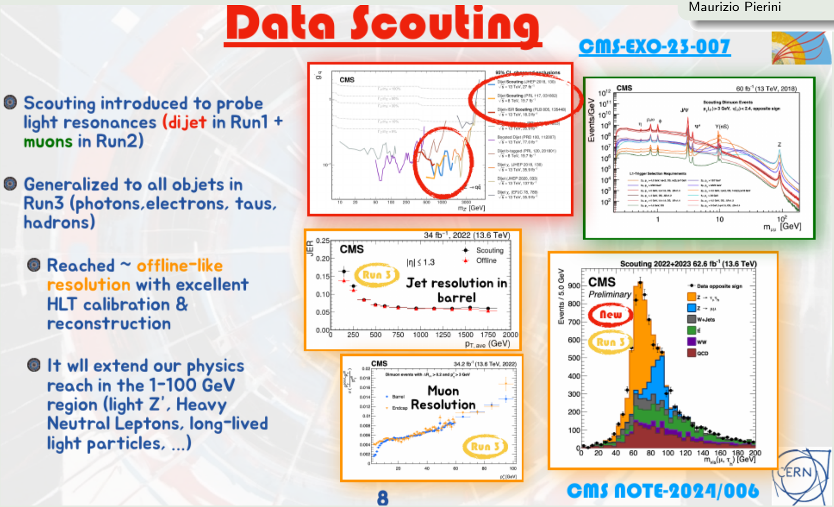
Scouting and Parking. Future: only Scouting for High Rate Physics.

CMS data scouting, up to 100x more data "on tape".

Maurizio Pierini



Possible thanks to excellent understanding of detector calibration.

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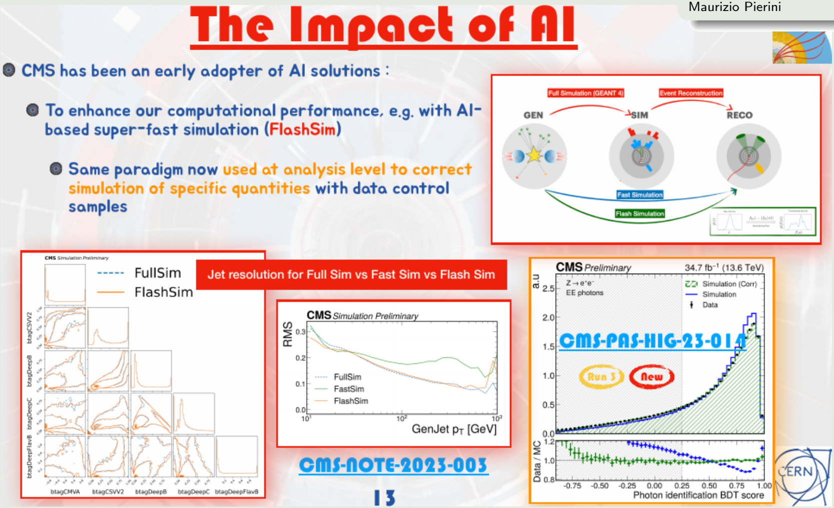
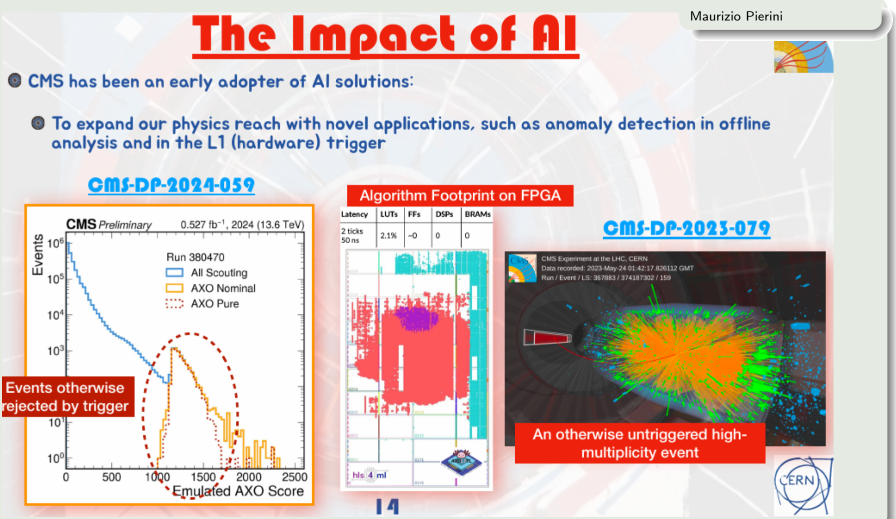
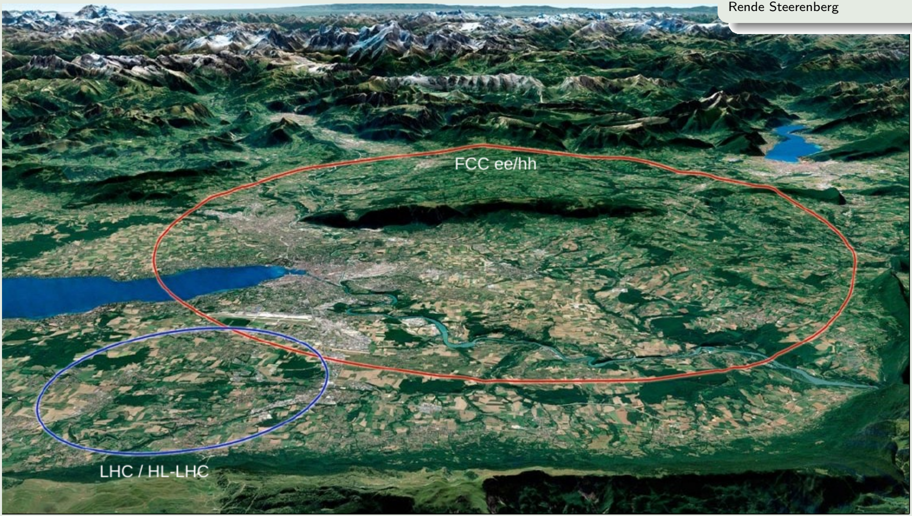


Application of AI for fast detector simulation



Application of AI for anomaly detection (at trigger Level I !)

FCC: The landscape



Rende Steerenberg

FCC: Future Circular Collider

Rende Steerenberg

Optimised placement and layout

Layout chosen:

- One out of ~100 initial variants, based on geology and surface constraints, environment, infrastructure

Baseline:

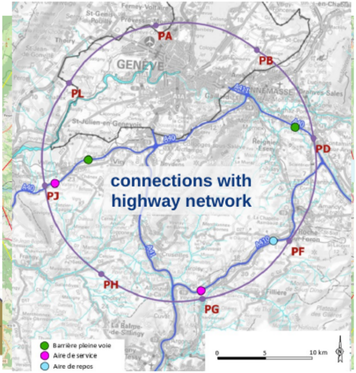
- 90.7 km ring
- 8 surface points
- 4-fold super-periodicity
- 4 interaction points for experiments

Integration with regional services:

- Connections with highway network
- Electrical connection concept developed with the French electricity grid operator

Sustainability is an integral part of the study:

- Commitment to environmental protection
- Heat recuperation, reduced water consumption, etc…



Distance along ring clockwise from CERN (km)

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Latest version of FCC layout: optimized for existing network of public roads

Rende Steerenberg

FCC-ee

2-ring collider with full energy booster in a single tunnel

- Integration of all services and transport corridor

Designed to operate in multiple energy stages to address the different physics cases:

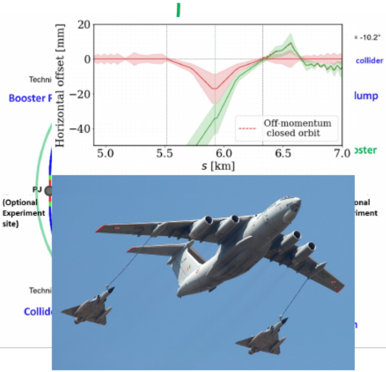
- Z: 45.6 GeV (~4 years)
- WW: 80 GeV (~2 years)
- H(ZH): 120 GeV (~3 years)
- ttbar: 182.5 GeV (~5 years)

Scalable superconducting RF system

- Increase needs as physics evolves Z ⇒ W ⇒ H ⇒ ttbar
- SRF is a main area of R&D for the FCC-ee

On-axis top-up injection for high luminosities

- Beam lifetime and high bunch charge require continuous top-up injection



Parameter table available in the back-up slides

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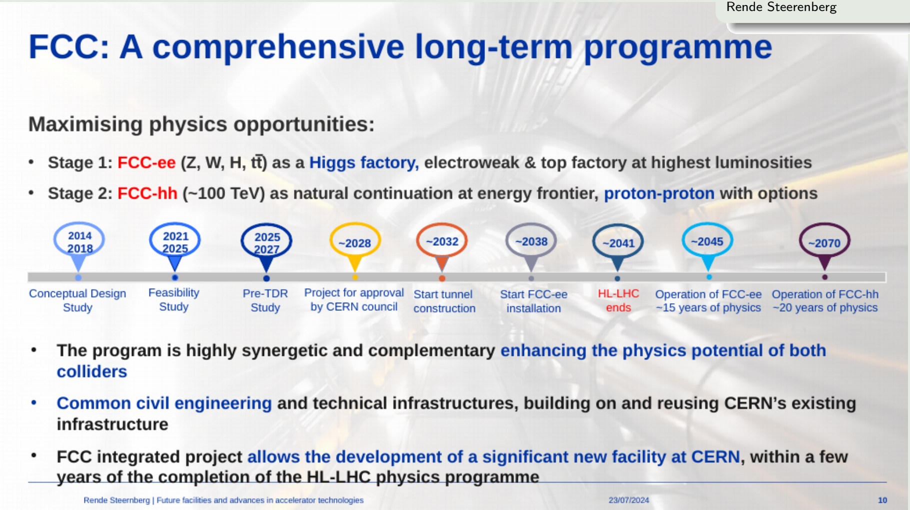
FCC-ee: physics programme

Rende Steerenberg



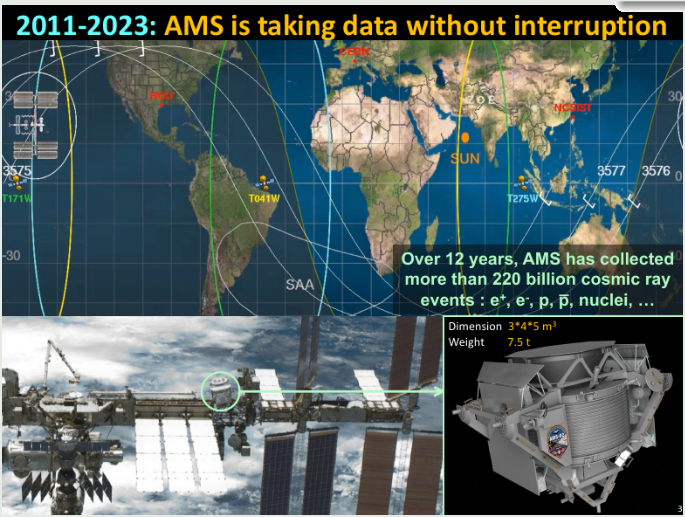
FCC: data taking in 2045 (FCC-ee) and 2070 (FCC-hh)

ICHEP'24: panel discussion

60 minutes, 4 directors of HEP labs, 1:1:2 - Europe : America : Asia

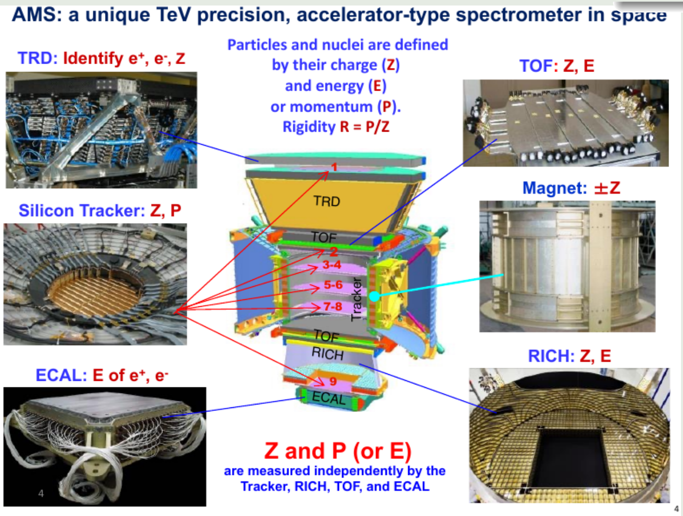
AMS-2: 12 years of data taking

AMS Collab.



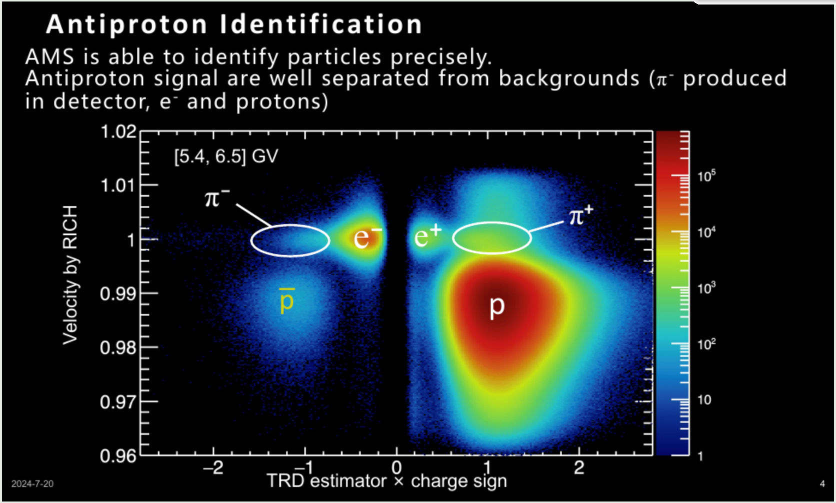
2.2×10^{11} events over 12 years $\rightarrow$ and more to come (till 2030)

AMS Collab.



"full function" HEP detector in space

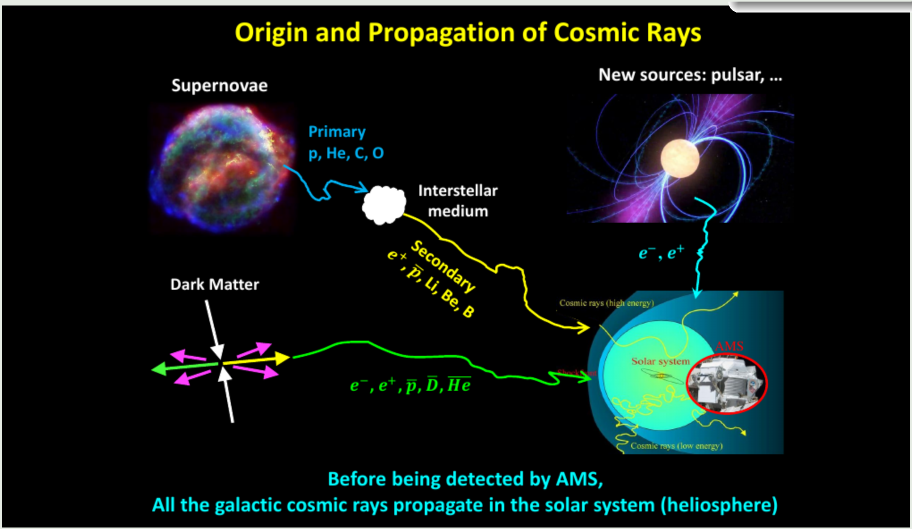
AMS Collab.



matter antimatter separation

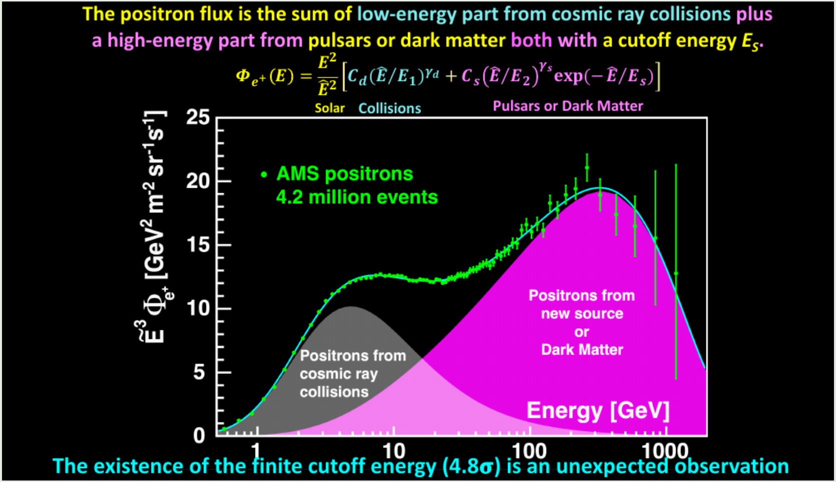
AMS-2: origin of cosmic rays

AMS Collab.



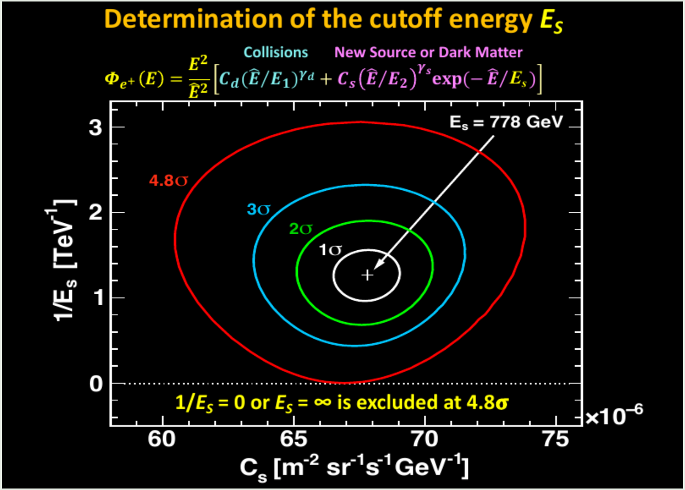
a lot of effort to understand CR propagation in heliosphere

AMS Collab.



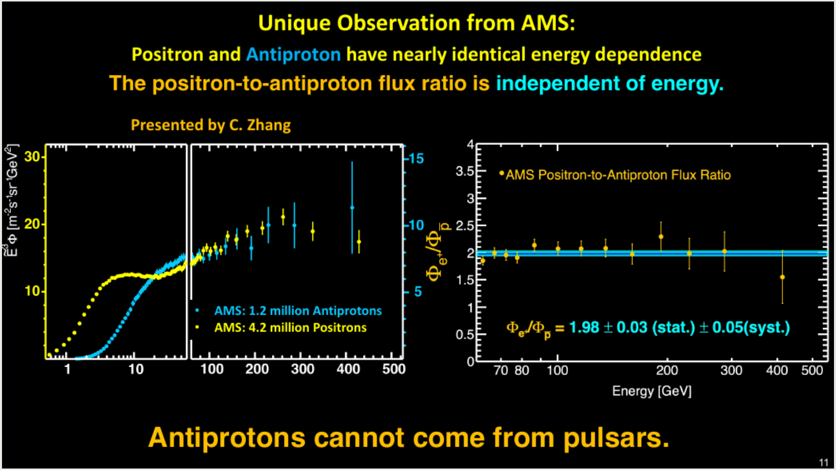
positron flux decomposition

AMS Collab.



spectrum cut-off significance: 4.8σ

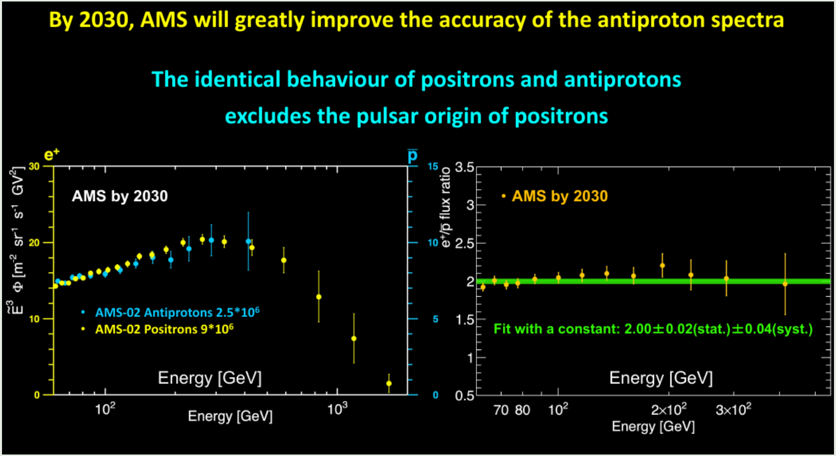
AMS Collab.



positron and antiprotons have similar energy dependence

AMS-2: positrons are not from pulsars

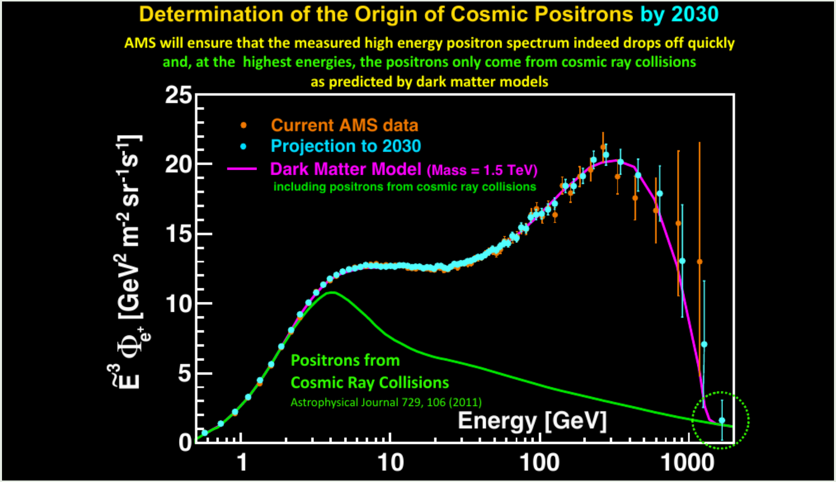
AMS Collab.



tendency is already visible, expected projections by 2030

AMS-2: positrons spectrum: expected precision by 2030

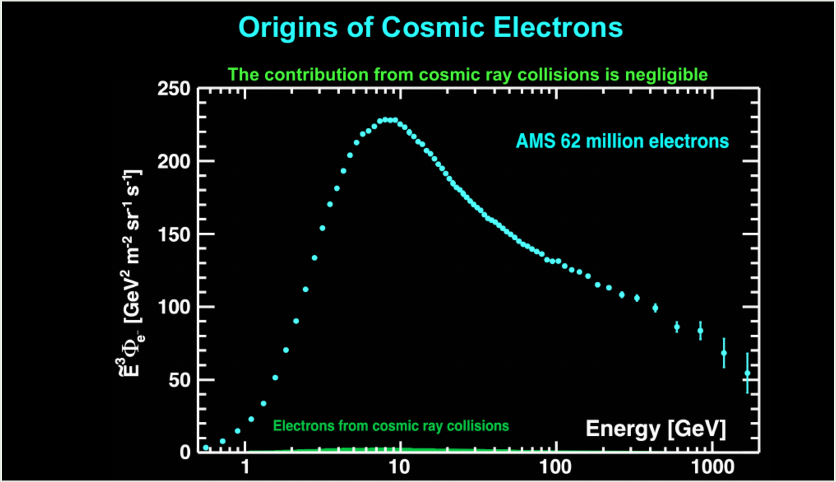
AMS Collab.



Precision of positron spectrum projected to 2030

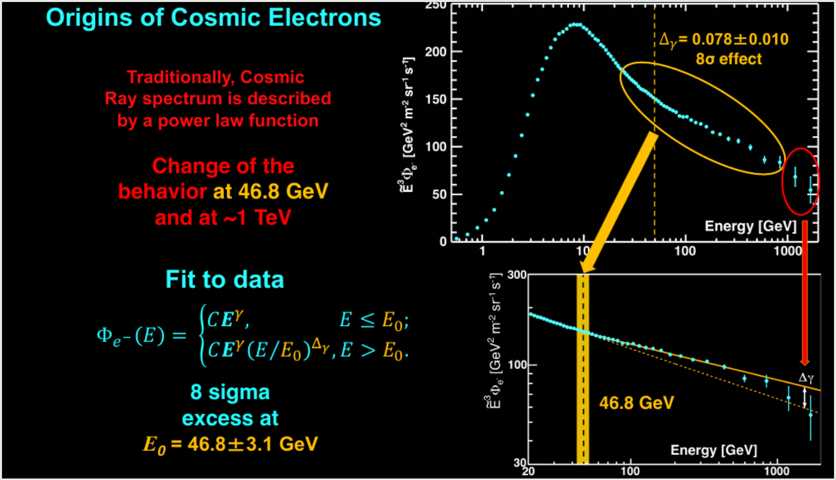
AMS-2: electrons spectrum

AMS Collab.



negligible contribution from secondary interactions → more clean picture

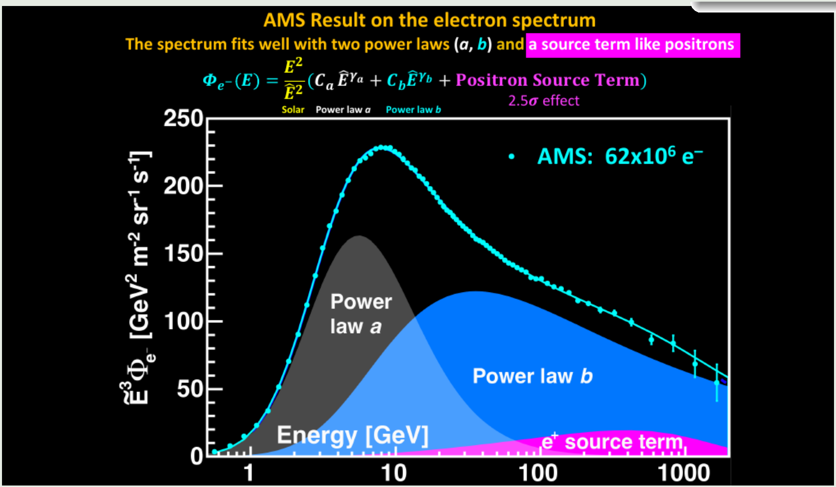
AMS Collab.



cannot be described only by power law dependency (Fermi mechanism)

AMS-2: electrons spectrum, source term contribution

AMS Collab.



visible contribution from source "positron-like counterpart" term
(2.5σ at present, 4σ expected at 2030)

AMS-2 anti-Helium observation

- AMS-2 reports of ~ 10 events (#COSPAR2022) of ${}^3\overline{\mathrm{He}}$ and ${}^4\overline{\mathrm{He}}$ nuclei
- **possible sources:**
- Supernovas explosions $\rightarrow$ extremely low rate, (should be correlated to anti-protons)
- Cosmic Rays interaction plus Supernovas Shock Waves acceleration ?
  $\rightarrow$ too small flux...
- Dark Matter annihilation:
  like $X + X \rightarrow WW, ZZ, bb, \ldots$ (as product of single heavy particle decay from $W, Z, bb \rightarrow jets$ fragmentation and hadronization)
- More Exotic Sources ?

Anti-He from AMS-2: possible sources

Cosmic-Ray Propagation Models Elucidate the Prospects for Antinuclei Detection

Pedro De La Torre Luque[a,b] **Martin Wolfgang Winkler**[c] **Tim Linden**[b]

[a]Instituto de Física Teórica, IFT UAM-CSIC, Departamento de Física Teórica, Universidad Autónoma de Madrid, ES-28049 Madrid, Spain

flux from both astrophysical and dark matter annihilation models. We show that astrophysical sources are capable of producing $\mathcal{O}(1)$ antideuteron events and $\mathcal{O}(0.1)$ antihelium-3 events over 15 years of AMS-02 observations. Standard dark matter models could potentially produce higher levels of these antinuclei, but showing a different energy-dependence. Given the uncertainties in these models, dark matter annihilation is still the most promising candidate to explain preliminary AMS-02 results. Meanwhile, any robust detection of antihelium-4

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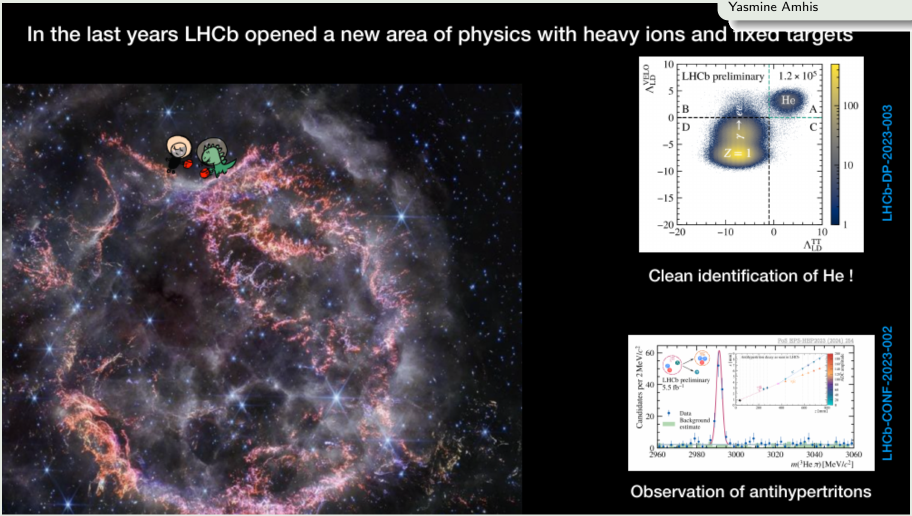
events would require more novel dark matter model building or a new astrophisical production mechanism.

Dan Moise

LHCb: looking for anti-helium production in *pp* collisions

LHCb (plenary): production of anti-helium

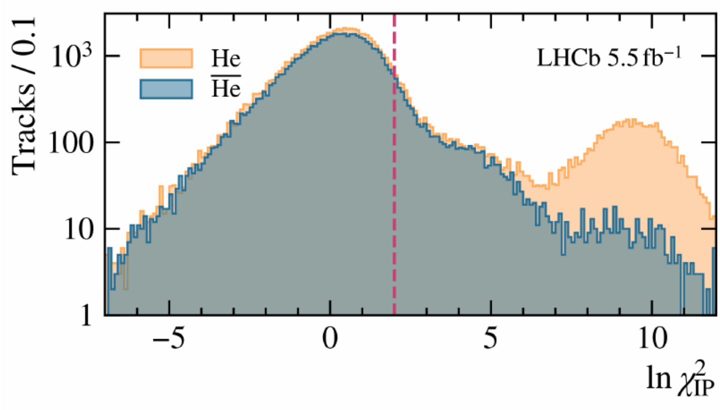
Yasmine Amhis



LHCb: contribution to AMS observations

Dan Moise

Prompt and displaced helium



LHCb: prompt (anti)helium : from fragmentation of recombination of QCD strings

LHCb: anti-hypertriton and displaced production of anti-helium

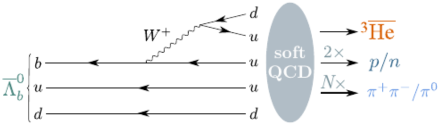
Dan Moise

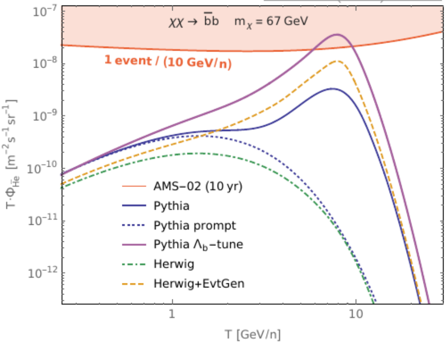
Dark Matter Annihilation Can Produce a Detectable Antihelium Flux through $\bar{\Lambda}_b$ Decays

Martin Wolfgang Winkler[1,*] and Tim Linden[1,†]

[1] *Stockholm University and The Oskar Klein Centre for Cosmoparticle Physics, Alba Nova, 10691 Stockholm, Sweden*

PRL 126(2021)101101





$\mathcal{B}(\overline{\Lambda}_b^0 \to {}^3\overline{\text{He}}X)$ predicted as high as 3×10^{-6} (modified Pythia 8.2)

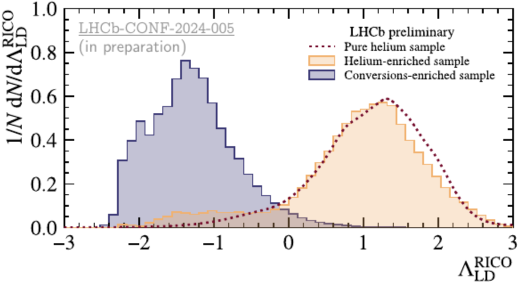
well within reach of LHCb

NB: discussion ongoing, e.g. PRC 1018(2023) 024903

LHCb: BR predictions from Pythia within LHCb reach, soft-QCD uncertainties

Dan Moise

Helium selection: conversion rejection



- **R**ICH, **I**solation, **C**alorimetry, and **O**T information combined into additional log-likelihood estimator: Λ_{LD}^{RICO}

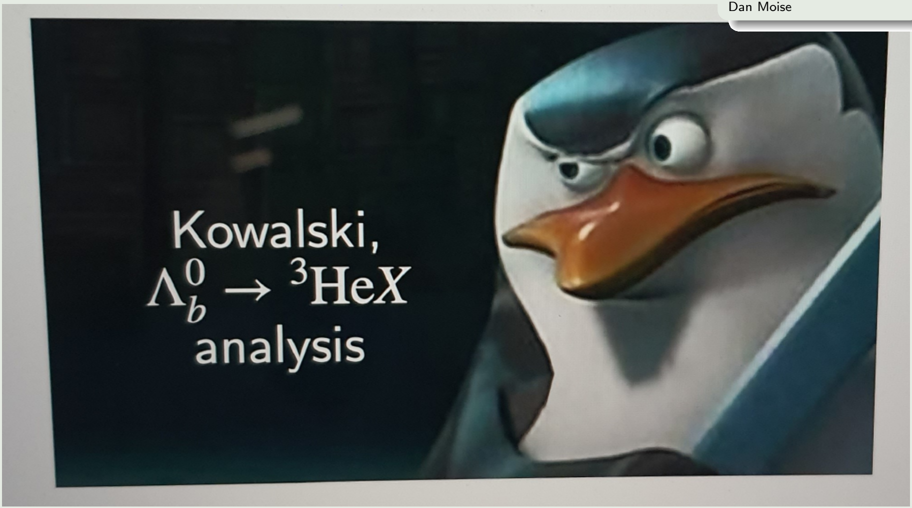
$\Rightarrow$ removes residual background from conversions

$\Rightarrow$ signal $\nearrow$ 10%, background $\searrow$ 3x *cf.* previous publications

Background: $\gamma \to e^+e^-$ conversion with small opening angle (mimics Z=2 ionization)

LHCb: another penguin process

Dan Moise



Penguins analysis :).

Dan Moise

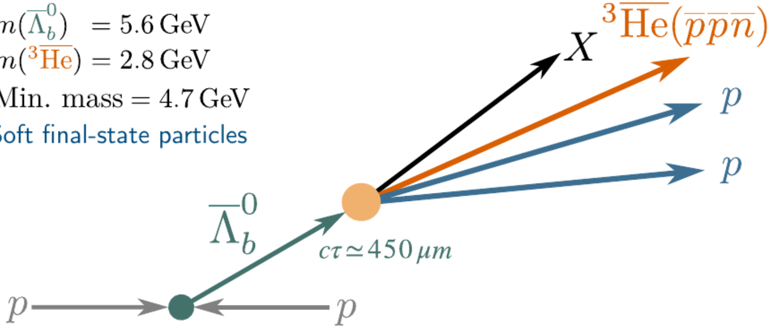
Topology & kinematics

$m(\overline{\Lambda}_b^0) = 5.6\,\text{GeV}$

$m(^3\overline{\text{He}}) = 2.8\,\text{GeV}$

$\text{Min. mass} = 4.7\,\text{GeV}$

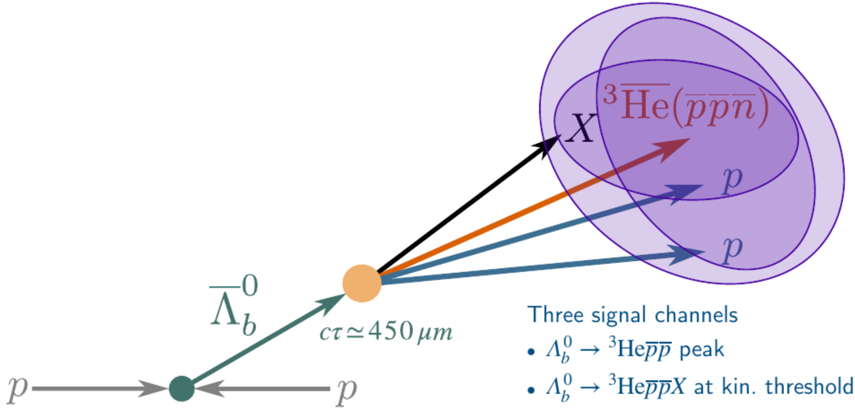
Soft final-state particles



barion number conservation $\rightarrow$ 2 nucleons are expected $(+\text{X})$

Dan Moise

Topology & kinematics



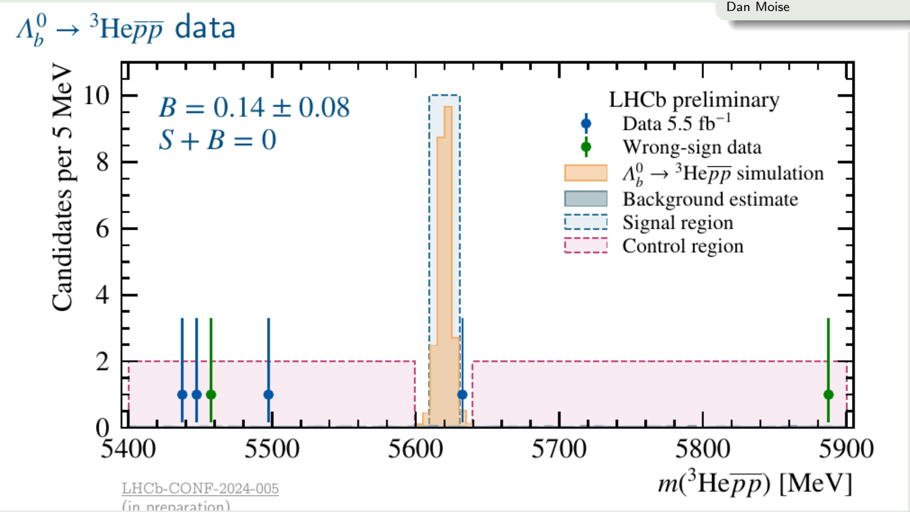
Three signal channels

- $\Lambda_b^0 \to {}^3\text{He}\overline{p}\overline{p}$ peak
- $\Lambda_b^0 \to {}^3\text{He}\overline{p}\overline{p}X$ at kin. threshold
- $\Lambda_b^0 \to {}^3\text{He}\overline{p}X$ at kin. threshold

barion number conservation $\to$ 2 nucleons are expected $(+X)$

LHCb: (no) signal of $\bar{\Lambda}_b^0$ decay

Dan Moise

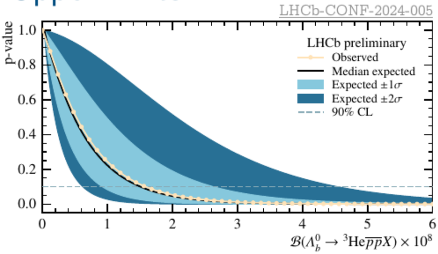


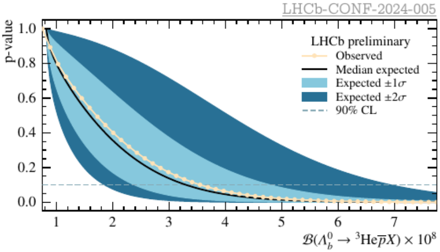
exclusive channel, similar for inclusive channels, no signal...

LHCb: limits for $\bar{\Lambda}_b^0$ BR decay

Dan Moise

Upper limits





$\mathcal{B}(\Lambda_b^0 \to {}^3\mathrm{He}\overline{p}\overline{p}X) < 1.6 \times 10^{-8}$

$\mathcal{B}(\Lambda_b^0 \to {}^3\mathrm{He}\overline{p}X) < 3.6 \times 10^{-8}$

isospin

$$\mathcal{B}(\Lambda_b^0 \to {}^3\mathrm{He}X) < 6.3 \times 10^{-8}$$

$\overline{p}\overline{p}$: 25% $\overline{p}\overline{n}$: 25%
$\overline{n}\overline{p}$: 25% $\overline{n}\overline{n}$: 25%
(Pythia: $\overline{p}\overline{p} \sim 40\%$)

$\mathcal{B}(\Lambda_b^0 \to {}^3\mathrm{He}\overline{p}\overline{p}) < 1.9 \times 10^{-9}$
profile likelihood NIMA458(2001)745-758

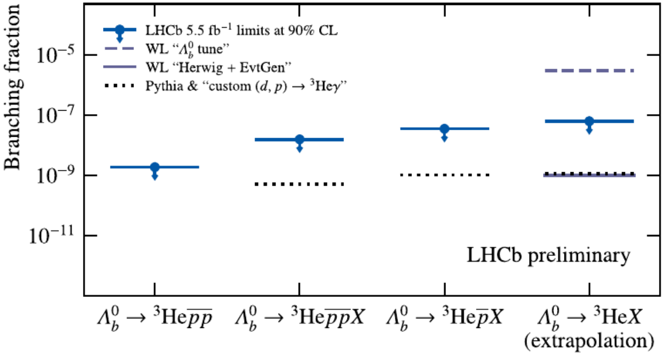
limits well below (naive ?) Pythia BR expectations...

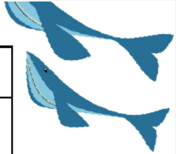
LHCb: $\bar{\Lambda}_b^0 \to {}^3\bar{He} + X$ Summary

Dan Moise

Summary

LHCb-CONF-2024-005 (in preparation)





These are the first results on (anti)helium production in (anti)Λ_b decays.
They significantly restrict abundance of ${}^3\overline{\mathrm{He}}$ in cosmic rays.
LHCb Upgrade II offers the potential to cover current estimates.

14

translation to the abundance of ${}^3\overline{\mathrm{He}}$ in CR requires more work... (**what about ${}^4\overline{\mathrm{He}}$?**)

Vivian Poulin,[1] Pierre Salati,[2] Ilias Cholis,[3,1] Marc Kamionkowski,[1] and Joseph Silk[1,4,5]

[1] *Department of Physics and Astronomy, Johns Hopkins University, Baltimore, MD 21218, USA*
[2] *LAPTh, Université Savoie Mont Blanc & CNRS, 74941 Annecy Cedex, France*
[3] *Department of Physics, Oakland University, Rochester, MI 48309, USA*
[4] *Sorbonne Universités, UPMC Univ. Paris 6 et CNRS, UMR 7095, Institut dAstrophysique de Paris, 98 bis bd Arago, 75014 Paris, France*
[5] *Beecroft Institute of Particle Astrophysics and Cosmology, Department of Physics, University of Oxford, Denys Wilkinson Building, 1 Keble Road, Oxford OX1 3RH, UK*

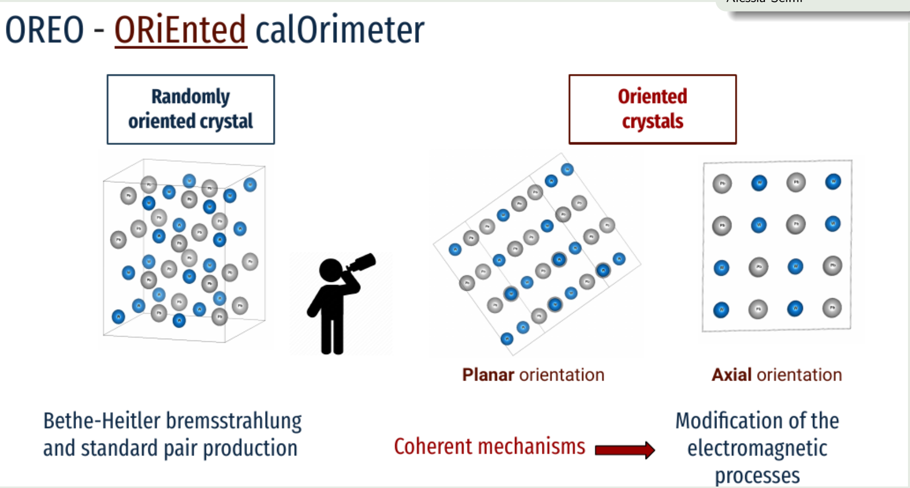
(Dated: March 26, 2019)

We discuss the origin of the anti-helium-3 and -4 events possibly detected by *AMS-02*. Using up-to-date semi-analytical tools, we show that spallation from primary hydrogen and helium nuclei onto the ISM predicts a $\overline{^3\mathrm{He}}$ flux typically one to two orders of magnitude below the sensitivity of *AMS-02* after 5 years, and a $\overline{^4\mathrm{He}}$ flux roughly 5 orders of magnitude below the *AMS-02* sensitivity. We argue that dark matter annihilations face similar difficulties in explaining this event. We then entertain the possibility that these events originate from anti-matter-dominated regions in the form of anti-clouds or anti-stars. In the case of anti-clouds, we show how the isotopic ratio of anti-helium

Thank You For Your Attention

BACKUP PLOTS FOLLOWS...

Alessia Selmi

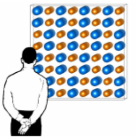


Coherent mechanism of Electromagnetic shower development along crystal axis

OREO: EM calorimetry in oriented crystals

Alessia Selmi

Relativistic particle incident on atomic string → **STRONG FIELD REGIME**



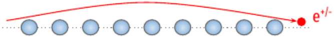
$$\chi = \frac{\gamma E}{E_0} > 1$$

Lorentz factor: γ

Field experienced by the electron in its rest frame: E

QED critical electric field: $E_0 \sim 1.3 \cdot 10^{18} \frac{V}{m}$

The particle experiences an **intense field** that can be considered **constant** along the string

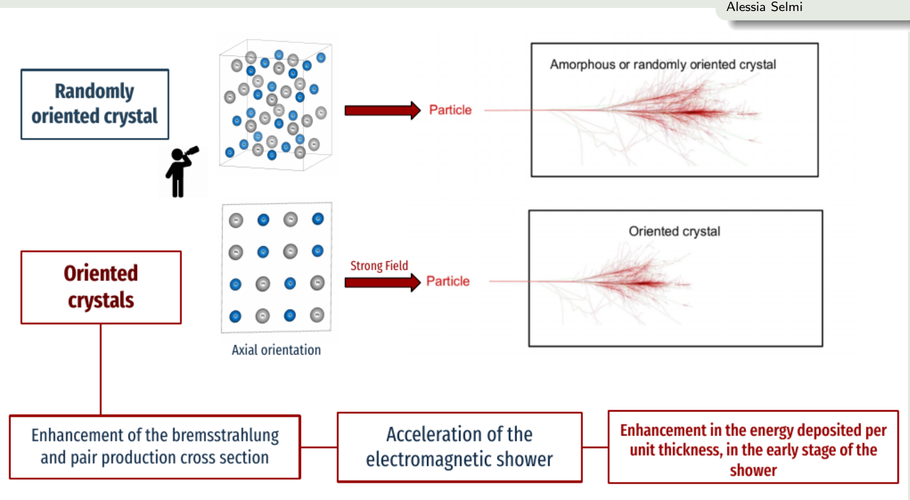


Coherent interactions all over the string of atoms → Shift of bremsstrahlung spectra towards higher energies and enhancement of pair production cross section

alignment of crystal axes wrt. the impact particle is crucial: ~ 1 mrad

OREO: EM calorimetry in oriented crystals

Alessia Selmi

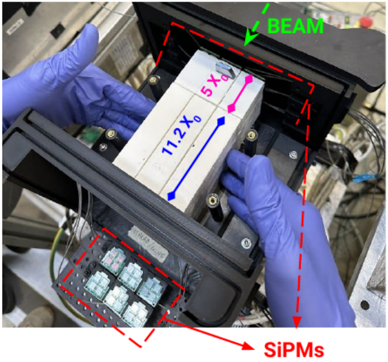


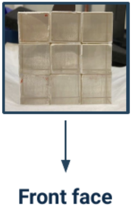
acceleration of EM shower: simulation by Geant4 extension

Alessia Selmi

OREO - ORiEnted calOrimeter → Prototype of compact crystal based calorimeter

National Coordinator
Laura Bandiera, INFN FE





GOAL

1. Demonstrate the possibility to **align a layer of crystals along the same crystallographic direction**
2. Prove that it's possible to **contain e.m. showers in a reduced volume/weight** and cost

$PbWO_4$ prototype assembled within INFN project at test beam: proof of principle

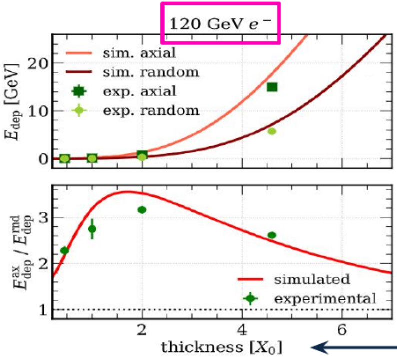
OREO: EM calorimetry in oriented crystals

Alessia Selmi

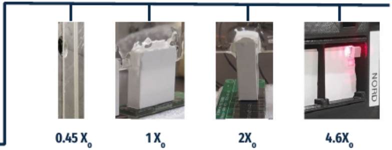
Experimental investigation of the Strong Field effects in oriented $PbWO_4$.

Results: shower acceleration →enhancement of the effective thickness !

Soldani et al.



thickness [X_0]	effective thickness [X_0]	thickness enhancement [%]
0.45	0.745	165.48
1	1.520	151.98
2	2.923	146.17
4.6	6.208	134.96



shower acceleration was observed for the first time

OREO: EM calorimetry in oriented crystals

Alessia Selmi

ORiEnted calOrimeter for...

space-borne γ-ray (VHE/UHE) detectors with pointing systems e.g. Fermi LAT

- reduced thickness
- improved shower containment with less longitudinal leakage
- higher γ efficiency
- better γ/hadron discrimination

↓

Bandiera, CRIS-MAC 2024
Bandiera et al.

forward-geometry accelerator-based experiments

fixed-target   collider forward region

- improved shower containment and energy resolution
- higher γ efficiency: ideal for γ vetoes
- better γ/hadron discrimination: ideal for γ/n in small-angle calorimeters on neutral hadron beamlines

↓

Monti-Guarnieri et al.

possible fields of application