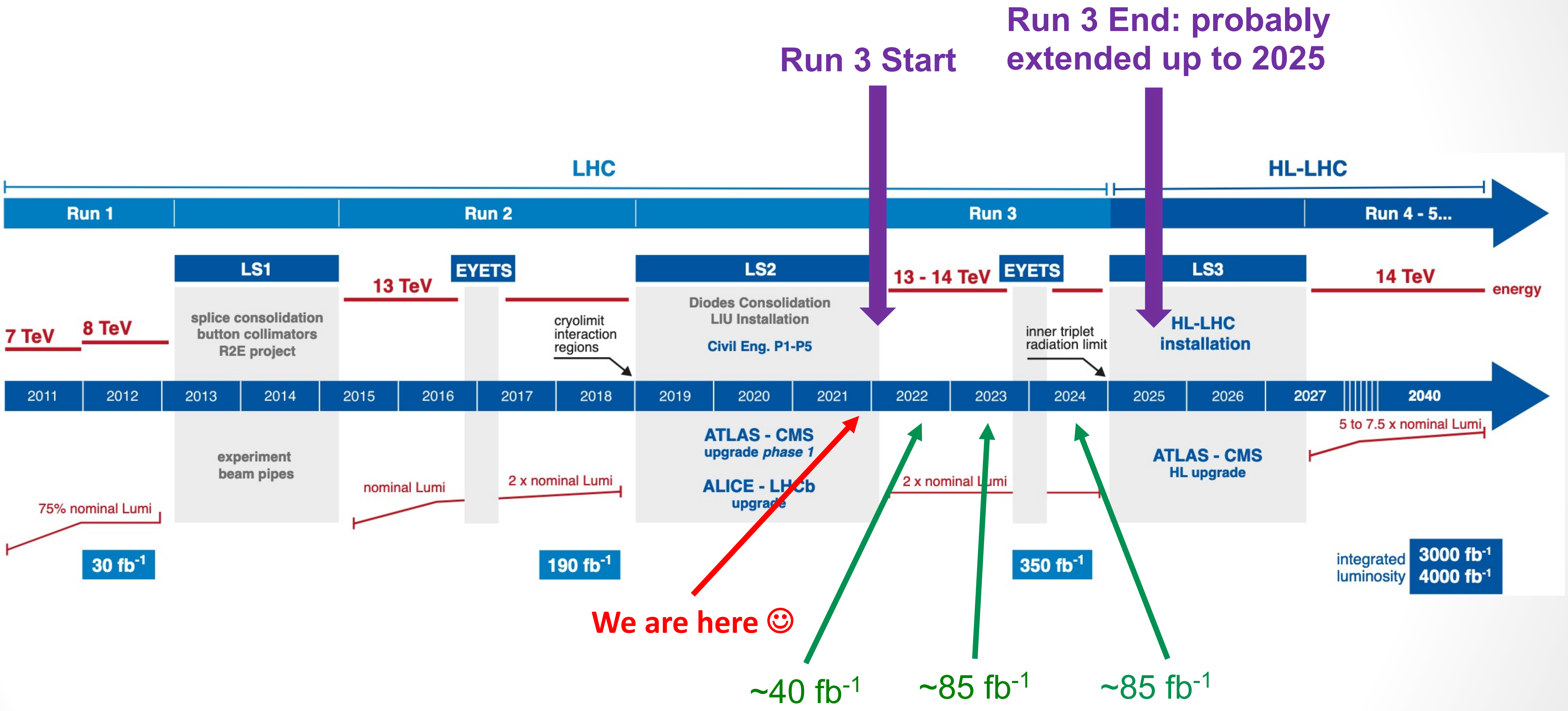
LHC restart: Run 3

ATLAS

& CMS

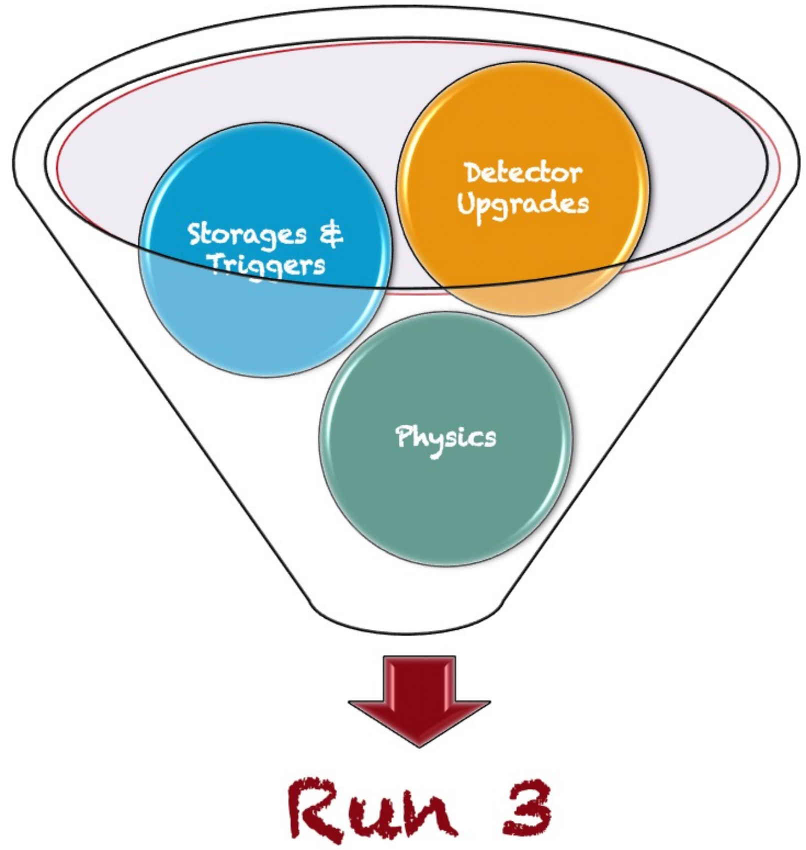
A. O. M. Iorio & E. Rossi

Run 3



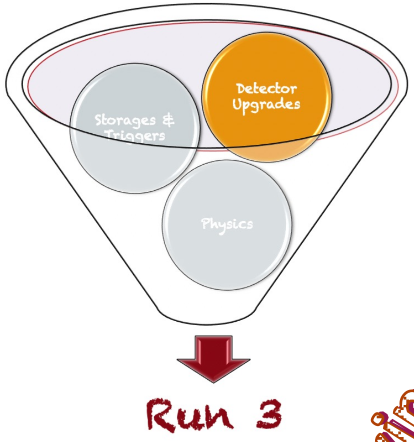
$\sqrt{s}$ = 13.6 TeV e/o 14 TeV

Going beyond √n: lessons from Run-2

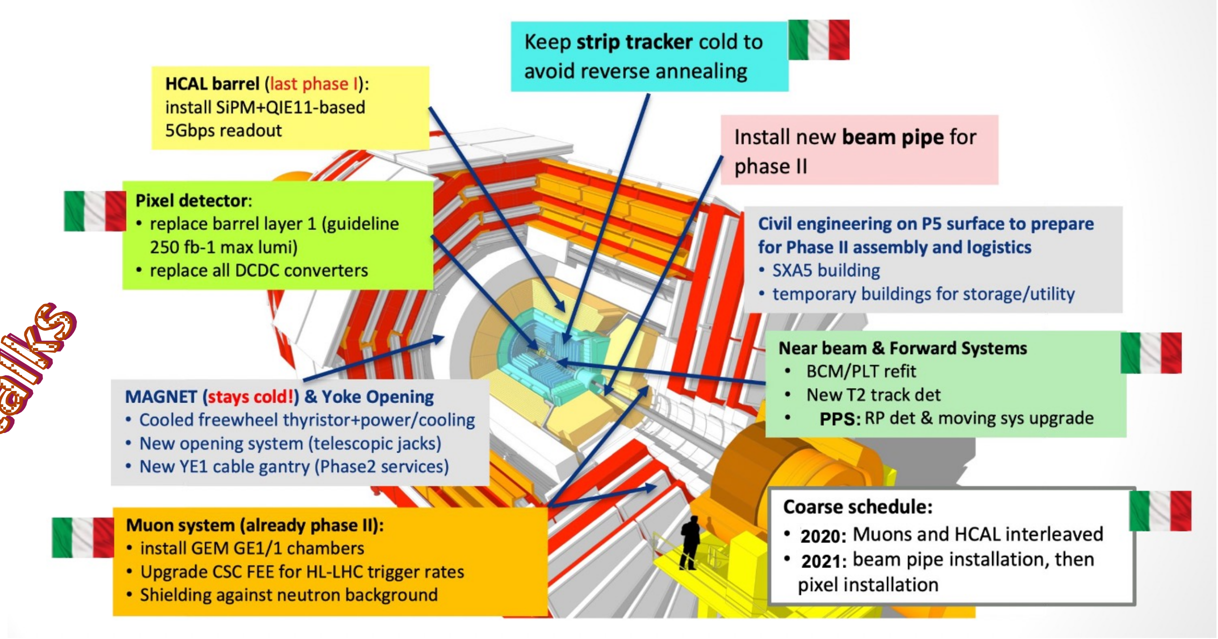


- **Quality AND Quantity:** Run-2 allowed to really push the envelope of the analysis techniques.
  - **Lesson 1:** Often allow **opening up of new channels, higher regimes**
  - **Lesson 2**: Validation in data is crucial --> **more statistics** is always needed also to **improve beyond √n!**
- **New analysis preparation:** more data means one can get creative with analysis strategies and triggers.
  - **Lesson 3:** we need to try new things **early in the run to profit of full statistics and HL-LHC!**

Long shutdown 2 activities/upgrades

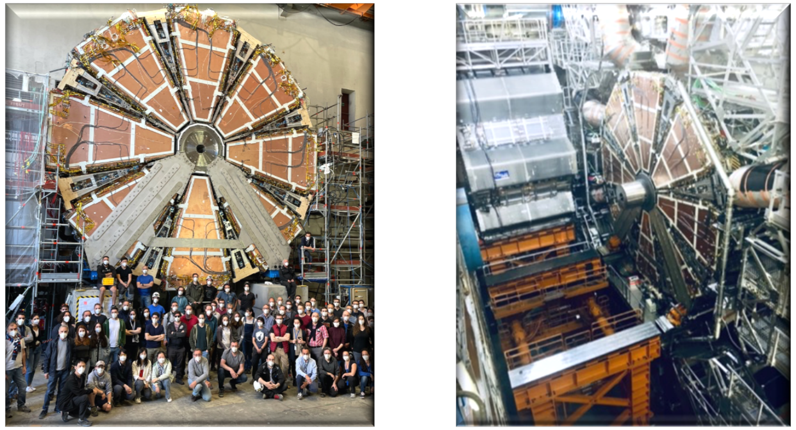


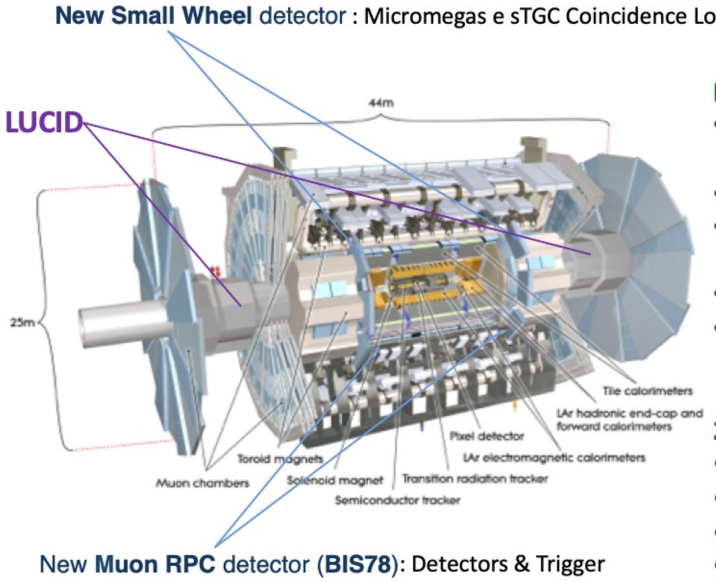
More details in following talks



GEM

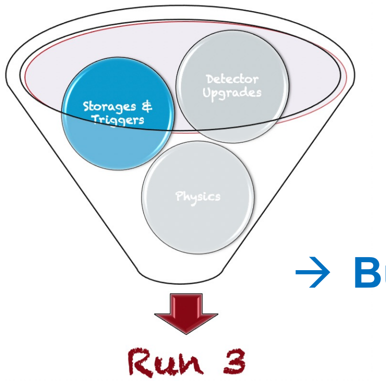
New Small Wheel





Phase 1 Upgrade
- **New Small Wheel:** Micromegas e sTGC Coincidence Logic
- **BIS78 RPC:** Detectors & Trigger
- **LUCID** (LUminosity Cherenkov Integrating Detector): Detector
- **LAr:** trigger electronic
- **TDAQ:** New boards, Readout & DAQ Software

2020-2021 Maintainance
- **Muon System**
- **LAr**
- **Tile**
- **Pixels**



Run 3: Luminosity & Triggers

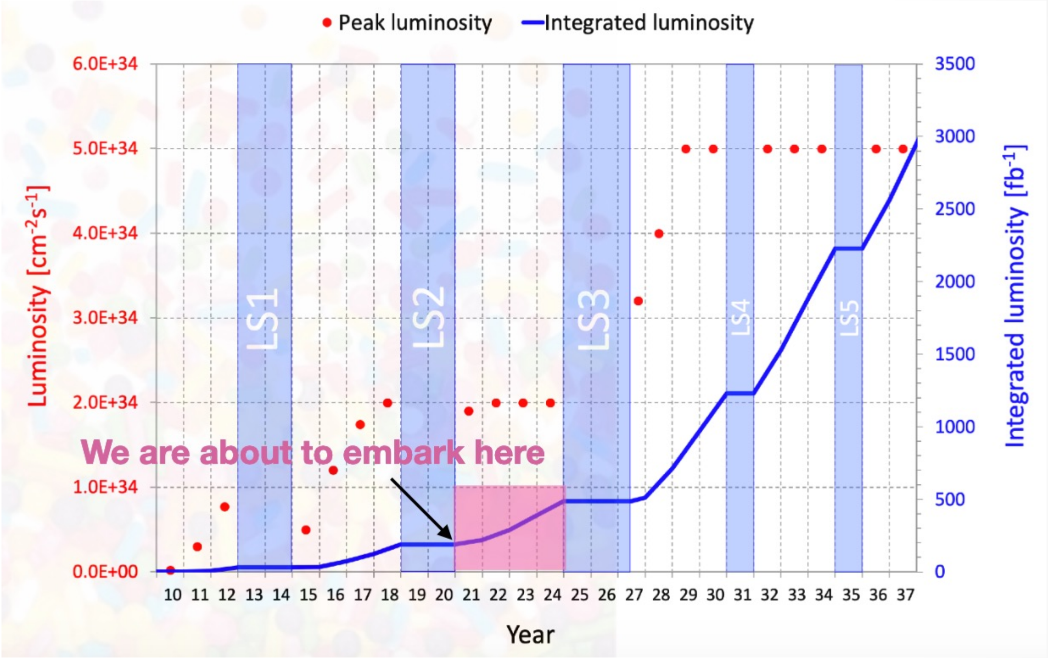
Run 3 brings 160fb^{-1} ~ Doubles our integrated luminosity

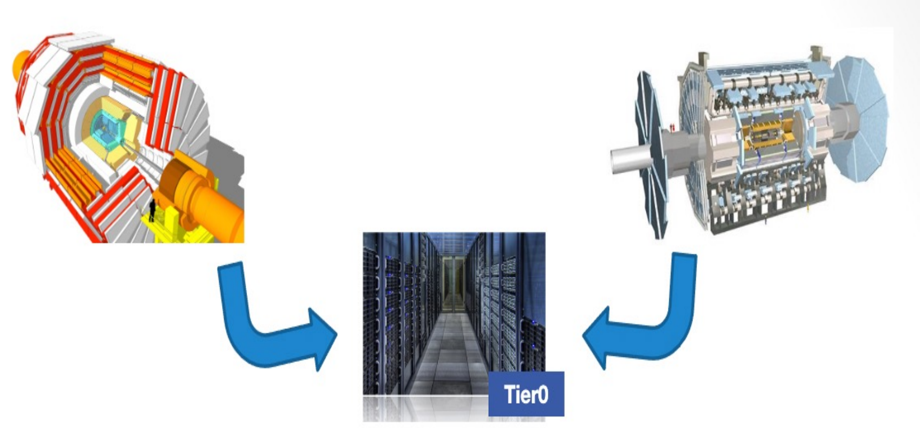
→ Only stats improved sensitivity over Run 2 searches.

→ But also...Opportunity to explore new trigger strategies and collect different data!

The Challenge ➔ We see more than we can record!

- ✓ To control trigger rates, we mainly raise thresholds ➔ leaving softer signals behind.
- ✓ And we can't record all, because of limitations in bandwidth, processing and storage.





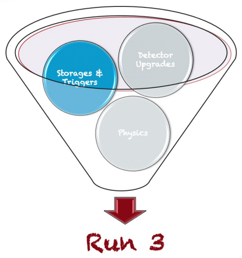
How to record more data ➔ Circumvent some limitations:

(1) Trigger Machine performance & storage -> Upgraded/more

If want more → Event Rate; we decrease → Event Size

(2) Bandwidth limitation to TIER0 -> Bandwidth = Event Rate x Event Size

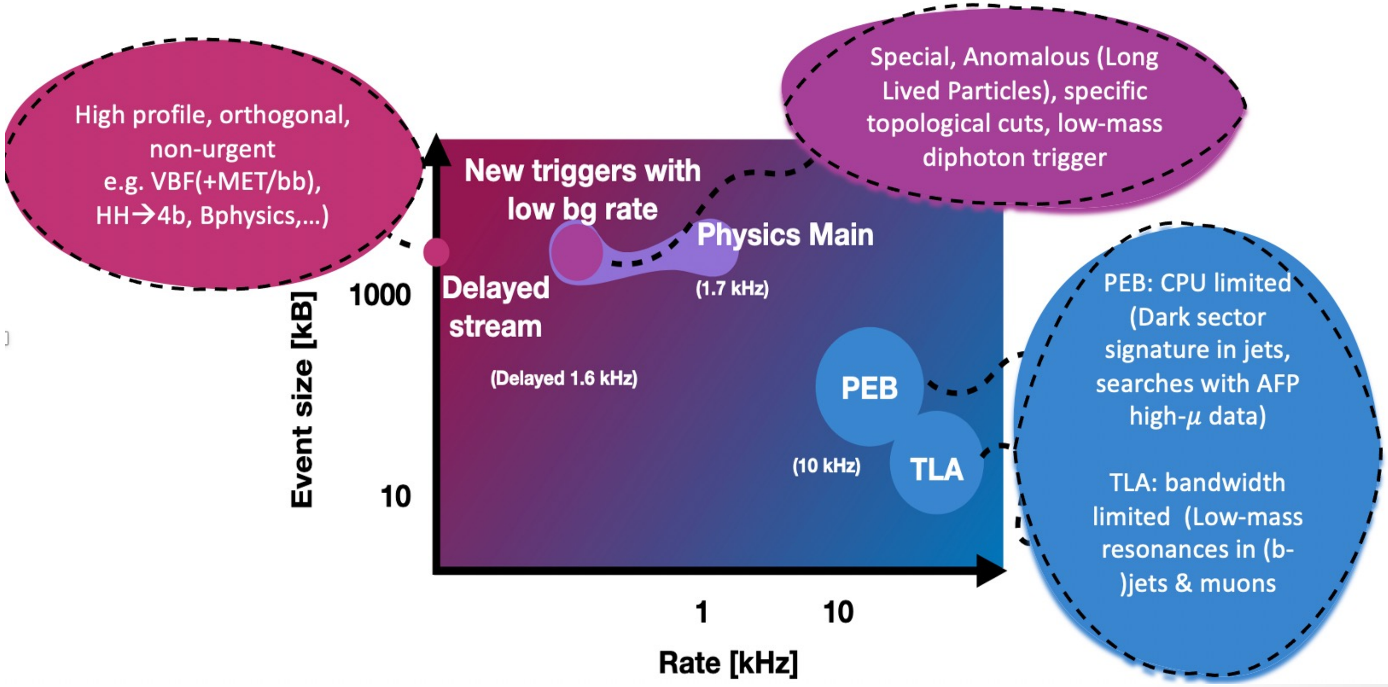
(3) High Level Trigger CPU processing limitations -> Make algorithms faster, or don't use CPU at all



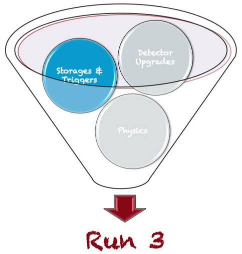
Run 3: Luminosity & Triggers

Several recording strategies to circumvent limitations:

- **New Trigger:** Develop new trigger logic to enhance selection of your signatures, sufficiently selective for minimal background (↓Bandwidth = ↓Rate x Size). **Advantage: Full detector information, unique data.** **Examples:** Special, Anomalous (Long Lived Particles), specific topological cuts, low-mass diphoton trigger.
- **Delayed Stream Strategy:** Store full event data on Storage at the detector to reduce TIER0 bottleneck. **Advantage: Full detector information.** Examples: VBF(+MET/bb), HH→4b, Bphysics,…).



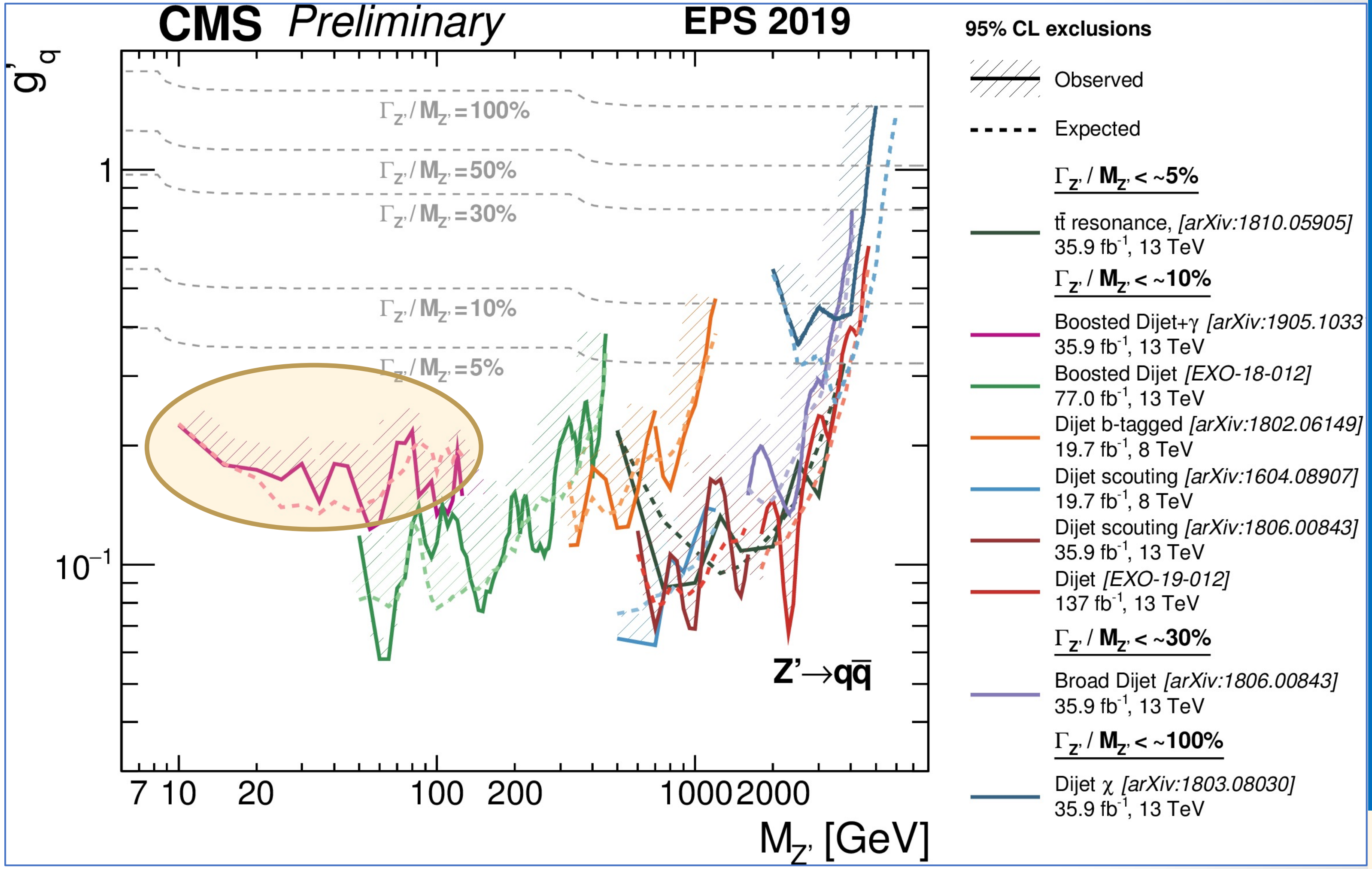
- **Trigger(-object) Level Analysis (TLA) - Data scouting:** Reduce event size 100x by recording only HLT reconstructed objects - take advantage of offline-like reco algorithms at HLT (↓Bandwidth = ↑Rate x ↓↓Size). **Advantage: Trigger thresholds no longer limited by HLT thresholds.** Examples: Di-muon Searches (Dark matter searches); Dijet bump-hunt in Run 2 → Great Proof-of-Concept for TLA; Multi-jet searches (R-Parity Violating SUSY offers signatures with many jets…); Multi-jet searches with b-jets (opens up low-mass searches with heavy flavour coupling preference or increase S/B with QCD light jet rejection)
- **Partial Event Building (PEB):** Reduce event size by recording only raw detector data in Regions Of Interest (↓Bandwidth = ↑Rate x ↓↓Size, ↓↓↓CPU). **Advantage: CPU limitations lifted.** Examples: invisible particle searches.



Run 3: Luminosity & Triggers

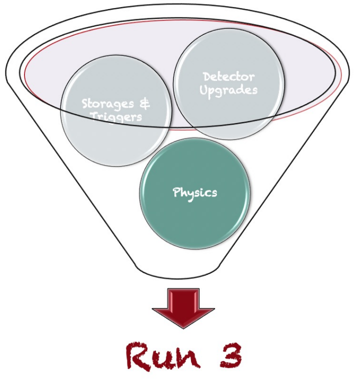
- ✓ **Several trigger strategies targeting low-mass signals:**
  - Delayed Stream
  - More selective triggering
  - Trigger(-object) Level Analysis
  - Partial Event Building

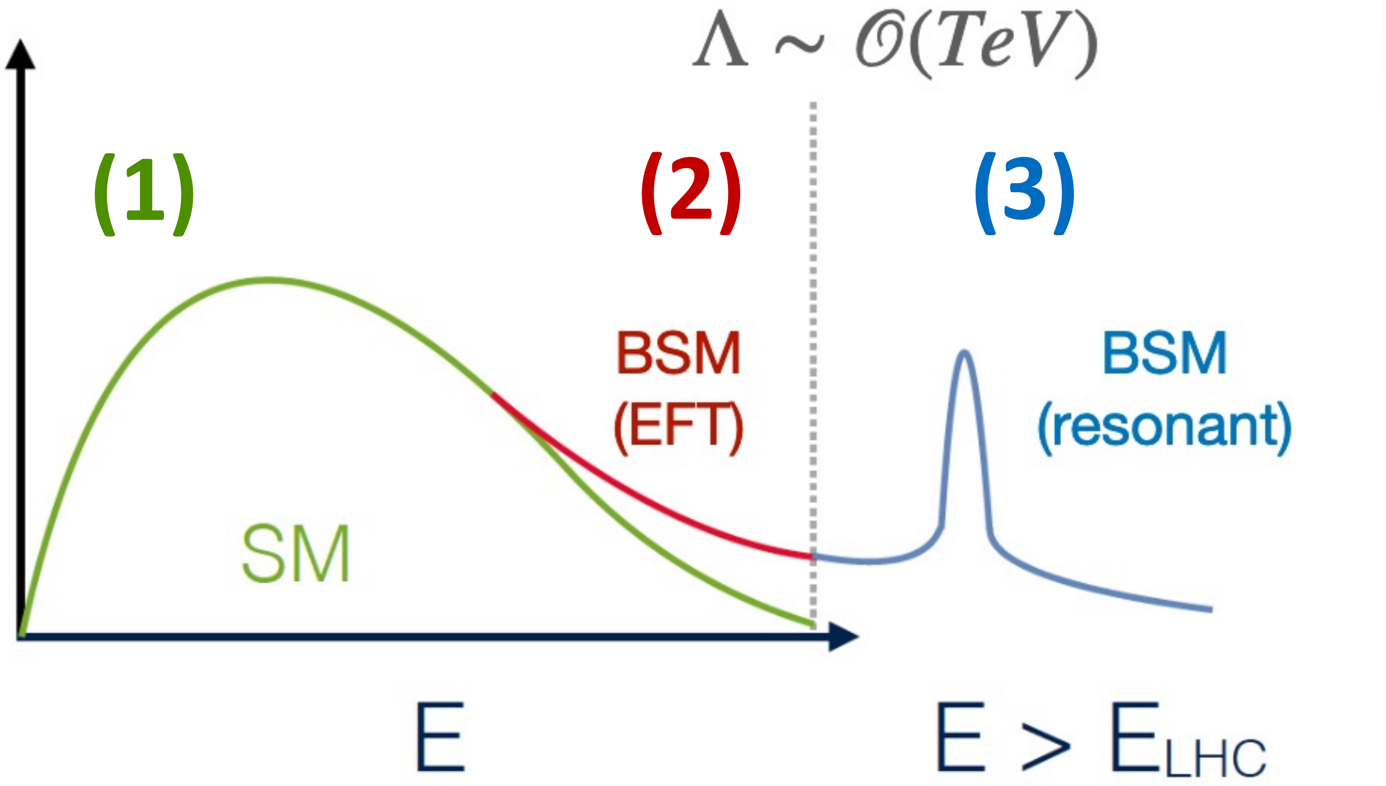
  To search for axion-like particles, low mass RPV SUSY, dark photons, Z', new scalar particles in Run 3.
- ✓ New trigger strategies come with many benefits for trigger:
  - Analysers become trigger developers: Enhances expertise in trigger technical development, and interest in better or faster online algorithms and lean data.
  - Developing Proof-Of-Concepts for Run 4: Many challenges for Run 3, enhanced in Run 4 (higher pile-up, early selections, limitations of online tracking)-laying groundwork for high threshold mitigation options.



We look forward to making the most out of ATLAS/CMS Run 3 data!

The LHC three-way paradigm



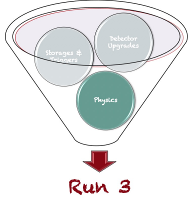


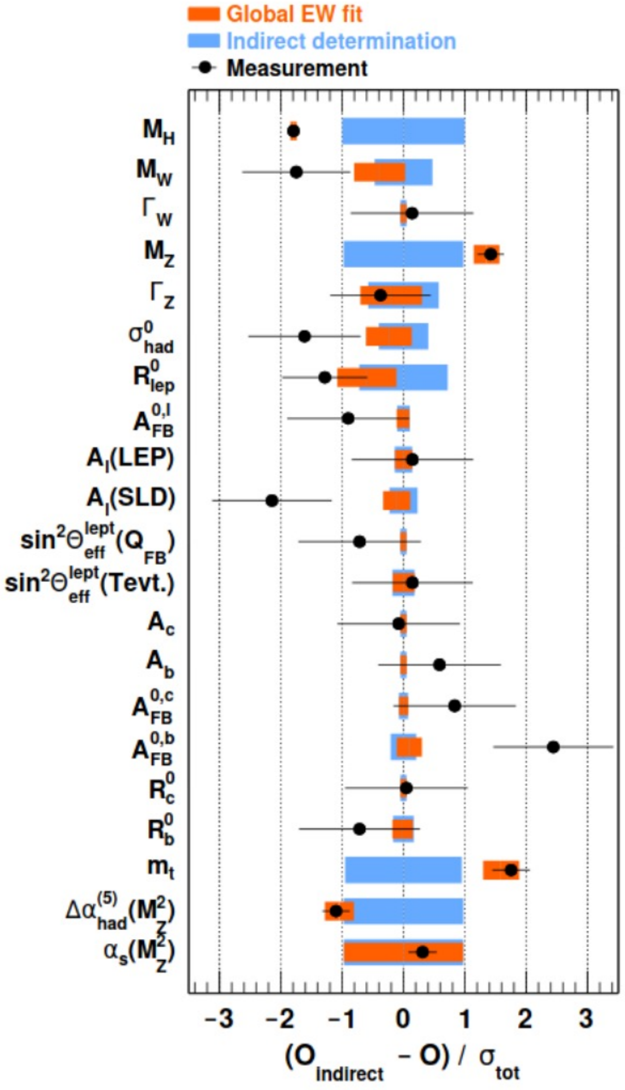
1 - Standard Model:
Improving the known to constrain the unknown

2 - Non-resonant BSM (EFT):
Smooth deviations can give indications **beyond the LHC energy regime**

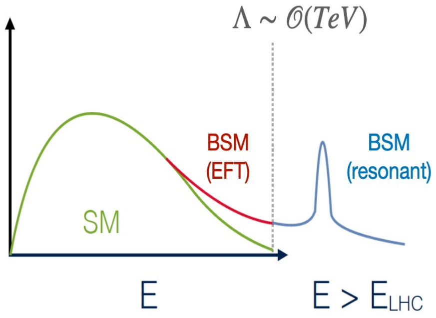
3 - Resonant BSM:
Multiple challenges:
High energy, low energy, challenging signatures...unexpected signatures!

Precision measurements of EW parameters

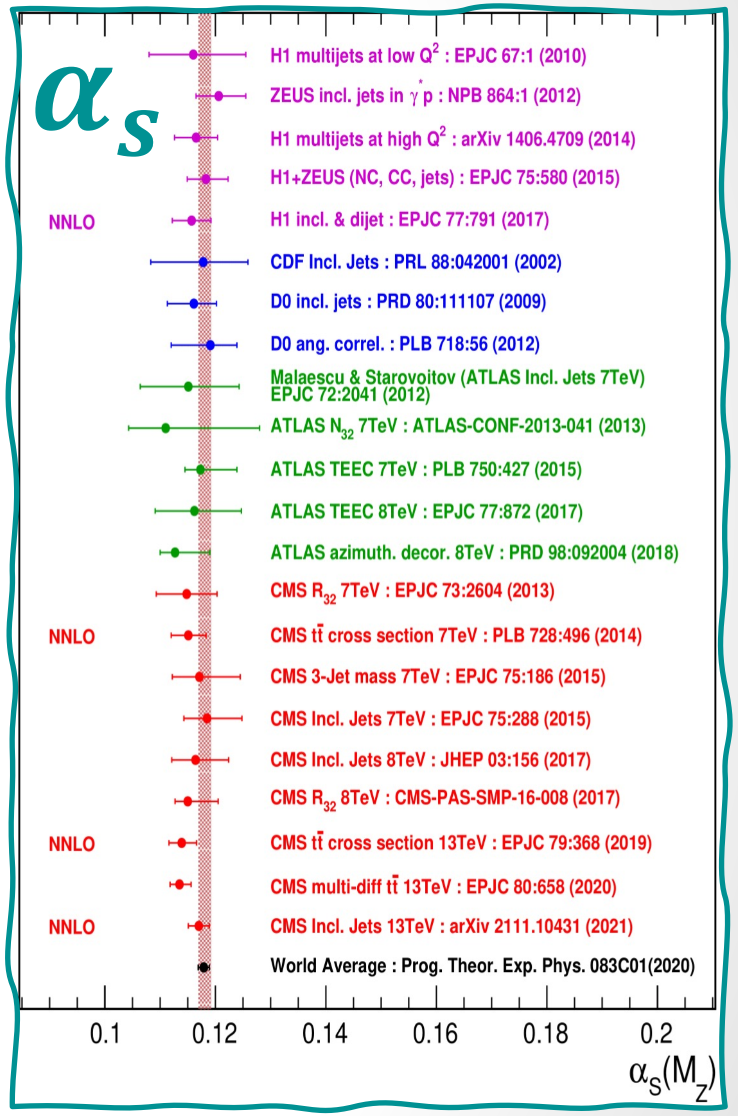




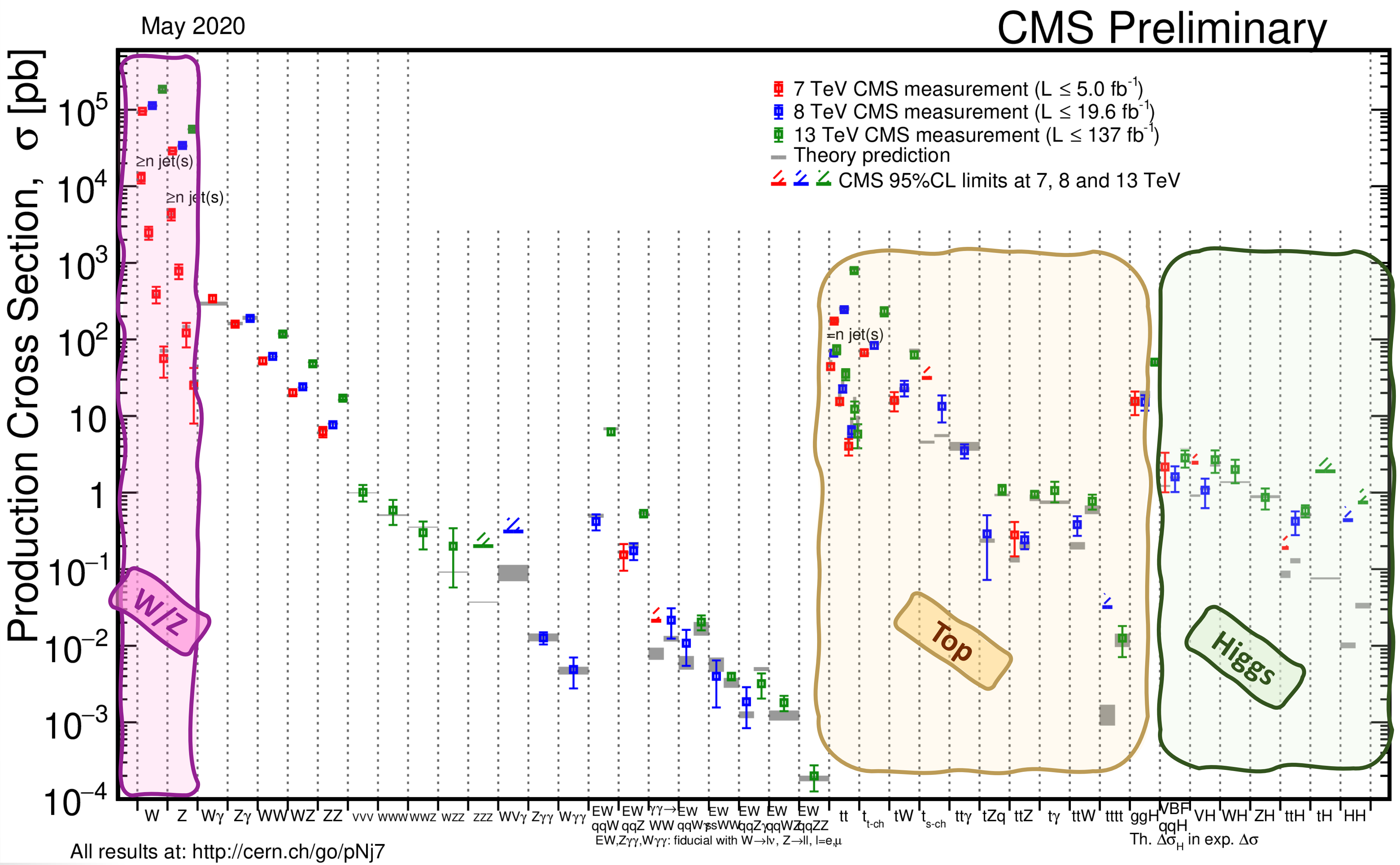
[Eur. Phys. J. C78, 675 (2018)](#)



- In the recent past, the global electroweak fit was able to predict the masses of new particles before their discovery
- Nowadays, all the free parameters of the Standard Model are known, and relations between electroweak observables can be predicted at 2-loop level
- Precise measurements of the electroweak parameters allow:
  - ✓ Stringent test of the self consistency of the SM
  - ✓ Looking for hints of physics beyond the SM
  - ✓ Exclusion of a large range of BSM models
- With the large statistics available in Run 2, significant improvements in precision are achieved through efforts and new methodologies in performance and physics modelling ➔ Run 3 statistic allows even more stringent precision limits



Precision measurements of EW parameters



ATLAS/CMS Naples Activities in SM Physics:

- ✓ Top Physics
- ✓ Higgs Physics:
  - ✓ Discovery
  - ✓ Properties measurements (mass, spin/CP,…)
  - ✓ Production Mechanisms
- ✓ W/Z:
  - ✓ cross section measurement
- ✓ Vector Boson Scattering (VBS):
  - ✓ cross section measurement (anomalous coupling constant)

Effective Field Theory (EFT)

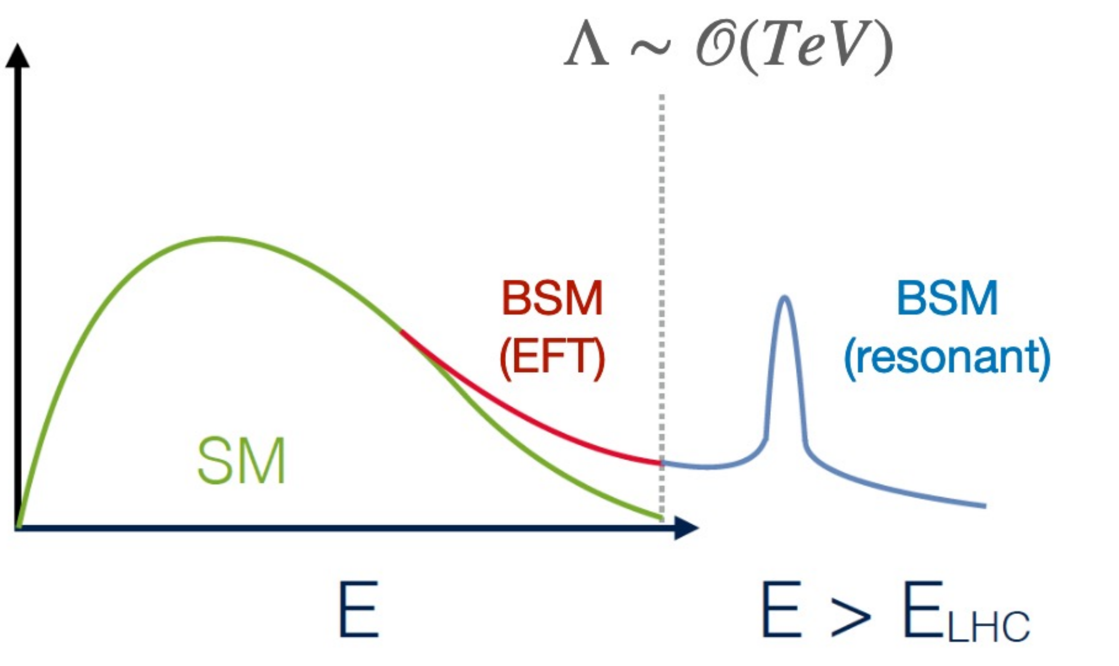
Why EFT?

In the absence of a direct evidence for BSM physics so far, the SM could be viewed as a low-energy approximation to a more fundamental theory.

Effective Field Theory (EFT) Lagrangian:

$$\mathscr{L} = \mathscr{L}_{SM} + \sum_i \frac{C_i^{(d)}}{\Lambda^{d-4}} \mathcal{O}_i^{(d)}$$

Deviations from SM described by higher-dim. operators $O_i^{(d)}$, suppressed by powers of Λ. $C_i^{(d)}$ Wilson coefficients can be constrained from data.



Interpreting the measured (differential) cross sections (x BR x efficiency) in terms of EFT:

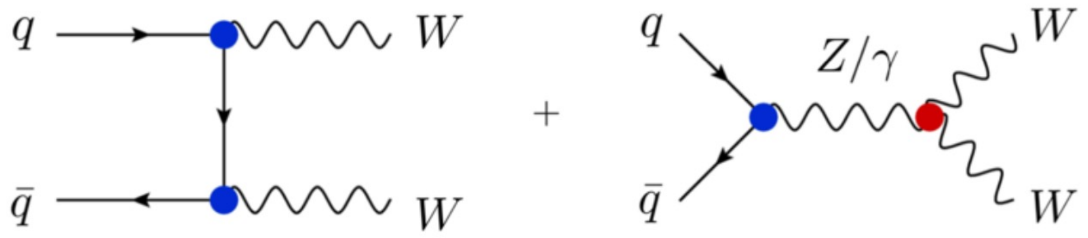
$$\sigma = \sigma_{SM}\left(1 + \sum_i A_i^{(6)} \frac{C_i^{(6)}}{\Lambda^2} + \sum_{ij} B_{ij}^{(6)} \frac{C_i^{(6)} C_j^{(6)}}{\Lambda^4} + \ldots\right)$$

linear dim-6 terms — quadratic dim-6 terms — higher-dimension terms

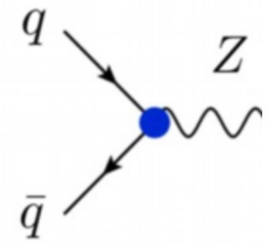
Most commonly used: SMEFT framework with Warsaw basis operators.

EFT Challenge: LHC vs LEP

Schematically diboson production (WW,WZ):



Equivalent to study modifications to Zqq and aTGC

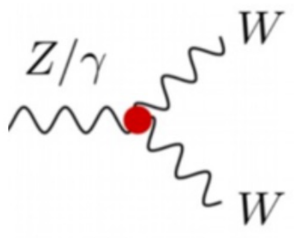


Z couplings to quarks

(**LEP-I** @ Z-pole)

$\delta g \lesssim 0.1\% - 1\%$

$g_{SM}\,(1+\delta g)$

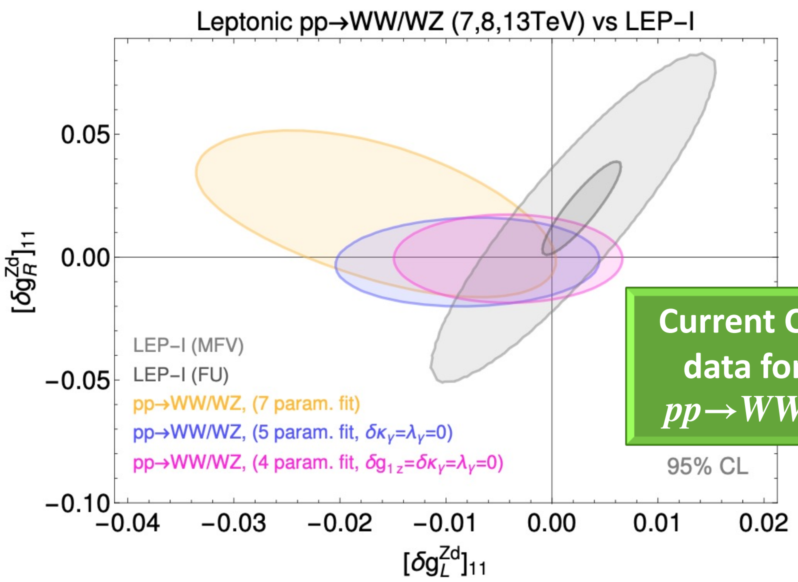


anomalous TGC

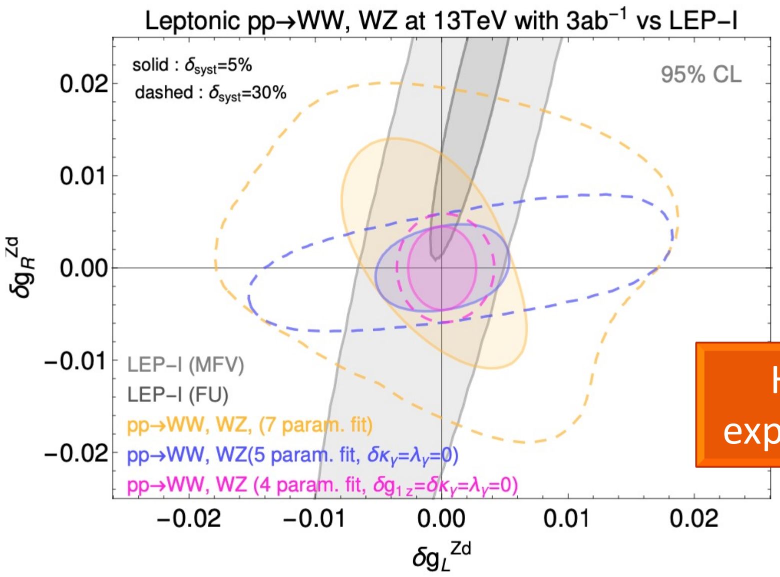
(**LEP-2**)

$\delta g \lesssim 1\% - 10\%$

[1810.05149] Diboson at the LHC vs LEP - arXiv

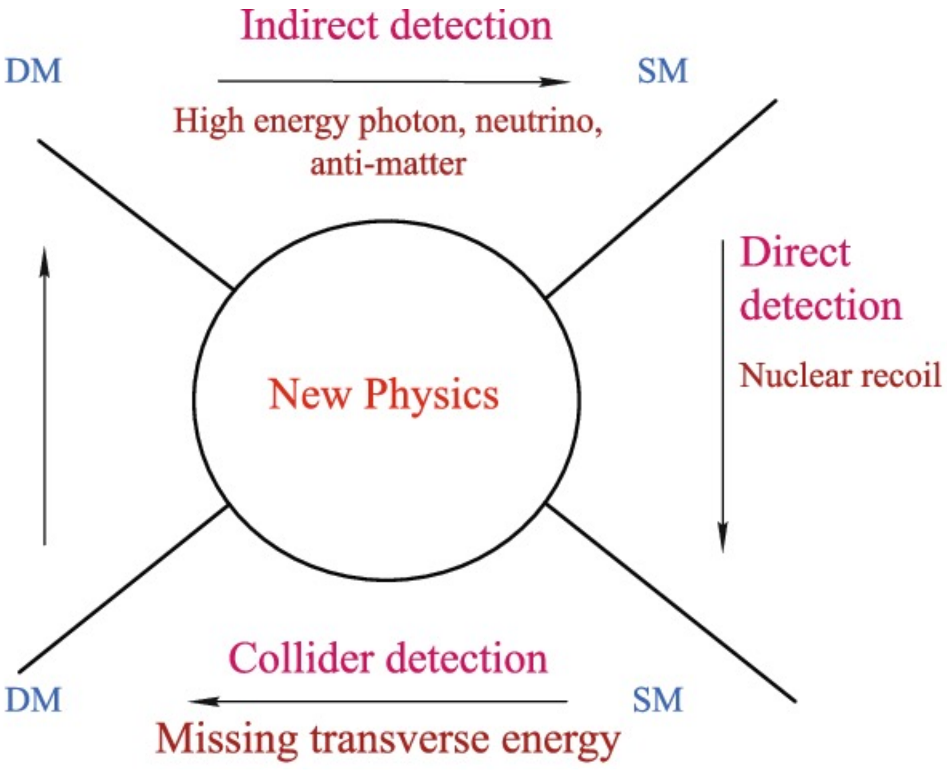


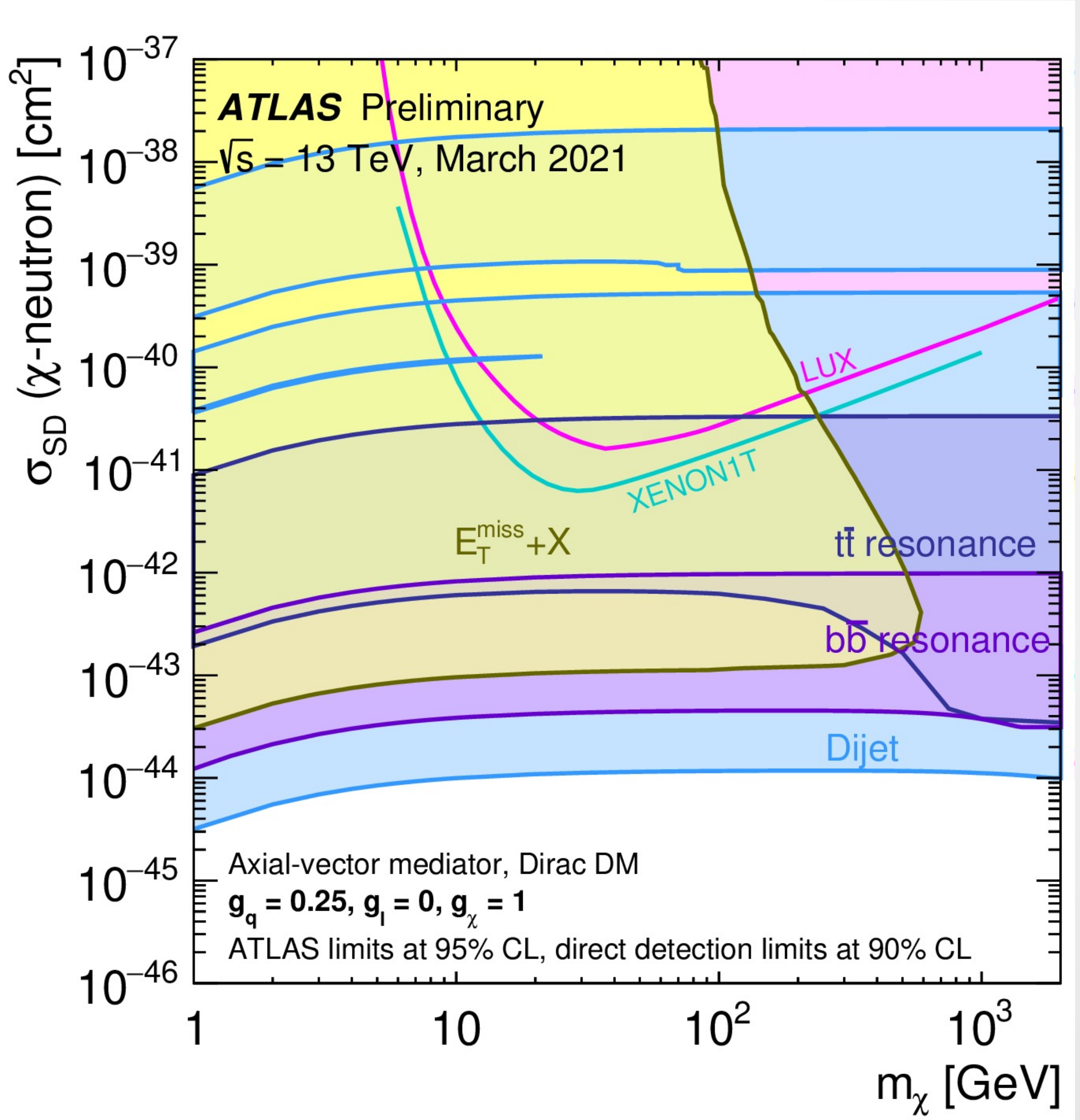
Current CMS and ATLAS data for the leptonic *pp→WW,WZ* channels



HL-LHC expectations

Dark sector searches in ATLAS/CMS





Dark Matter at LHC:

- Potential to search in regions unexplored by DS!
- Vast possible phenomnenology

B-onus round: B-Anomalies

Physics workshop 2021 - "ATLAS Physics from Run 2 to Run 3 and beyond"

14 Dec 2021, 09:00 → 17 Dec 2021, 17:00 Europe/Zurich

Zoom and Webcast

Arantxa Ruiz Martinez (Univ. of Valencia and CSIC (ES)), Christian Grefe (University of Bonn (DE)), Guillaume Unal (CERN), Marumi Kado (Sapienza Universita e INFN, Roma I (IT)), Pamela Ferrari (Nikhef National institute for subatomic physics (NL)), Savanna Shaw (University of Manchester), Simone Pagan Griso (Lawrence Berkeley National Lab. (US)), Stephane Willocq (University of Massachusetts (US)), Yasuyuki Okumura (University of Tokyo (JP))

Description The 2021 ATLAS physics workshop "ATLAS Physics from Run 2 to Run 3 and beyond" will take place December 14-17th in online mode

Sessions:

- Status of Run 2 analysis (organizers:Frederic Deliot, Bill Murray, Stephane Willocq)
- Release 22 CP status (organizers: Yanping Huang, Steven Schramm, Christian Grefe)
- Analysis tools and methods (organizers: Jana Schaarschmidt, Will Buttinger, Simone Pagan Griso)
- Run 3 preparations (organizers: Antonia Strubig, Bertrand Martin Dit Latour, Savanna Shaw)
- Early Run 3 physics plans (organizers: Liron Barak, Andrew Pilkington, Yasu Okumura)
- Combined Run2+Run3 longer term views, including outlook to run4 (organizers: Narei Lorenzo Martinez, Matthias Schott, Arantxa Ruiz Martinez)

abstracts.pdf

Videoconference ATLAS Physics workshop 2021 — Join

Registration registration to attend the workshop in the main auditorium — 200 / 200 — Register

Webcast There is a live webcast for this event — Watch

TUESDAY, 14 DECEMBER

11:00 → 11:05 Welcome (5m)
Speakers: Guillaume Unal (CERN), Pamela Ferrari (Nikhef National institute for subatomic physics (NL))
workshop-intro.pdf

11:05 → 13:05 Status of run 2 analyses
organizers: Frederic Deliot, Bill Murray, Stephane Willocq

- 11:05 **Review of status of legacy measurement papers** (20m)
  Speaker: Nedaa Alexandra Asbah (Harvard University (US))
  SummaryMeasure... video1888026761...
- 11:30 **Review of status of legacy search papers** (20m)
  Speaker: Federico Meloni (Deutsches Elektronen-Synchrotron (DE))
  LegacySearchesAtP... video2888026761...
- 11:55 **B physics anomalies at ATLAS** (15m)
  Speaker: Ann-Kathrin Perrevoort (Nikhef National institute for subatomic physics (NL))
  ATLASphysicsWS20... video3888026761...
- 12:15 **High energy implications of b anomalies** (15m)
  Speaker: Chris Pollard (University of Oxford (GB))
  AtlasPhysWkshp20... video4888026761...

Workshop internazionale CMS B-Physics 2021

Evento

Titolo:	Workshop internazionale CMS B-Physics 2021
Quando:	Mer, 13. Ottobre 2021, 13:00 - Ven, 15. Ottobre 2021
Dove:	sala Aula Alessandro Leogrande - Centro Polifunzio - BARI,
Categoria:	Eventi

Descrizione

Nei giorni 13-15 ottobre, l'Universita' degli Studi di Bari ospitera' i lavori del **workshop internazionale CMS B-Physics 2021**, presso la sala Leogrande del Centro Polifunzionale Studenti (ex Palazzo delle Poste), in collaborazione con l'Istituto Nazionale di Fisica Nucleare ed il supporto del Ministero degli Affari Esteri e Cooperazione Internazionale.
Trattasi di uno dei primissimi eventi internazionali svolti in presenza della Collaborazione Internazionale CMS dall'inizio della pandemia, che vedra' a Bari una trentina colleghi fisici sperimentali provenienti dagli Usa, Messico, Brasile, Russia ed altri paesi europei.

Il workshop e' interno a CMS e riguarda la pianificazione dell'LHC Run-3 in relazione al programma di fisica di CMS nel settore di Heavy Flavour e Quarkonia.

La prima sessione dei lavori, subito dopo i saluti istituzionali alle 14.30 di mercoledi' 13, sara' una OPEN session e prevede le comunicazioni di tre colleghi teorici (Bordone, Polosa e Silvestrini) su argomenti "caldi" quali le "**B-anomalies**" e la **Spettroscopia Adronica Esotica**.

A causa delle restrizioni sanitarie sull'uso delle sale Leogrande e Trizio si prega di contattare l'organizzazione per prenotare la propria partecipazione.

Alexis Pompili (per conto degli organizzatori).

Timetable

Wed 13/10 | Thu 14/10 | Fri 15/10 | All days

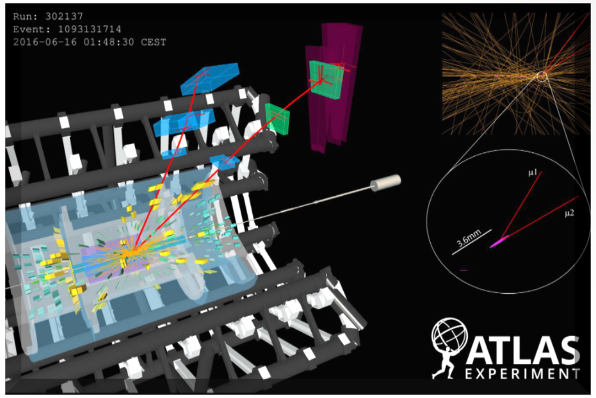
Print | PDF | Full screen | Detailed view | Filter

Session legend: OPEN Session with theorists | Session B

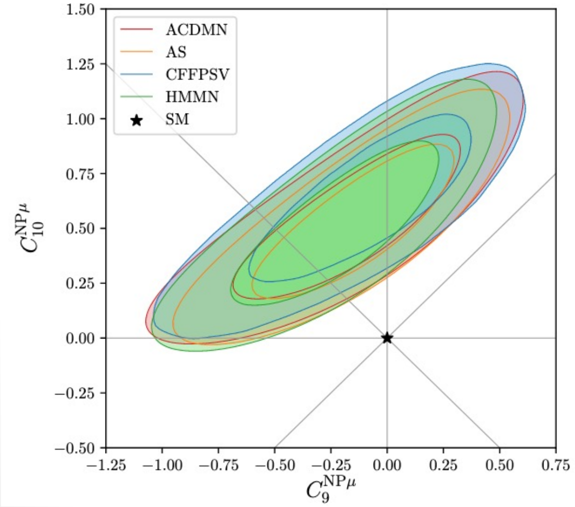
- 14:30 - 14:45 **Institutional greetings** — *Aula-I Palazzo delle Poste, Bari*
- 14:45 - 15:15 **Exotic hadron spectroscopy (selected topics and recent results)** — *Prof. Antonello Polosa* — *Aula-I Palazzo delle Poste, Bari*
- 15:15 - 15:45 **Introduction to B-anomalies and angular analyses for the b to sll transitions** — *Dr Luca Silvestrini* — *Aula-I Palazzo delle Poste, Bari*
- 15:45 - 16:15 **Lepton Flavour Universality tests** — *Dr Marzia Bordone* — *Aula-I Palazzo delle Poste, Bari*

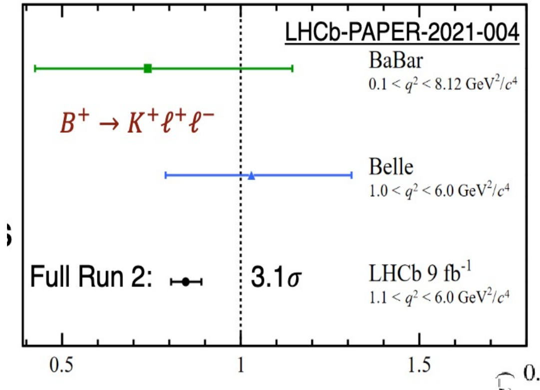
B-onus round: B-Anomalies

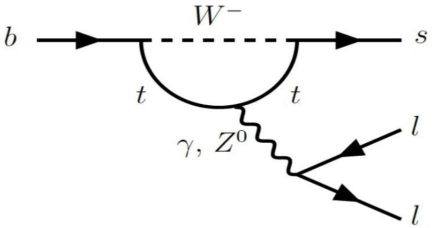
- ✓ **Long-standing tension wrt SM in rare b-hadron decays** esp. in FCNC $b \to s\ell\ell$ transitions
- ✓ **Observables:** branching ratios, angular decay distributions, lifetimes, lepton flavour universality tests,...
- ✓ **Commonly interpreted in Effective Field Theories →** Largest deviations for coefficients C_9 and C_{10} of the semileptonic operators

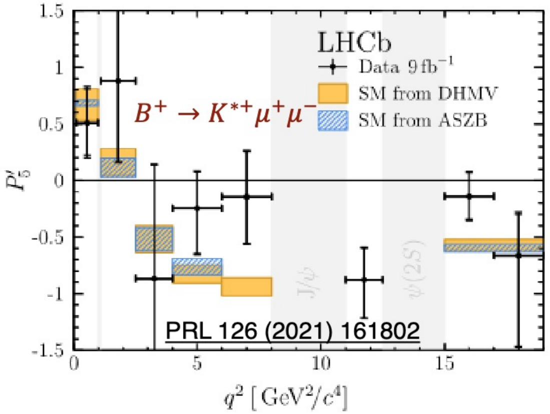


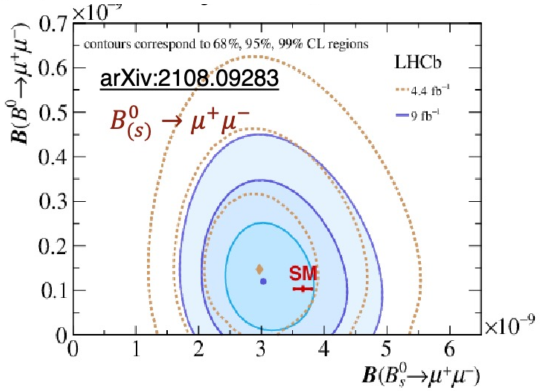
Talk by Capdevila, Fedele, Neshatpour, Stangl in Flavour Anomalies Workshop

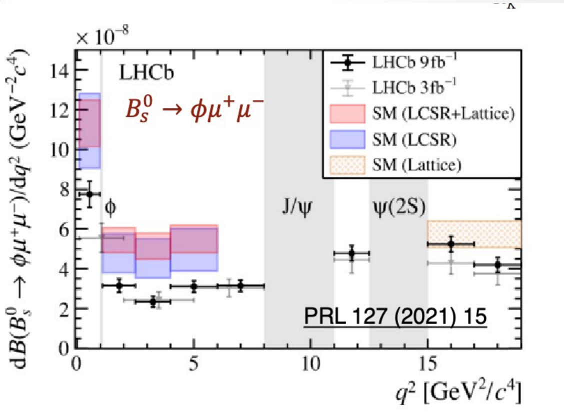










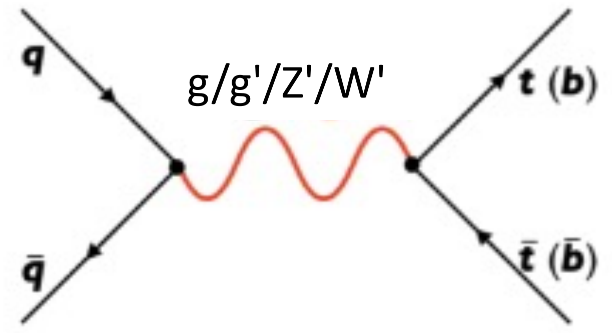


More news in next GR1 meeting!

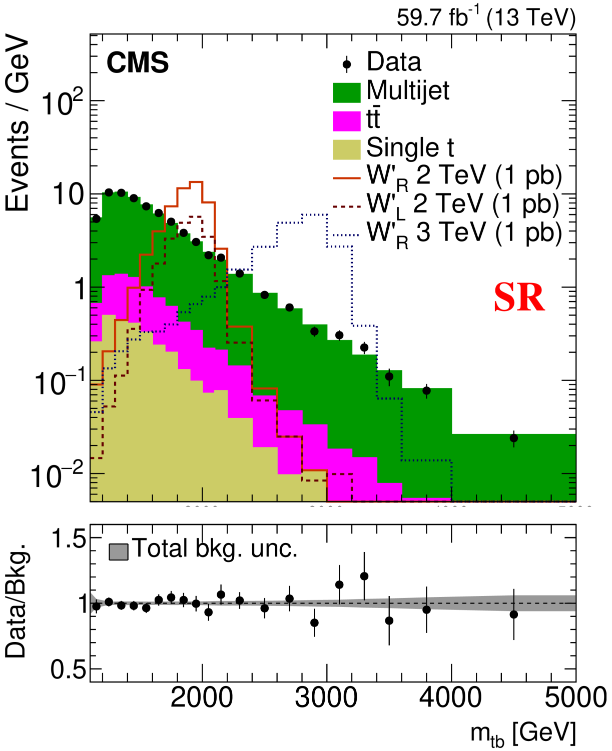
B-Anomalies @LHC: direct searches

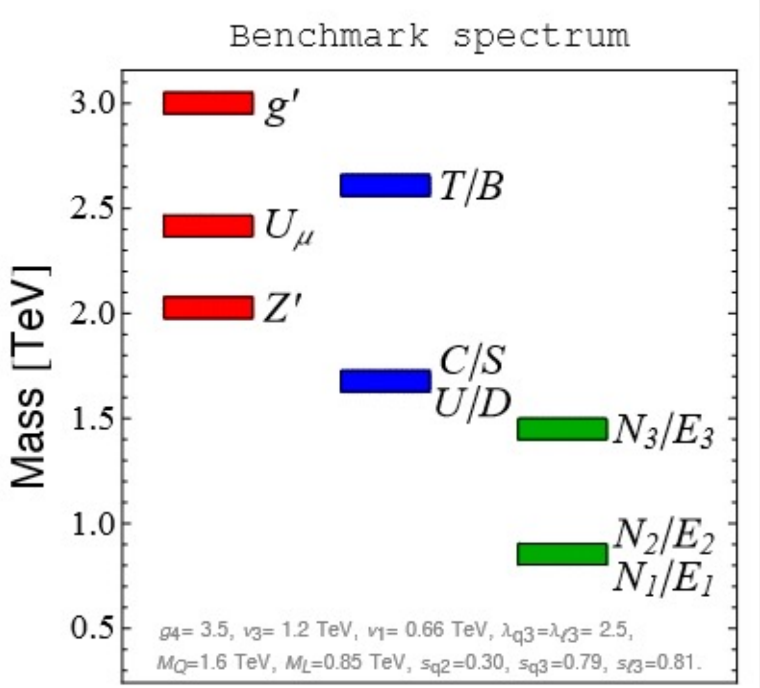
Many composite models can explain b-anomalies and

- ✓ **Leptoquarks**
- ✓ Multiple possible signals including new **bosons** or **fermions**
- ✓ New resonances coupling to **third generation quarks**



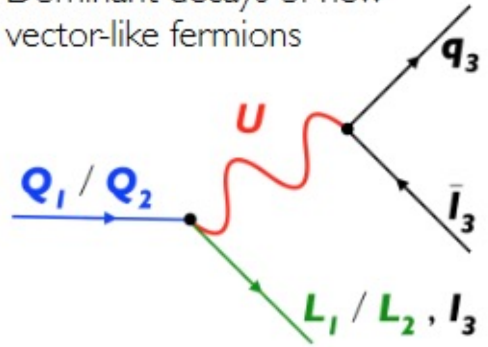
Depending on the model!





Di Luzio, Fuentes-Martin, AG, Nardecchia, Renner; 1808.00942

Dominant decays of new vector-like fermions



Early run 3 physics and longer term views

Early run 3 physics plans:

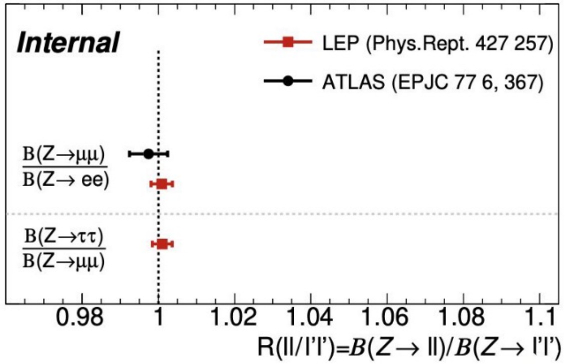
- New triggers
- Improved analysis technique
  - Offline reconstruction improvement
  - Improved background estimation
  - Improvement with Machine Learning extension
- New measurements with new sqrt(s) of 13.6 TeV
  - W/Z, top, Higg

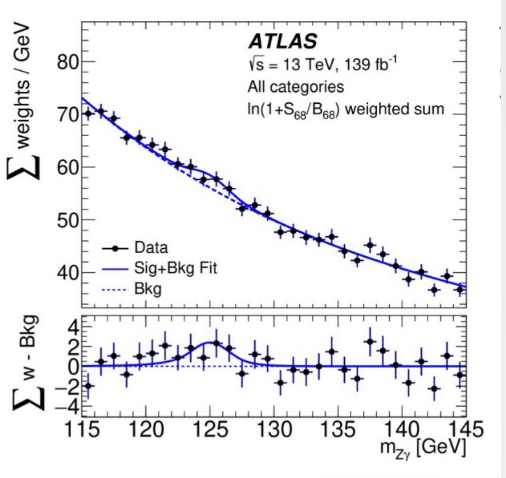
Sharing common ideas and learning new system from experience of early Run3 analyses for future full Run3 projects is important outcome of the Early Run3 physics projects

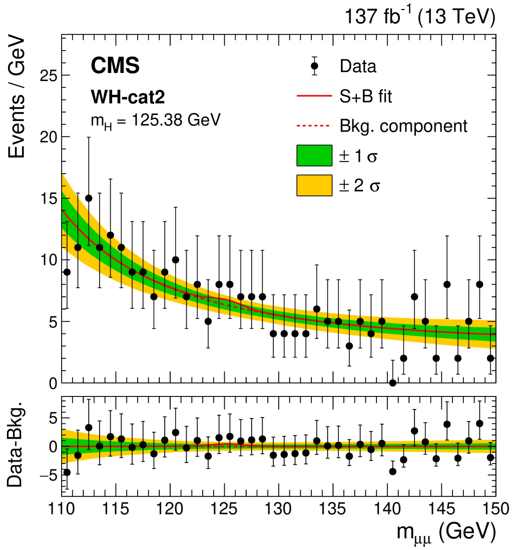
Early run 3 physics and longer term views

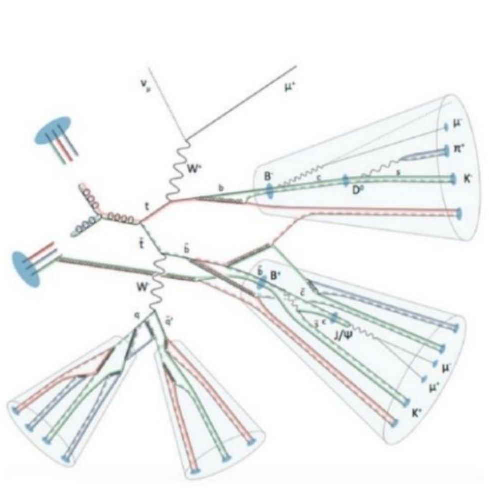
Longer term plans:

- **Significant improvement expected for many measurements by controlling systematic uncertainties**
  - Jet / Lepton / Photon Calibration
  - Backgrounds / Control Regions
  - MonteCarlo Generators
  - Examples: VBS/VBF and Polarization; W/Z Couplings
- **The additional statistics of Run-3 helps for some processes, e.g. first observation of $H \to \mu\mu$ or $H \to Z\gamma$**
  - $H \to \mu\mu$ is, to date, the most sensitive channel to study Higgs boson couplings to the 2nd generation fermions
  - Studying Higgs boson to muon coupling has important implication for muon collider
  - Challenge: small branching ratio BR($H \to \mu\mu$): 0.02%, large background S/B: 1~2%
- **New approaches for the Top-quark mass measurement**
  - Direct measurements of m_{top} have reached an uncertainty of 0.5 GeV ➔ theoretical issues in the interpretation of the measured m_{top} call for alternative precise measurements
  - Measurements of m_{top} from cross sections with uncertainty close to or below 0.5-1 GeV are possible
  - Alternative measurements exploiting leptons originating from b or J/psi decays are likely to become competitive with large Run 2+3 statistics, and with an improved understanding of the b-fragmentation function

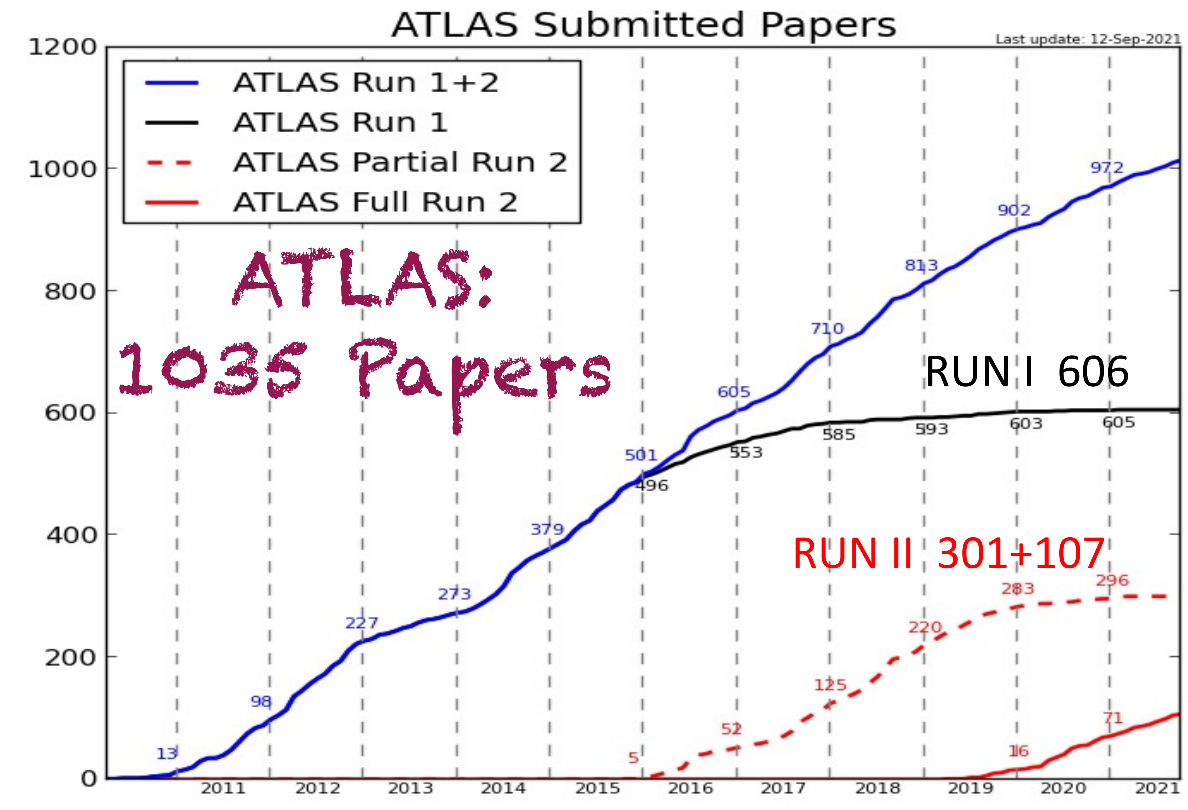


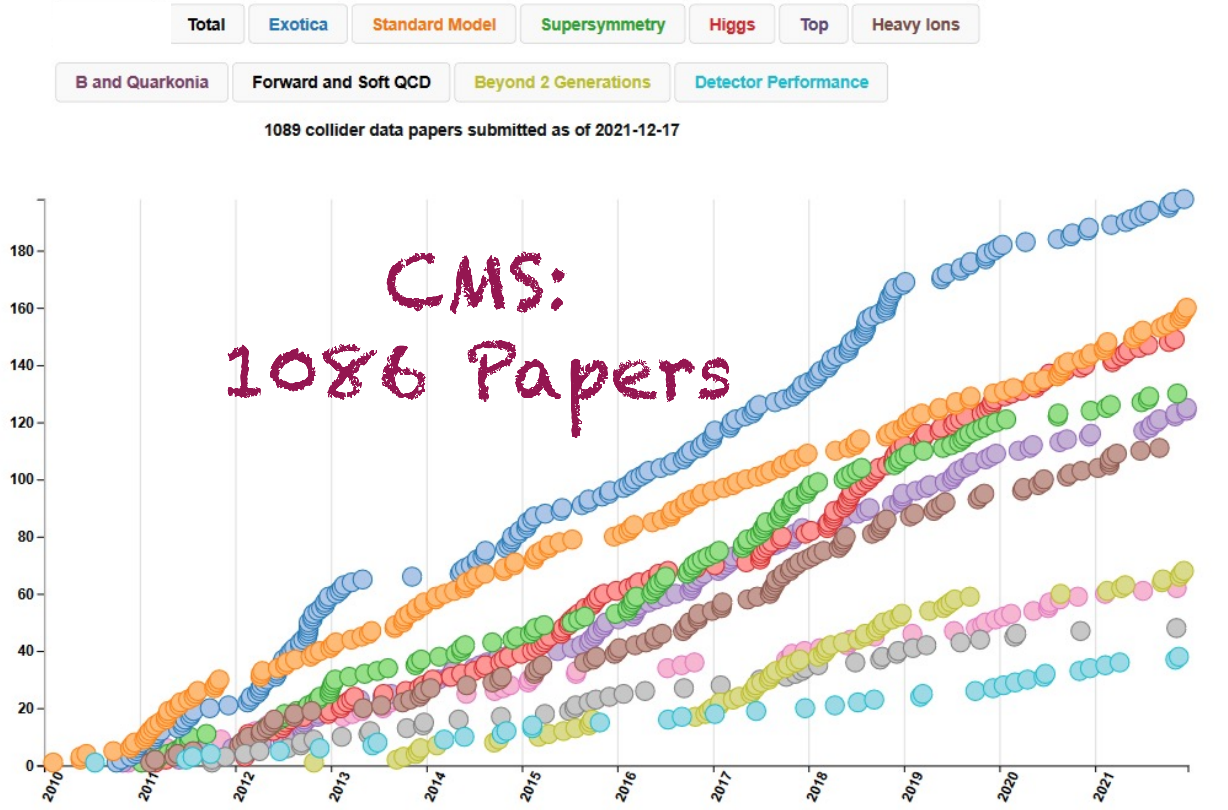




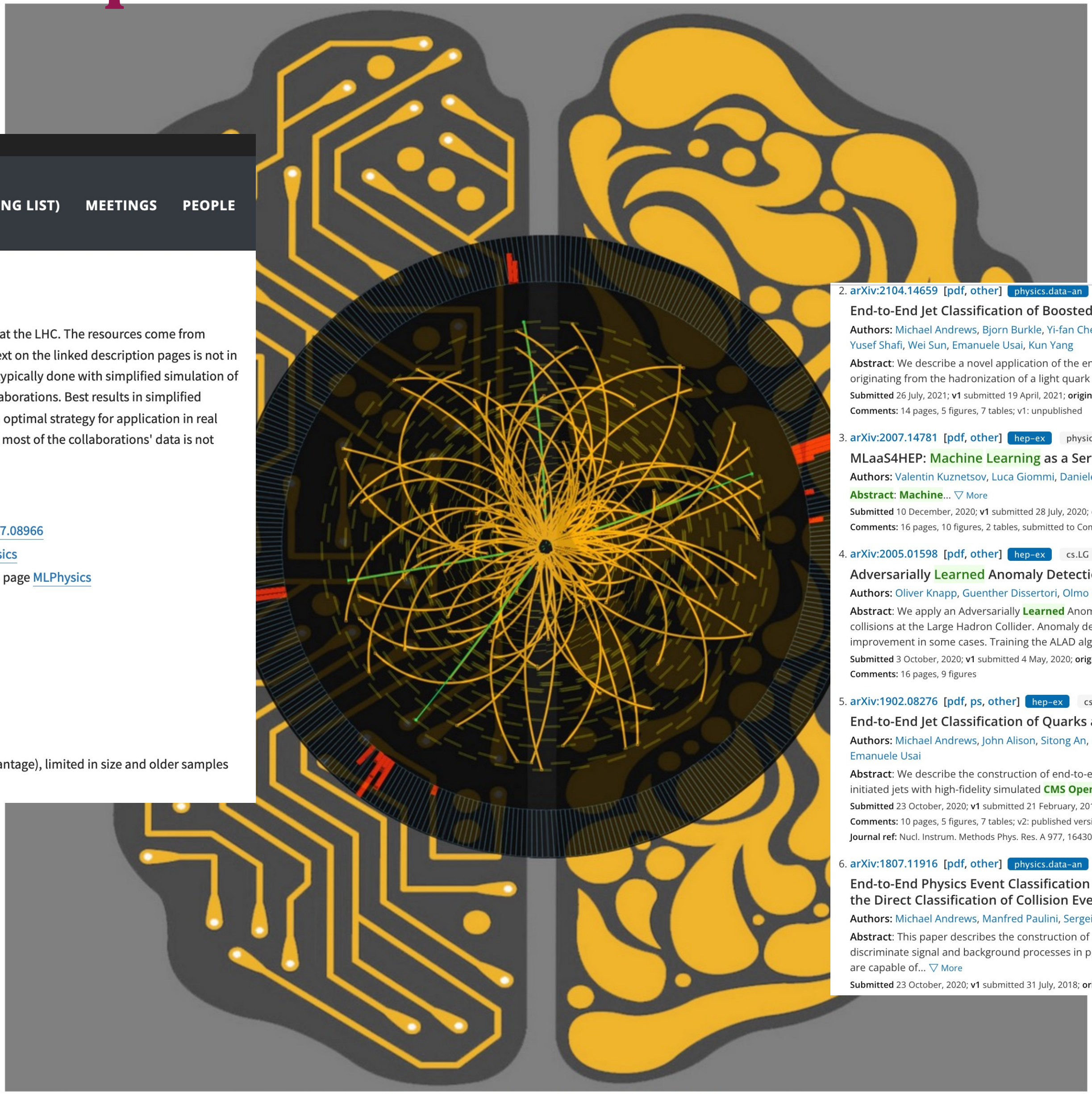


Run 2: Papers submitted as of 10/12/2021





ATLAS/CMS Open Data and Machine Learning papers



CERN Accelerating science

IML

ABOUT IML | FORUM (MAILING LIST) | MEETINGS | PEOPLE

Public datasets

This page collects public datsets that are used for machine learning studies at the LHC. The resources come from voluntary contributions of authors from papers as well as challenges. The text on the linked description pages is not in the responsibility of the IML. We want to emphasis that public datasets are typically done with simplified simulation of the real detectors and with much smaller samples than available to the collaborations. Best results in simplified simulation with limited number of samples do not automatically suggest an optimal strategy for application in real experiments, however currently there is no other option for comparisons as most of the collaborations' data is not public.

Simplified datasets for benchmarking:

- Top tagging without heavy flavour & pileup: Data and details of arXiv:1707.08966
- Jet substructure: Data from arXiv:16107.08633 at UC Irvines page MLPhysics
- Flavour tagging without pileup: Data from arXiv:1603.09349 at UC Irvines page MLPhysics

Datasets for developing simulation:

- Data for jet images from LAGAN
- Data for 3D jet images from CaloGan
- Electromagrentic jet images

Realistic datasets from the CMS experiment:

- CMS open data (non trivial data format (CMS software knowledge of advantage), limited in size and older samples 2011)

2. arXiv:2104.14659 [pdf, other] physics.data-an cs.CV cs.LG hep-ex

End-to-End Jet Classification of Boosted Top Quarks with the CMS Open Data

Authors: Michael Andrews, Bjorn Burkle, Yi-fan Chen, Davide DiCroce, Sergei Gleyzer, Ulrich Heintz, Meenakshi Narain, Manfred Paulini, Nikolas Pervan, Yusef Shafi, Wei Sun, Emanuele Usai, Kun Yang

Abstract: We describe a novel application of the end-to-end deep learning technique to the task of discriminating top quark-initiated jets from those originating from the hadronization of a light quark or a gluon. The end-to-end deep... ▽ More

Submitted 26 July, 2021; **v1** submitted 19 April, 2021; **originally announced** April 2021.

Comments: 14 pages, 5 figures, 7 tables; v1: unpublished

3. arXiv:2007.14781 [pdf, other] hep-ex physics.comp-ph

MLaaS4HEP: Machine Learning as a Service for HEP

Authors: Valentin Kuznetsov, Luca Giommi, Daniele Bonacorsi

Abstract: Machine... ▽ More

Submitted 10 December, 2020; **v1** submitted 28 July, 2020; **originally announced** July 2020.

Comments: 16 pages, 10 figures, 2 tables, submitted to Computing and Software for Big Science. arXiv admin note: text overlap with arXiv:1811.04492

4. arXiv:2005.01598 [pdf, other] hep-ex cs.LG hep-ph

Adversarially Learned Anomaly Detection on CMS Open Data: re-discovering the top quark

Authors: Oliver Knapp, Guenther Dissertori, Olmo Cerri, Thong Q. Nguyen, Jean-Roch Vlimant, Maurizio Pierini

Abstract: We apply an Adversarially Learned Anomaly Detection (ALAD) algorithm to the problem of detecting new physics processes in proton-proton collisions at the Large Hadron Collider. Anomaly detection based on ALAD matches performances reached by Variational Autoencoders, with a substantial improvement in some cases. Training the ALAD algorithm on 4.4 fb-1 of 8 Te... ▽ More

Submitted 3 October, 2020; **v1** submitted 4 May, 2020; **originally announced** May 2020.

Comments: 16 pages, 9 figures

5. arXiv:1902.08276 [pdf, ps, other] hep-ex cs.CV cs.LG physics.data-an doi 10.1016/j.nima.2020.164304

End-to-End Jet Classification of Quarks and Gluons with the CMS Open Data

Authors: Michael Andrews, John Alison, Sitong An, Patrick Bryant, Bjorn Burkle, Sergei Gleyzer, Meenakshi Narain, Manfred Paulini, Barnabas Poczos, Emanuele Usai

Abstract: We describe the construction of end-to-end jet image classifiers based on simulated low-level detector data to discriminate quark- vs. gluon-initiated jets with high-fidelity simulated CMS Open Data. We highlight the importance of precise s... ▽ More

Submitted 23 October, 2020; **v1** submitted 21 February, 2019; **originally announced** February 2019.

Comments: 10 pages, 5 figures, 7 tables; v2: published version

Journal ref: Nucl. Instrum. Methods Phys. Res. A 977, 164304 (2020)

6. arXiv:1807.11916 [pdf, other] physics.data-an cs.CV cs.LG hep-ex doi 10.1007/s41781-020-00038-8

End-to-End Physics Event Classification with CMS Open Data: Applying Image-Based Deep Learning to Detector Data for the Direct Classification of Collision Events at the LHC

Authors: Michael Andrews, Manfred Paulini, Sergei Gleyzer, Barnabas Poczos

Abstract: This paper describes the construction of novel end-to-end image-based classifiers that directly leverage low-level simulated detector data to discriminate signal and background processes in pp collision events at the Large Hadron Collider at CERN. To better understand what end-to-end classifiers are capable of... ▽ More

Submitted 23 October, 2020; **v1** submitted 31 July, 2018; **originally announced** July 2018.

https://iml.web.cern.ch/public-datasets

Events@Naples

Workshop annuale dell'esperimento CMS ad LHC

11–13 Oct 2021
Napoli
Europe/Rome timezone

Enter your search term

- Overview
- Timetable
- Contribution List
- Registration
- Participant List

CMS Italia
Napoli, 11-13 Ottobre 2021

Il workshop italiano dell'esperimento CMS si svolgerà a Napoli dall'11 al 13 Ottobre 2021

11 ottobre - Aula Rossa del Complesso Universitario di Monte Sant'Angelo

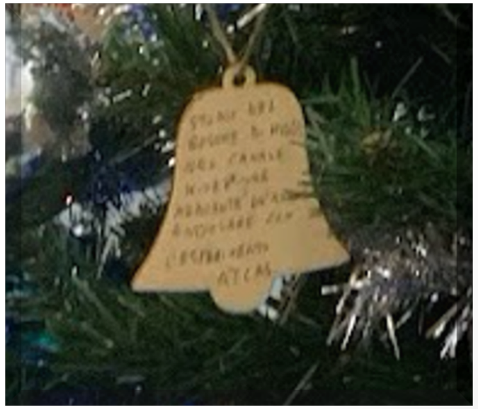
12 ottobre - Città della Scienza

13 ottobre - Aula Rossa del Complesso Universitario di Monte Sant'Angelo

Participant List
107 participants

…And most importantly

Buon Natale

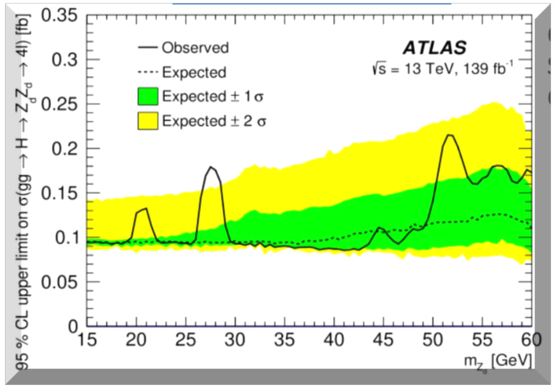


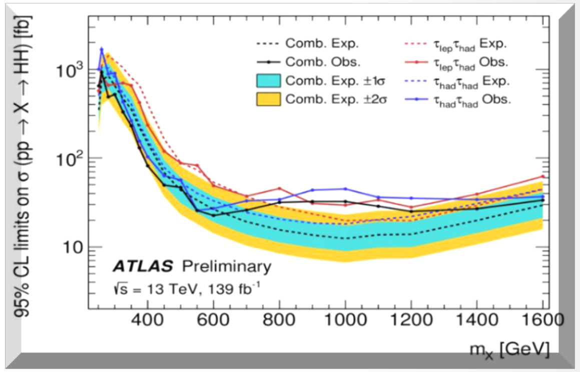
Backup

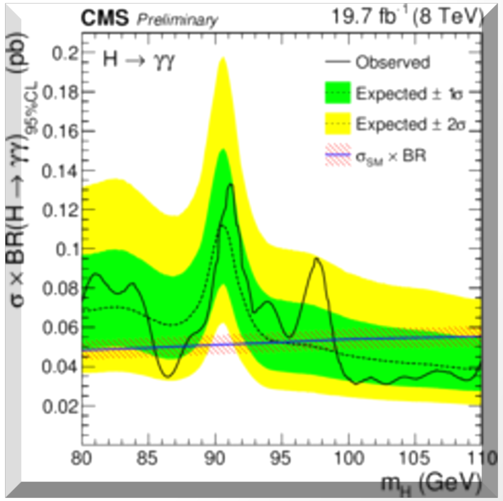
Selected Run 2 “spicy” analyses to be further investigated

Selected Excesses observed in Run-2 and should be followed up:

- Vector Like Quarks:
  - T/Y → Wb ➔ 3.7σ (local) at m_{VLQ} of 1.8 TeV,
  - T → tH => 3.0σ (local) at mVLQ of 0.68 TeV,
- Heavy WR, Leptons and Vector Like Leptons
  - CMS Excess in dielectron 2.95/2.78σ local/global
  - ATLAS boosted analysis 2.4σ in dielectrons
- DiPhoton resonances
  - CMS sees small excess near 95 GeV
  - Followed up by ATLAS HIGG-2020-09
- Dilepton searches: μμ/*ee* mass ratio, discrepancy from 1, p-value 0.012 (2.3σ)
- Further Excesses in Higgs Processes
  - H → aa → bbμμ (ma = 52 GeV 3.3/1.7σ local/global)
  - Search for S → XX → 4ℓ: Excess at mS ≃ 110 GeV, mX ≃ 30 GeV under investigation, 3.8σ local, 2.8σ global
  - Resonant HH:
    - bbττ: 3/2σ local/global at mX ~ 1 TeV
    - bbbb: 2.3/0.4σ local/global at mX = 1.1 TeV

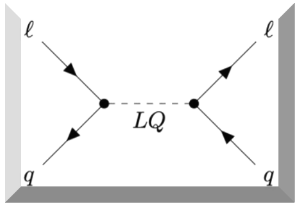




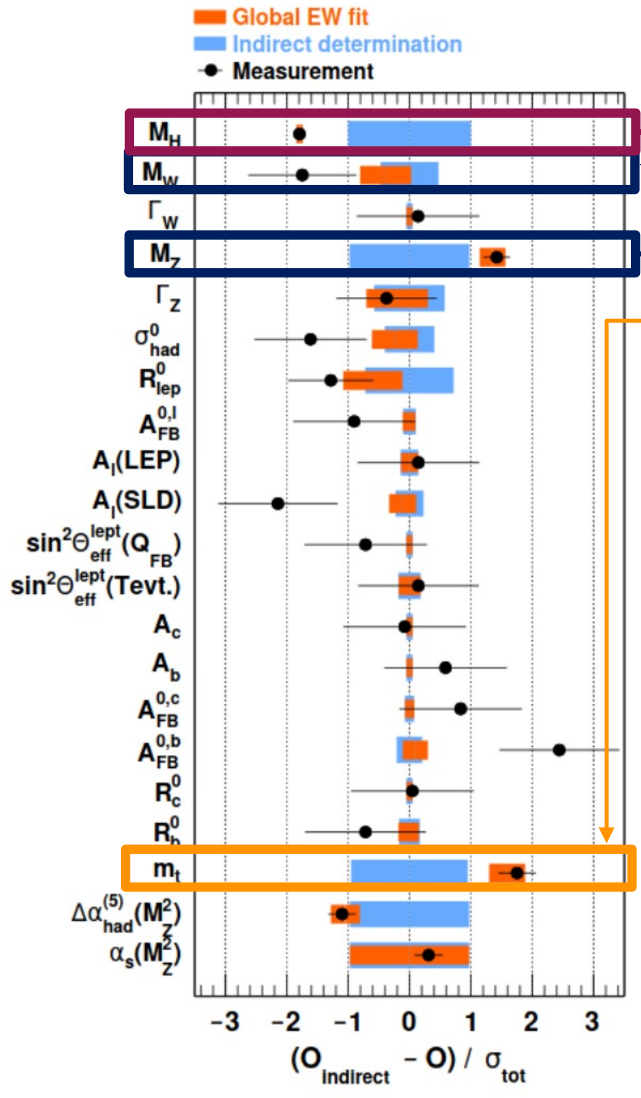


Hints for Lepton Flavour Universality Violation in the b-Sector motivates additional efforts in Semi-leptonic B and Tau decay and Leptoquark Searches ➔ One specific idea: Use the LHC as proton-lepton collider

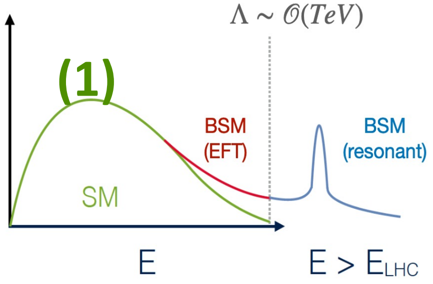
- Utilize lepton content of proton originating from quantum fluctuations
- → lepton + (small-R) jet final state not well covered until now
- Sensitive to both mass and coupling parameters
- Invariant mass m_{lq} as key observable
- Analysis effort just started



Precision measurements of EW parameters



Eur. Phys. J. C78, 675 (2018)



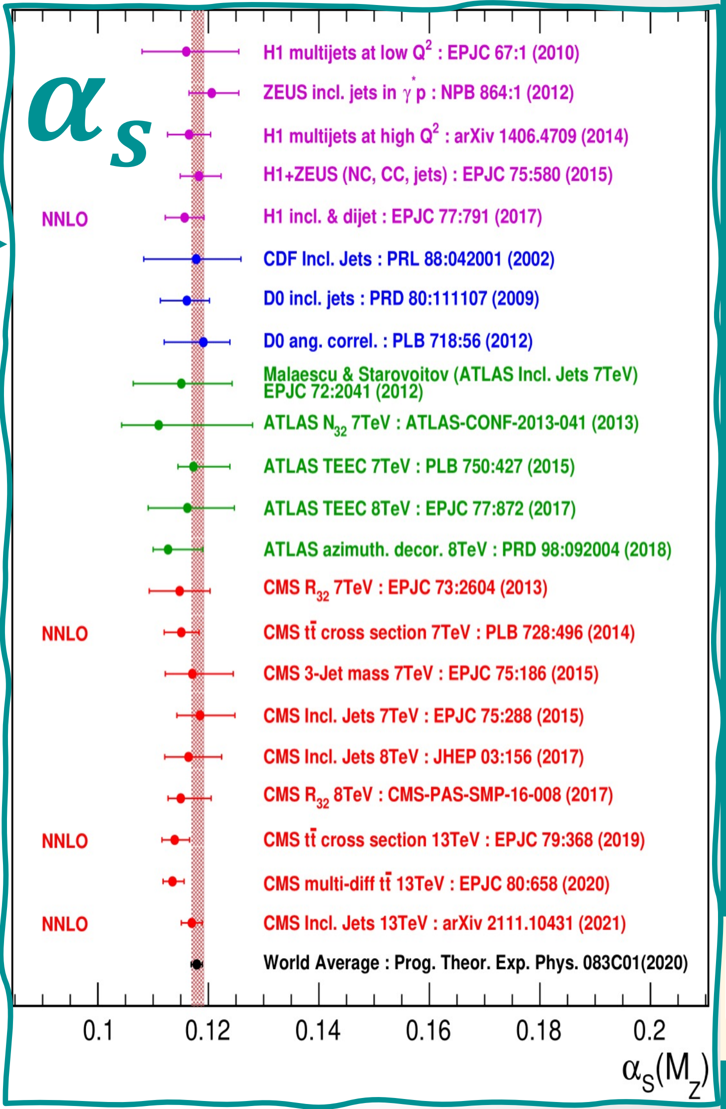
- m_H → Higgs
- m_W and m_Z → QCD
- m_t → Electroweak
- α_s

> In the recent past, the global electroweak fit was able to predict the masses of new particles before their discovery

> Nowadays, all the free parameters of the Standard Model are known, and relations between electroweak observables can be predicted at 2-loop level

> Precise measurements of the electroweak parameters allow:
  - ✓ Stringent test of the self consistency of the SM
  - ✓ Looking for hints of physics beyond the SM
  - ✓ Exclusion of a large range of BSM models

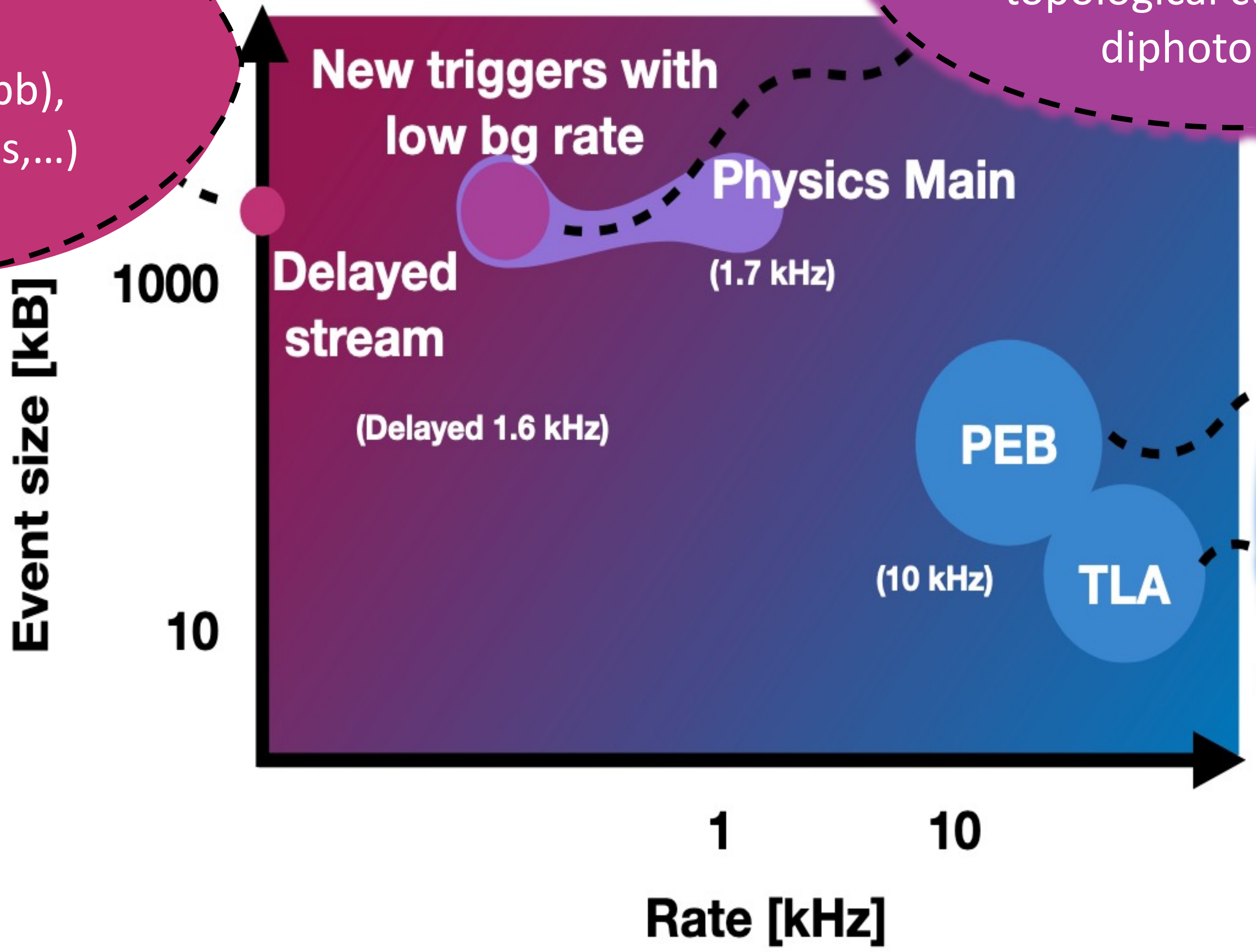
> With the large statistics available in Run 2, significant improvements in precision are achieved through efforts and new methodologies in performance and physics modelling ➔ Run 3 statistic allows even more stringent precision limits



Run 3: Luminosity & Triggers

High profile, orthogonal, non-urgent
e.g. VBF(+MET/bb), HH→4b, Bphysics,…)

Special, Anomalous (Long Lived Particles), specific topological cuts, low-mass diphoton trigger

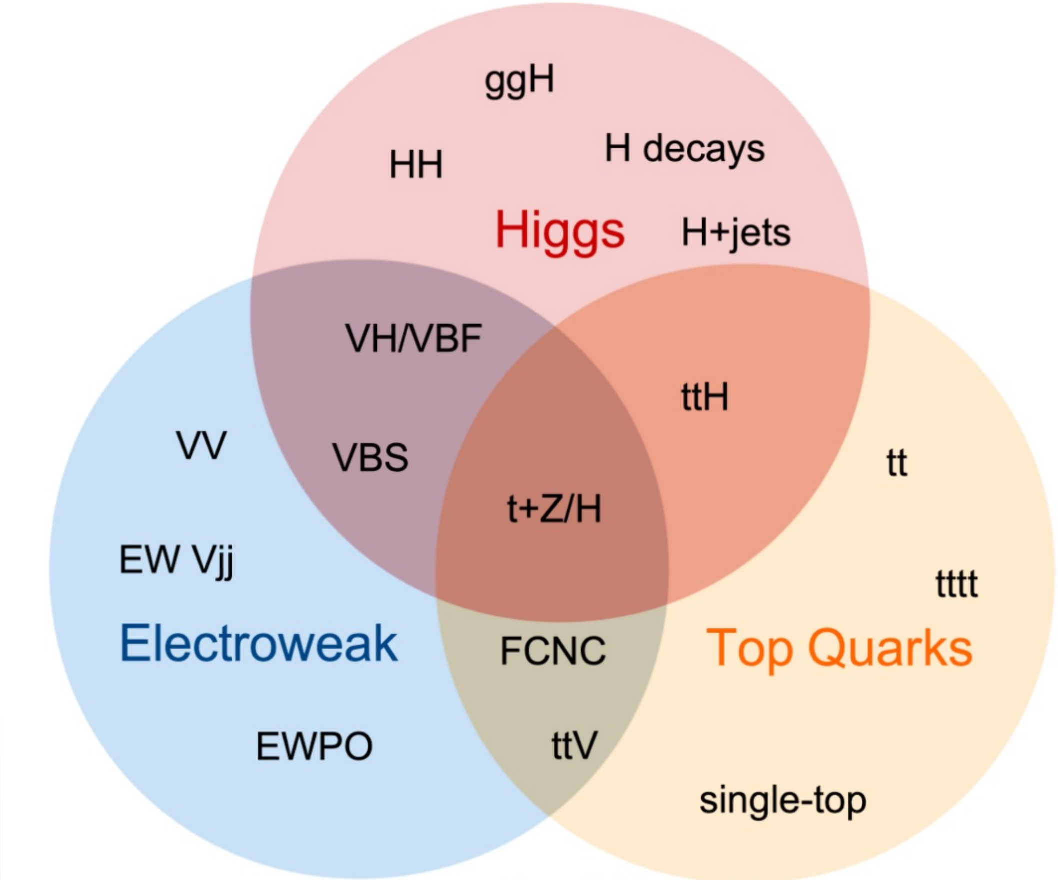


PEB: CPU limited (Dark sector signature in jets, searches with AFP high-μ data)

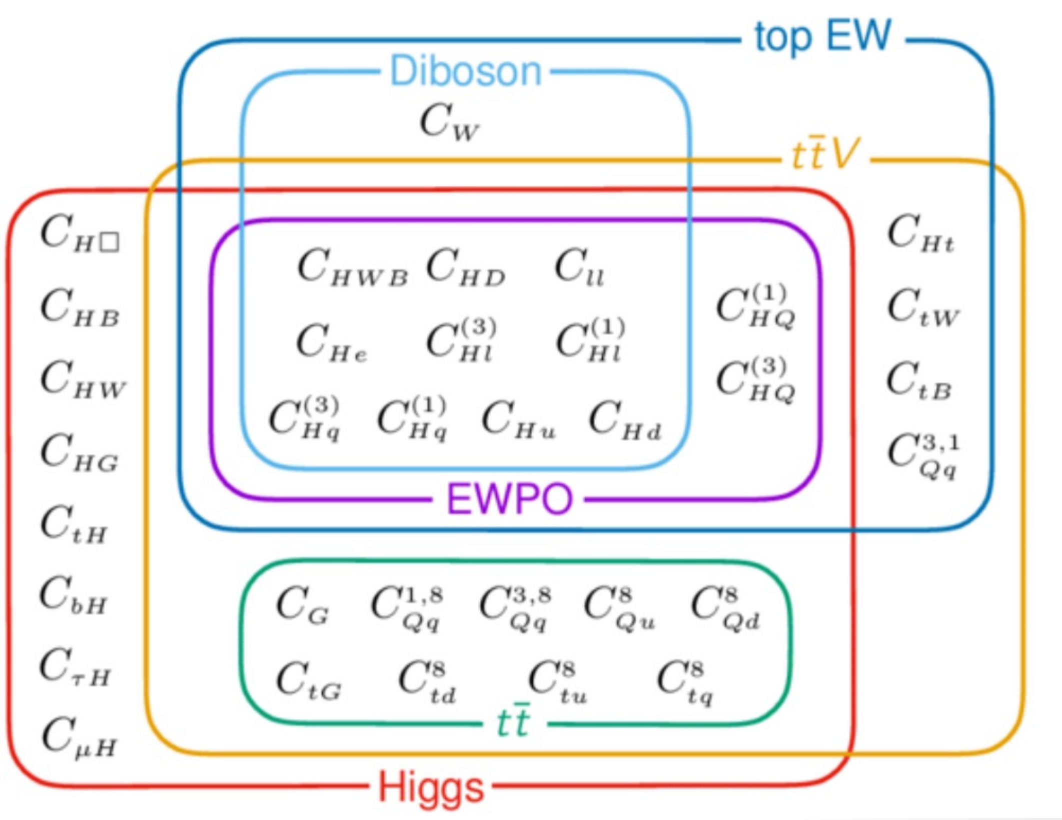
TLA: bandwidth limited (Low-mass resonances in (b-)jets & muons

EFT Challange

Very large number of correlated Wilson coefficients to be fitted (dim-6: ~2500).
Ultimate goal: global fit of all Wilson coefficients (within a certain flavour symmetry scenario).
Strong interplay of constraints from the top quark, EW and Higgs measurements.



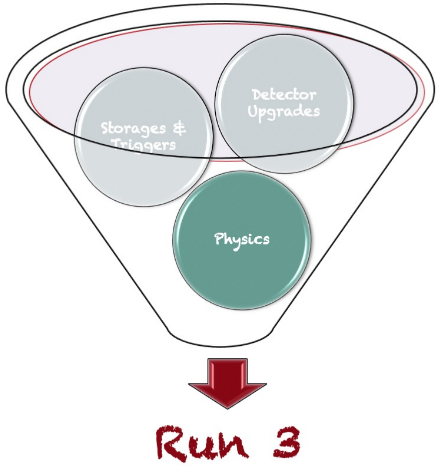
Adapted from K. Mimasu



J. Ellis et al, JHEP 04 (2021) 279

Measurements of fundamental SM parameters

In ATLAS/CMS we can measure various SM parameters, in many cases with best precision or with a precision competitive with previous determinations



	δ PDG	δ ATLAS		
m_H	0.11%	0.19%	Uniquely measured at the LHC	Higgs
m_t	0.17%	0.28%	Among most precise measurements	QCD
$\alpha_s(m_Z)$	0.8%	7.5%	Currently dominated by large theory uncertainty	QCD
m_W	0.015%	0.023%	Competing with Tevatron precision	Electroweak
$\sin^2\theta_W$	0.07%	0.15%	Prospects to become competitive with LEP and SLD	Electroweak

Many ongoing efforts to reach the ultimate precision on fundamental SM parameters used in the EW fit. With the large statistics available in Run 2, significant improvements in precision are achieved through efforts and new methodologies in performance and physics modelling

EFT Challenge : comparison with flavor

See also EPS book

Indirect flavor facilities searches have higher reach, although do rely on several assumptions:

Current bounds of MFV make predictions comparable with the ones from collider physics!