Data Scouting and Data Parking with the CMS High level Trigger

Swagata Mukherjee (On behalf of the CMS collaboration)

III. Physikalisches Institut A

RWTH Aachen University, Germany

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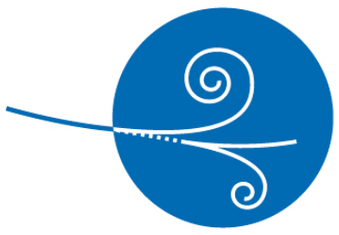

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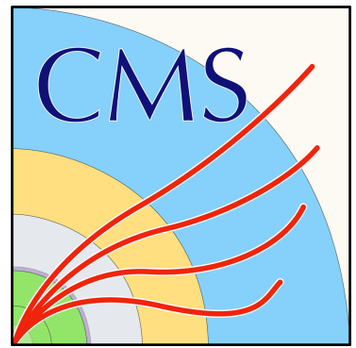
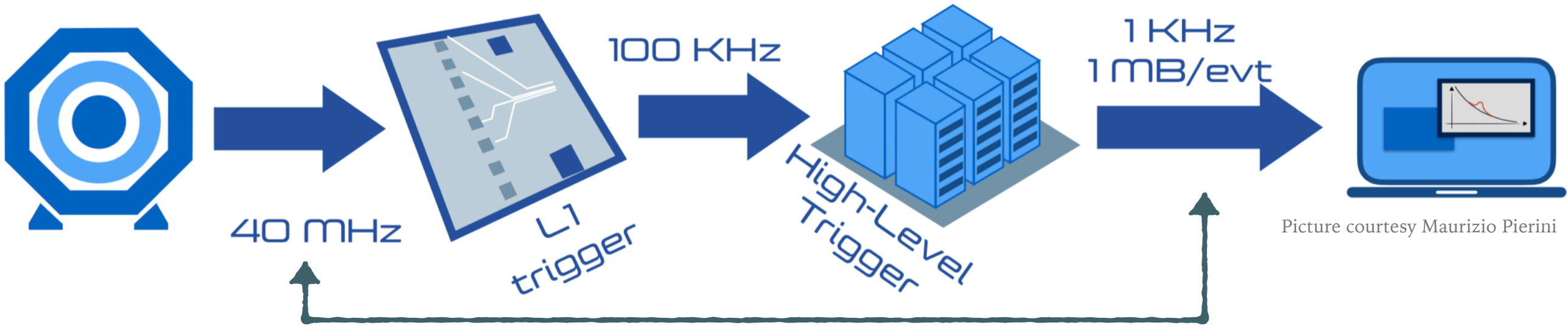


TRIGGER STRATEGY IN CMS *AND SOME DRAWBACKS*

Huge amount of data from LHC. Need to filter out online.

Filters based on theory/pheno bias. Store events with high p_T objects.

Low or **zero** sensitivity to new physics with low-mass.



Picture courtesy Maurizio Pierini

Huge reduction in rate. We might be losing good events

Reconstruction in:

L1 trigger: hardware based, read-out of detector with coarse granularity, VERY FAST.

High Level Trigger (HLT): software based, full readout of detector with full granularity, FAST.

Offline: software based, no time constraint.

ONE WAY OUT FOR LOW MASS SEARCHES: SCOUTING

Trigger Bandwidth = Event Rate × Event Size

Event Rate ~1 kHz

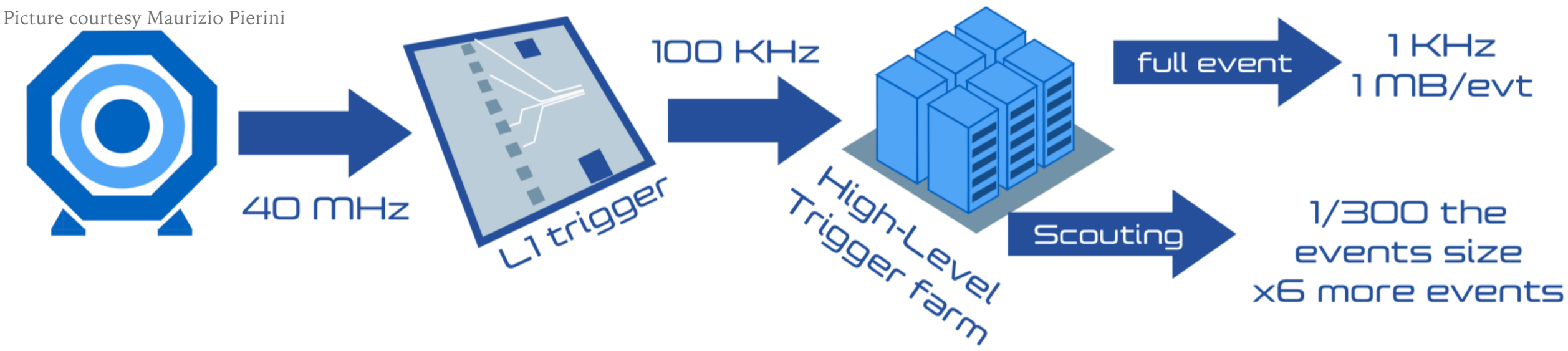
Event Size ~1 MB

If we want to **increase** rate

We need to **decrease** event size

This is the idea of data scouting

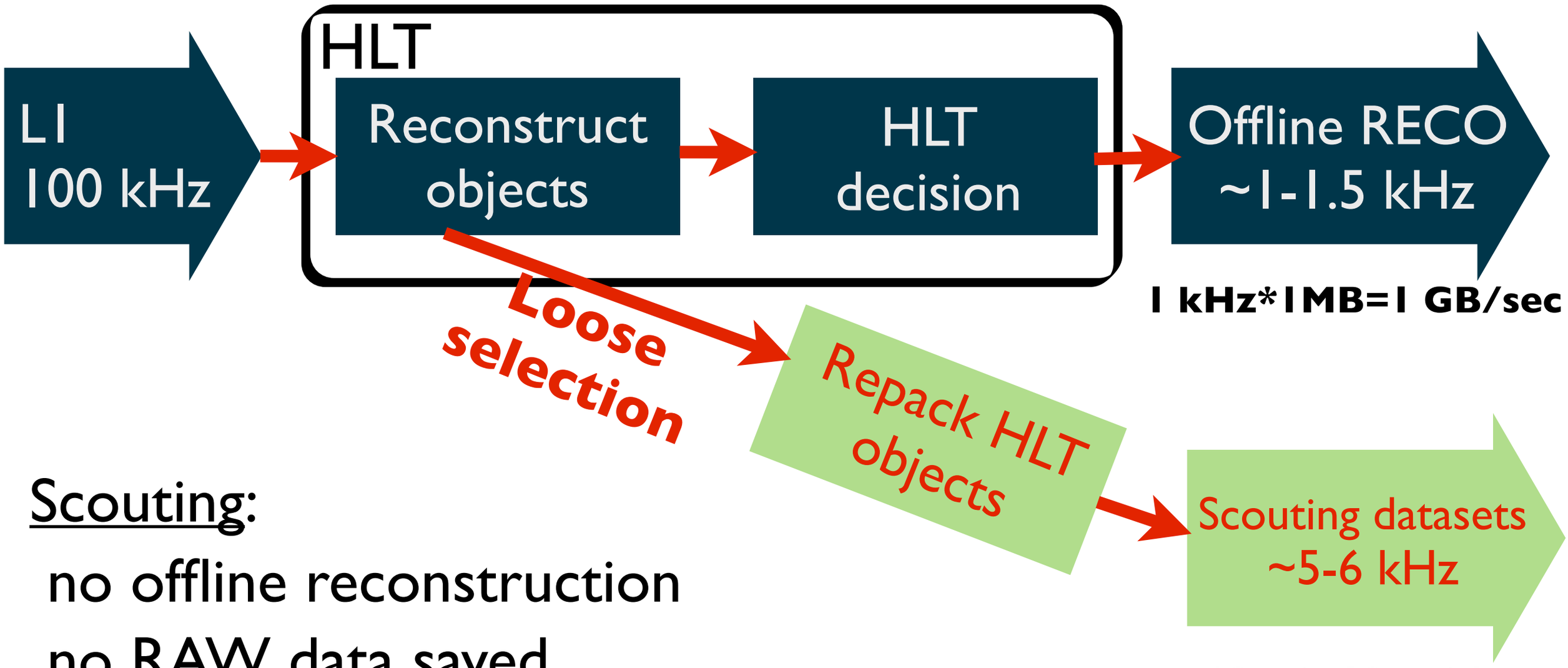
Picture courtesy Maurizio Pierini



No offline reconstruction, use HLT reconstructed objects.

Practical (so far) only for specific topologies

Data Scouting: technicalities in a nutshell



Scouting:

no offline reconstruction

no RAW data saved

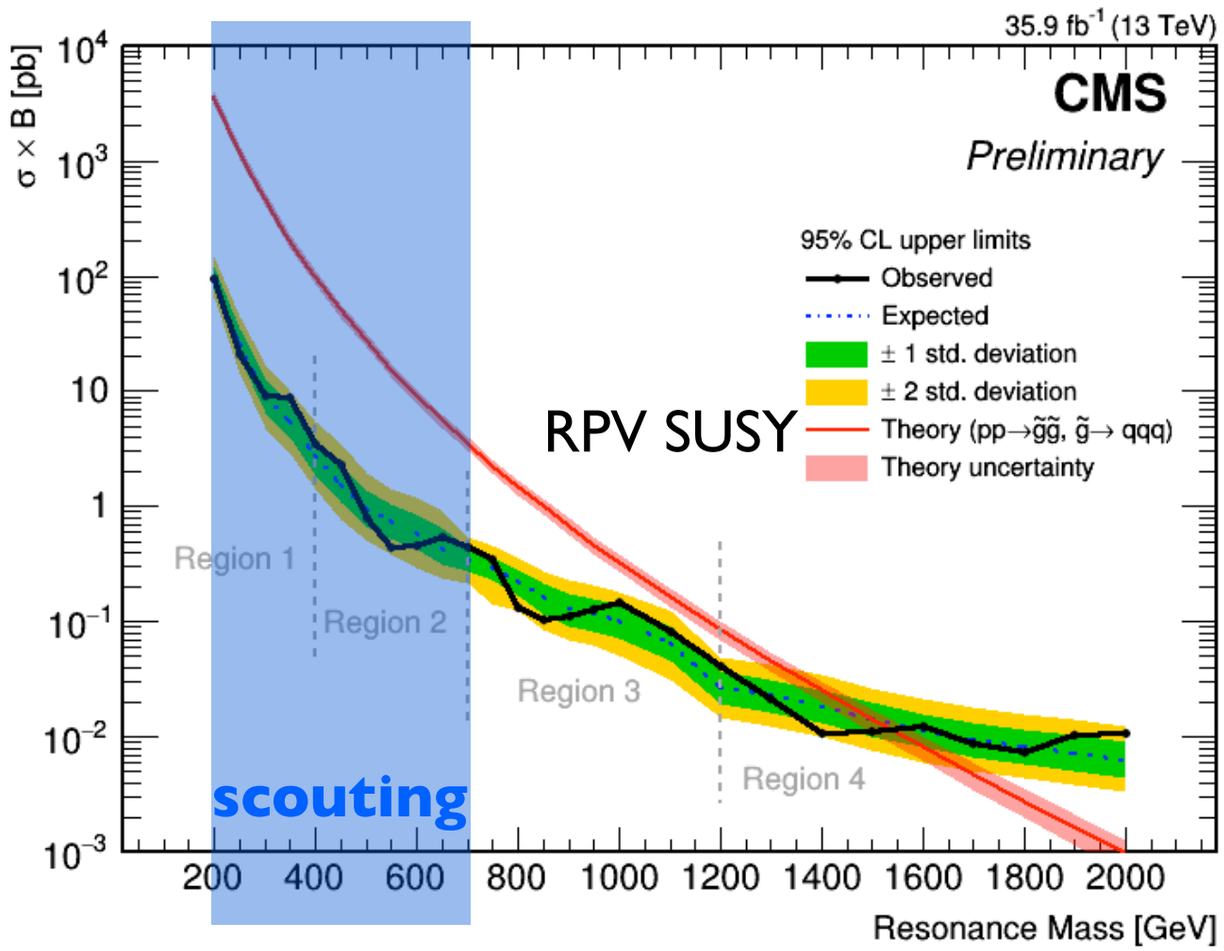
Scouting being used in CMS since 2011

Di-jet resonance search: first successful application of scouting

What do we gain? From **HEAVY** to LIGHT

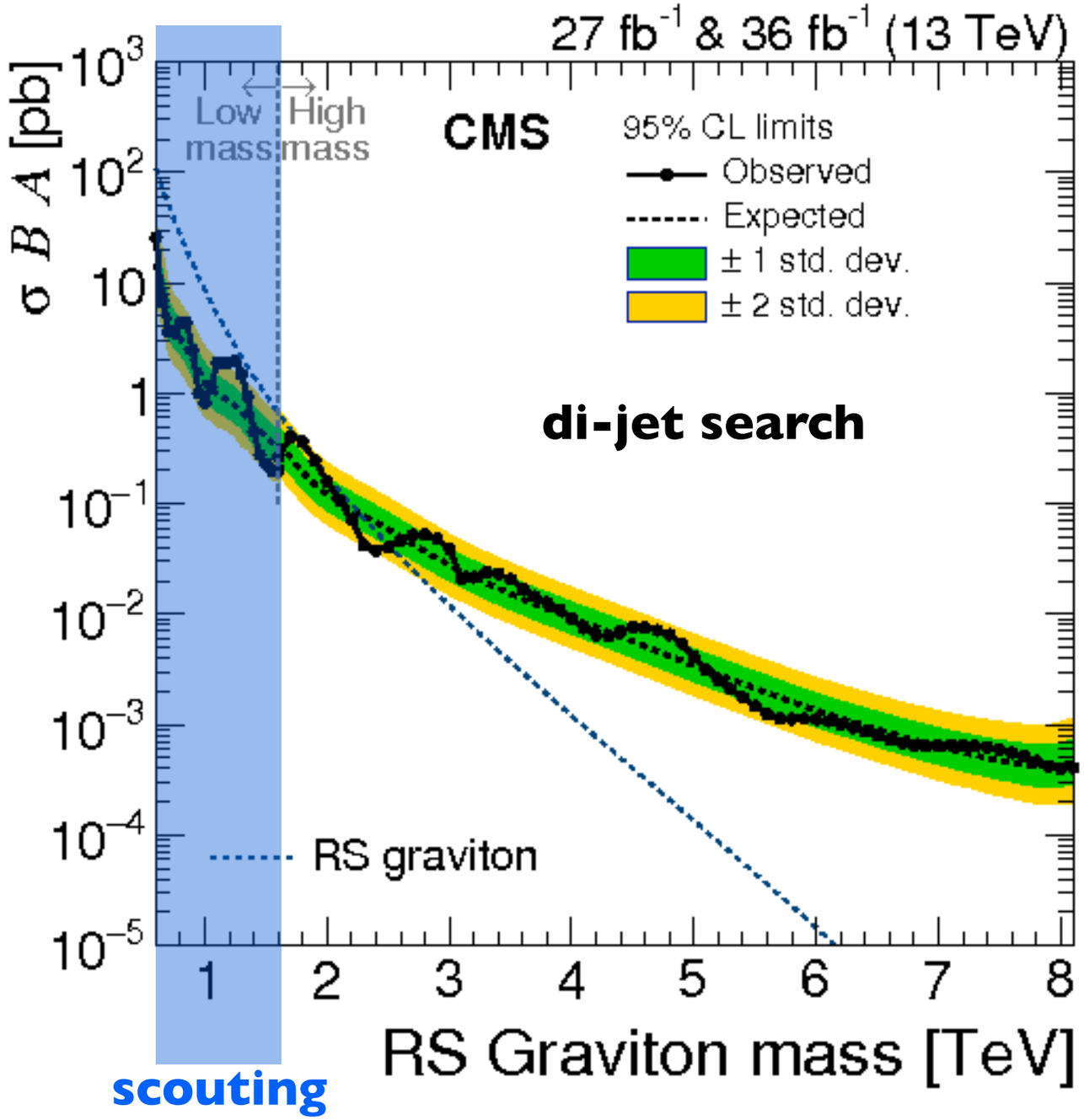
200<Mjjj<700 GeV accessible by H_T particle flow scouting

tri-jet search



Searches involving jet substructure techniques seems promising with PF scouting.

600<Mjj<1600 GeV accessible by H_T calo scouting



Going beyond hadronic scouting: Di-muon scouting trigger

Di-muon scouting trigger designed in 2015, improved in 2017

In 2017-onward version, very loose HLT requirement:

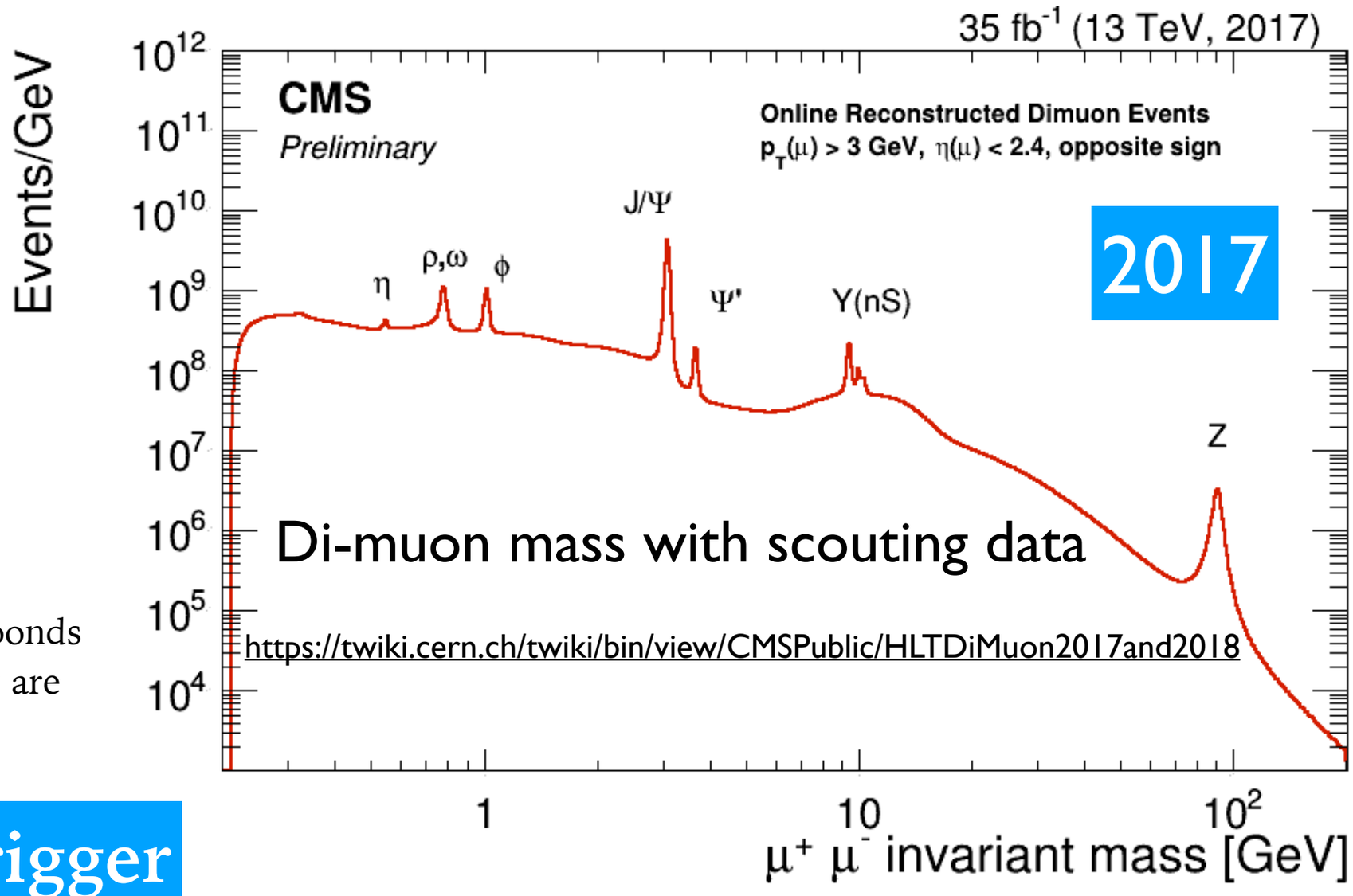
At least 2 muons with p_T>3 (1) GeV in 2017 (2018). **No cut on invariant mass.**

Muon tracks should have

Targeting endcap muons

>0 hit in pixel and overall >4 hits in tracker

Hits in muon chamber

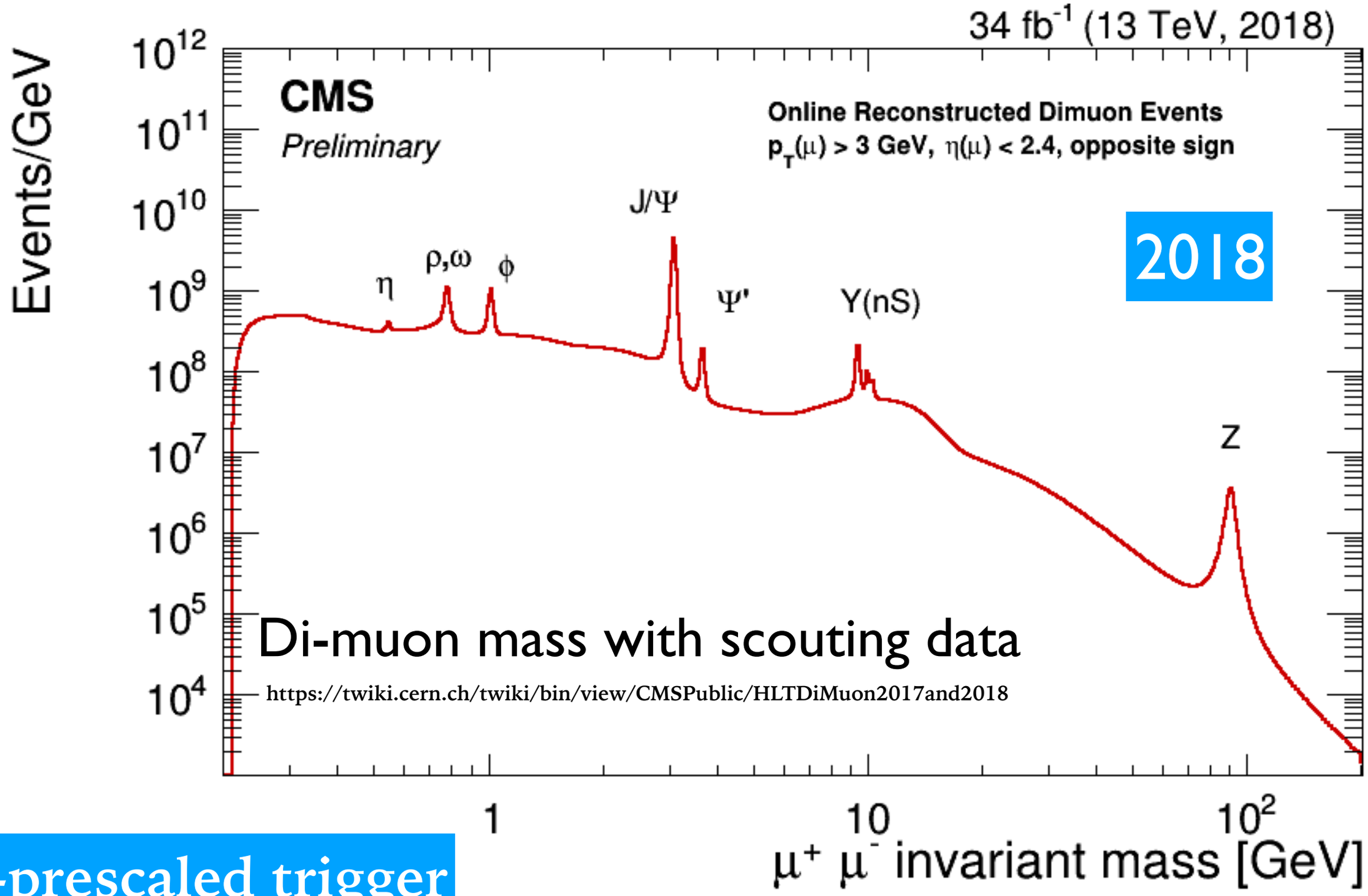


Small excess ~330 MeV corresponds to $\phi \rightarrow K^+K^-$ decays where Kaons are misidentified as prompt muons.

Un-prescaled trigger

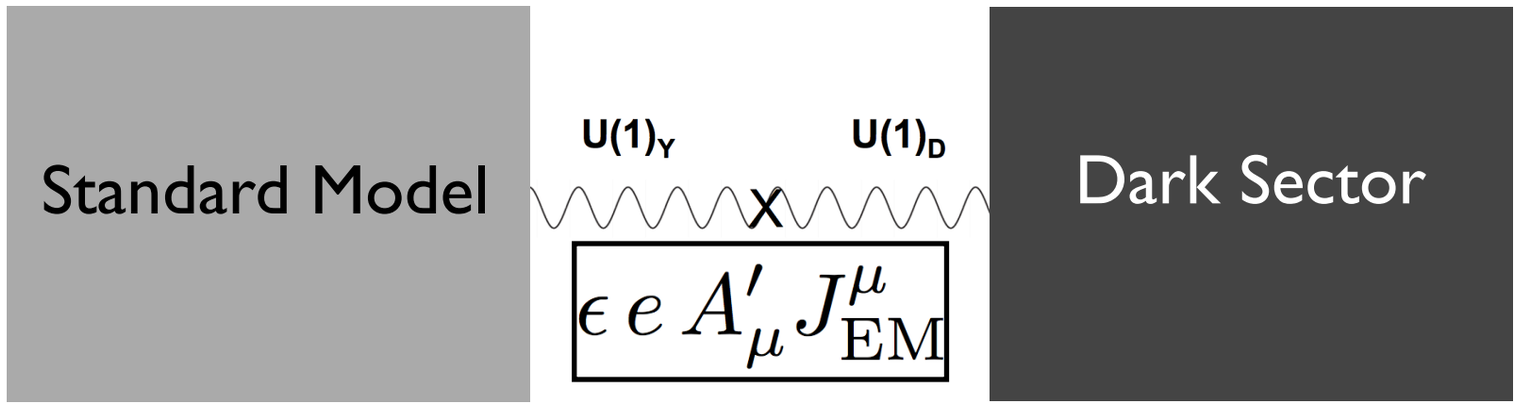
Di-muon scouting trigger

~90 fb^{-1} data collected using di-muon scouting trigger in 2017 and 2018



Un-prescaled trigger

Theoretical motivation for di-muon scouting



cross section is suppressed by ϵ^2

Scouting data can be used to test other models also

Search for dark photons (A') in dimuon channel.

For small mixing (ϵ), A' can be long-lived → displaced muon-pair

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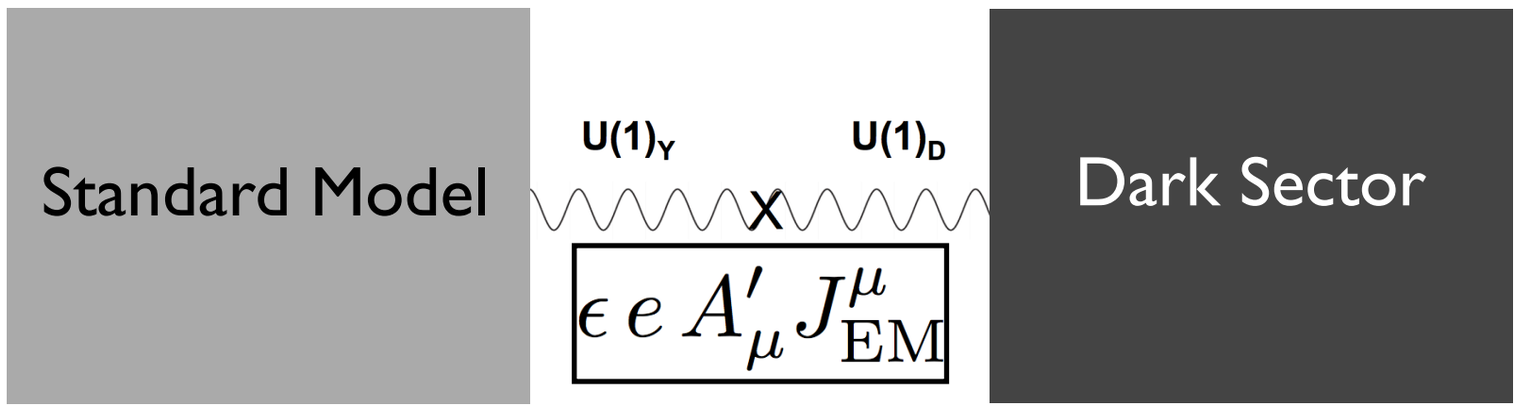

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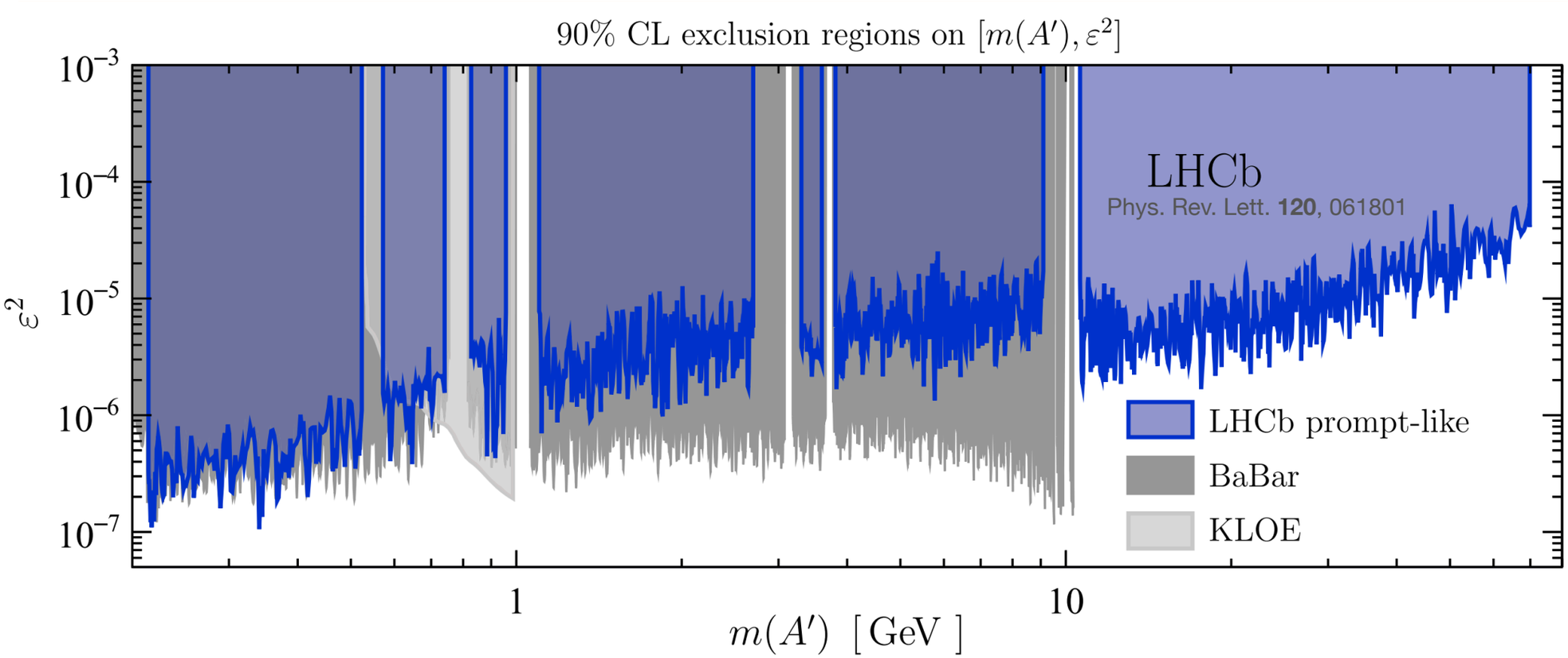
BABAR / LHCb already put constrains in M(A')-ϵ plane



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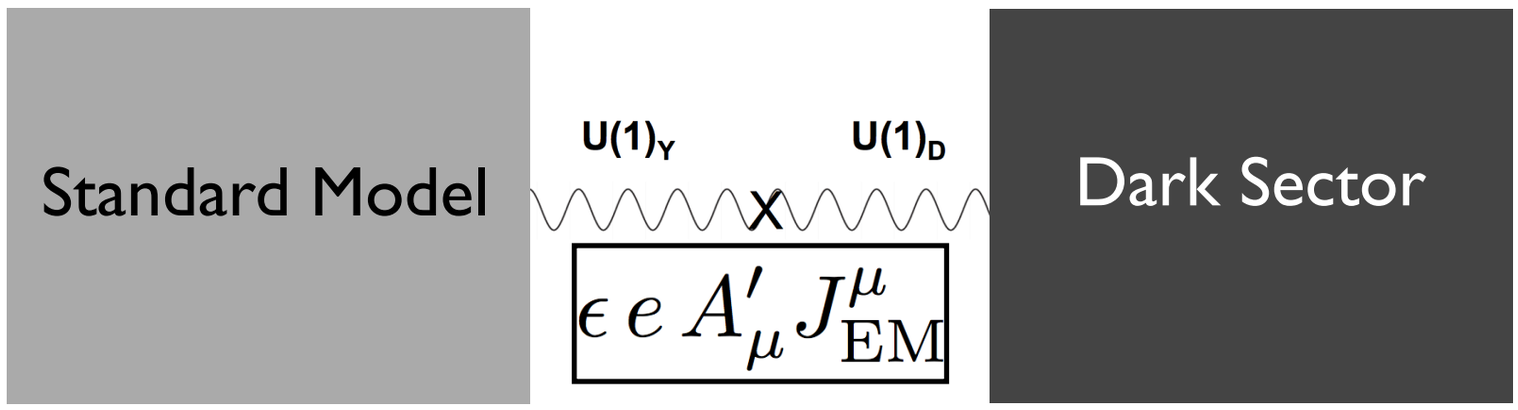

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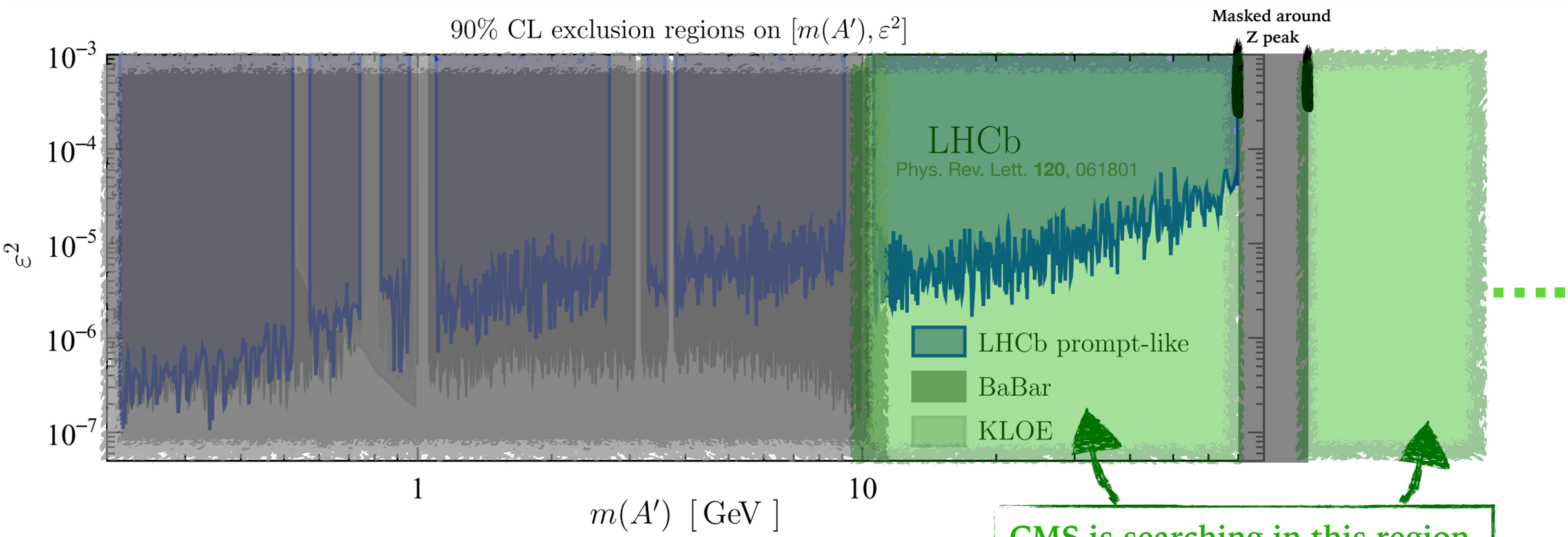
CMS prompt dark-photon search in di-muon channel is in progress



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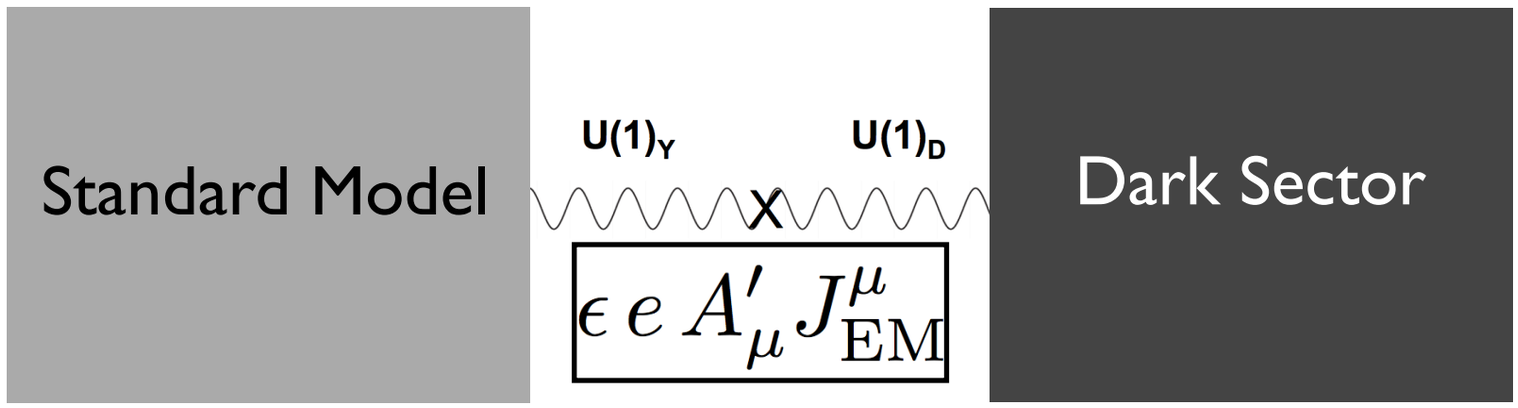

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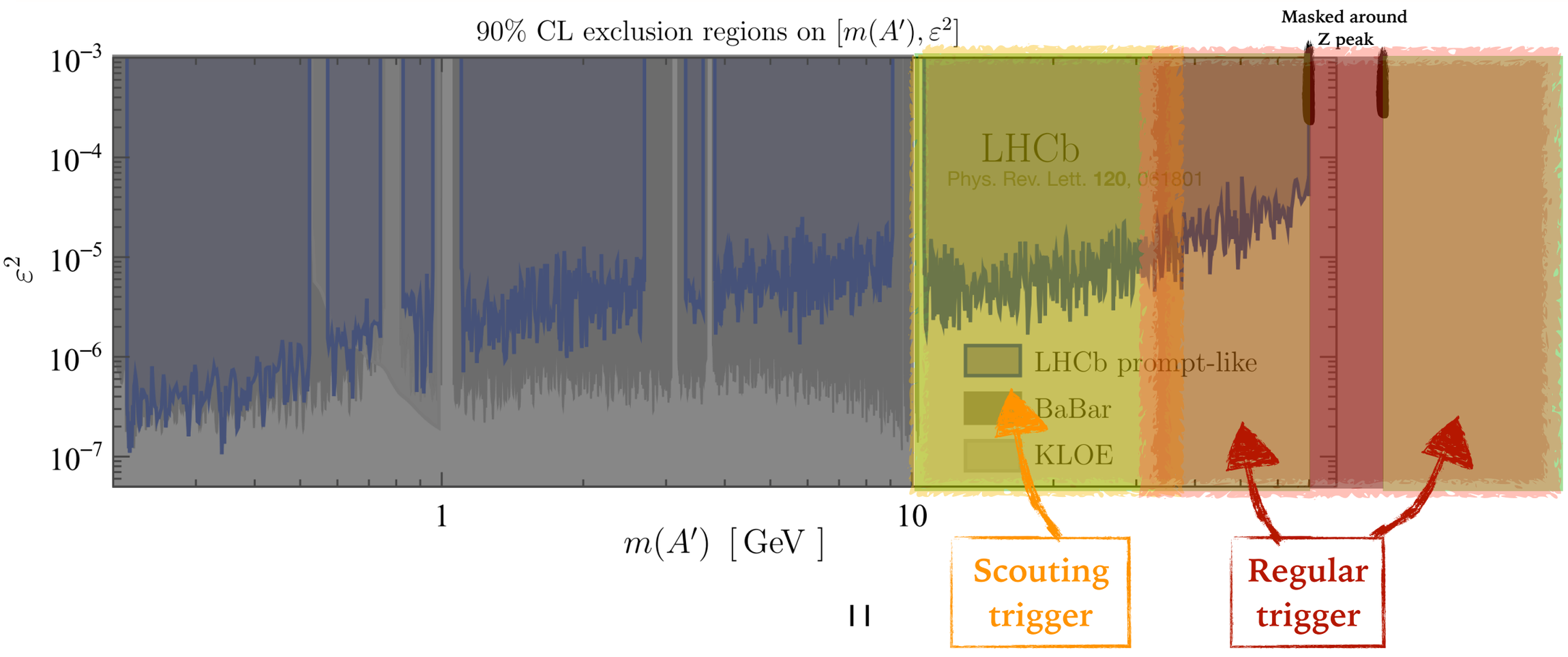


Published papers / public PAS using scouting data

Search for Narrow Resonances using the **dijet** Mass Spectrum in pp collisions at **7 TeV** CMS-PAS-EXO-11-094 http://cds.cern.ch/record/1461223

Search for narrow resonances in **dijet** final states at **8 TeV** with the novel CMS technique of data scouting, arxiv1604.08907, PRL 117, 031802 (2016)

Search for **dijet** resonances in proton-proton collisions at **13 TeV** and constraints on dark matter and other models, arxiv1611.03568, PLB 769 (2017) 520

Search for narrow and broad **dijet** resonances in proton-proton collisions at **13 TeV** and constraints on dark matter mediators and other new particles, arxiv1806.00843, JHEP 08 (2018) 130

Search for pair-produced **three-jet** resonances in proton-proton collisions at **13 TeV**, arxiv1810.10092, PRD 99 (2019) 012010

Scouting is well established strategy in CMS.
Being used consistently in new physics searches since 2011

A drawback of Scouting & the idea of Parking

- Full event information not available in scouting
  - Difficult to fully characterize a potential signal (if seen)
- Way out: Parking of the full RAW data
  - NO offline reconstruction immediately
  - Reconstruct later (during technical stop / long shutdown) according to need

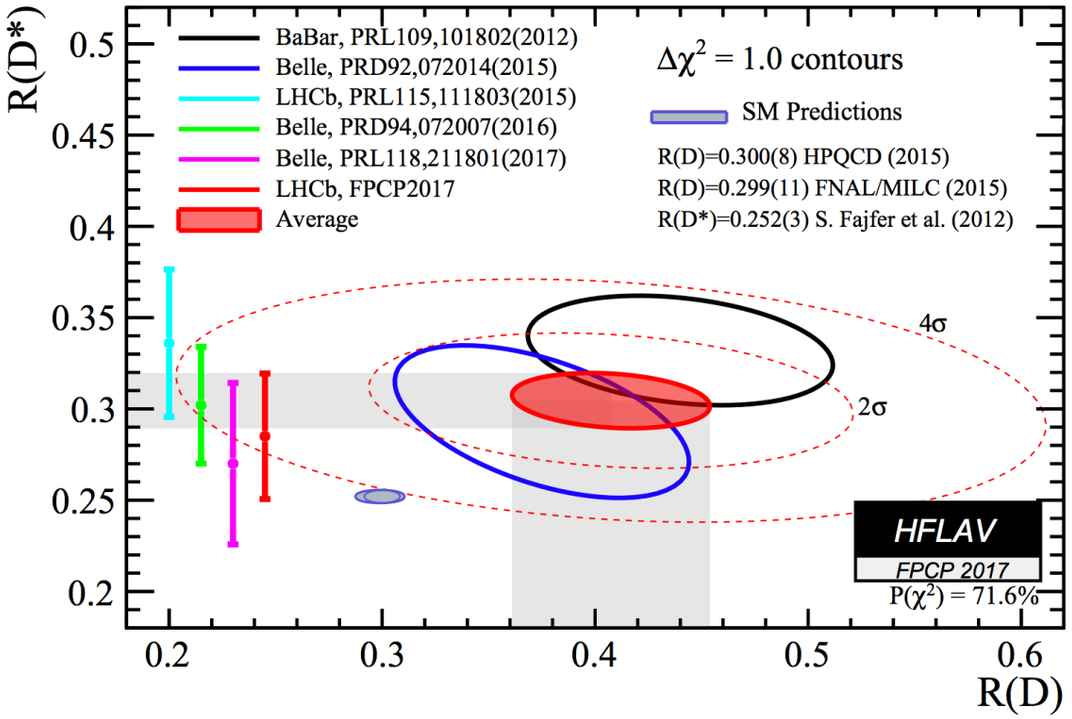
2016(Full), 2017 (partial) scouting data was parked

Data parking **not necessarily** only for scouting trigger.

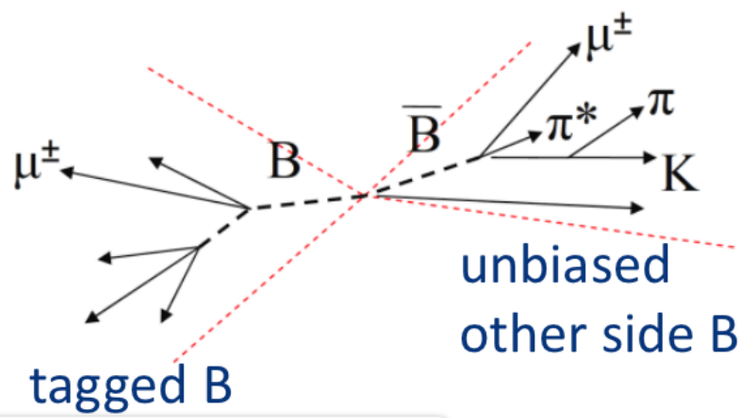
Eg. in 2018, CMS invested major effort and resource in B-physics parking.

B parking in CMS

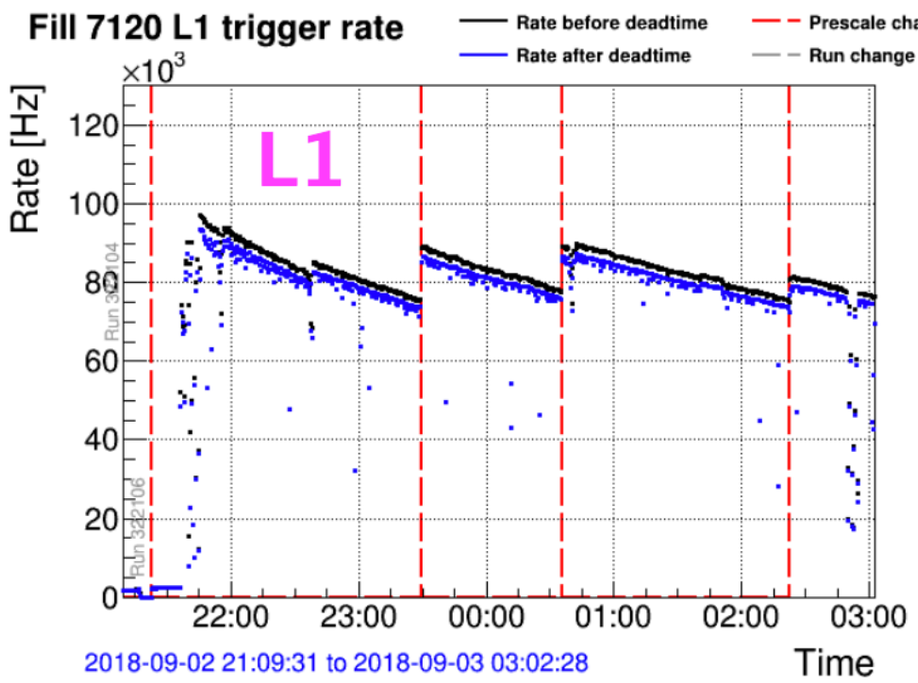
Single copy, 2 kHz to DAQ

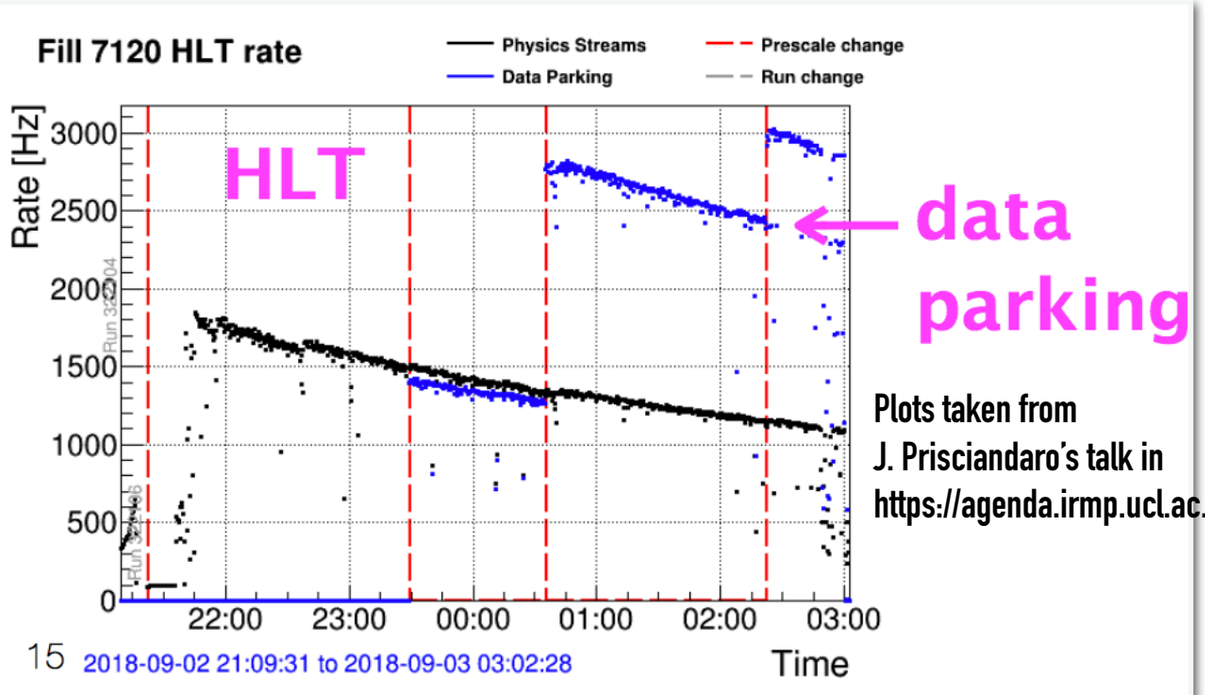


Motivation: Study B anomalies observed by other experiments. Can be useful for other searches also, eg. Long-lived exotic new particle searches.



Data sample: Collected large unbiased sample of B (~10^{10} events)
Strategy: Triggered on muon from B (tag), to collect unbiased B on the other side (probe). Rates up to 5 kHz.





data parking

Plots taken from
J. Prisciandaro's talk in
https://agenda.irmp.ucl.ac.be/event/3186/

Summary

- Reach so-far-unexplored territory with the help of scouting & parking.
- Successful ‘prompt’ searches using scouting technique motivate more challenging attempts.
- Scouting and parking strategies for Run III under discussion. Possibility to expand to other final states.
- Investing efforts to optimally use the B parking dataset
- Leave no stone unturned. Do the best that can be done with CMS.

More searches to come.

Stay tuned !