SEARCH FOR MANIFESTATIONS OF NEW PHYSICS AT **LHC**

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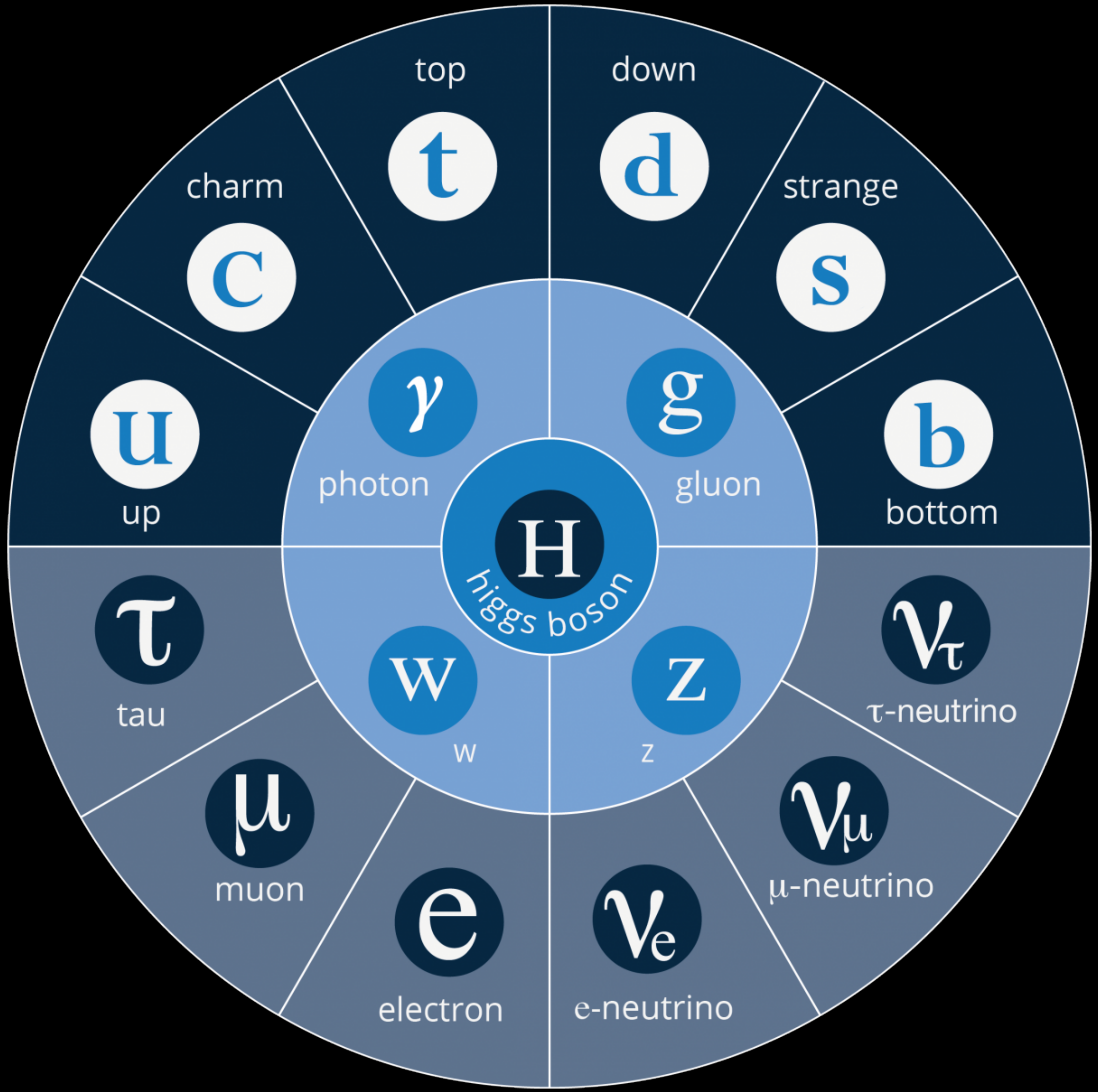
on behalf of the ATLAS,CMS and LHCb collaborations

HEIDELBERG UNIVERSITY, KIRCHHOFF INSTITUTE FOR PHYSICS

NEW TRENDS IN HIGH ENERGY PHYSICS, BUDVA, MONTENEGRO
29 SEPTEMBER 2018

THE STANDARD MODEL (SM)

- **Great! But still many unknowns:**
  - SM particles → only ~5% of universe
  - Baryon asymmetry
  - Neutrino issues
  - CP Violation
  - Hierarchy problem



THE STANDARD MODEL (SM)

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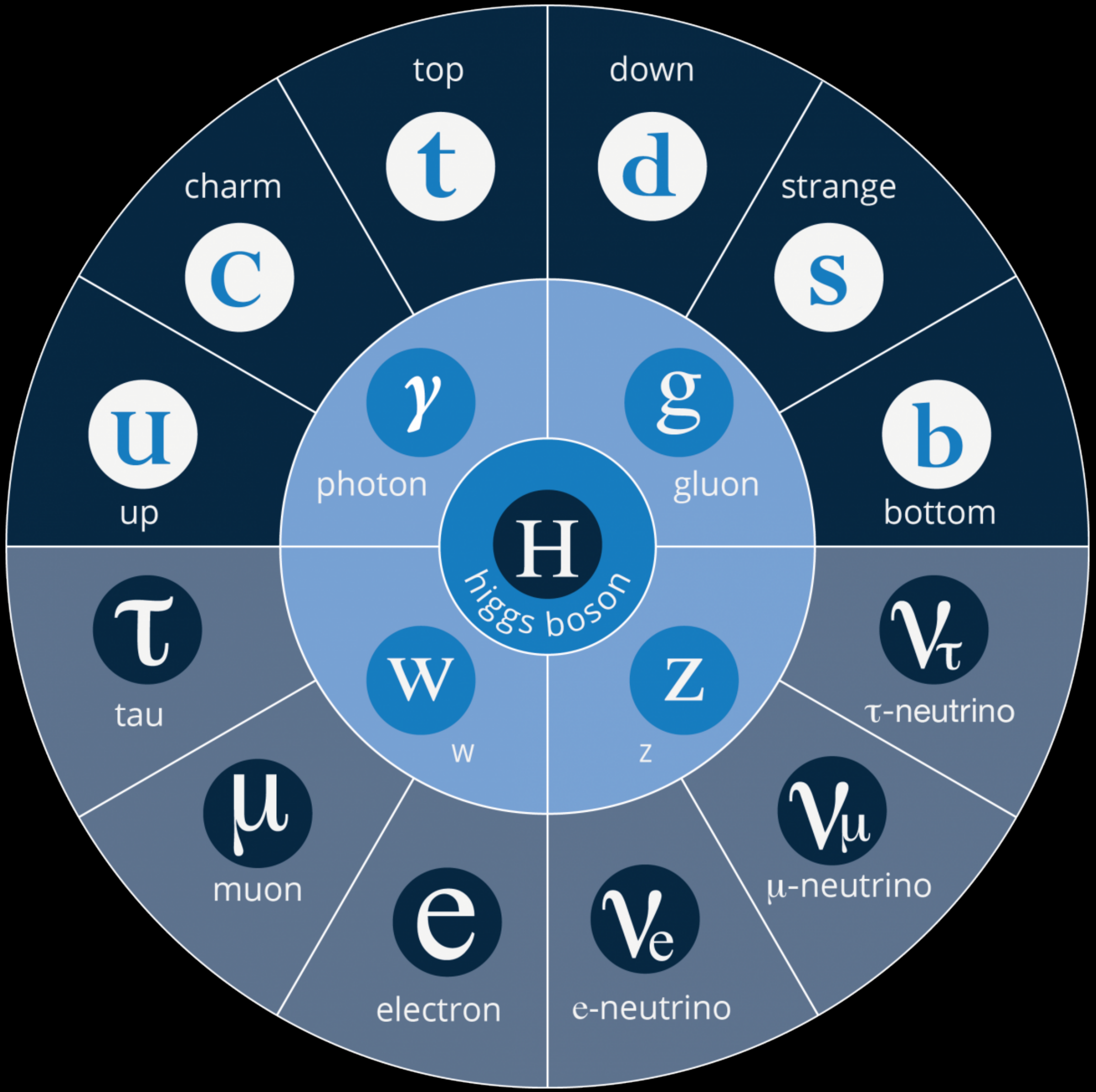
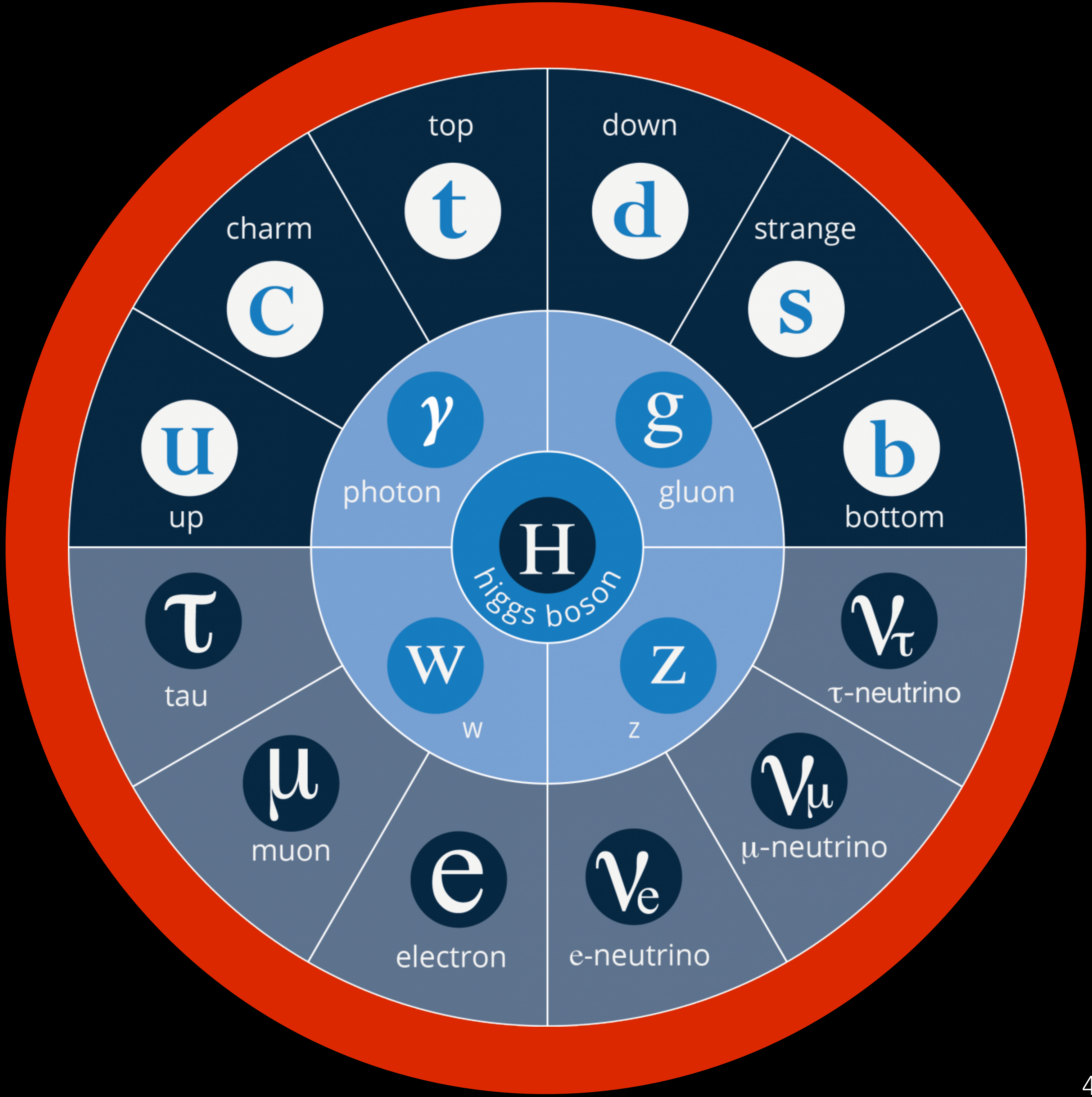
  - N issues
  - CP Violation
  - Hierarchy problem

See the nice talk given by Dimitry Kazakov



BEYOND THE STANDARD MODEL (BSM)

- **We need new physics to understand**
  - SM particles → only~5% of universe
  - Baryon asymmetry
  - Neutrino issues
  - CP Violation
  - Hierarchy problem



WHERE IS NEW PHYSICS?

…ARE WE LOOKING EVERYWHERE?

ROADMAP / WHERE TO GO?

- Indirect Searches: Test / validate SM
  - Precision measurements
  - Rare processes
- Direct searches for BSM
  - Search for new physics models
  - Signature driven searches

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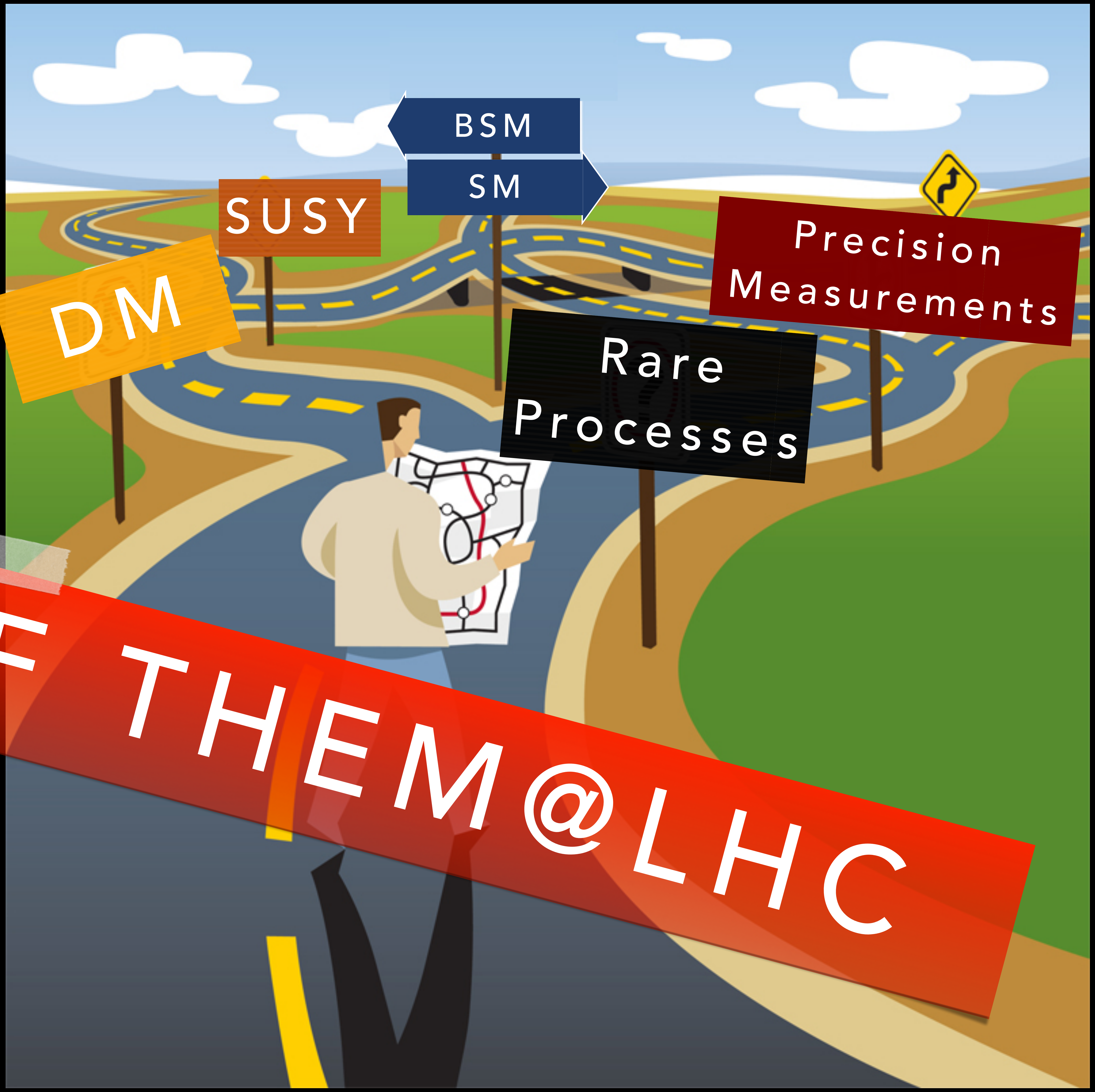


DOING ALL OF THEM@LHC

THE ROAD SO FAR: TESTING THE SM

RARE DECAYS

LEPTON FLAVOR UNIVERSALITY(LFU)

- SM predicts the same electroweak couplings to all three lepton flavours (LFU)

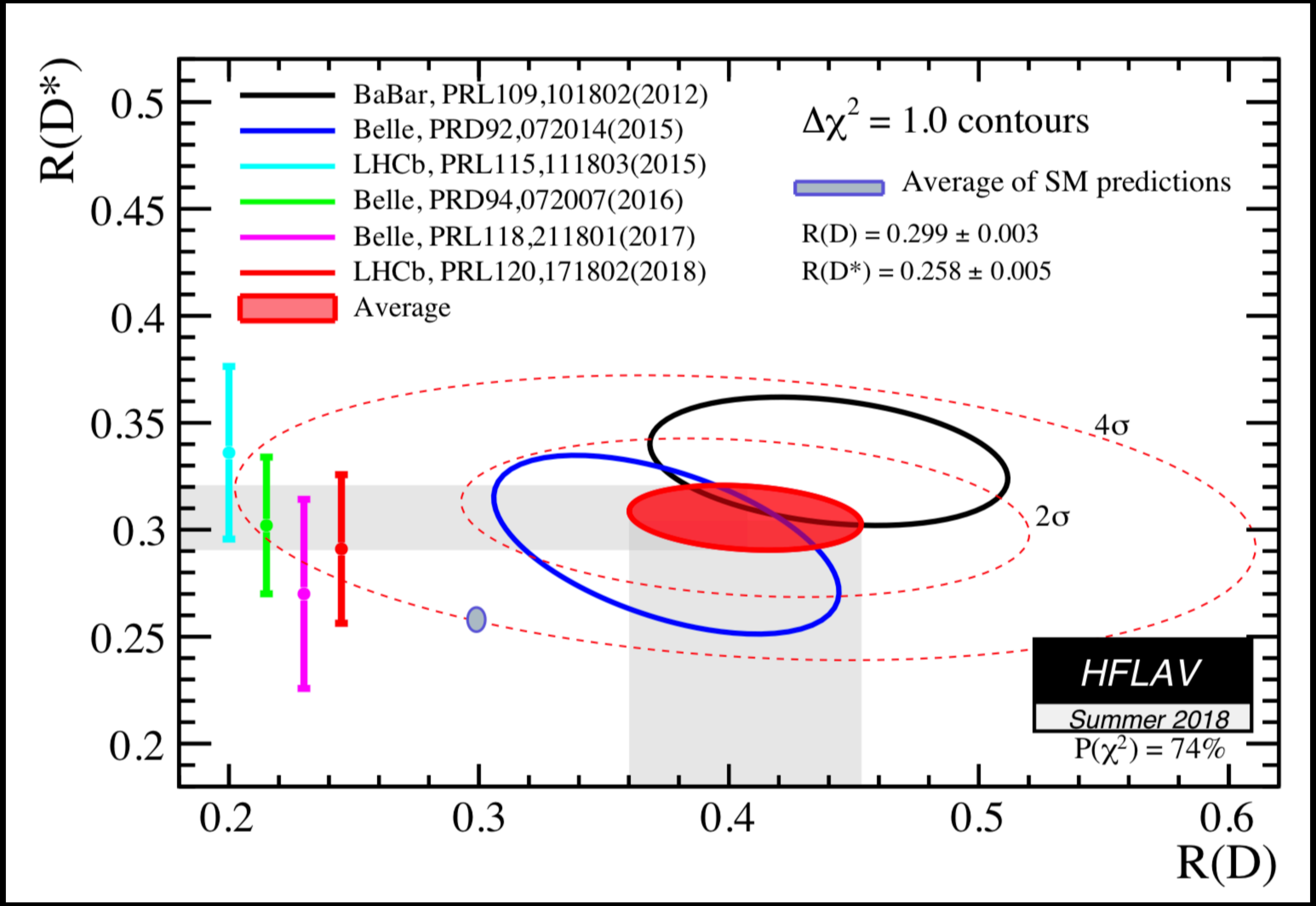
- Measuring the ratio of the production rates of different flavours
  - If there is an anomaly ⇒Sign for **new physics**!

See P.Krokovny's talk
to find out more about anomalies:
e.g.Angular distribution anomaly 3.4**σ**

First measurement of R(D*-) with 3 prong **τ** decay

$$\mathcal{R}(D^{*-}) \equiv \mathcal{B}(B^0 \to D^{*-}\tau^+\nu_\tau)/\mathcal{B}(B^0 \to D^{*-}\mu^+\nu_\mu)$$

LHCB, PRL 120 (2018) 171802



Inclusion of this result to the world average:

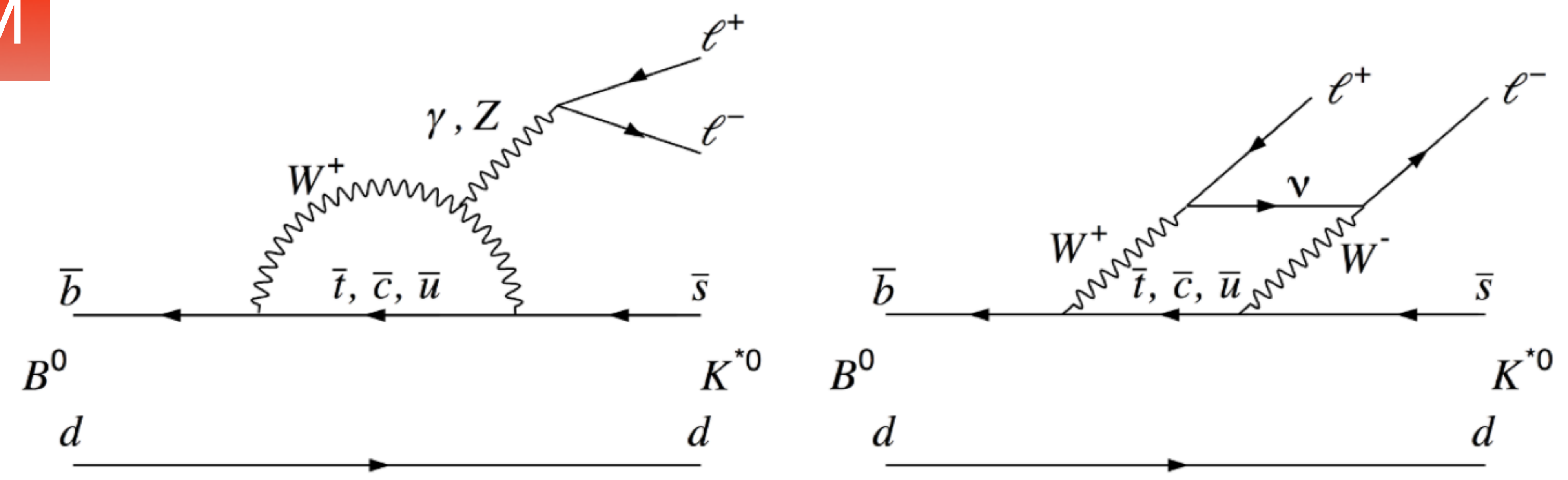
~4σ LFU VIOLATION

TEST OF LEPTON UNIVERSALITY

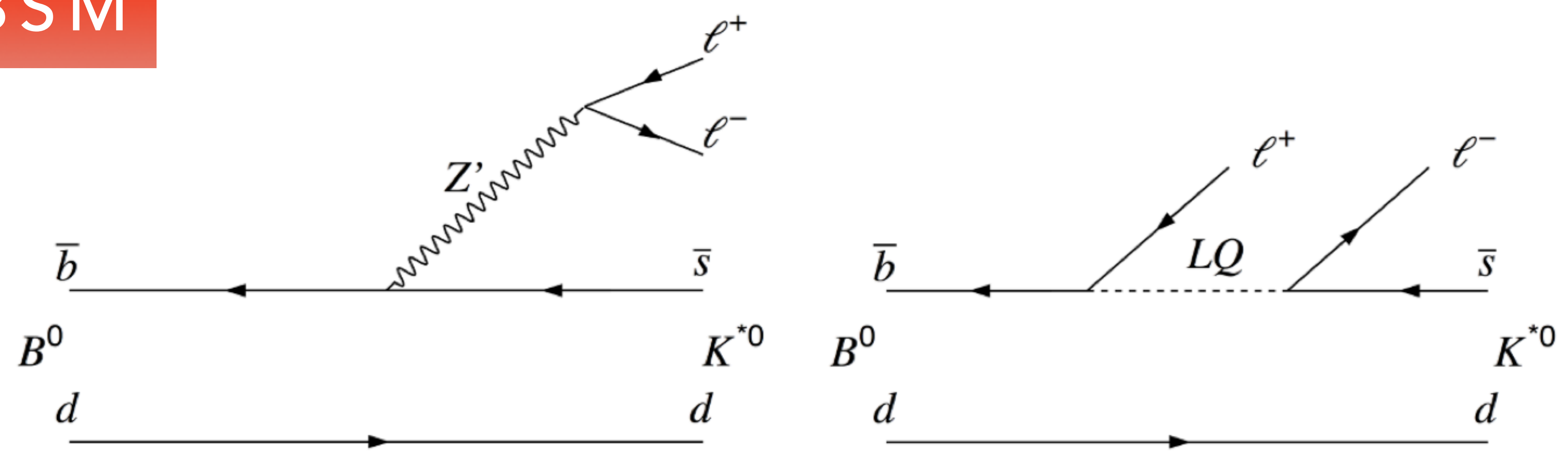
JHEP08(2017)055

MOST PRECISE MEASUREMENT OF $R_{K^{*0}}$ AT LHCB

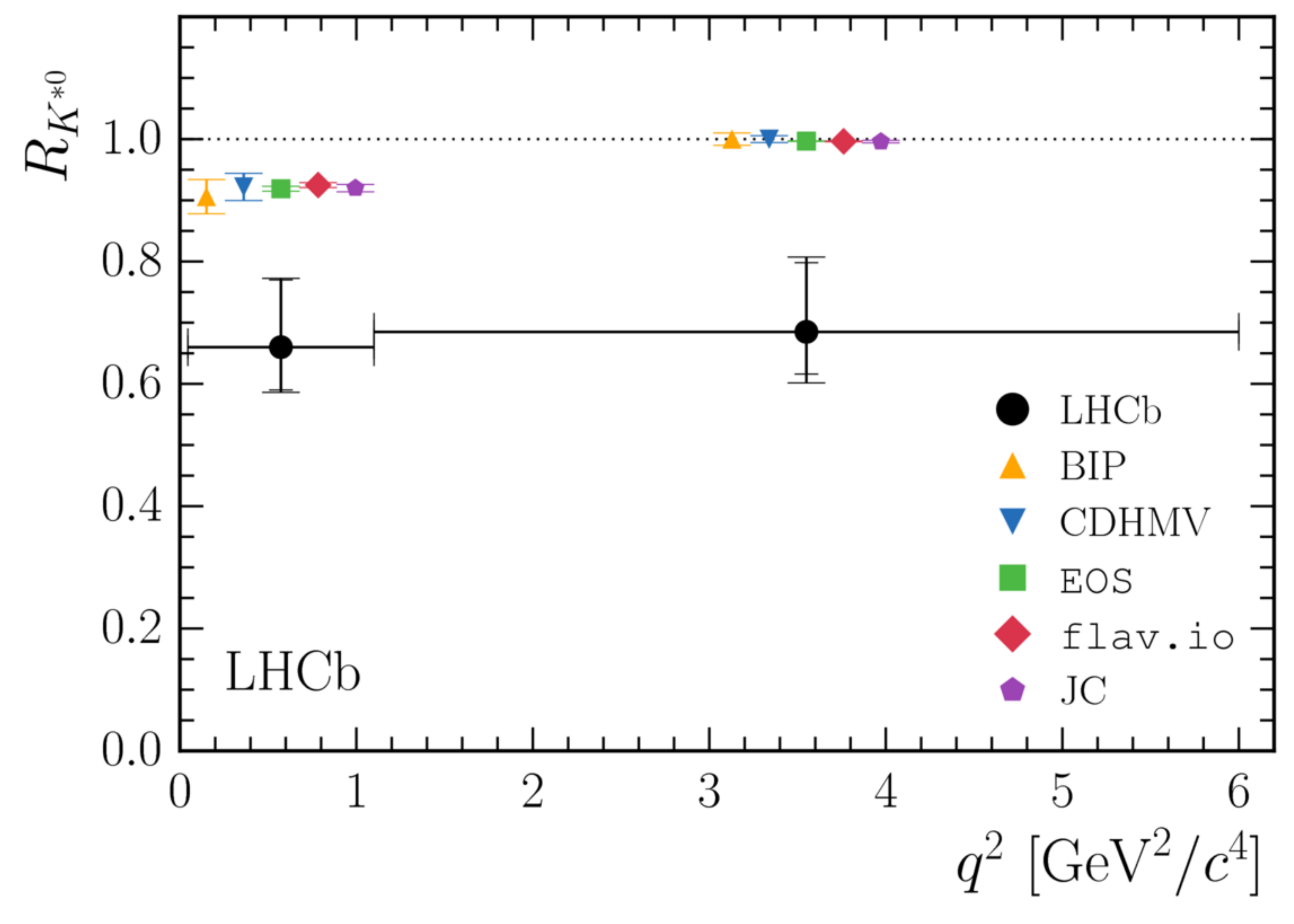
SM



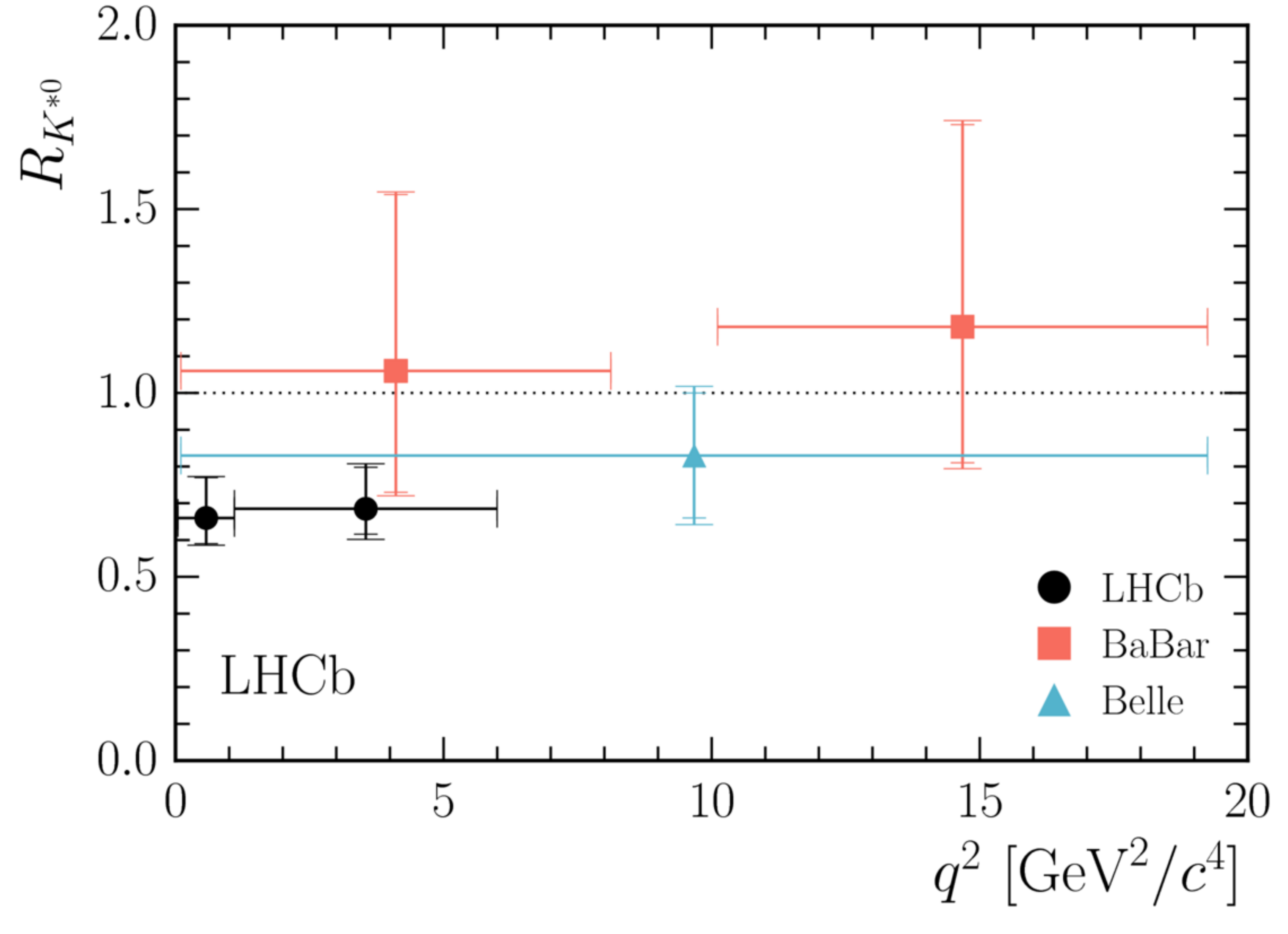
BSM



COMPARISON TO THE SM THEORETICAL PREDICTIONS



COMPARISON TO THE RESULTS FROM B FACTORIES



$$R_K = \frac{BR(B^+ \to K^+ \mu^+ \mu^-)}{BR(B^+ \to K^+ e^+ e^-)}$$

UP TO 2.6σ STANDARD DEVIATION

THE ROAD SO FAR:
SEARCHES FOR BSM

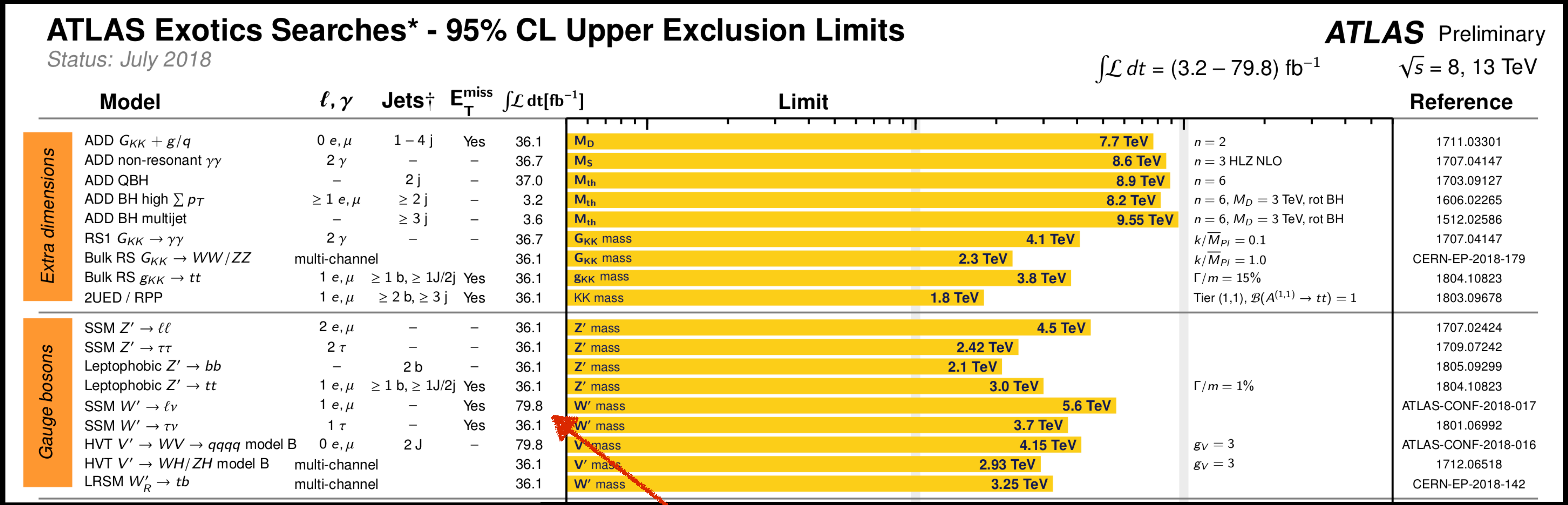
NEWEST RESULTS FROM ATLAS AND CMS

EXPLORED ALMOST 80 FB^{-1} DATA

≈8000 TRILLION P-P COLLISIONS

STATUS OF THE BSM SEARCHES

- Exploring the TeV Mass Scales thanks to LHC, hundreds of papers published so far.
- Impossible to cover all these searches, in this talk only highlights and latest results with the largest datasets ~80fb^{-1}!
- Focus on different search strategies for exploration of the phase space:
  - Simplified models, summaries, scans, combinations…



HEAVY NEUTRINOS

VECTOR LIKE QUARKS

AXIGLUONS

SUPERSYMMETRY

UNCONVENTIONAL

LONG LIVED PARTICLES

TECHNICOLORS

DISAPPERAING TRACKS

COMPOSITENESS

DARK QCD

GRAVITONS

DISPLACED VERTICES

NEW GAUGE BOSONS

LEPTOQUARKS

COLORONS

DARK PHOTONS

LIGHT Z′ BOSON

CONTACT INTERACTIONS

DARK MATTER

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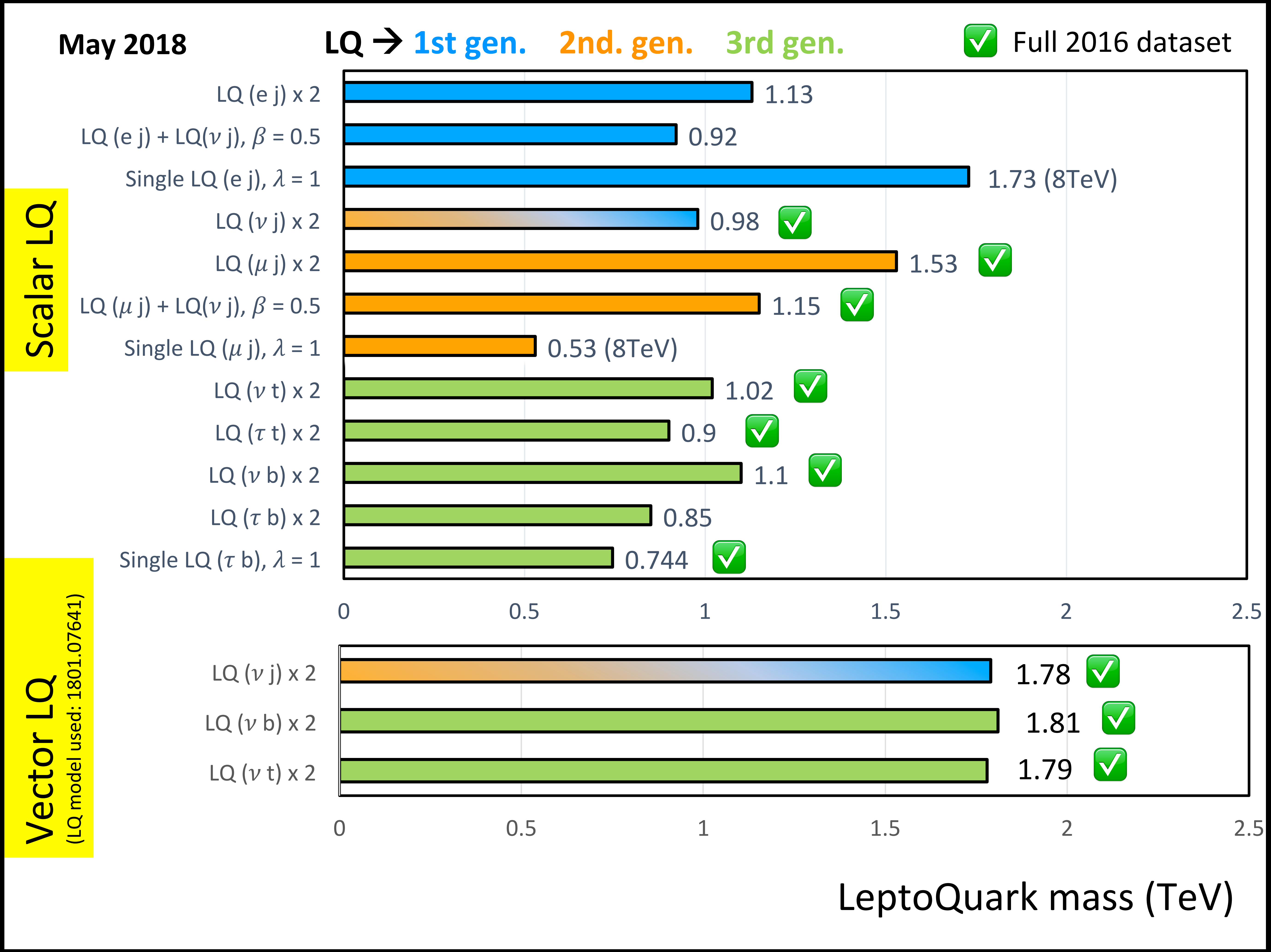
LEPTOQUARKS

LEPTOQUARKS(LQ)

EXCITING TO EXPLAIN THE RECENT ANOMALIES!

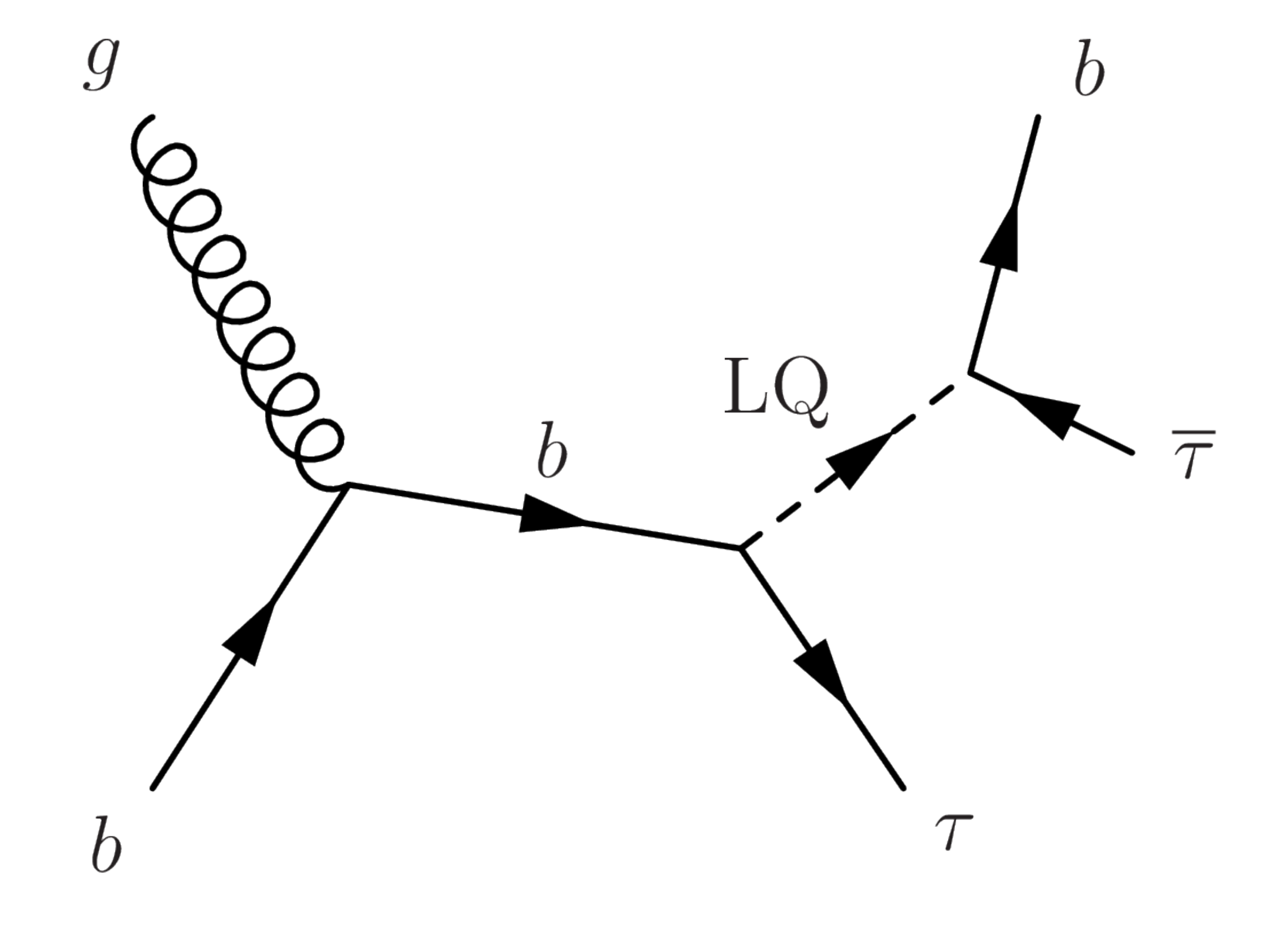
- What?
  - Hypothetical color-triplet bosons
  - Both lepton and baryon number with fractional electric charge, decay to a lepton and jet
- Why?
  - Grand Unification Theories, SUSY, technicolor ,composite models, E_6, …
  - Provides explanations to **LFUV** and anomalous magnetic moment of the muon



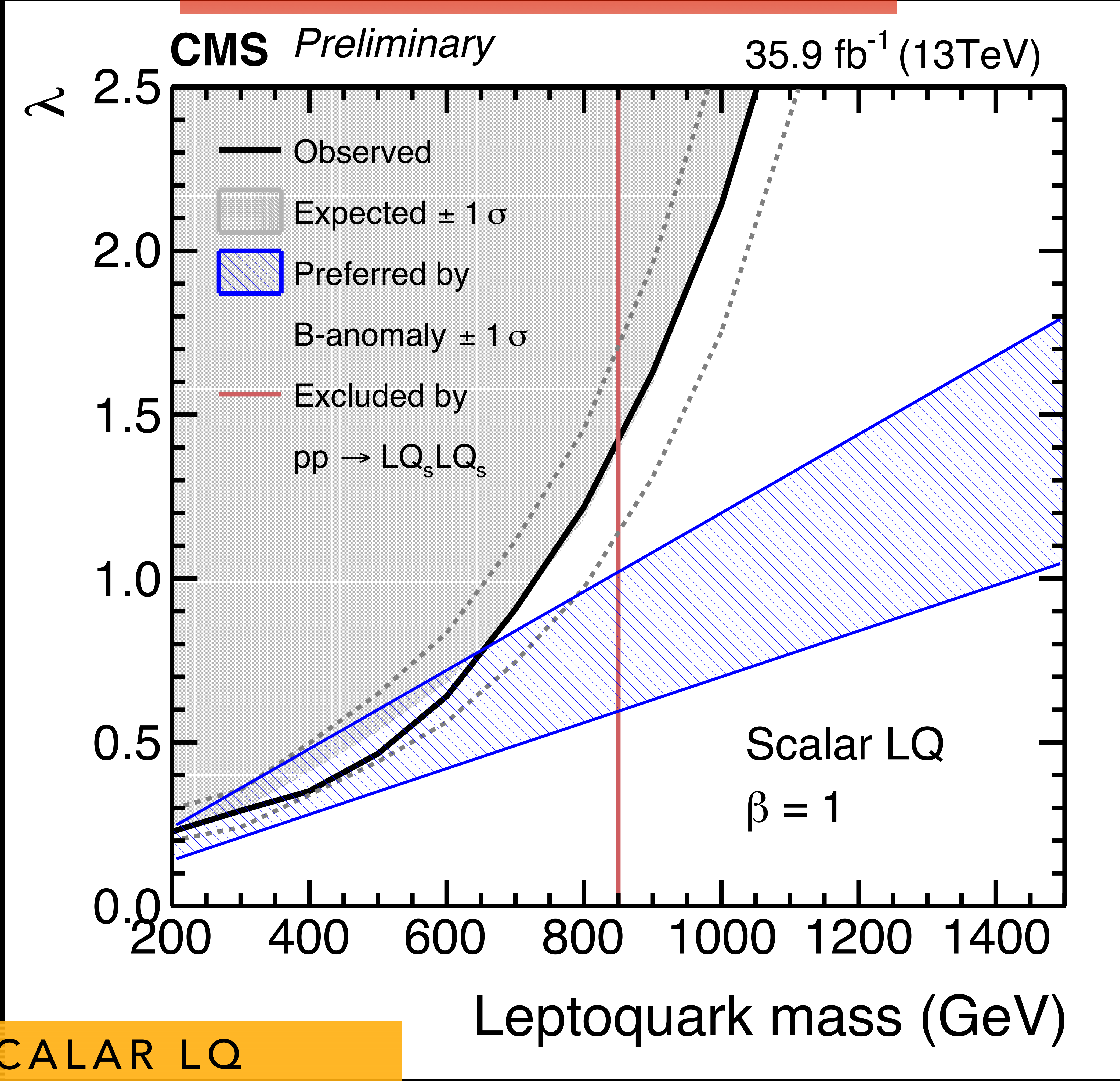
LQ-SINGLE PRODUCTION

CMS-EXO-17-029

- More sensitive than pair production in higher masses
  - λ (Yukawa coupling) plays important role
- Final state: **ττ**b depending on the subsequent decays of **τ**:
  - *Hadronic final state:* $\tau_{had}\tau_{had}b$
  - *Leptonic final state:* $\ell_{had}\tau_{had}b$



LIMIT SCAN THROUGH Λ



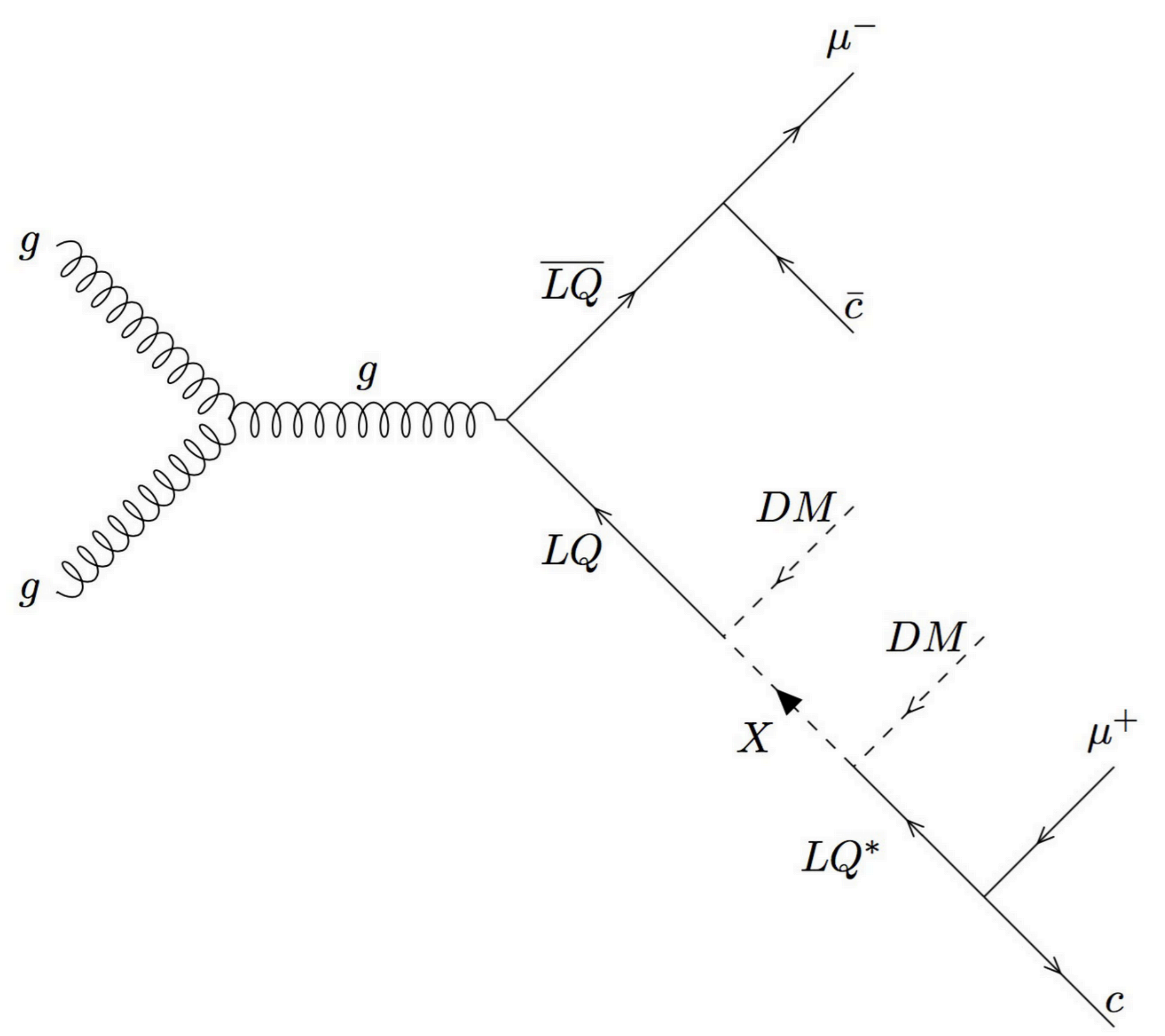
3RD GENERATION SCALAR LQ
EXCLUDED FOR MASSES BELOW 744 GEV
FOR Λ =1

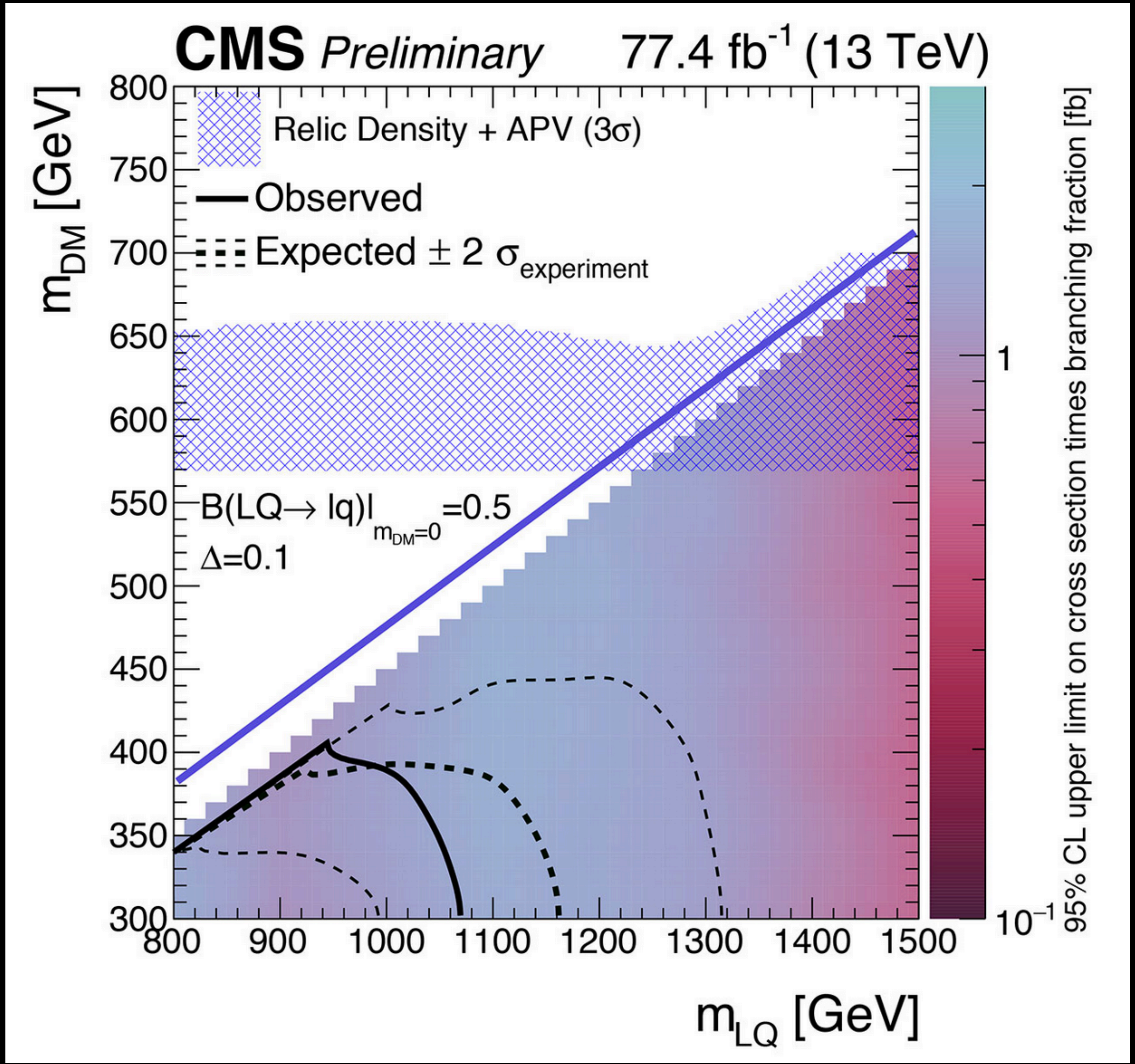
LQ-PAIR PRODUCTION

USING 77.4 FB^{-1} DATA

CMS-EXO-17-015

- Search for both Dark Matter and LQ using a new approach: *(M.Baker et al, JHEP12(2015)120)*
    - DM particle is either annihilated or produced in conjunction with a partner X.
- Searching for a peak in the LQ candidate mass spectrum

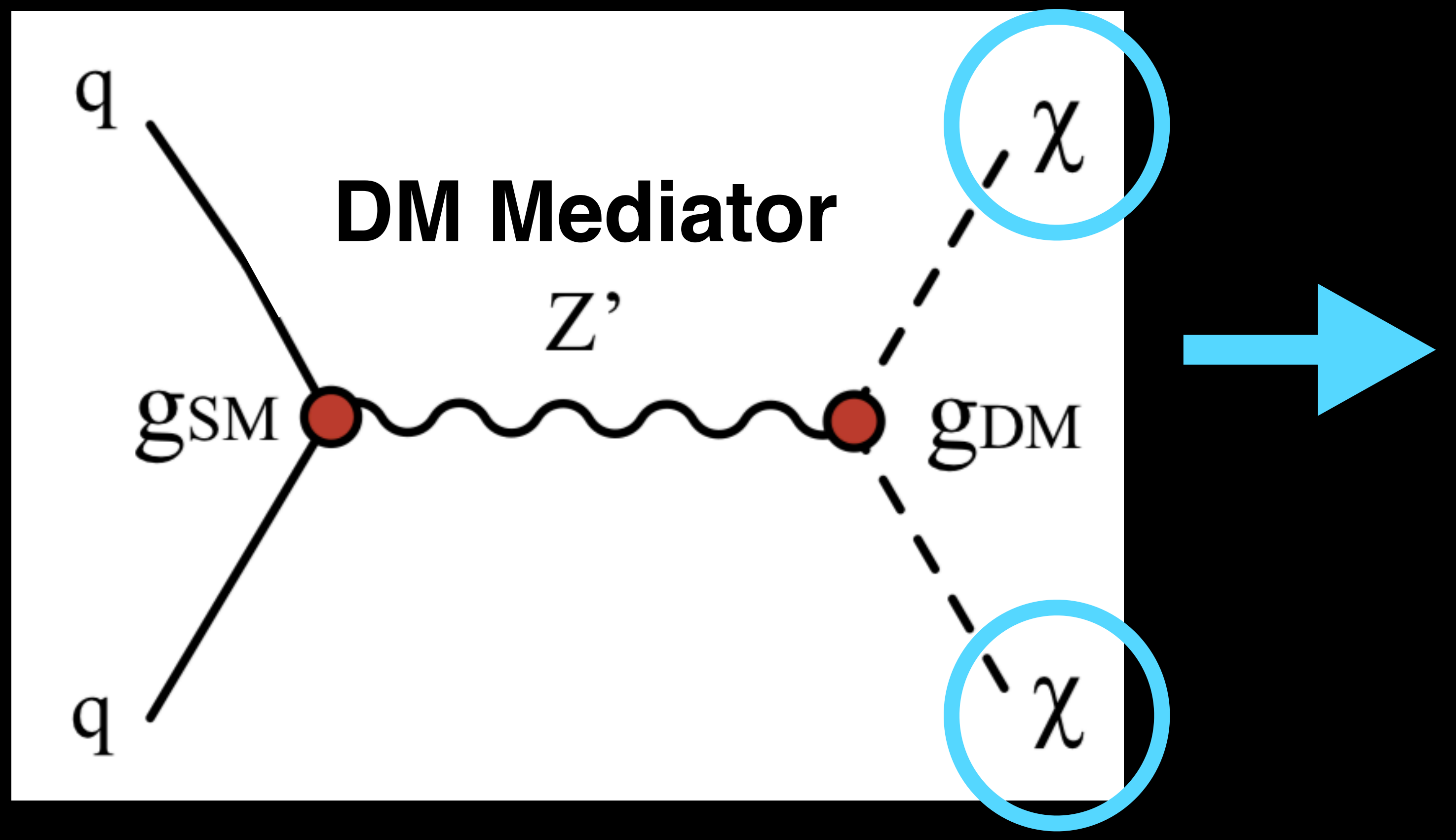




LQ MASS UP TO 1160 GEV EXCLUDED FOR M_{DM} ≈300GEV, AND UP TO 1000GEV FOR M_{DM}≈425GEV

DARK MATTER

DARK MATTER SEARCHES IN COLLIDERS



YOU HAVE NOTHING TO SEE

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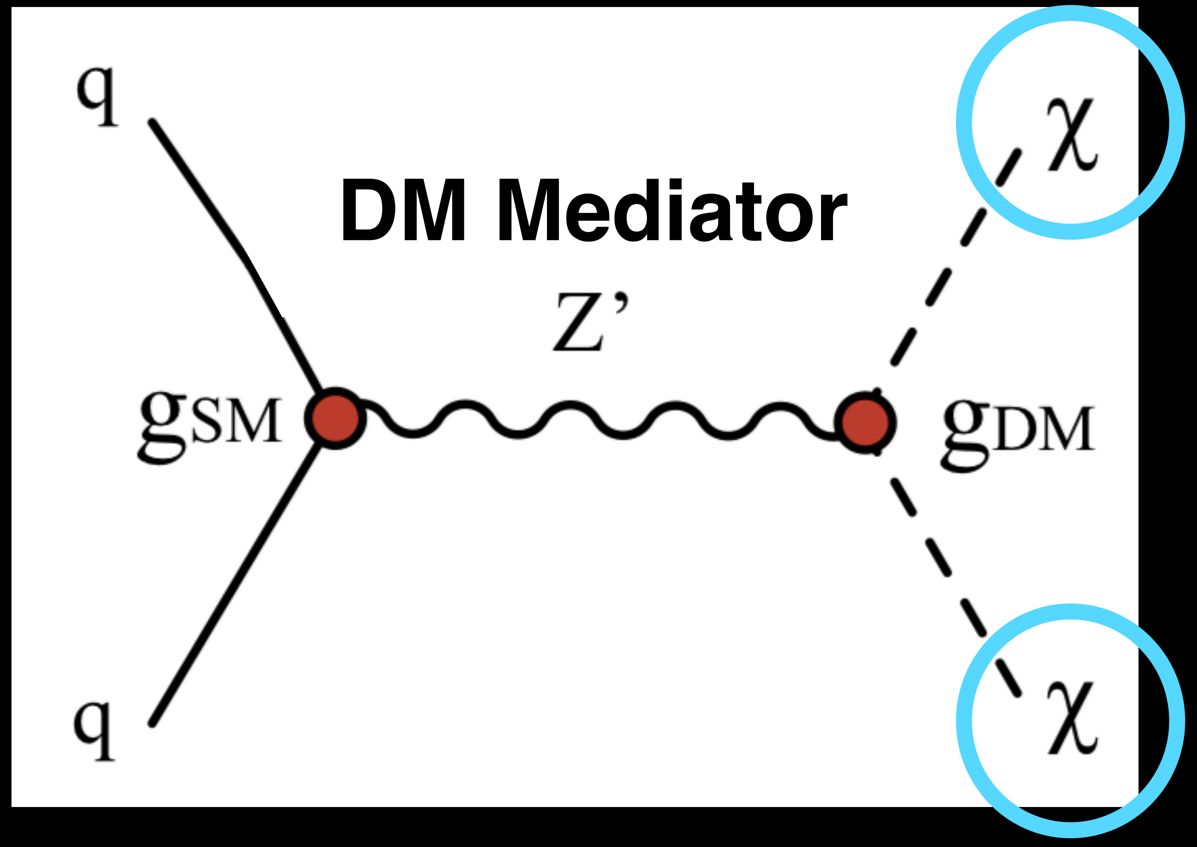

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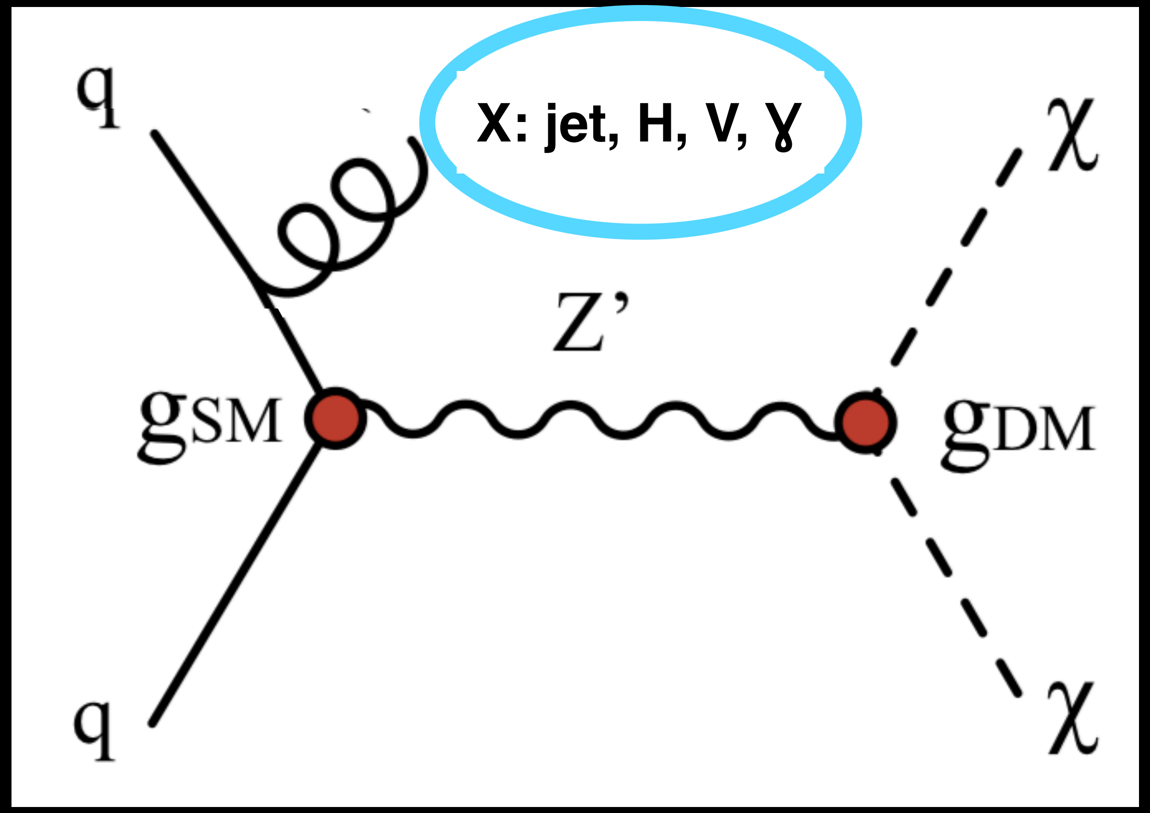
…but if DM candidate recoil against other particles…



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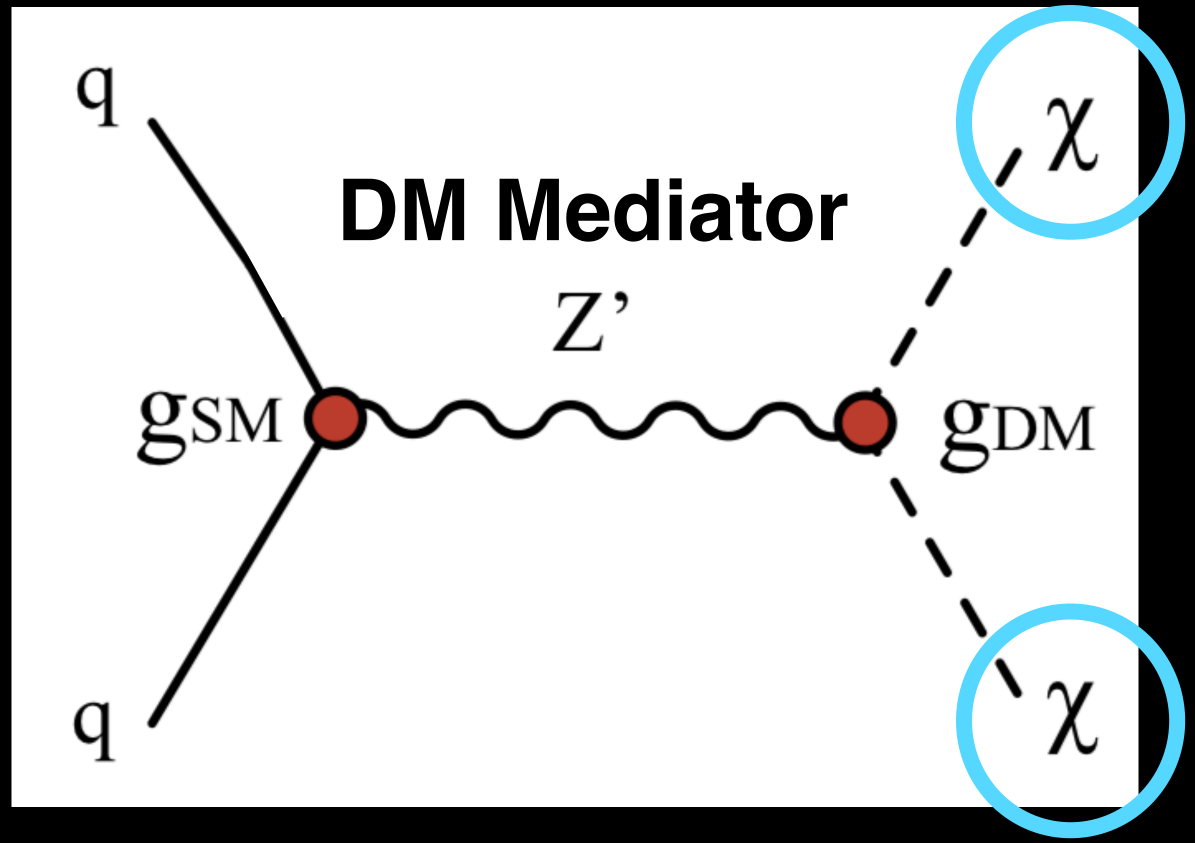

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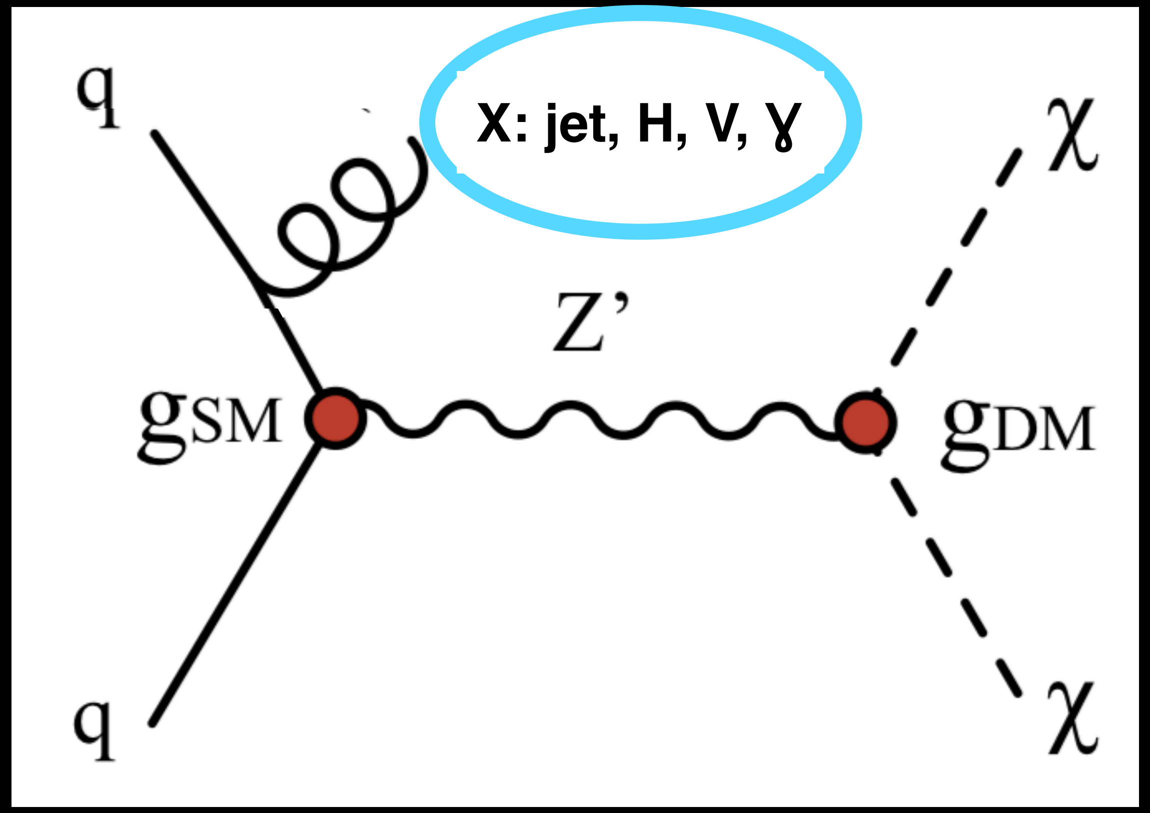
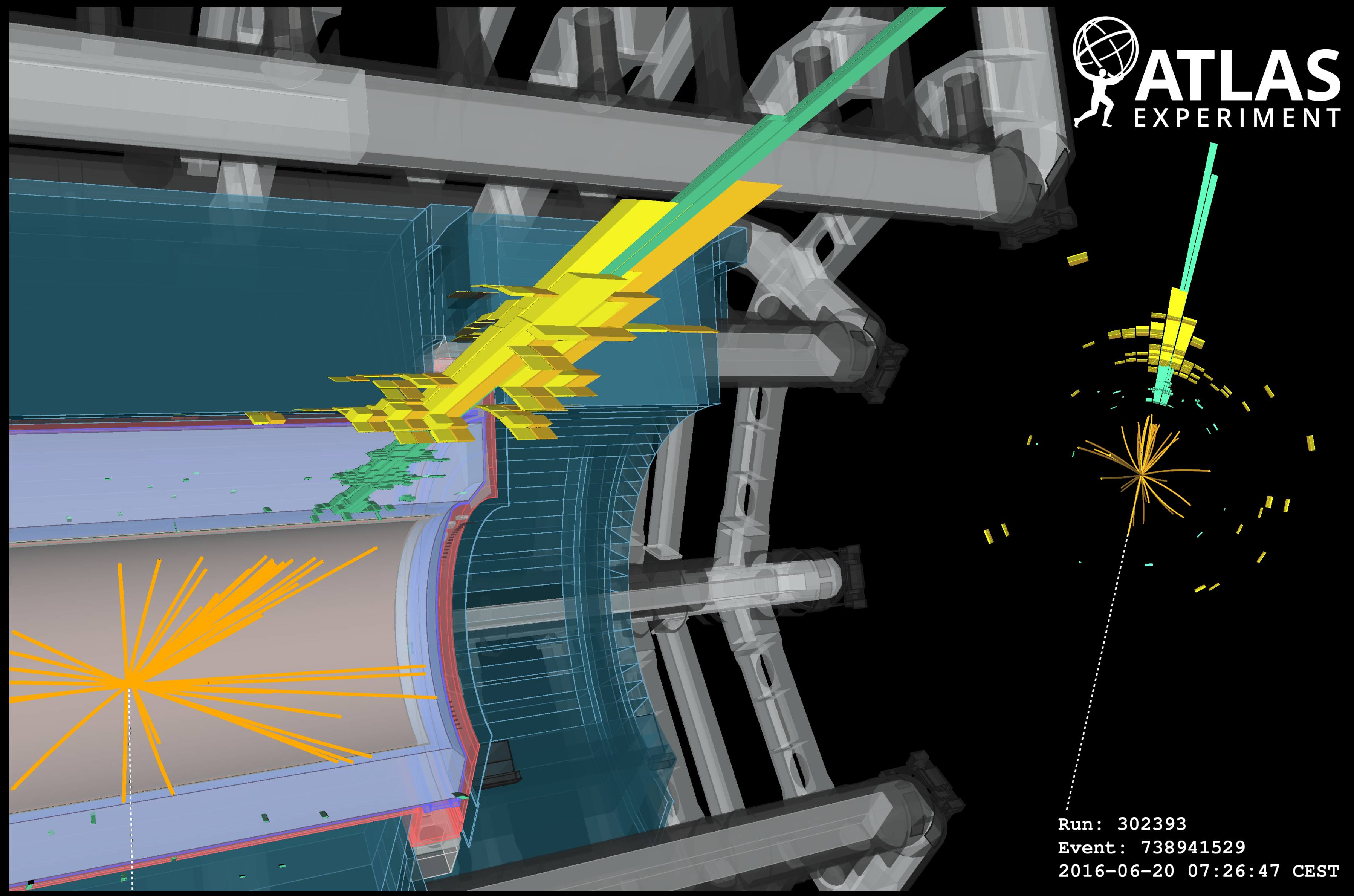
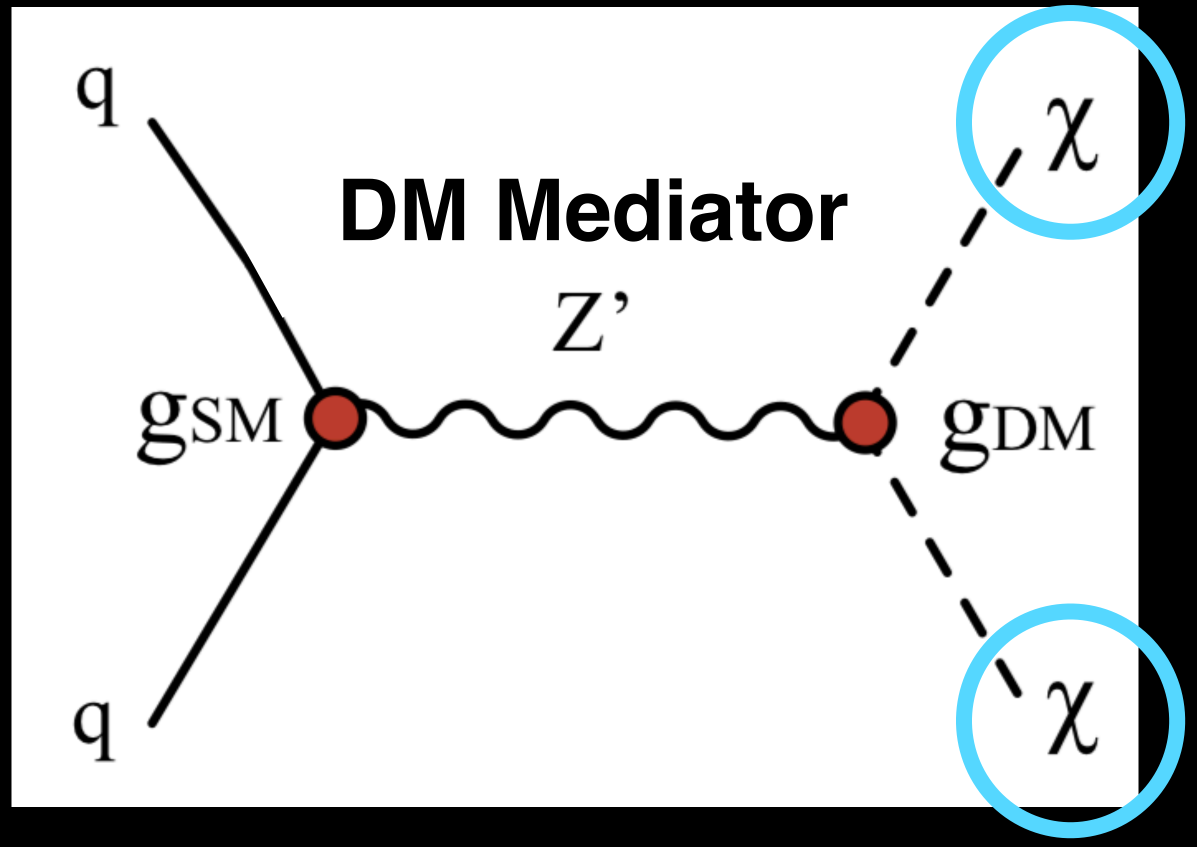




MONO-X SEARCHES

DARK MATTER SEARCHES IN COLLIDERS



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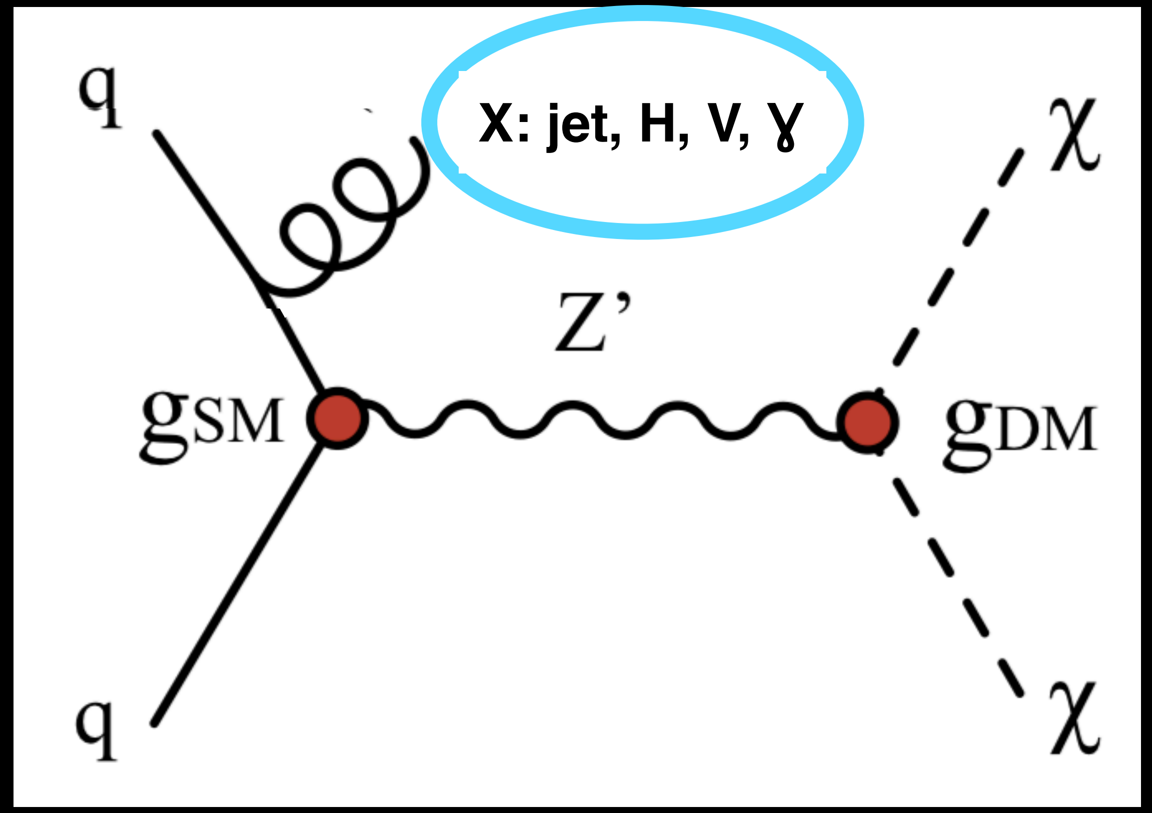
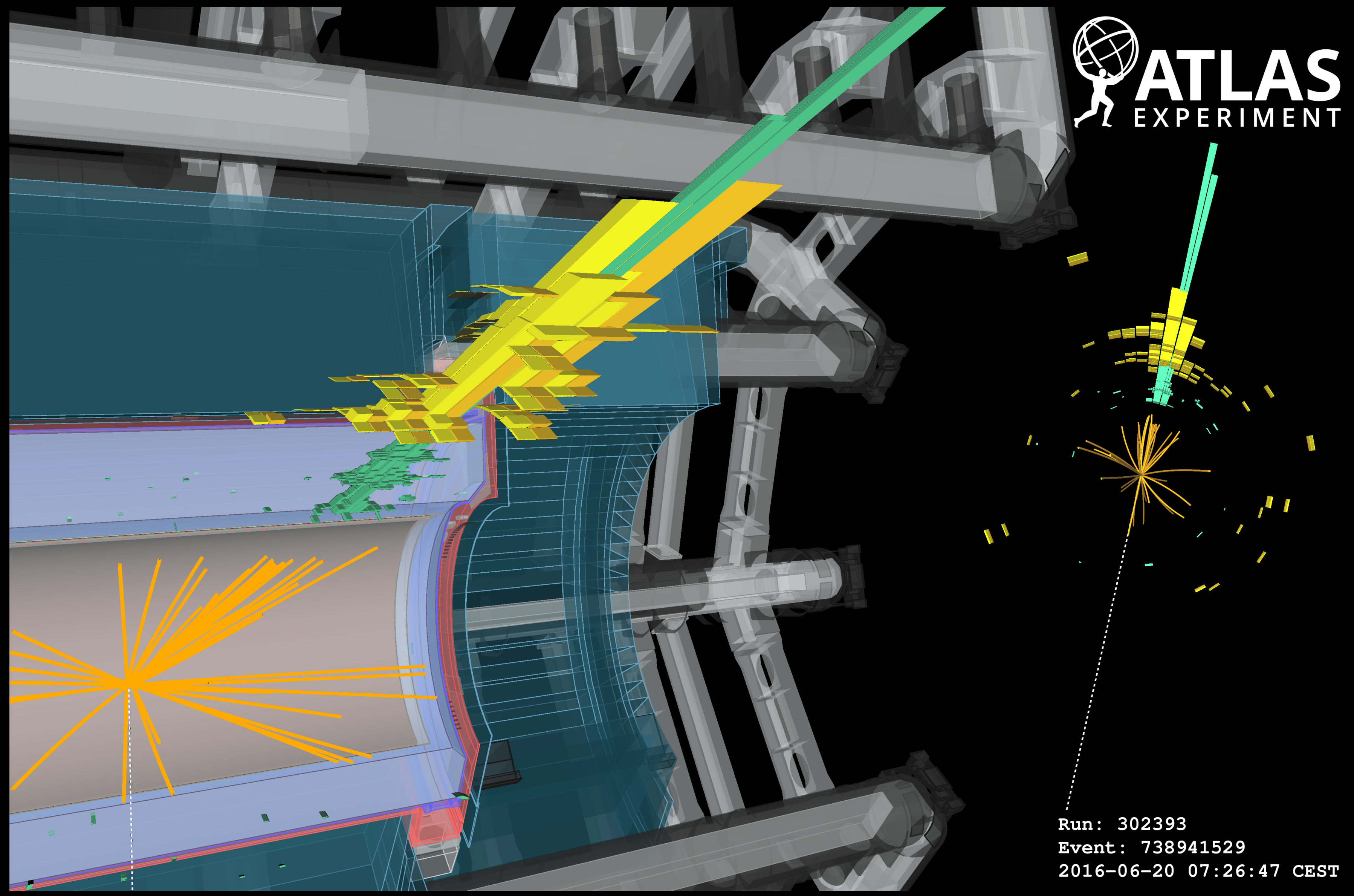
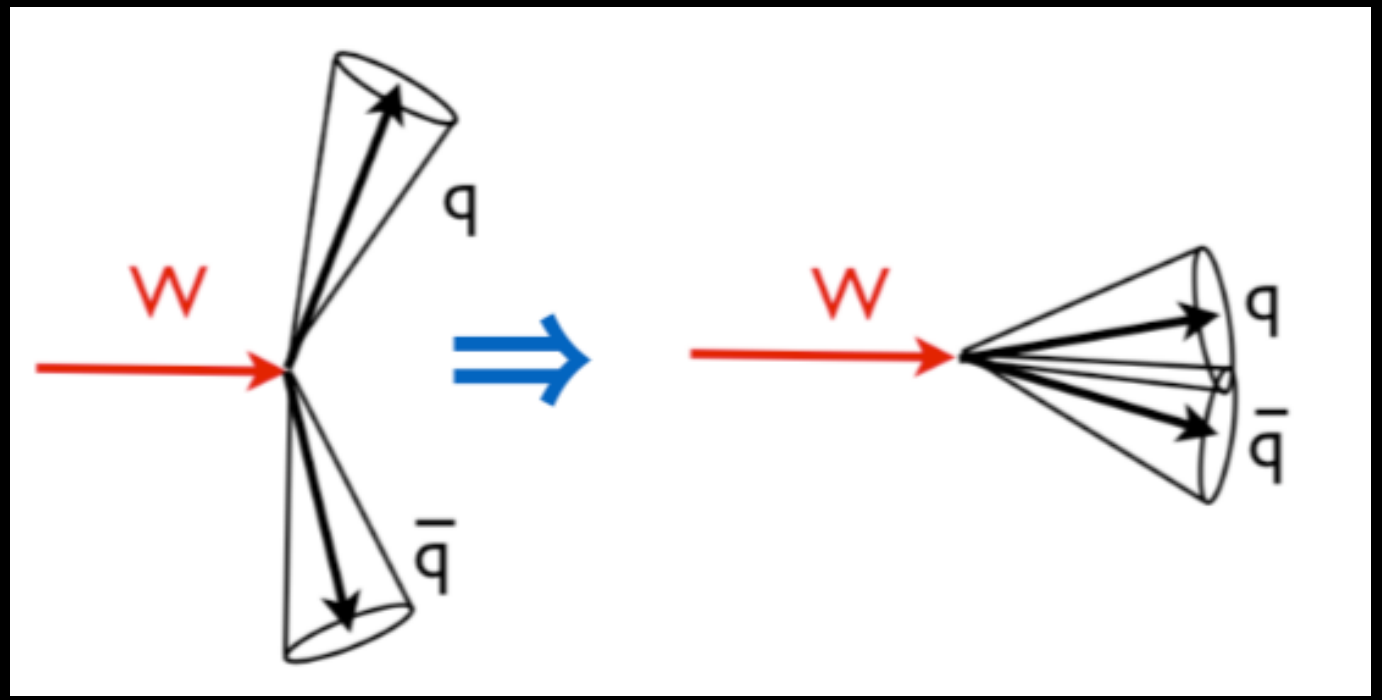




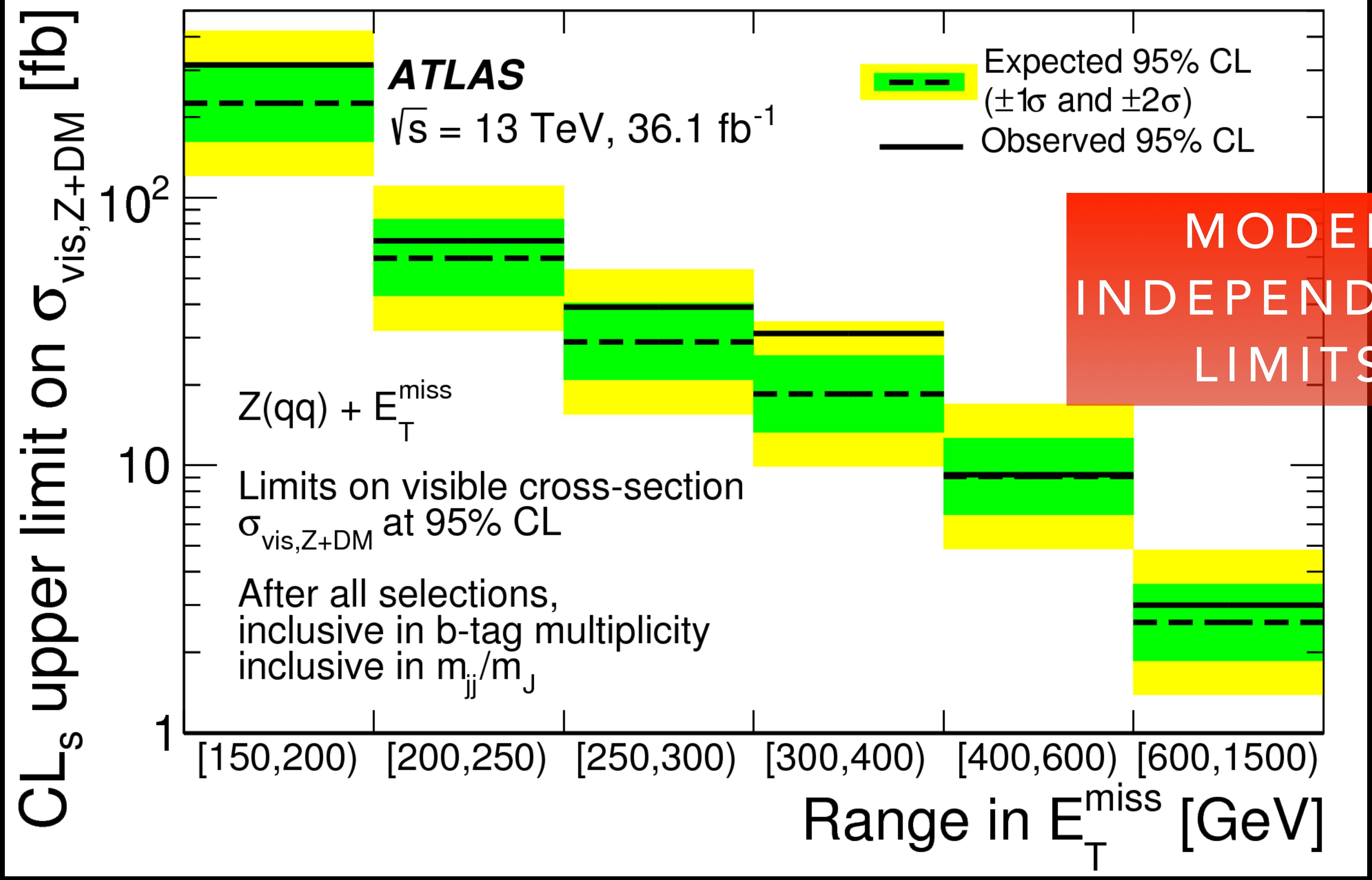
MONO-X SEARCHES

MONO-V SEARCHES

SUBMITTED TO JHEP: ARXIV1807.11471

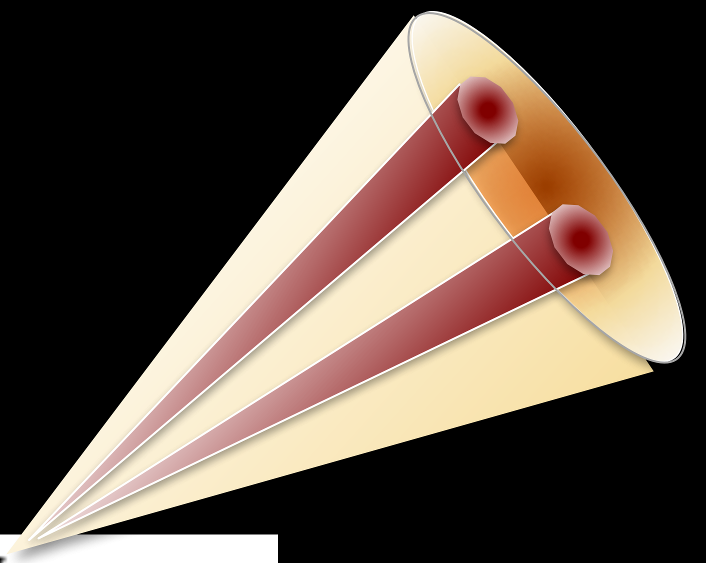


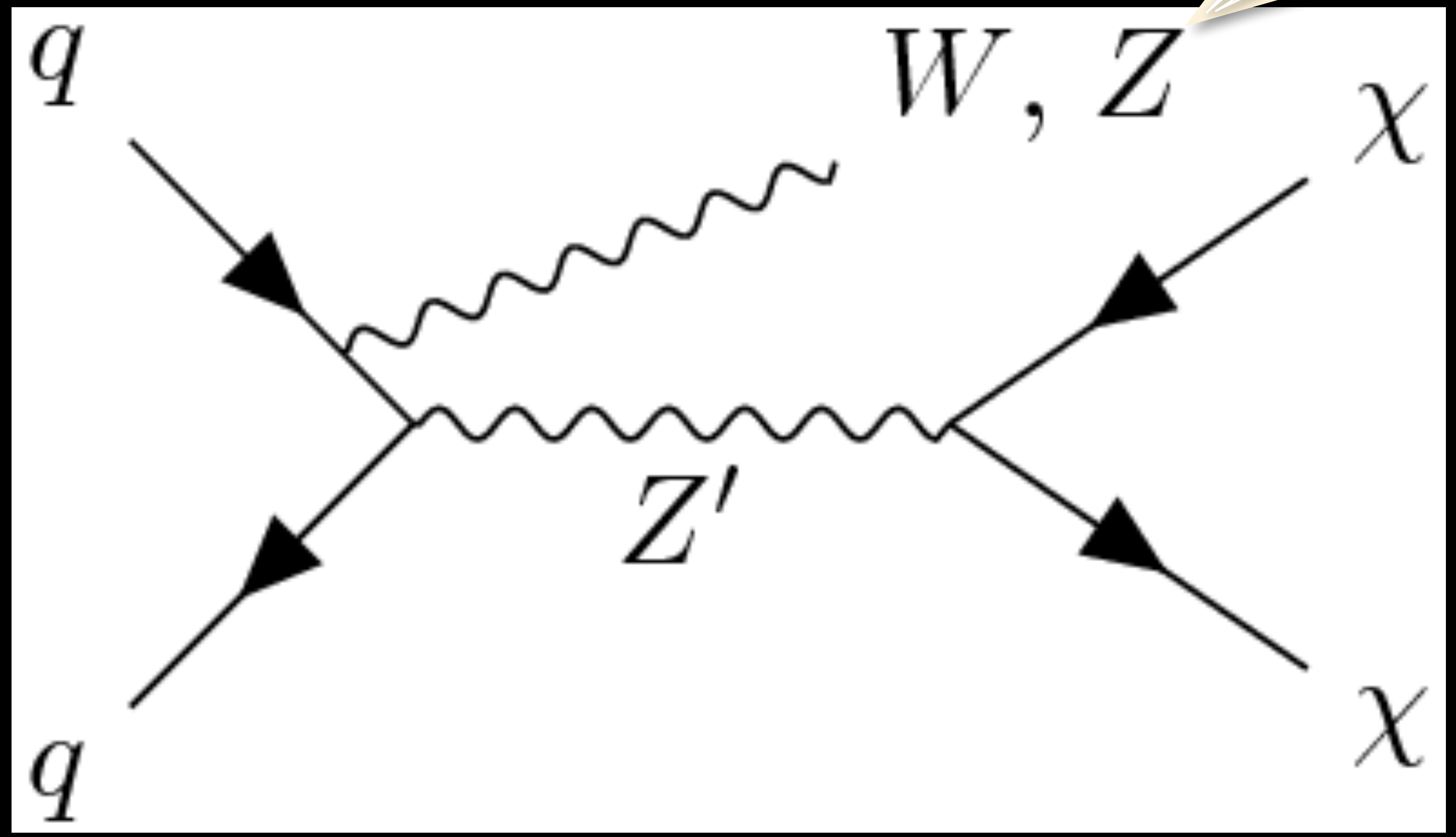
- Hadronic decays of W(qq) and Z(qq)
- High p_T ⇒ collimated decay products ⇒ larger radius jet cone
- Boson tagging using boosted topologies and jet substructure techniques



MODEL INDEPENDENT LIMITS

BACKGROUND REJECTION WITH BOSON TAGGING



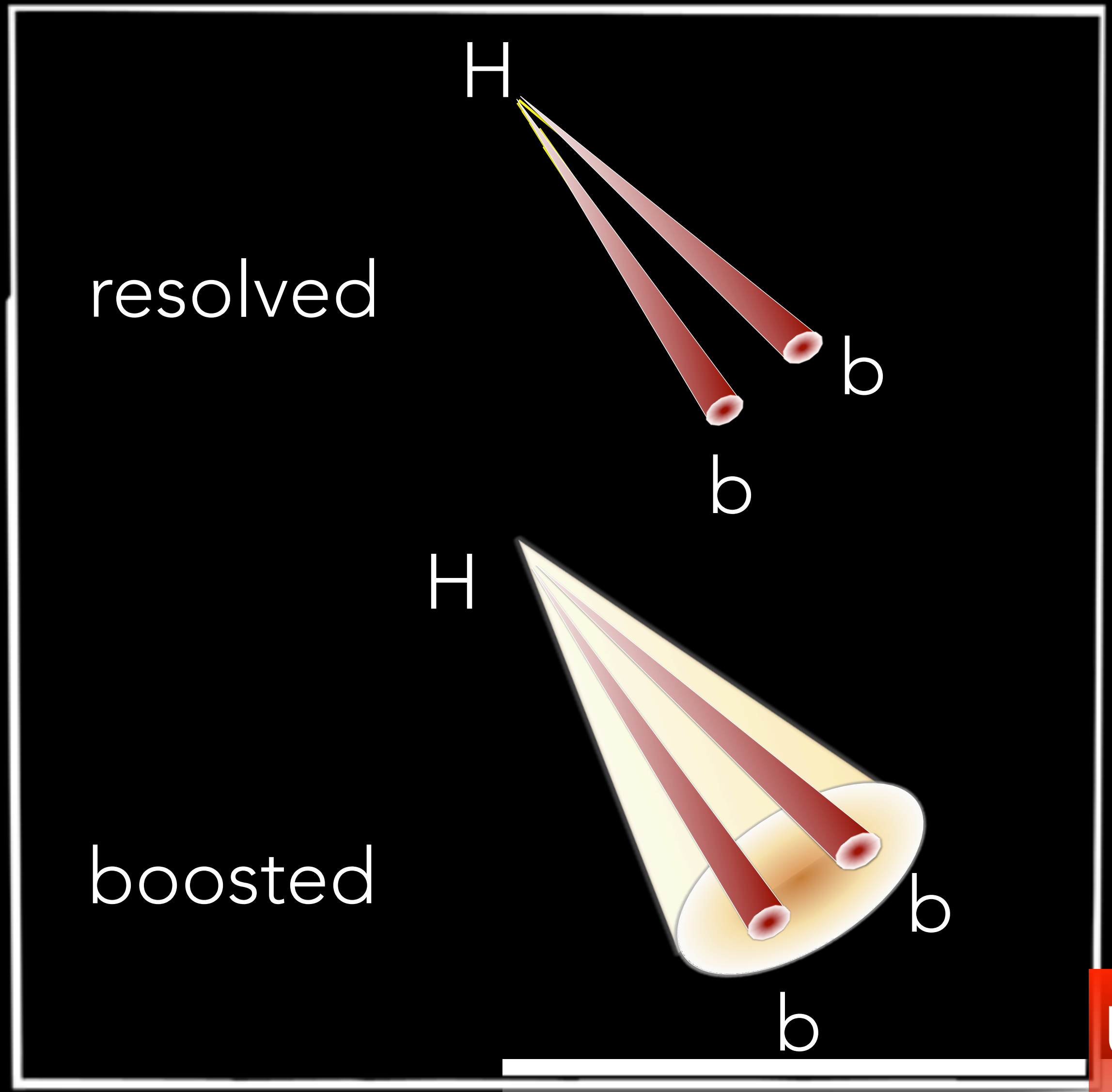


GENERIC UPPER LIMITS PROVIDING INPUTS TO THE **THEORISTS**

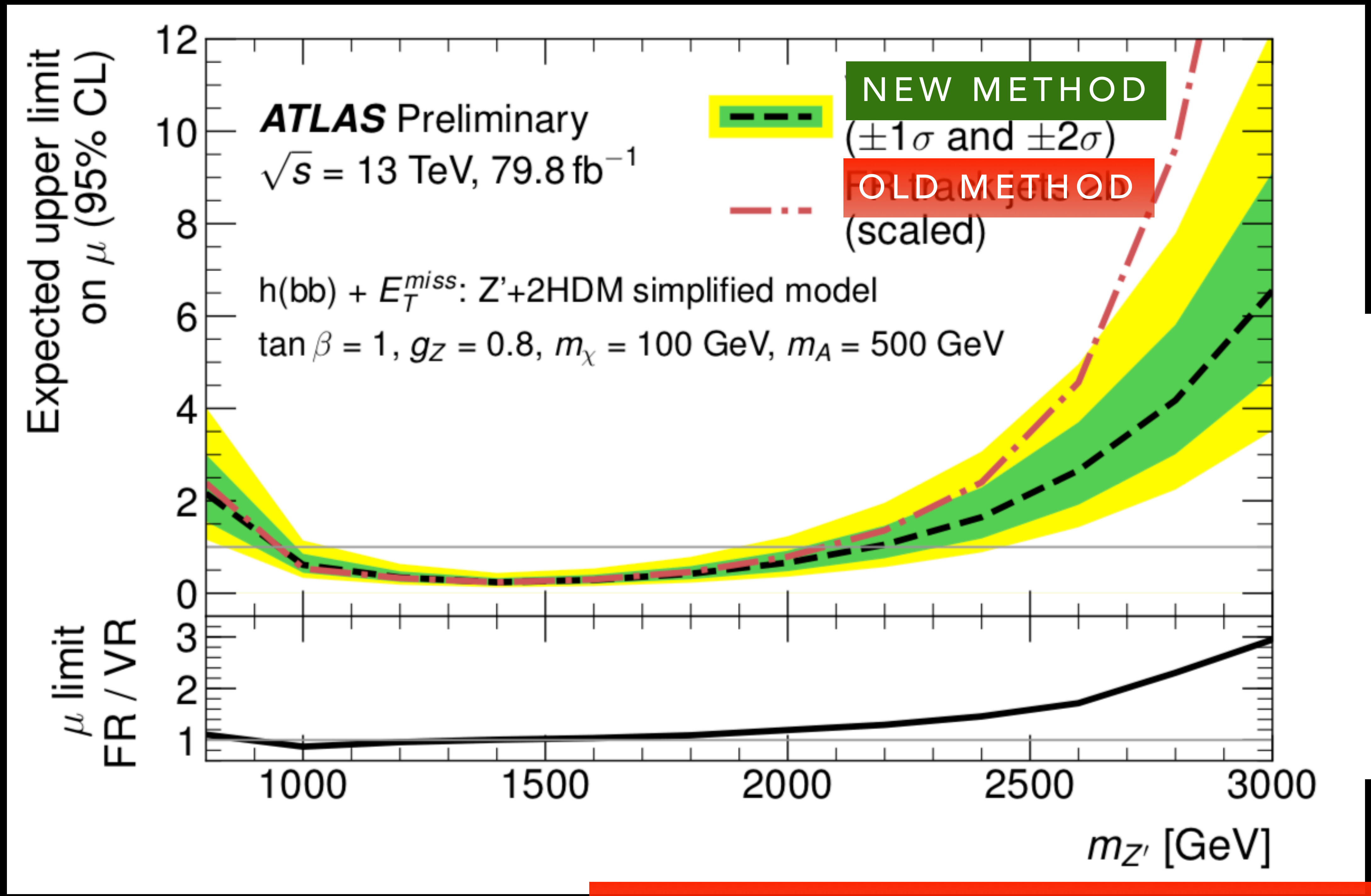
[ATLAS-CONF-2018-039]

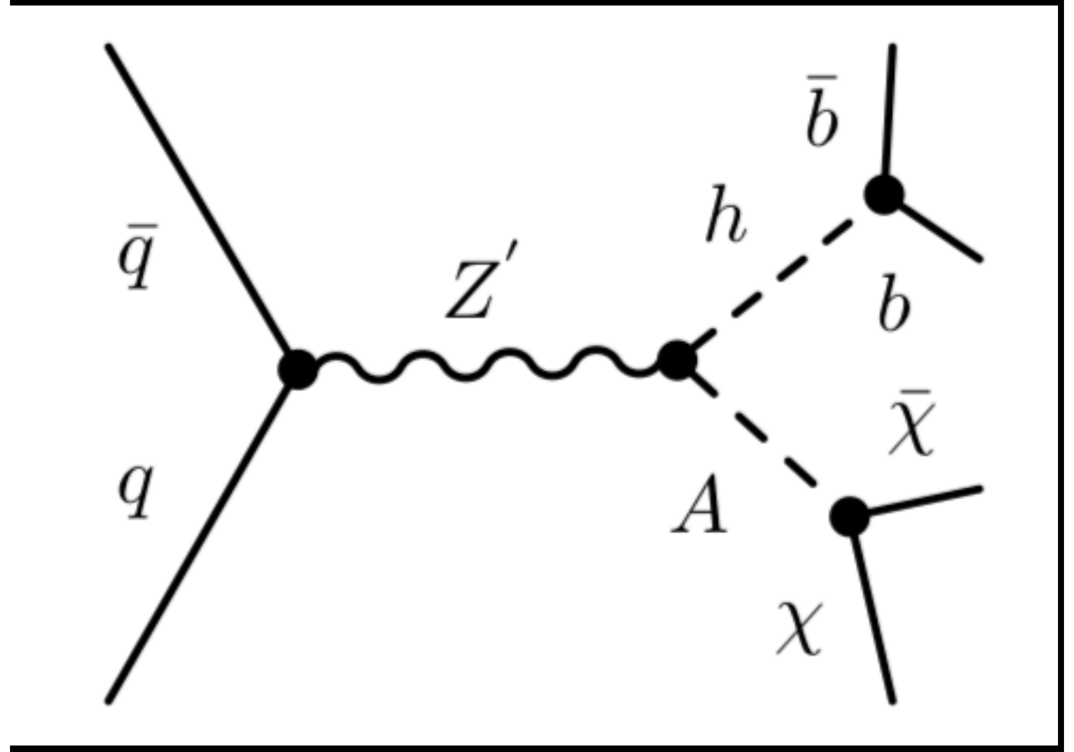
MONO-H SEARCHES

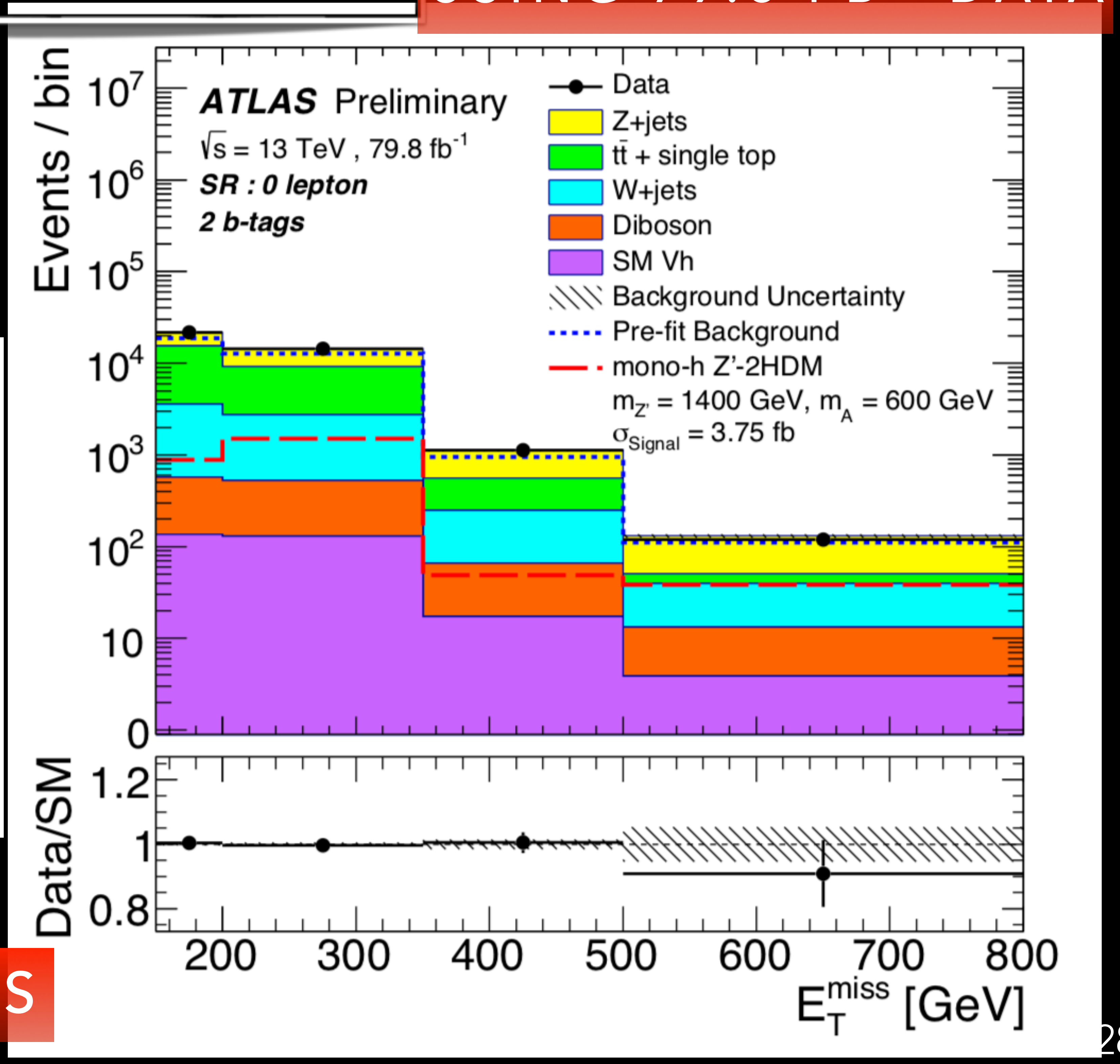
- DM production in association with a Higgs boson
- **H(bb):** High branching fraction to bb pair
- **New jet reconstruction method** depending on the p_T of the small jets



USING 79.8 FB^{-1} DATA







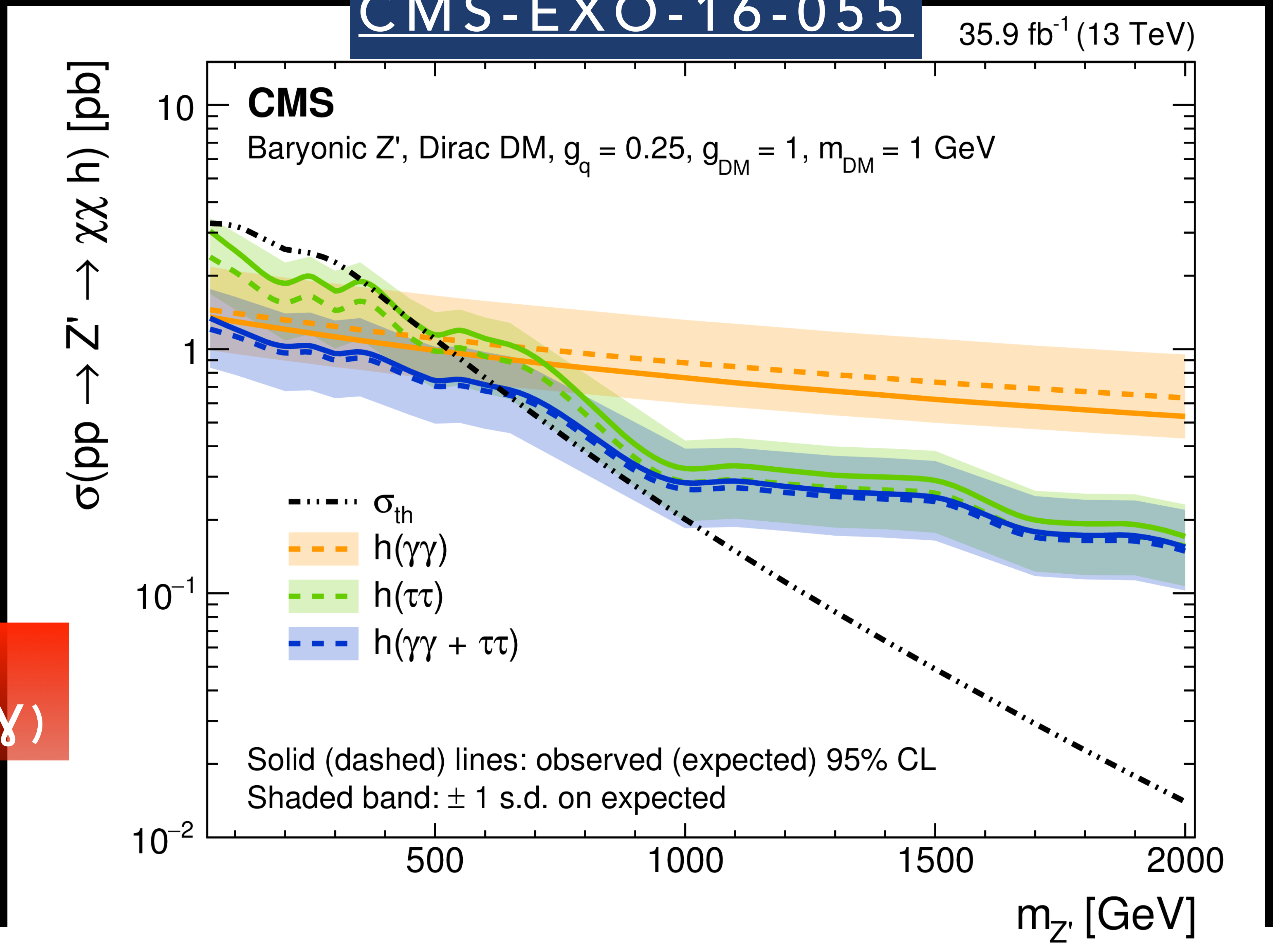
IMPROVEMENT WITH THE NEW TECHNIQUES

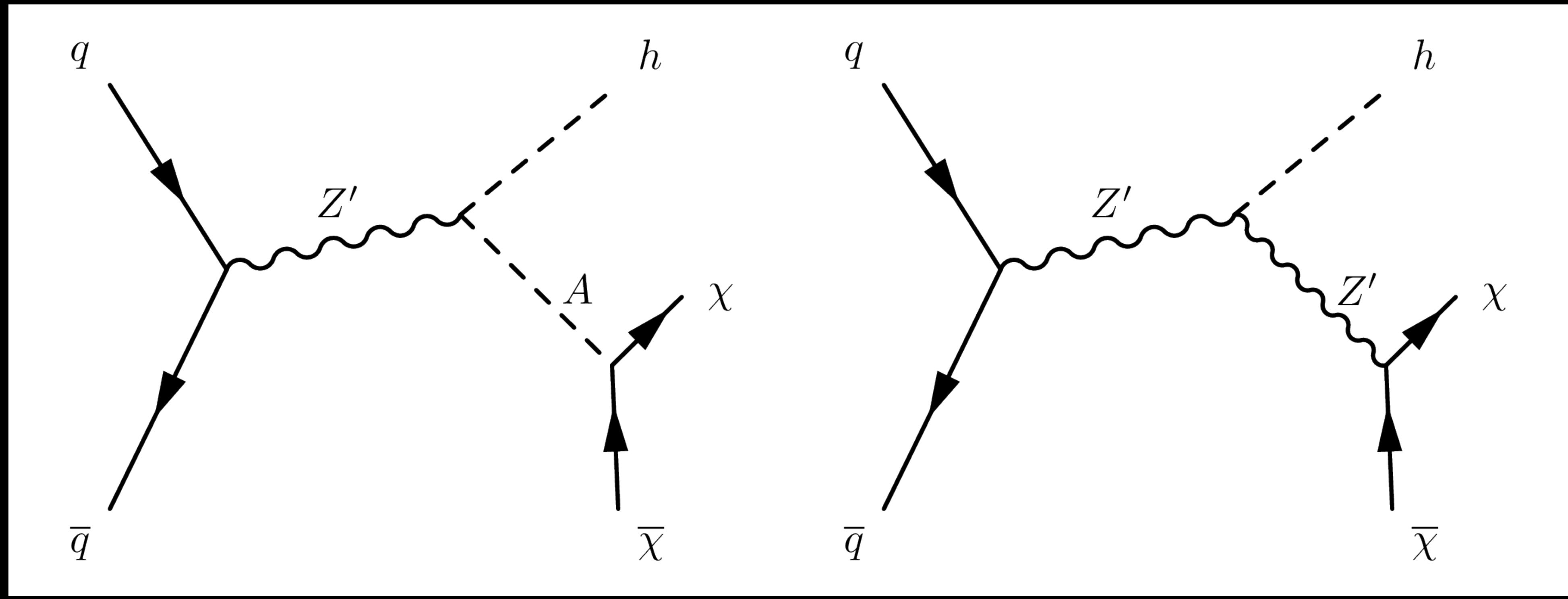
MONO-H SEARCHES

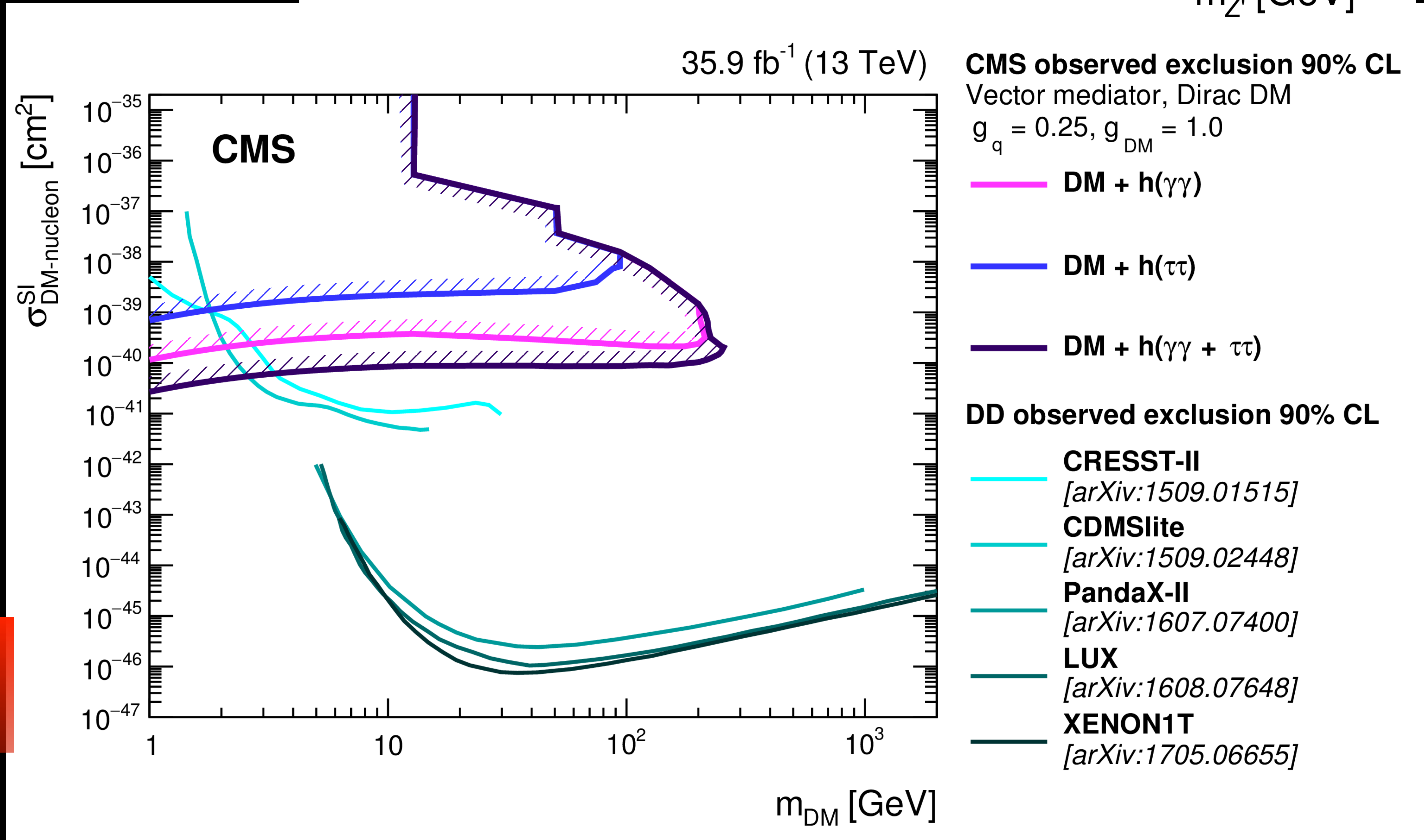
- DM production in association with a Higgs boson
  - **H(γγ):** higher precision in reconstructed invariant mass reconstruction than H(bb)
  - **H(ττ):** smaller SM background than H(bb)

COMBINED LIMITS FOR H(ττ) AND H(γγ)

CMS-EXO-16-055



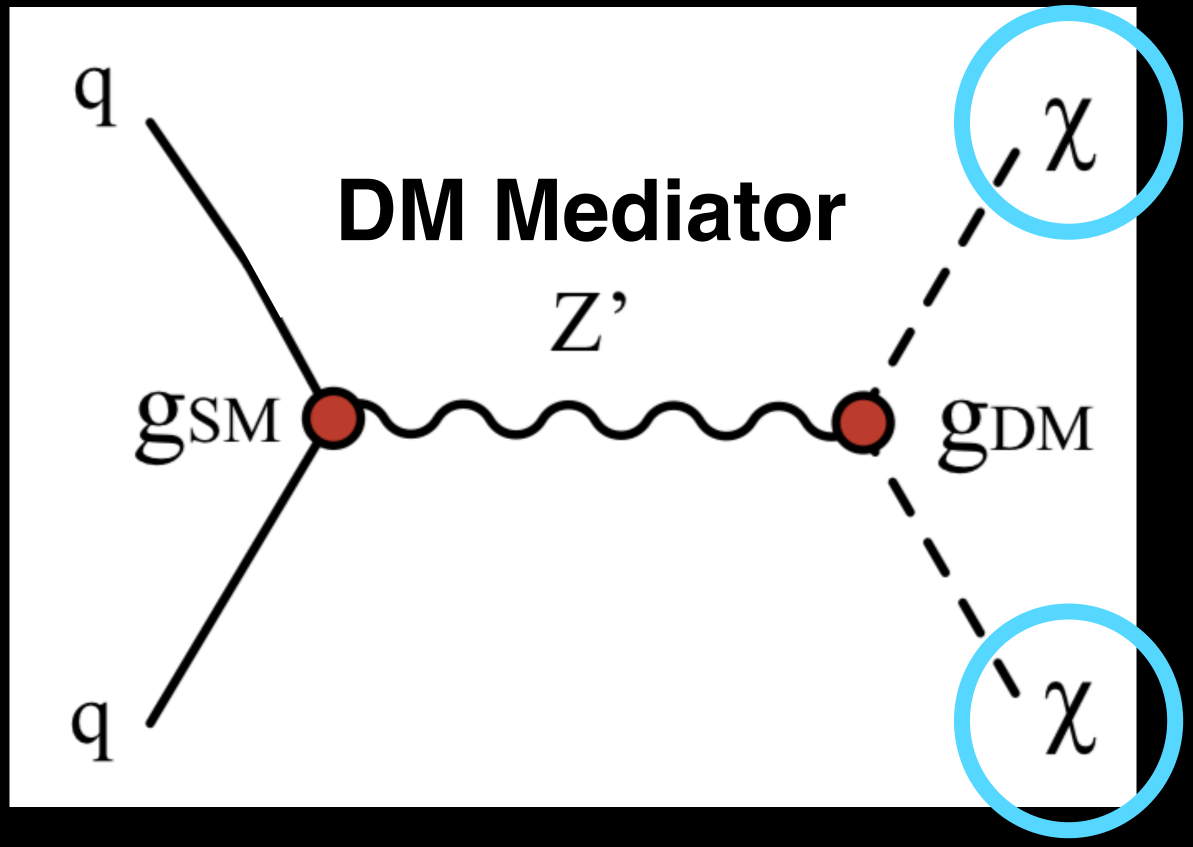




FIRST SEARCH IN ASSOCIATION WITH H → $\tau^+\tau^-$
FIRST COMBINATION OF THE γγ AND THE $\tau^+\tau^-$

COMBINATION WITH THE DIRECT DETECTION RESULTS FROM OTHER EXPERIMENTS

DARK MATTER SEARCHES IN COLLIDERS



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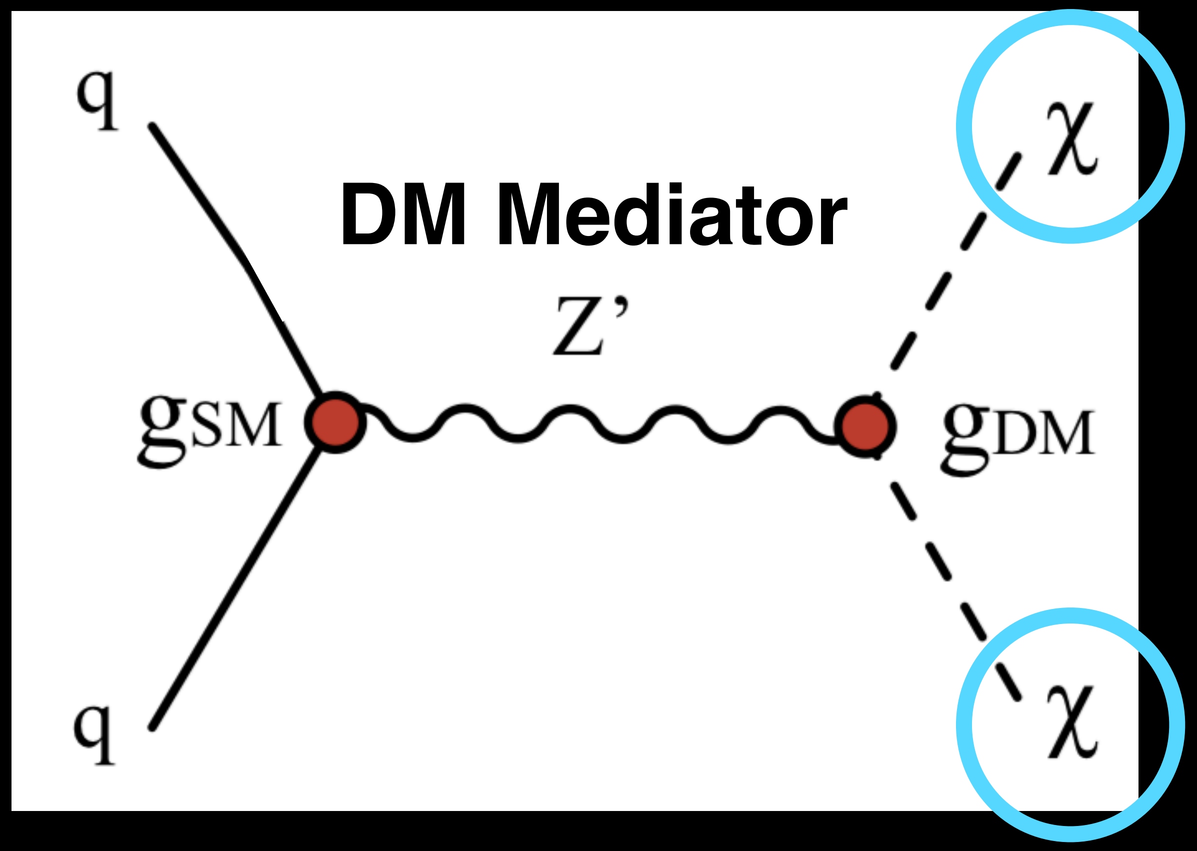

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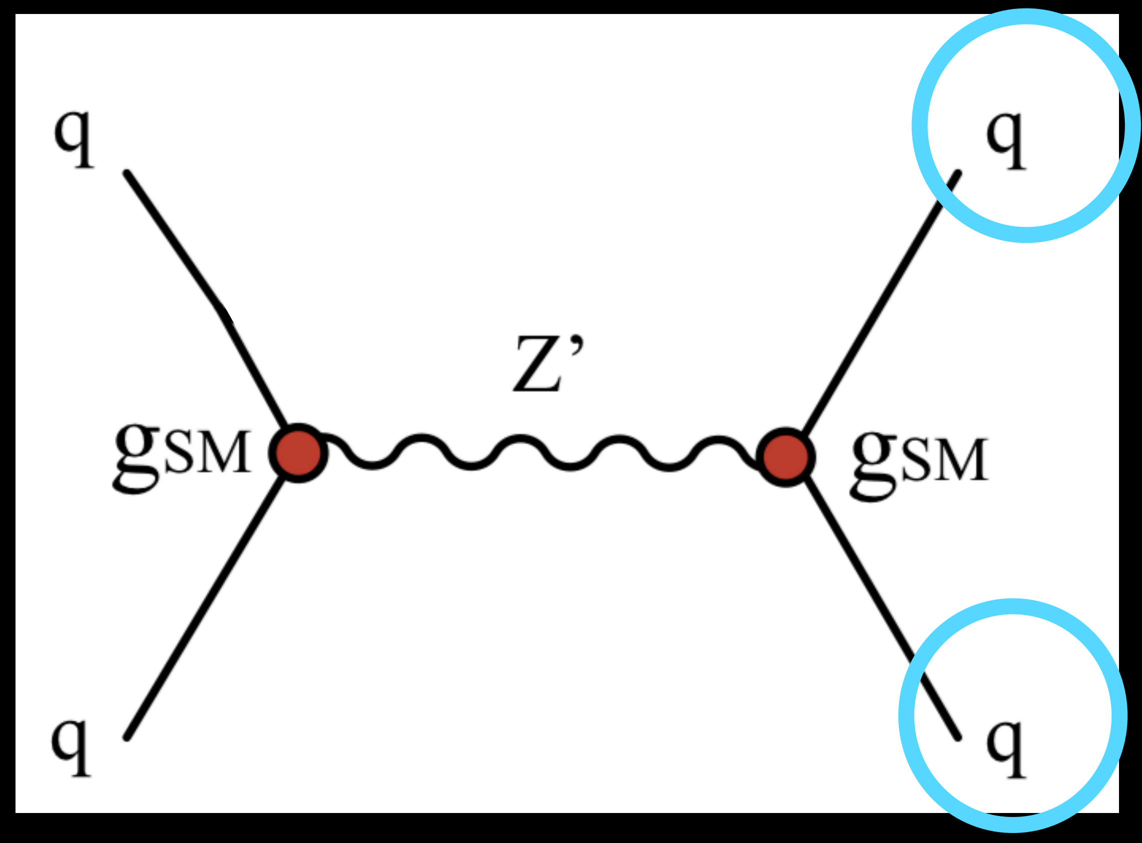
…but when DM mediator couples to SM particles…



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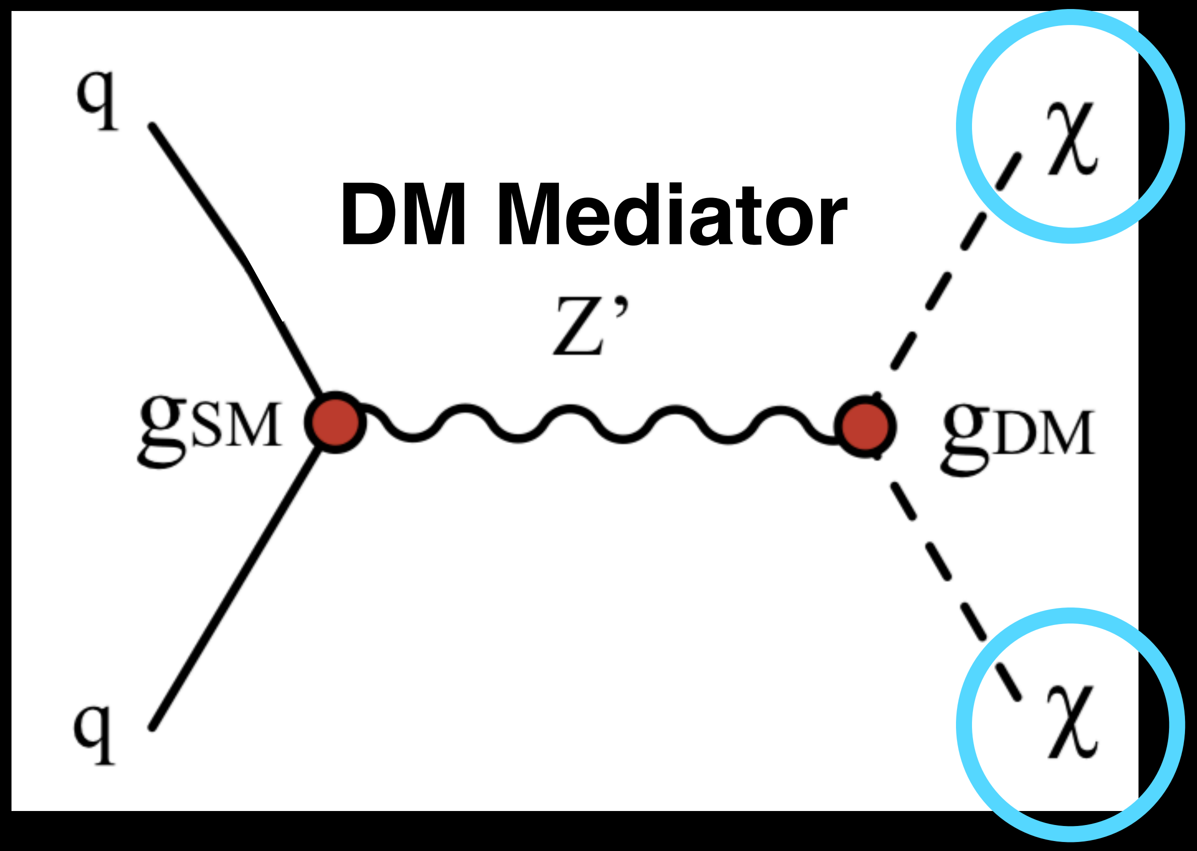

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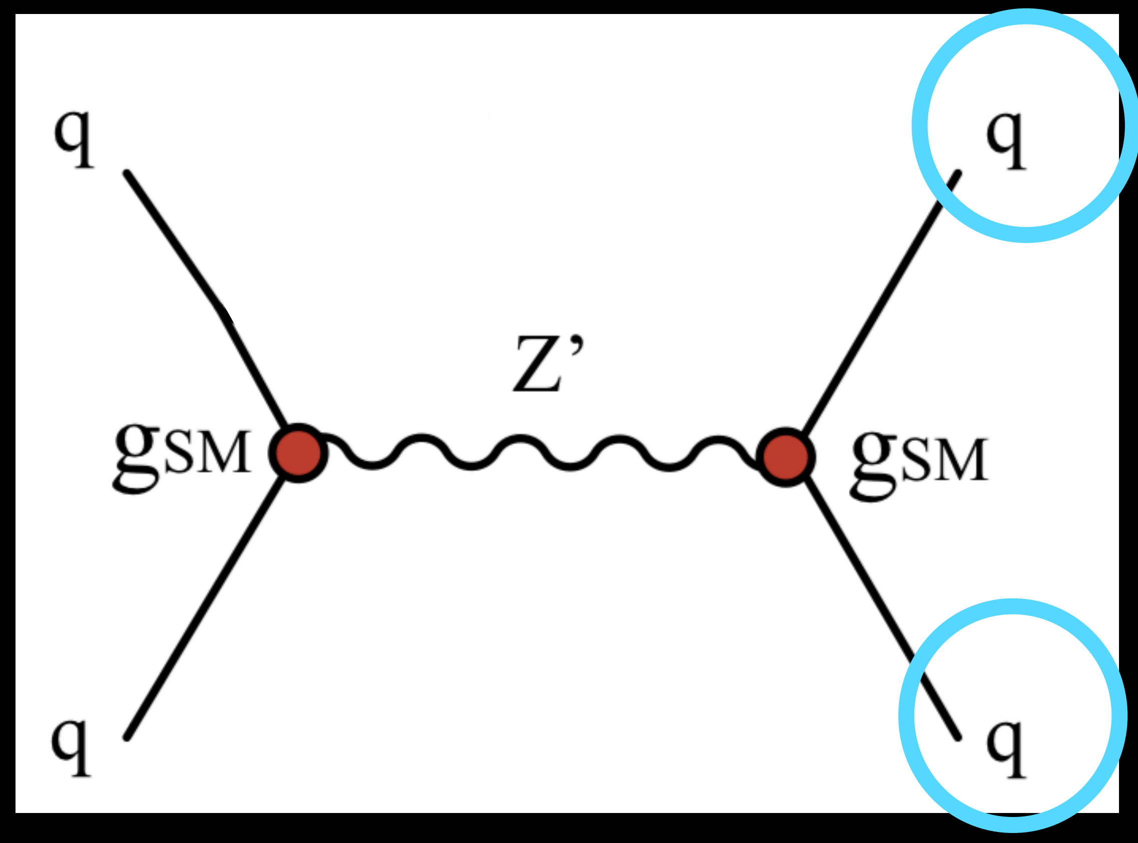
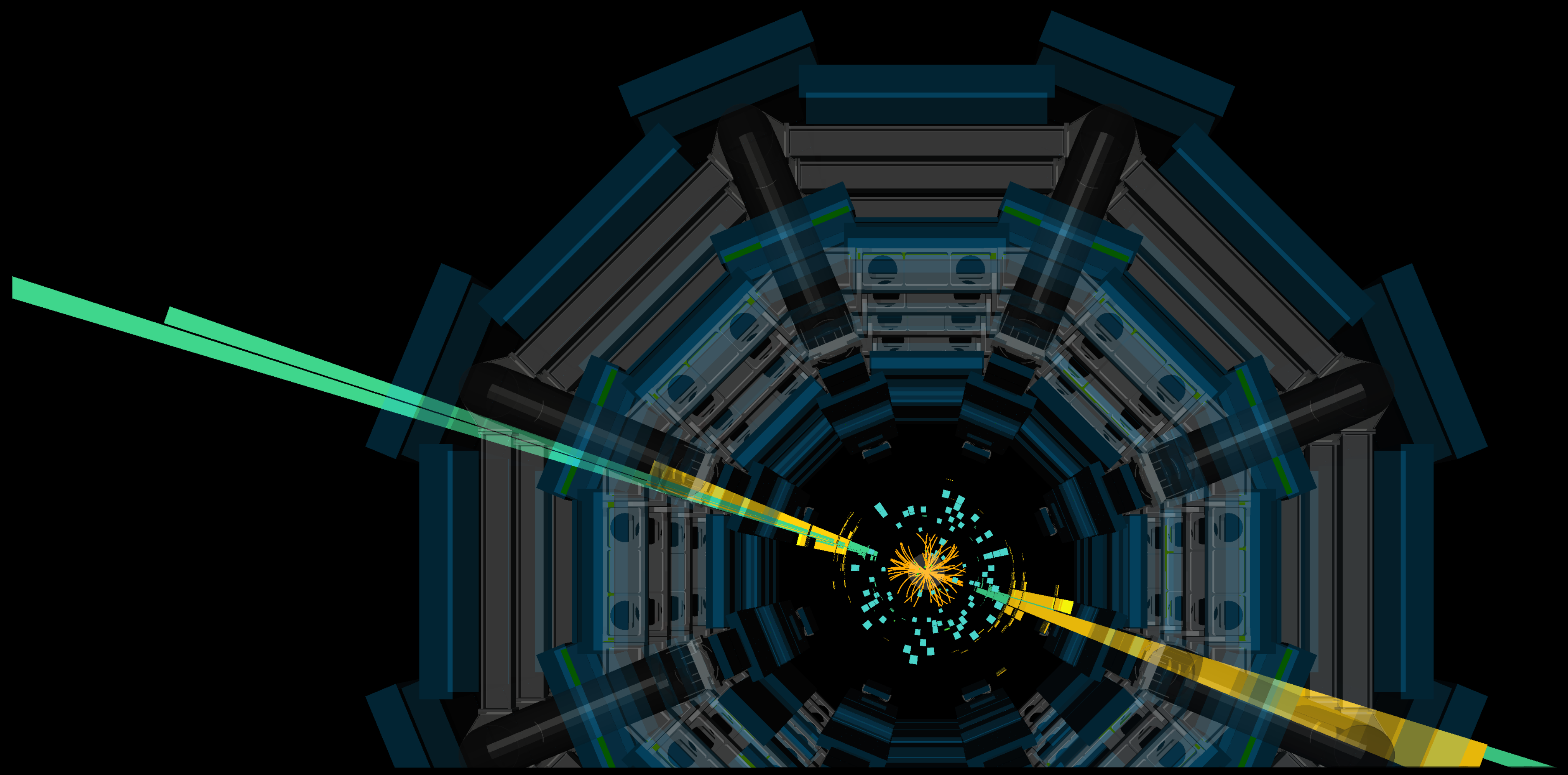
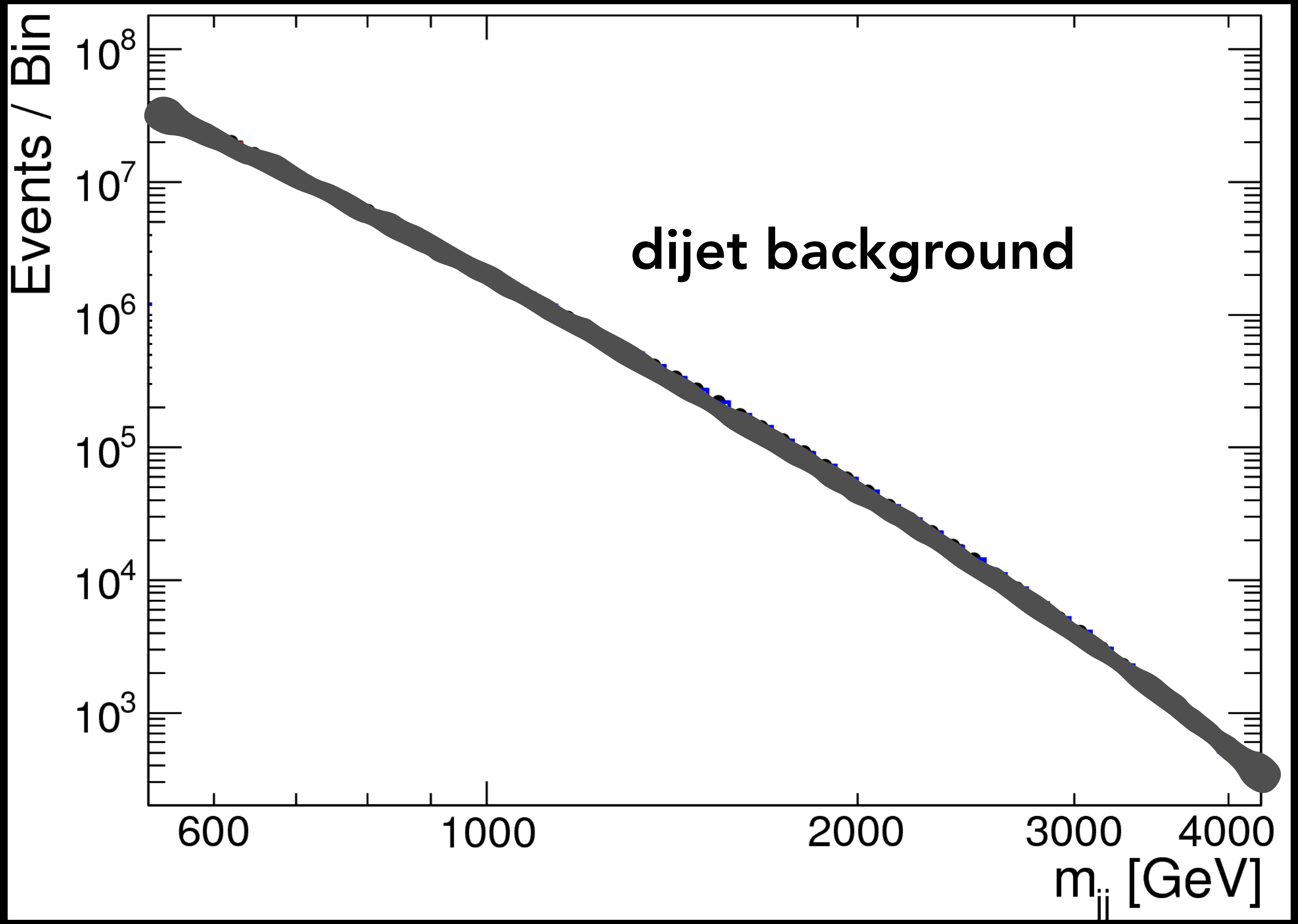


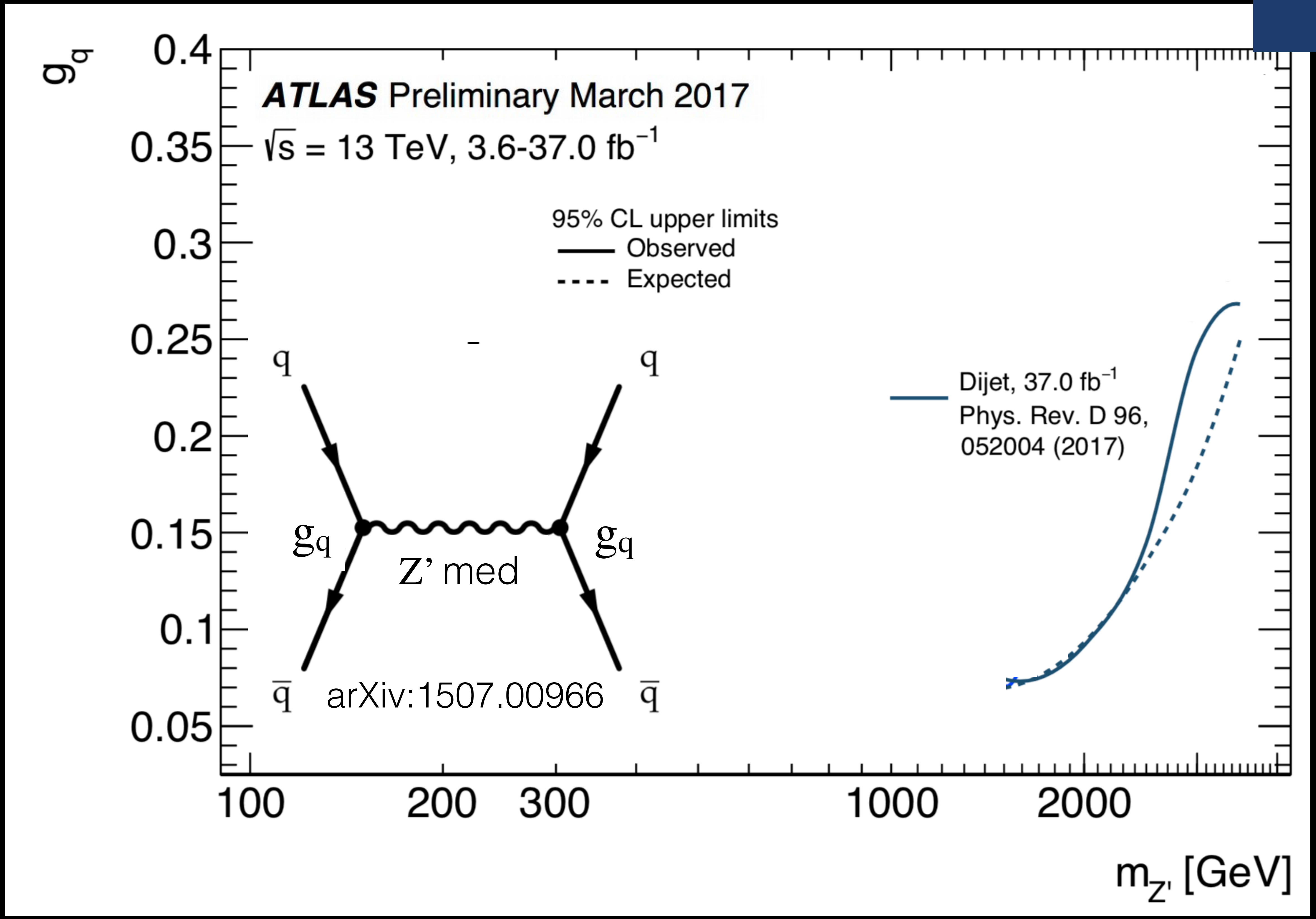
DIJET RESONANCE SEARCHES



DIJET RESONANCE SEARCHES

Leptophobic axial-vector Z′ model

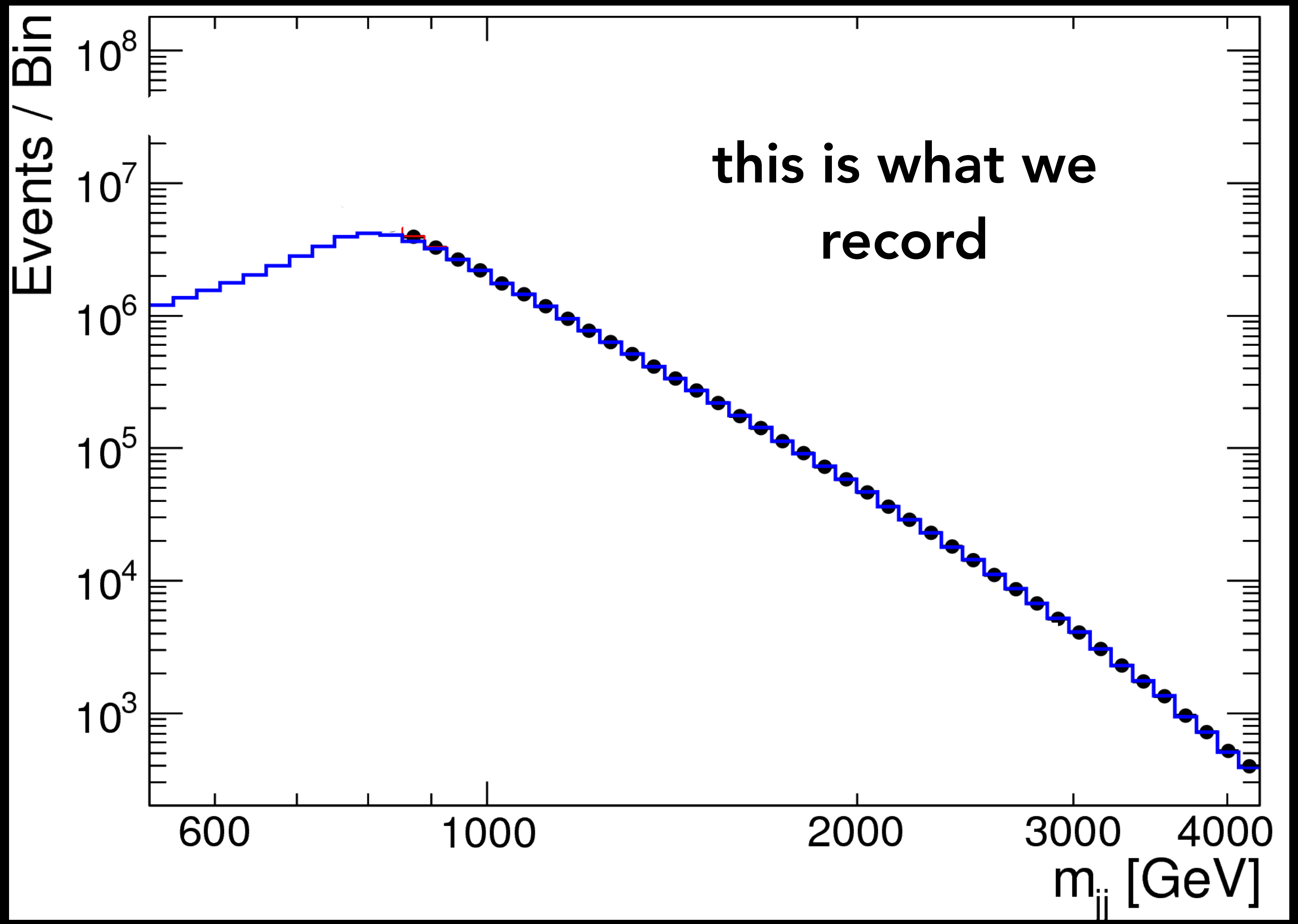


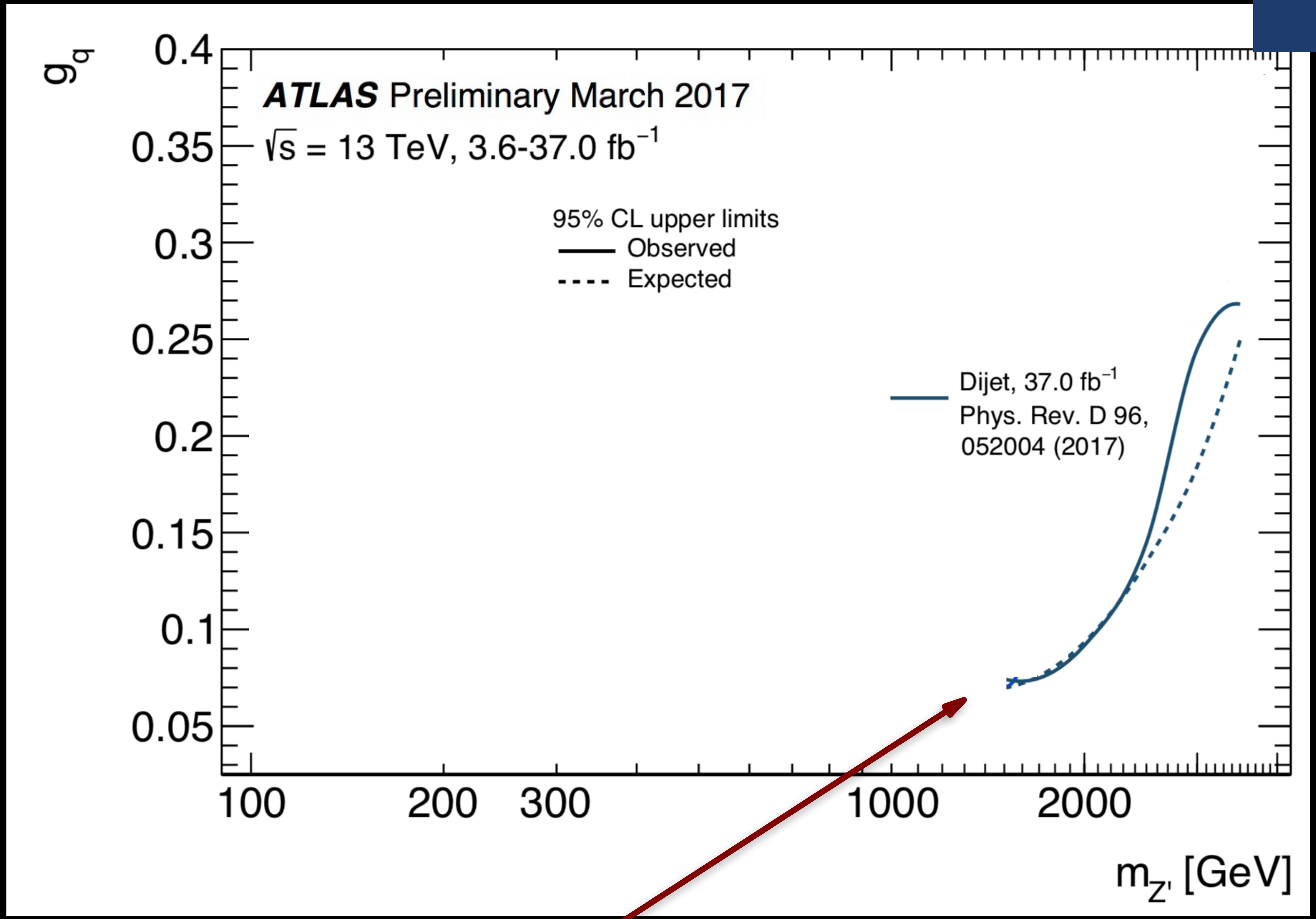


☞HIGH MASS DIJET SEARCHES

DIJET RESONANCE SEARCHES

Leptophobic axial-vector Z' model

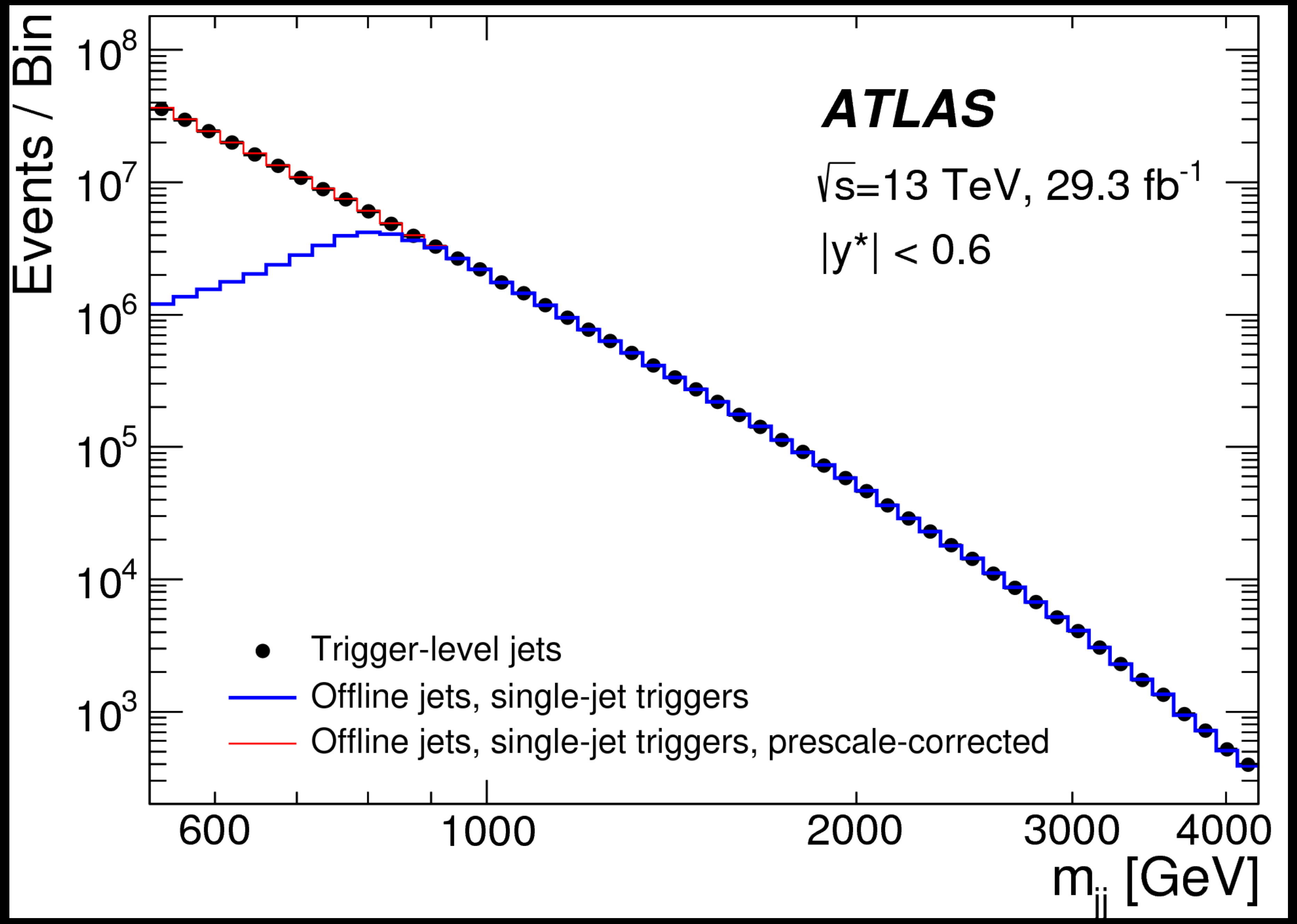


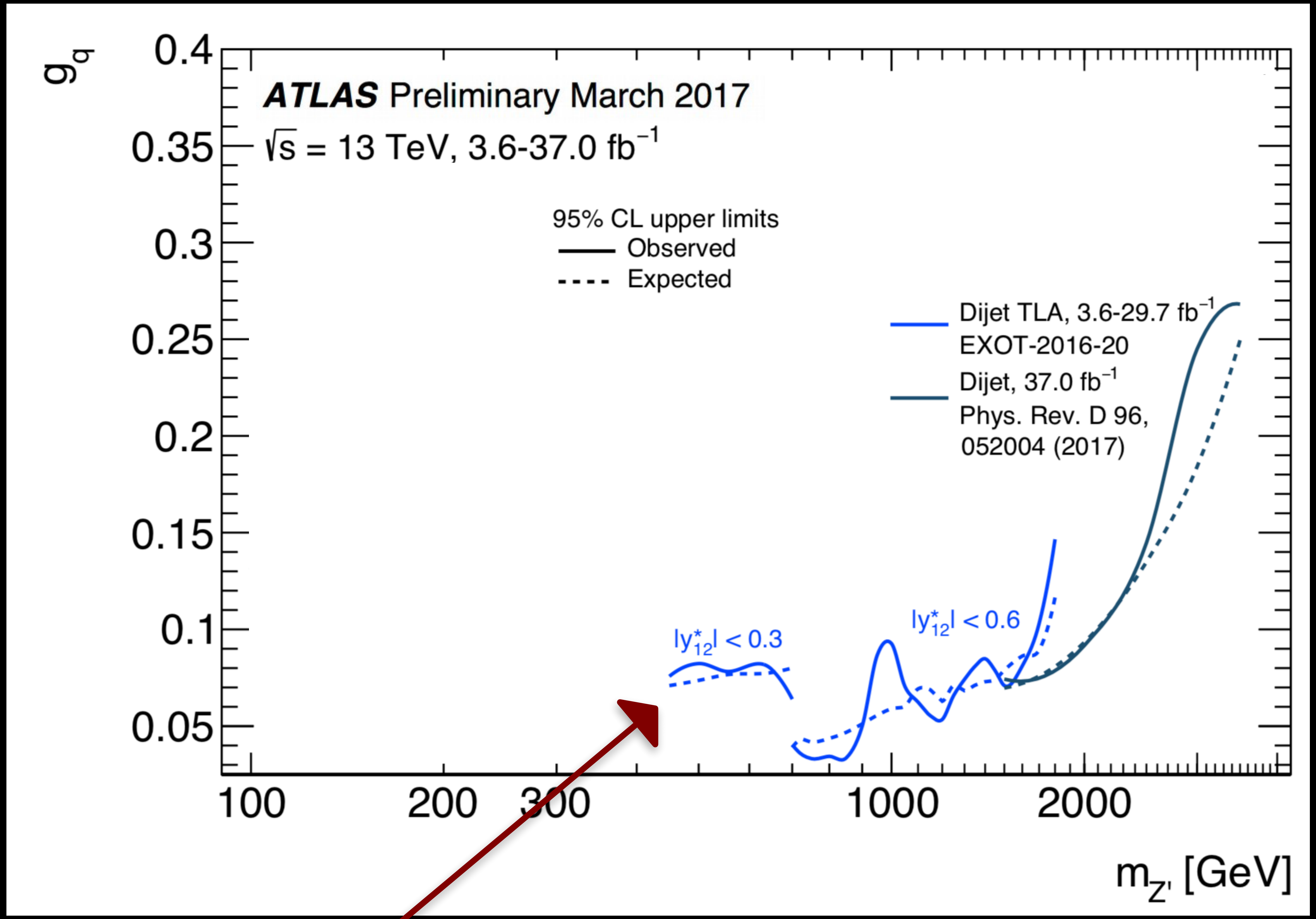


☞ HIGH MASS DIJET SEARCHES LOWER BOUND:LIMITED WITH THE HIGH LEVEL TRIGGER THRESHOLDS

DIJET RESONANCE SEARCHES

Phys.Rev.Lett.121.081801

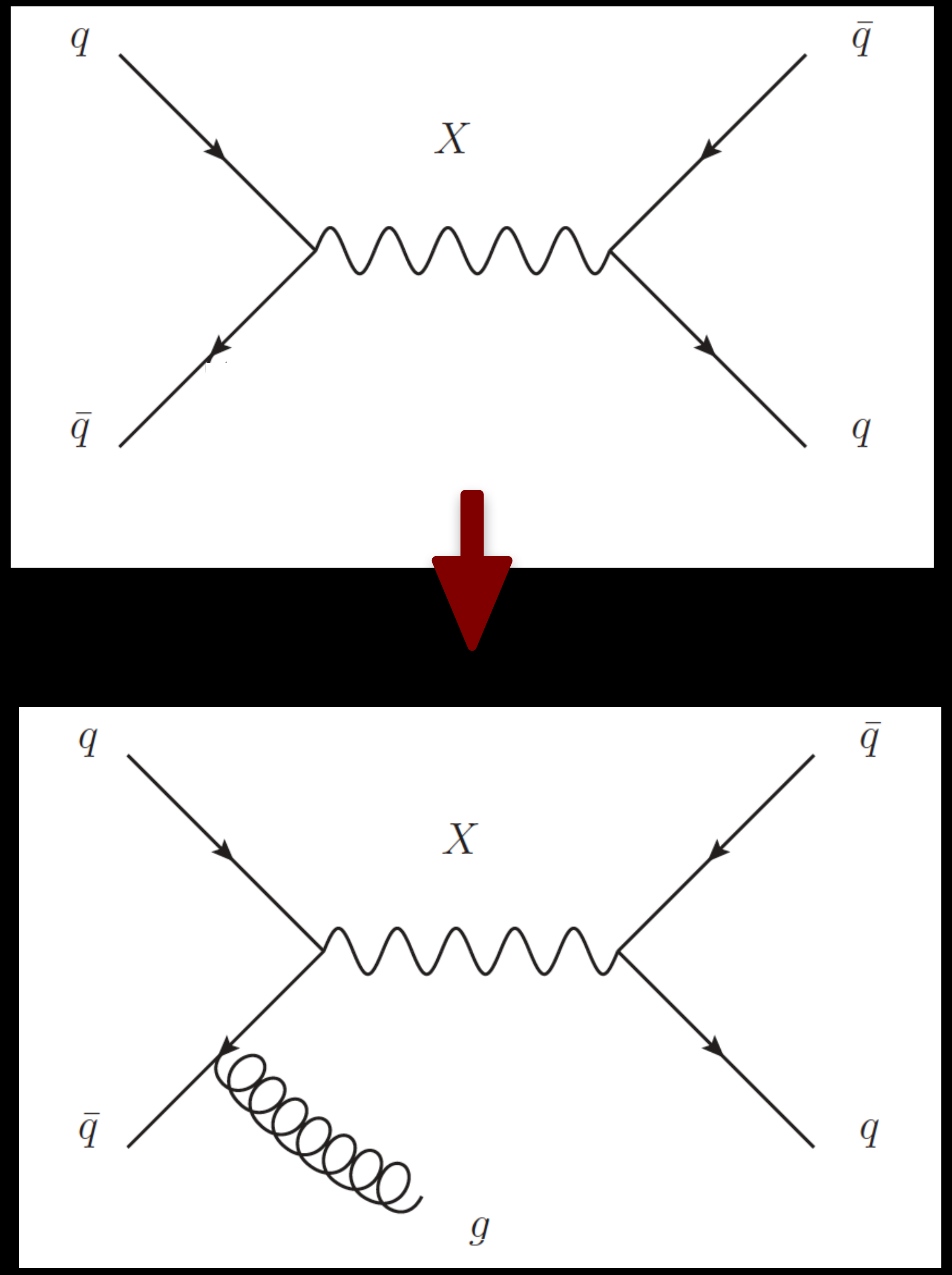


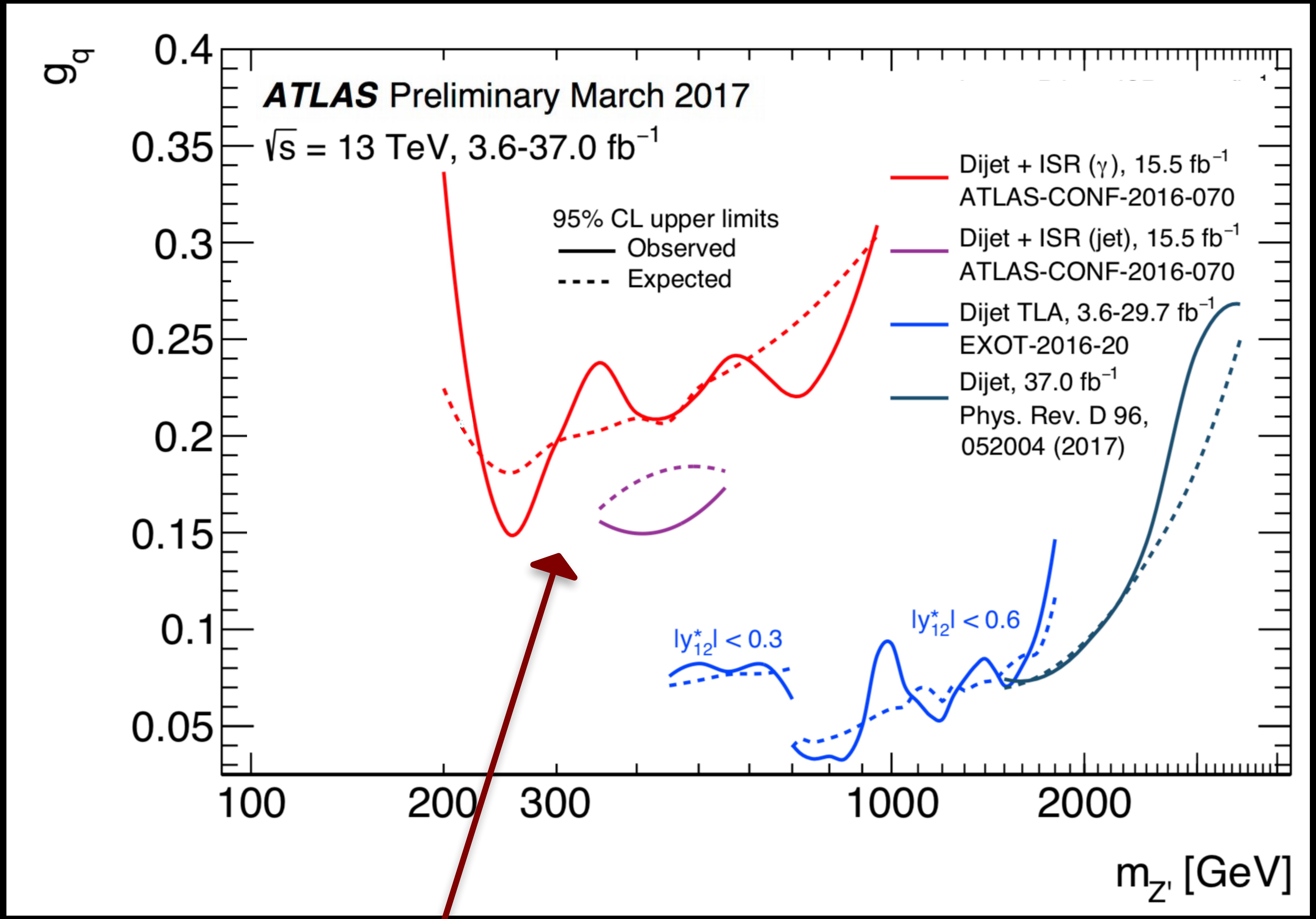


☞HIGH MASS DIJET SEARCHES LOWER BOUND:LIMITED WITH THE HIGH LEVEL TRIGGER THRESHOLDS

☞TRIGGER LEVEL ANALYSIS(TLA) LOWER BOUND:LIMITED WITH LEVEL 1 THRESHOLDS

DIJET RESONANCE SEARCHES



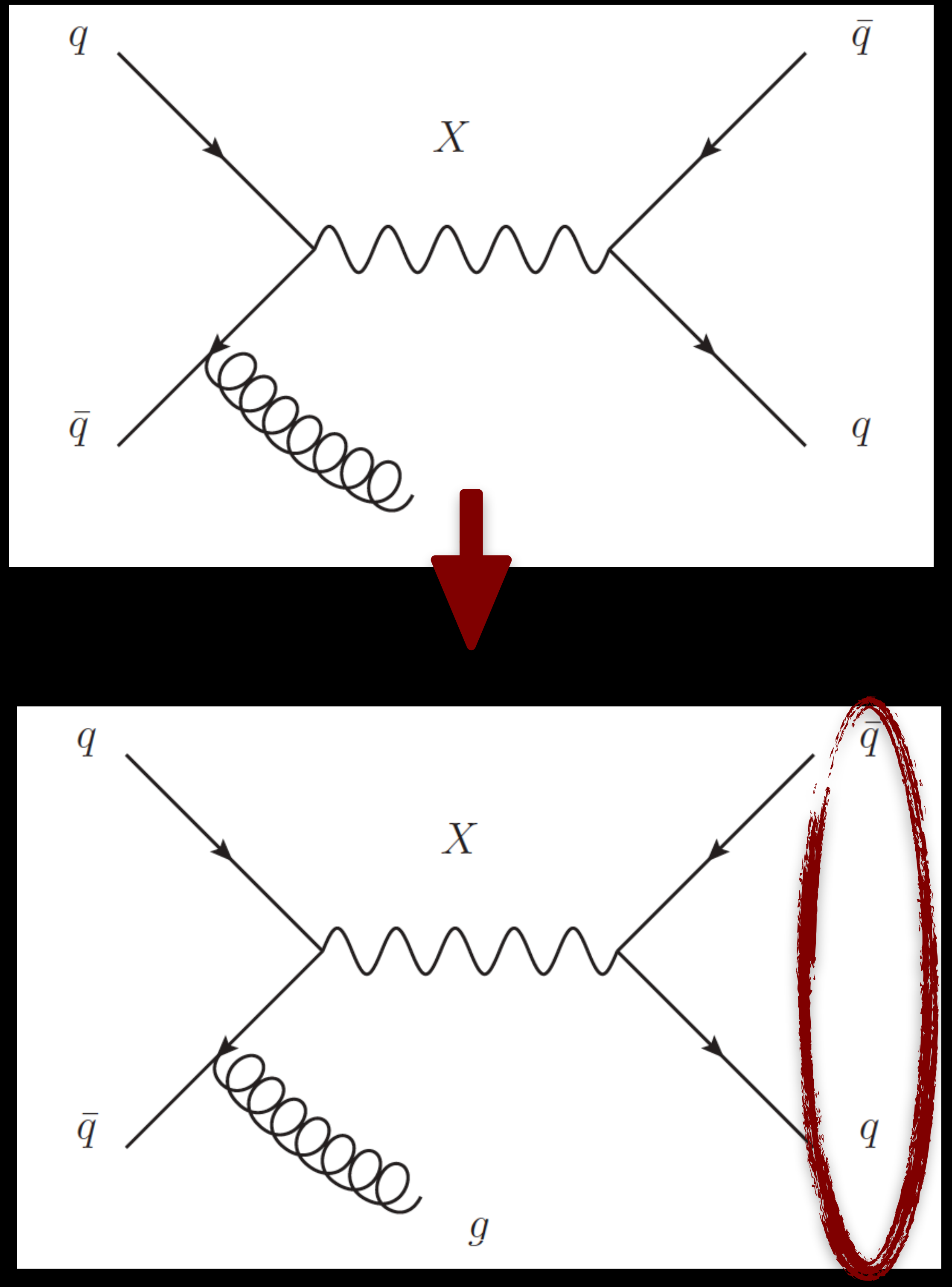


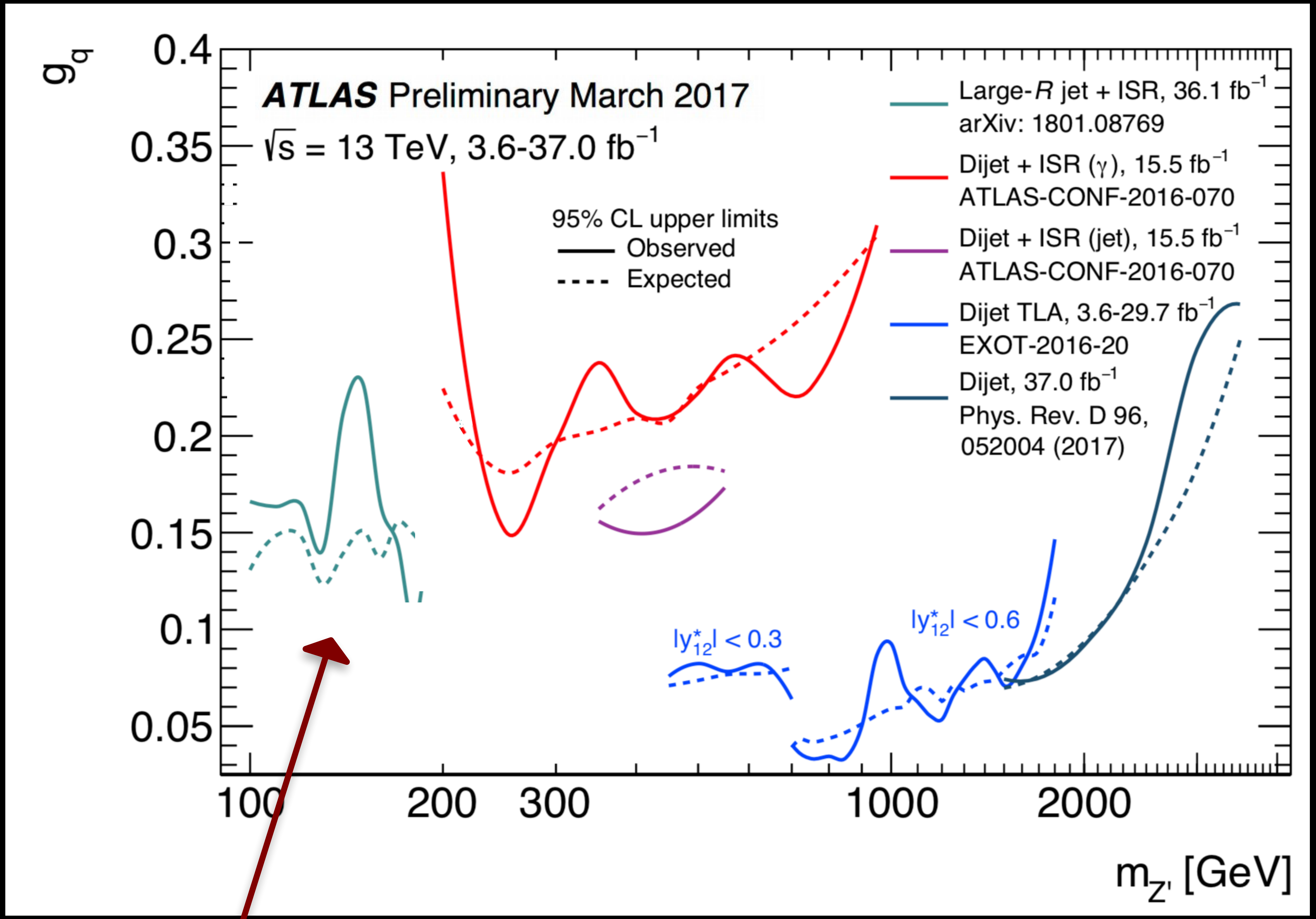
☞HIGH MASS DIJET SEARCHES LOWER BOUND:LIMITED WITH THE HIGH LEVEL TRIGGER THRESHOLDS

☞TRIGGER LEVEL ANALYSIS LOWER BOUND:LIMITED WITH LEVEL 1 THRESHOLDS

☞DIJET+ISR ANALYSIS LOWER BOUND: LIMITED WITH THE SEPERATION OF DI-JETS

DIJET RESONANCE SEARCHES

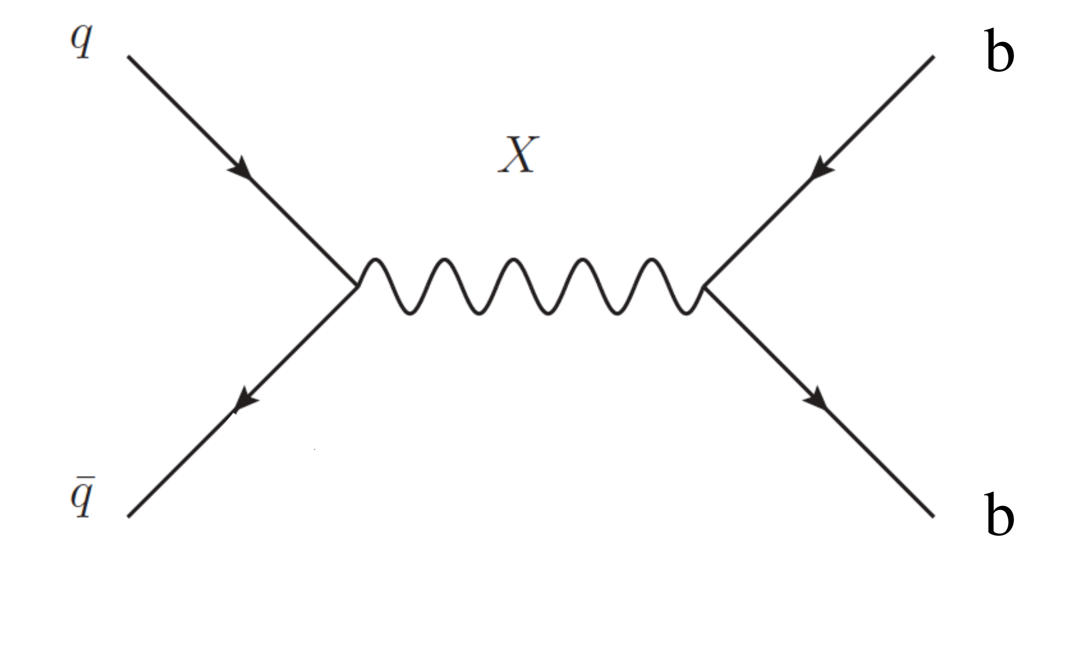


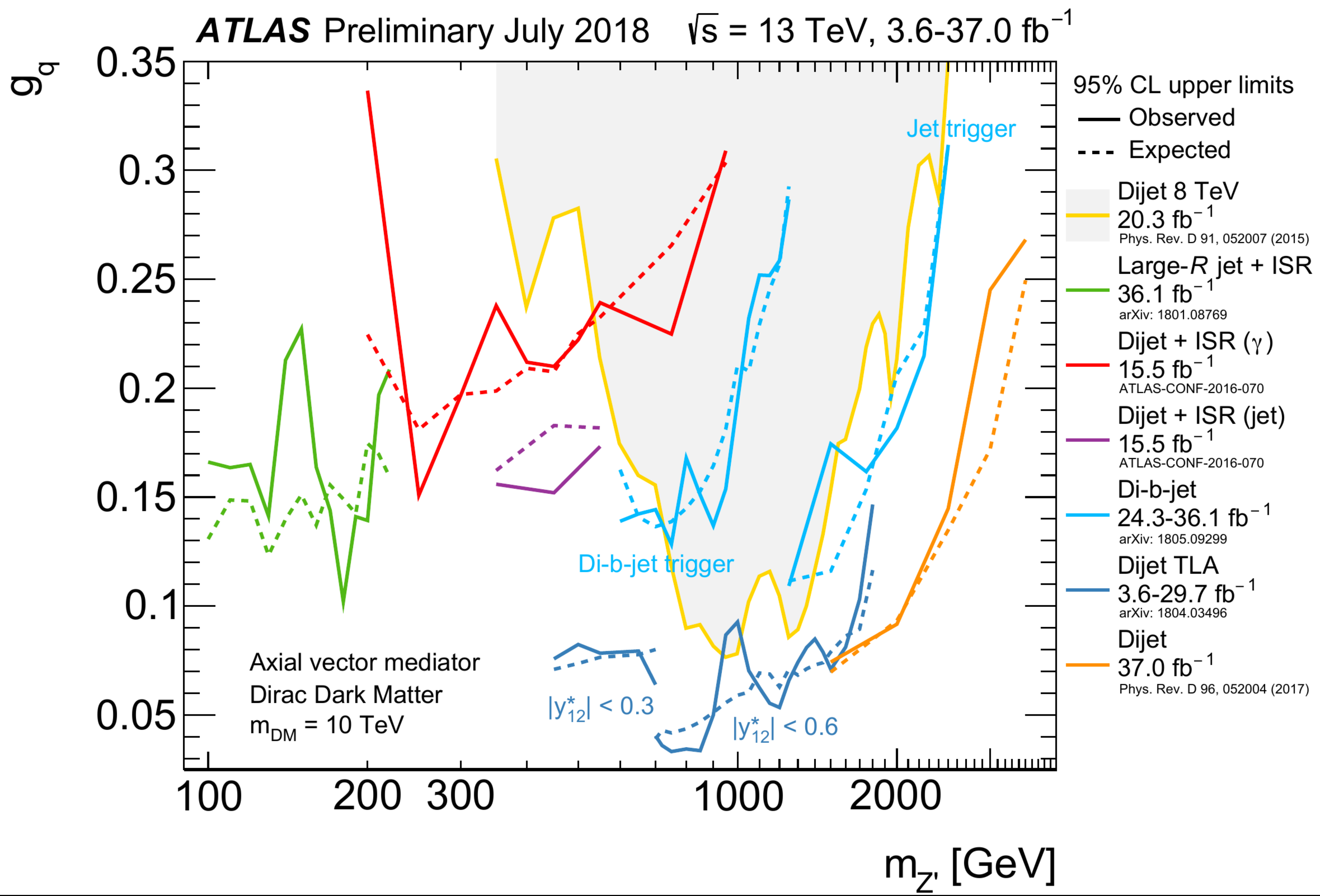


- ☞HIGH MASS DIJET SEARCHES LOWER BOUND:LIMITED WITH THE HIGH LEVEL TRIGGER THRESHOLDS
- ☞TRIGGER LEVEL ANALYSIS(TLA) LOWER BOUND:LIMITED WITH LEVEL 1 THRESHOLDS
- ☞DIJET+ISR ANALYSIS LOWER BOUND: LIMITED WITH THE SEPERATION OF DI-JETS
- ☞BOOSTED DIJET+ISR ANALYSIS

DIJET RESONANCE SEARCHES

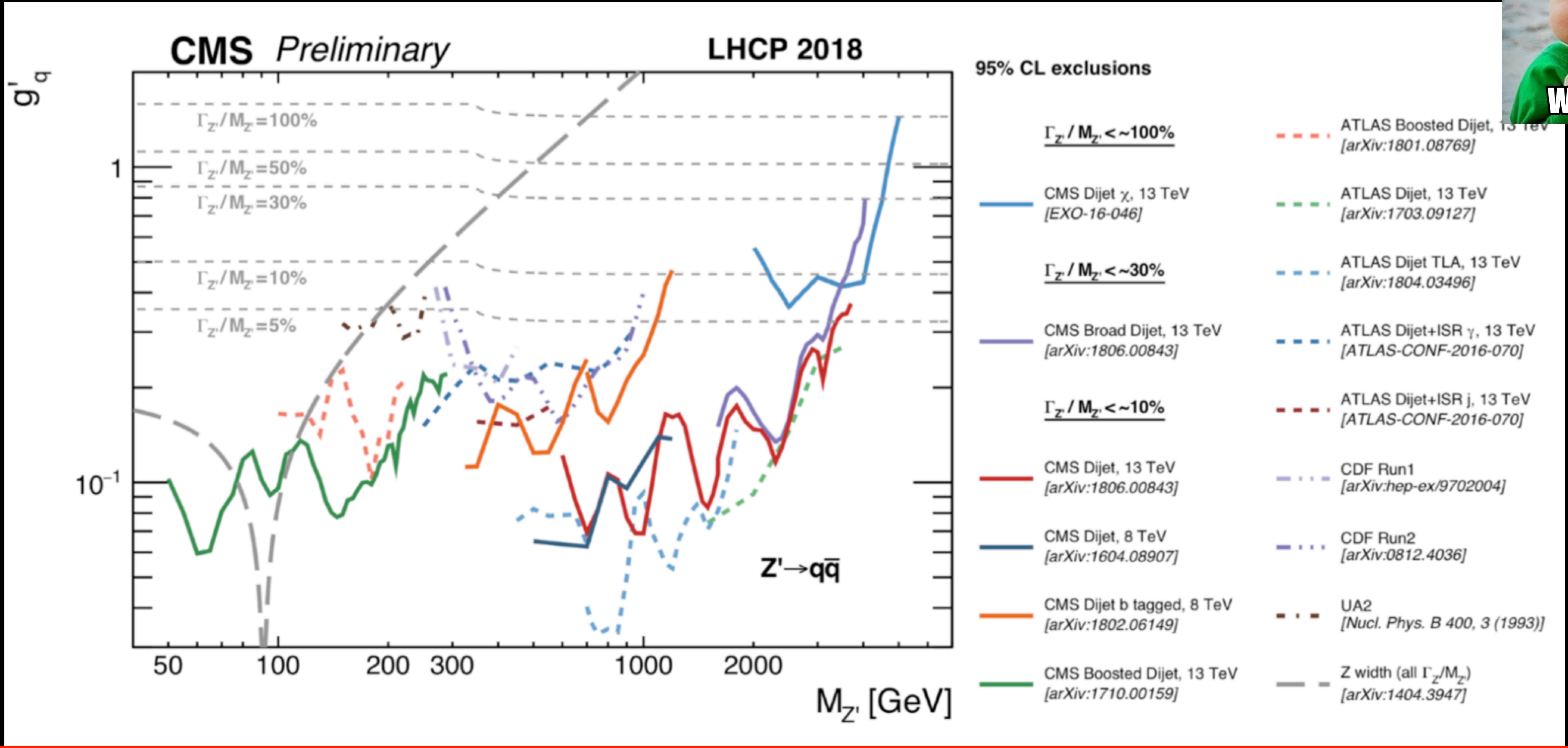
LATEST RESULTS
INCLUDING DI-B JET RESONANCES
AND 8 TEV RESULTS





NOT ONLY SEARCHING FOR THE HIGH MASS REGIONS, BUT ALSO EXPLORING THE LOW MASS REGIONS!

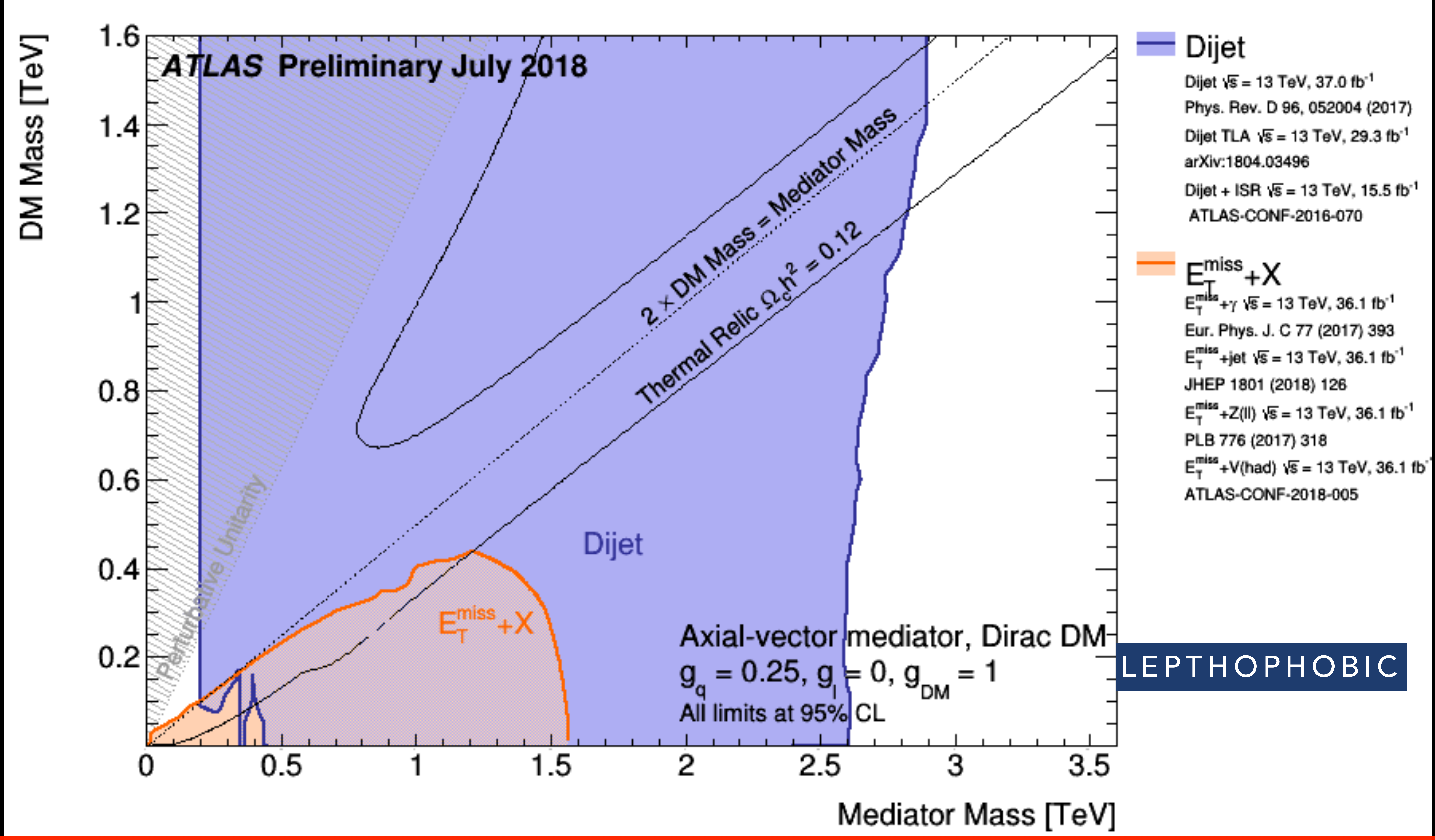
DIJET RESONANCE SEARCHES



LHC PROVIDING THE STRONGEST LIMITS, BUT THERE IS STILL ROOM FOR NEW PHYSICS! AIM IS TO REACH THE LOWER COUPLING VALUES

DARK MATTER SUMMARY

COMBINING THE RESULTS FROM MONO-X AND DIJET SEARCHES



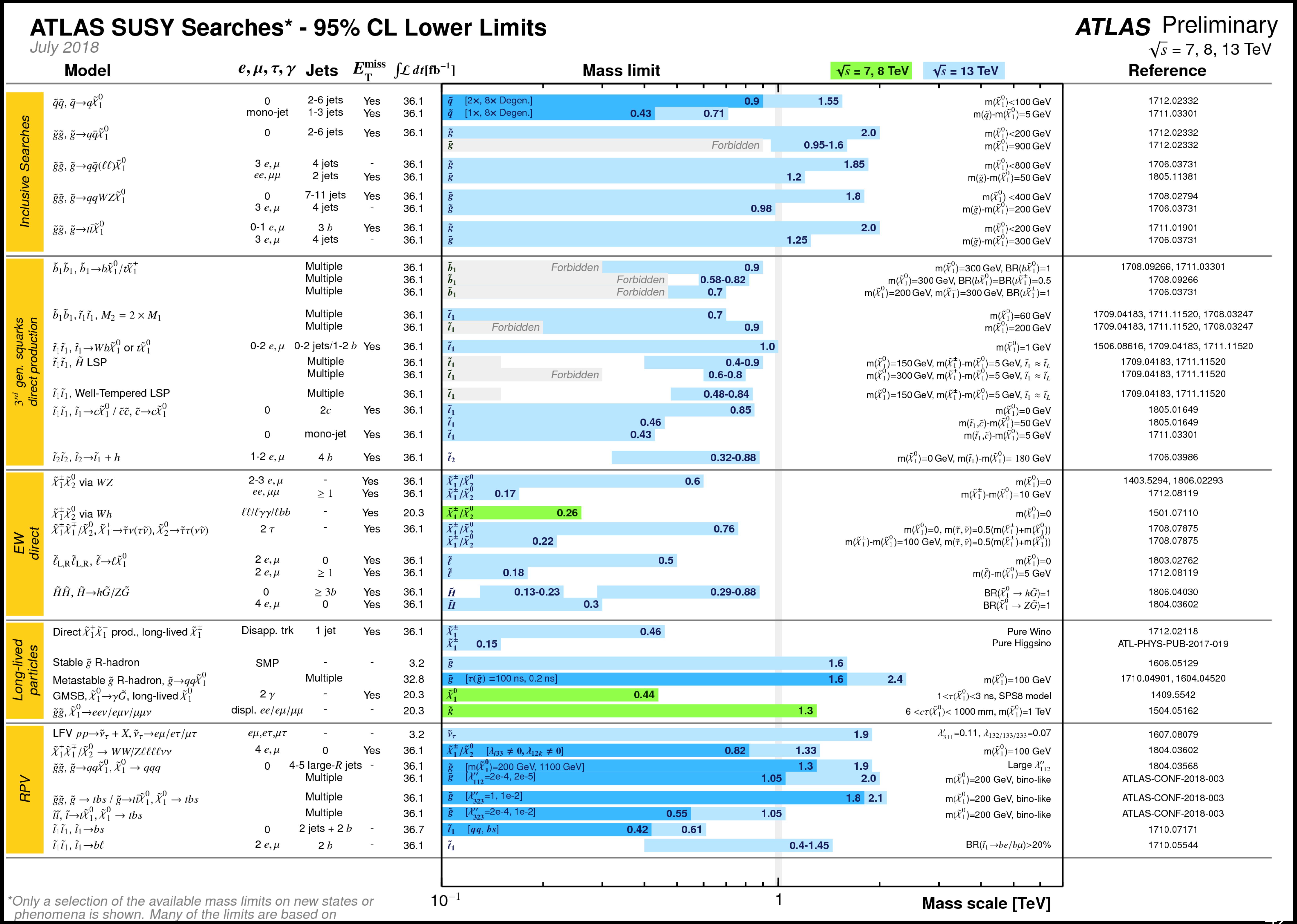
LEPTHOPHOBIC

ABILITY TO EXPLORE LARGE PHASE SPACE WITH DIFFERENT SIGNATURES

SUPERSYMMETRY

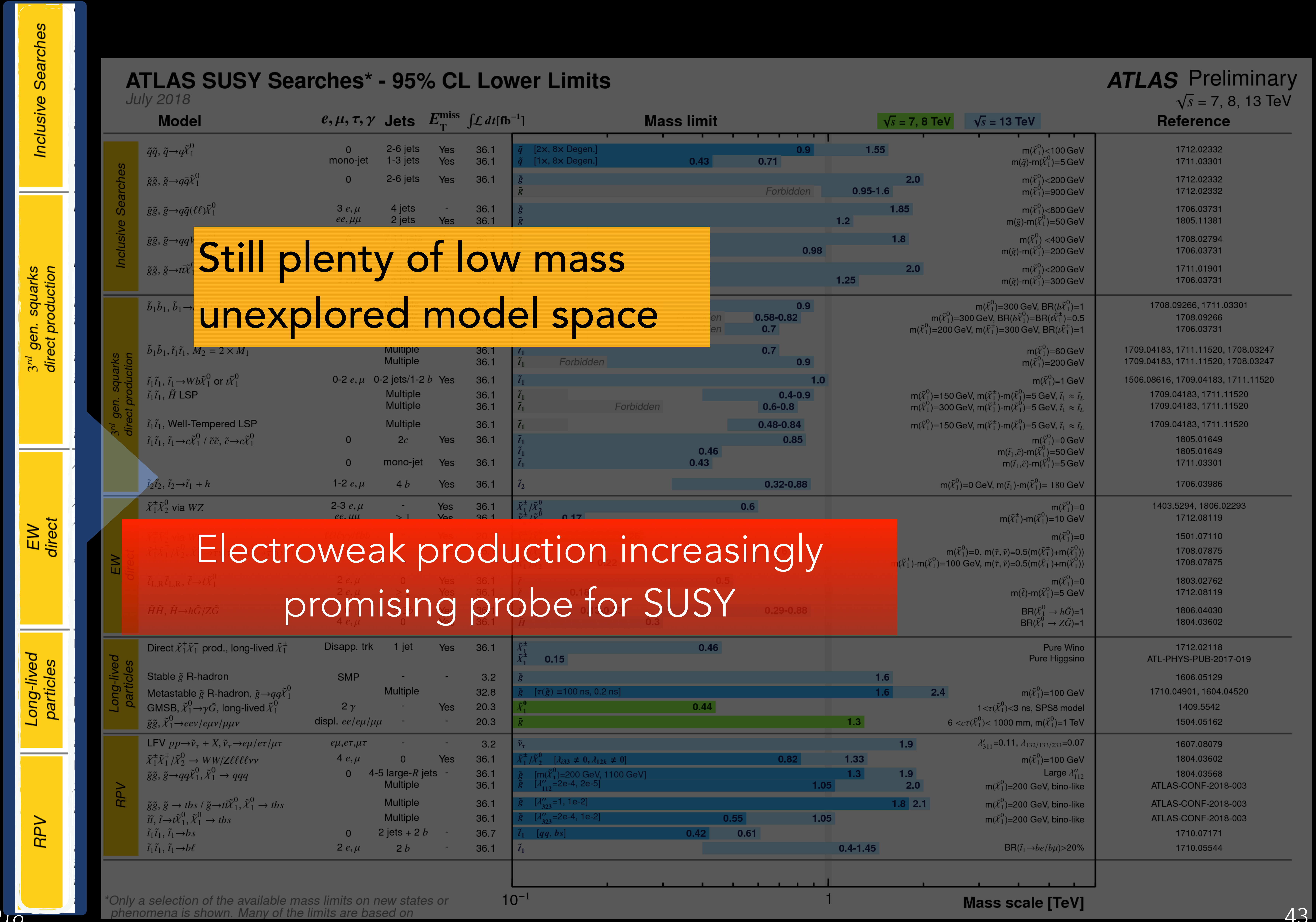
SUPERSYMMETRY

- New boson/fermion supersymmetric partner to each boson/fermion in the SM
- Motivations for SUSY
  - Hierarchy problem, unification of forces
  - Candidate for the observed Dark Matter…
- Very rich variety of of signatures



SUPERSYMMETRY

Simplified signatures excluded up to **TeV Scale**



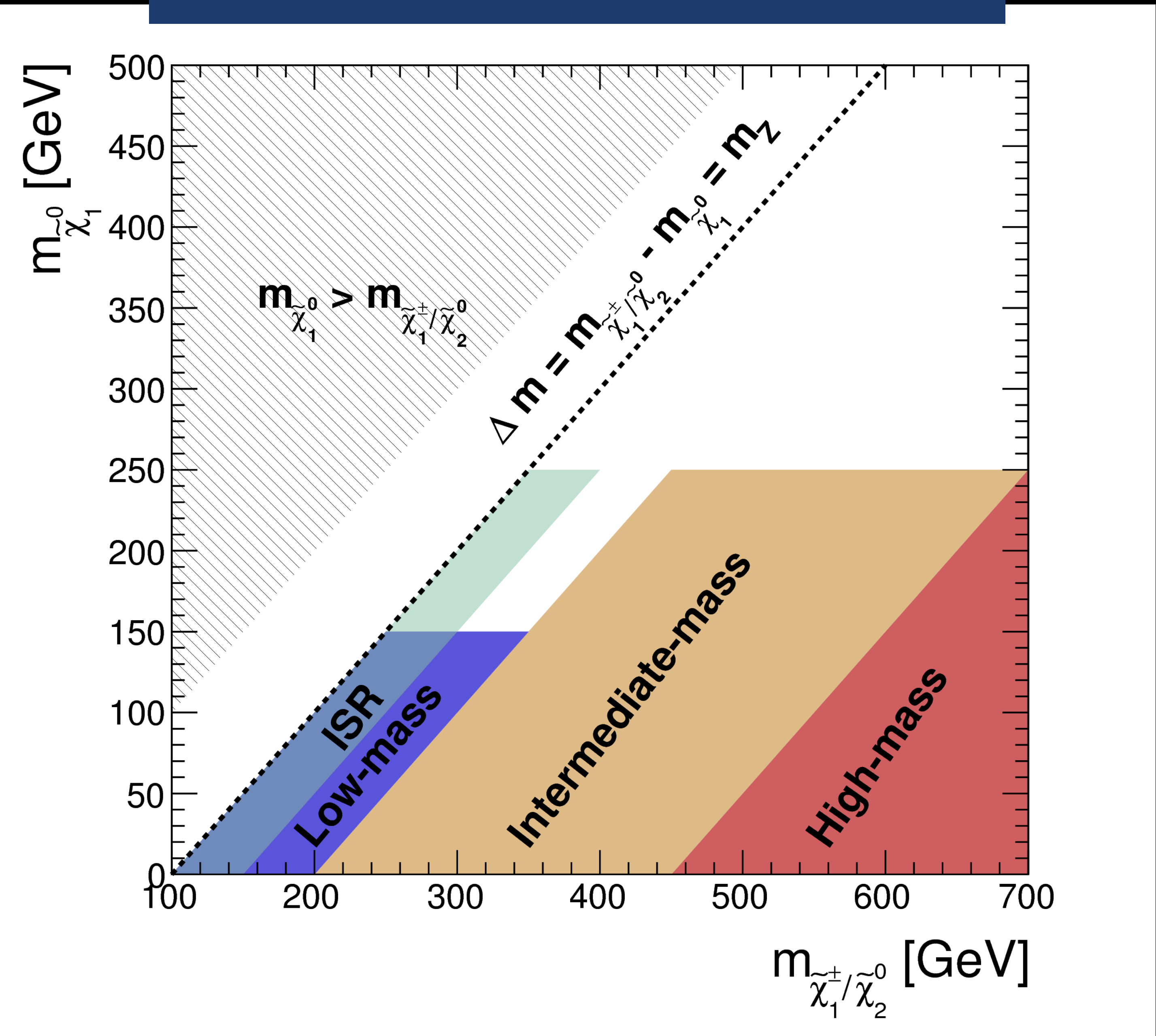
Still plenty of low mass unexplored model space

Electroweak production increasingly promising probe for SUSY

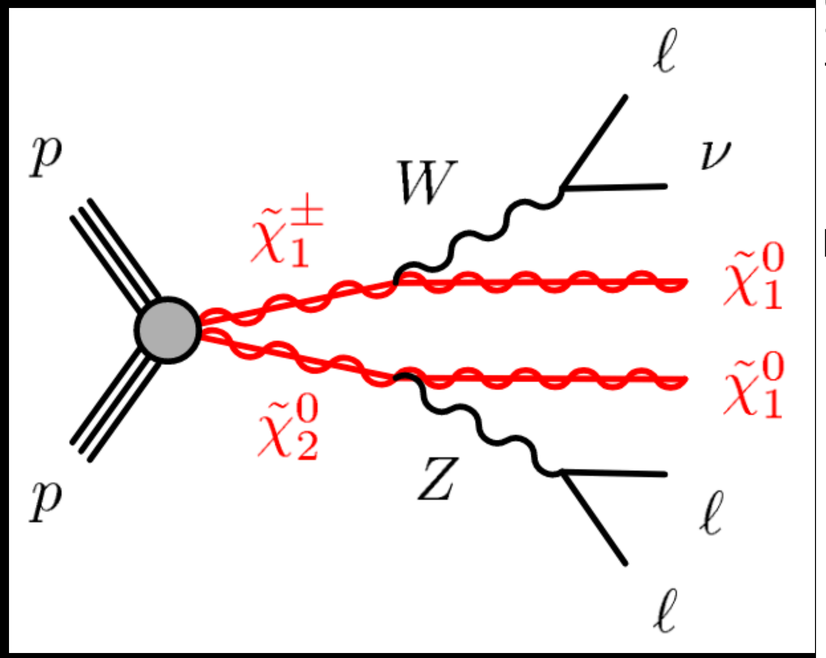
SUSY:EWK PRODUCTION

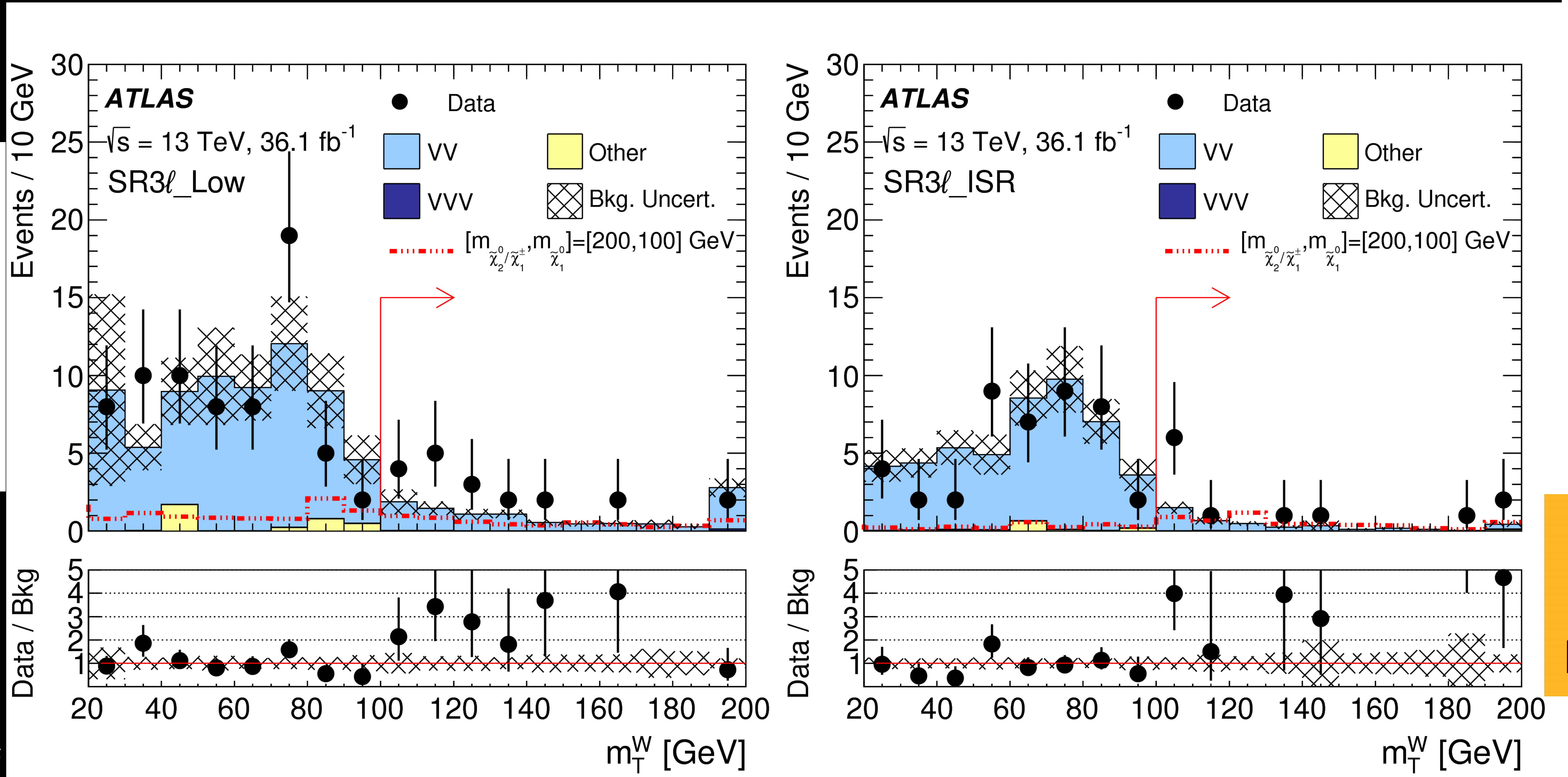
SUBMITTED TO PRD, ARXIV.1806.02293

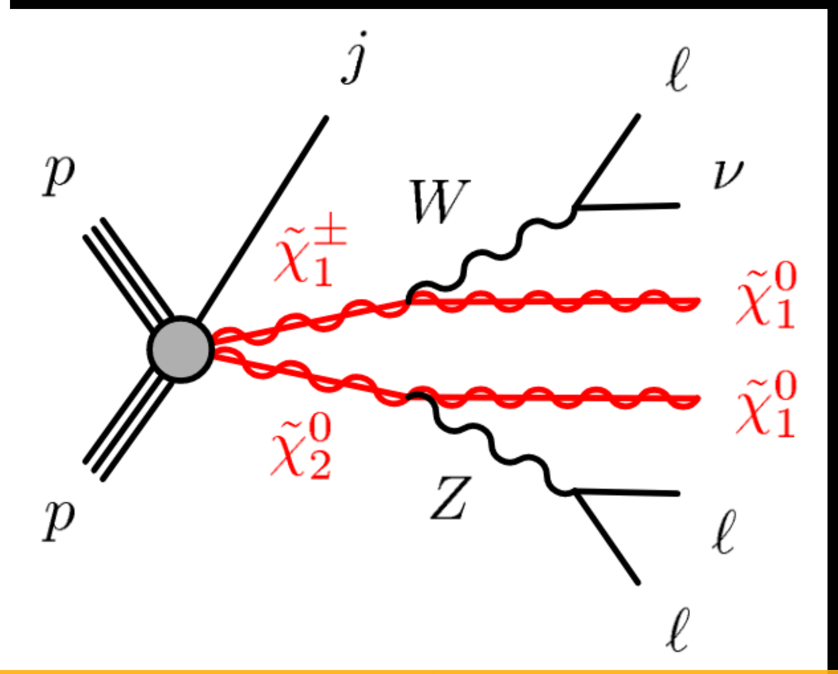
- Search for pair-produced electroweakinos
- Different signal regions: Mass differences in the range of 100-600 GeV



LOCAL EXCESS UP TO 3σ IN LOW-MASS SPLITTING







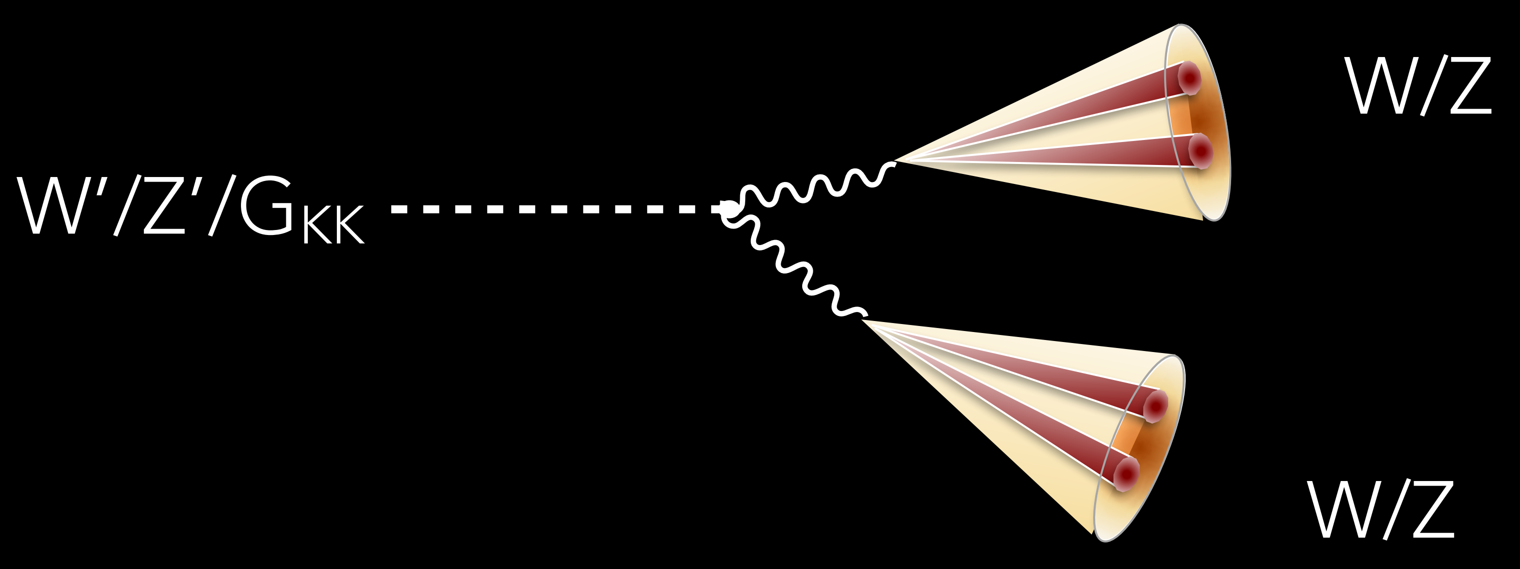
HIGH/INTERMEDIATE-MASS SPLITTING: EXCLUSION UP TO 600 GEV

NEW GAUGE BOSONS

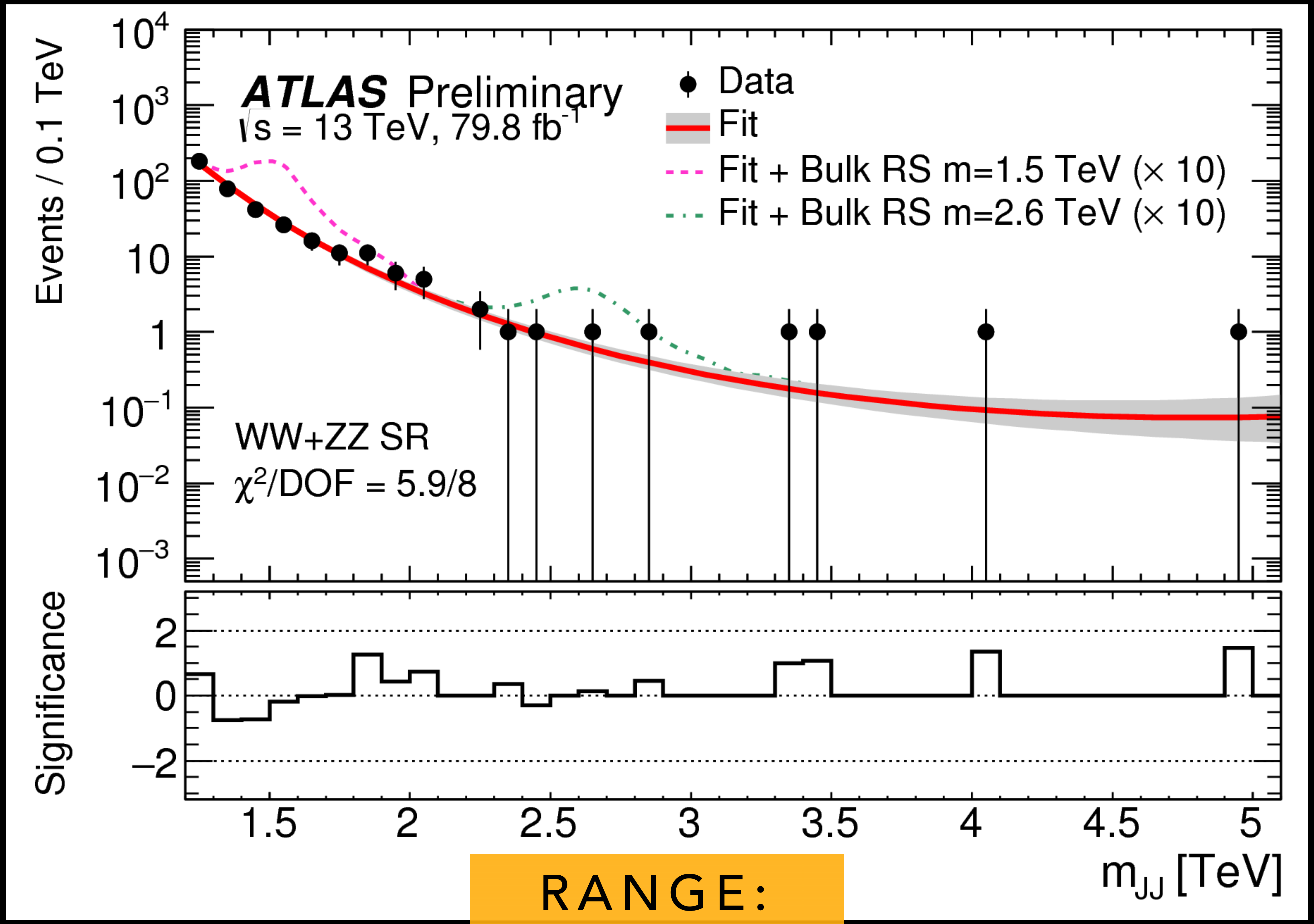
NEW BOSONS:WITH DIBOSONS

ATLAS-CONF-2018-016

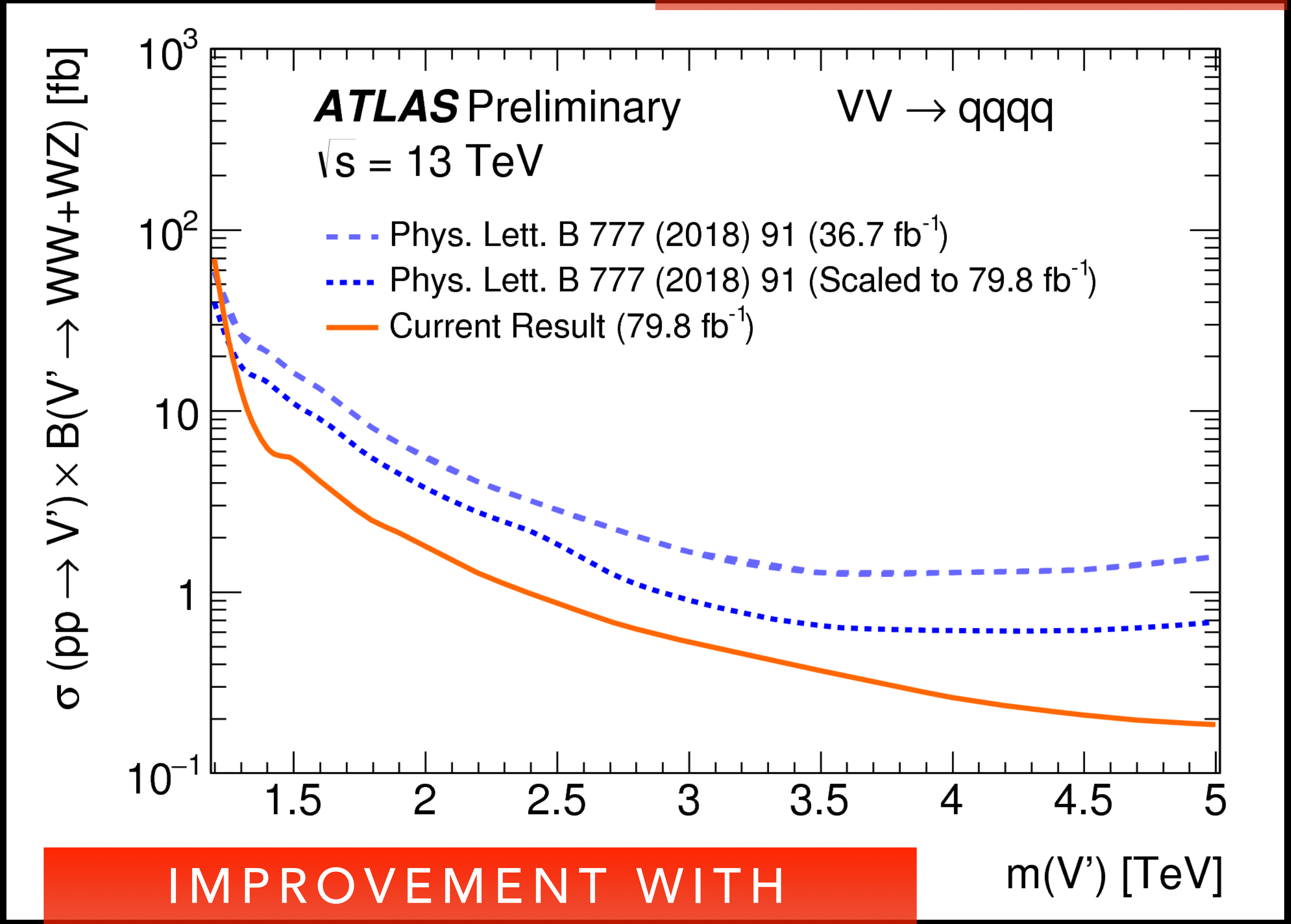
- Benchmarks: Spin-1 Heavy Vector Triplet Model (HVT) and spin-2 graviton G_{KK}
- Hadronic decay channel of WW,WZ,ZZ
- **New** jet reconstruction methods using tracker (*ATL-PHYS-PUB-2017-015*)



USING 79.8 FB-1 DATA



RANGE:
1.2-5.0 TEV



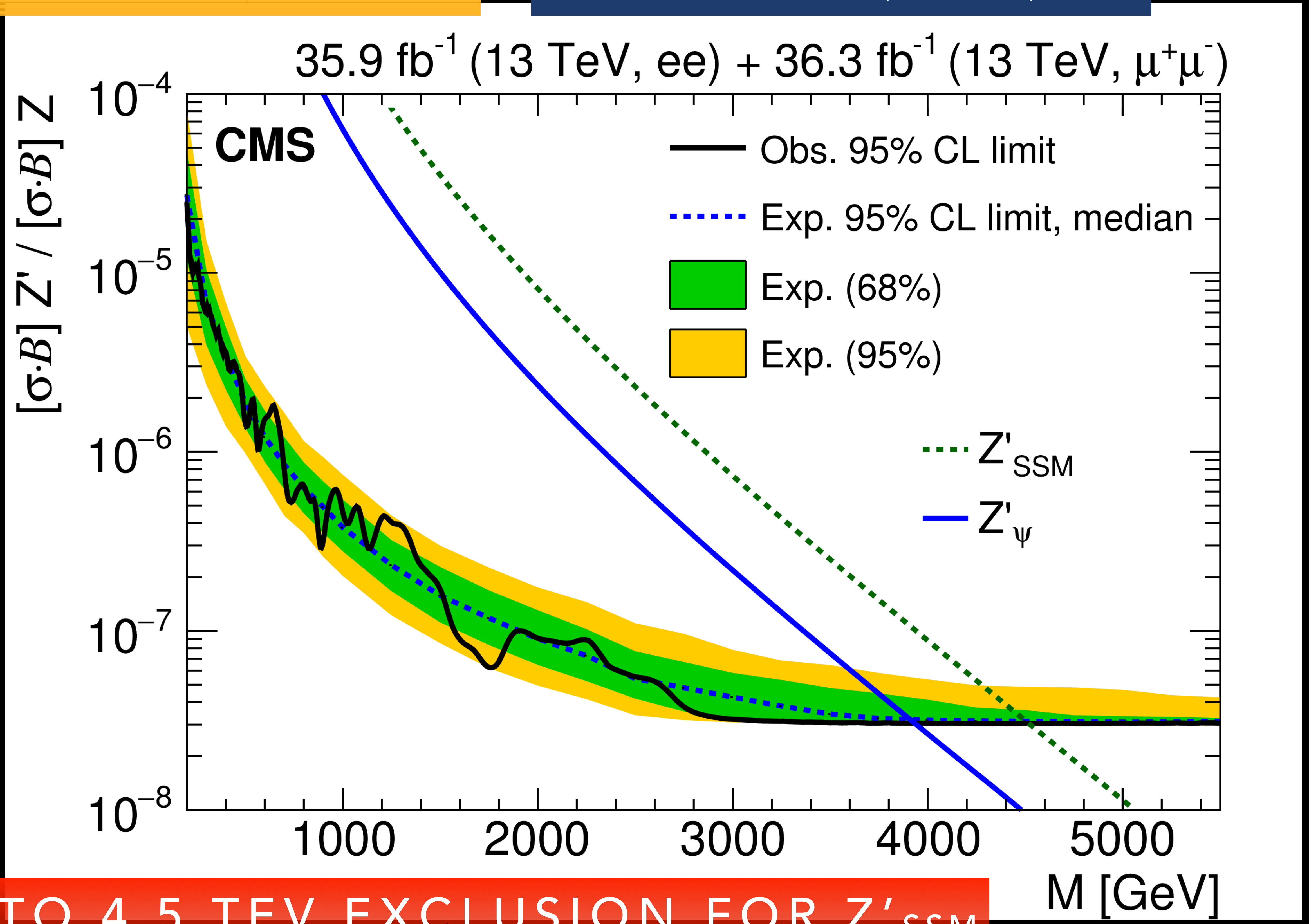
IMPROVEMENT WITH
NEW JET RECO TECHNIQUE

NEW BOSONS:WITH LEPTONS

- Benchmarks:Superstring-inspired model (Ψ), Sequential Standard Model(SSM)
    - $Z'_{SSM/\psi}$ (CMS) & W'_{SSM} (ATLAS)
- Strong limits with leptons, high background suppresion

DILEPTON SEARCH

CMS,JHEP06(2018)120



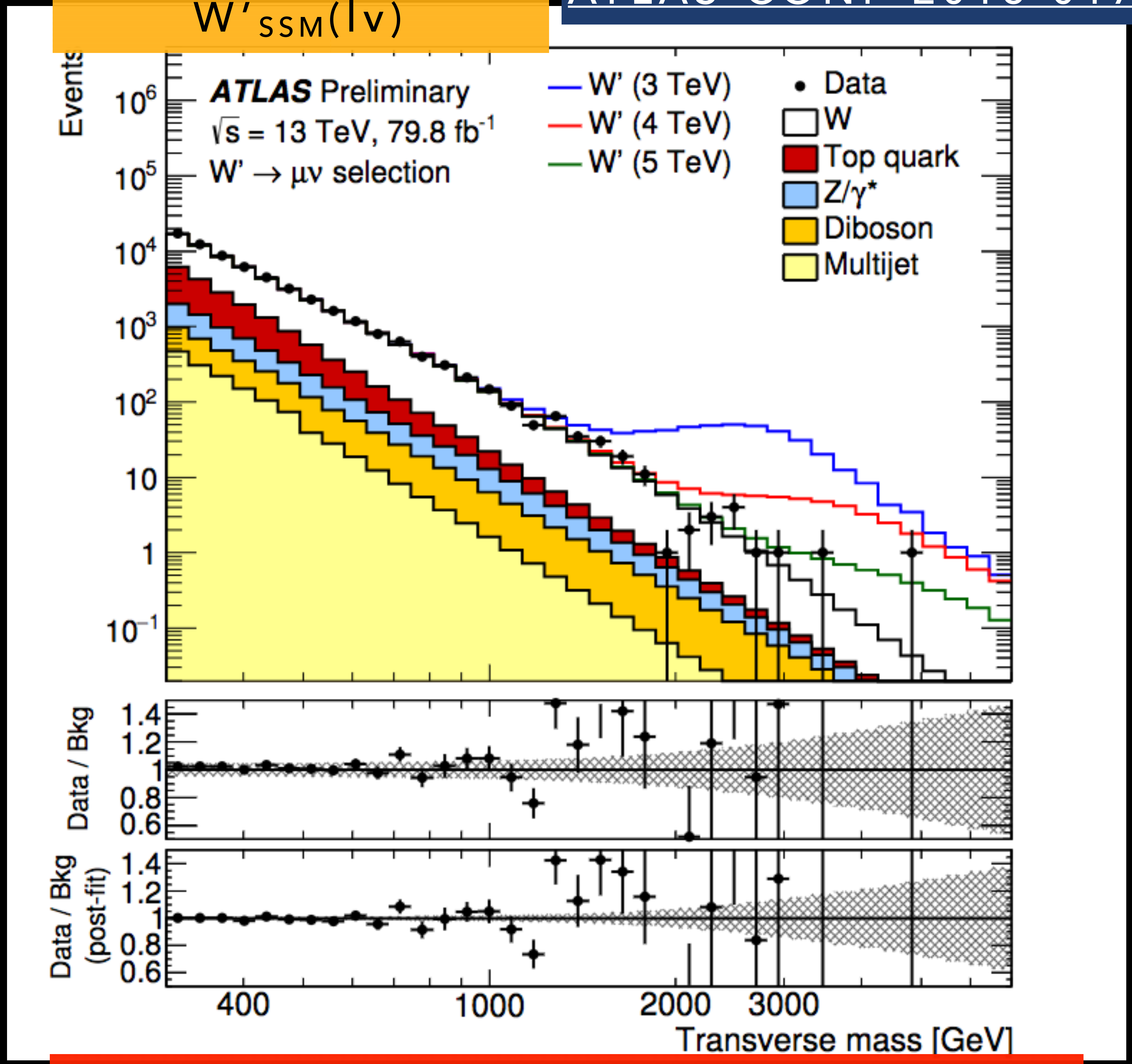
UP TO 4.5 TEV EXCLUSION FOR Z'_{SSM}

USING 79.8 FB^{-1} DATA

LEPTONIC DECAY

$W'_{SSM}(l\nu)$

ATLAS-CONF-2018-017

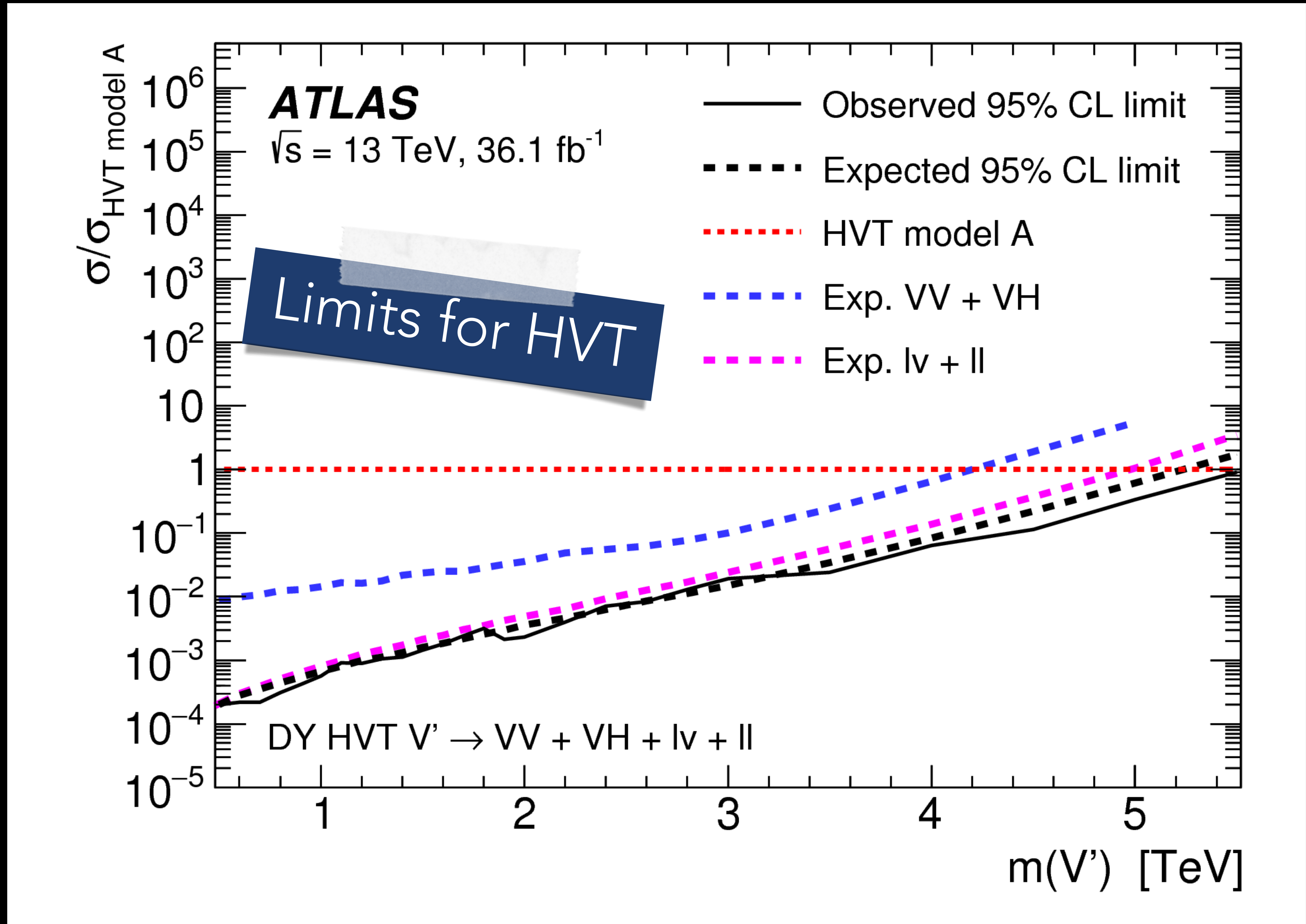


UP TO 5.6 TEV EXCLUSION FOR W'_{SSM}

COMBINATIONS

SUBMITTED TO PRL, ARXIV.1808.02380

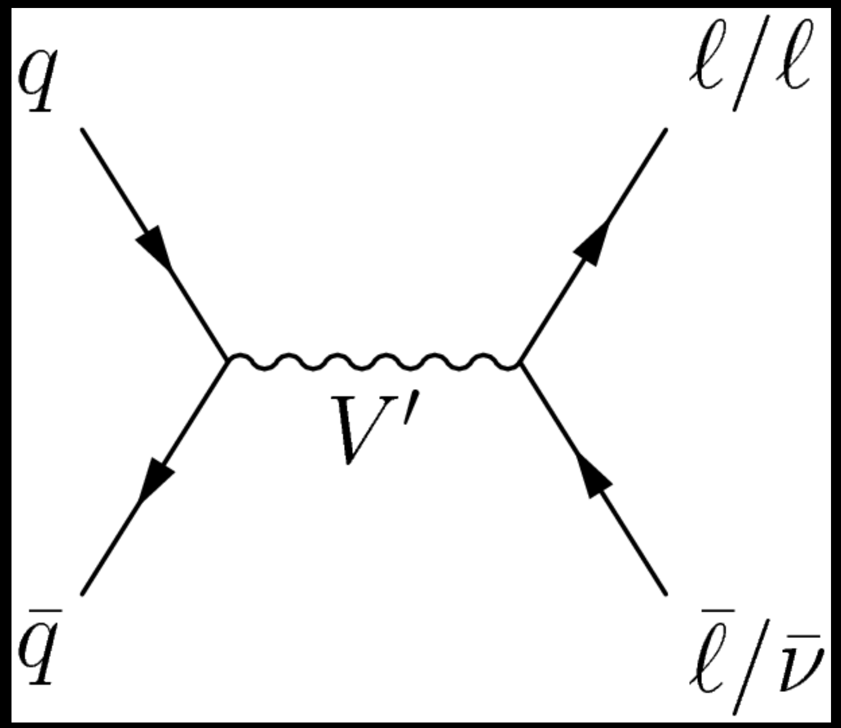
- Diboson+ll+lv combination:
  - qqqq, ννqq, lνqq, llqq, lνlν, llνν, lνll, llll, qqbb, ννbb, lνbb, and llbb final states= Combined **Bosonic**
  - lν +ll final states = Combined **Leptonic**
  - Combination of **Bosonic+Leptonic**



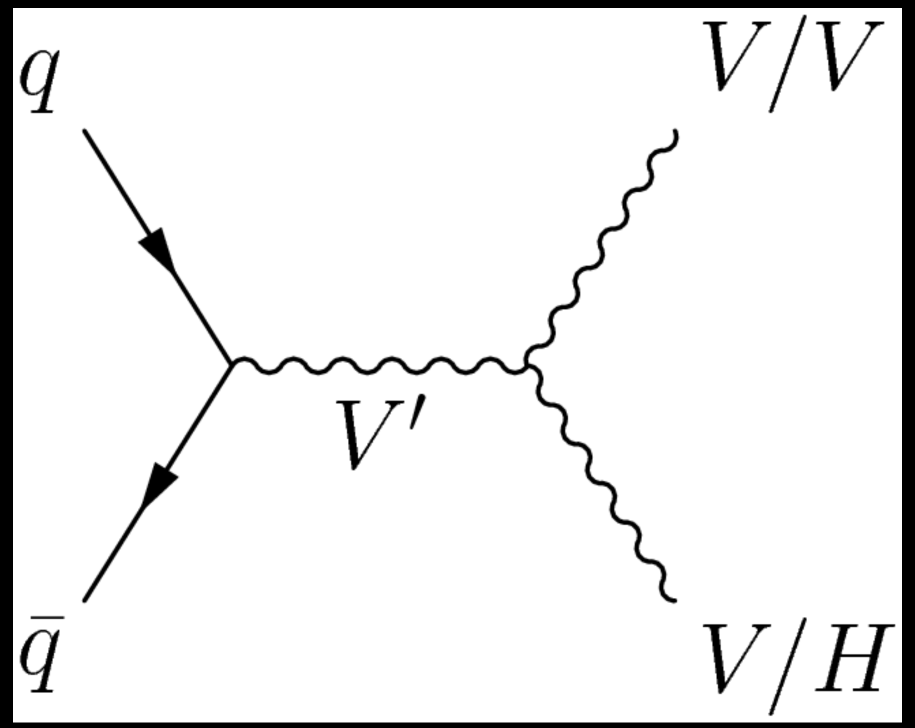
COMBINATIONS GIVE THE BEST LIMITS

BENCHMARKS

Model \ Decay mode	WW	WZ	ZZ	WH	ZH	$\ell\nu$	$\ell\ell$
HVT	Z'	W'		W'	Z'	W'	Z'
Bulk RS	G_{KK}		G_{KK}				
Scalar	Scalar		Scalar				



LEPTONIC DECAY



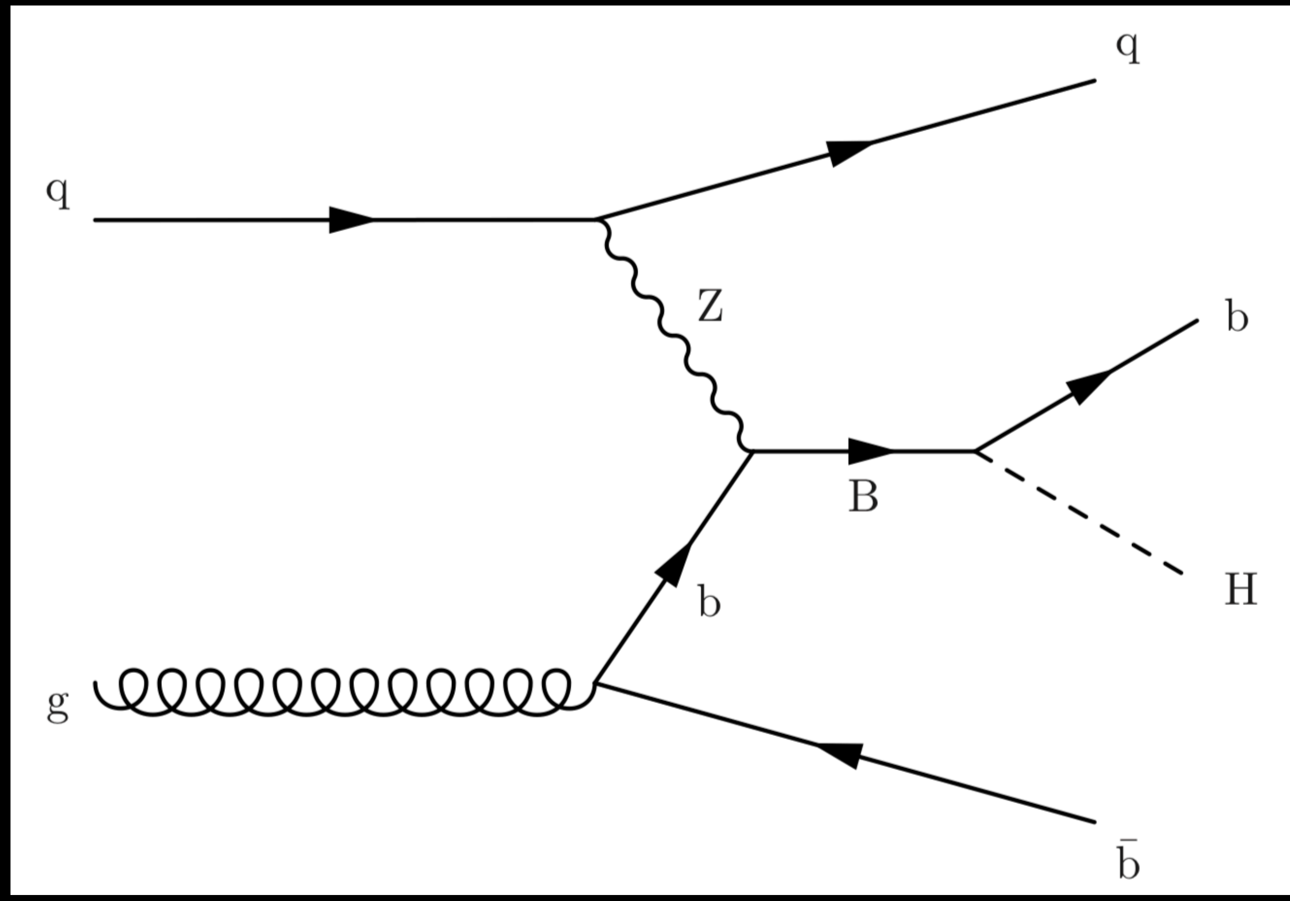
BOSONIC DECAY

VECTOR LIKE QUARKS

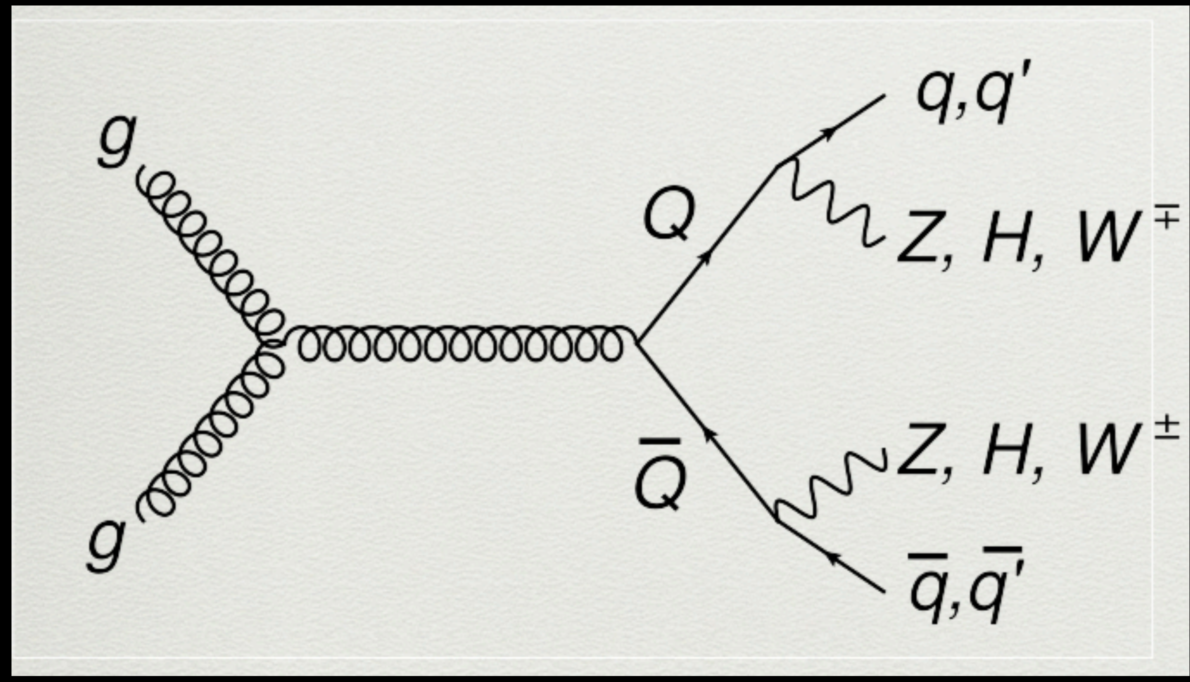
VECTOR LIKE QUARKS

- What?
  - Spin 1/2, ferminoic top/bottom quarks
  - Singlet, doublet or triplet
  - Produced via FCNC or SM-like processes
  - Preferentially decay to 3rd generation
  - Left and right handed components transform identically under SU(2) x U(1) gauge transformations
- Why?
  - Solves hierarchy problem, baryon asymmetry
  - GUTs, little Higgs, composite Higgs…

	Charge	Decay Mode	
T singlet	+2/3	$T \to W^+b, Zt, Ht$	
B singlet	-1/3	$B \to W^-t, Zb, Hb$	
(T,B) doublet	(+2/3,-1/3)	$T \to W^+b, Zt, Ht$	$B \to W^-t, Zb, Hb$
(X,T) doublet	(+5/3,+2/3)	$X \to W^+t$	$T \to Zt, Ht$
(B,Y) doublet	(-1/3,-4/3)	$B \to Zb, Hb$	$Y \to W^-b$

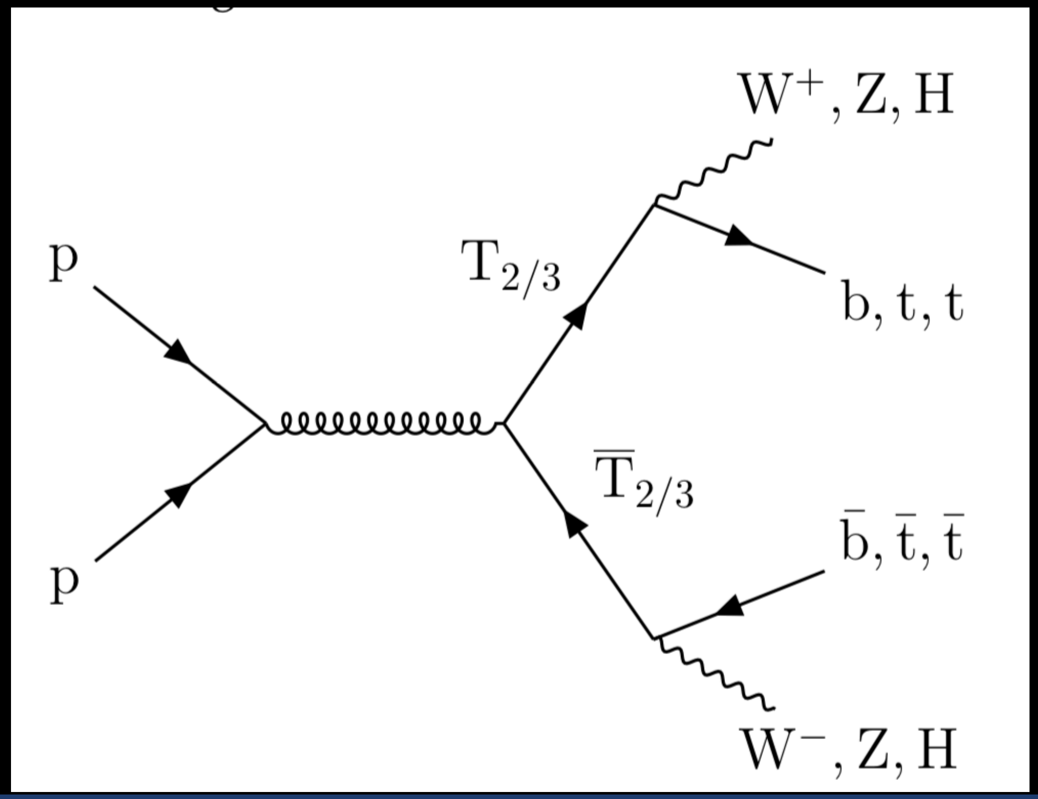


SINGLE PRODUCTION



PAIR PRODUCED

VLQ-PAIR PRODUCTION

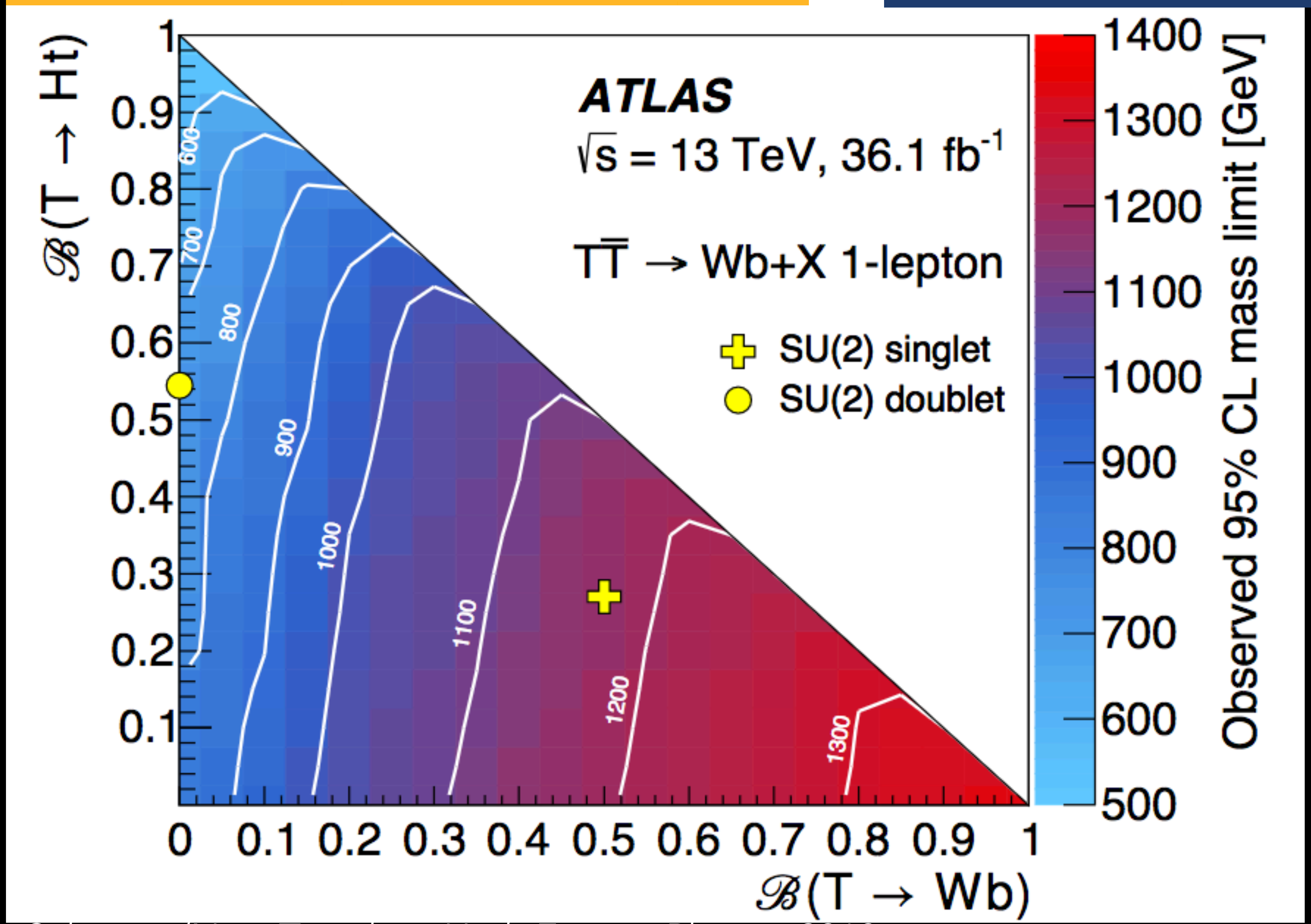


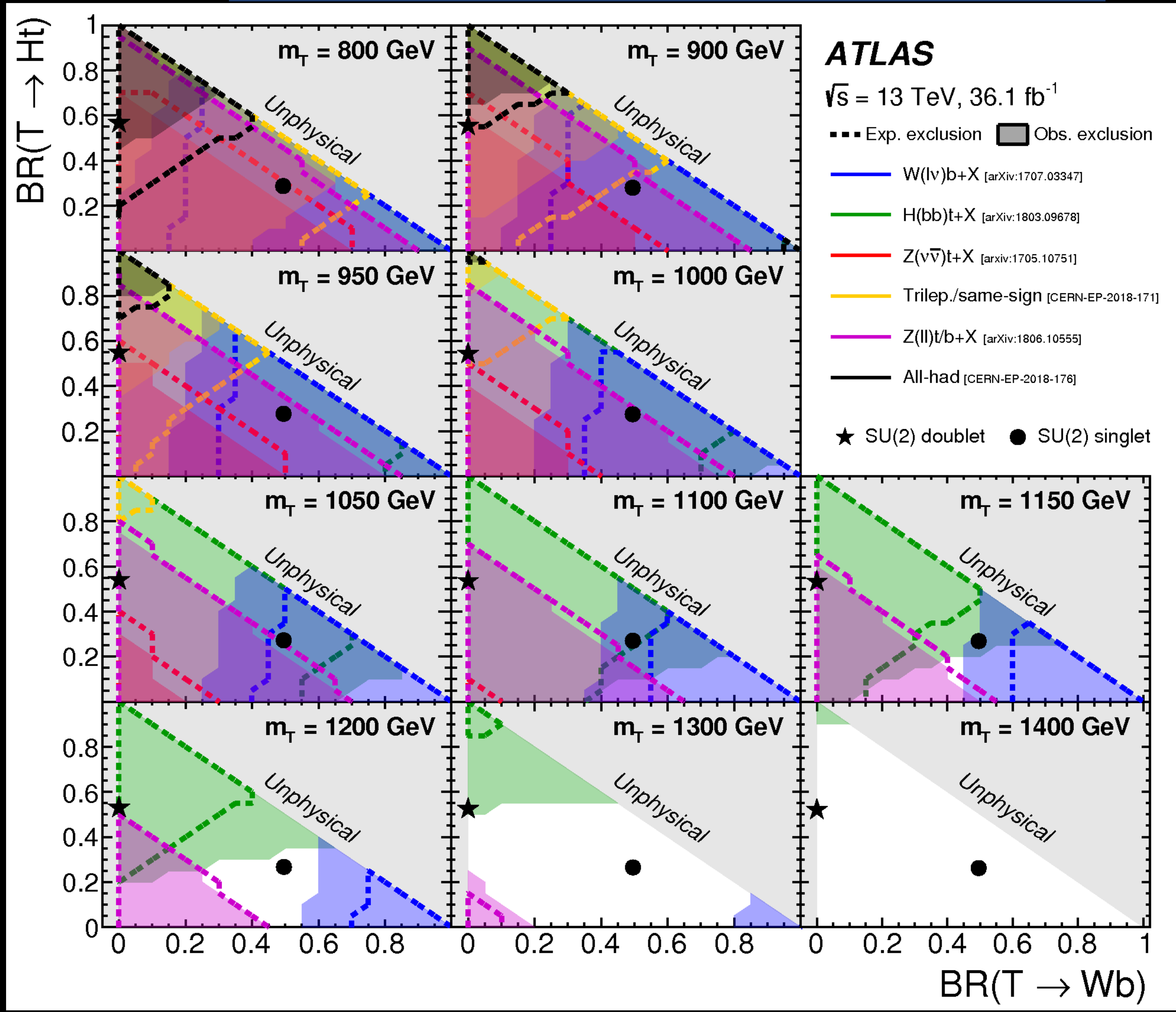
- Up to 1 TeV of VLQ mass, dominant production mechanism is pair production
  - Rich final states / Many different searches for VLQ T and B
    - Lepton+jets, dilepton+jets (same/opposite sign), 3lepton+jets
- General strategy: Scan **different branching fractions** to W, Z and H

SUBMITTED TO PRL, ARXIV.1808.02343

LEPTON+JETS FINAL STATE

JHEP 10 (2017) 141





VLQ-COMBINATIONS

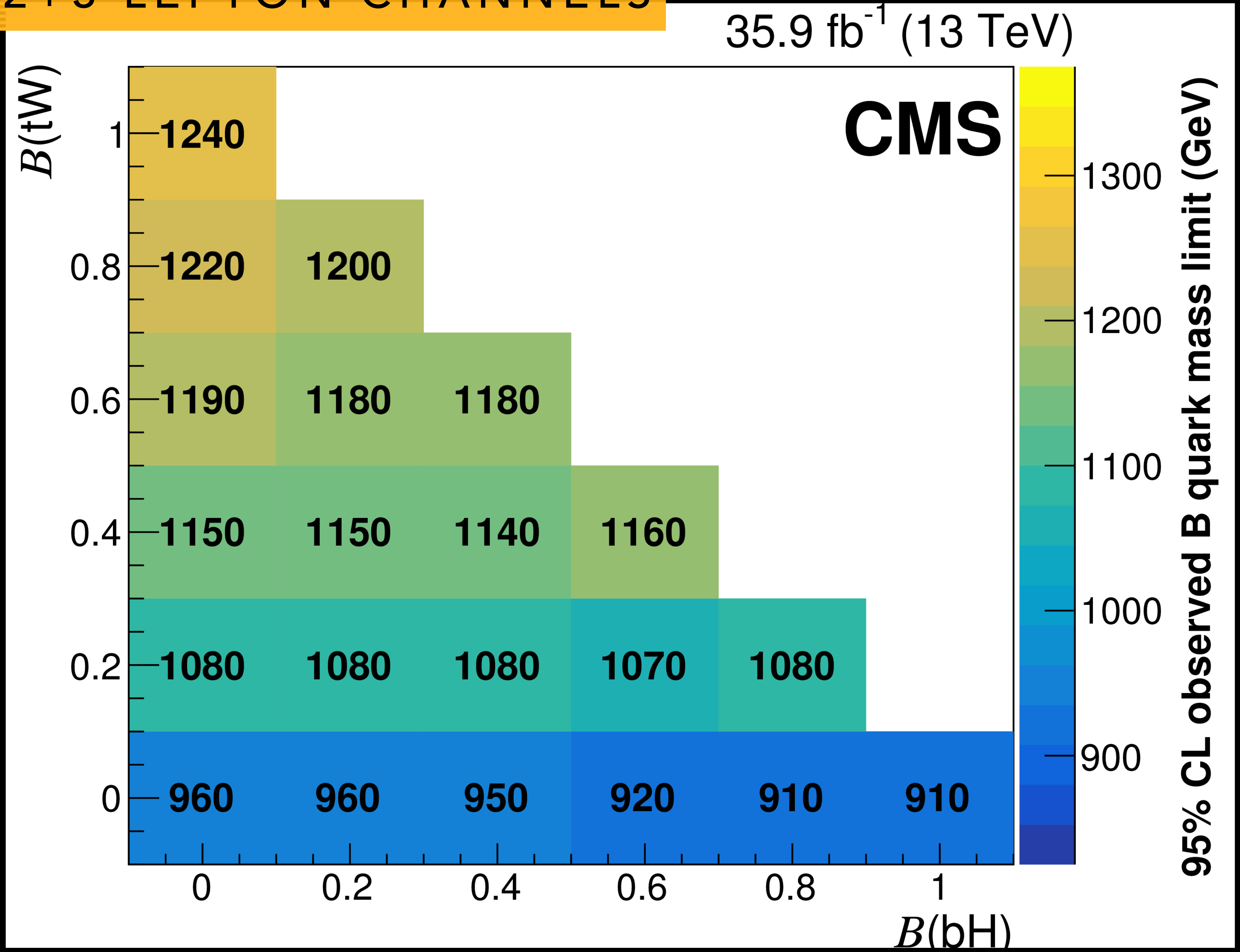
SUBMITTED TO PRL
arxiv.1808.02343

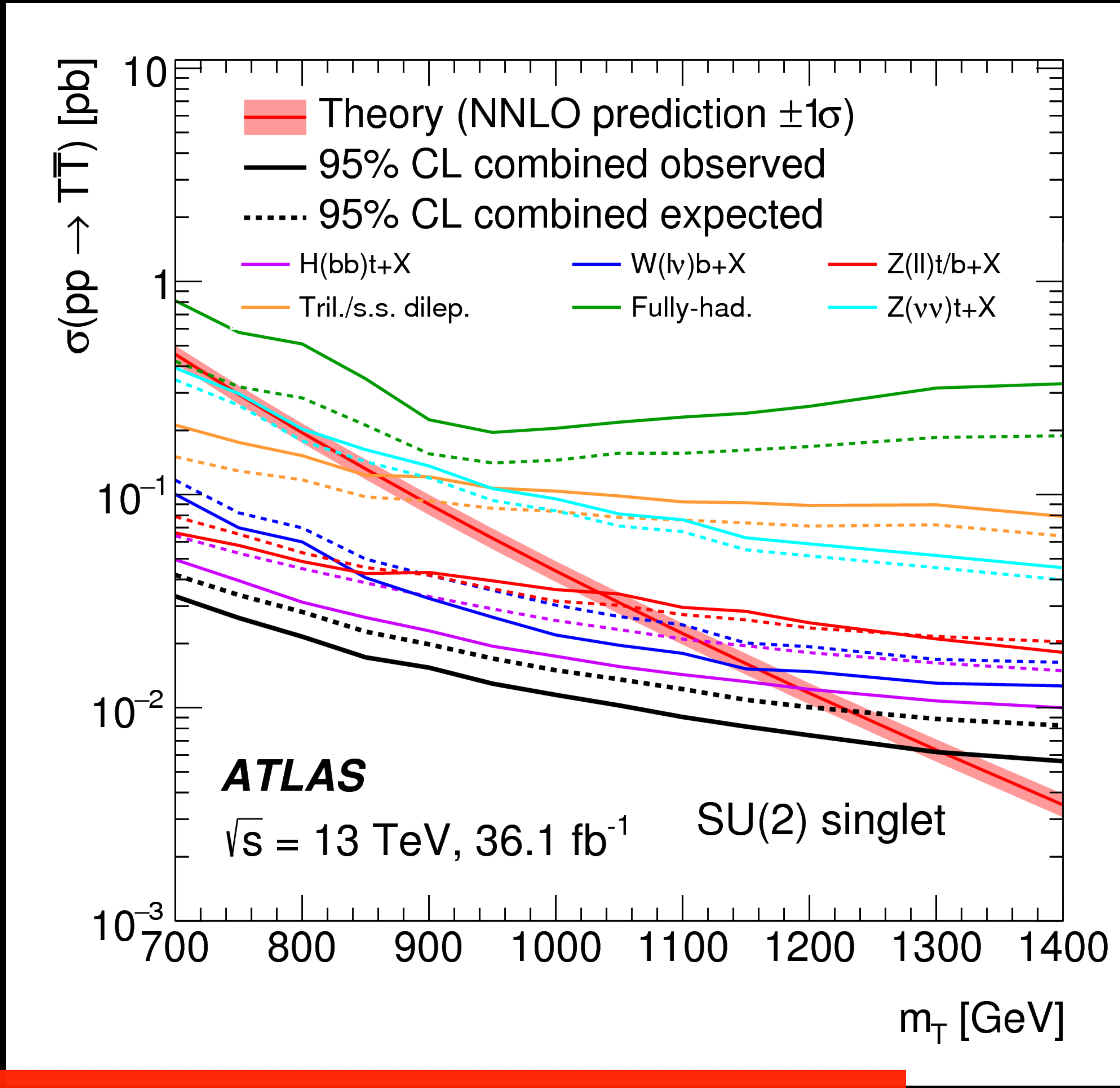
- Each analysis excludes the the different regions in the branching ratio triangles

- Combination of different analysis are giving the best sensitivity

COMBINATION OF
1+2+3 LEPTON CHANNELS

JHEP 08 (2018) 177





STRONG SENSITIVITY WITH COMBINATIONS
FROM ATLAS AND CMS
SINGLET T(B) UP TO 1.31(1.24)TEV

WE ARE LOOKING FOR NEW PHYSICS IN MANY WAYS…

SUSY

PRECISION

LEPTOQUARKS

RARE DECAYS

NEW GAUGE BOSONS

VECTOR LIKE QUARKS

DARK MATTER

...AND THERE ARE MUCH MORE SEARCHES THAT I COULD NOT MENTION...

SUMMARY

- LHC performing extremely well! Lots of data to analyse and much more data will be there
- Searches for new physics in a vast variety of channels
- Many new methods and performance studies to improve searches
- No significant excess found yet, but we are narrowing down the possibilities, excluding the significant portion of phase space and chasing for new physics eveywhere!

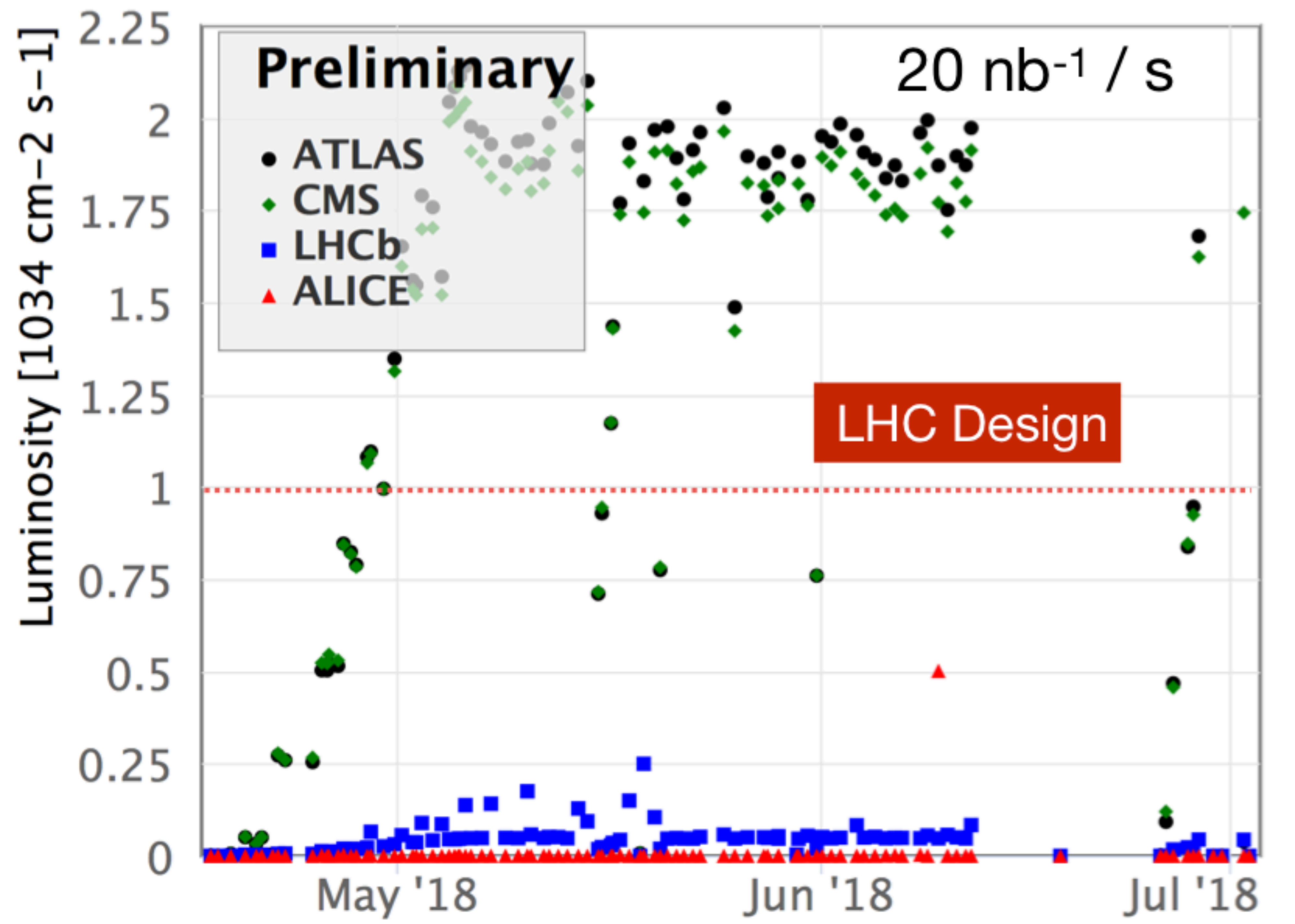
STAY TUNED FOR THE NEW RESULTS AND HOPEFULLY FOR NEW PHYSICS!

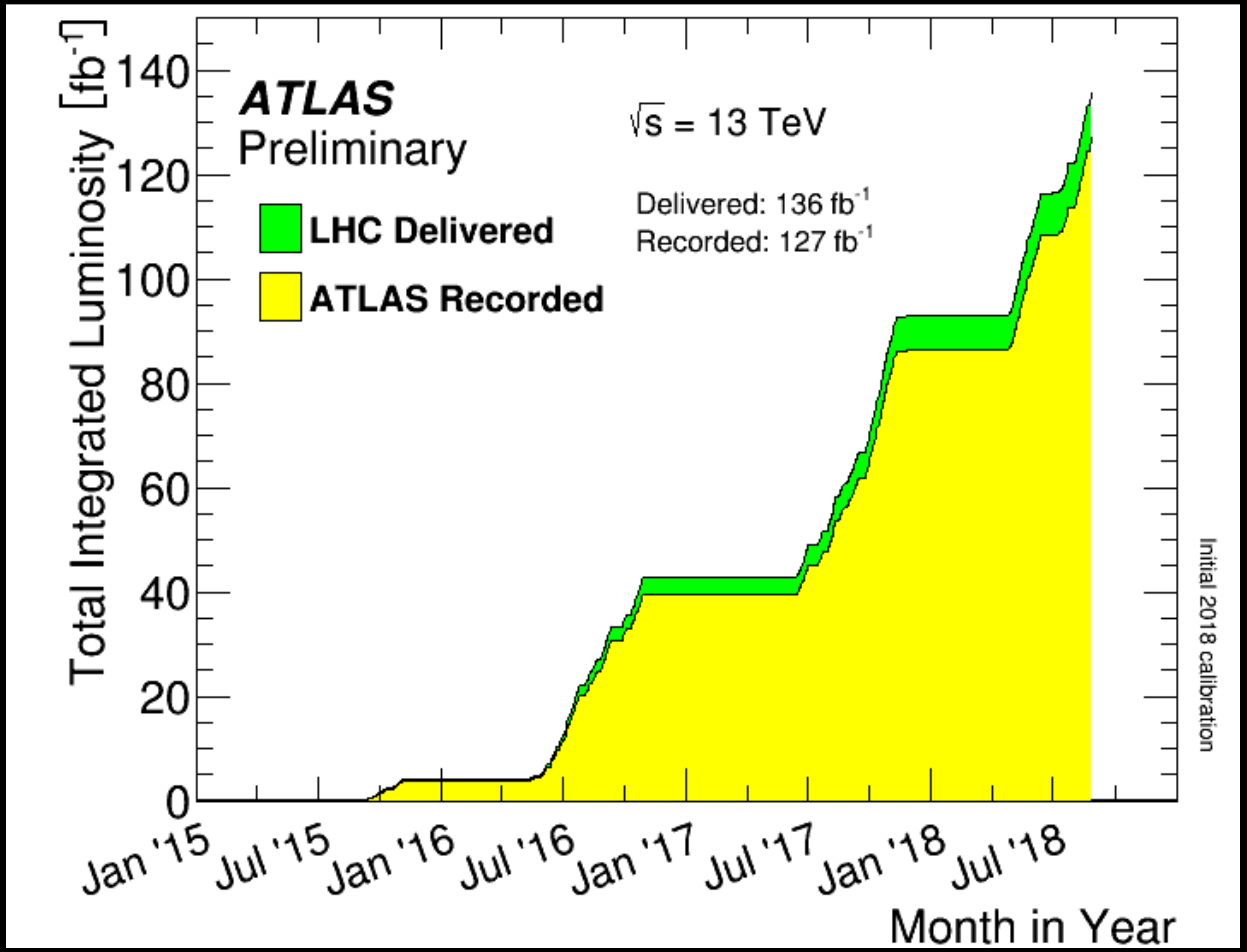
BACK UP

LARGE HADRON COLLIDER

LHC DATA/PERFORMANCE

- Excellent performance from LHC!
  - Doubled the design luminosity
  - Challenging conditions, large pile up





AT THE END OF RUN2:

150 FB^{-1} DATA TO ATLAS AND CMS
5 FB^{-1} DATA TO LHCB

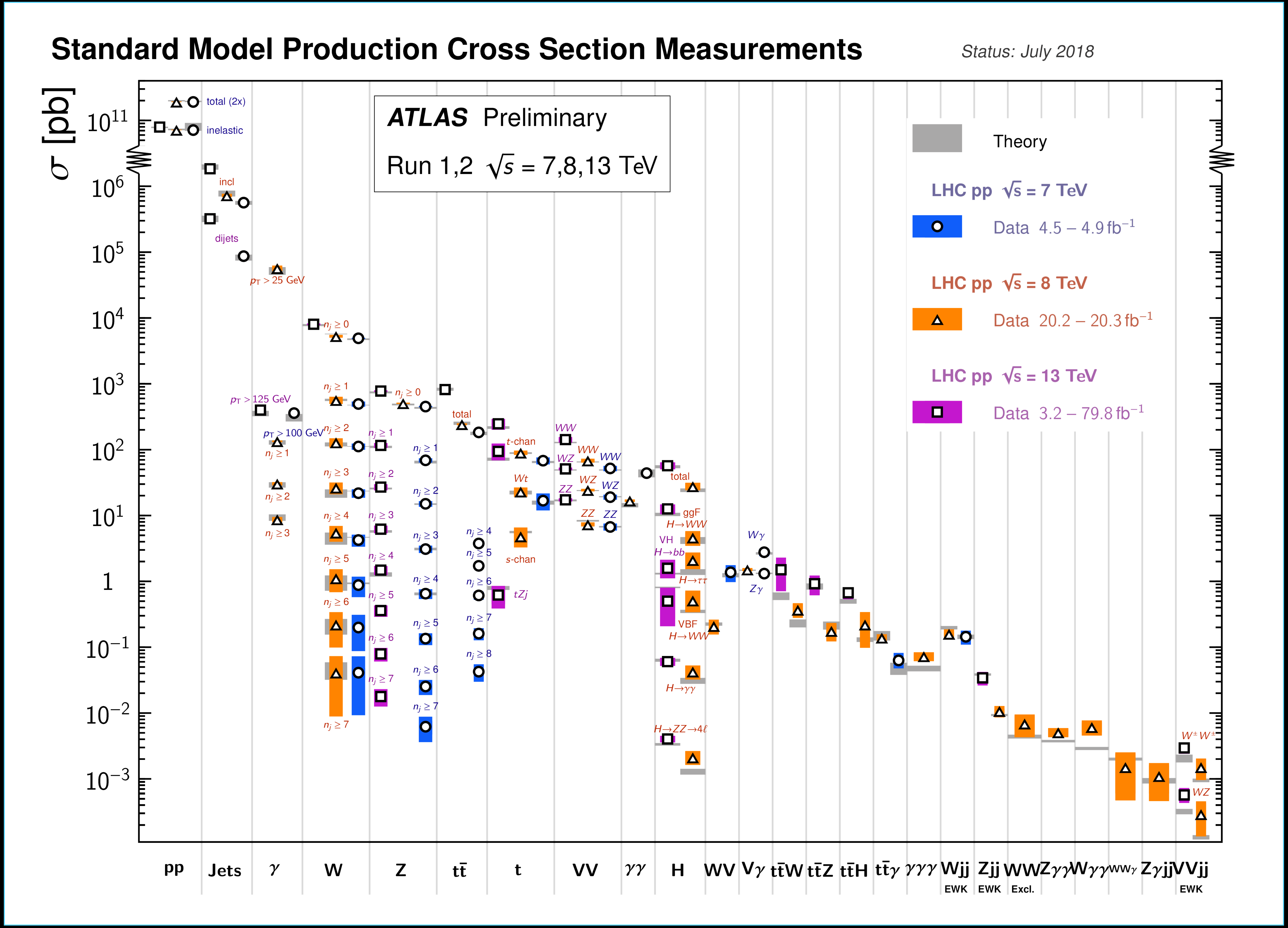
Plenty of data to analyse!

Exciting days ahead, more data will come!

RUN3:300 FB^{-1}

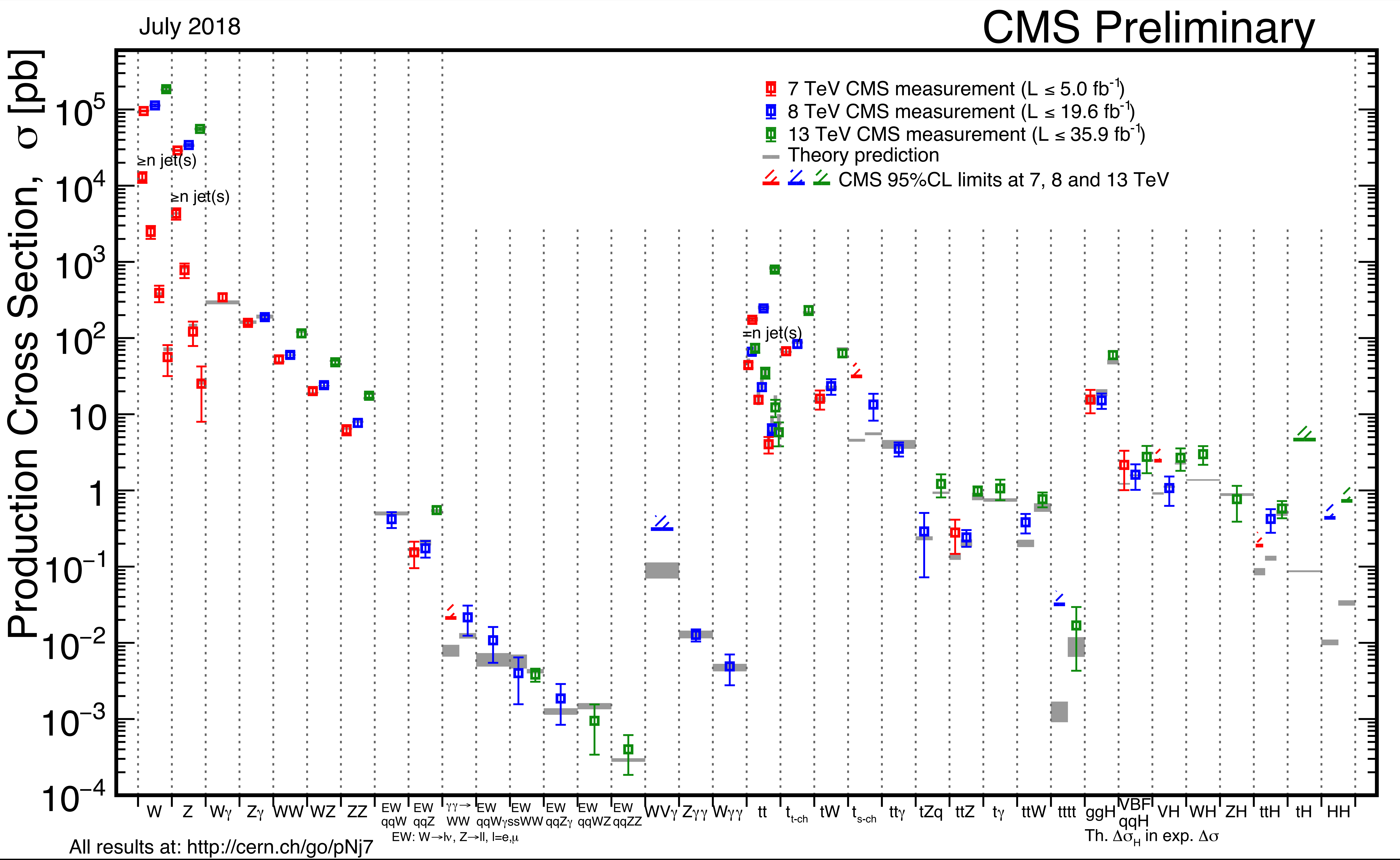
HIGH LUMINOSITY LHC:3000FB^{-1}

PRECISION



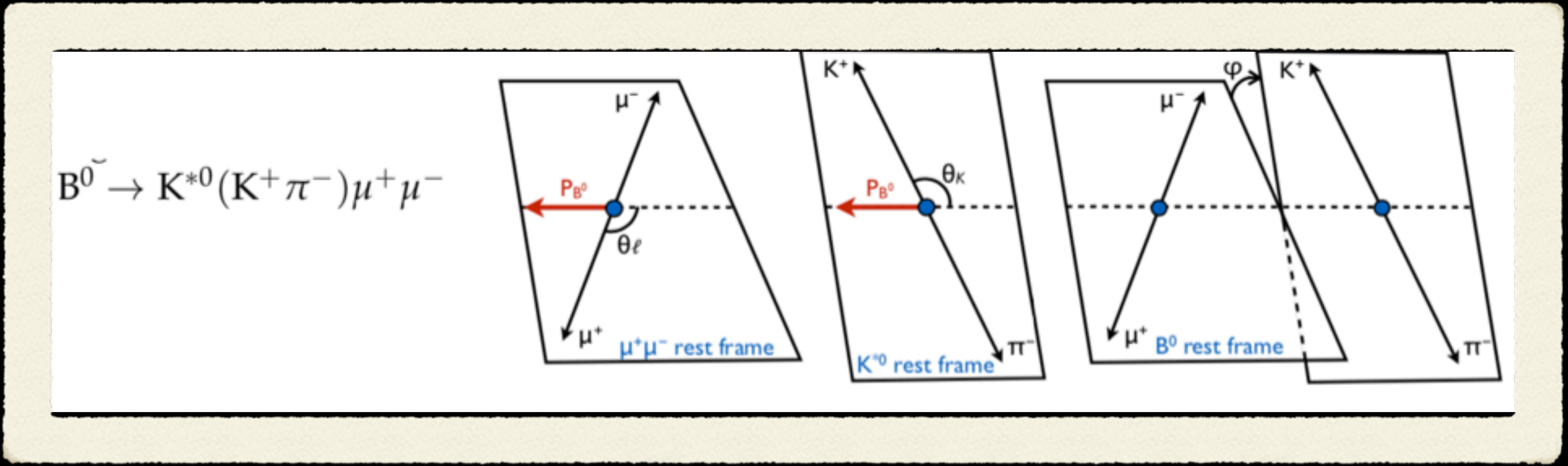
Standard Model Production Cross Section Measurements
Status: July 2018
ATLAS Preliminary
Run 1,2 √s = 7,8,13 TeV
Theory
LHC pp √s = 7 TeV
Data 4.5 – 4.9 fb⁻¹
LHC pp √s = 8 TeV
Data 20.2 – 20.3 fb⁻¹
LHC pp √s = 13 TeV
Data 3.2 – 79.8 fb⁻¹
σ [pb]
pp
Jets
γ
W
Z
tt̄
t
VV
γγ
H
WV
Vγ
tt̄W
tt̄Z
tt̄H
tt̄γ
γγγ
Wjj EWK
Zjj EWK
WW Excl.
Zγγ
Wγγ
WWγ
Zγjj
VVjj EWK

PRECISION



July 2018
CMS Preliminary
Production Cross Section, σ [pb]
7 TeV CMS measurement (L ≤ 5.0 fb-1)
8 TeV CMS measurement (L ≤ 19.6 fb-1)
13 TeV CMS measurement (L ≤ 35.9 fb-1)
Theory prediction
CMS 95%CL limits at 7, 8 and 13 TeV
≥n jet(s)
≥n jet(s)
≥n jet(s)
W Z Wγ Zγ WW WZ ZZ EW qqW EW qqZ γγ→WW EW qqWγ EW ssWW EW qqZγ EW qqWZ EW qqZZ WVγ Zγγ Wγγ tt t-ch tW s-ch ttγ tZq ttZ tγ ttW tttt ggH VBF qqH VH WH ZH ttH tH HH
EW: W→lν, Z→ll, l=e,μ
Th. Δσ_H in exp. Δσ
All results at: http://cern.ch/go/pNj7

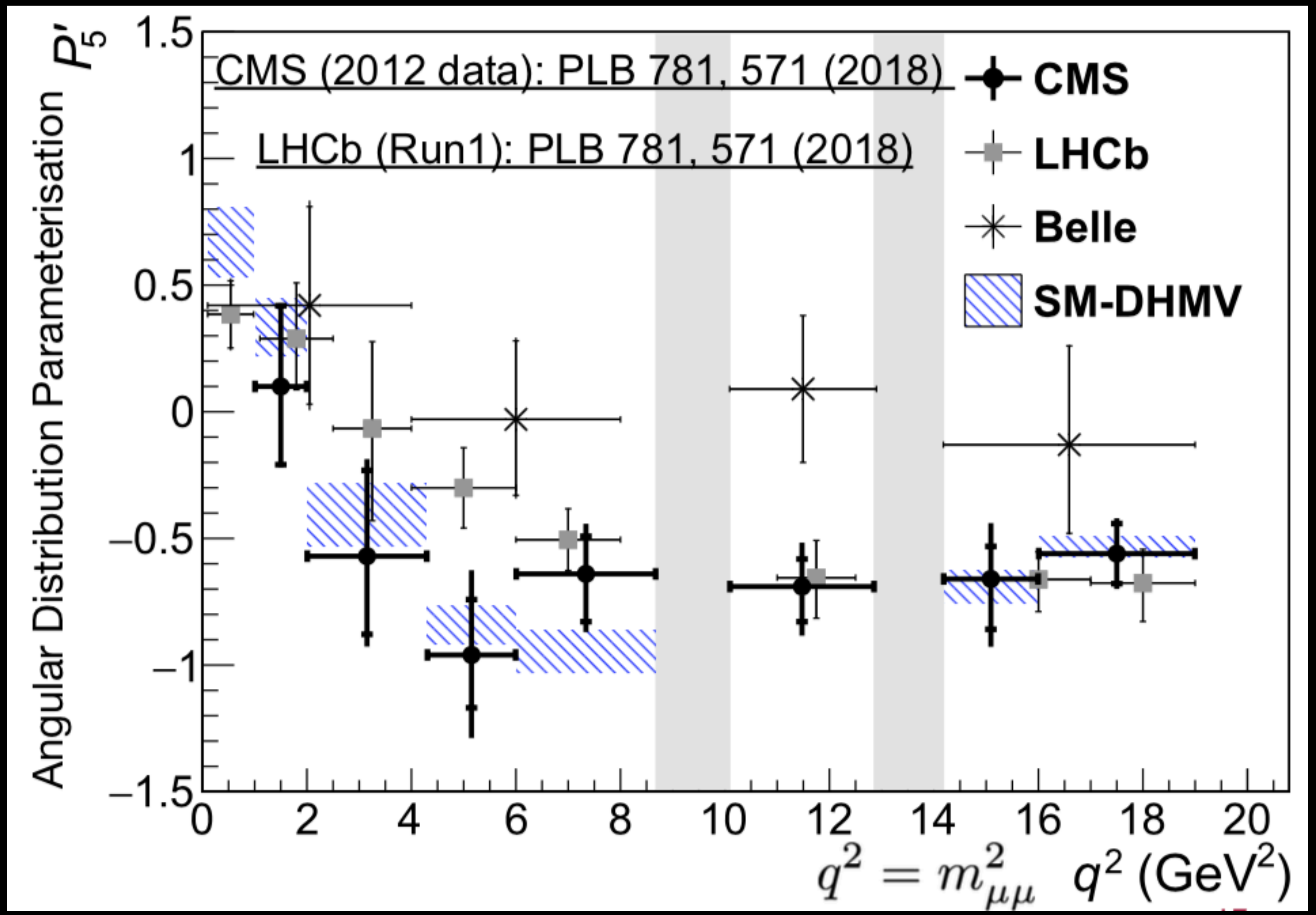
ANOMALIES IN ANGULAR DISTRIBUTIONS



See P.Krokovny's talk

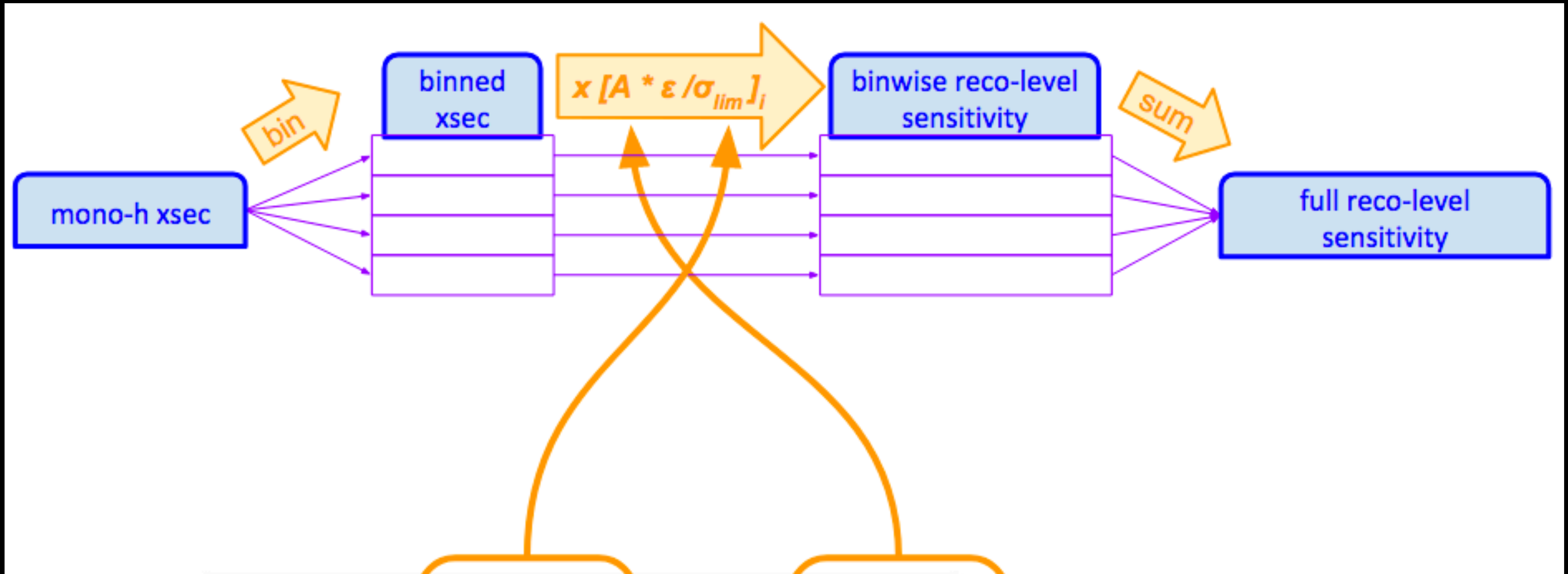
- More statistic is needed!

UP TO 3.4σ
STANDARD DEVIATION



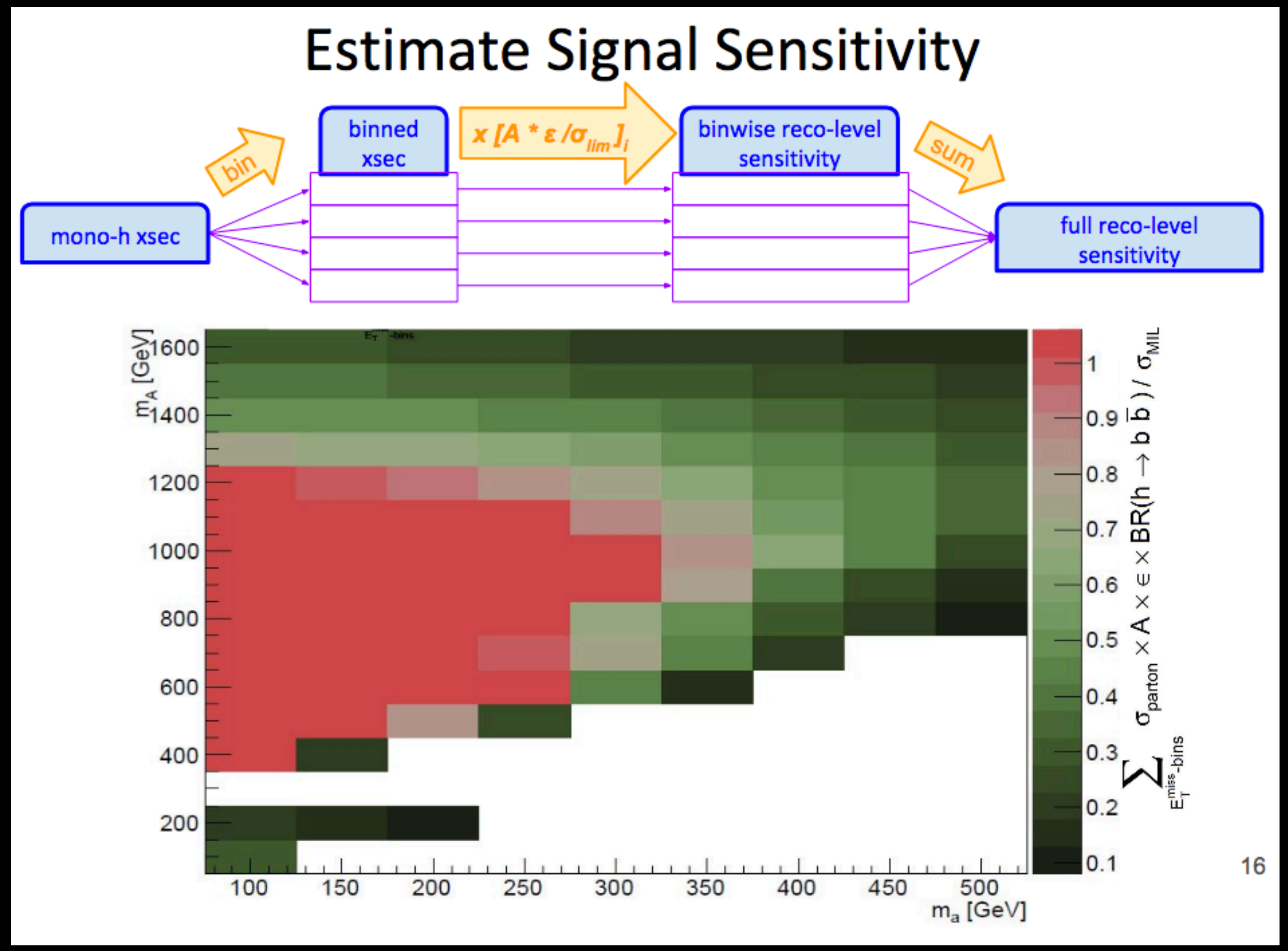
MODEL INDEPENDENT LIMITS

SEE THE
TALK FROM L.HENKELMANN



Range in E_T^{miss} [GeV]	$\sigma^{obs}_{vis,h(b\bar{b})+DM}$ [fb]	$\sigma^{exp}_{vis,h(b\bar{b})+DM}$ [fb]	$\mathcal{A}\times\varepsilon$ [%]
[150, 200)	19.1	$18.3^{+7.2}_{-5.1}$	15
[200, 350)	13.1	$10.5^{+4.1}_{-2.9}$	35
[350, 500)	2.4	$1.7^{+0.7}_{-0.5}$	40
[500, ∞)	1.7	$1.8^{+0.7}_{-0.5}$	55

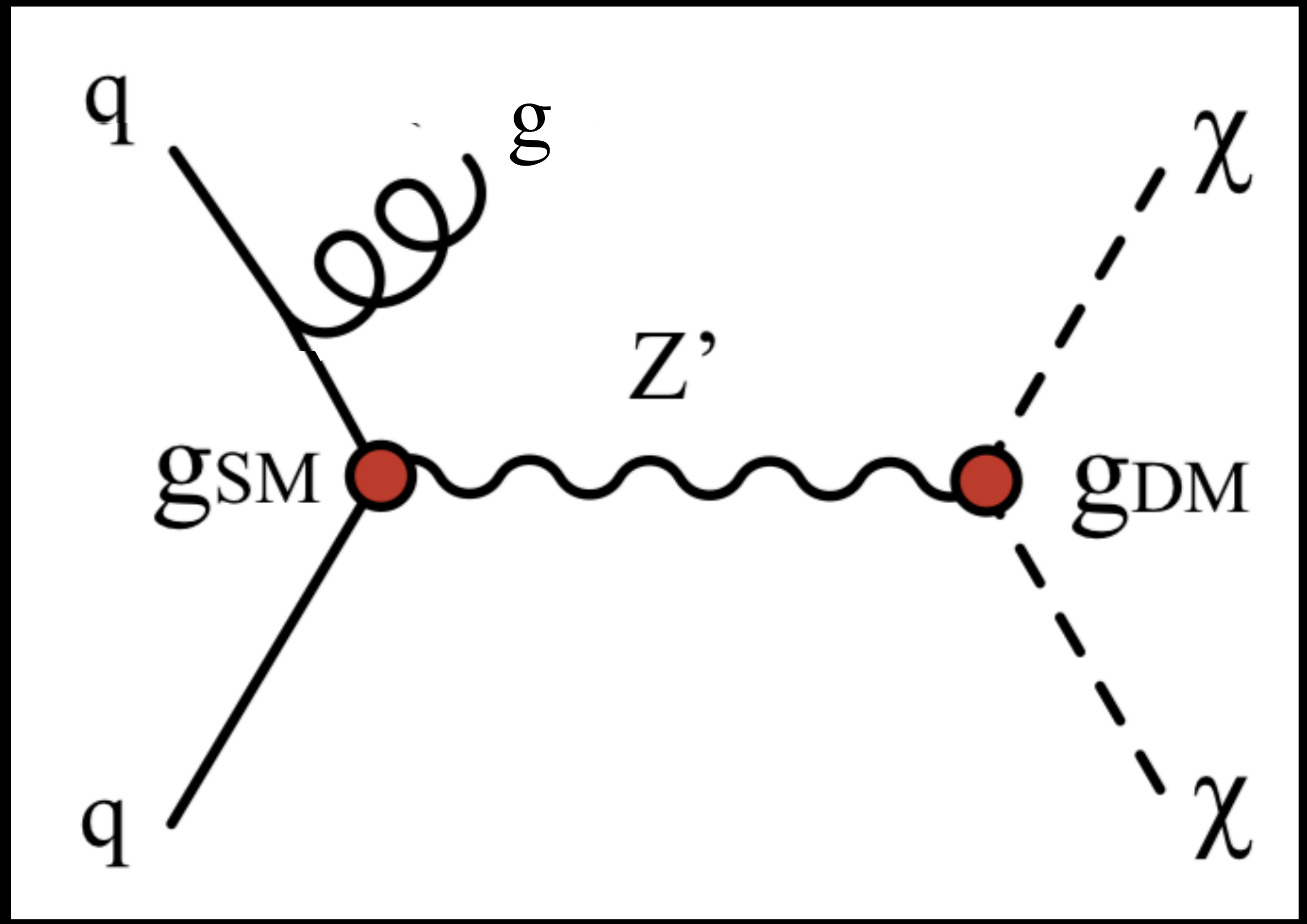
talk from
DM@LHC2018

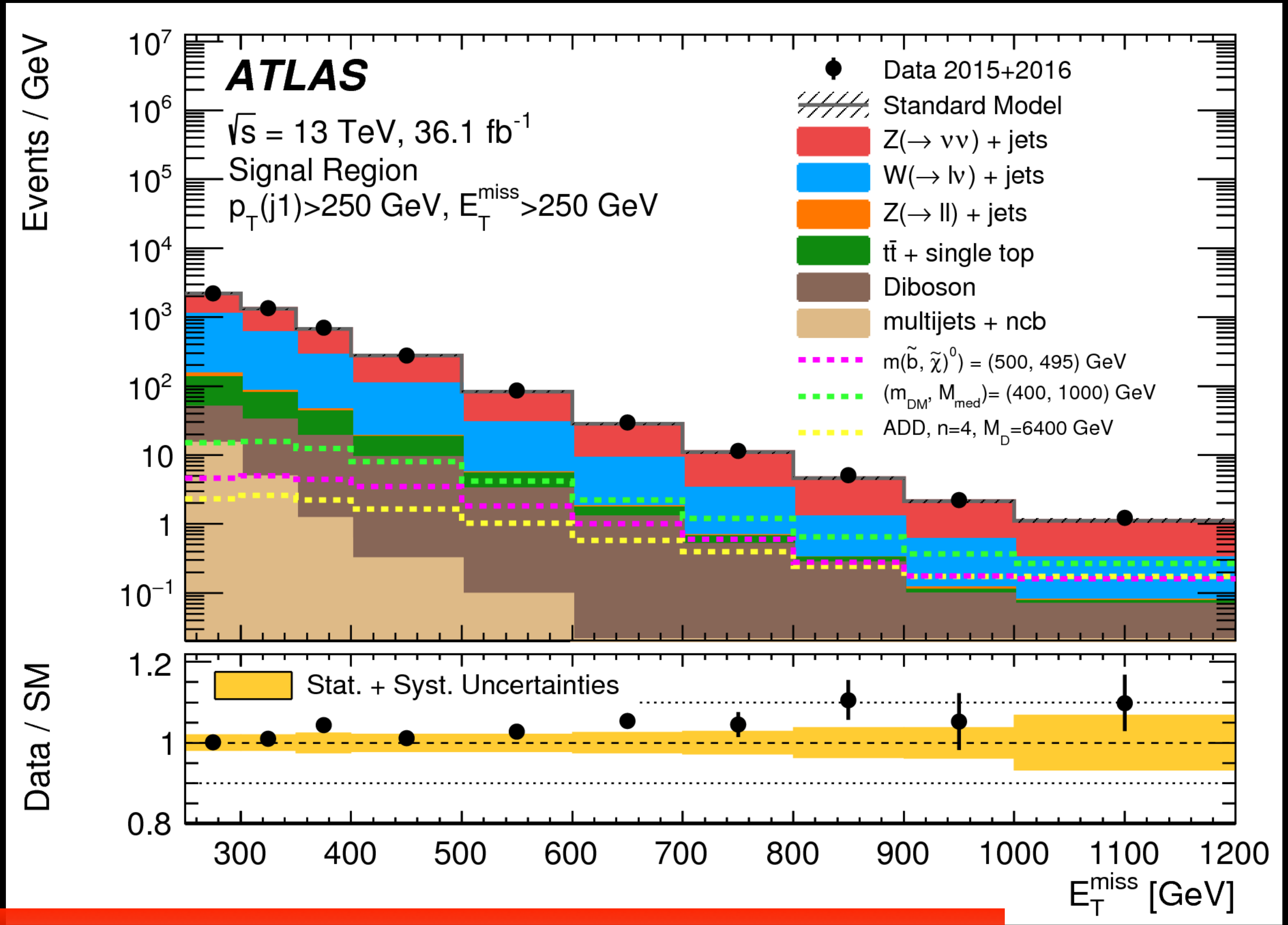


MONO-JET SEARCHES

JHEP 01 (2018) 126

- Initial state radiation jet recoils against missing transverse energy (E_T^{miss})
  - Not only DM, weakly interacting new particles: SUSY, extra dimensions
- Search for an excess in the E_T^{miss} spectrum
- Dominant background : Z(νν)+jets
- Ongoing work to reduce the systematics!

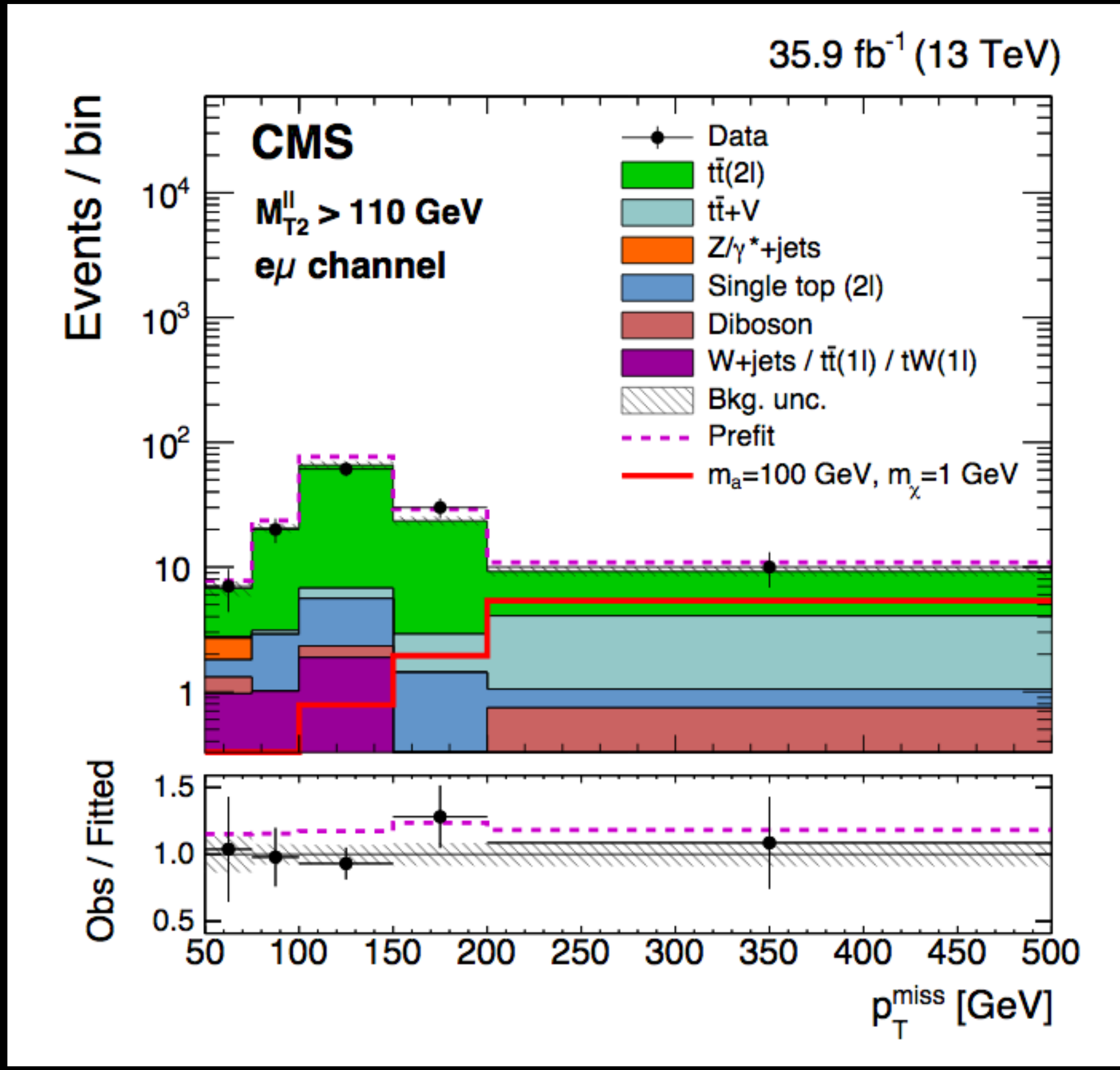


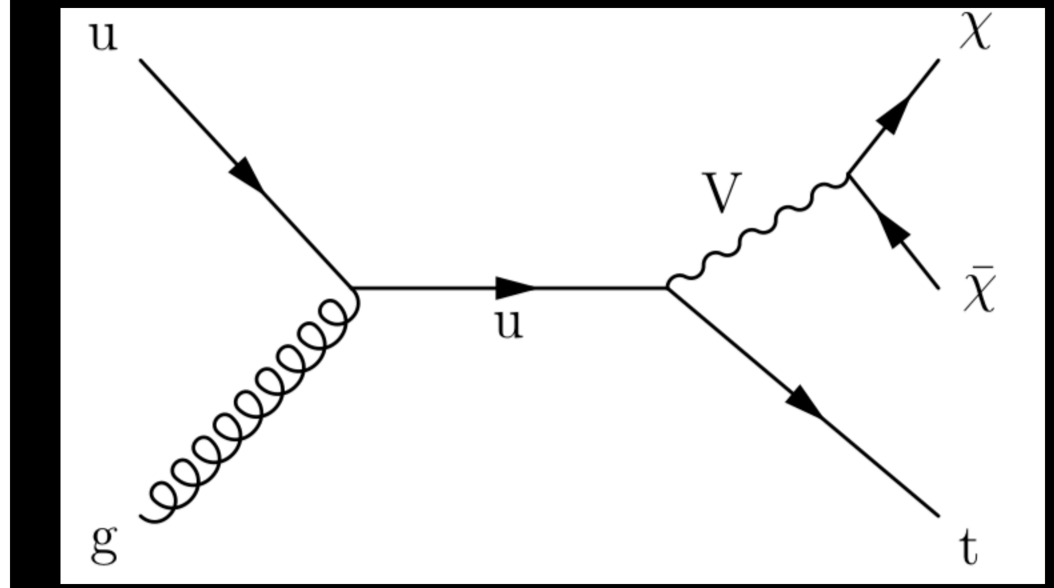


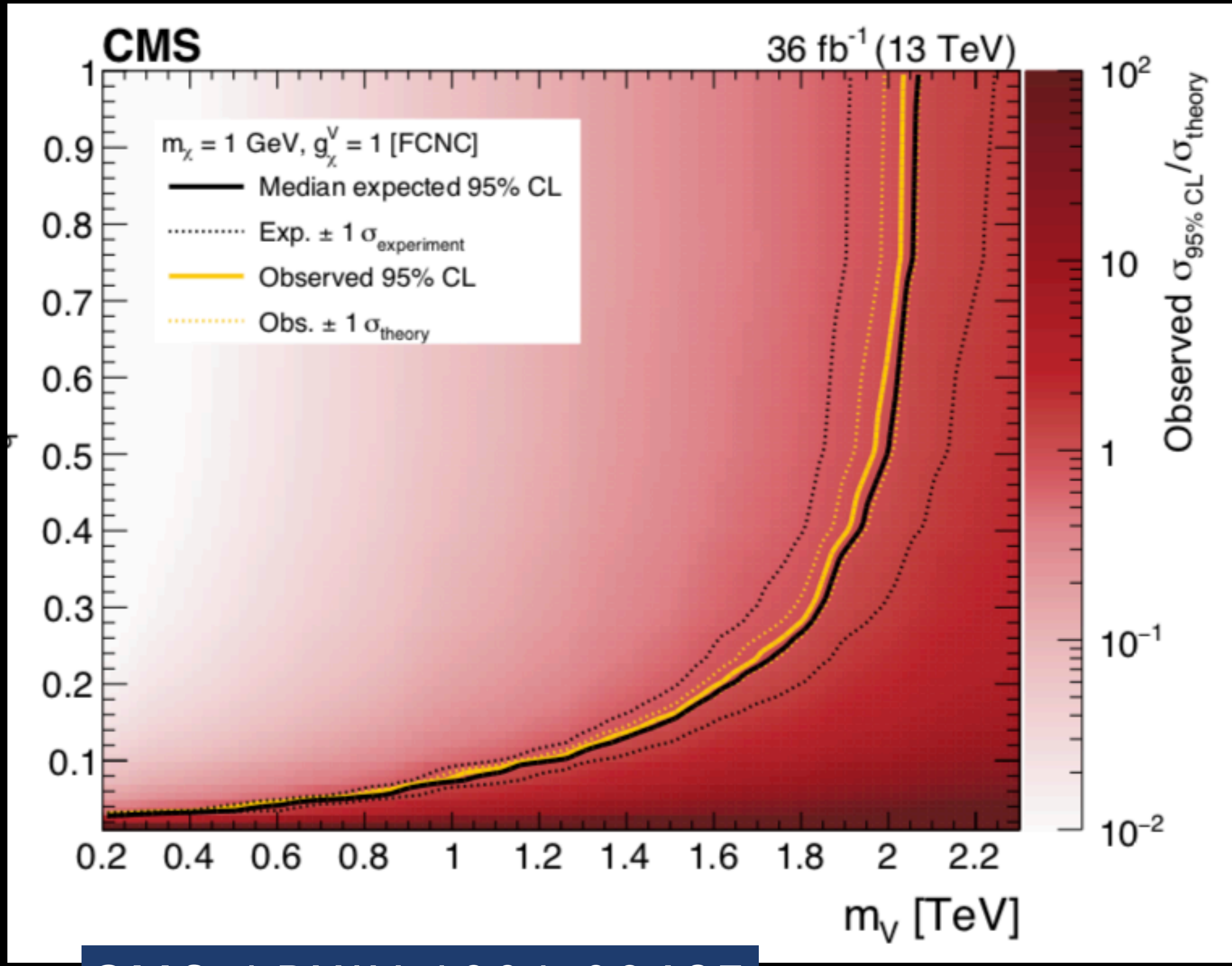
ONE SIGNATURE MANY INTERPRETATION

MONO-TOP SEARCHES

CMS, ARXIV:1807.06522





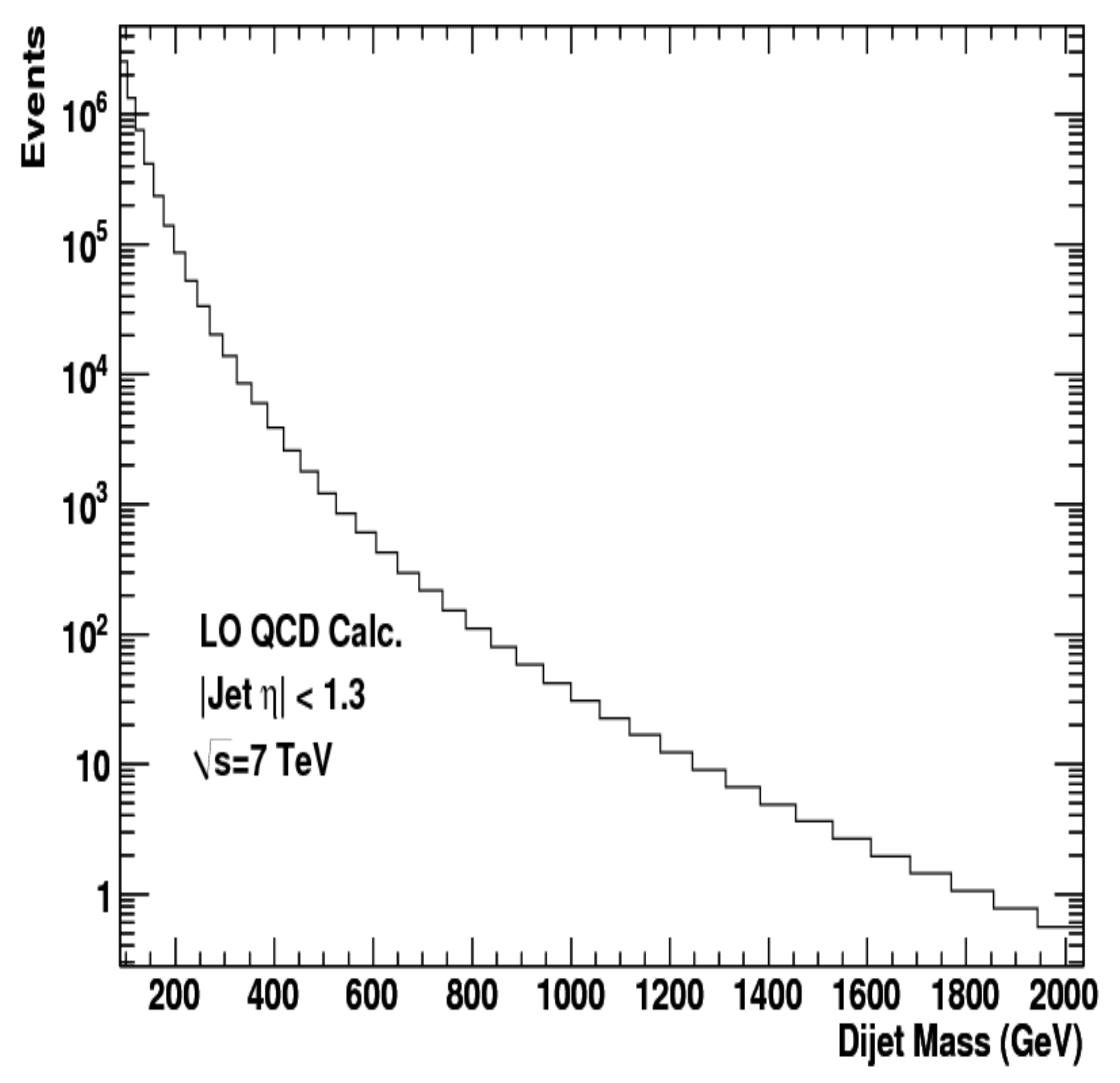


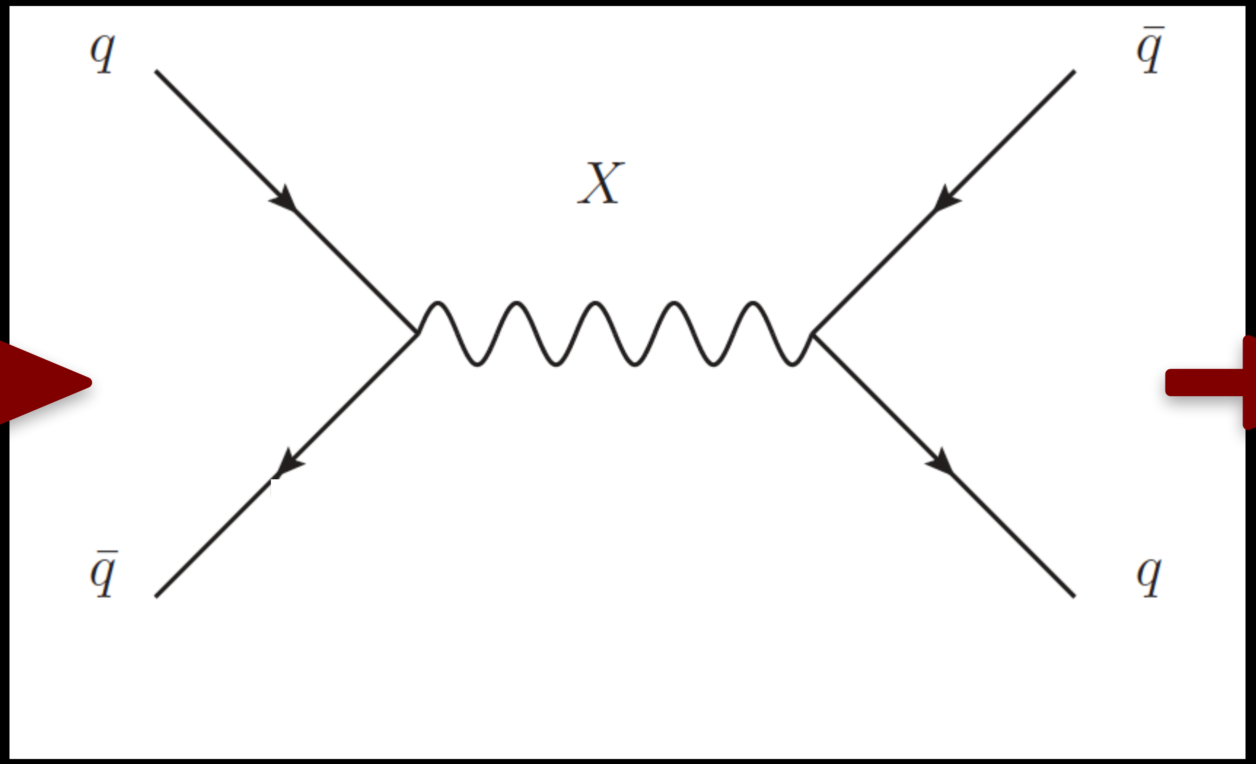
CMS, ARXIV:1801.08427

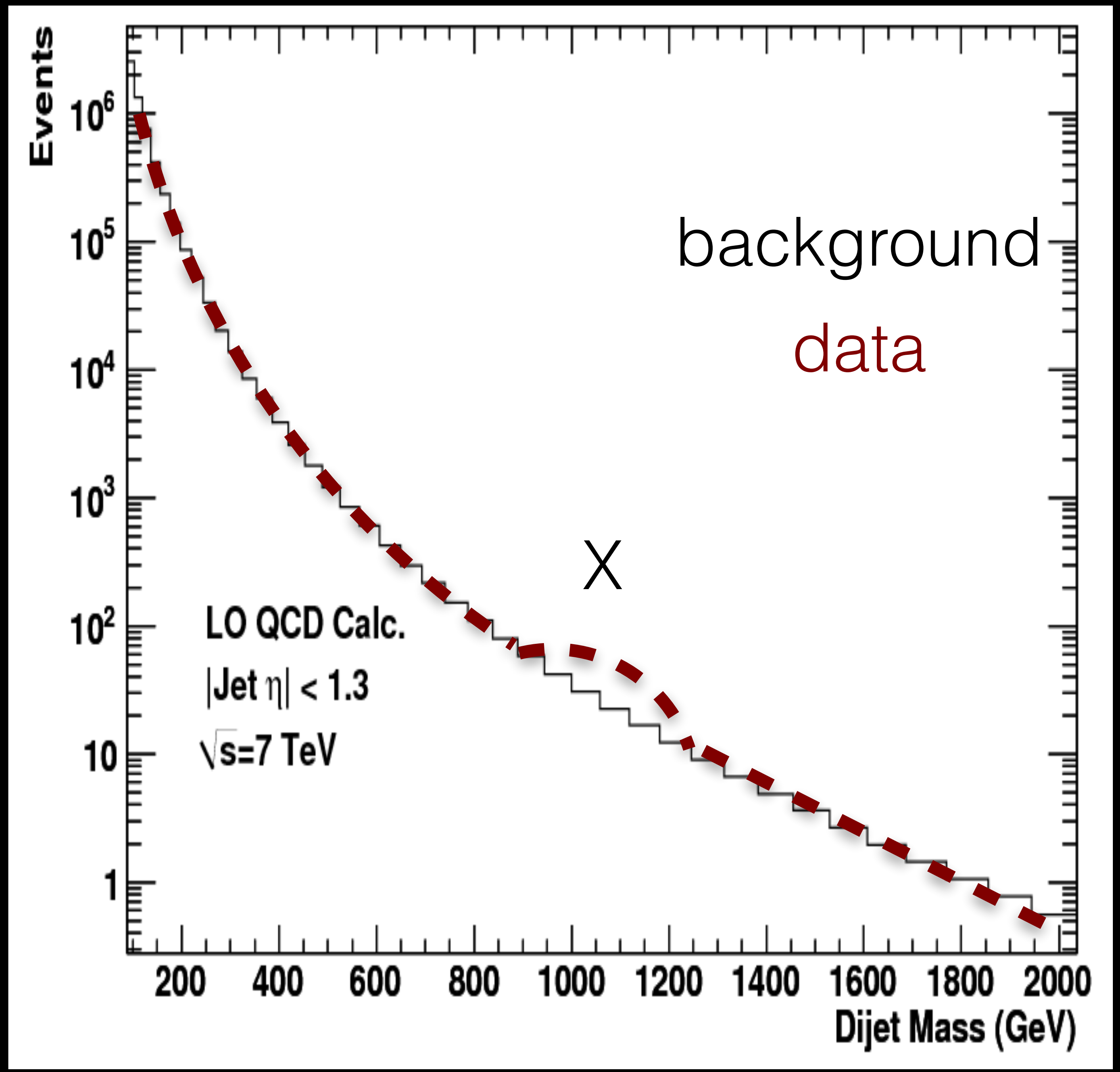
- DM association with tops
  - Strong limits!

- DM association with tops
  - Hadronic decay channel with top tagging methods
    - Assuming FCNC

A TYPICAL DIJET RESONANCE SEARCH







☞ OVERWHELMING LARGE DIJET BACKGROUND

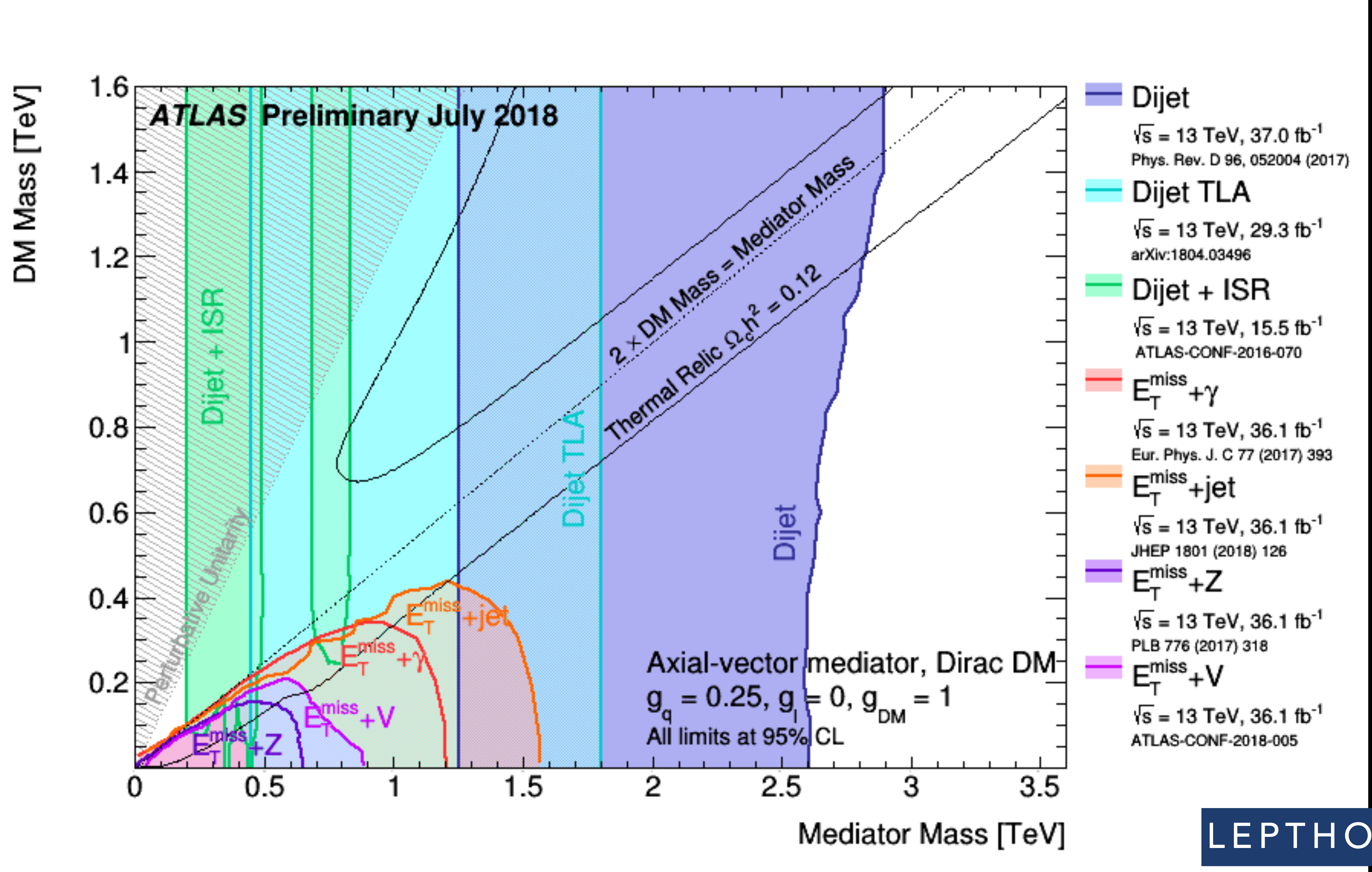
☞ UPPER BOUND ON THE RESONANCE MASS LIMITED BY THE COLLISION ENERGY

☞ GOING TO LOWER MASS POINTS CHALLENGING DUE TO THE LARGE BACKGROUND

☞ **NEW APPROACHES NEEDED TO EXPLORE LOWER MASS VALUES ✓**

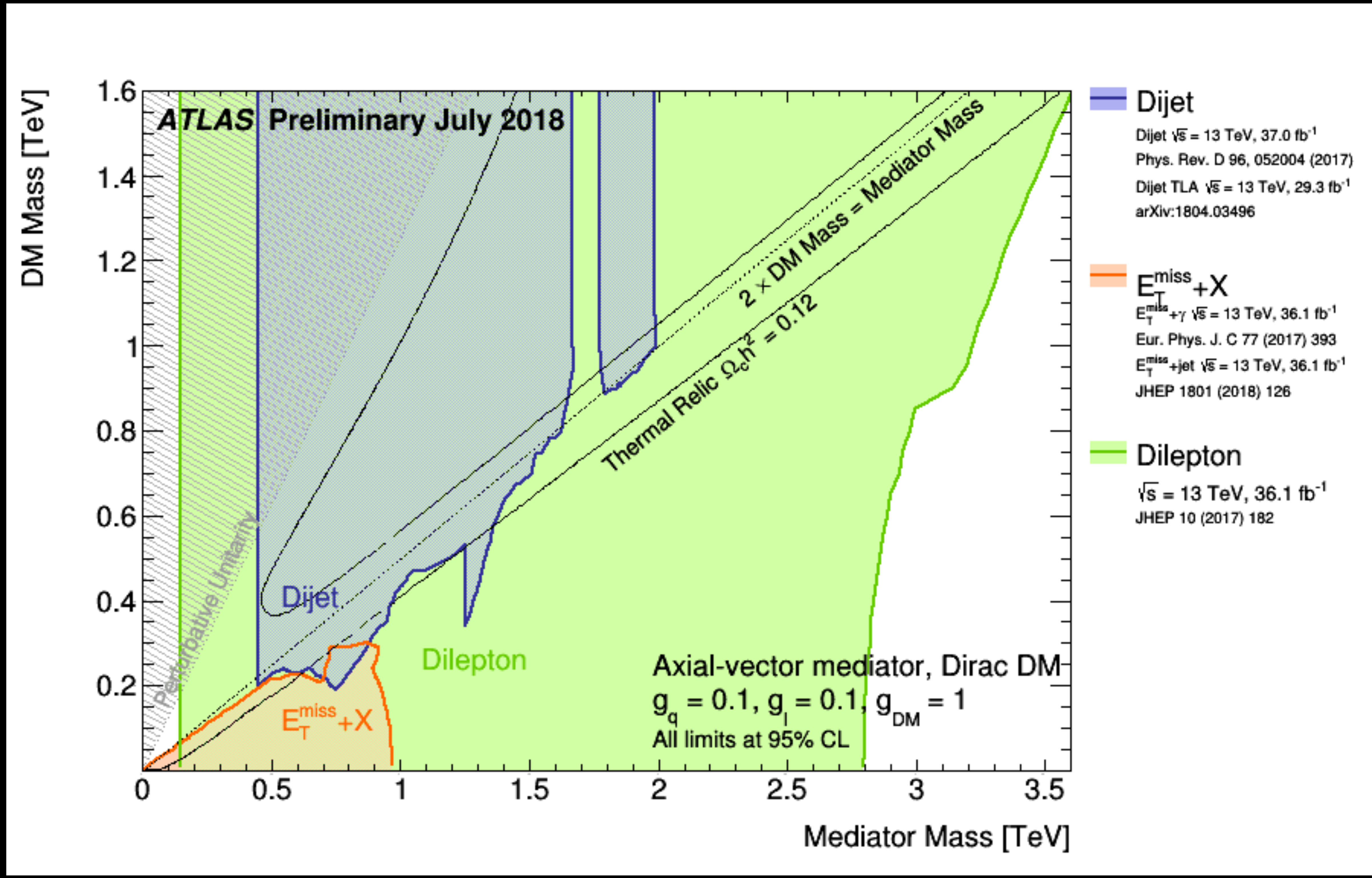
DARK MATTER SUMMARY

Combining the results from mono-X and dijet searches

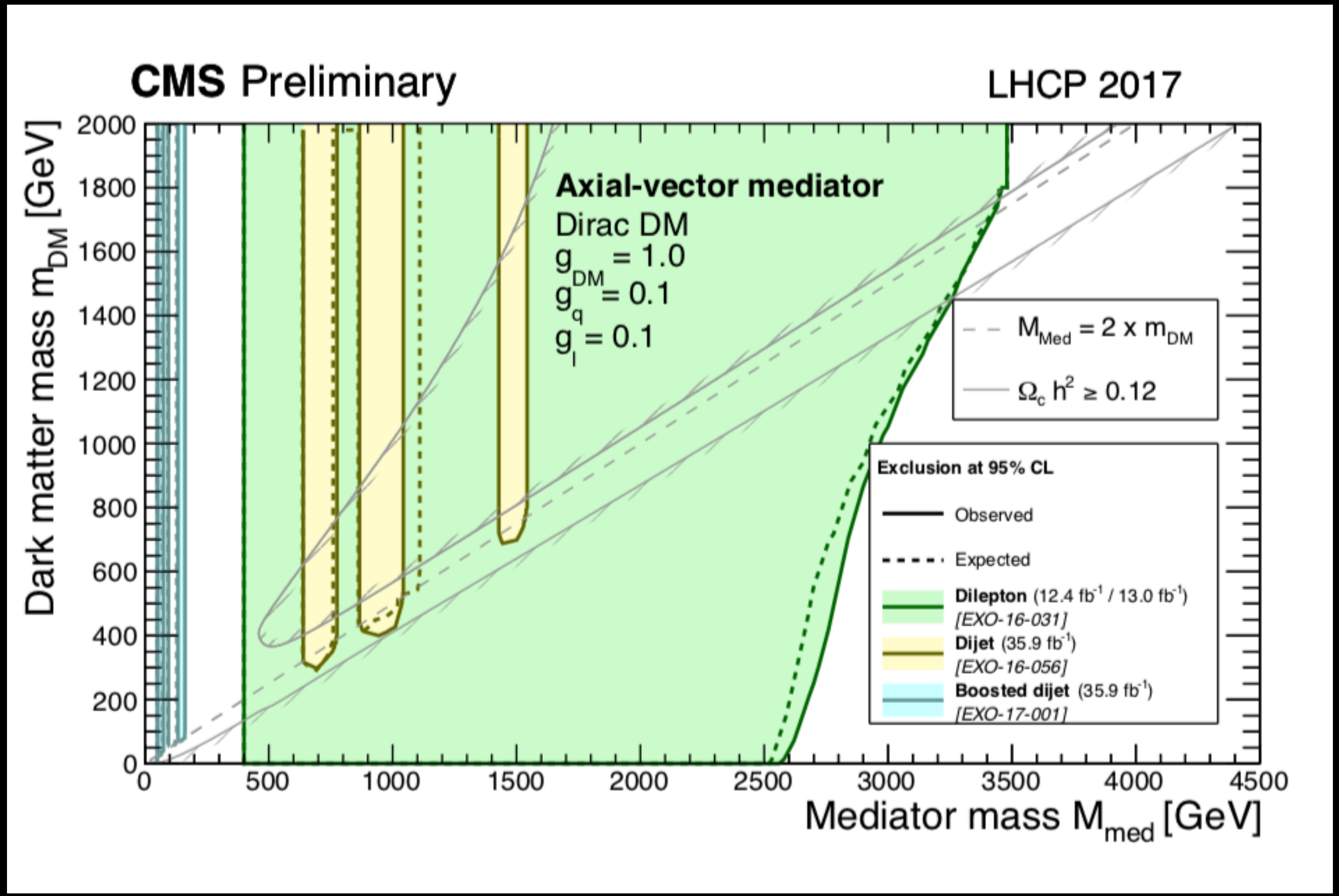


LEPTHOPHOBIC

DARK MATTER SUMMARY



ATLAS LEPTHOPHILIC



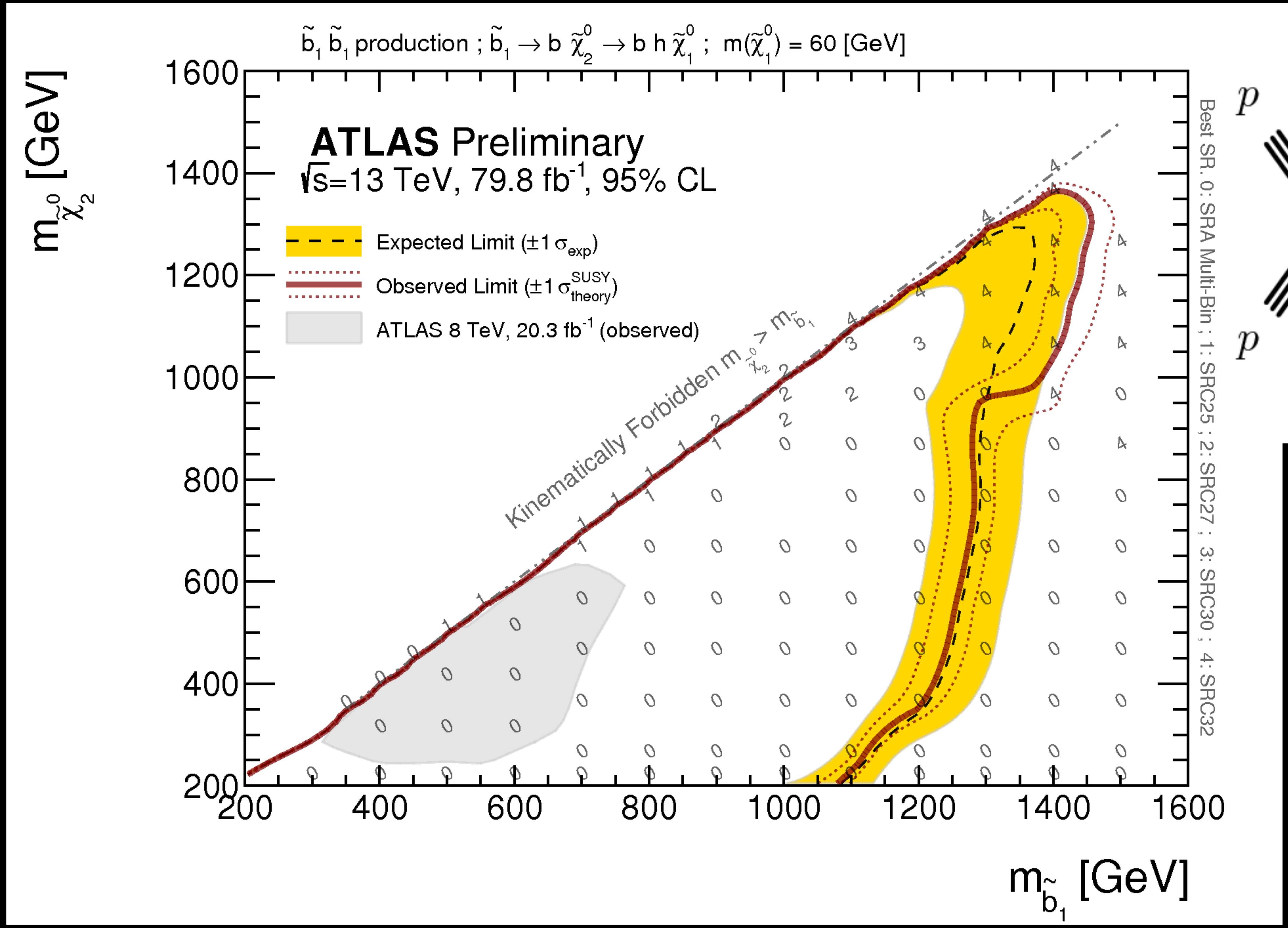
CMS LEPTHOPHILIC

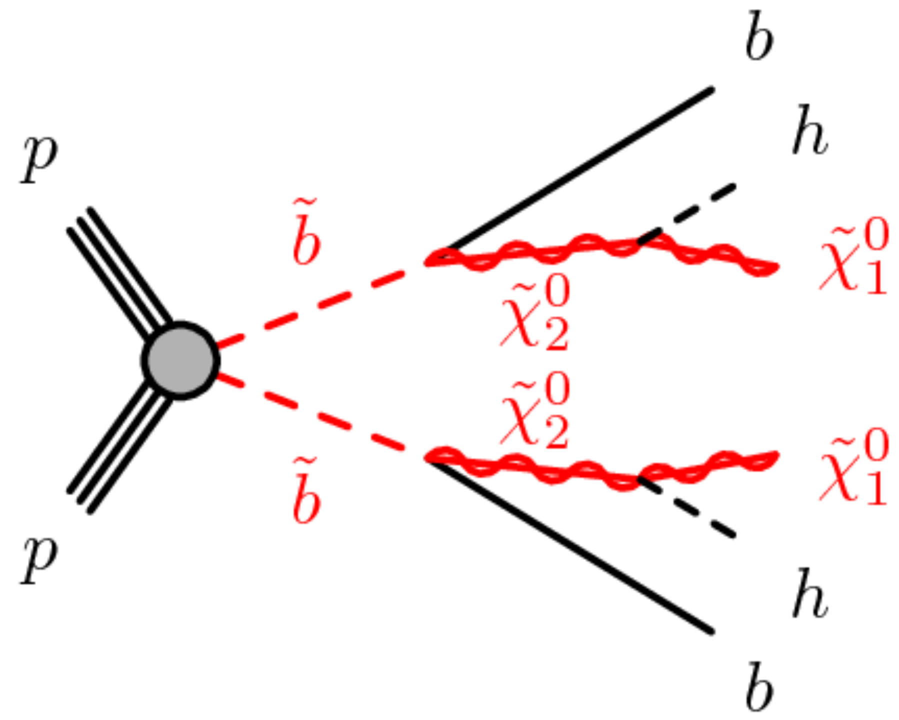
SUSY: SIMPLIFIED MODELS

ATLAS-CONF-2018-040

USING 79.8 FB-1 DATA

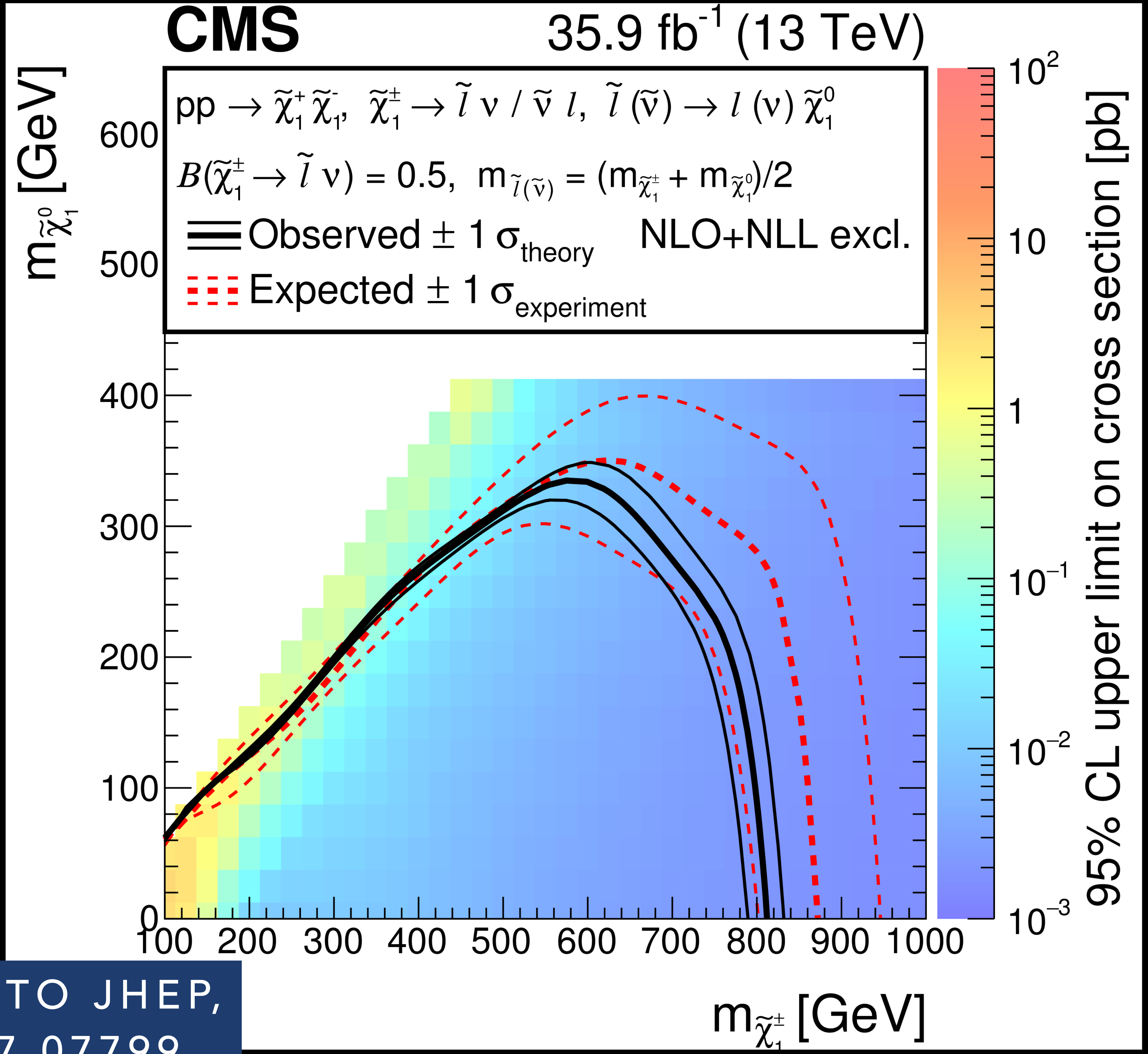
Search for the bottom-squark pair production
0 leptons, 3 or more b-jets and E_T^{miss}



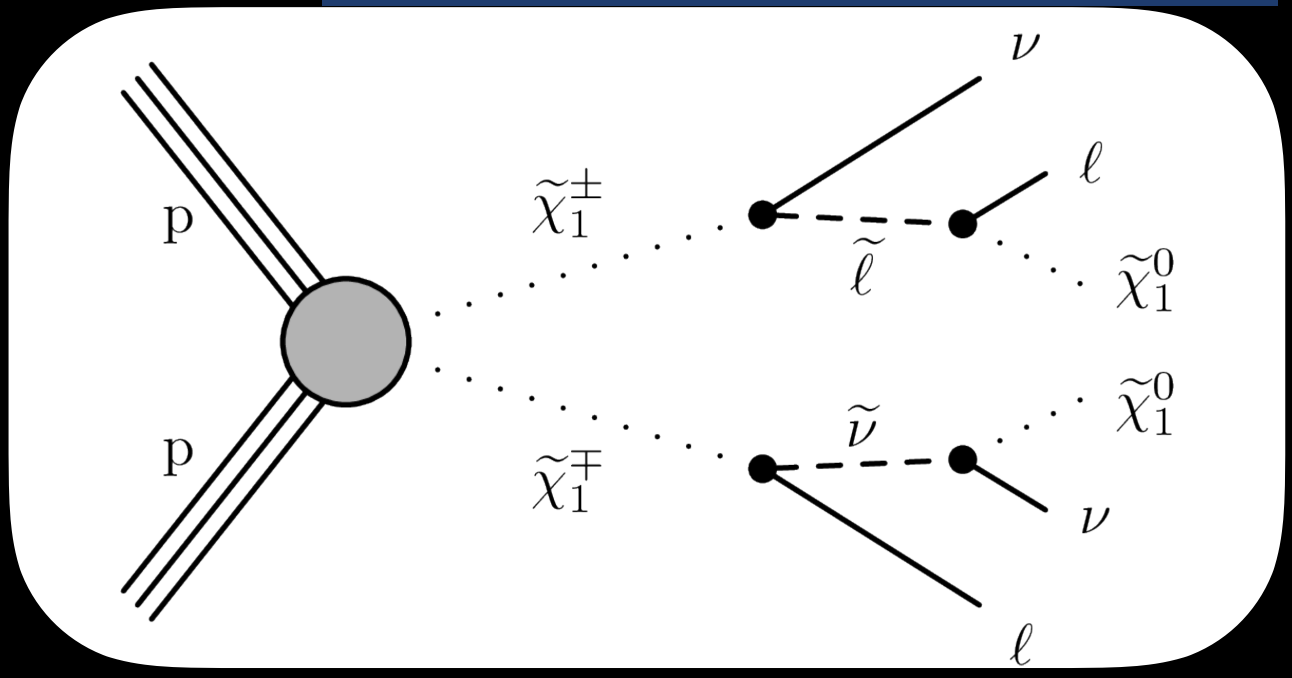


UP TO 1.4 TEV EXCLUSION FOR BOTTOM-SQUARK MASS

Chargino and stop pair production
2 opposite charged leptons, large E_T^{miss}



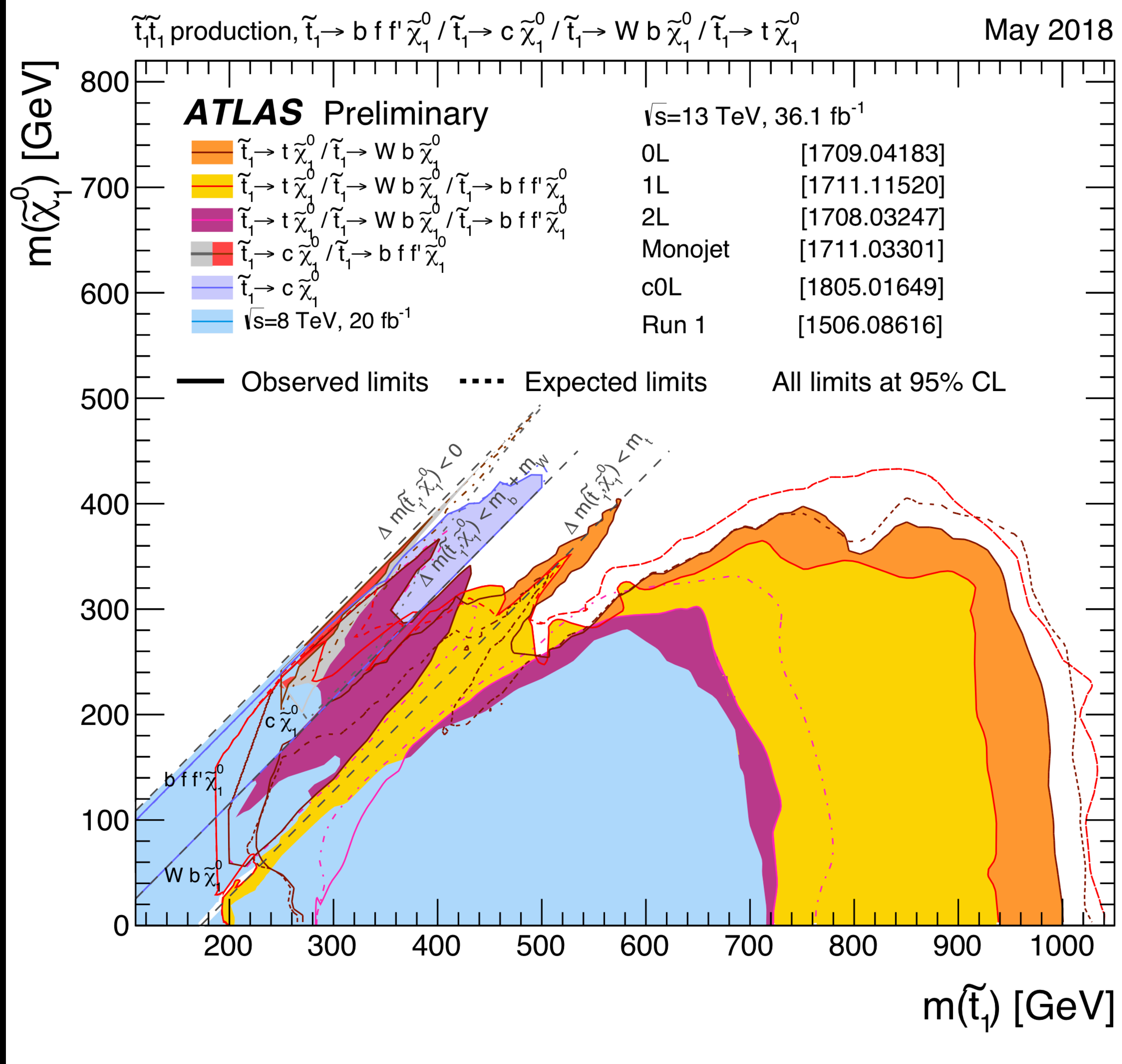
SUBMITTED TO JHEP, ARXIV.1807.07799



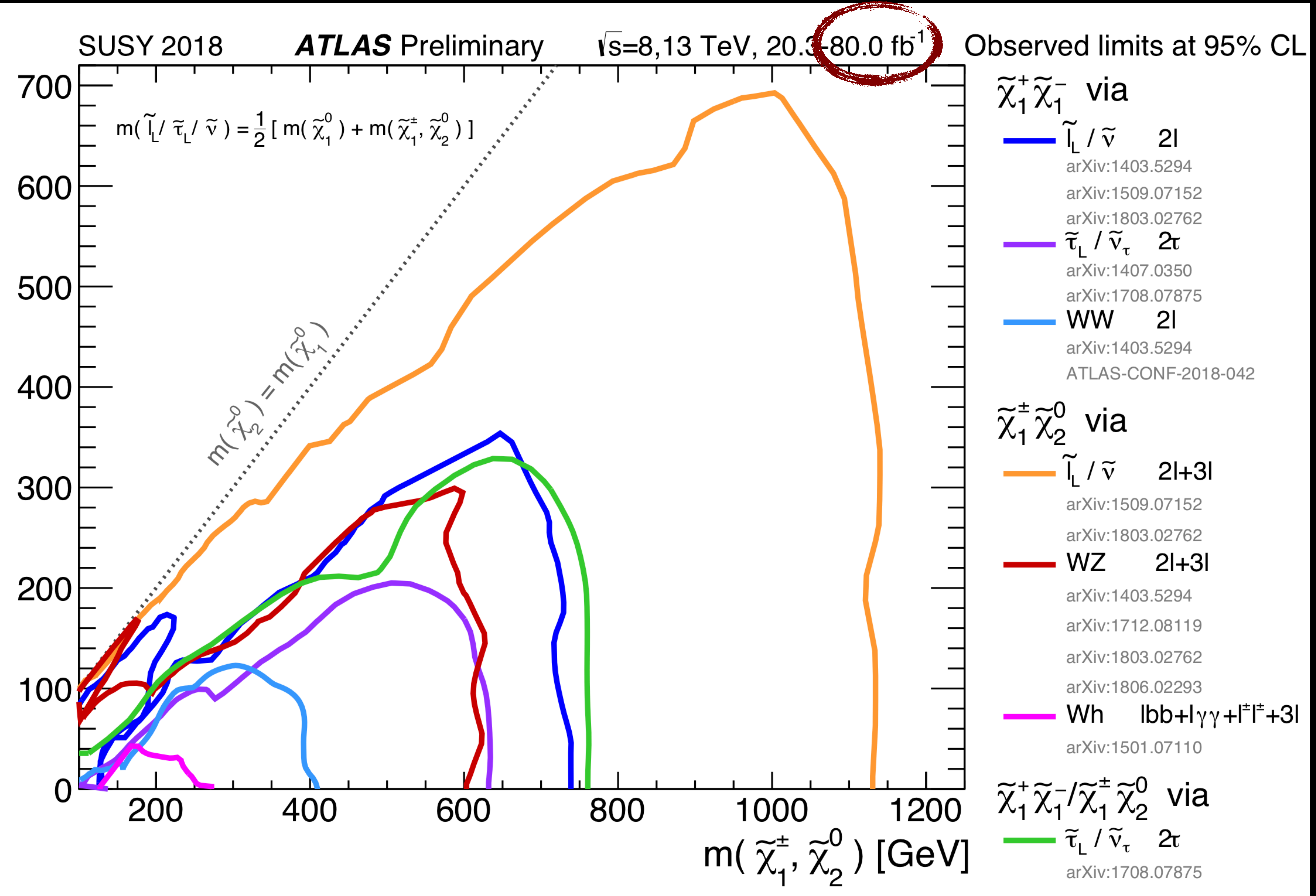
UP TO 800(320)GEV EXCLUSION FOR CHARGINO (NEUTRALINO) MASS

SUSY SUMMARY

TOP SQUARK PAIR PRODUCTION SUMMARY



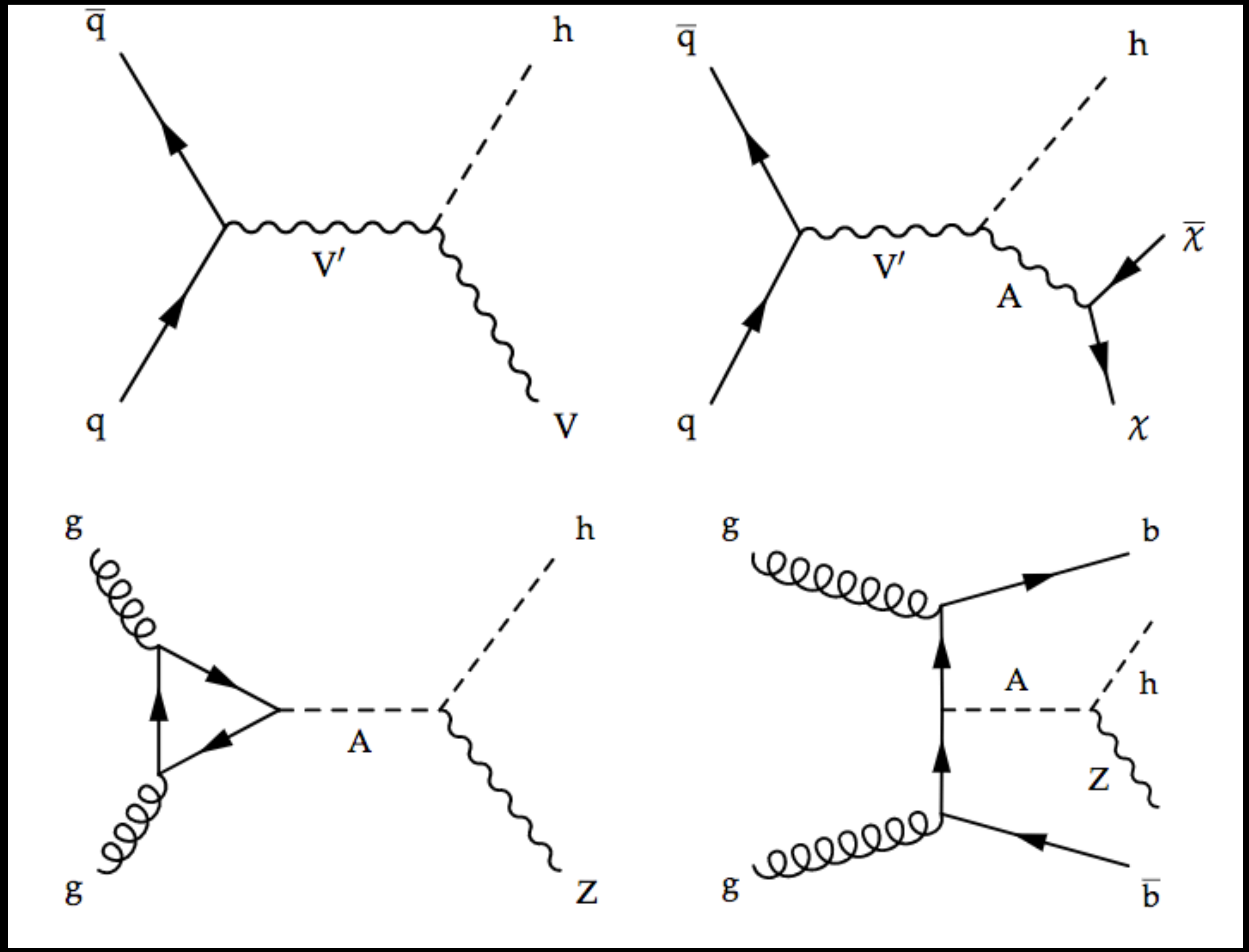
ELECTROWEAK CHARGINO-NEUTRALINO PRODUCTION SUMMARY

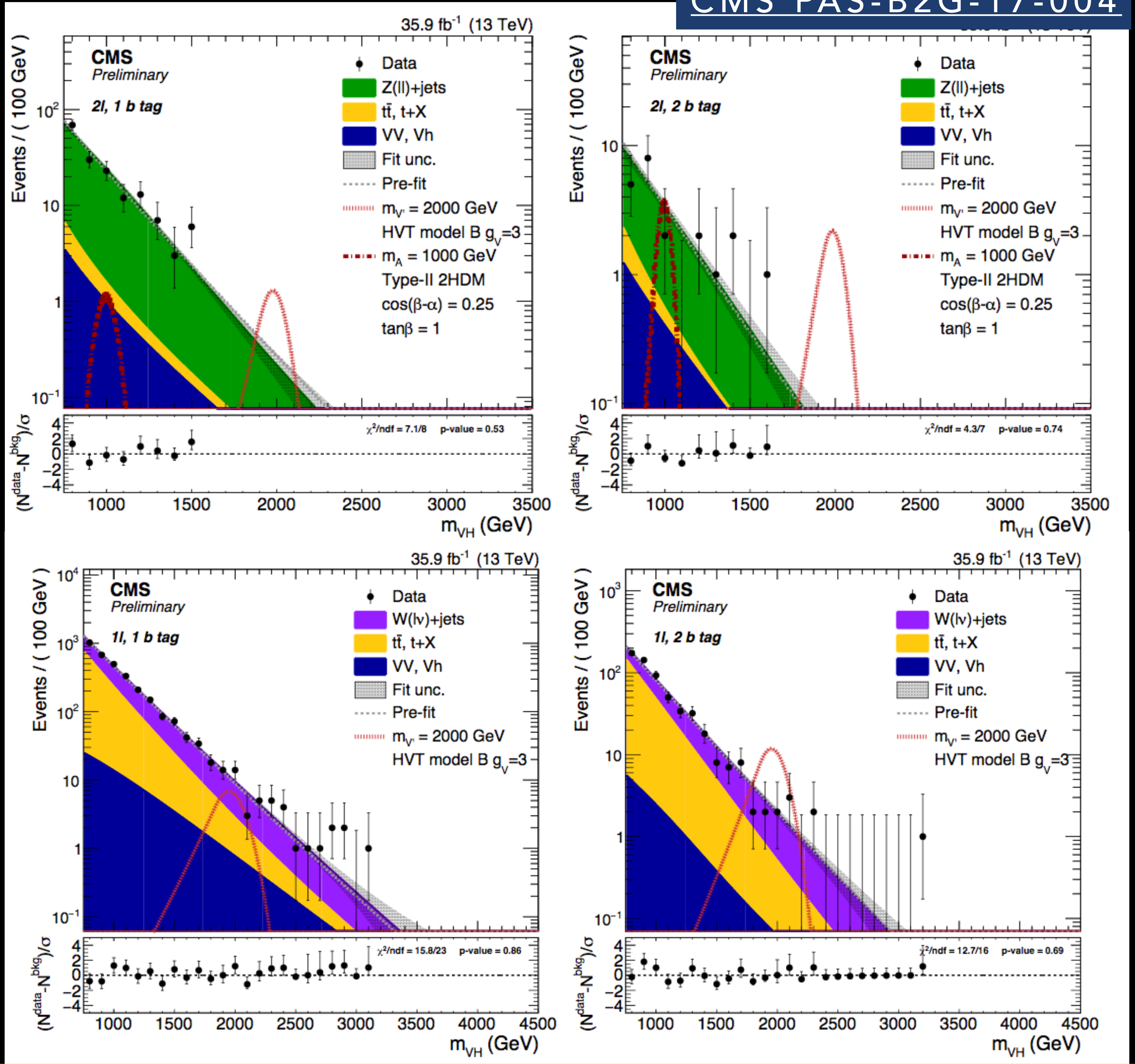


VH SEARCH

CMS PAS-B2G-17-004

- One signature, many interpretations
  - 2HDM,HVT,W′,Z′,DM etc…
- Different analysis regions, different backgrounds
  - H→ bb, 1b or 2b tag
  - V→ 0,1,2 leptons: Z→ll, W→lν & Z→ νν



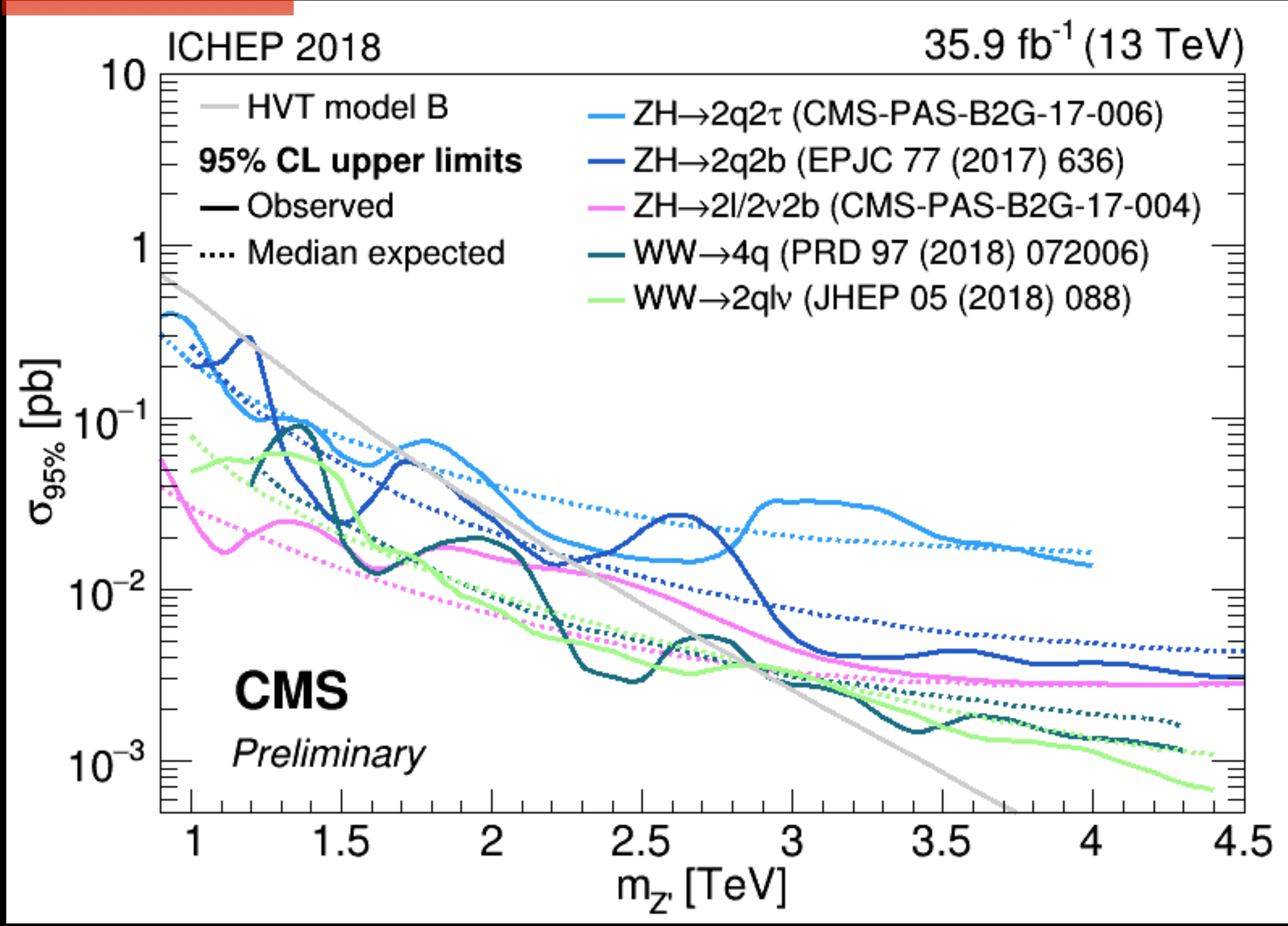


W' AND Z' RESONANCES WITH A DEGENERATE MASS SMALLER THAN 2.9 TEV EXCLUDED

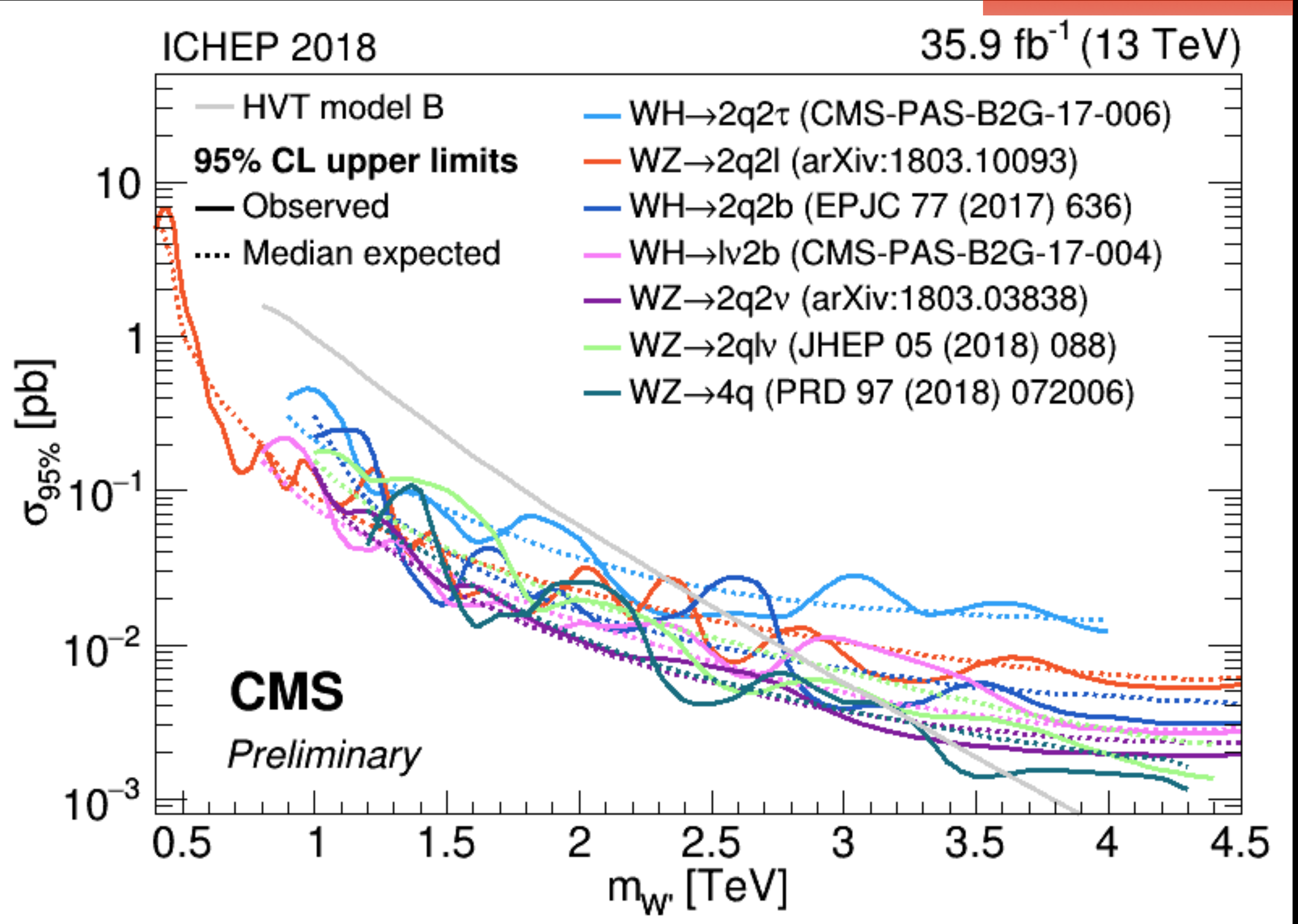
DIBOSON LIMIT SUMMARY

- Many final states exists in VV/VH channels
- Each individual analysis aiming for different final states, complementary searches using all the objects
  - Comparison for the sensitivities of different channels for HVT model for Z′ and W′

Z′ LIMITS



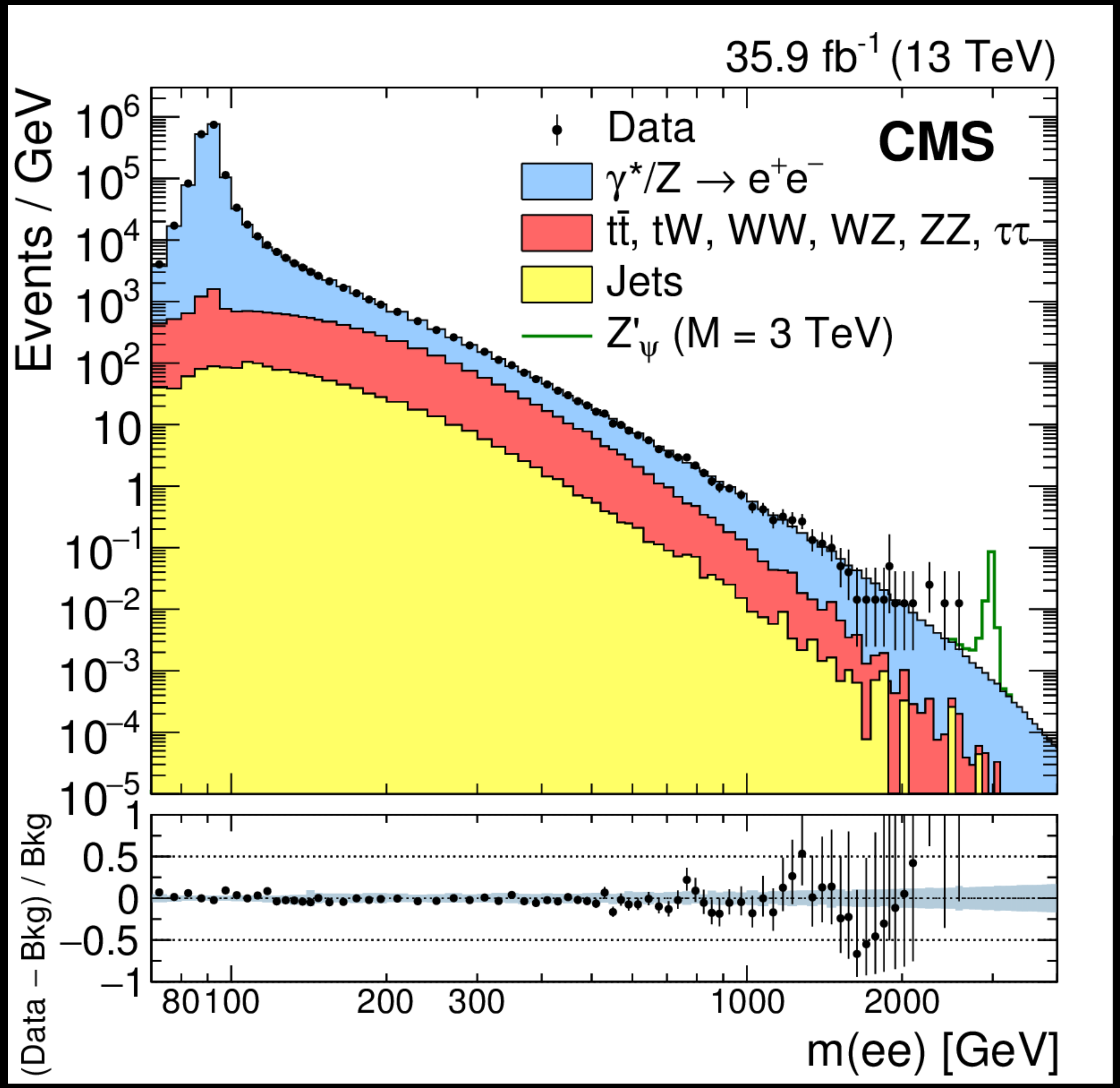
W′ LIMITS

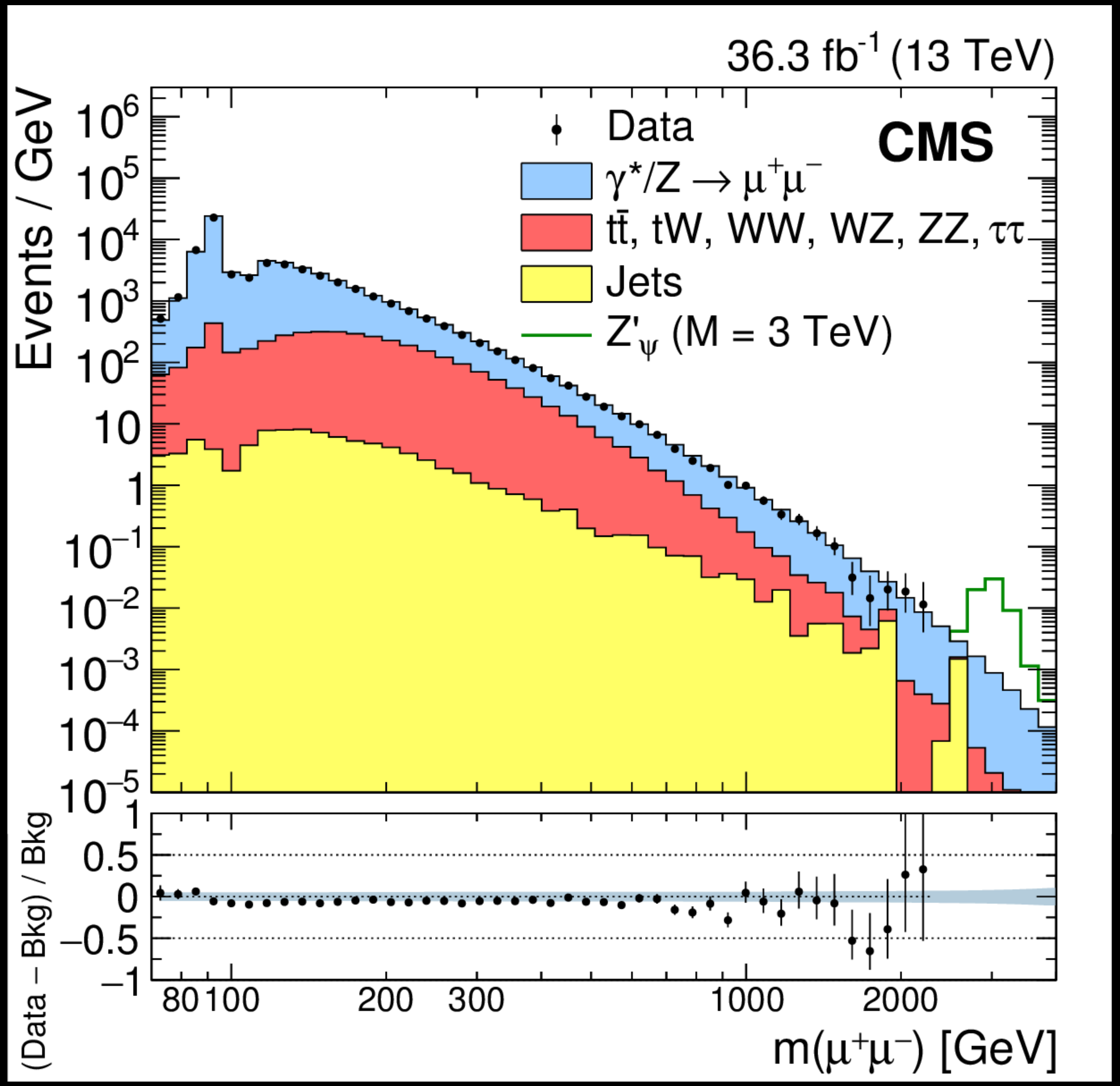


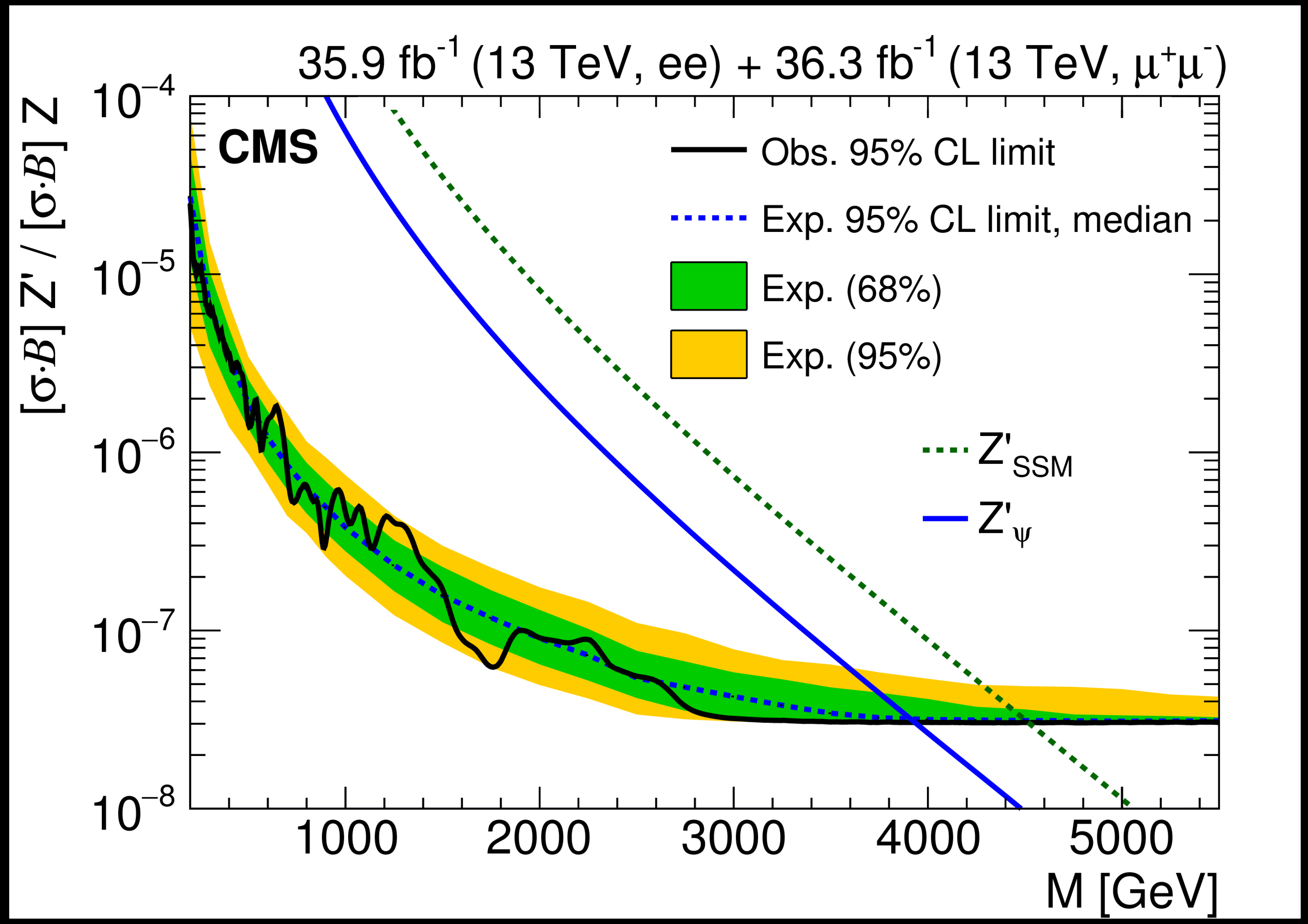
NEW BOSONS: Z′

CMS, JHEP06(2018)120

- Dilepton final state:
  - Combined limits for electron and muon channels ATLAS, JHEP10(2017)182
- Benchmarks: Z′ Sequential Standard Model(SSM) and Z′ superstring-inspired model



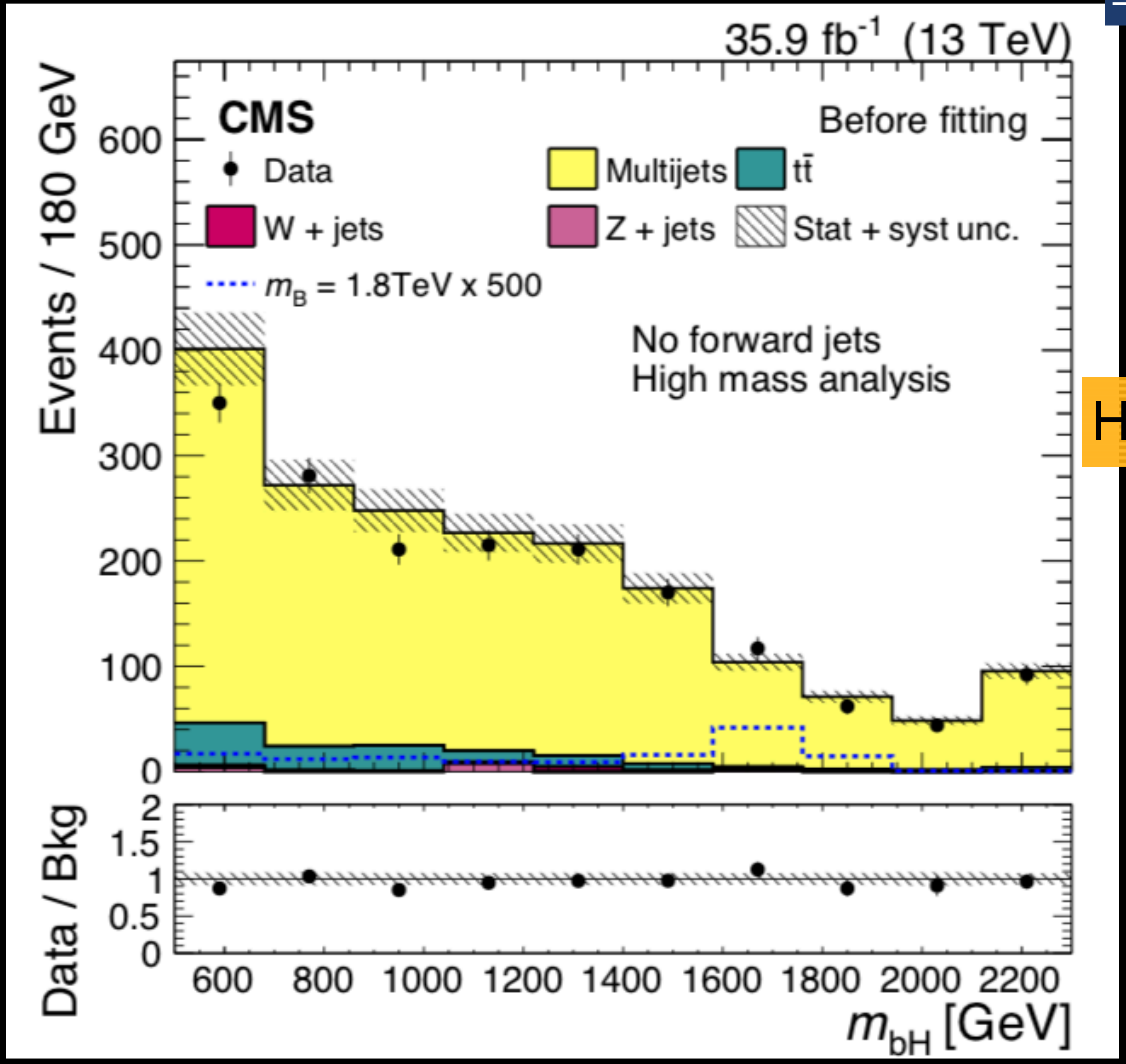




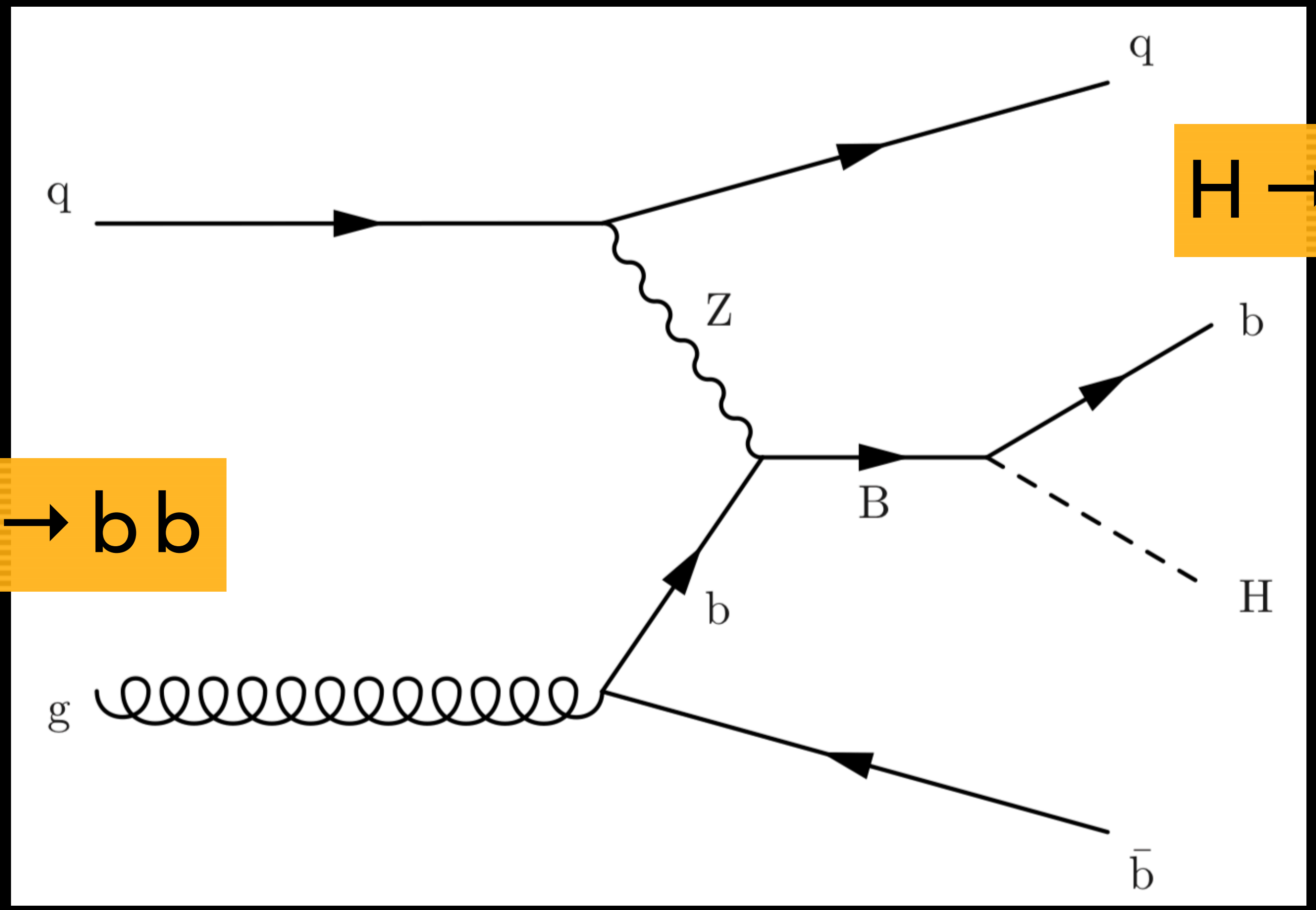
VLQ-SINGLE PRODUCTION

- First search for the single production of a B quark through its fully hadronic decay channel
- Considering finite resonance widths of B decay, different limits

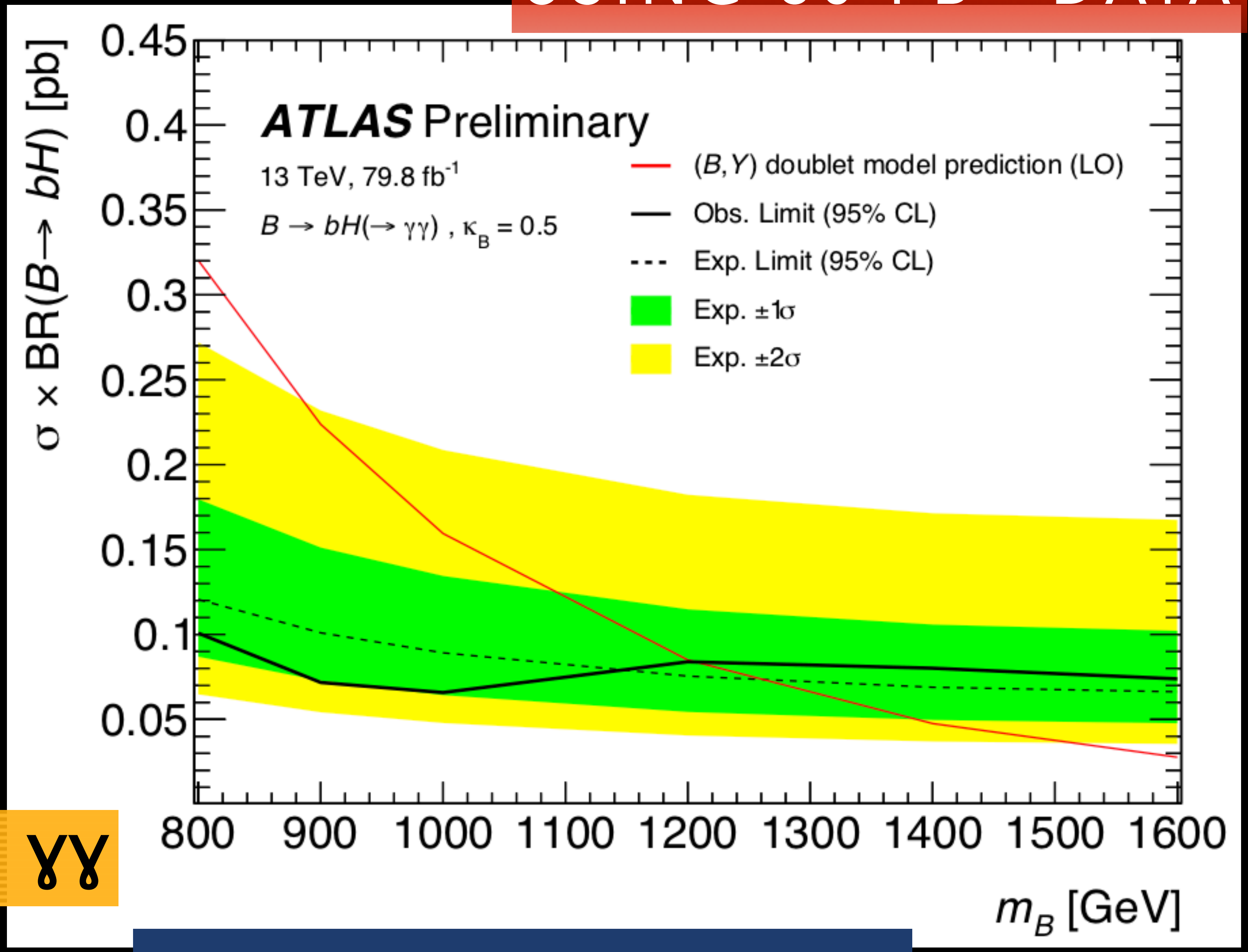
JHEP 06 (2018) 031



H → b b



USING 80 FB^{-1} DATA



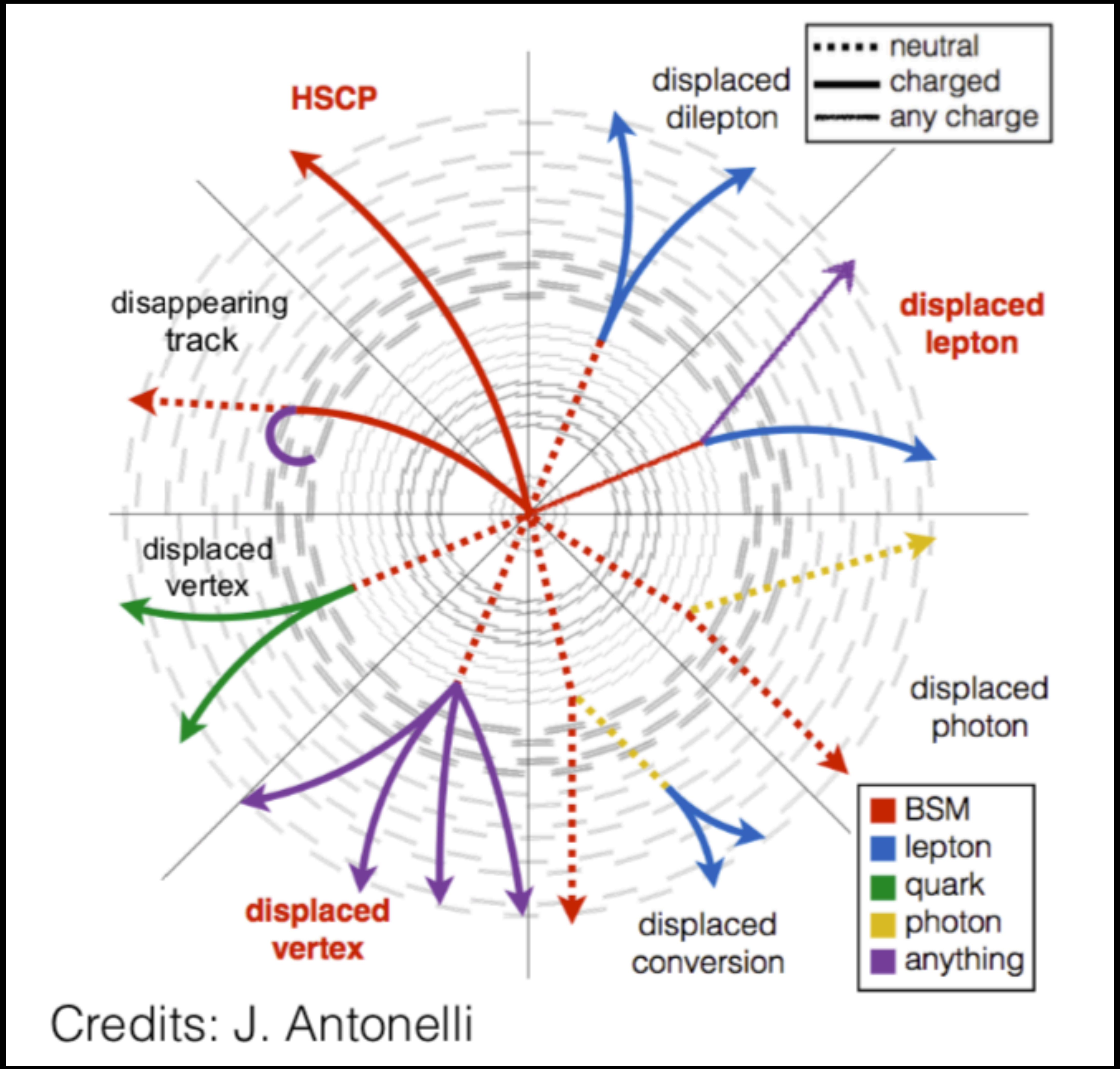
H → γγ

ATLAS-CONF-2018-024

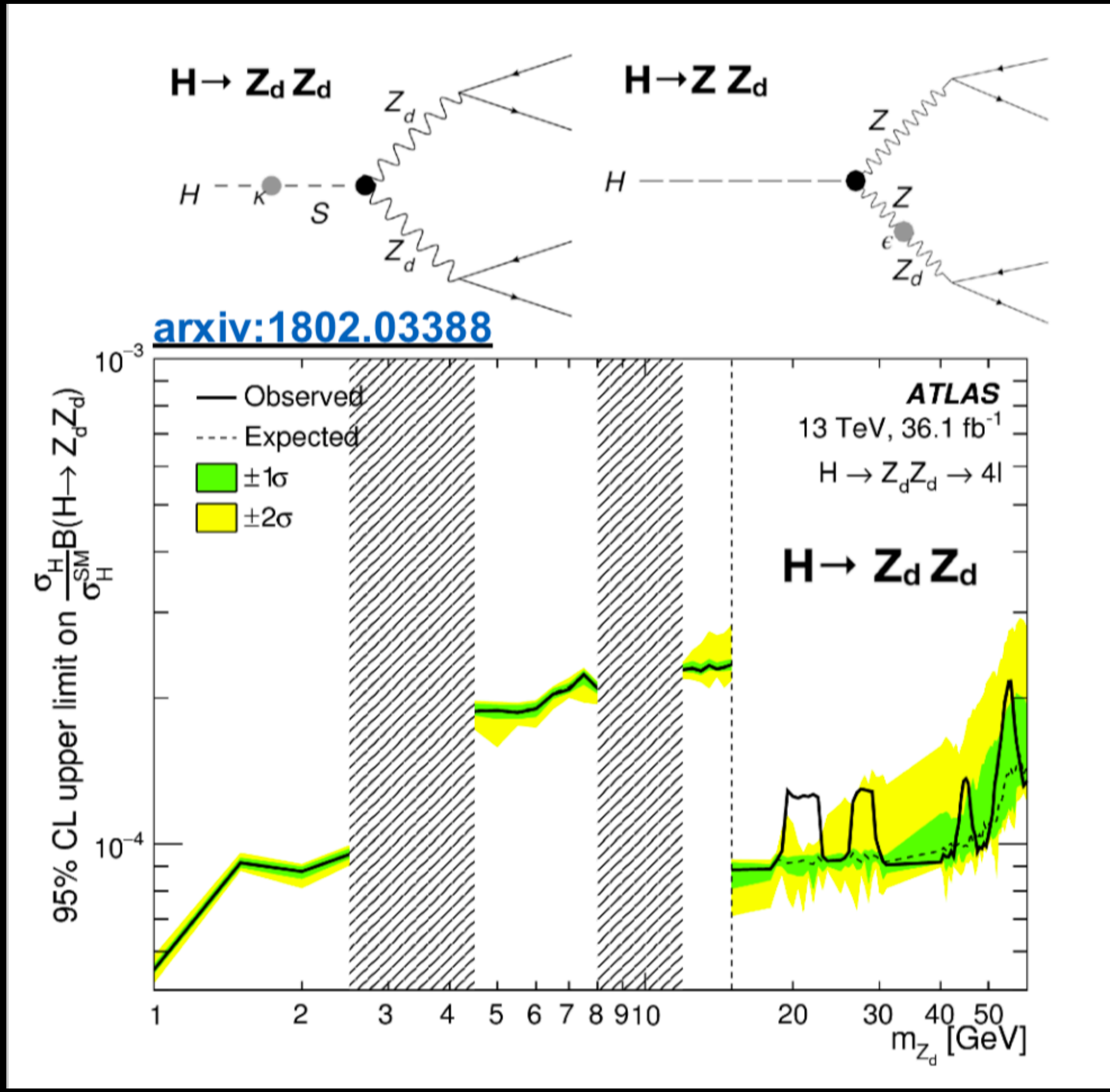
- Main background: non-resonant diphoton
- B quarks with masses less than 1210 GeV excluded under the assumptions

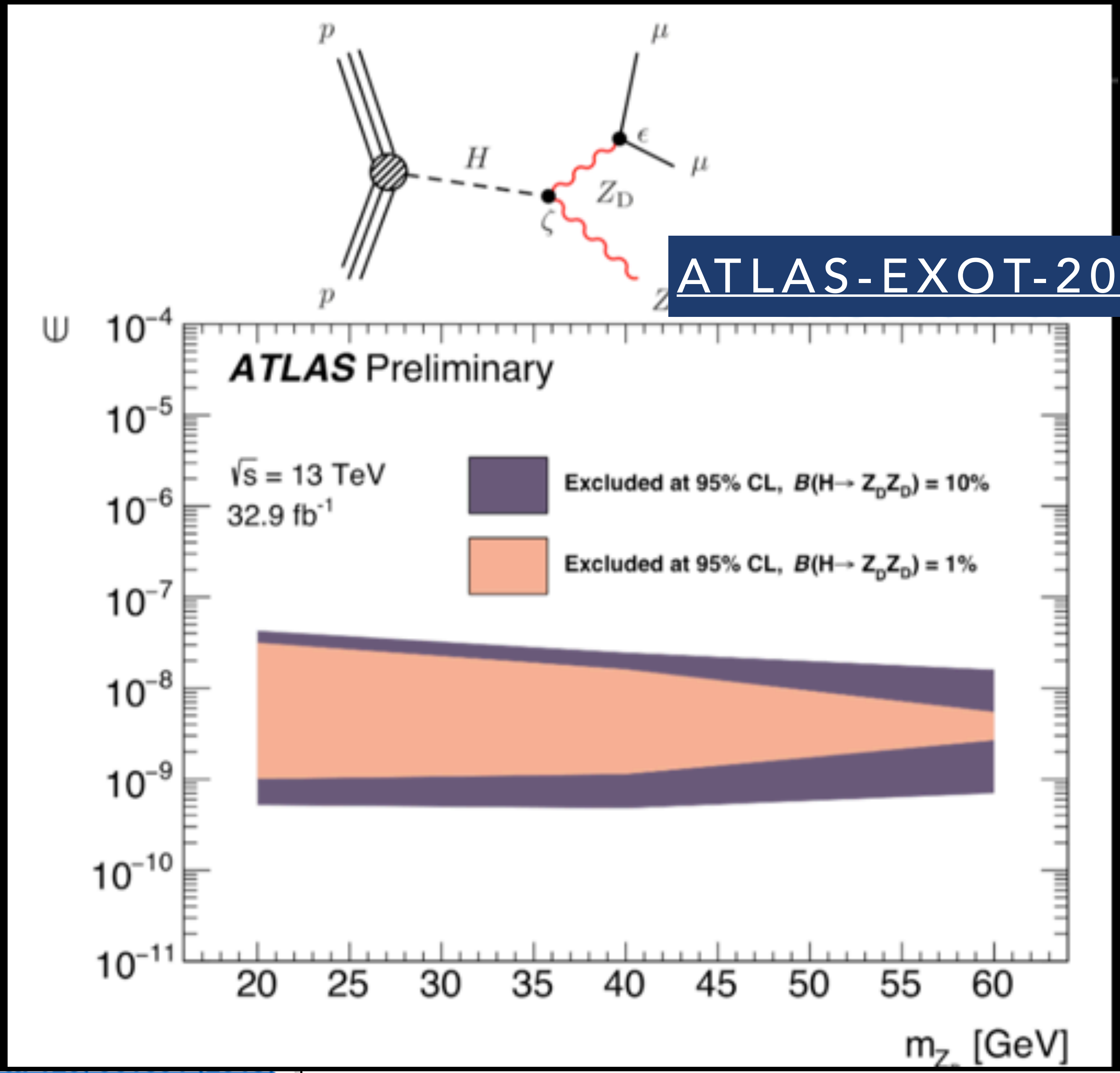
NO SIGNIFICANT EXCESS

LONG LIVED AND UNCONVENTIONAL

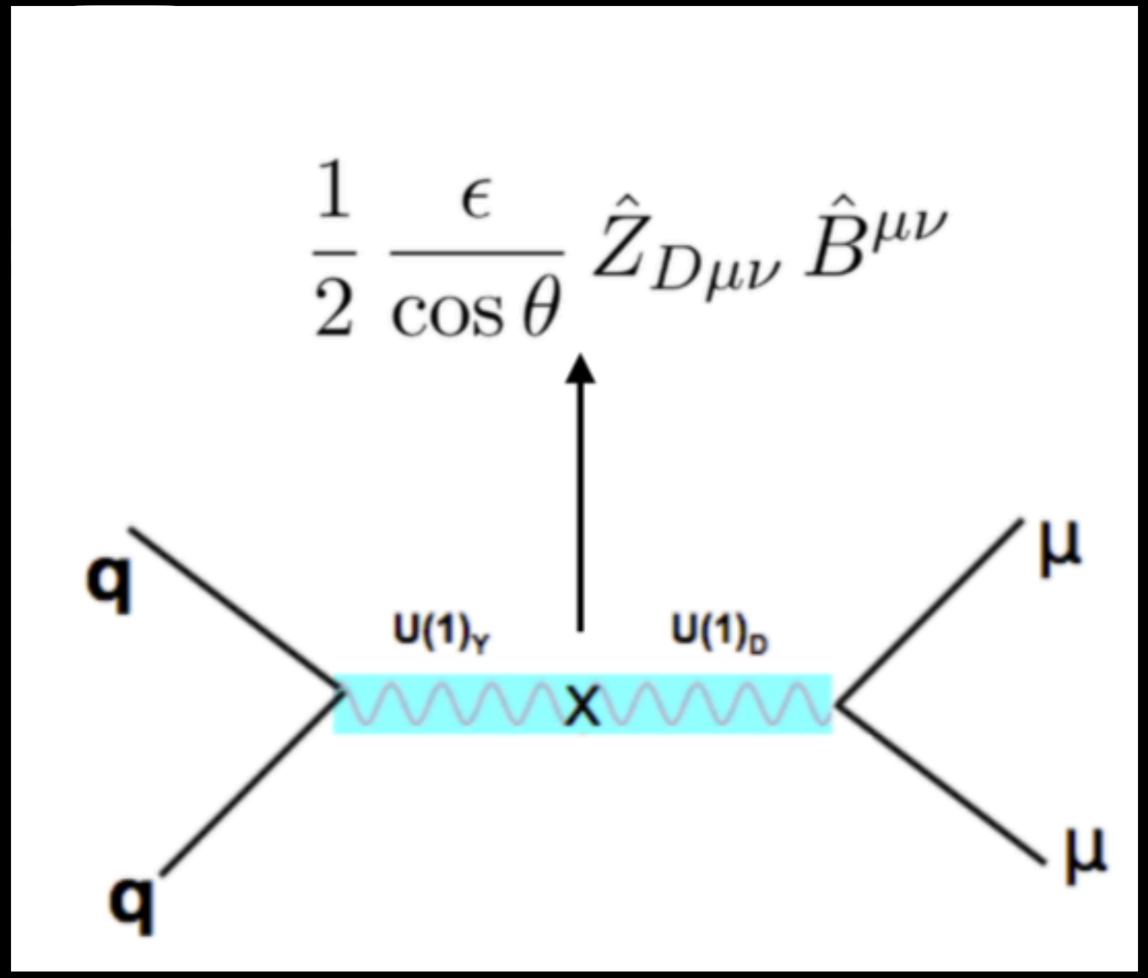


DARK PHOTON

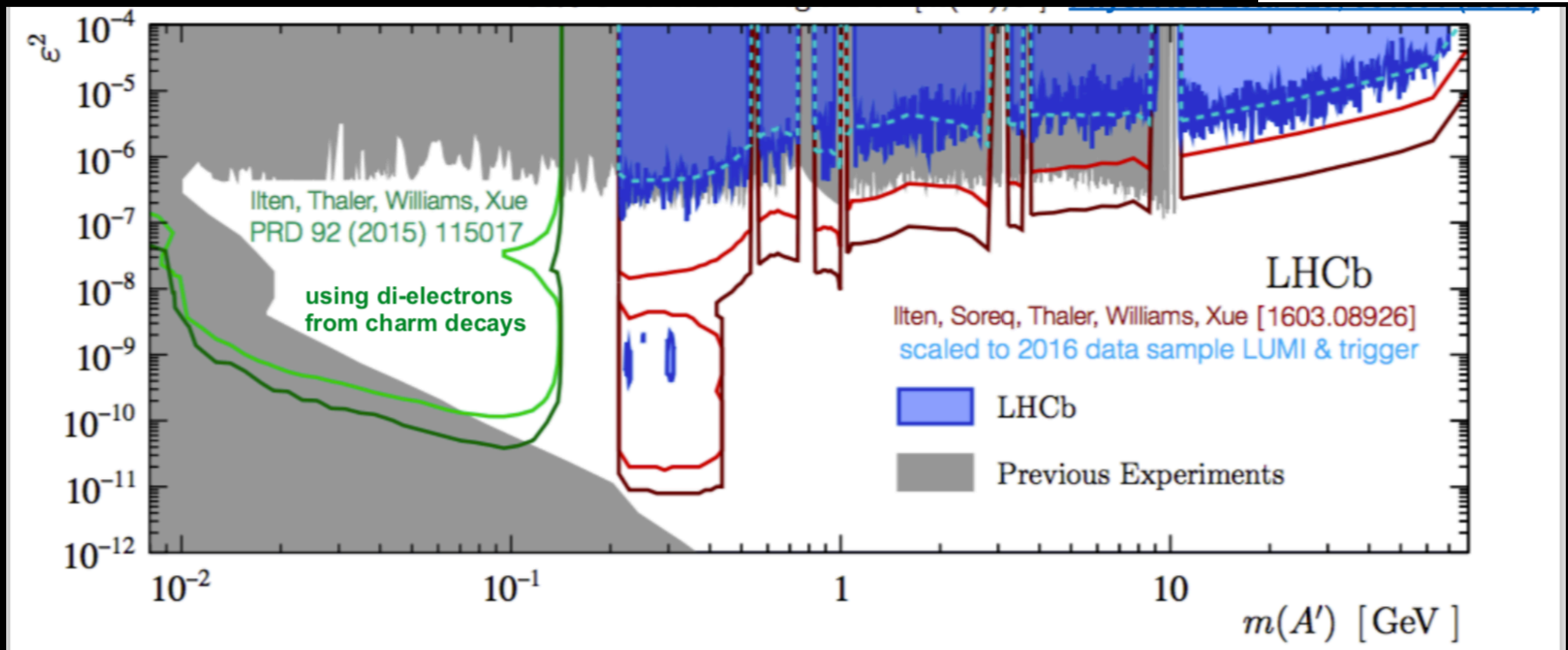


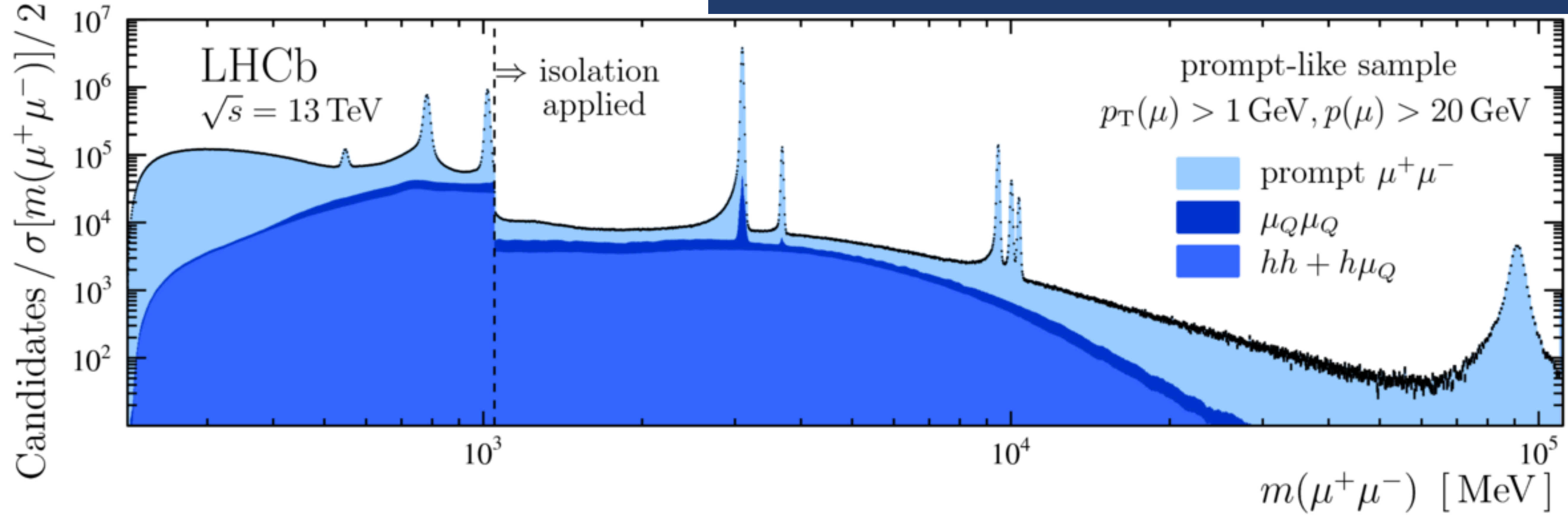


ATLAS-EXOT-2017-03



LHCB,PHYS.REV.LETT.120.061801





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- M.Baker et al, JHEP12(2015)120
- ATLAS Collaboration, Improving jet substructure performance in ATLAS using Track-CaloClusters, ATL-PHYS-PUB-2017-015, 2017,https://cds.cern.ch/record/2275636