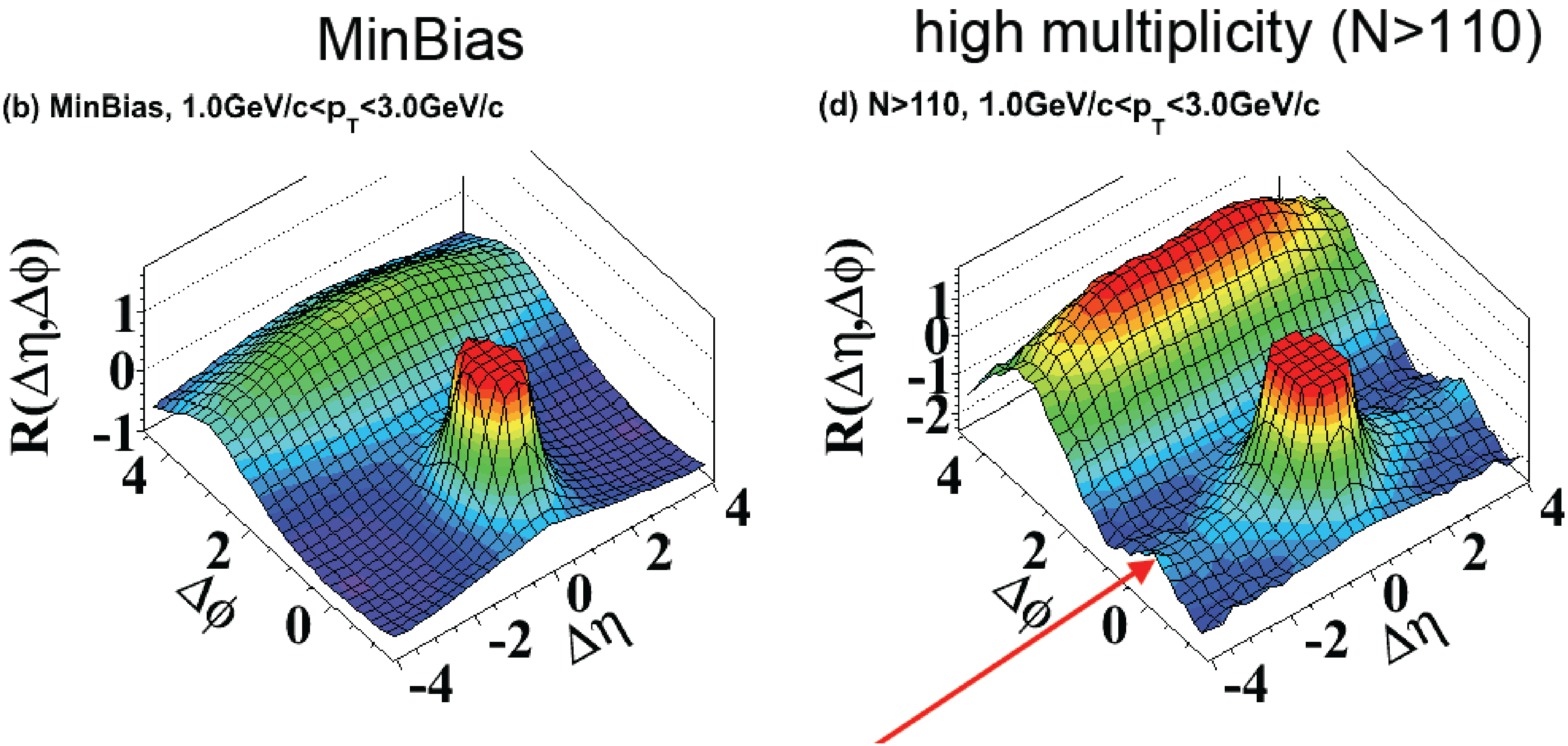
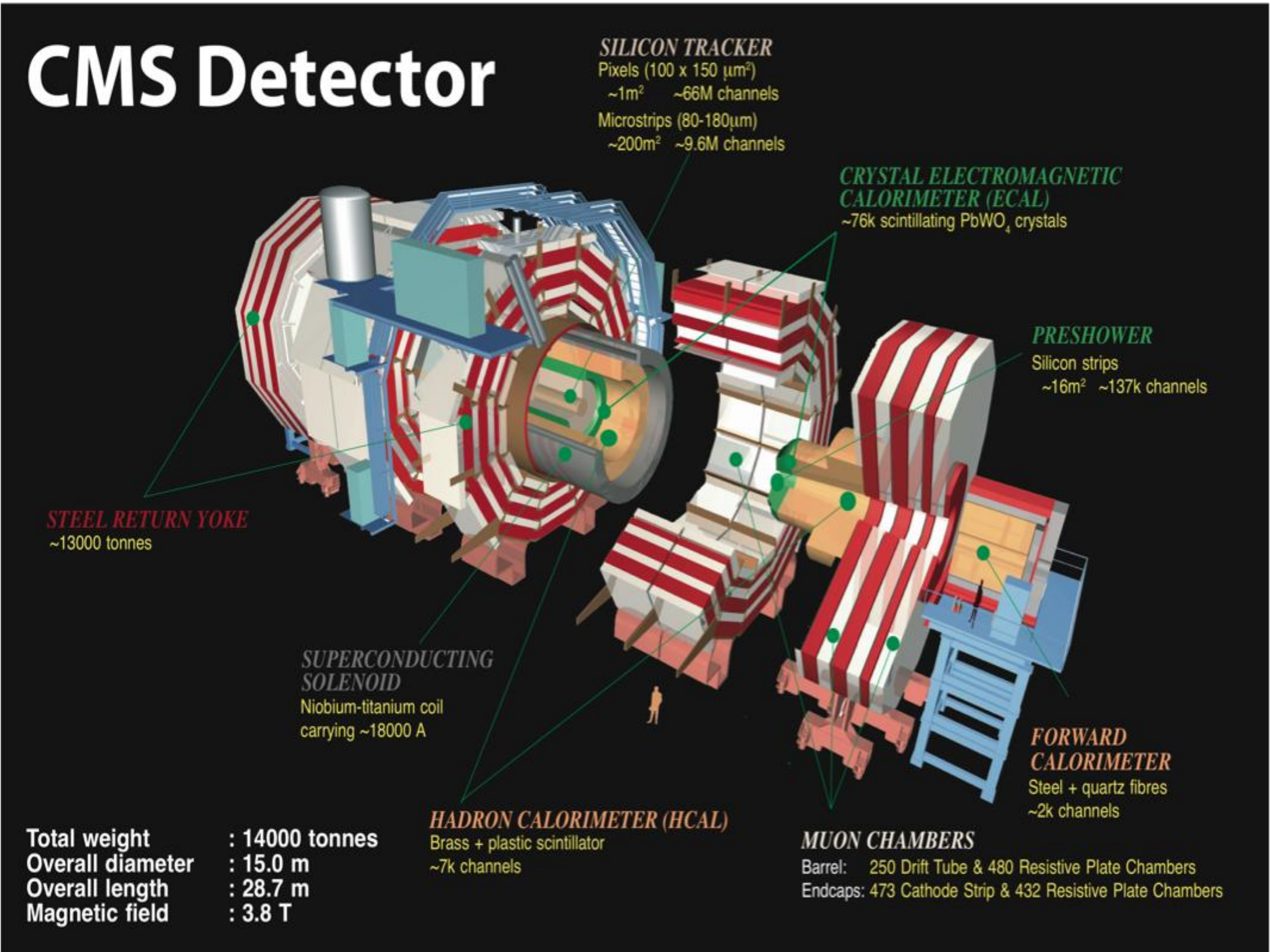


Long range same side correlations: arXiv:1009.4122

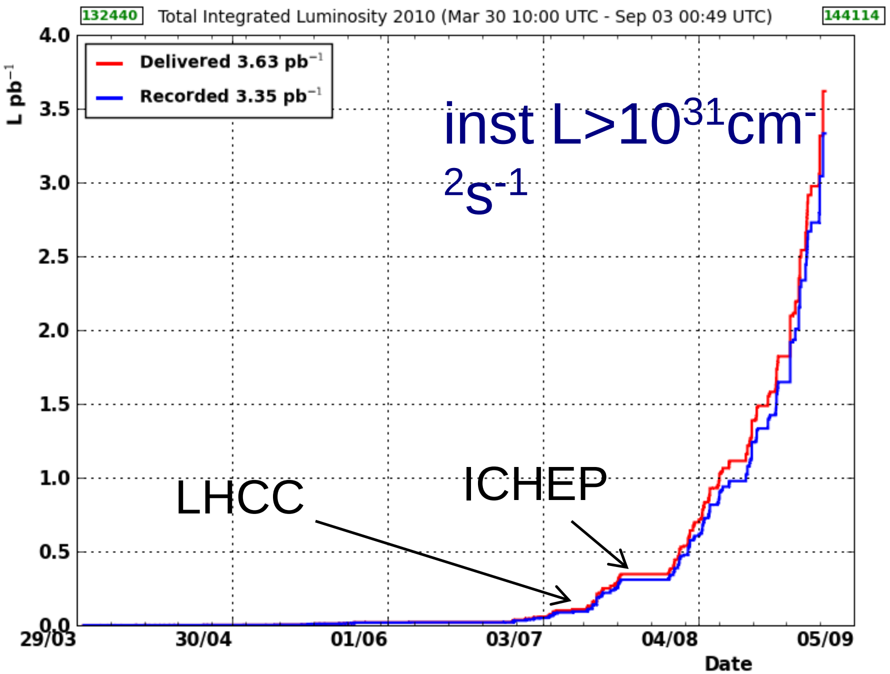
Outline

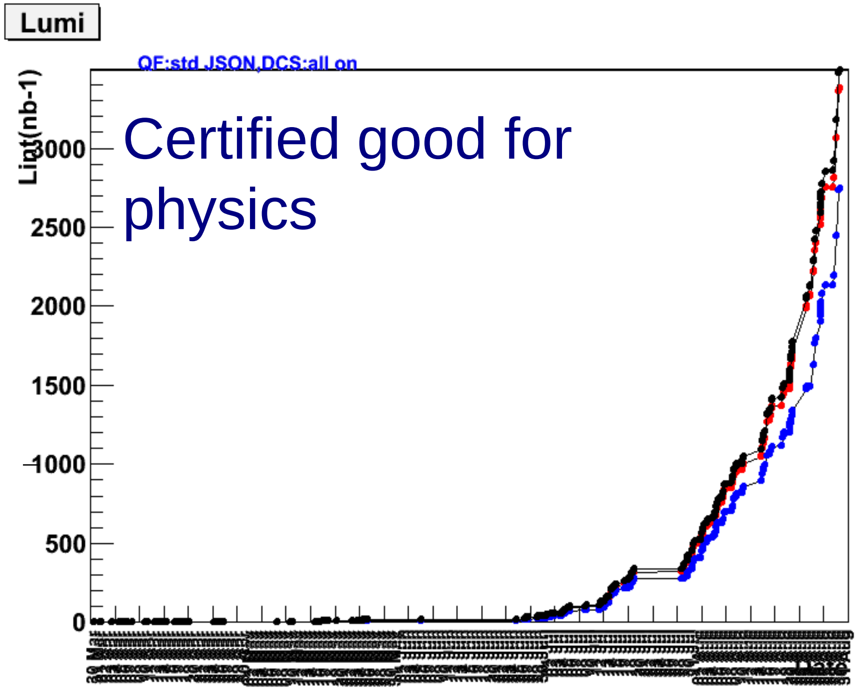
- Data acquisition, validation, transfer, analysis
  - most in the back-up slides
- Highlights on Physics Objects commissioning
  - Tracking and Muons
  - Electrons
  - Tau
  - Missing Energy
  - Jets
  - b-tagging

  and few related physics results
- Searches for new Physics


CMS Detector
SILICON TRACKER
Pixels (100 x 150 μm²)
~1m² ~66M channels
Microstrips (80-180μm)
~200m² ~9.6M channels
CRYSTAL ELECTROMAGNETIC CALORIMETER (ECAL)
~76k scintillating PbWO4 crystals
PRESHOWER
Silicon strips
~16m² ~137k channels
STEEL RETURN YOKE
~13000 tonnes
SUPERCONDUCTING SOLENOID
Niobium-titanium coil carrying ~18000 A
HADRON CALORIMETER (HCAL)
Brass + plastic scintillator
~7k channels
FORWARD CALORIMETER
Steel + quartz fibres
~2k channels
MUON CHAMBERS
Barrel: 250 Drift Tube & 480 Resistive Plate Chambers
Endcaps: 473 Cathode Strip & 432 Resistive Plate Chambers
Total weight : 14000 tonnes
Overall diameter : 15.0 m
Overall length : 28.7 m
Magnetic field : 3.8 T

Statistics accumulated so far





$$\frac{\text{Recorded}}{\text{Delivered}} = 92\%$$

$$\frac{\text{Certified}}{\text{Recorded}} = 88\%$$

Declared
Perfect by all systems

Last LHCC was

11 weeks,

3 pb^{-1},

1 ICHEP

ago

Since Last LHCC

BTV-10-001	Commissioning of b-jet identification with pp collisions at sqrt(s) = 7 TeV
EGM-10-003	Electromagnetic calorimeter calibration with 7 TeV data
EGM-10-005	Photon reconstruction and identification at sqrt(s) = 7 TeV
JME-10-003	Jet Performance in pp Collisions at 7 TeV
JME-10-004	Missing Transverse Energy Performance in Minimum-Bias and Jet Events from Proton-Proton Collisions at $\sqrt{s
JME-10-006	Commissioning of TrackJets in pp Collisions at 7 TeV
JME-10-008	Single-Particle Response in the CMS Calorimeters
MUO-10-002	Performance of muon identification in pp collisions at s**0.5 = 7 TeV
PFT-10-002	Commissioning of the Particle-Flow reconstruction in Minimum-Bias and Jet Events from pp Collisions at 7 TeV
PFT-10-003	Particle-flow commissioning with muons and electrons from J/Psi and W events at 7 TeV
PFT-10-004	Study of tau reconstruction algorithms using pp collisions data collected at sqrt(s) = 7 TeV
TRK-10-002	Measurement of Tracking Efficiency
TRK-10-003	Studies of Tracker Material
TRK-10-004	Measurement of Momentum Scale and Resolution of the CMS Detector using Low-mass Resonances and Cosmic Ray Muons
TRK-10-005	Tracking and Primary Vertex Results in First 7 TeV Collisions

http://cdsweb.cern.ch/collection/CMS%20Physics%20Analysis%20Summaries?ln=en&as=1

15 Physics Analysis Summaries (PAS) on Object Performance

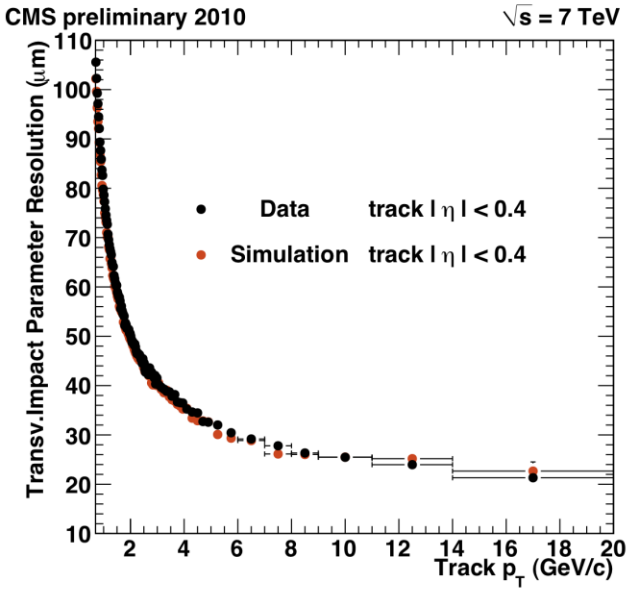
Since Last LHCC

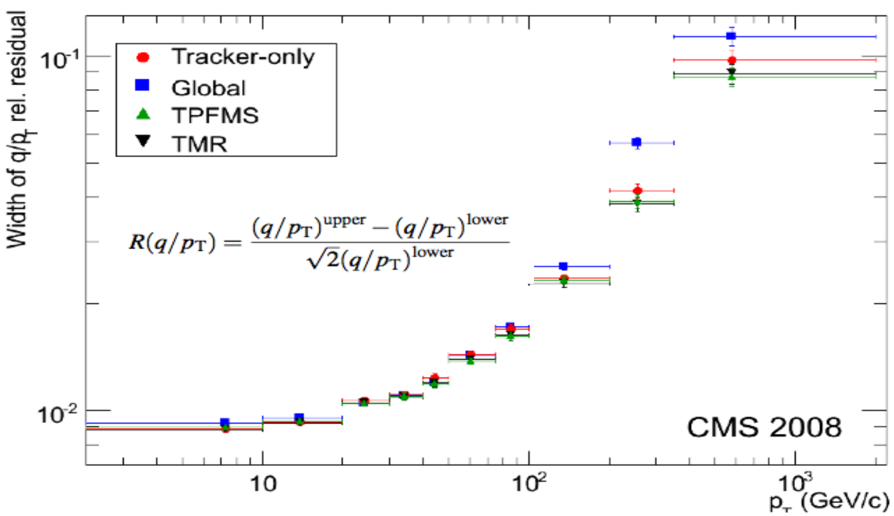
25 PAS on Analysis

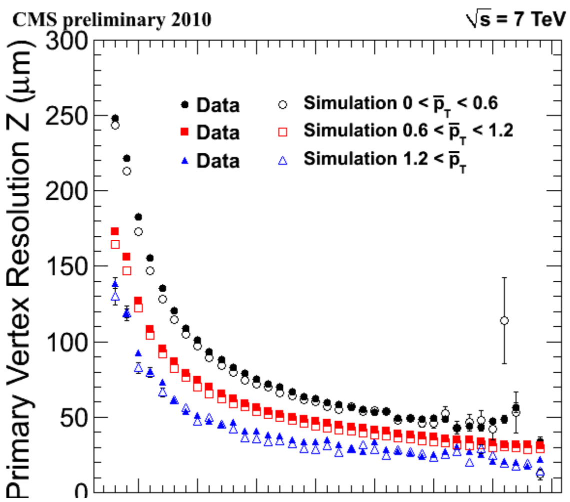
BPH-10-002	J/Psi prompt and non-prompt cross sections in pp collisions at sqrt(s) = 7 TeV
BPH-10-003	Measurement of the Inclusive Upsilon production cross section in pp collisions at $\sqrts=7$~TeV
BPH-10-007	Open beauty production cross section with muons in pp collisions at a center-of-mass energy of 7TeV
BPH-10-009	Inclusive b-jet production in pp collisions at sqrt(s)=7 TeV
EWK-10-002	Measurement of the W and Z inclusive production cross sections at sqrts=7 TeV with the CMS experiment at the LHC
EWK-10-004	Measurement of CMS Luminosity
EXO-01-002	Search for New Physics with the Dijet Centrality Ratio
EXO-10-001	Search for Dijet Resonances in the Dijet Mass Distribution in pp Collisions at sqrt(s)=7 TeV
EXO-10-003	First Results on the Search for Stopped Gluinos in pp collisions at sqrt s = 7 TeV
EXO-10-004	Search for Heavy Stable Charged Particles in pp collisions at 7 TeV
EXO-10-005	Search for Pair Production of First Generation Scalar Leptoquarks Using Events Containing Two Electrons And Two Jets Produced in pp Collisions at sqrt s = 7 TeV
EXO-10-010	Search for Dijet Resonances in the Dijet Mass Distribution in pp Collisions at sqrt(s)=7 TeV
FWD-10-002	Measurement of the energy flow in the forward region at the LHC at $\sqrt{s
QCD-10-004	Charged particle multiplicities in pp interactions at sqrt(s) = 0.9, 2.36, and 7.0 TeV
QCD-10-005	Measurement of the Underlying Event Activity with the Jet Area/Median Approach at 0.9 TeV
QCD-10-007	Strange Particle Production in pp collisions at sqrt(s) = 0.9 and 7 TeV
QCD-10-008	Jet-triggered charged particle transverse momentum spectra in pp collisions at 7 TeV
QCD-10-010	Measurement of the Underlying Event Activity at the LHC with $\sqrt{s
QCD-10-011	Measurement of the Inclusive Jet Cross Section in pp Collisions at 7 TeV
QCD-10-012	Measurement of the 3-jet to 2-jet Cross Section Ratio in pp Collisions at sqrt s = 7 TeV
QCD-10-013	Hadronic Event Shapes in pp Collisions at 7 TeV
QCD-10-014	Jet Transverse Structure and Momentum Distribution in pp Collisions at 7 TeV
QCD-10-015	Dijet Azimuthal Decorrelations and Angular Distributions in pp Collisions at sqrt(s) = 7 TeV
SUS-10-001	Performance of Methods for Data-Driven Background Estimation in SUSY Searches
TOP-10-004	Selection of Top-Like Events in the Dilepton and Lepton-plus-Jets Channels in Early 7 TeV Data

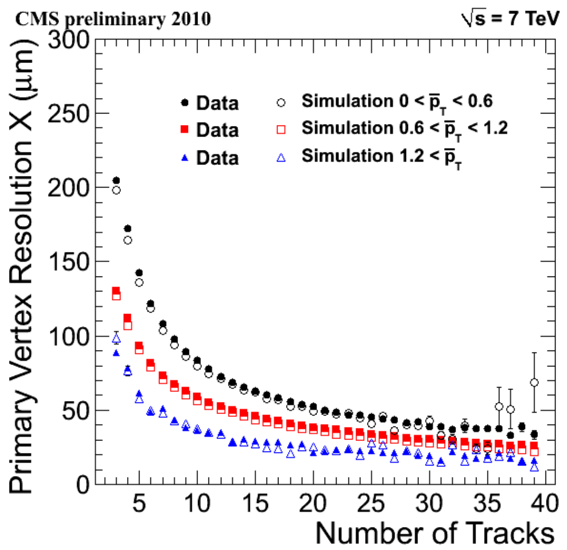
Tracking and Muons

Resolution on Track/Vertices





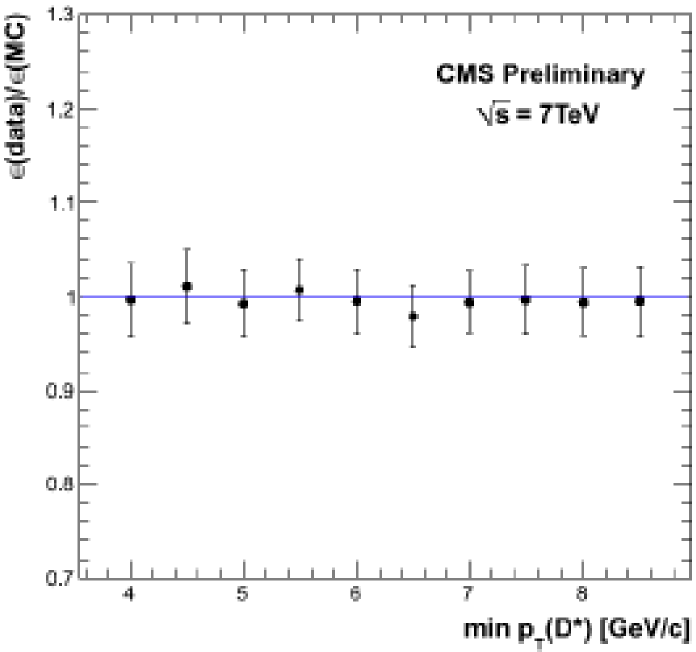




TRK-10-005

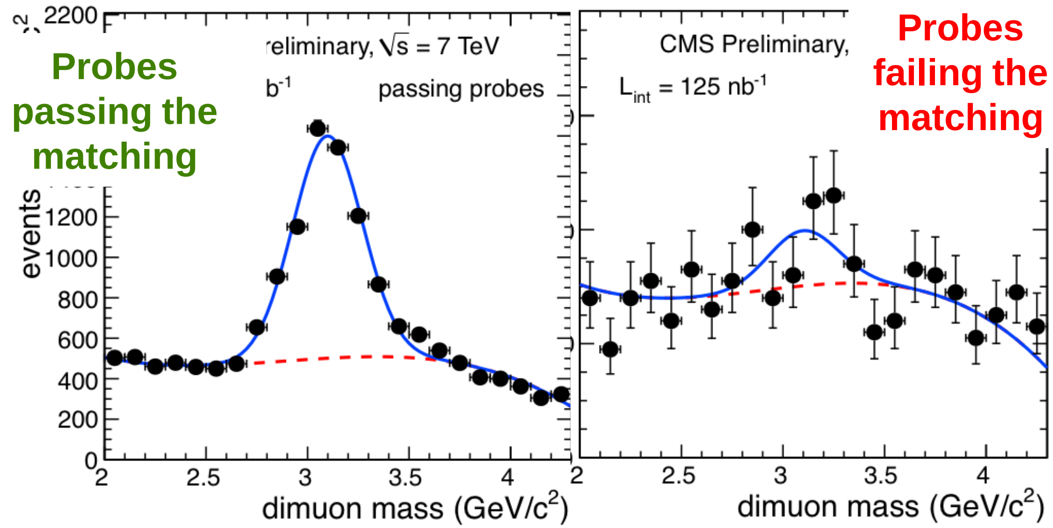
Tracking Efficiency

$$\frac{D^0 \rightarrow K^- \pi^+ \pi^- \pi^+}{D^0 \rightarrow K^- \pi^+}$$



TRK-10-002

J/Psi Tag and probe

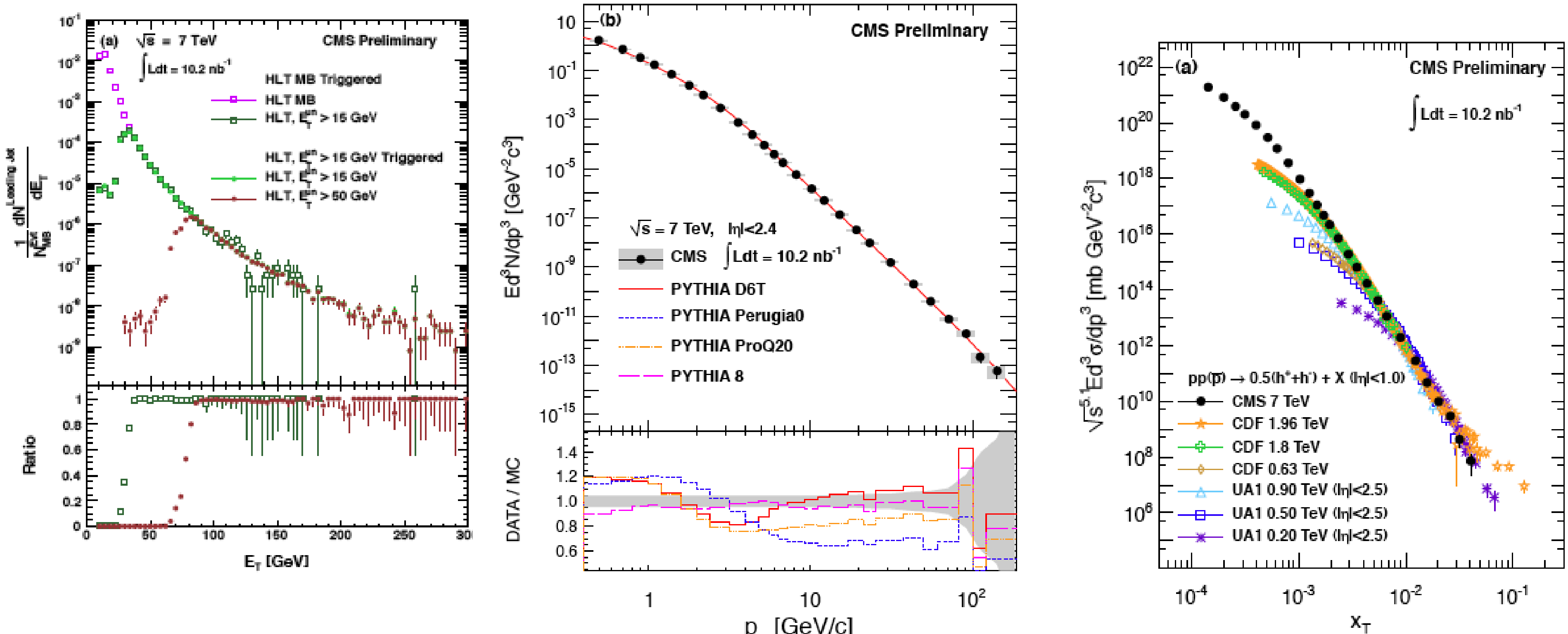


Region	Data Eff. (%)	Sim Eff. (%)	Data/Sim
$0.0 \leq \lvert\eta\rvert < 1.1$	$100.0^{+0.0}_{-0.3}$	$100.0^{+0.0}_{-0.1}$	$1.000^{+0.001}_{-0.003}$
$1.1 \leq \lvert\eta\rvert < 1.6$	$99.2^{+0.8}_{-1.0}$	$99.8^{+0.1}_{-0.1}$	$0.994^{+0.009}_{-0.010}$
$1.6 \leq \lvert\eta\rvert < 2.1$	$97.6^{+0.9}_{-1.0}$	$99.3^{+0.1}_{-0.1}$	$0.983^{+0.009}_{-0.010}$
$2.1 \leq \lvert\eta\rvert < 2.4$	$98.5^{+1.5}_{-1.6}$	$97.6^{+0.2}_{-0.2}$	$1.010^{+0.015}_{-0.016}$
Combined	$98.8^{+0.5}_{-0.5}$	$99.2^{+0.1}_{-0.1}$	$0.996^{+0.005}_{-0.005}$

Jet Triggered Charged particle Spectra

QCD-10-008

Using Jet trigger it is possible to extend the momentum range of charged particle spectra

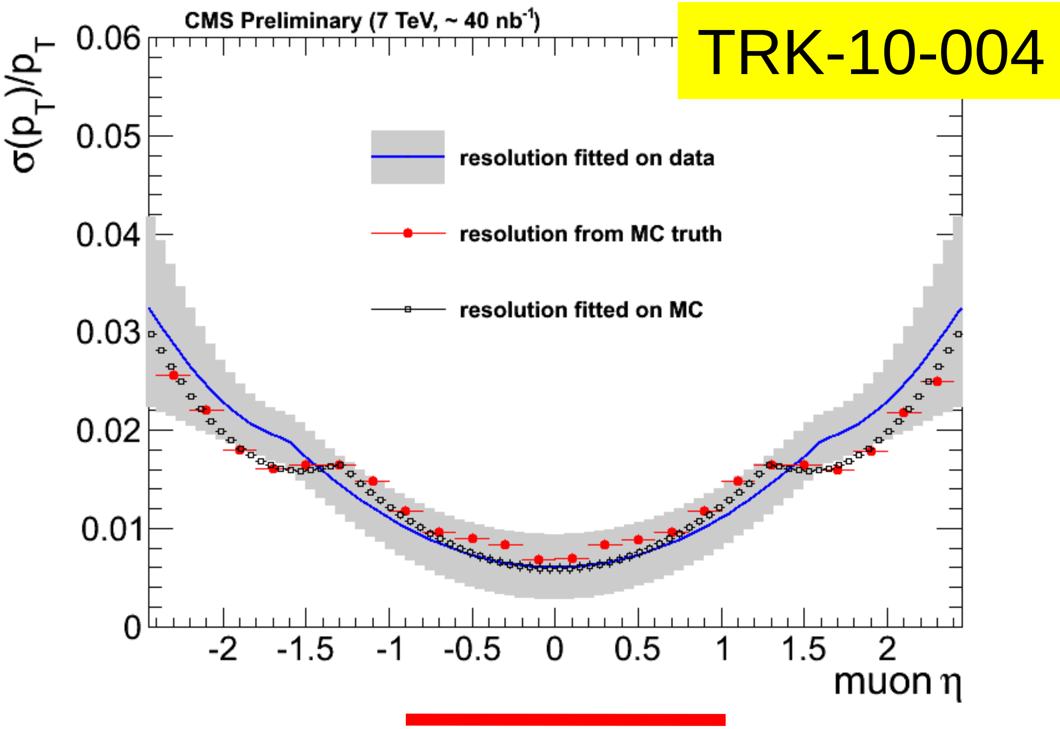


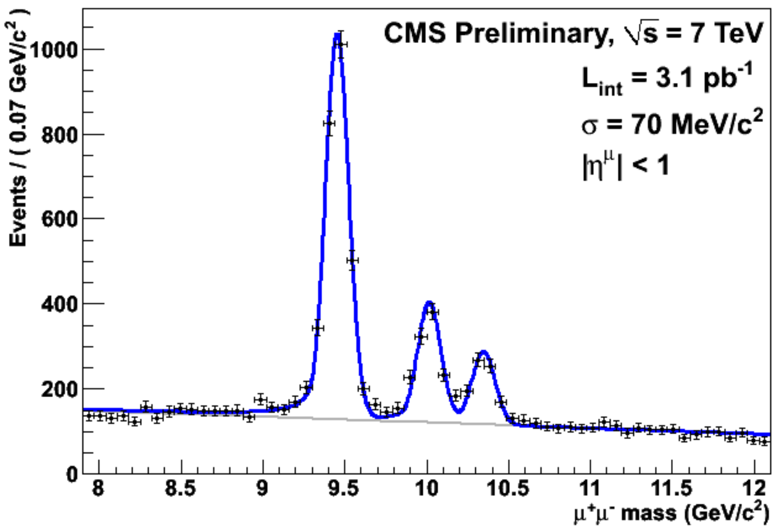
Cross sections scaled empirically by $(\sqrt{s})^{5.1}$

Momentum Resolution

J/Ψ width expressed as a function of the kinematics of the 2 tracks.

The best estimate of the p_T resolution is then determined through an unbinned likelihood fit of data.

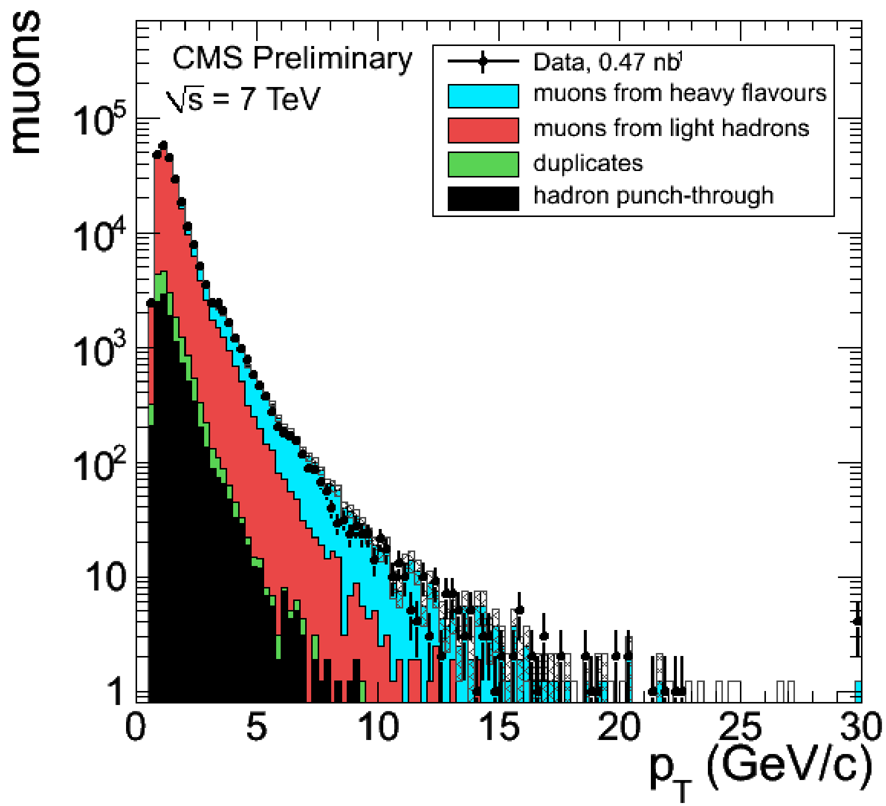


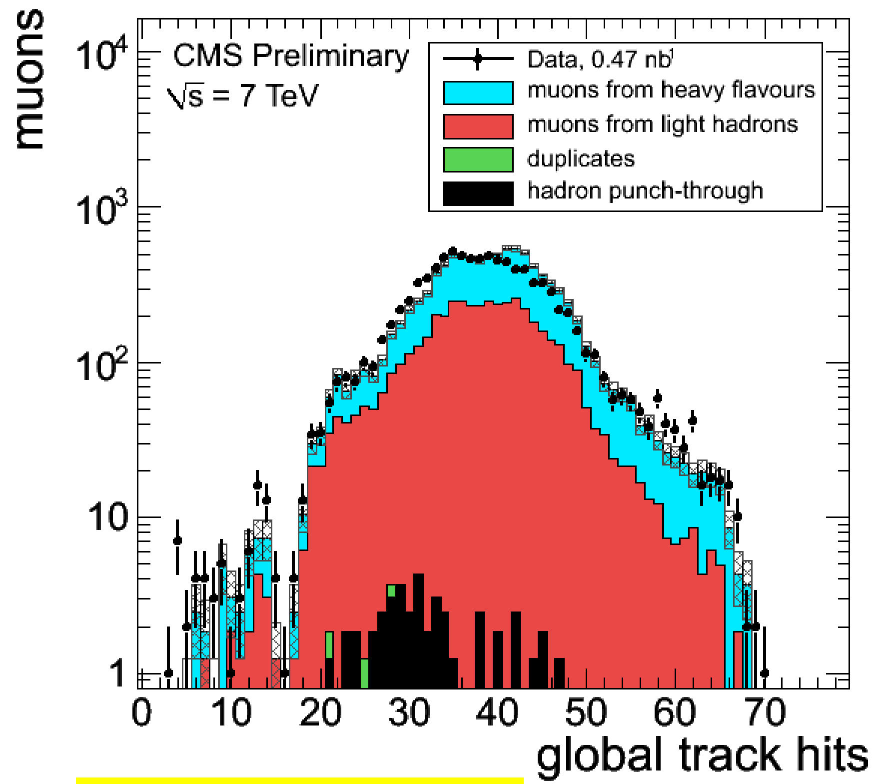


Muon Detector Performance

"Soft muon": a tracker track matched to at least one CSC or DT stub, to collect muons down to pT about 500 MeV in the endcaps (e.g. for J/Ψ)

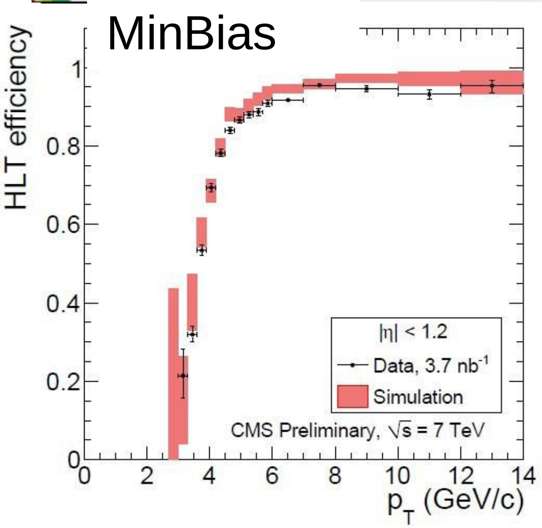
"Tight muon": a good quality track from a combined fit of the hits in the tracker and muon system, requiring signal in at least two muon stations to improve purity.

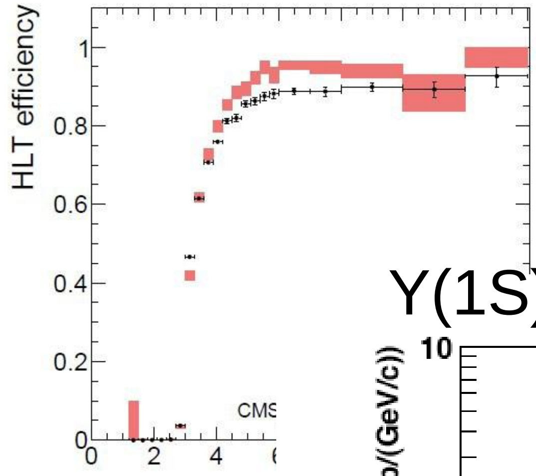




MUO-10-002

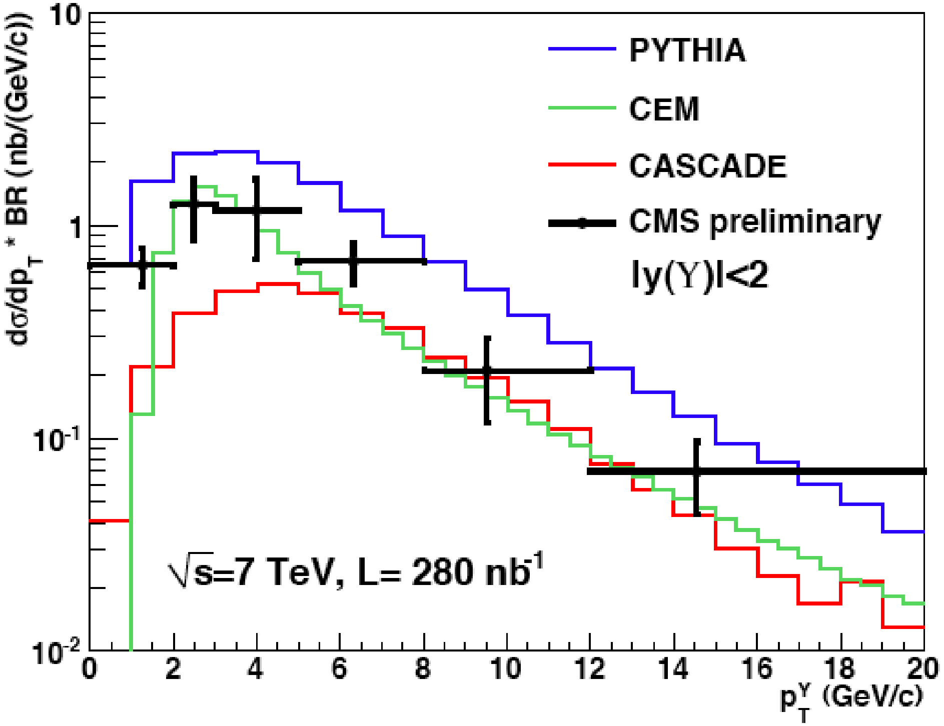
Muon Performance and Υ(1S)

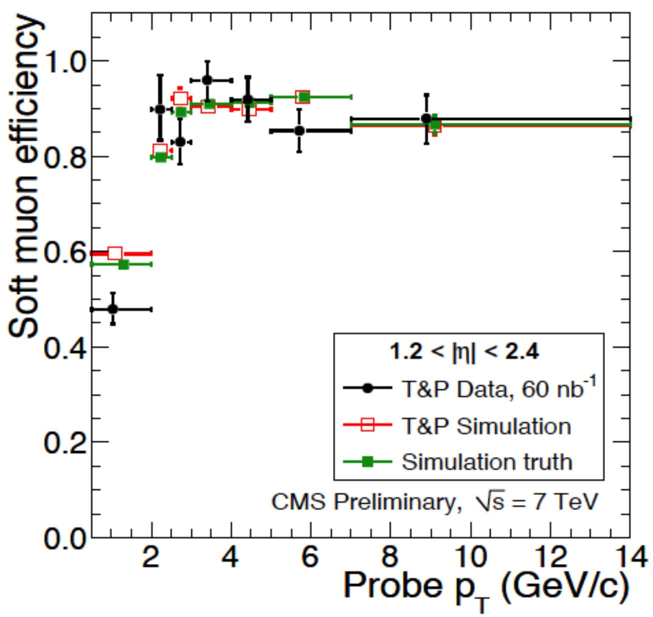




BPH-10-003

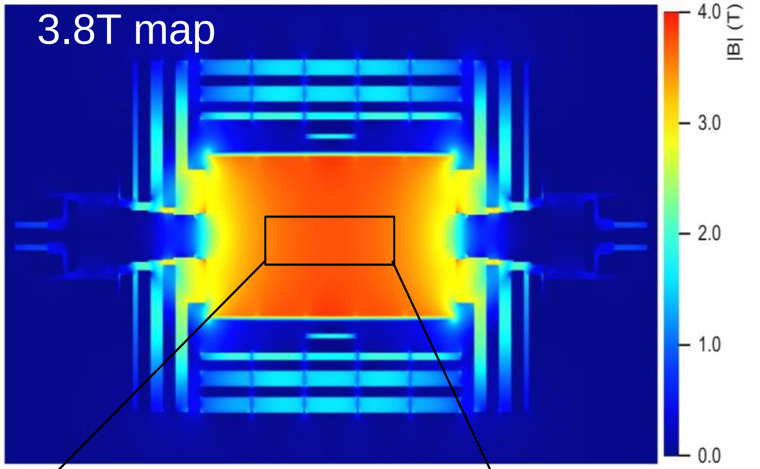
Υ(1S) differential Cross Section



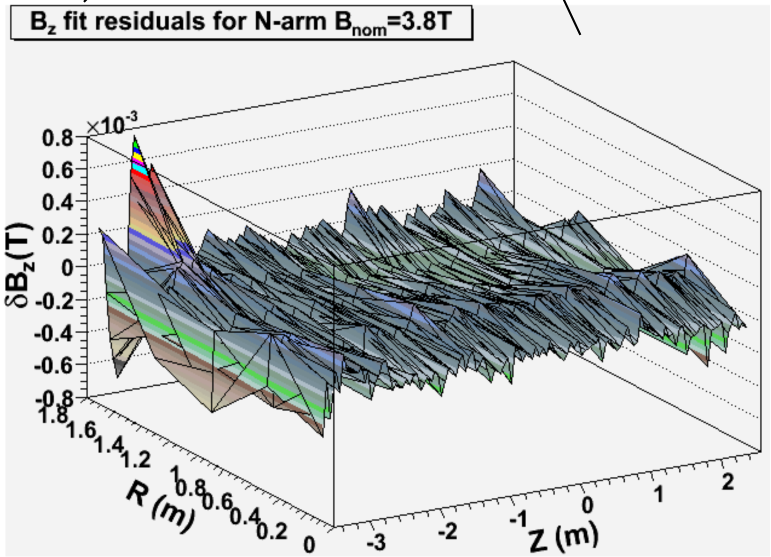


Momentum Scale

- Measured by Field Mapper (at 2, 3, 3.5, 3.8, 4 T) in 2006 MTCC
- TOSCA field map agrees < 0.1%



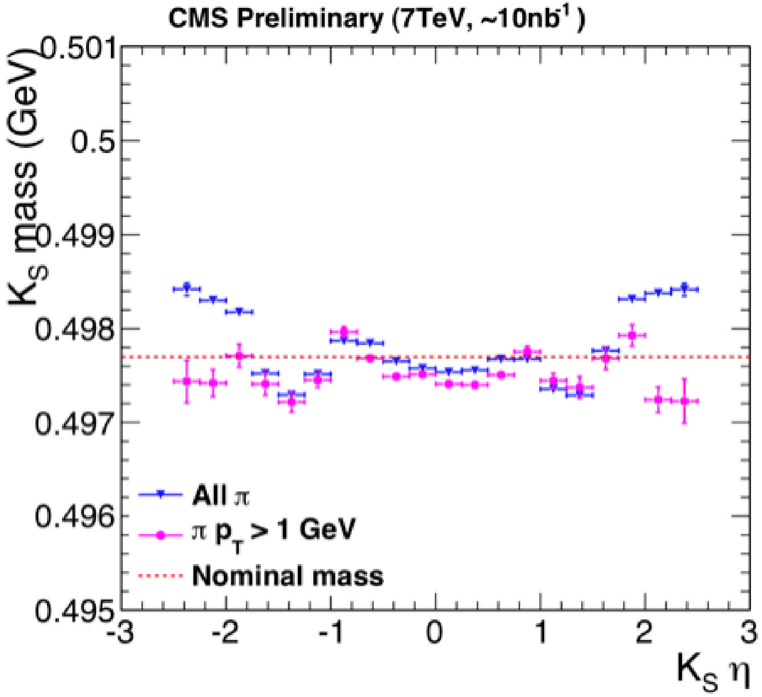
- analytical fit describes measurements to ~ 0.01%



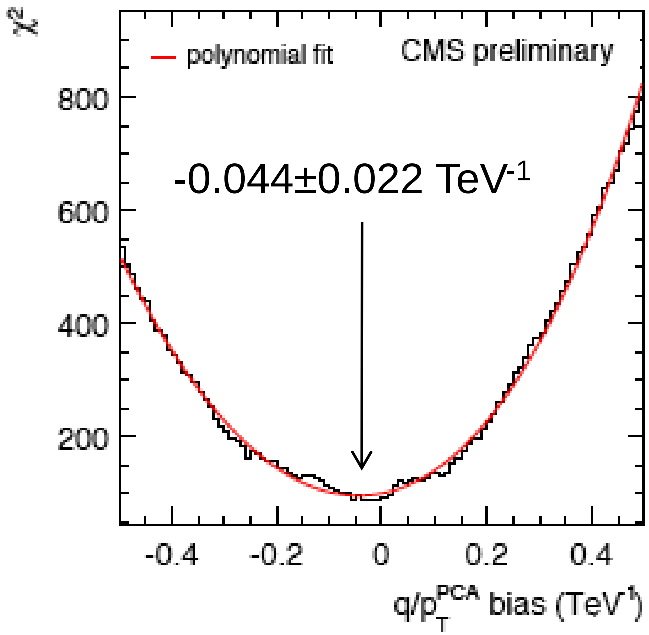
NMR probes inside solenoid confirm agreement scale <0.1% between 2006 and 2008

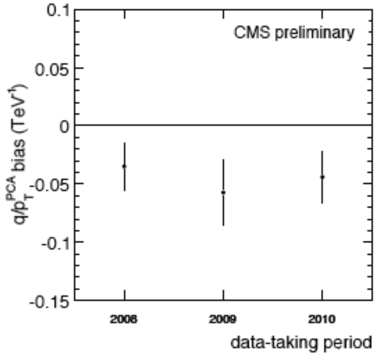
Momentum Scale

TRK-10-004



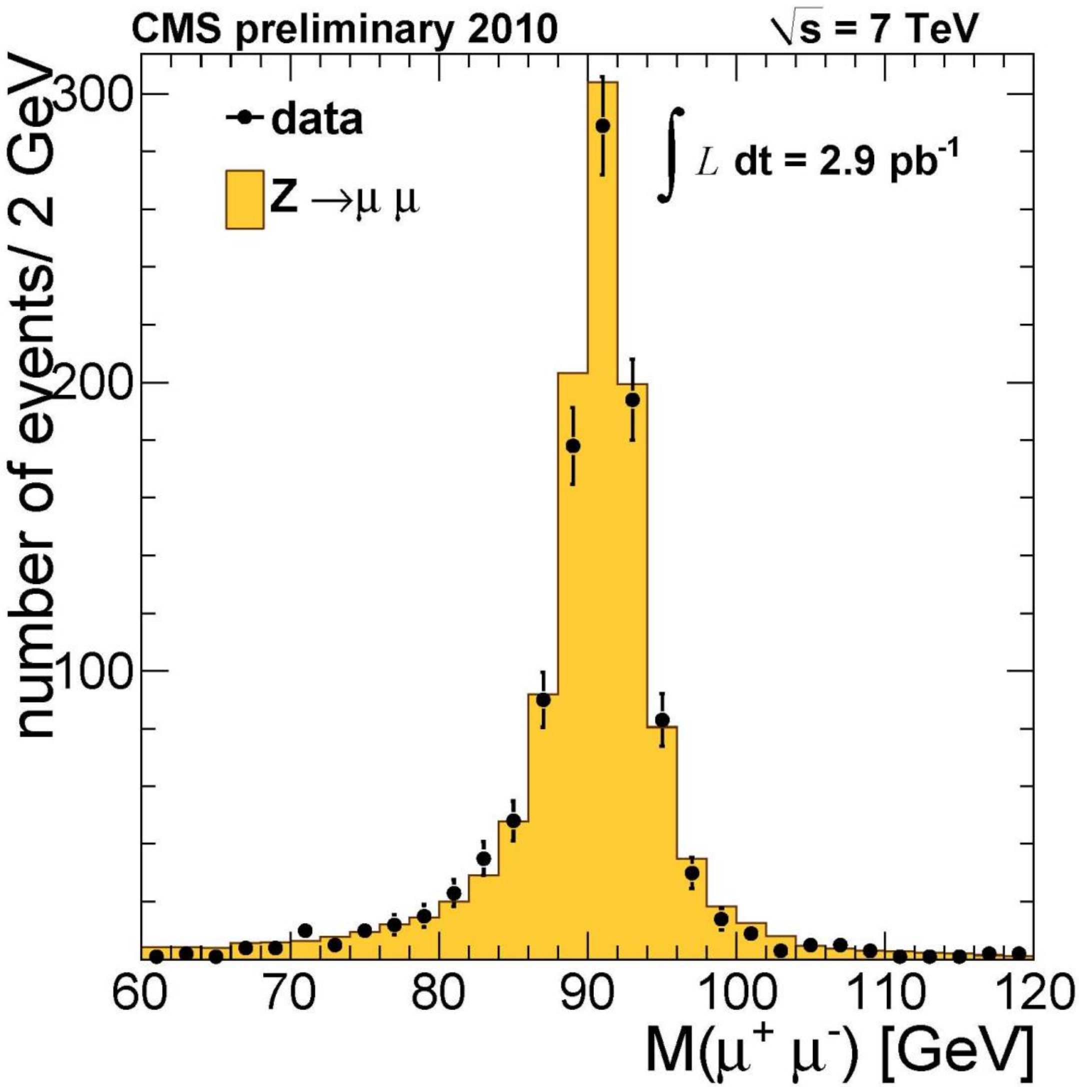
Cosmic ray spectrum





Using tracks with Pt >1GeV gives an agreement at the 0.6 per mille level.

Momentum Scale

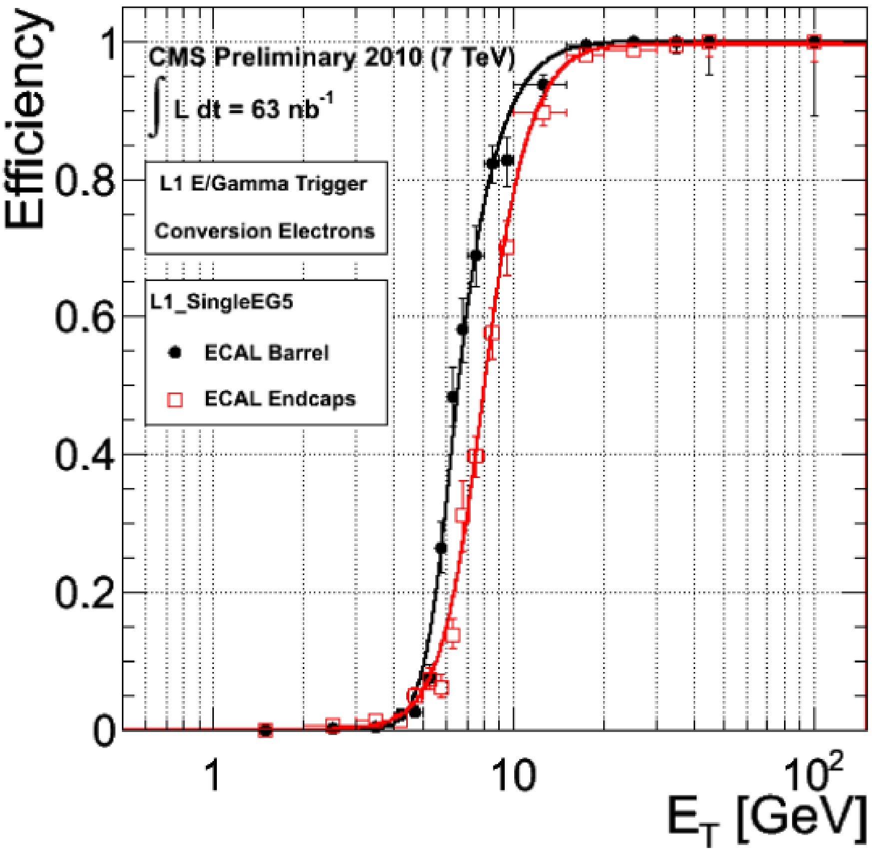


No bias with a precision of 0.15%

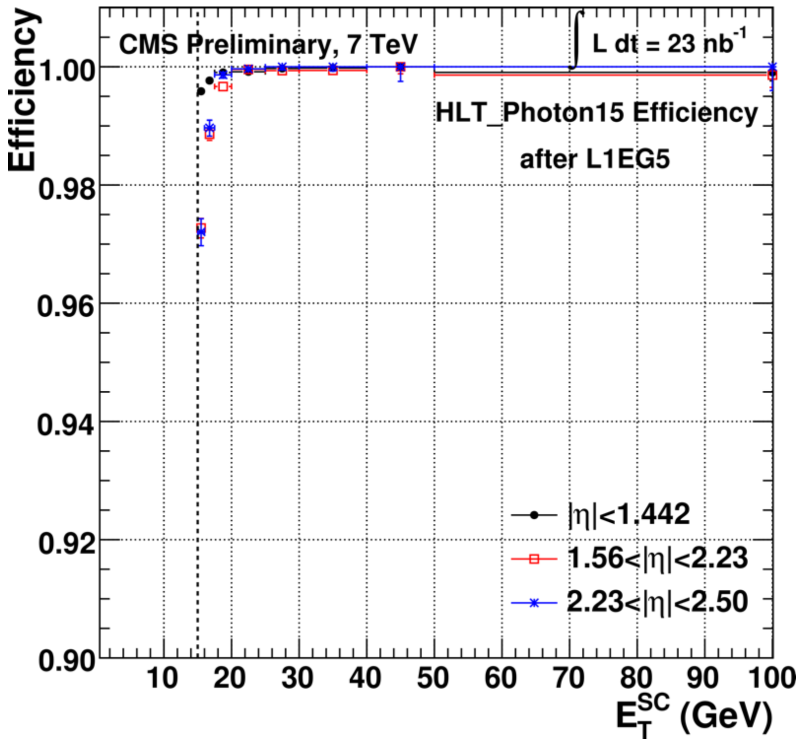
Electrons

Electron/Photon Trigger

L1 trigger efficiency



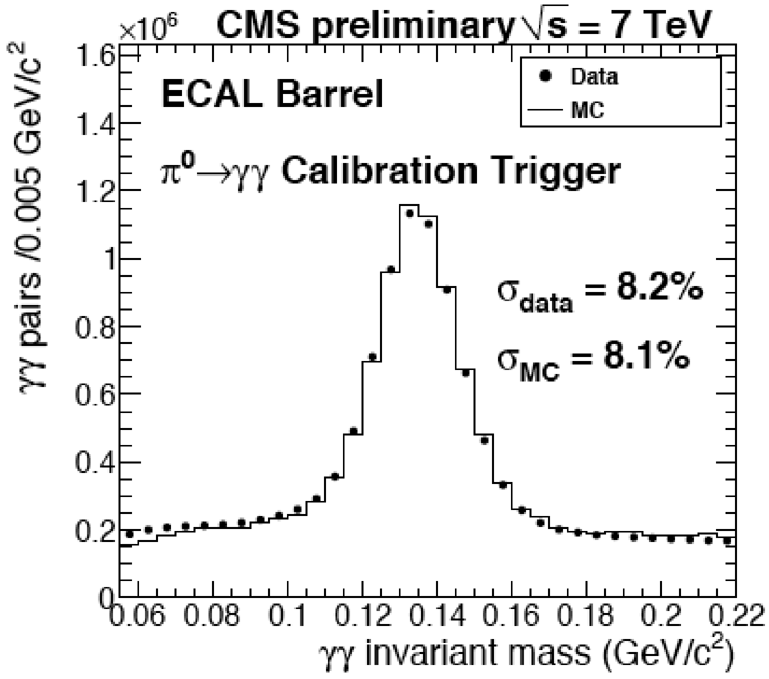
HLT Trigger efficiency vs energy of the supercluster measured in ECAL

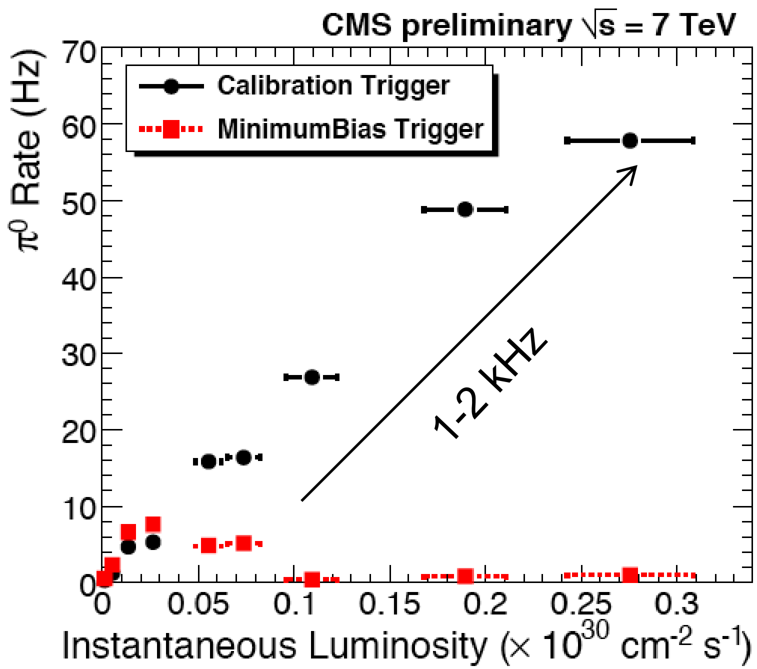


π^0 Calibration stream

Candidate di-photon decays are selected directly from events passing single-e/γ and single-jet L1 triggers. After selection, only information about a limited region of ECAL (20 to 40 crystals) is stored for the actual calibration.

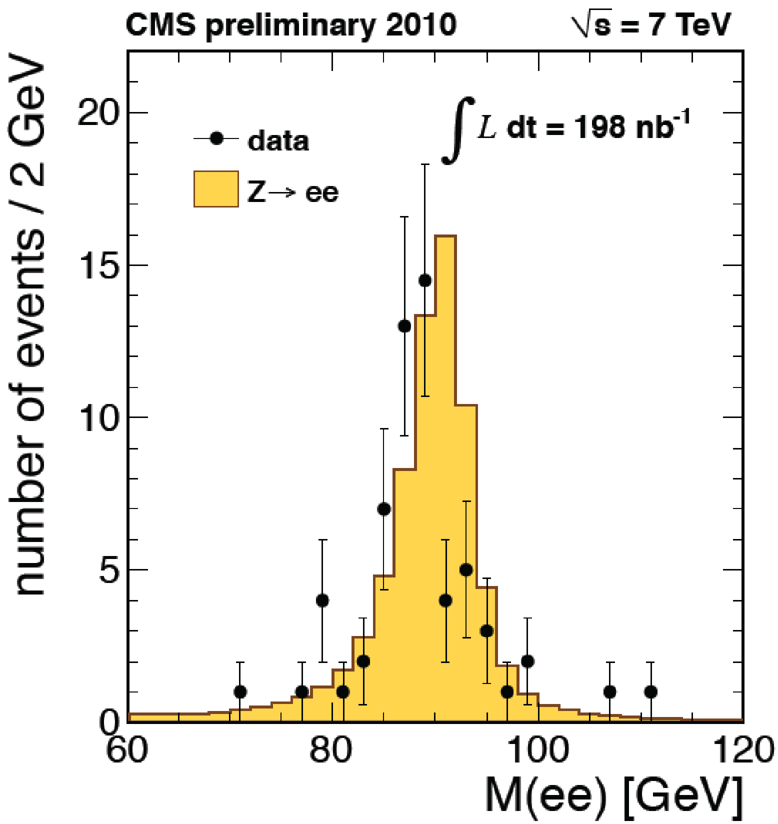
EGM-10-003

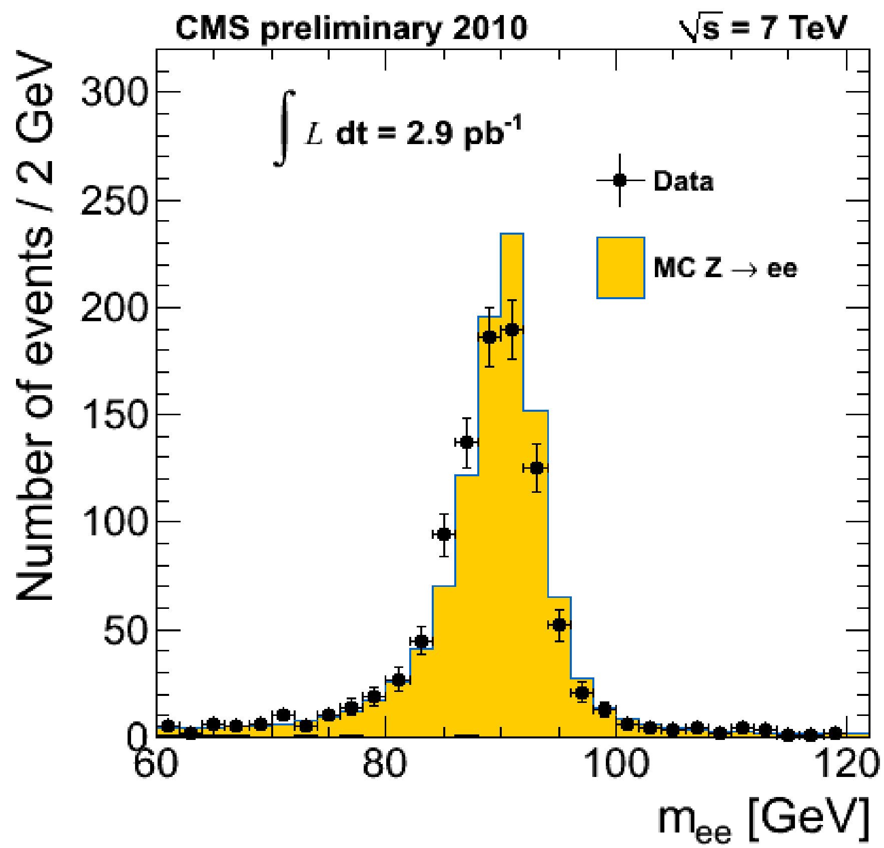




Today the barrel is 0.5% → 1.2% uniform depending on eta

ECAL energy scale



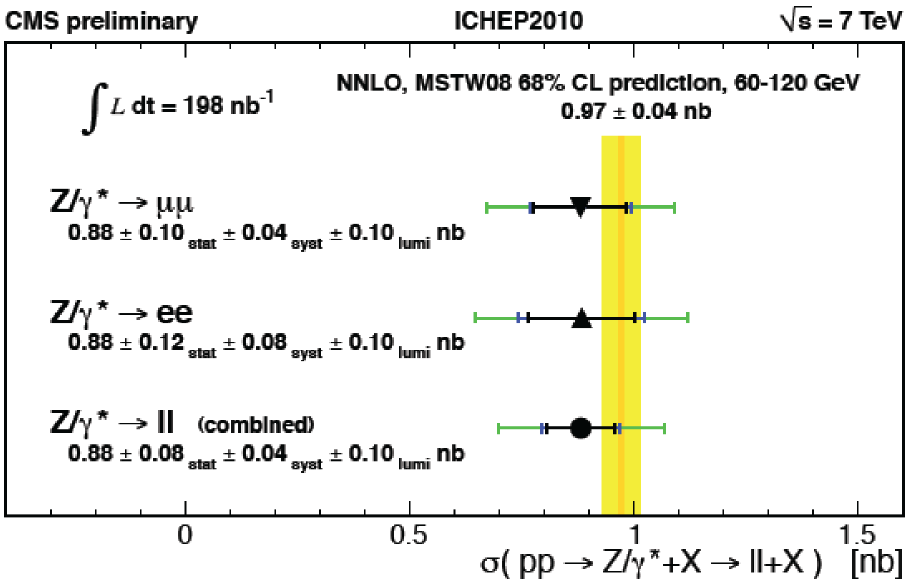


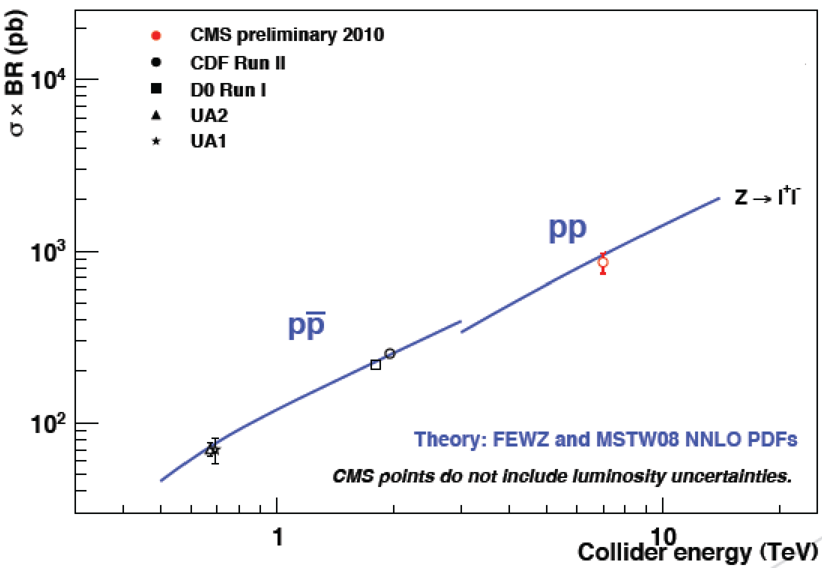
in the barrel the scale is now set by the π^0 calibration

EB ~ 1% ….. EE ~ 3%

Z cross section

EWK-10-002

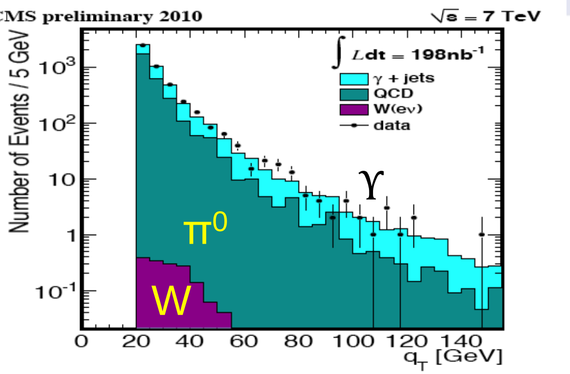


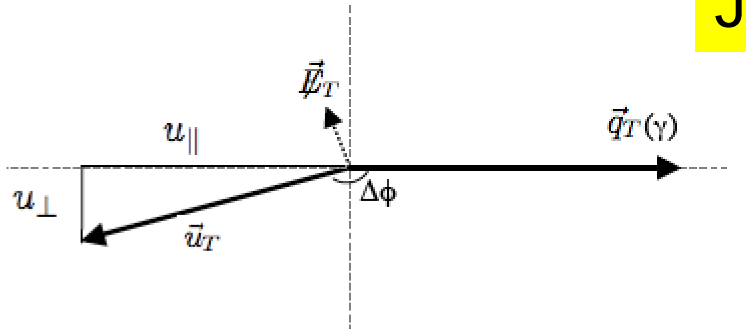


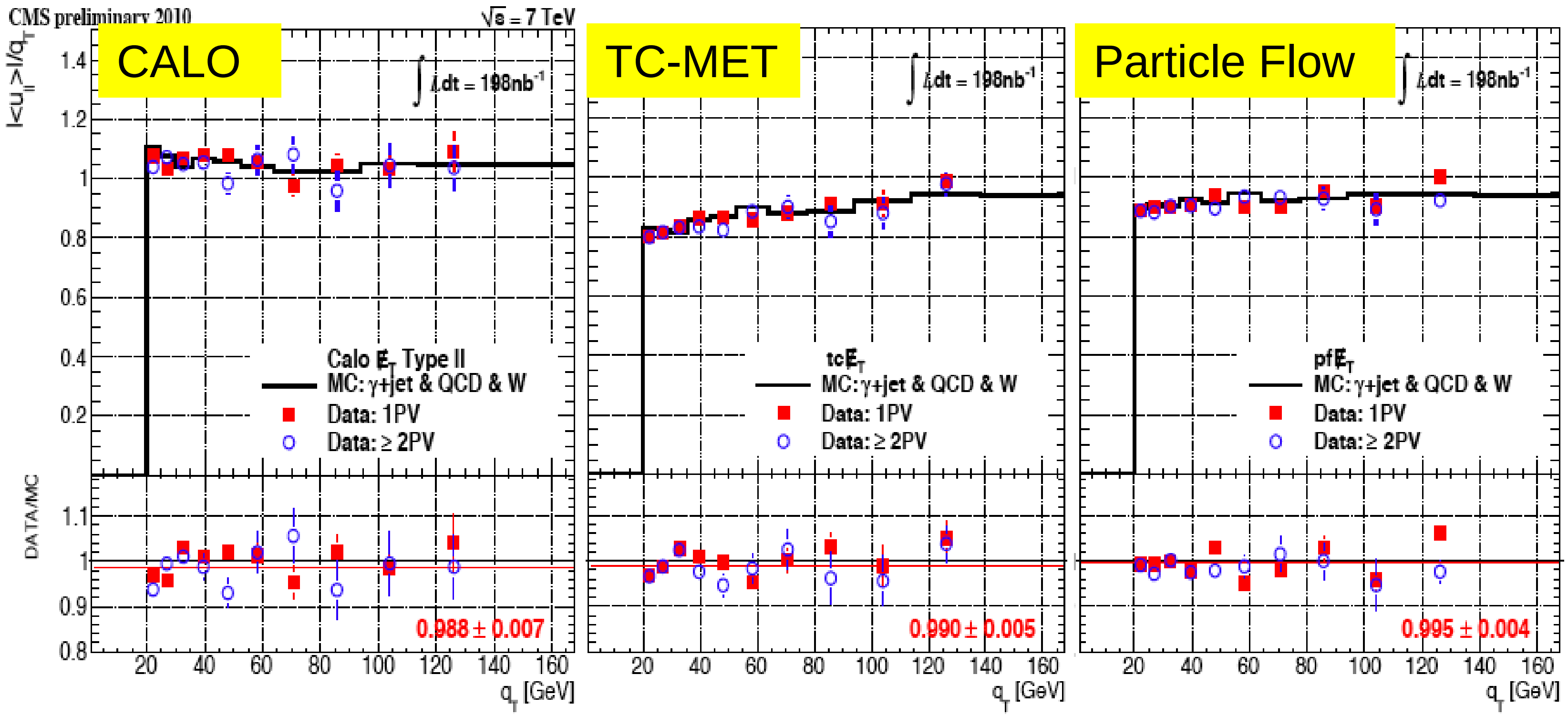
Missing Energy

Response in events with isolated photon

JME-10-005

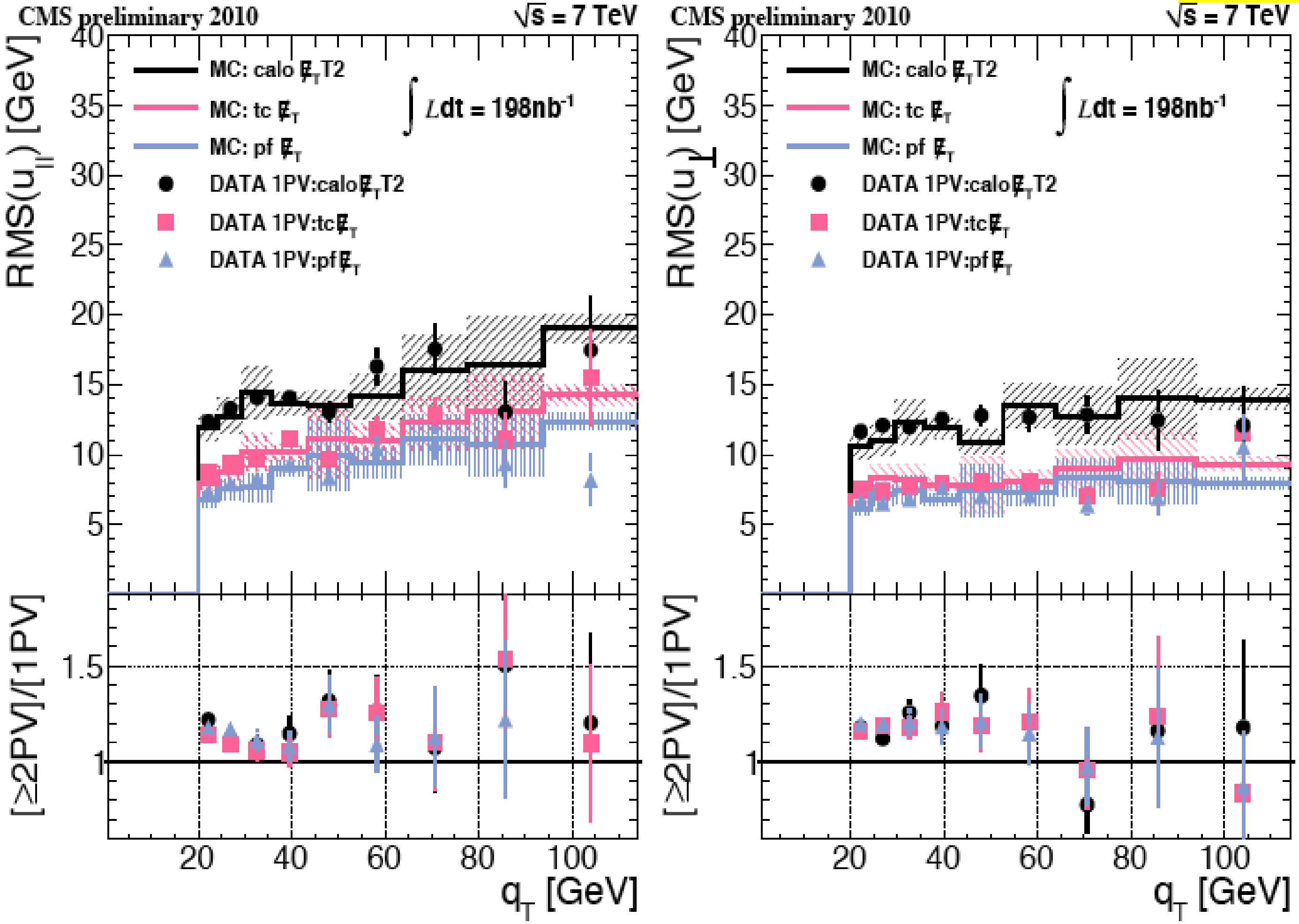




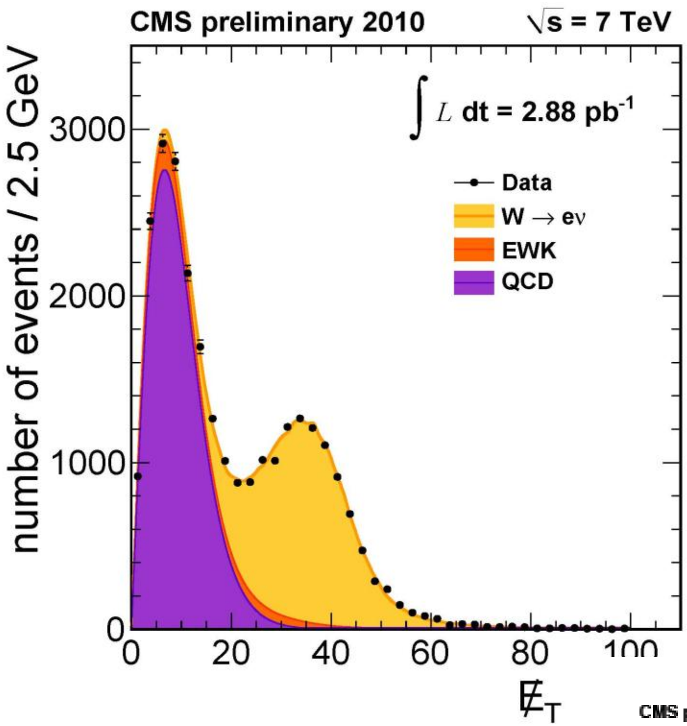


Resolution in events with isolated photon

JME-10-005

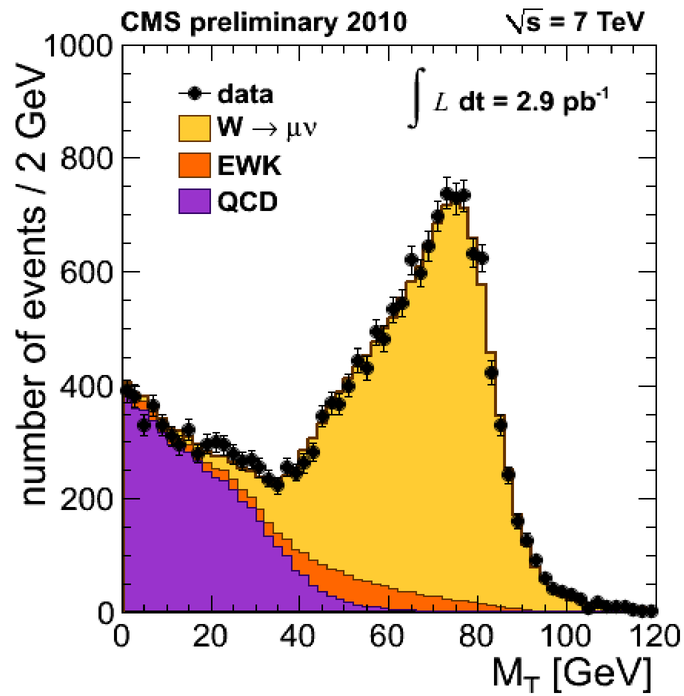


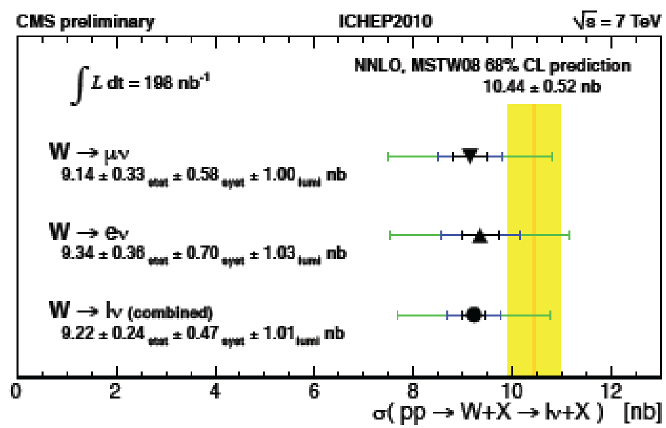
W cross sections



EWK-10-002

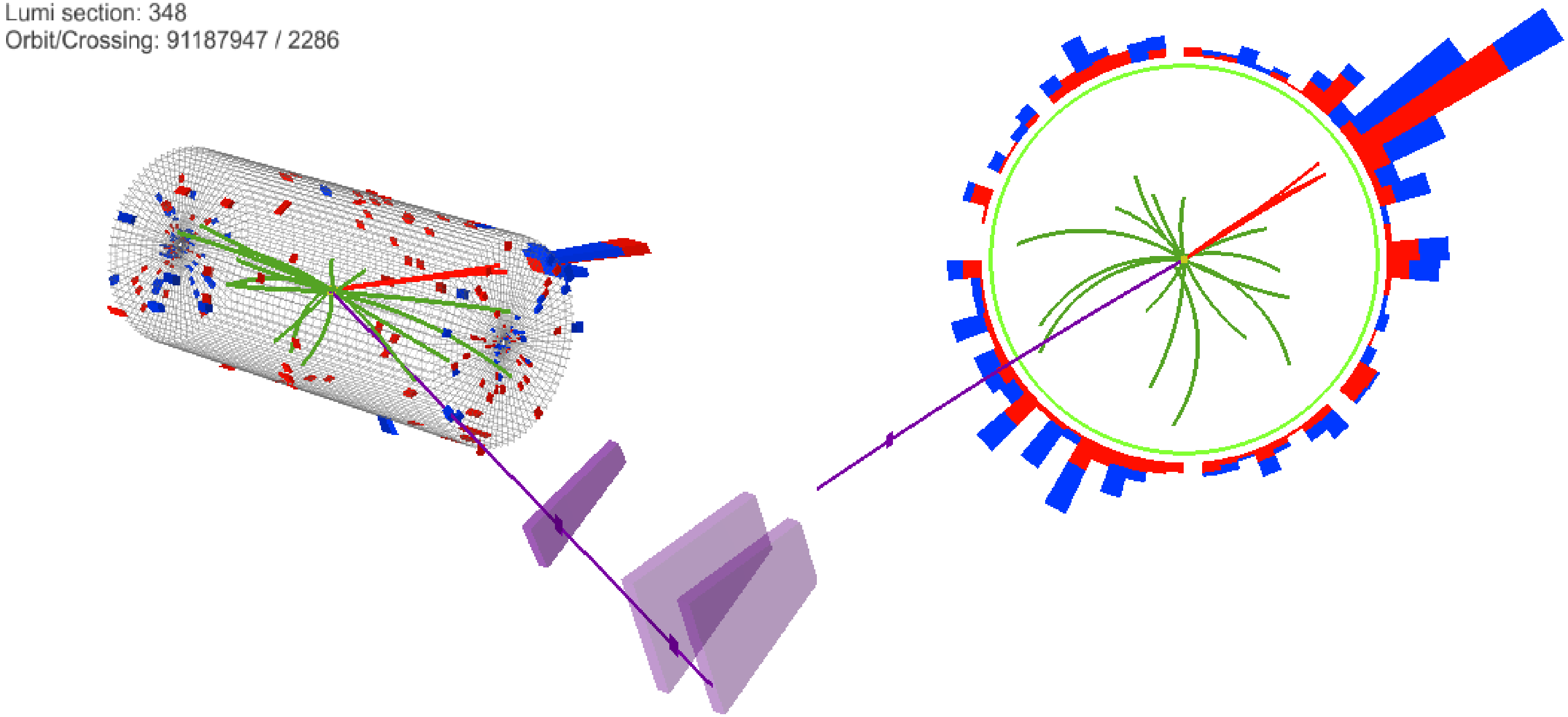
Data driven background shapes





Tau

Z → tau tau → mu +tauhad (three prong tau)



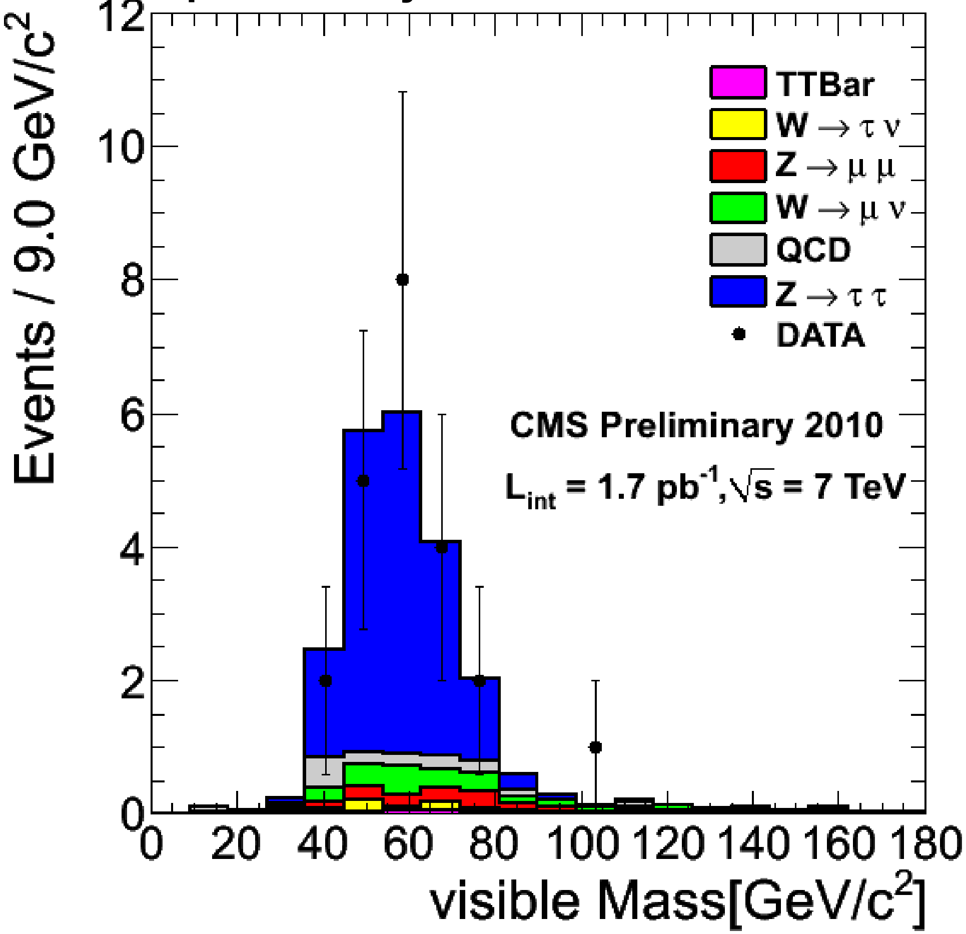
μ Pt = 32.4 GeV/c
η = 1.7

τ Pt = 37.4 GeV/c
η = 1.5
Mass = 1.2GeV/c^2

Z->tau tau selection

PFT-10-004

μ + tau-jet



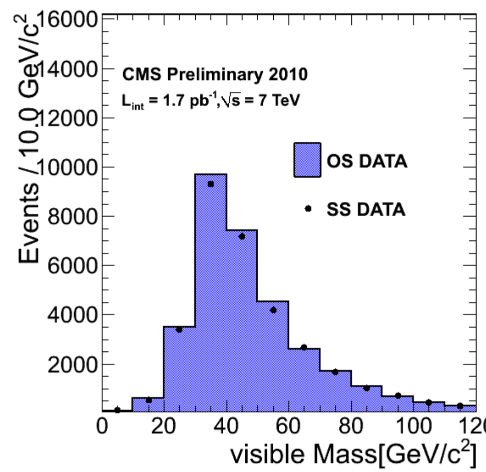
QCD Bkgr

Measured:

OS/SS = 1.03 +- 0.01(stat)

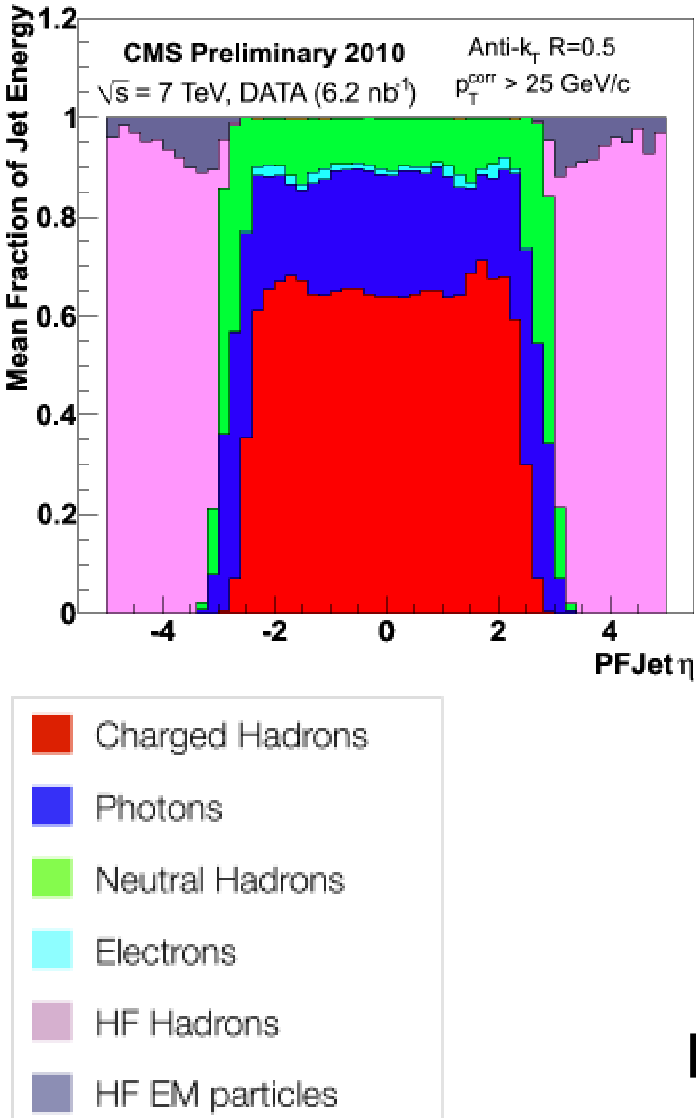
QCD MC expected value:

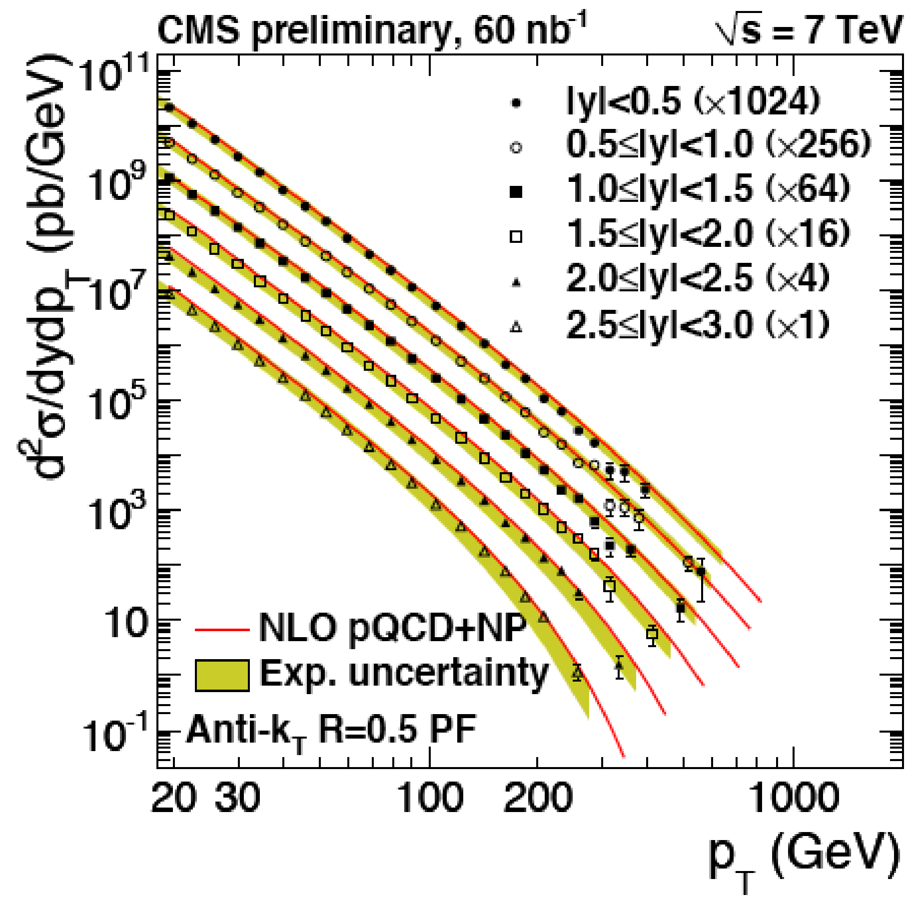
OS/LS = 1.036 +-0.002



JETs

Particle Flow Jets



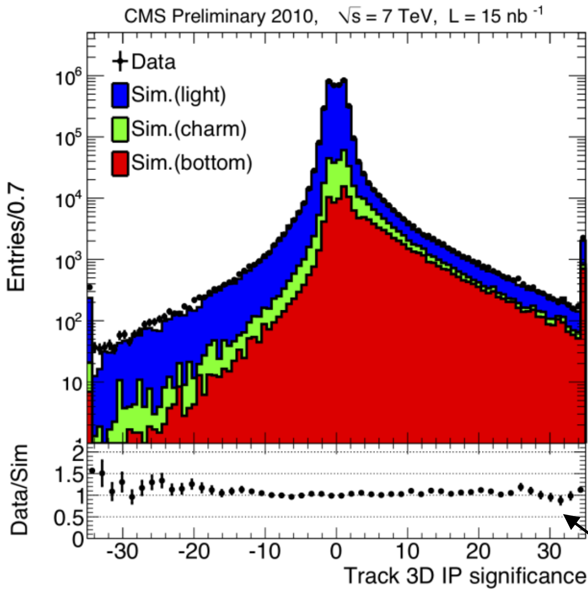


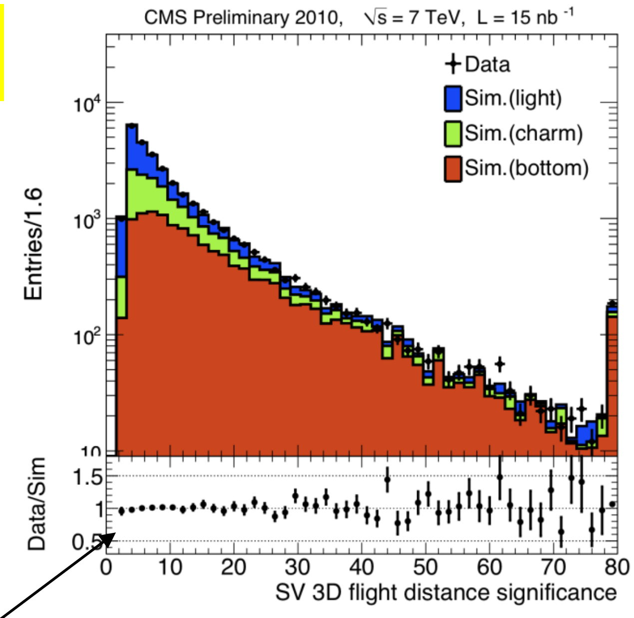
Down to pt=20 GeV and 5% JES

b-tagging

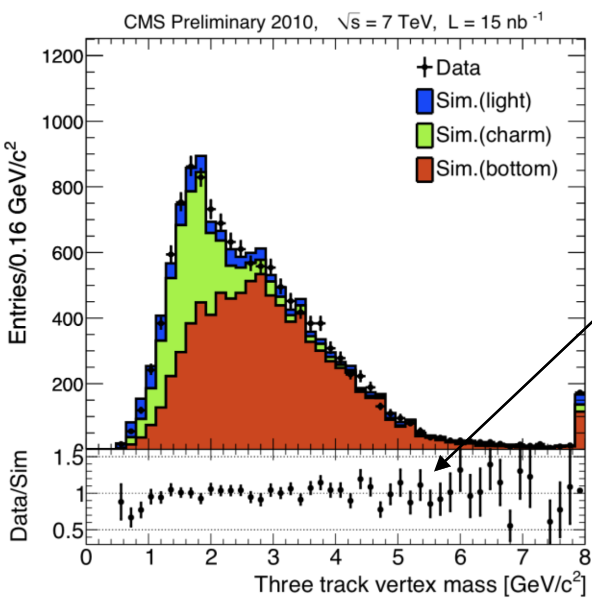
Data-MC comparison for b-tagging observables

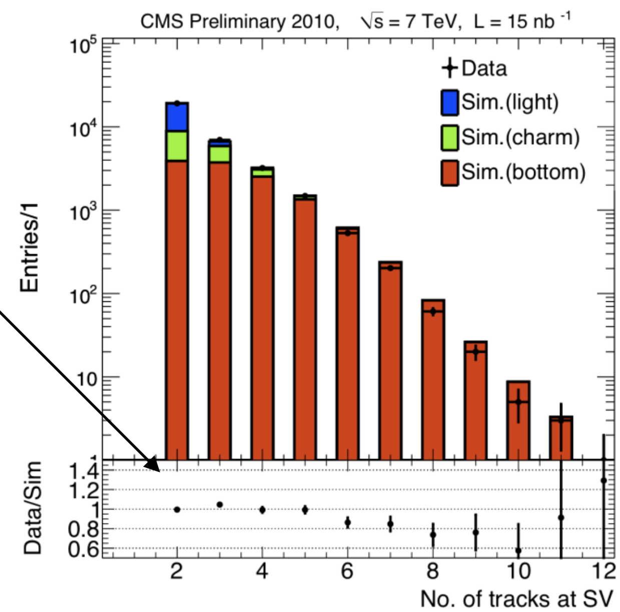
BTV-10-001



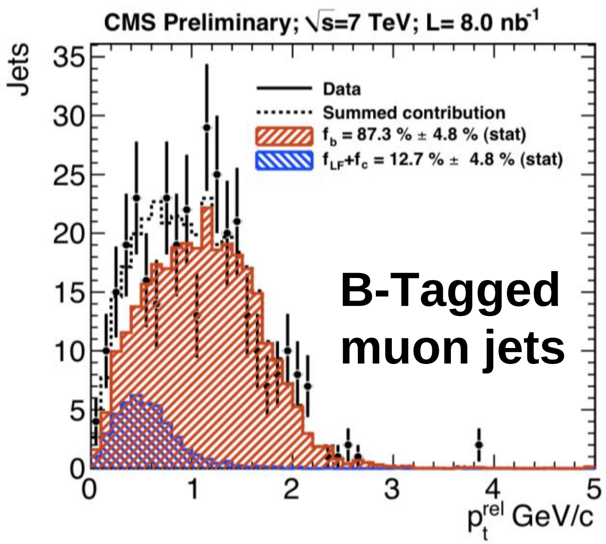


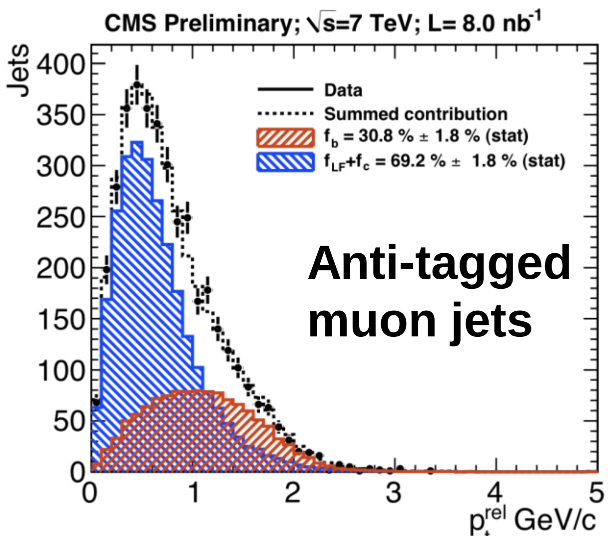
DATA/MC ratio is close to 1 for all observables





Data driven b-tagging efficiency





Light flavor+c fraction

B fraction

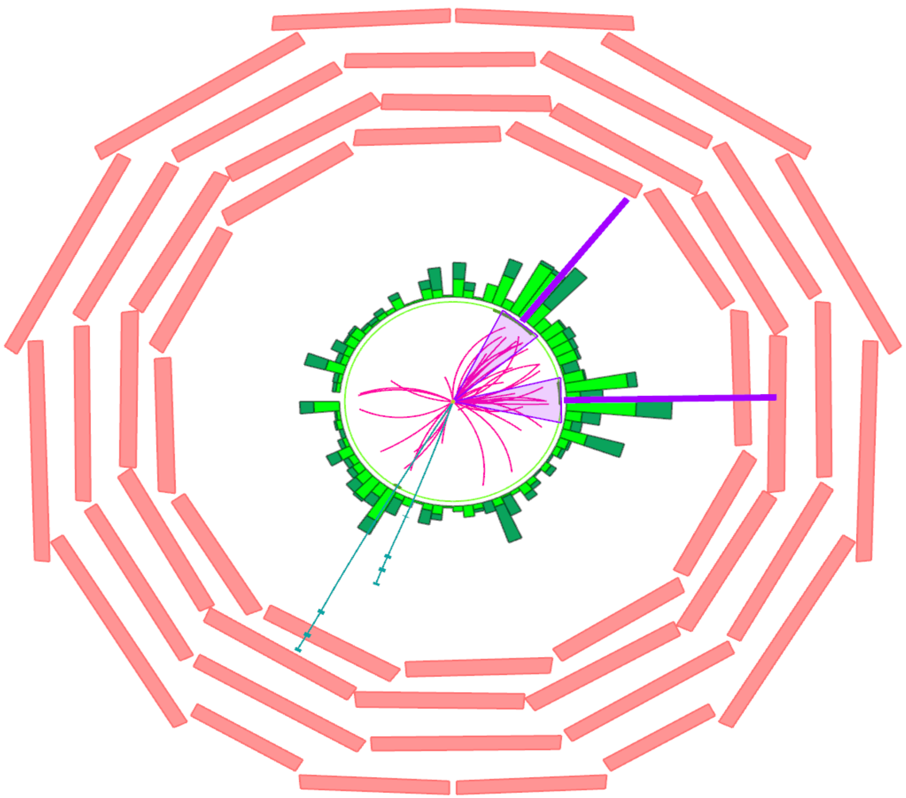
Efficiency is estimated from data fitting the p_T^{rel} distribution of muons in muon jets.

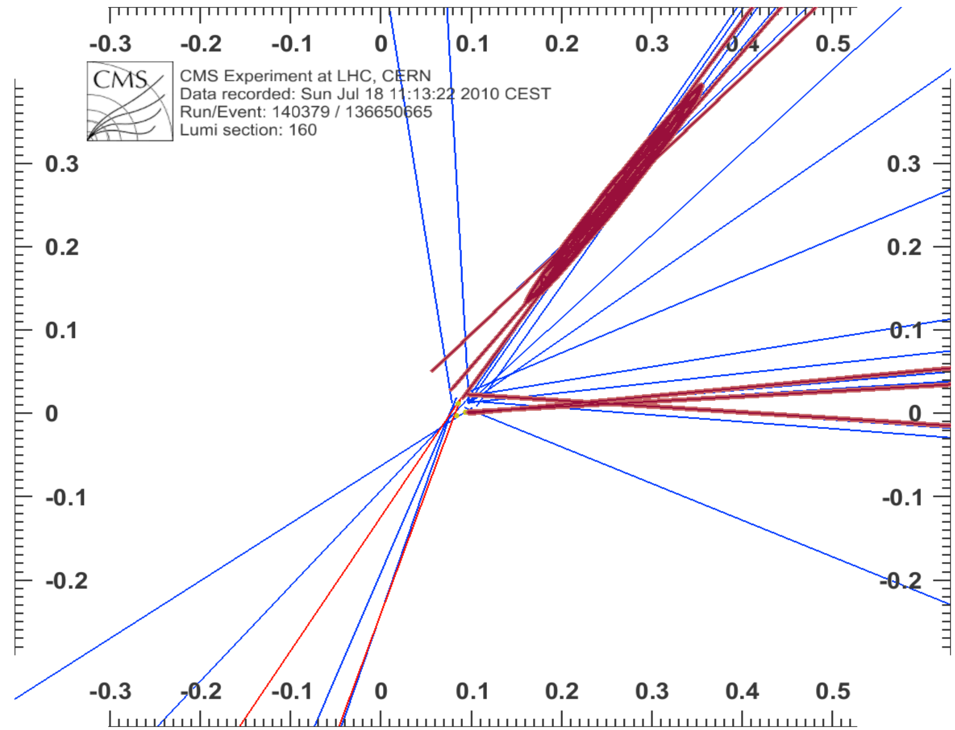
B-fraction is extracted from the fit of data using distribution templates based on MC

$$\epsilon_b^{data} = \frac{f_b^{tag} \cdot N_{data}^{tag}}{f_b^{tag} \cdot N_{data}^{tag} + f_b^{untag} \cdot N_{data}^{untag}}$$

Tagger+Operating Point	Scale factor
SSV algorithm High Purity configuration	0.98 ± 0.08±0.18
Track Counting algorithm High Purity configuration	0.95 ± 0.06±0.19

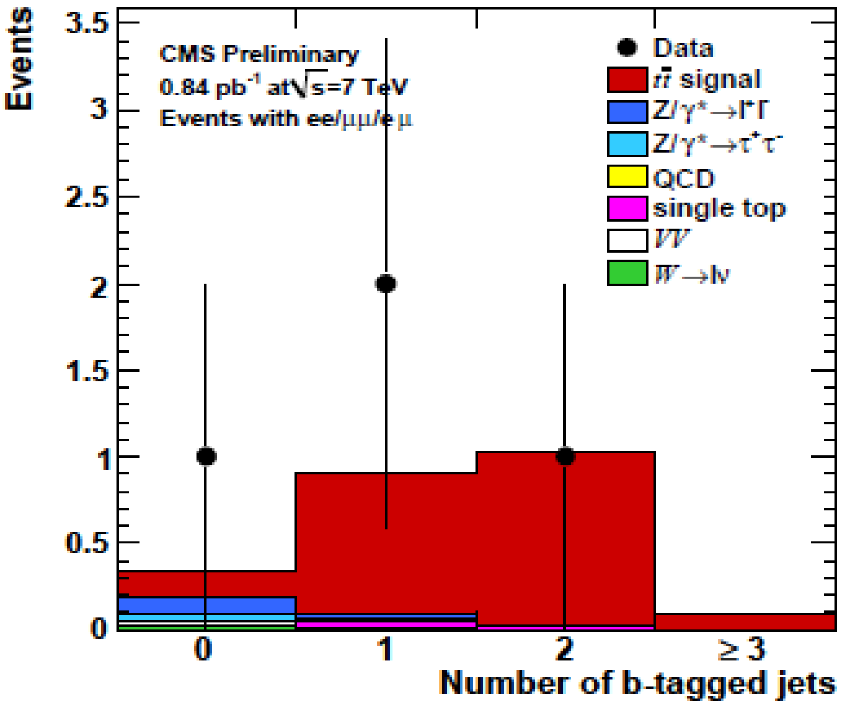
TOP candidate event display

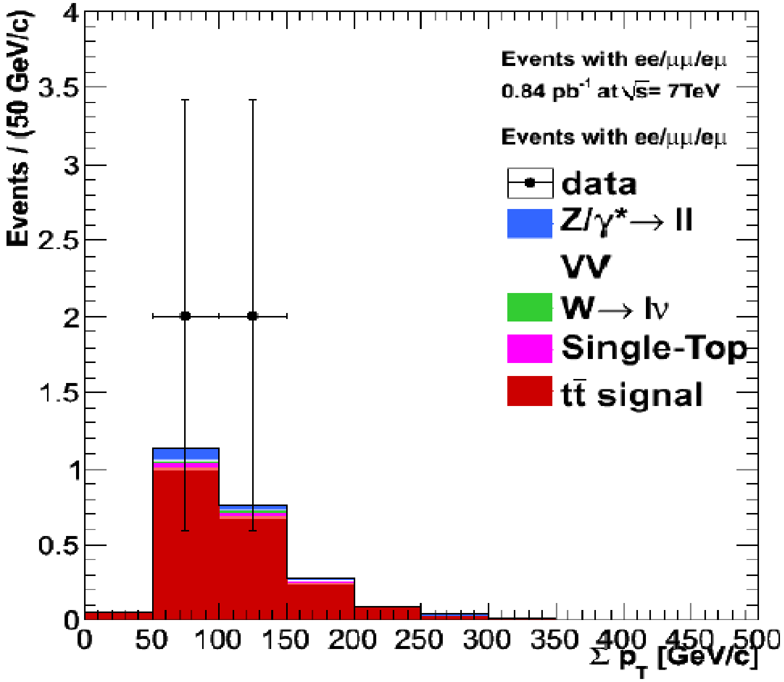




2 OS muons, 2 jets, both b-tagged (w/secondary vertices), MET >50 GeV, reconstructed mass consistent with mtop. Very low background expected.

t-tbar: dileptonic channel

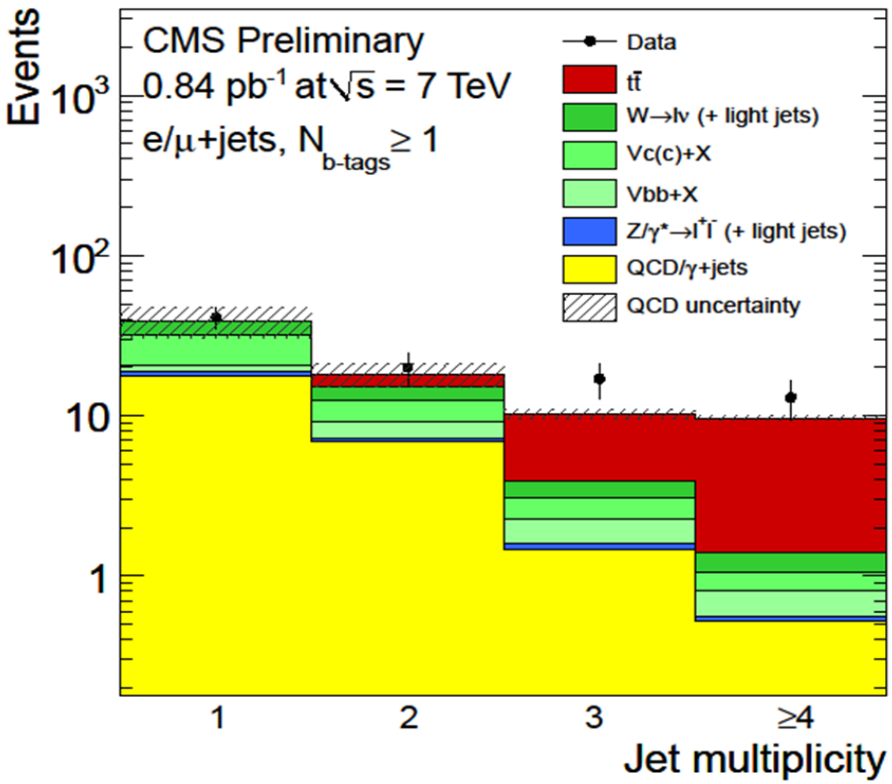




- Full selection applied: Z-bosonVeto, |M(ll)-M(Z)|>15 GeV
- MET >30 (20) GeV in ee, μμ, (eμ); N(jets) ≥2
- 4 tt candidates (1 eμ, 1 ee, 2 μμ) over a negligible background.
- Top signal at LHC established.

t-tbar : lepton+jets

- Using 0.84pb^{-1} and requiring at least 1 secondary vertex tagger with ≥2 tracks;
  - ~50% efficiency ~1% fake rate
- N(jets)≥3
  - 30 signal candidates over a predicted background of 5.3
- tt rate consistent with NLO cross section
  - Up to experimental (JES, b-tagging) and theoretical (scale, PDF, HF modeling, …) uncertainties.



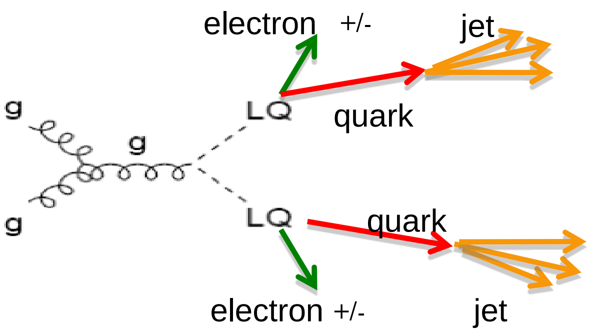
Searches for new Physics

First Generation Leptoquark (1)

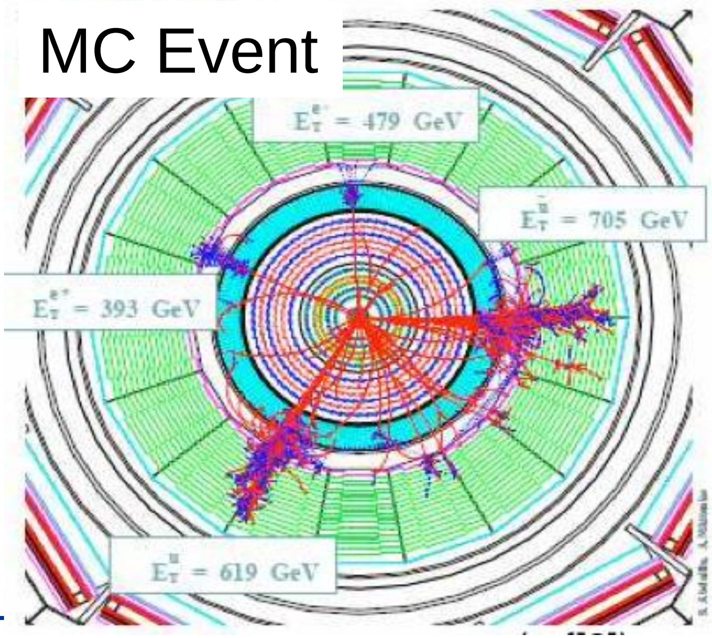
EXO-10-005

- Search for 1st generation scalar LQ in the eejj channel (goes as β^2)
- HEEP (High Energy e & photon) selection
- Optimize to minimize limit xsec
  - 2 isolated high-p_T electrons, 2 high-p_T jets
  - Z Veto
  - $S_T = p_T(e_1) + p_T(e_2) + p_T(j_1) + p_T(j_2) > f(M_{LQ})$
- Background estimation:
  - Data-driven techniques developed for 100 pb^{-1} cannot yet be applied
  - MC for main backgrounds (Z+jets and tt)
    - Data-driven/MC strategy for the uncertainty
  - Small QCD background est. from data

β = BR(LQ → $l^{+/-}$ + q) is unknown

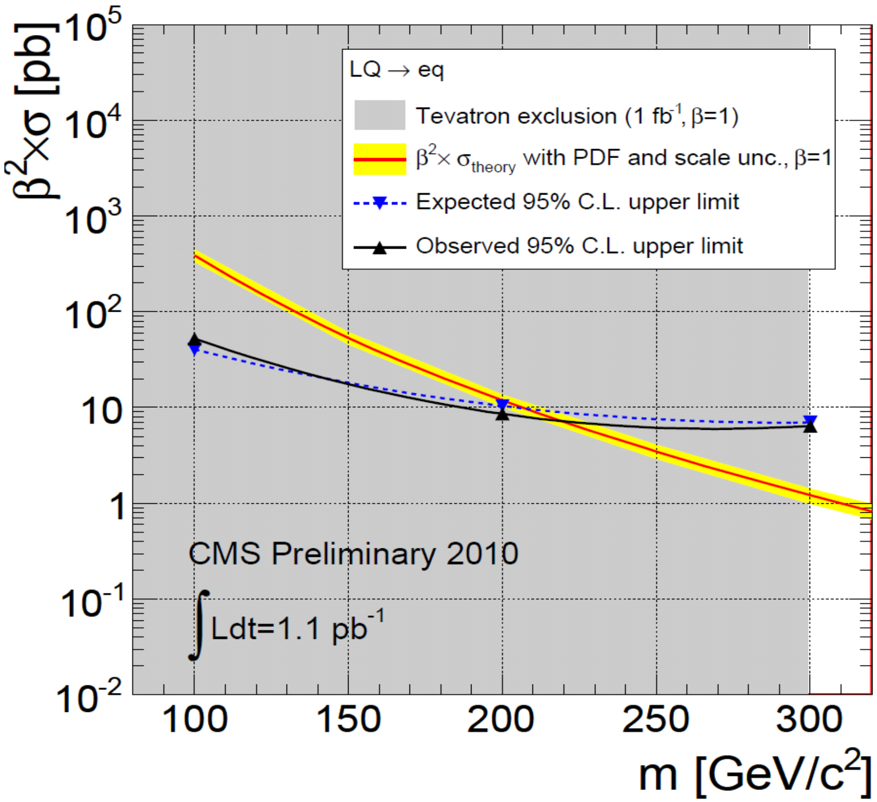


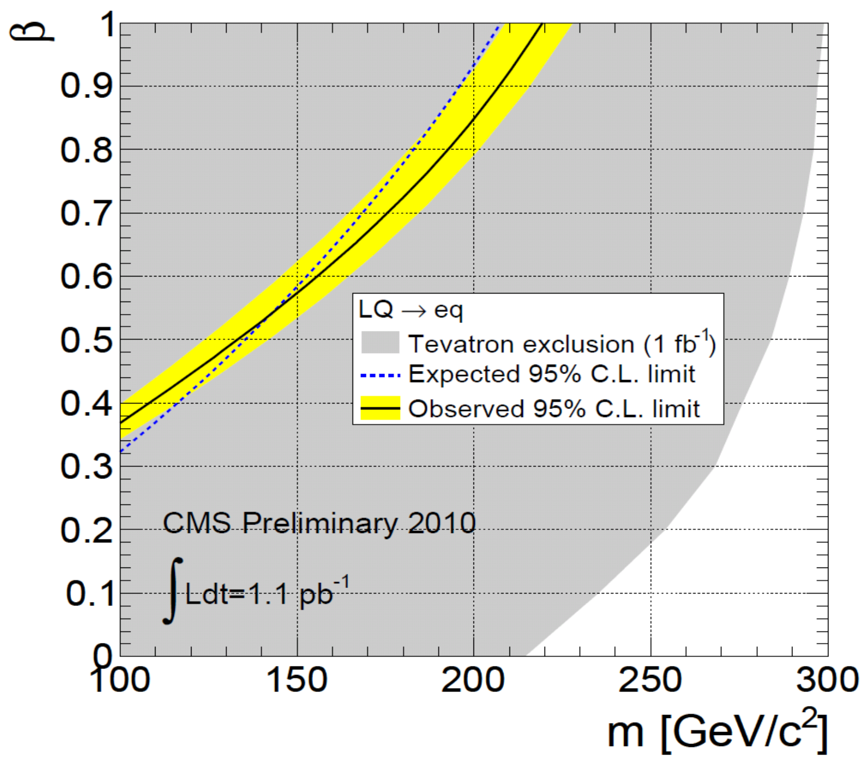
MC Event



First Generation Leptoquark (2)

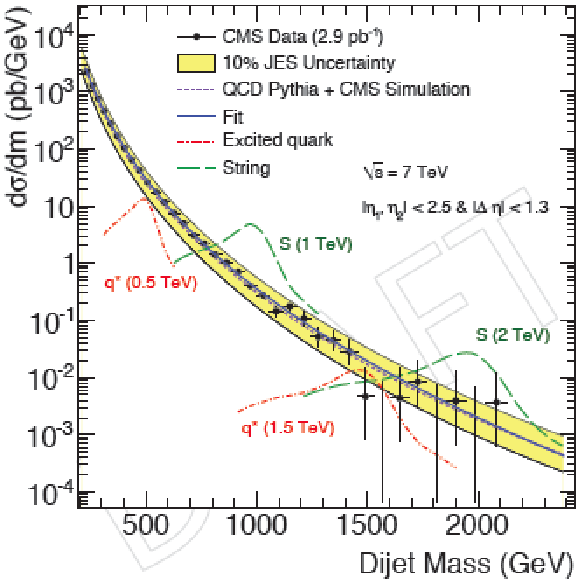
- Observation from data are consistent with SM bkg expectations
  - Set \upper limit on the LQ cross section (using a Bayesian approach)
  - Systematic uncertainties are included in the upper limit calculation
- A lower limit on the LQ mass is 220 GeV for β=1
  - The Tevatron limit is 299 GeV

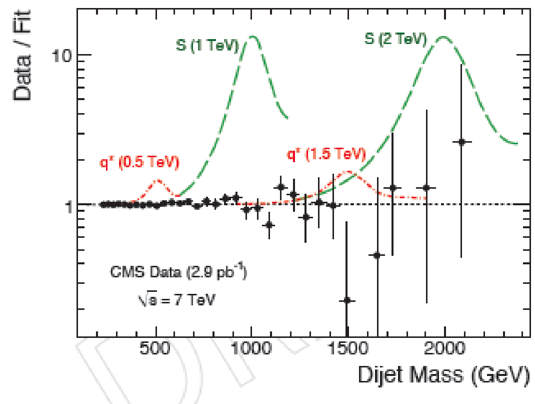


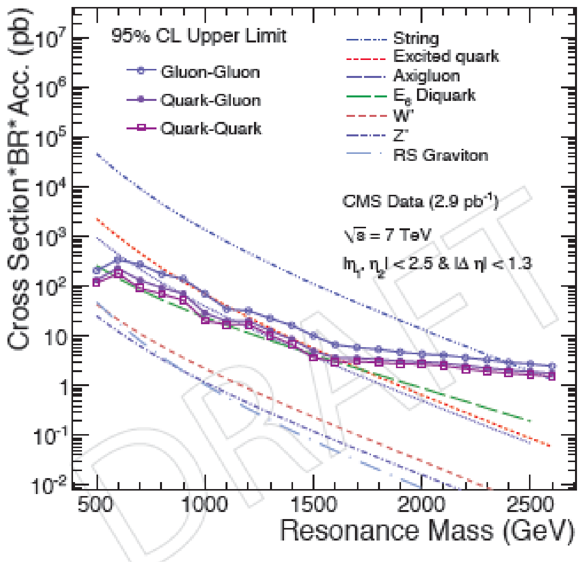


Di-Jet resonances

EXO-10-010



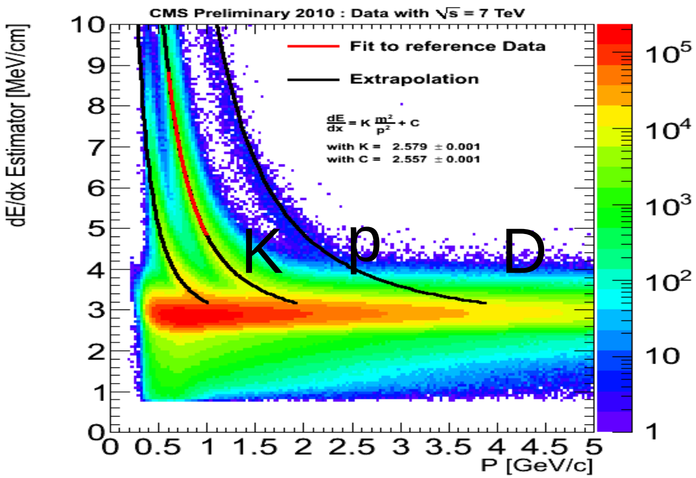


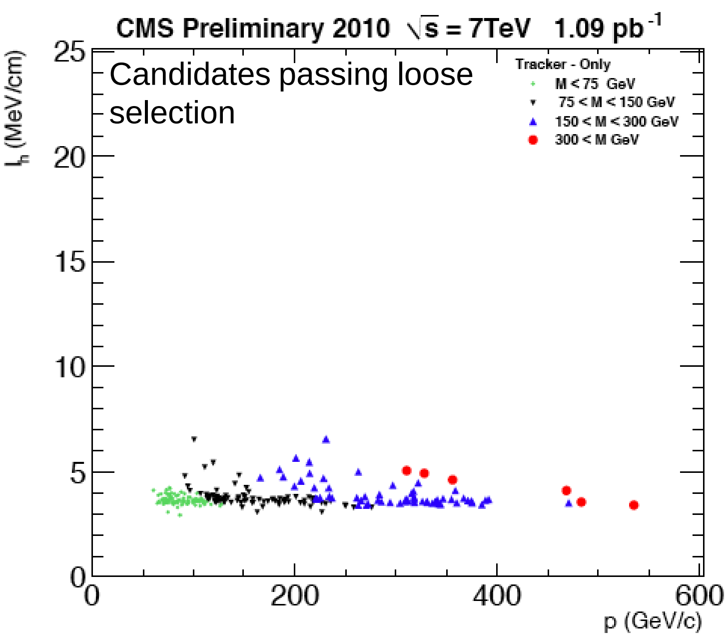


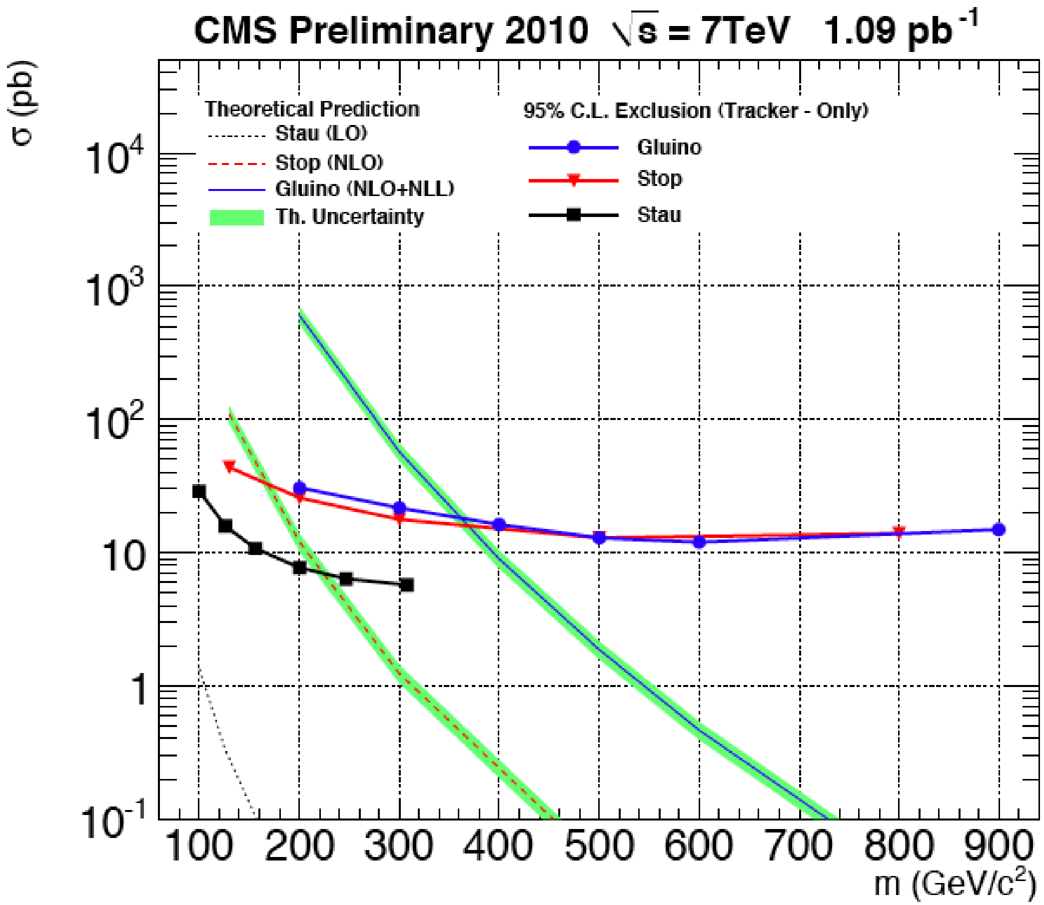
- Search for narrow resonances in di-jet final states.
  - Differential cross section for $|\eta_1,\eta_2|<2.5$ and $|\Delta\eta_{12}|<1.3$.
    - Sensitive to coupling of any new massive object to quarks and gluons.
  - 95% CL mass limits
    - String resonances >2.5 TeV, Excited quarks >1.58 TeV
    - Axigluons/Colorons >1.17 TeV

Heavy Stables Charged Particles

EXO-10-004







Tight Selection: 0.088±0.021 expected ; 0 observed

All this was possible because of a large and coherent effort of many, many members of the CMS Collaboration

Conclusions

• CMS is in a very healthy status

• Data are acquired and validated with large efficiency and shipped with fast turnaround to Tier2

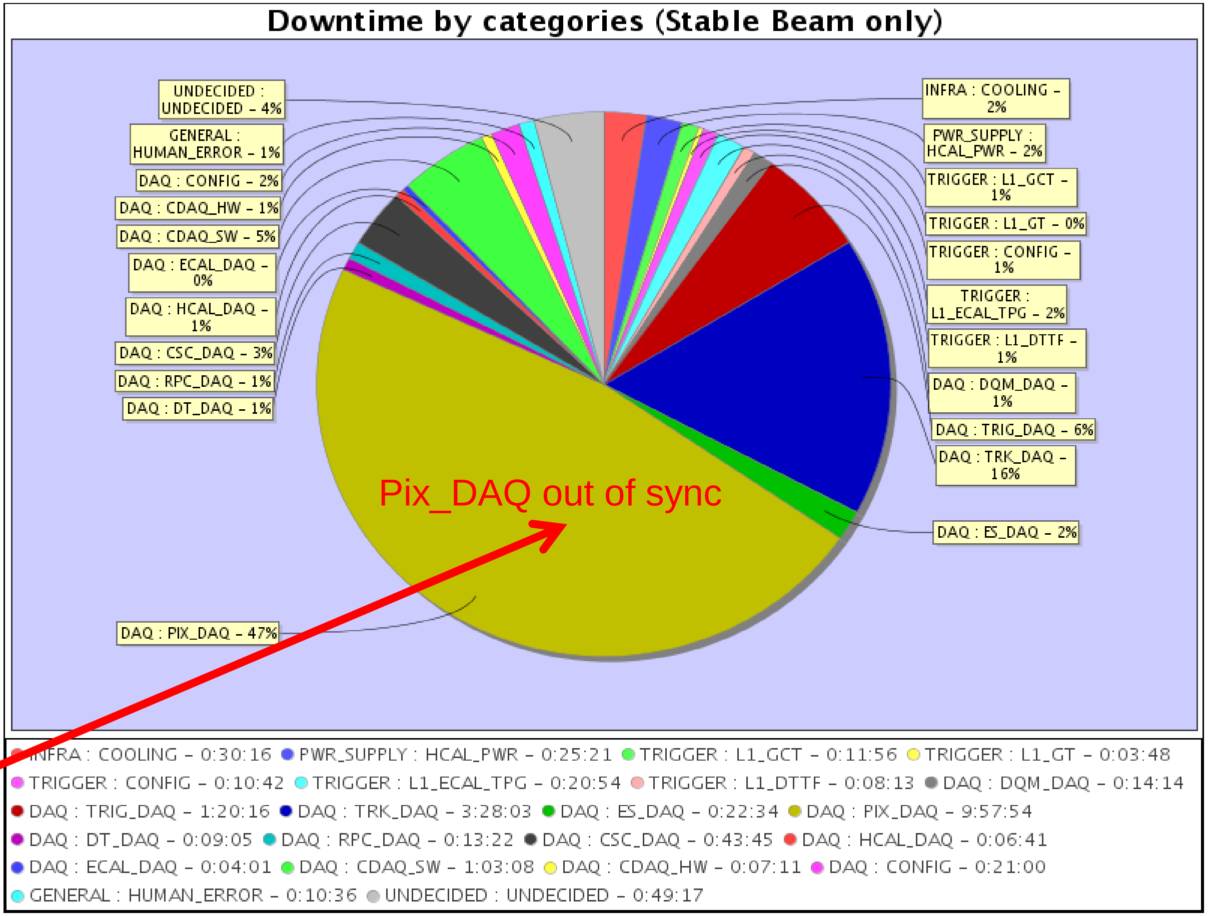
• Many physics objects are validated or will be validated with the 0.3/pb (ICHEP) , 3/pb (Now) and 30 /pb (Nov 2010)

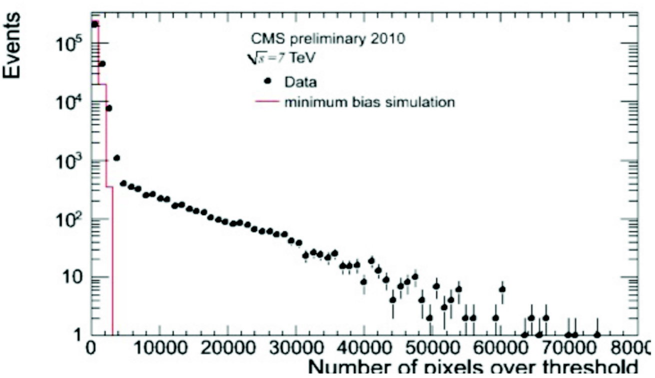
•CMS has demonstrated flexibility in converging on a large number of good quality analyses in a short amount of time

• Many new physics results expected in the near future

Data Taking efficiency

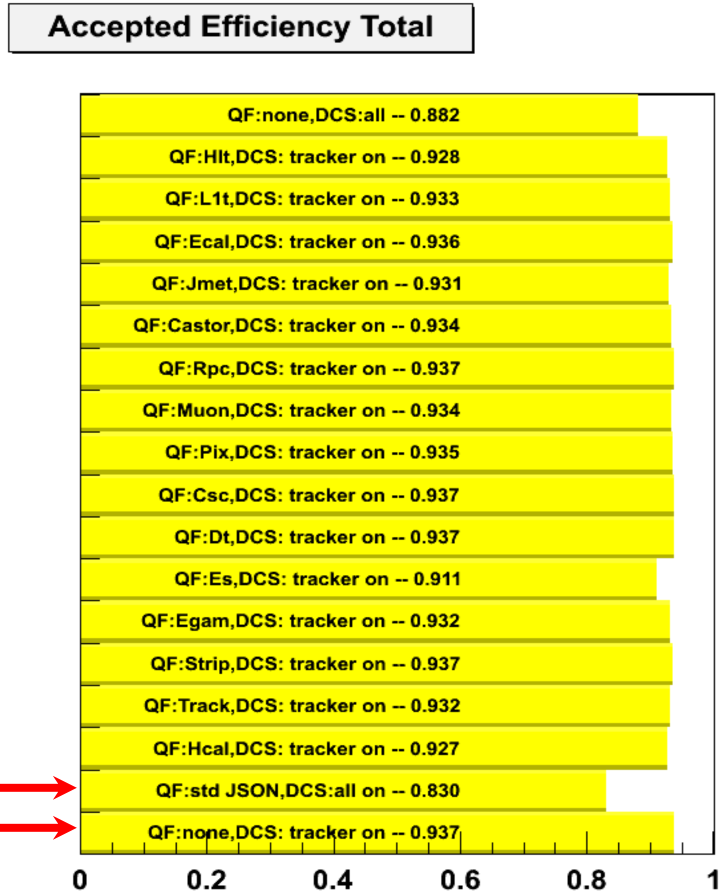
- Now operate subdetectors almost entirely without subdetector shifters.
- L1 trigger rates around 50-60 kHz at 10^{31} $cm^{-2}s^{-1}$.





Now fixed reducing slew rate in the FPGAs of the Pixel readout

Certification Efficiency



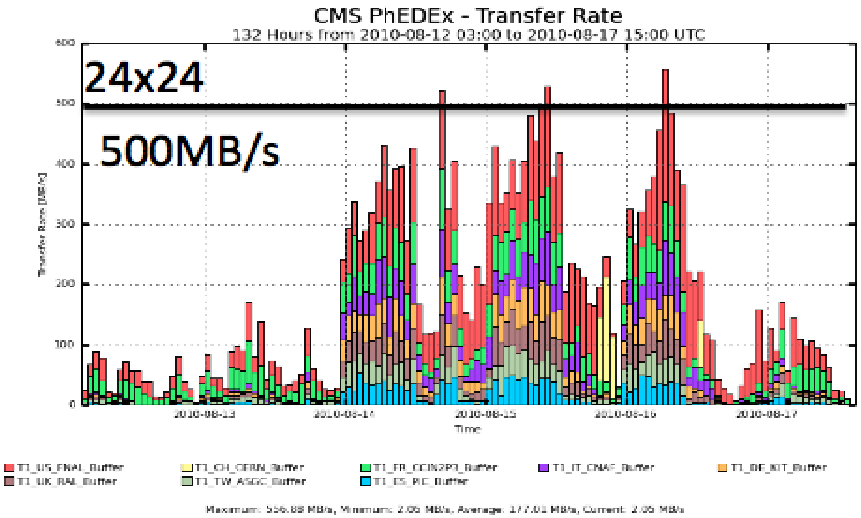
No single big offender for luminosity losses

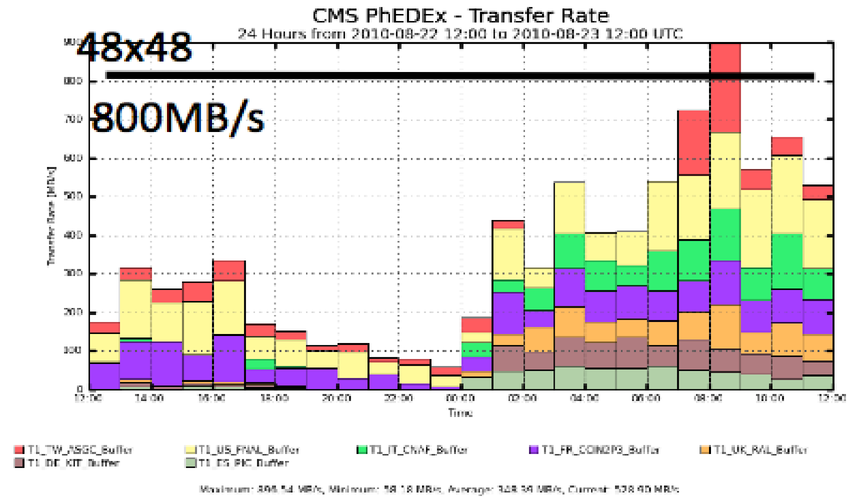
Revisiting the definition of the thresholds with the help of the analysis groups.

Expect 2-3% recovery

Fraction of “good” data in stable beam =0.83/0.937=88.5%

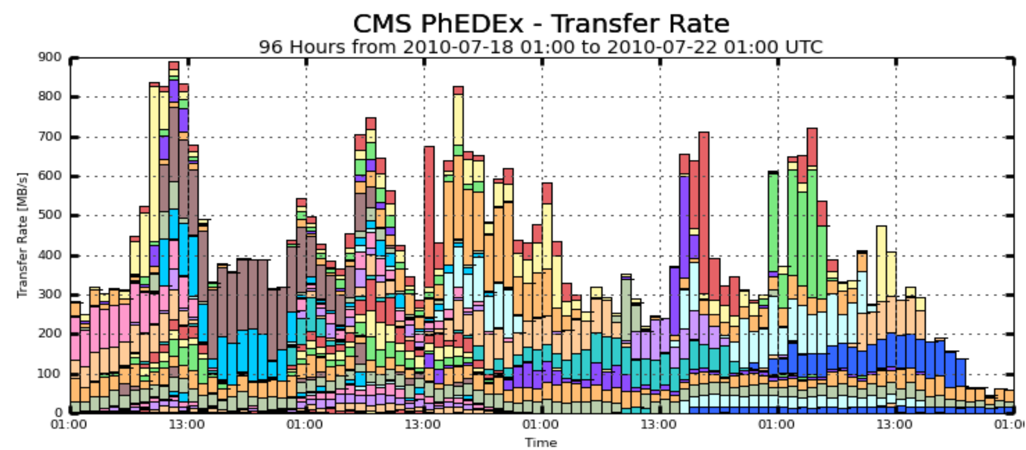
Data Transfer rate



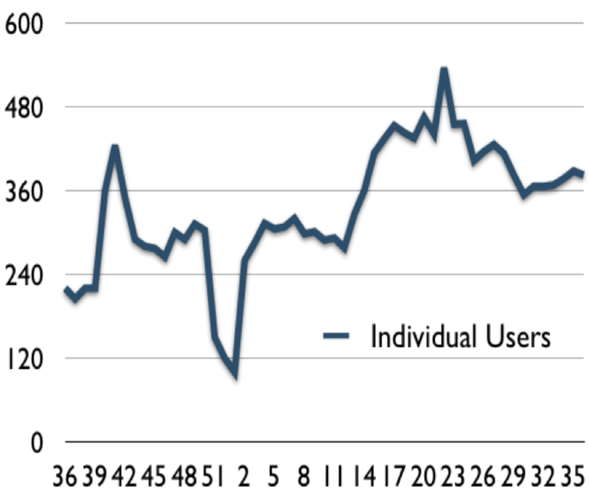


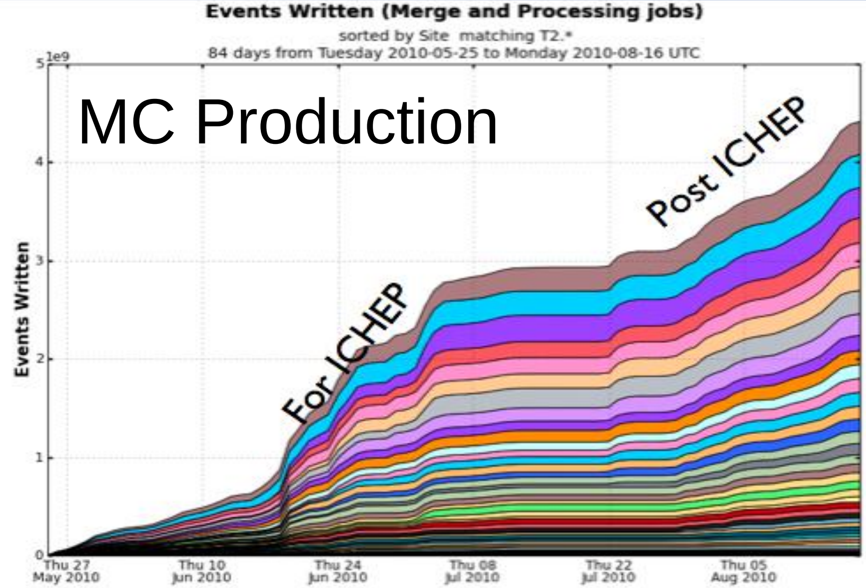
We largely maintained the same trigger moving from 24->48 bunches to study before tightening. The computing system kept up with data rate from CERN.

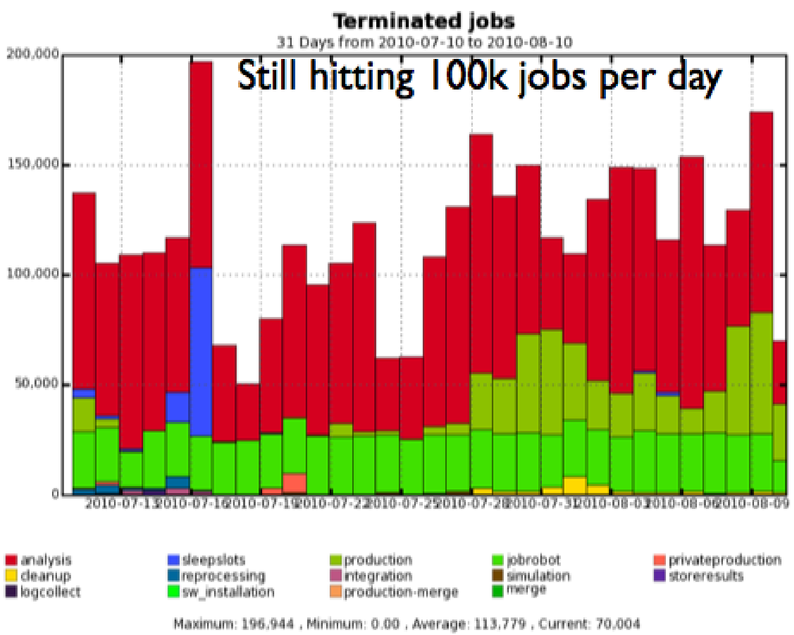
- Data Transferred to Tier-2 Centers regularly within a few hours of processing

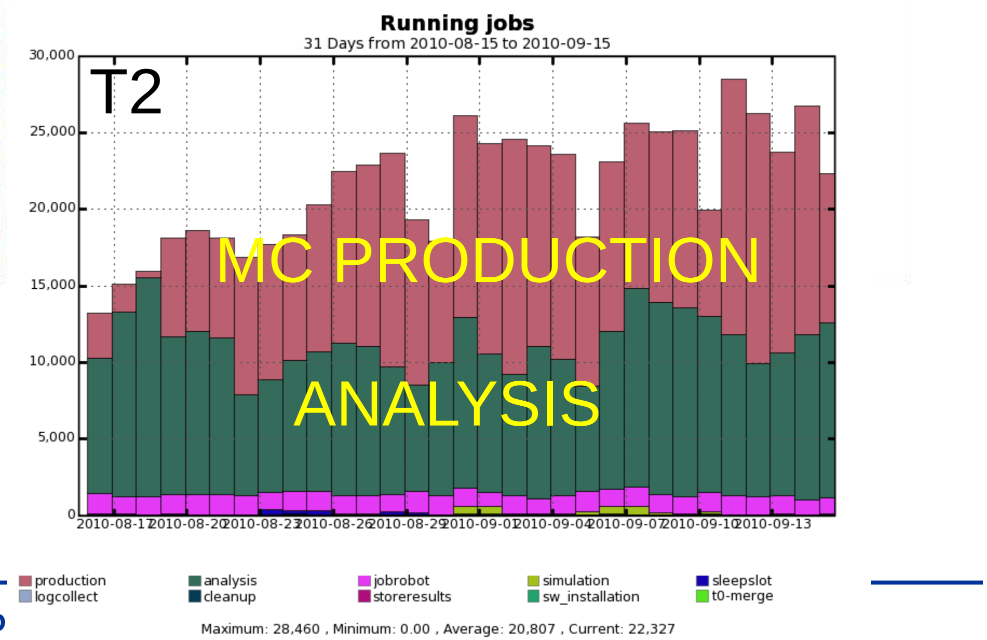


Analysis Activities









Missing ET projection fraction

- MPF method
  balances hadronic recoil against photon;
  no(t much) real MET in photon+jet events:

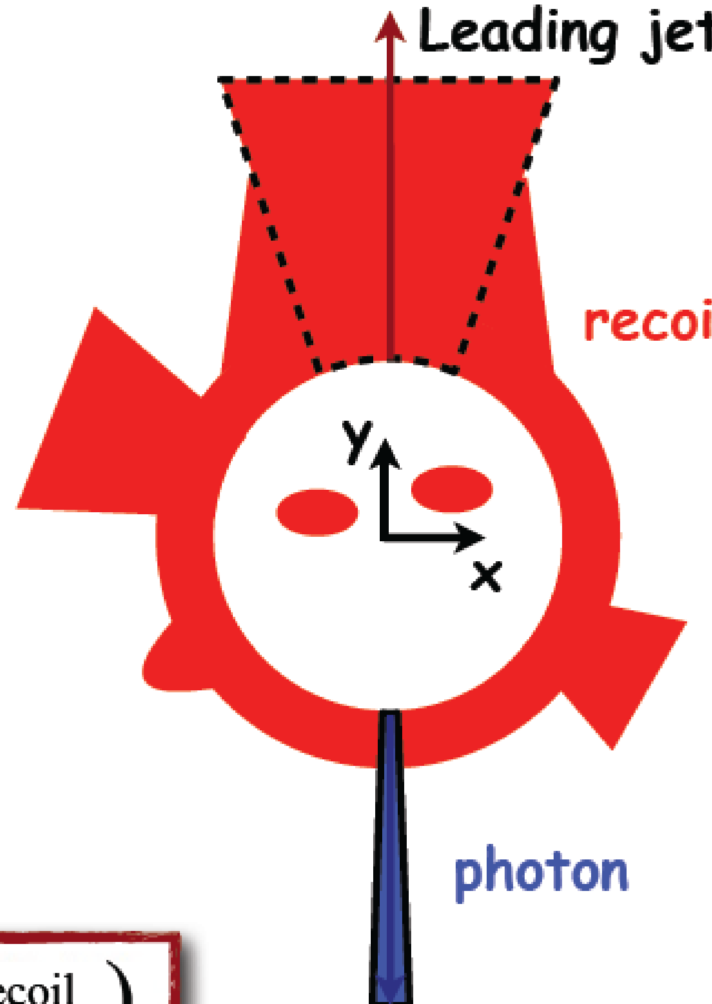
$$\vec{p}_T^{\gamma} + \vec{p}_T^{\text{recoil}} = \vec{0}$$

$$R_\gamma \vec{p}_T^{\gamma} + R_{\text{recoil}} \vec{p}_T^{\text{recoil}} = -\vec{E}_T^{\text{miss,meas}}$$

$$R_{\text{recoil}}/R_\gamma = 1 + \frac{\vec{E}_T^{\text{miss,meas}} \cdot \vec{p}_T^{\gamma,\text{meas}}}{|\vec{p}_T^{\gamma,\text{meas}}|^2} \equiv R_{\text{MPF}}.$$

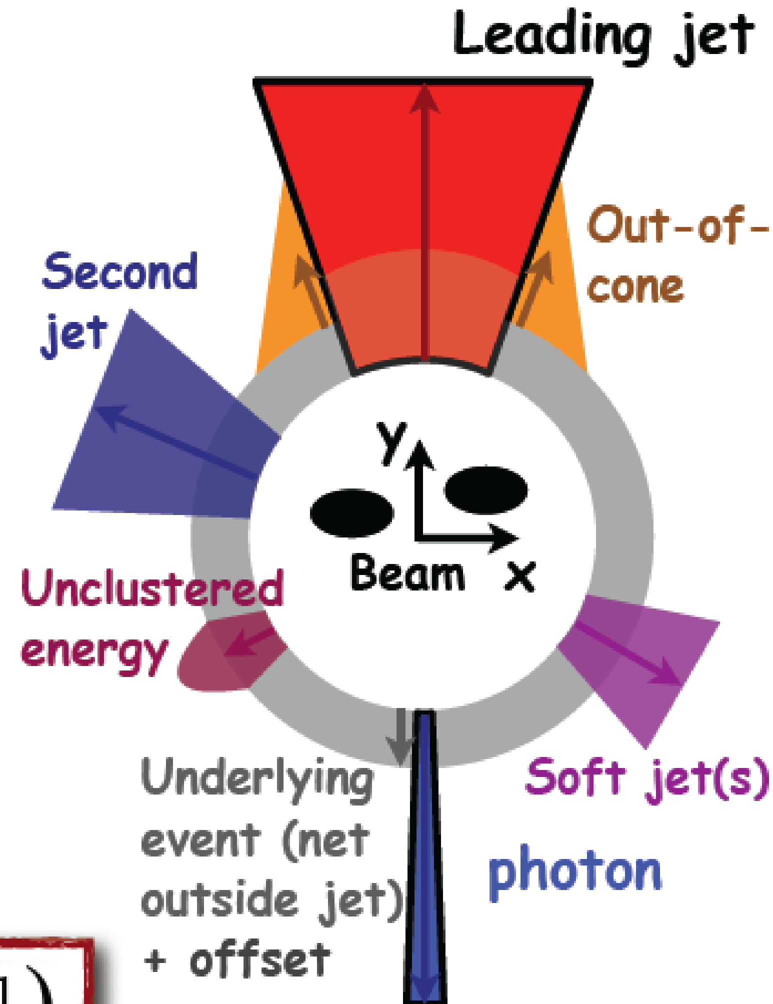
- Main challenge is to separate jet response from the rest of the recoil; easy if same response (ΔR=0), or if the rest averages out in vector sum (vec-p_T^{recoil}=0)

$$R_{\text{recoil}} = R_{\text{lead jet}} \cdot \left(1 + \Delta R_{\text{recoil}} \quad \cdot \hat{p}_T^{\text{recoil}}\right)$$



MPF Schematics

- PFlow is ideal for MPF, because component response differences small:
  - charged hadrons and photons measured with response ~1 everywhere
  - neutral hadron fraction is less than 15% => limited response differences
  - low p_T limitation is detector coverage $|\eta|<5$
- MPF method shares systematics with p_T balance, but is generally only sensitive to less than 15% of those when using PF:
  - parton correction: out-of-cone radiation + underlying event
  - secondary jets
  - QCD background



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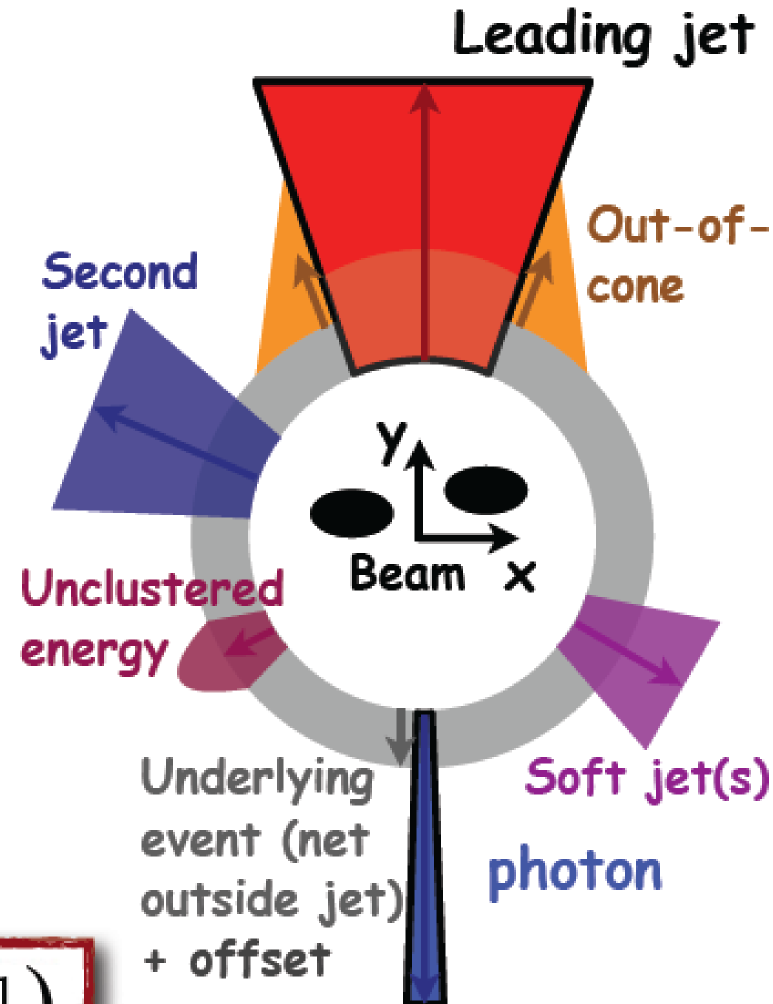

$$R_{\text{recoil}} = R_{\text{lead jet}} \cdot \left(1 + \Delta R_{\text{recoil}} \cdot \hat{p}_T^{\text{recoil}}\right)$$

MPF with Particle flow