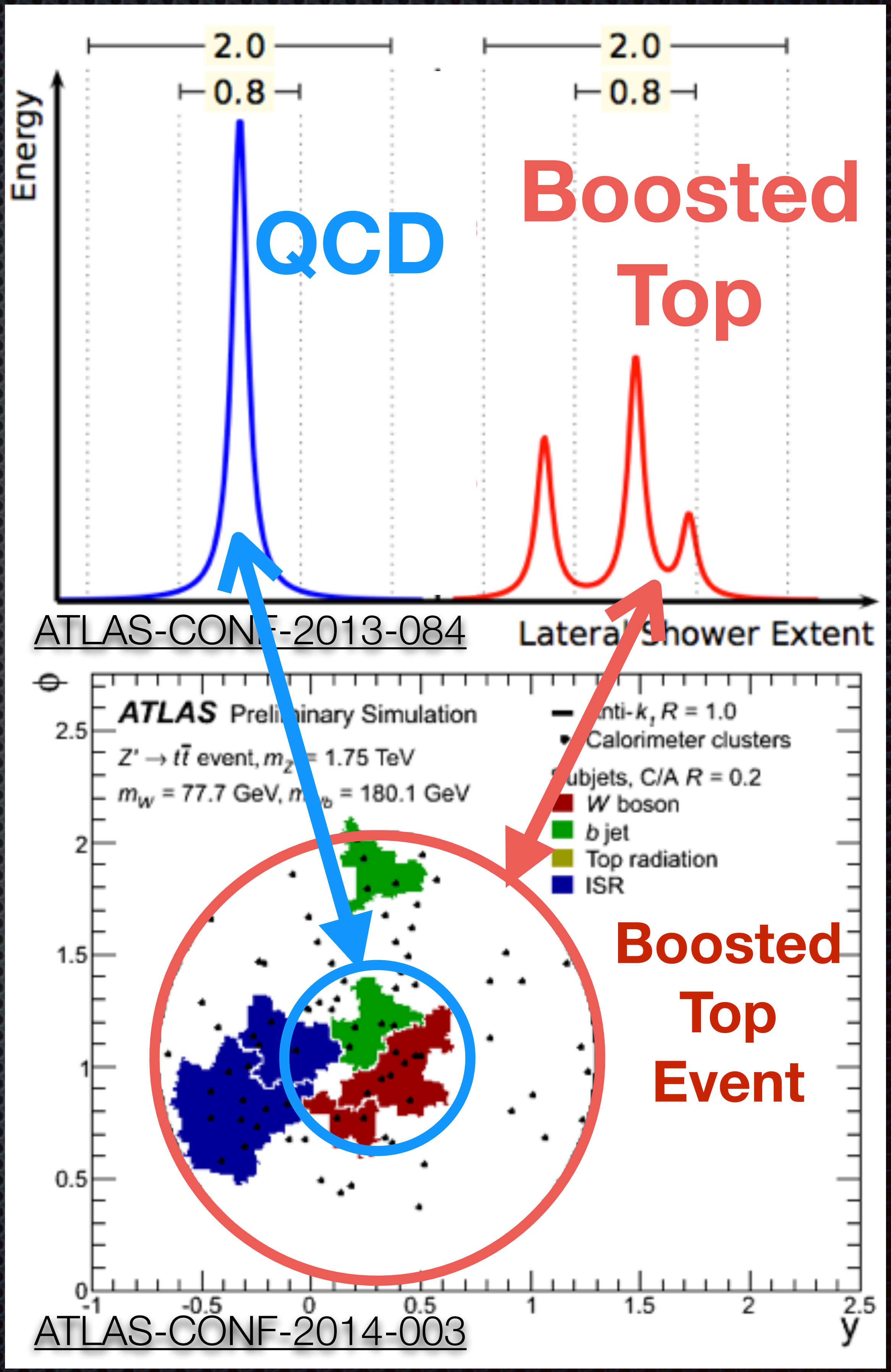
global **F**eature **EX**traction (gFEX)

Giordon Stark, David Miller (advisor)
LUA Talk 2014
November 14th, 2014

The Motivation

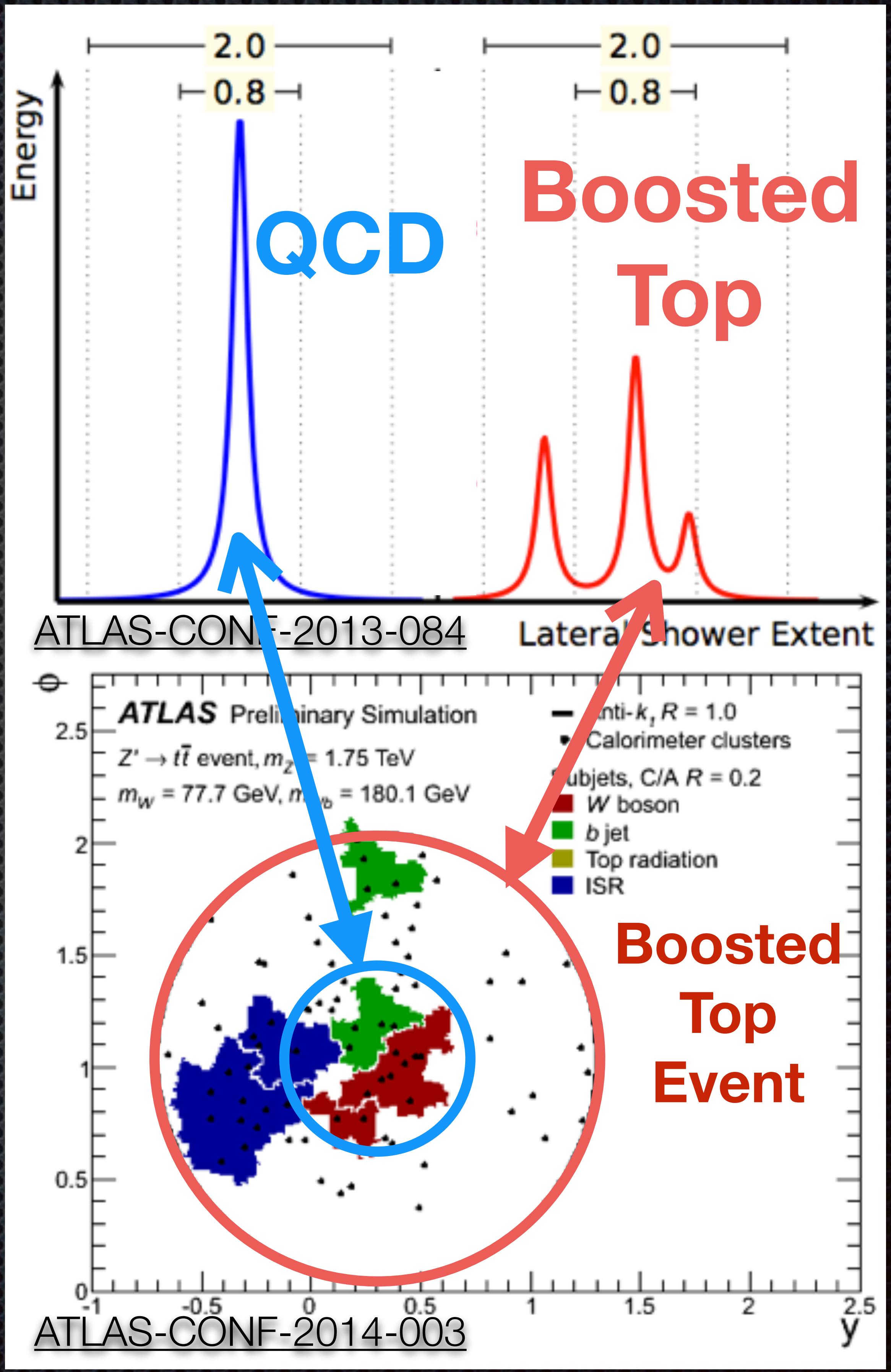


ATLAS-CONF-2013-084

ATLAS-CONF-2014-003

The Motivation

- Boosted objects with substructure are the crux of future ATLAS studies
    - Expect many boosted W/Z/h bosons & tops in LHC Run 2 and beyond



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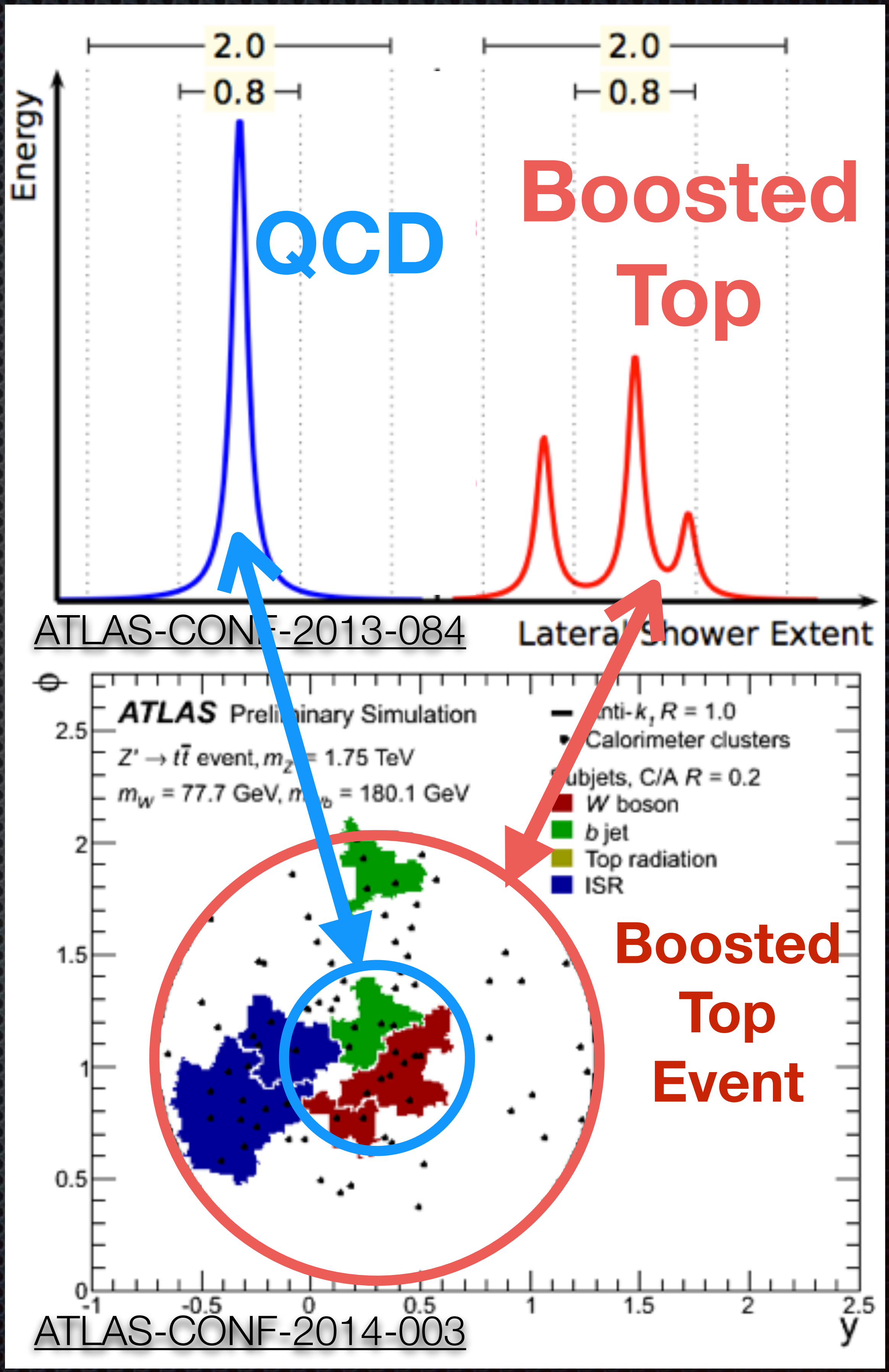

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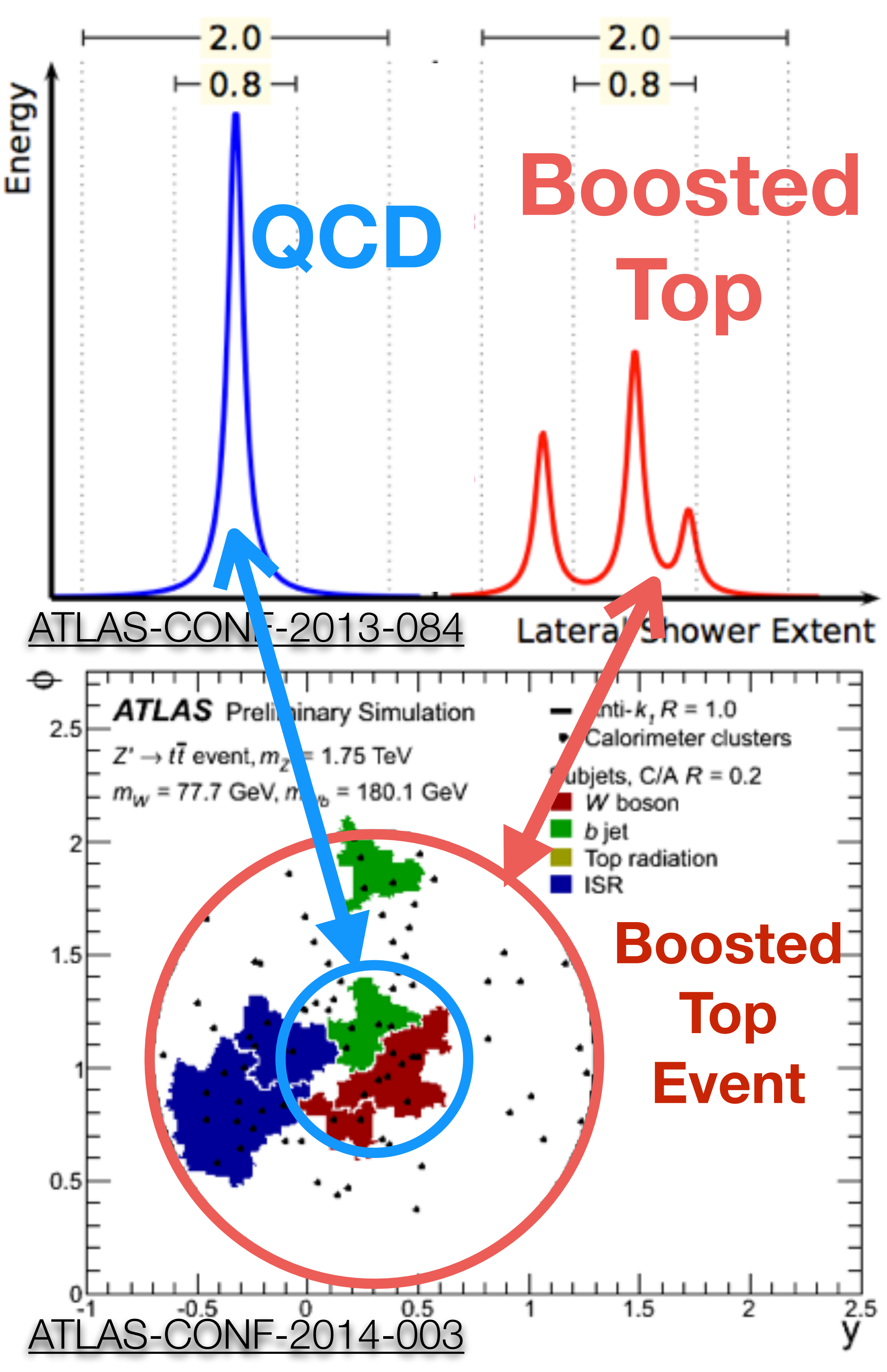
- Can we increase the trigger region?
  - **not possible with current L1Calo architecture!**



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Triggering on Jet Substructure

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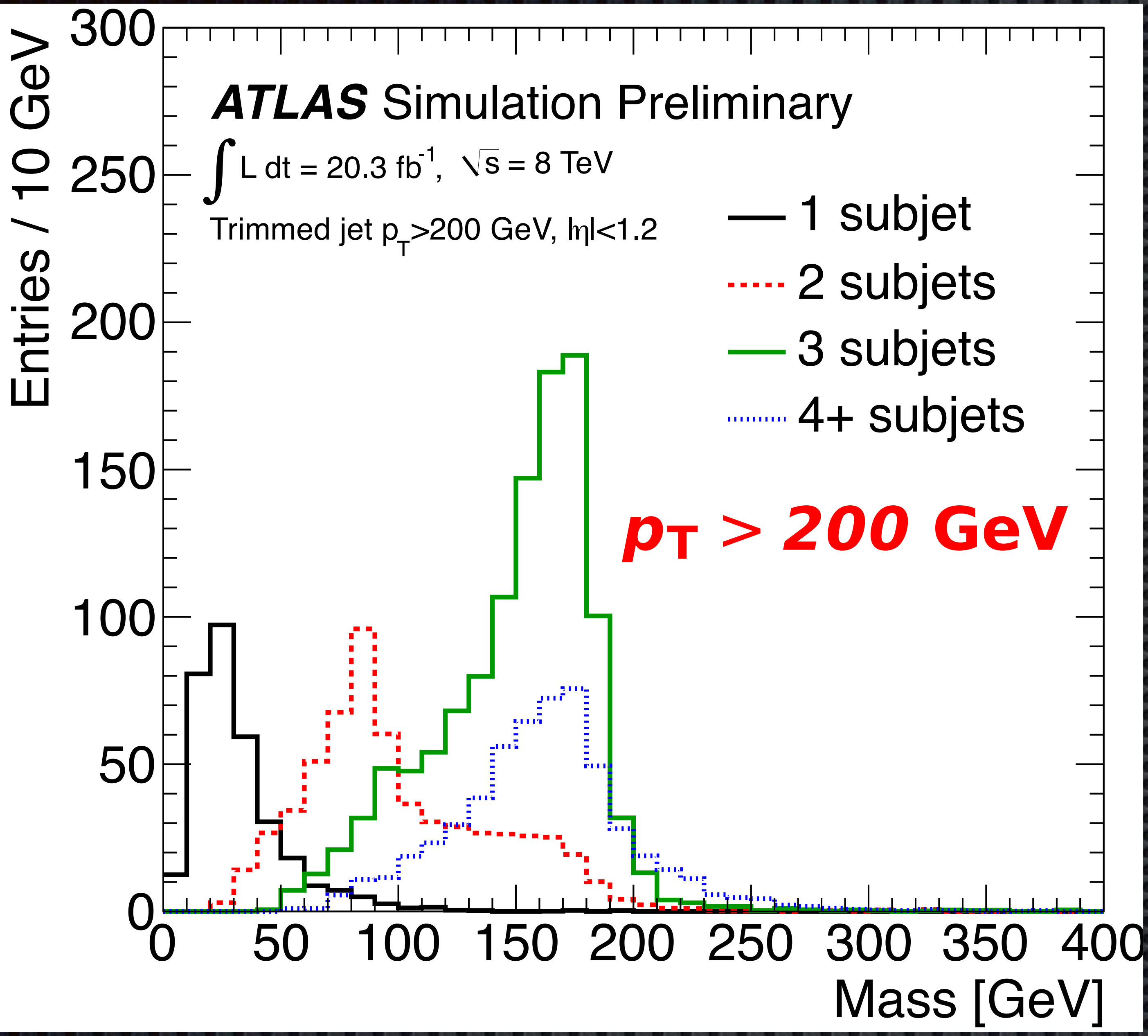
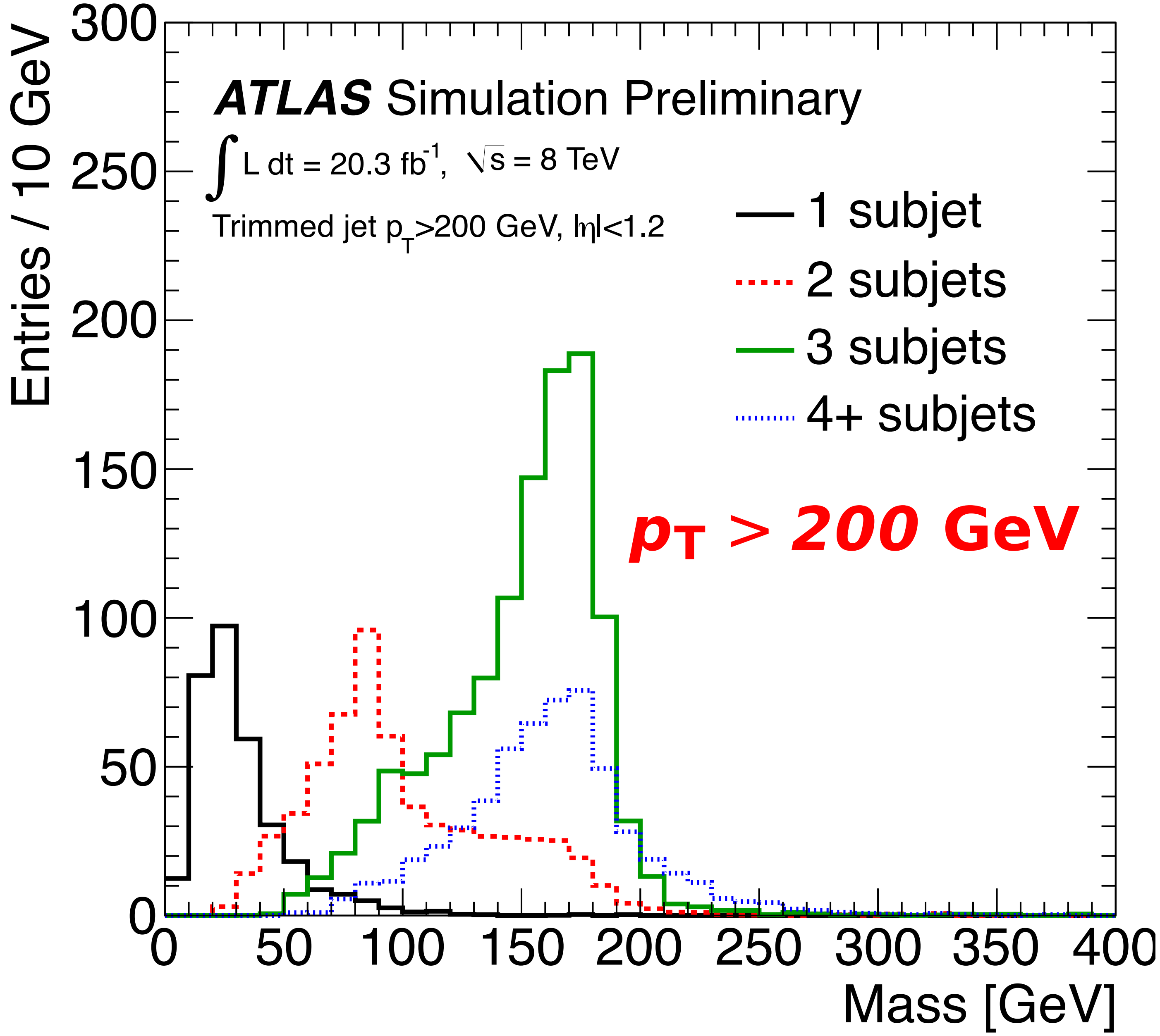
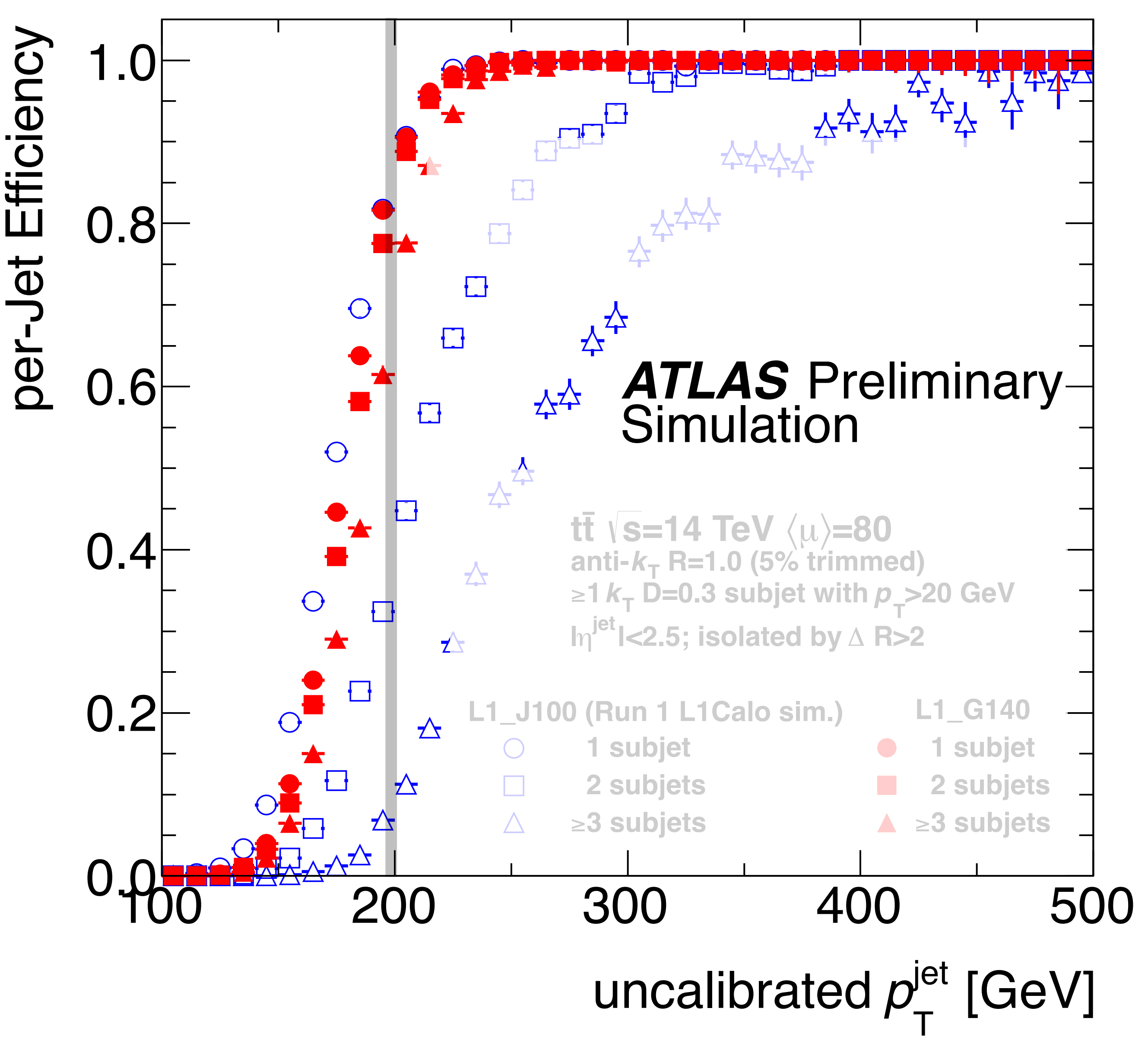


Triggering on Jet Substructure

Blue=Current Trigger @ 100 GeV



p_T > 200 GeV



Red=gFEX Trigger @ 140 GeV

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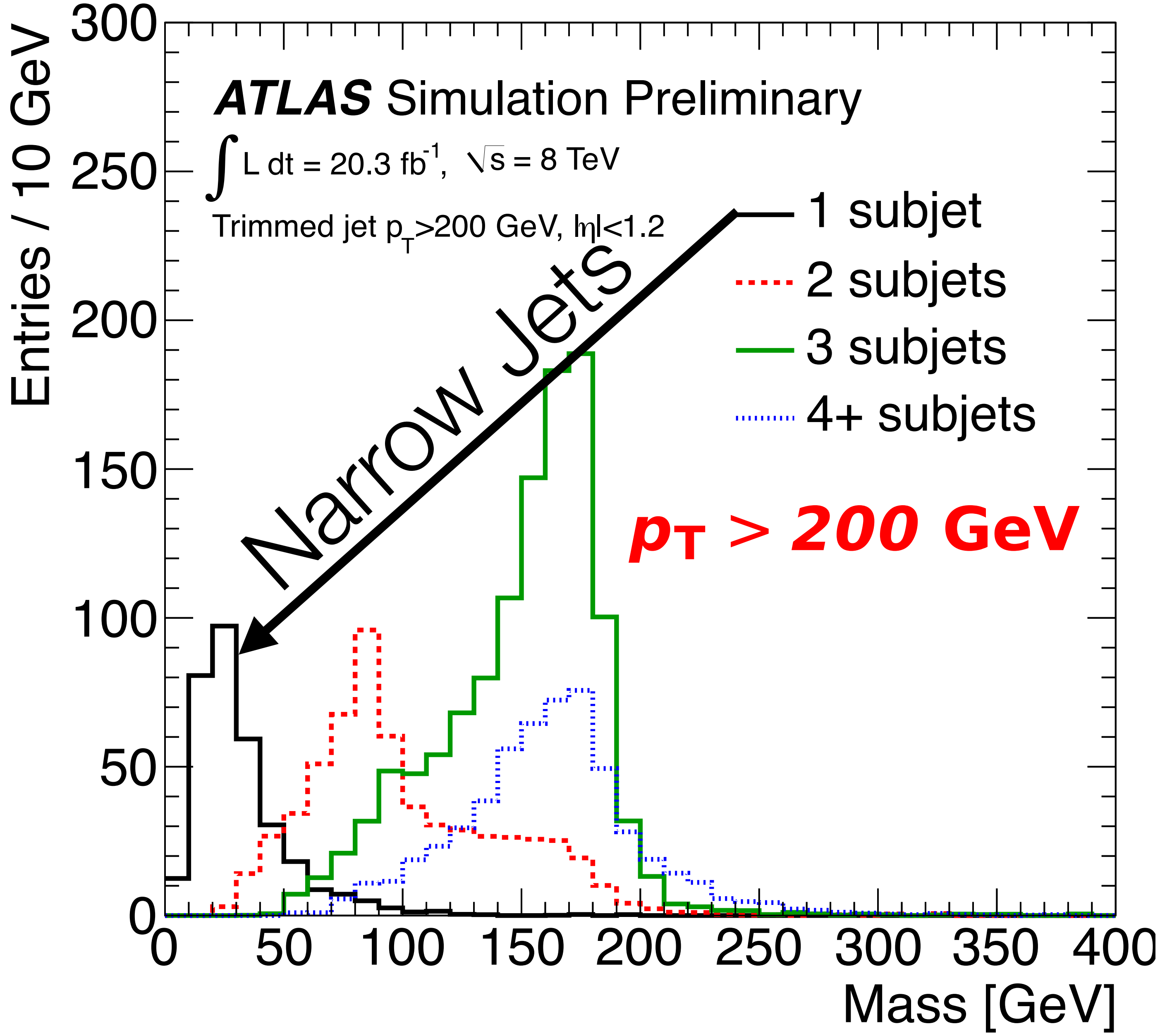
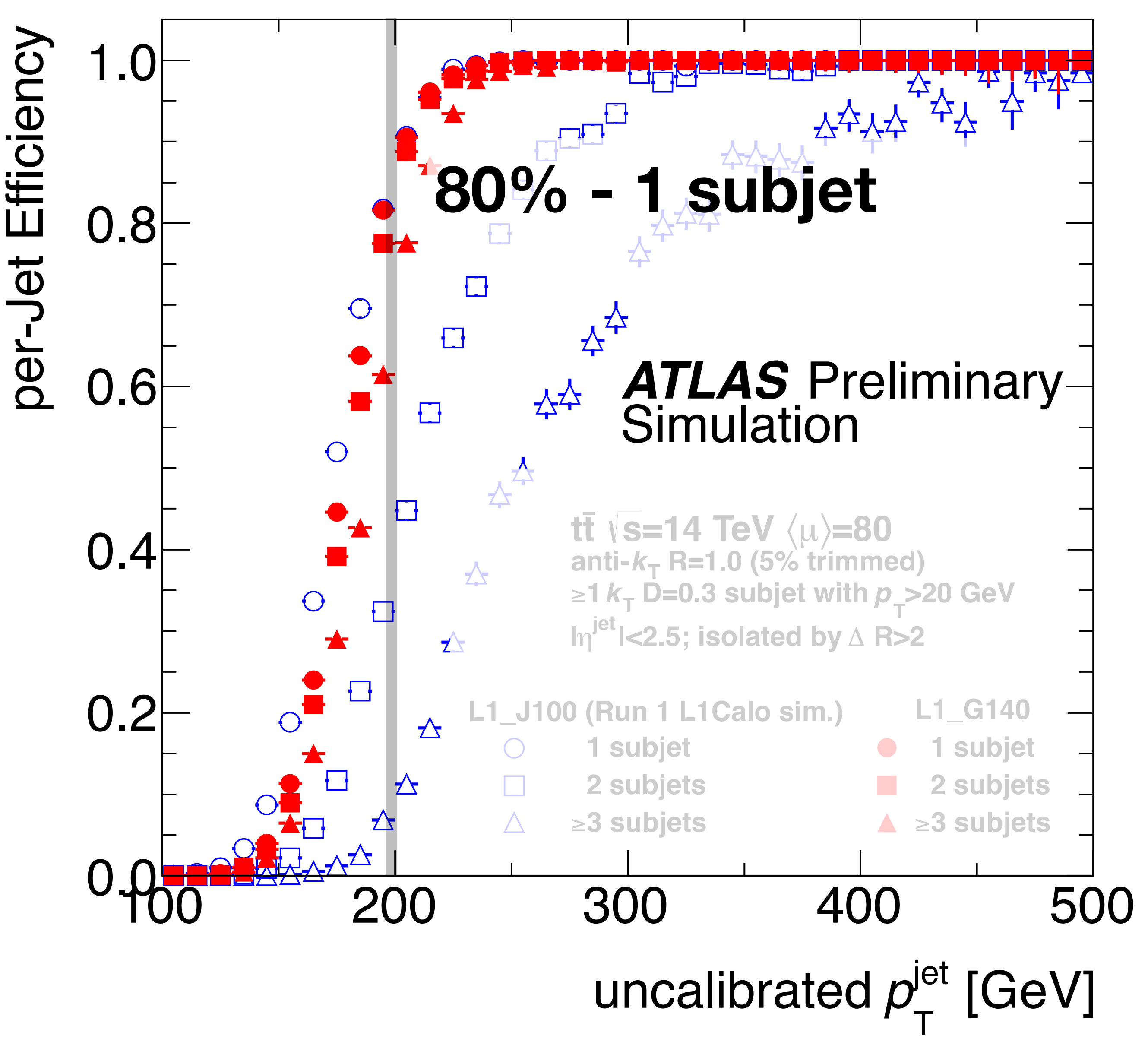


Narrow Jets

p_T > 200 GeV



80% - 1 subjet

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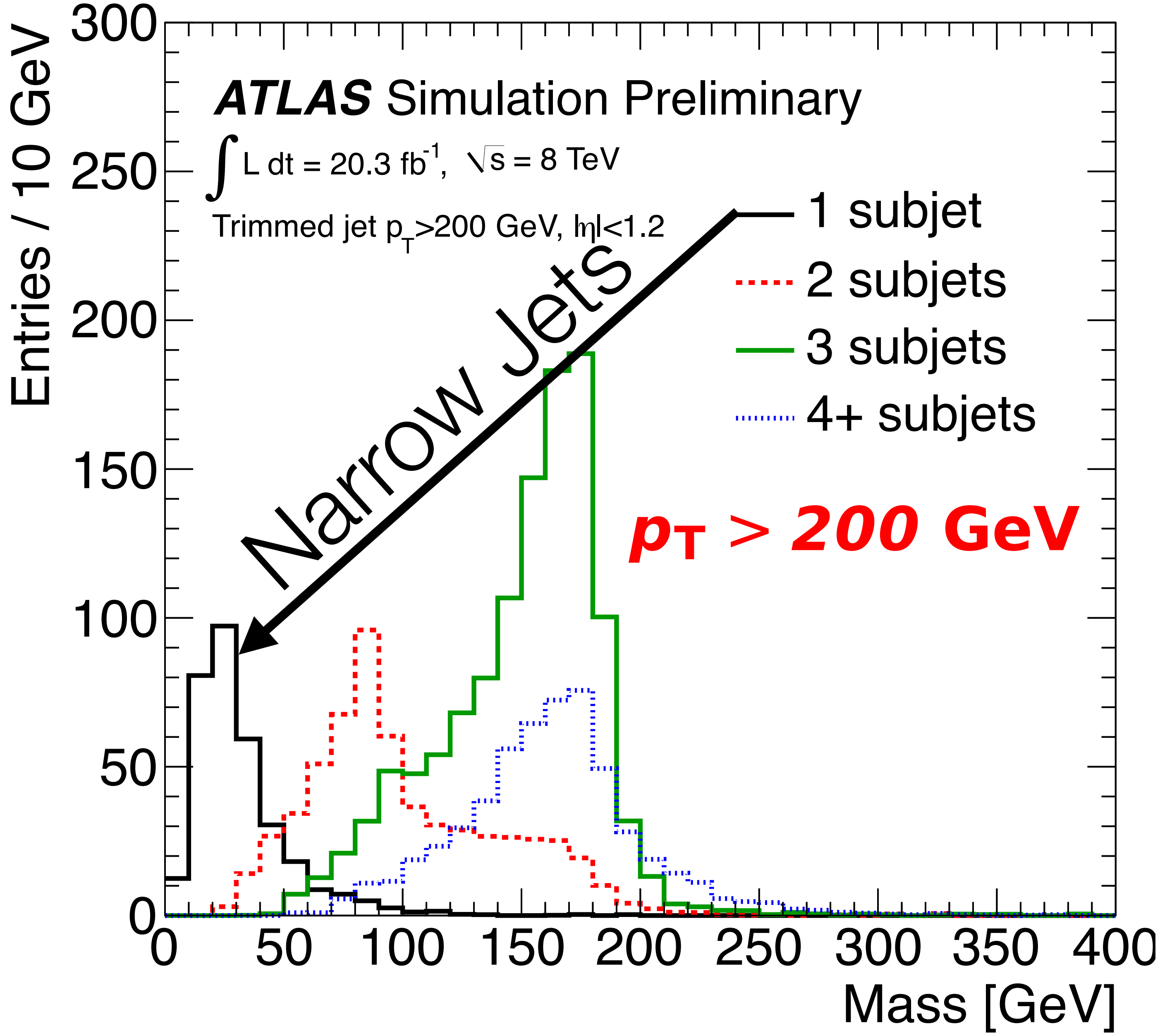

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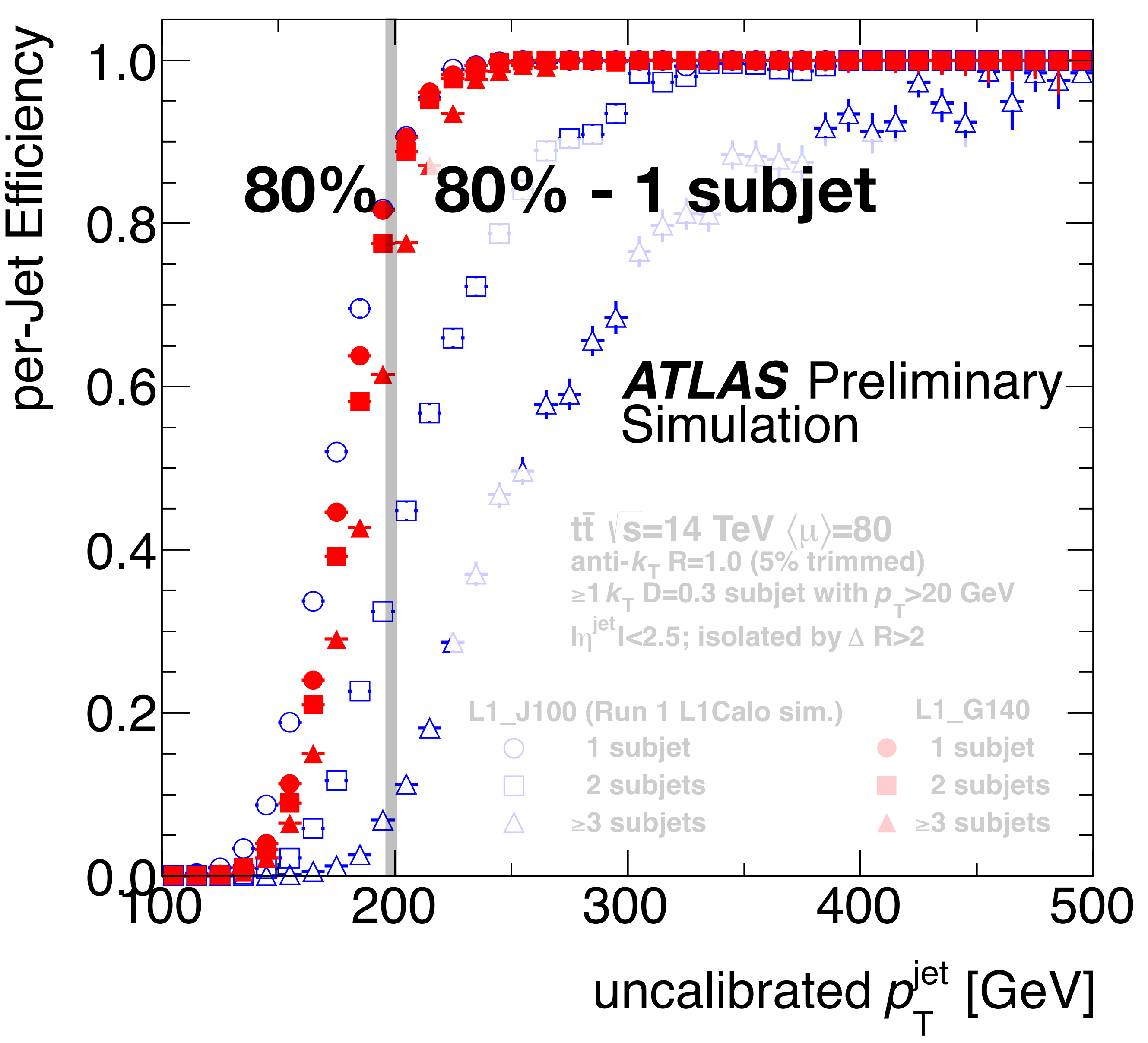

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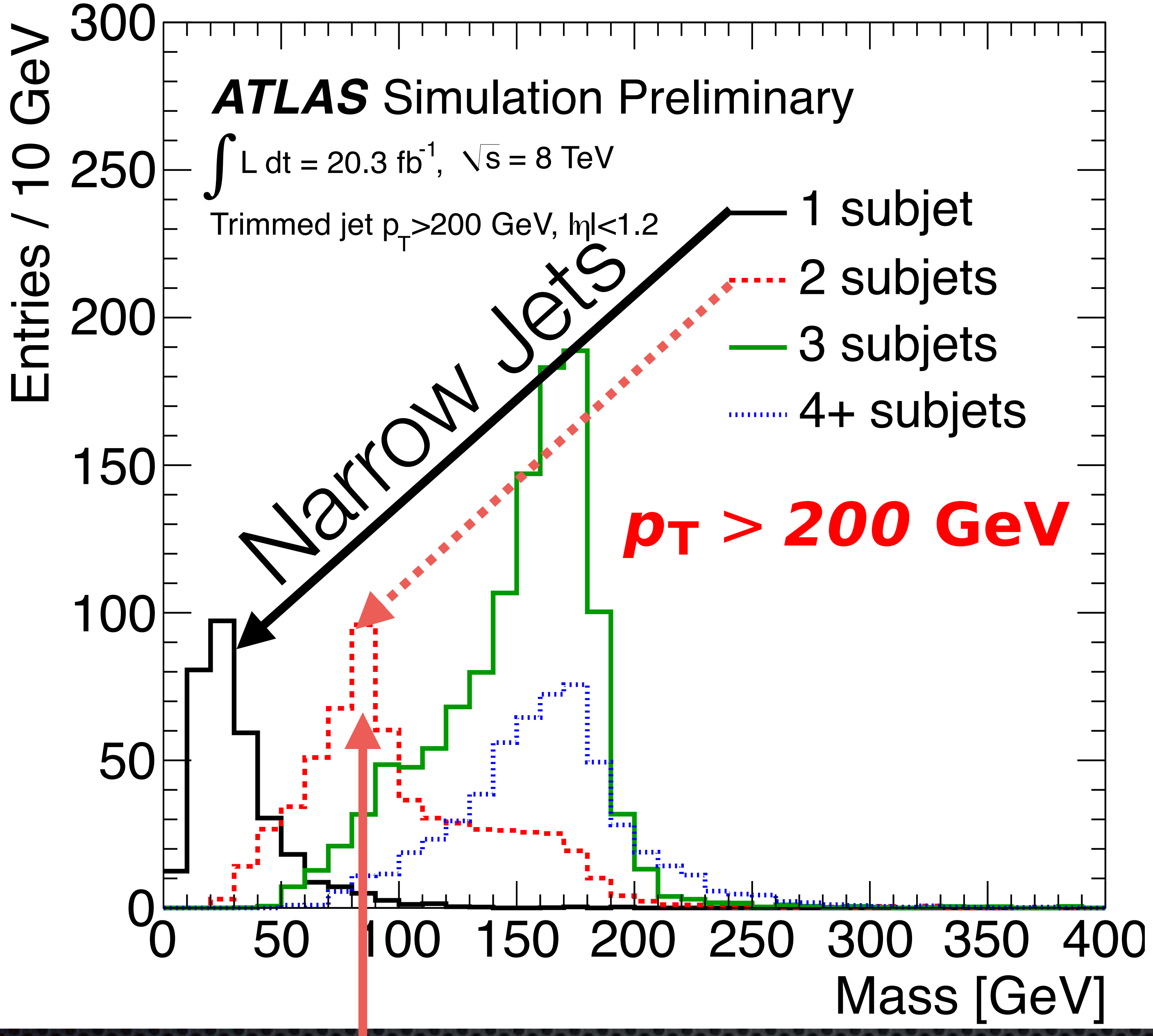

Narrow Jets

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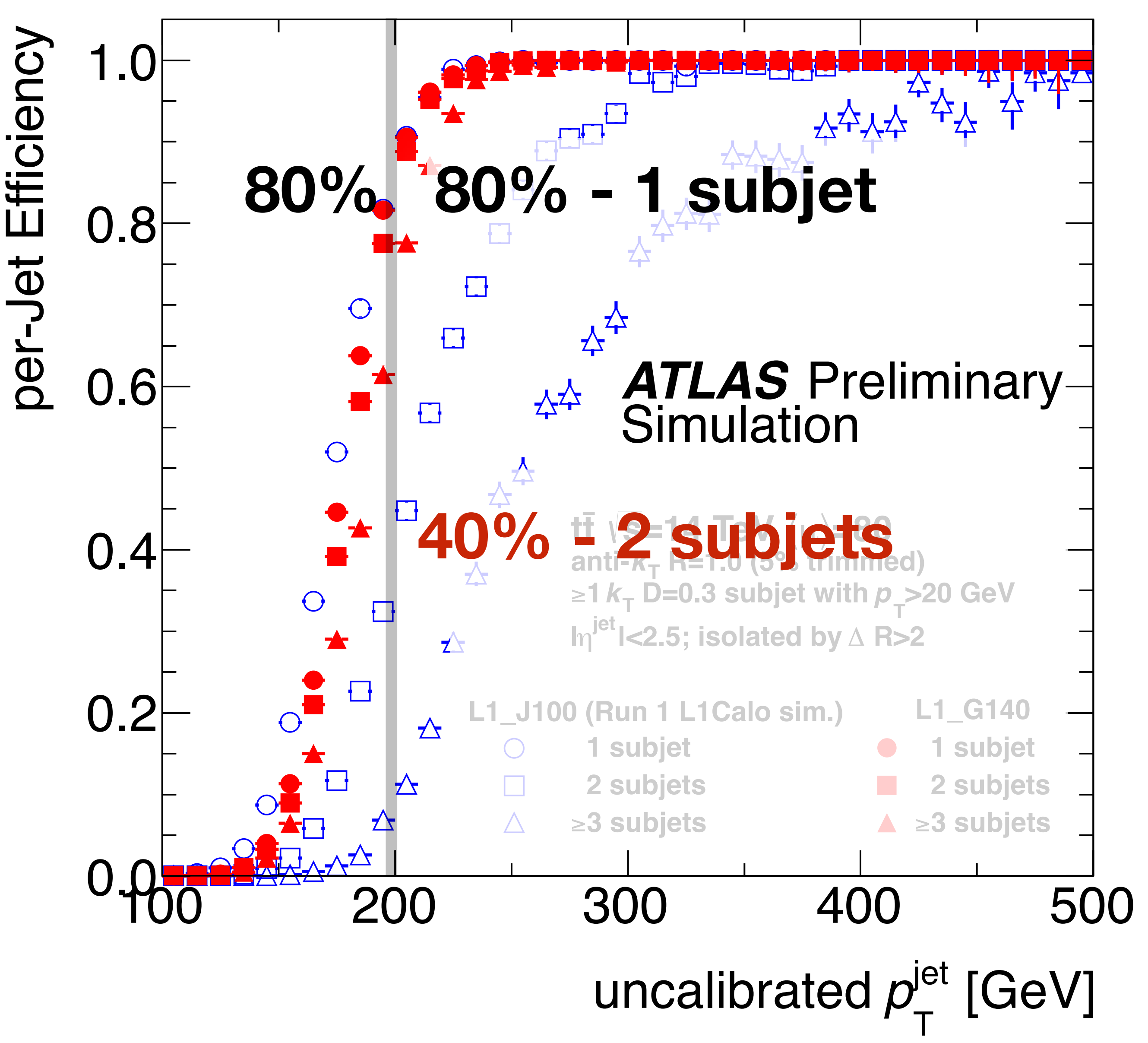
W/Z



80%

80% - 1 subjet

40% - 2 subjets

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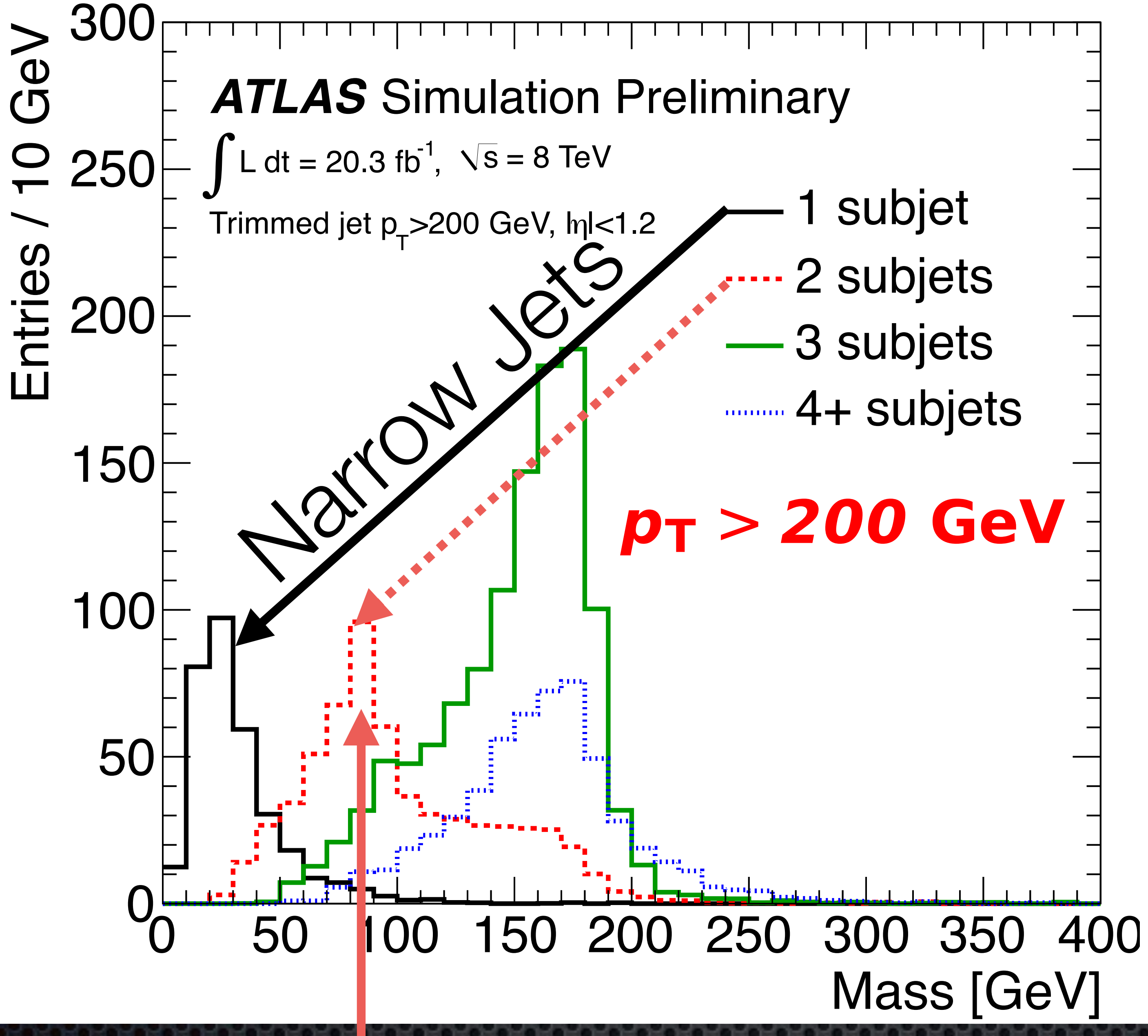

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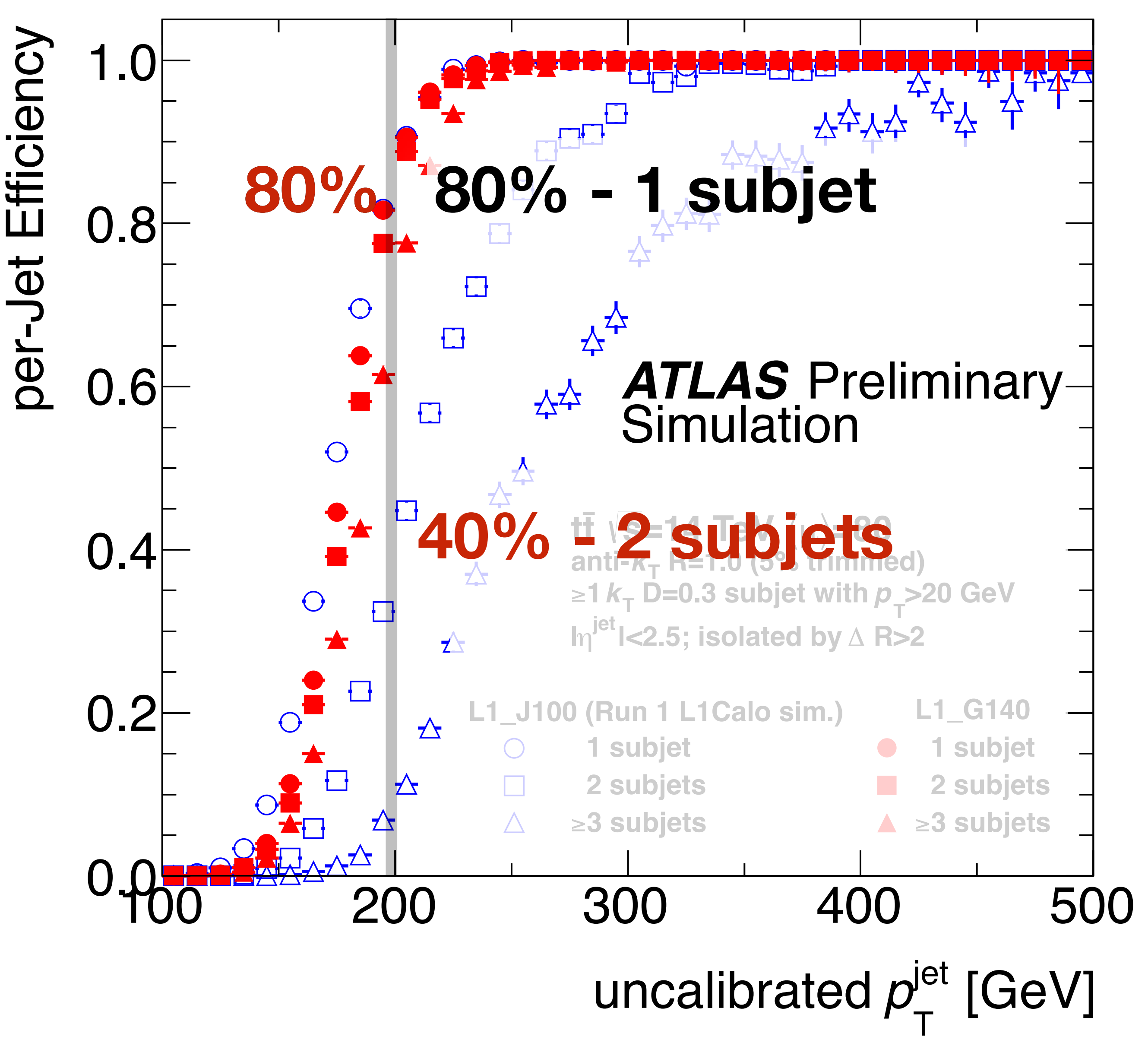

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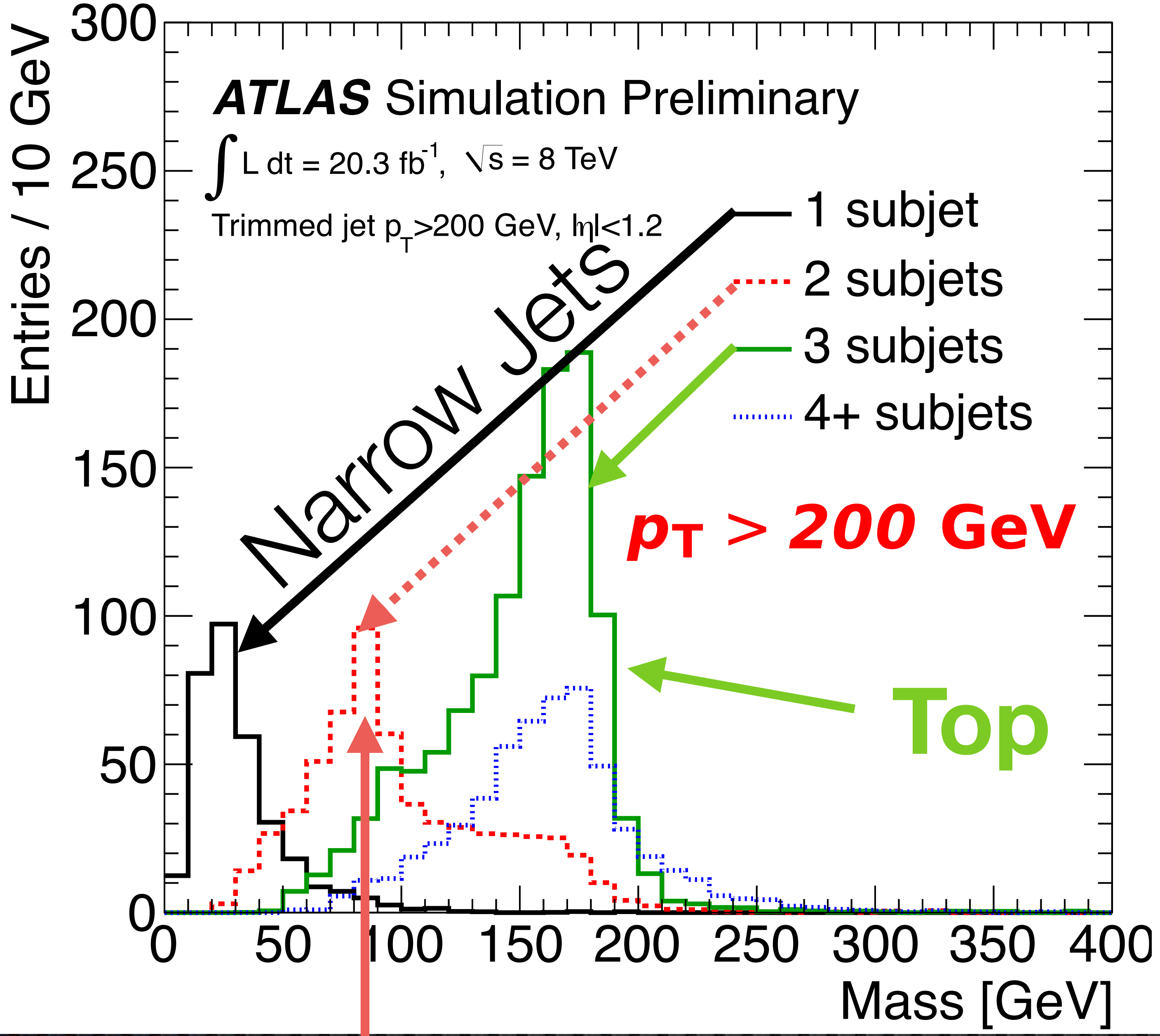
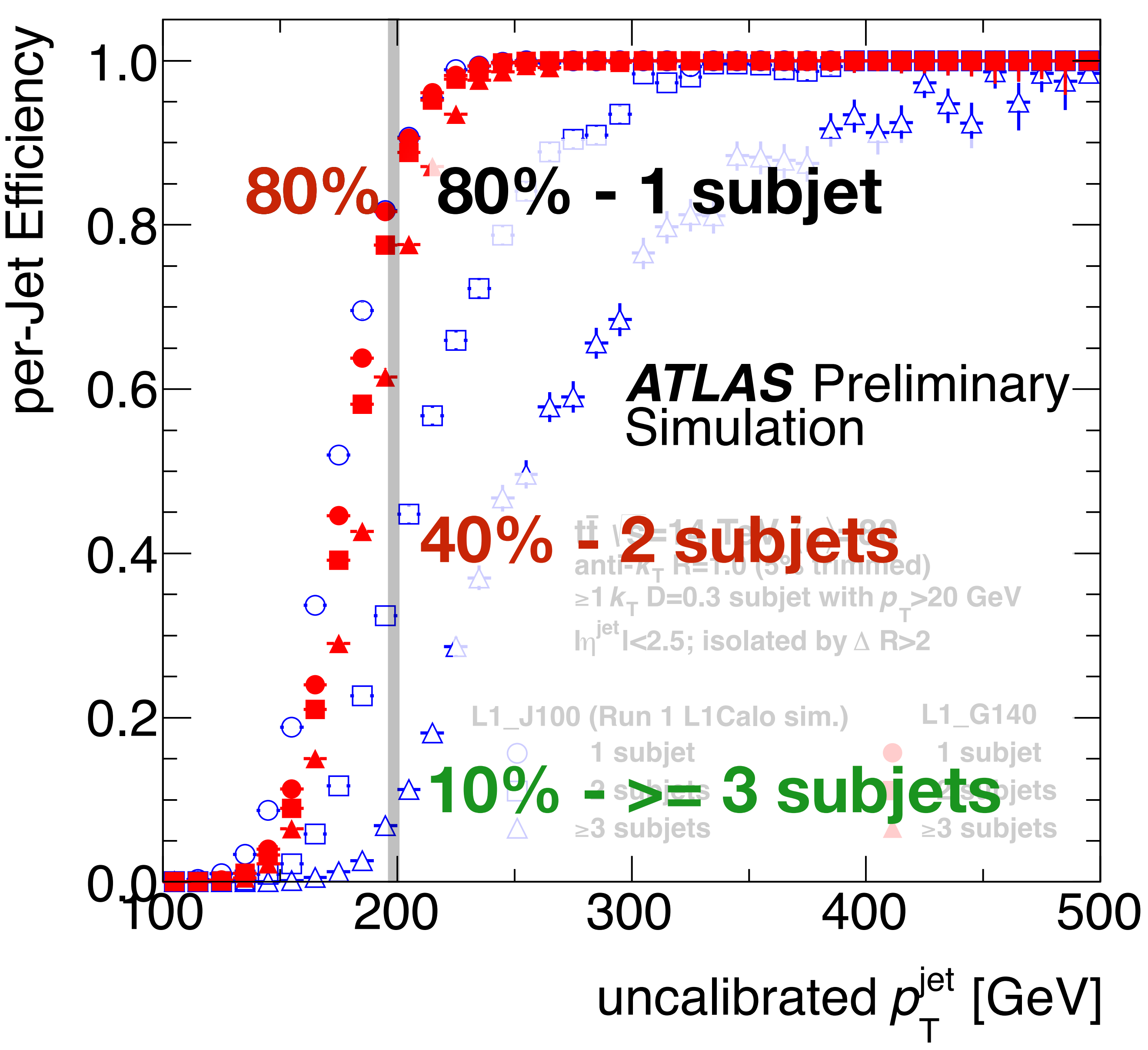


Narrow Jets

p_T > 200 GeV

Top



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10% - >= 3 subjets

W/Z

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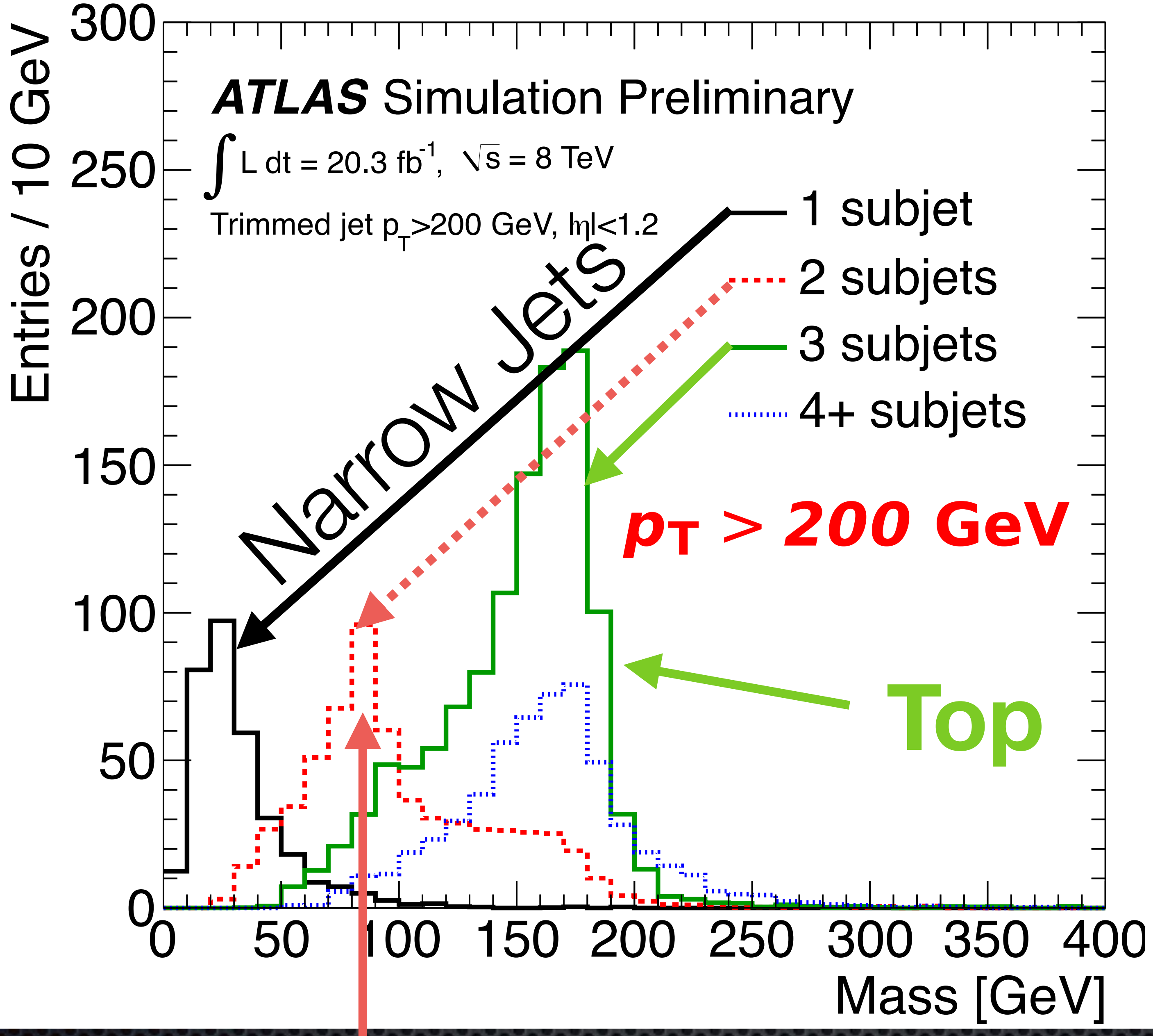

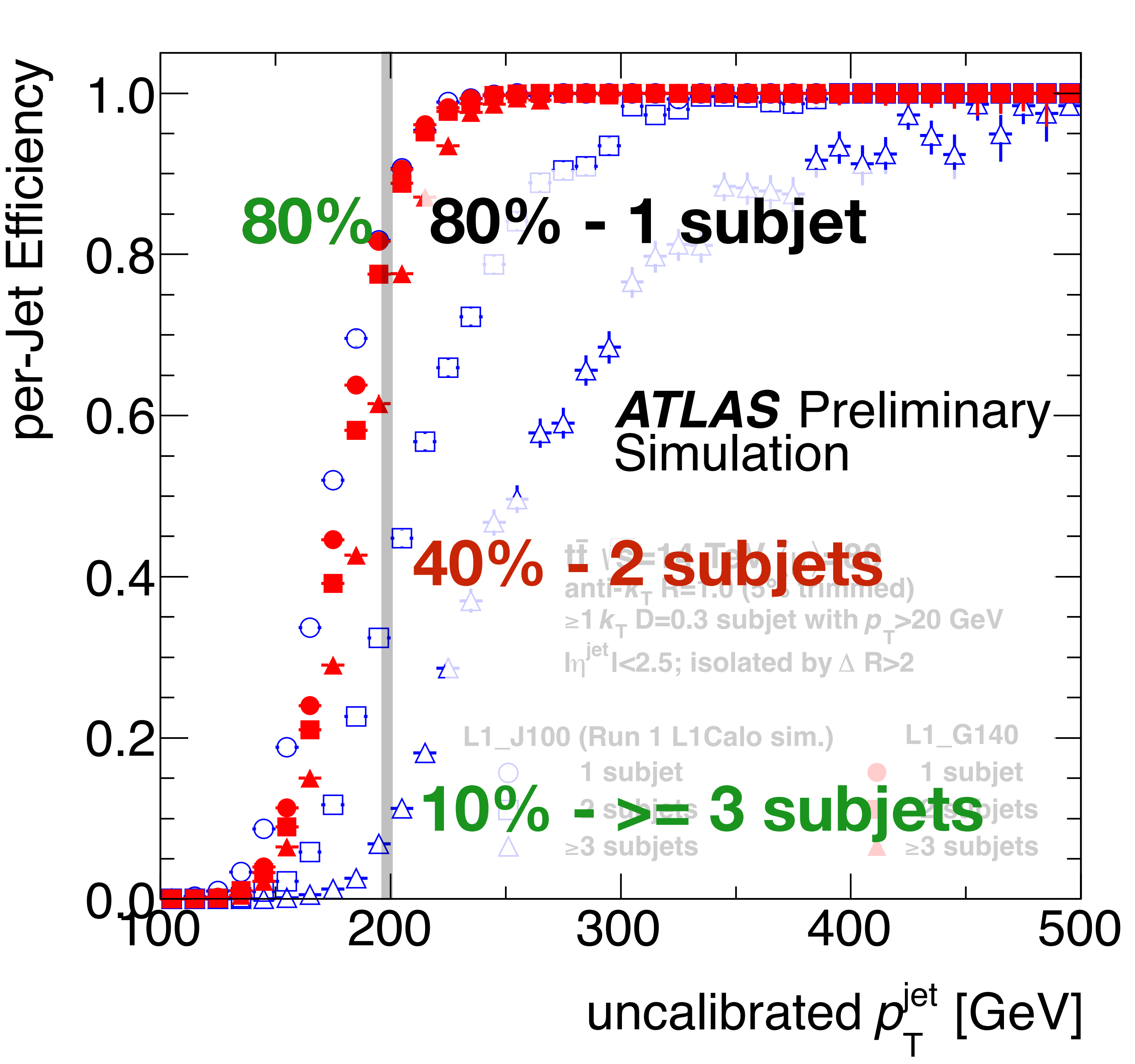

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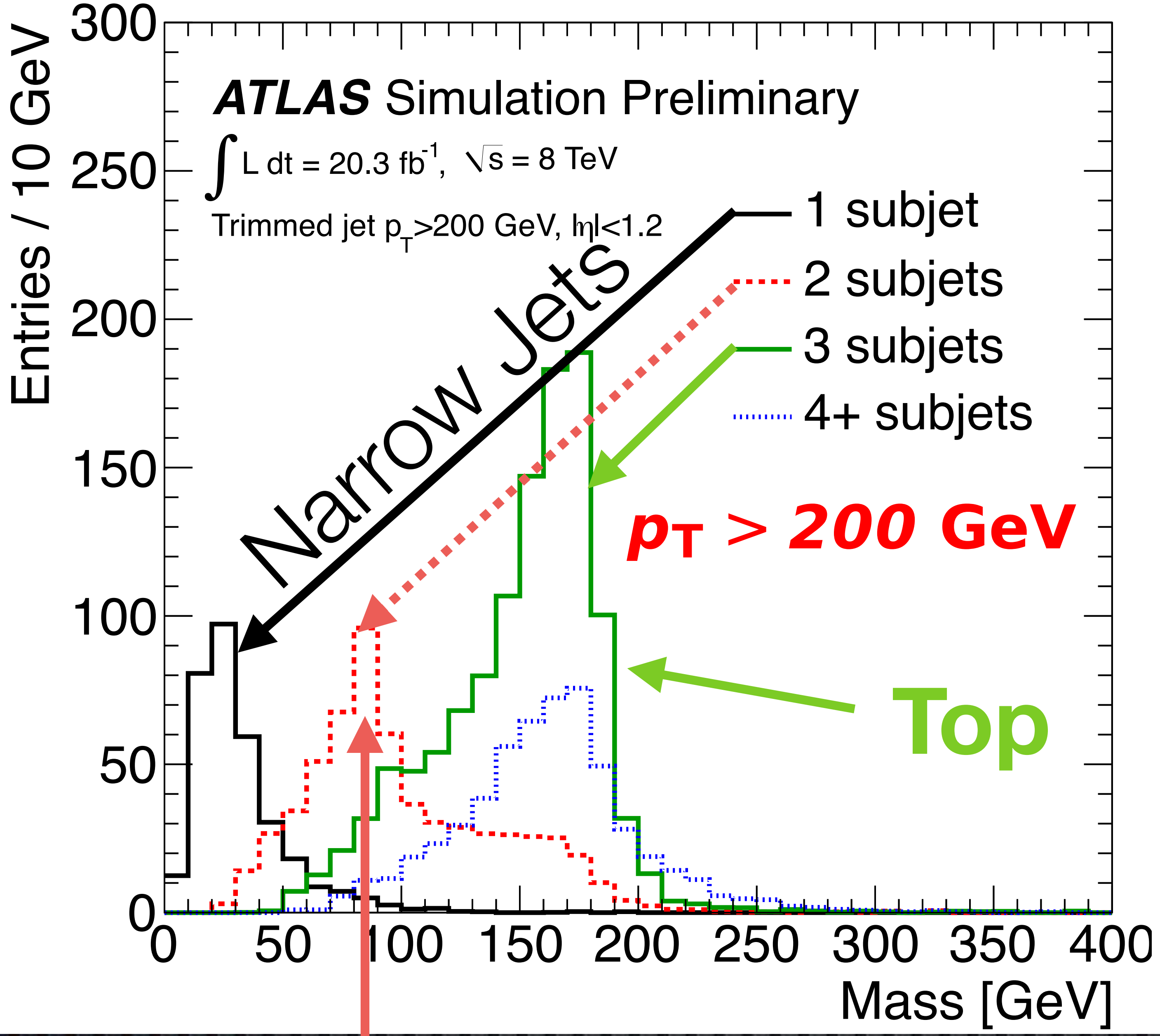

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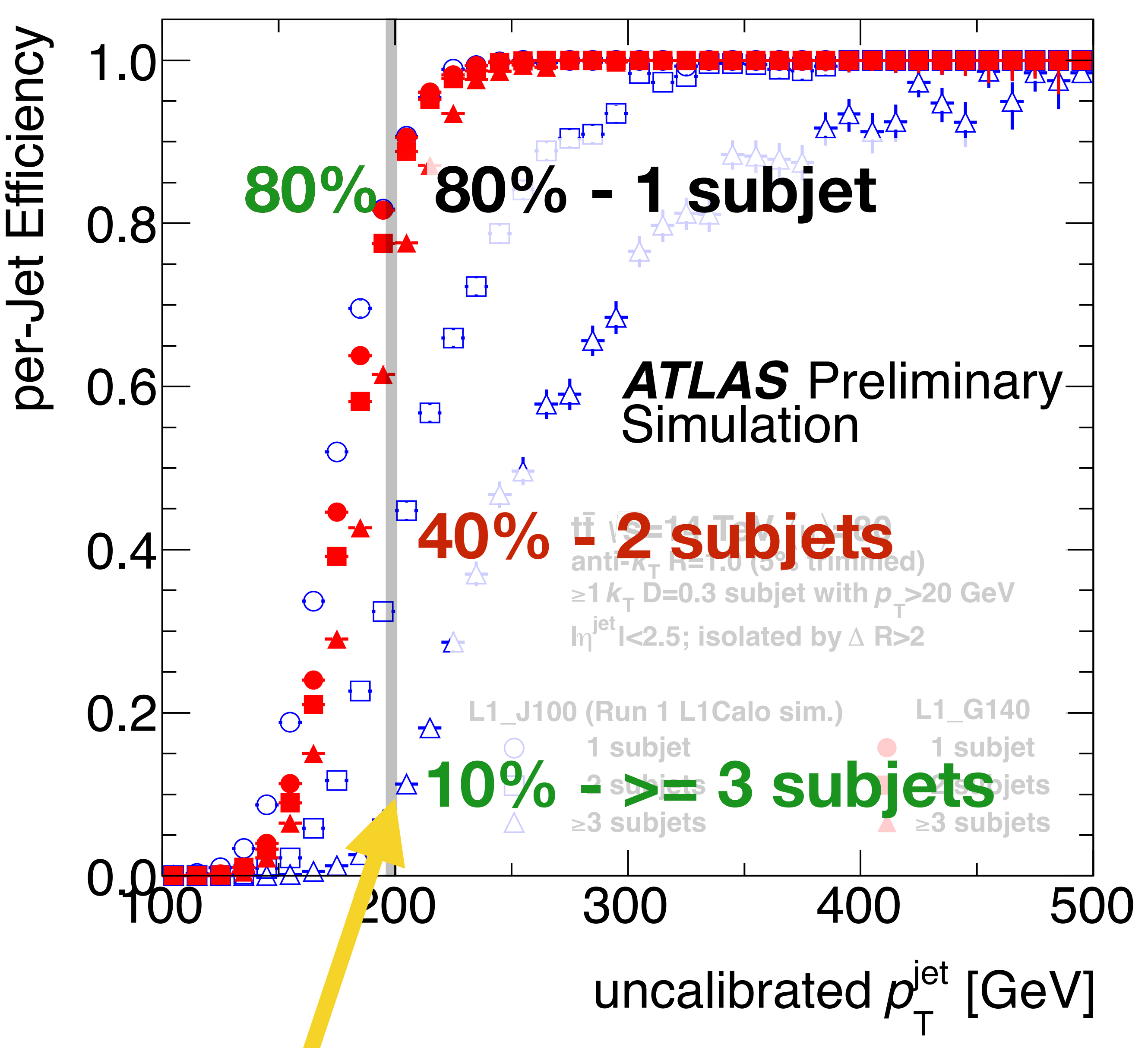
W/Z



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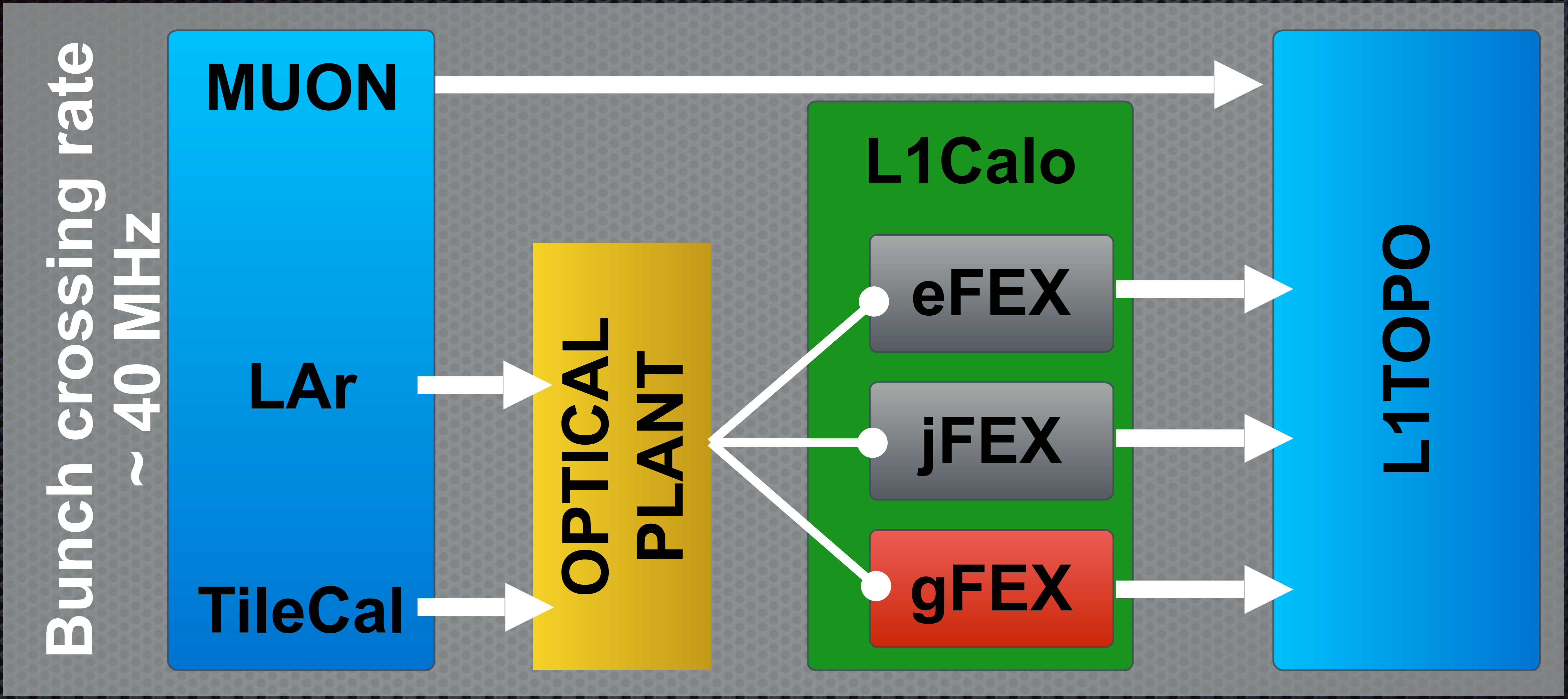
Current trigger is inefficient for jets with significant substructure

global Feature Extraction

LHC Run 3 — a new feature extraction module


Bunch crossing rate
~ 40 MHz
MUON
LAr
TileCal
OPTICAL
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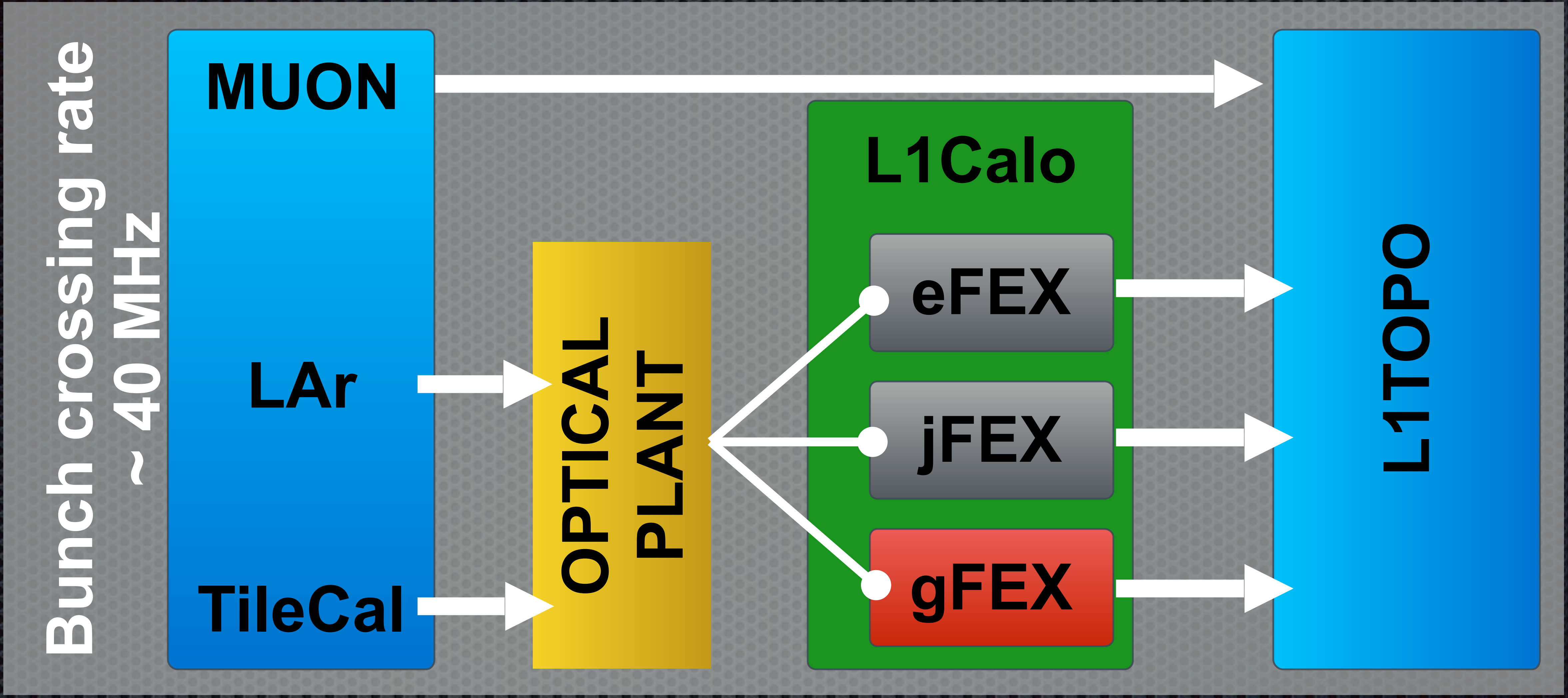
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Our Solution: increase the RoI and processing speed, but some loss in angular resolution

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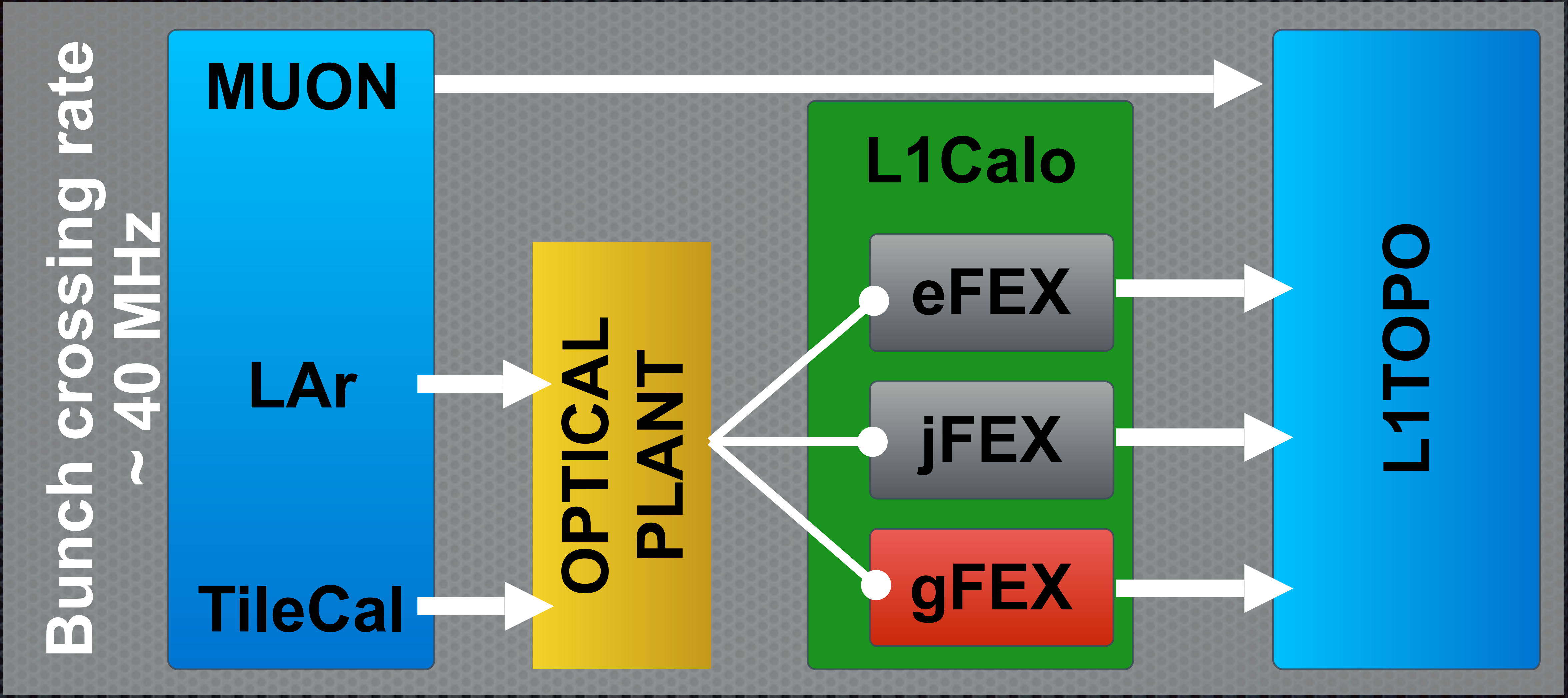
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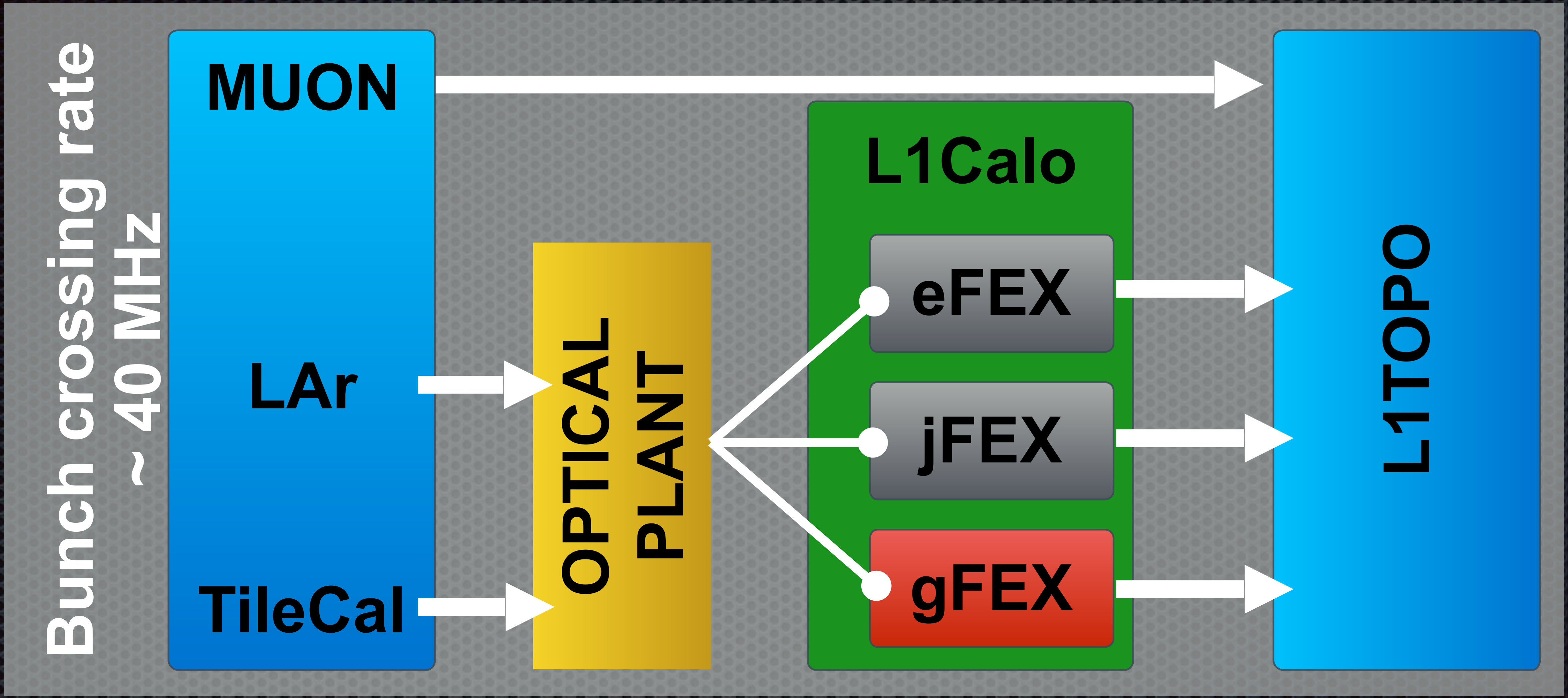
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- L1Topo/HLT get info about **jets above a threshold and pileup calculation** for other triggers

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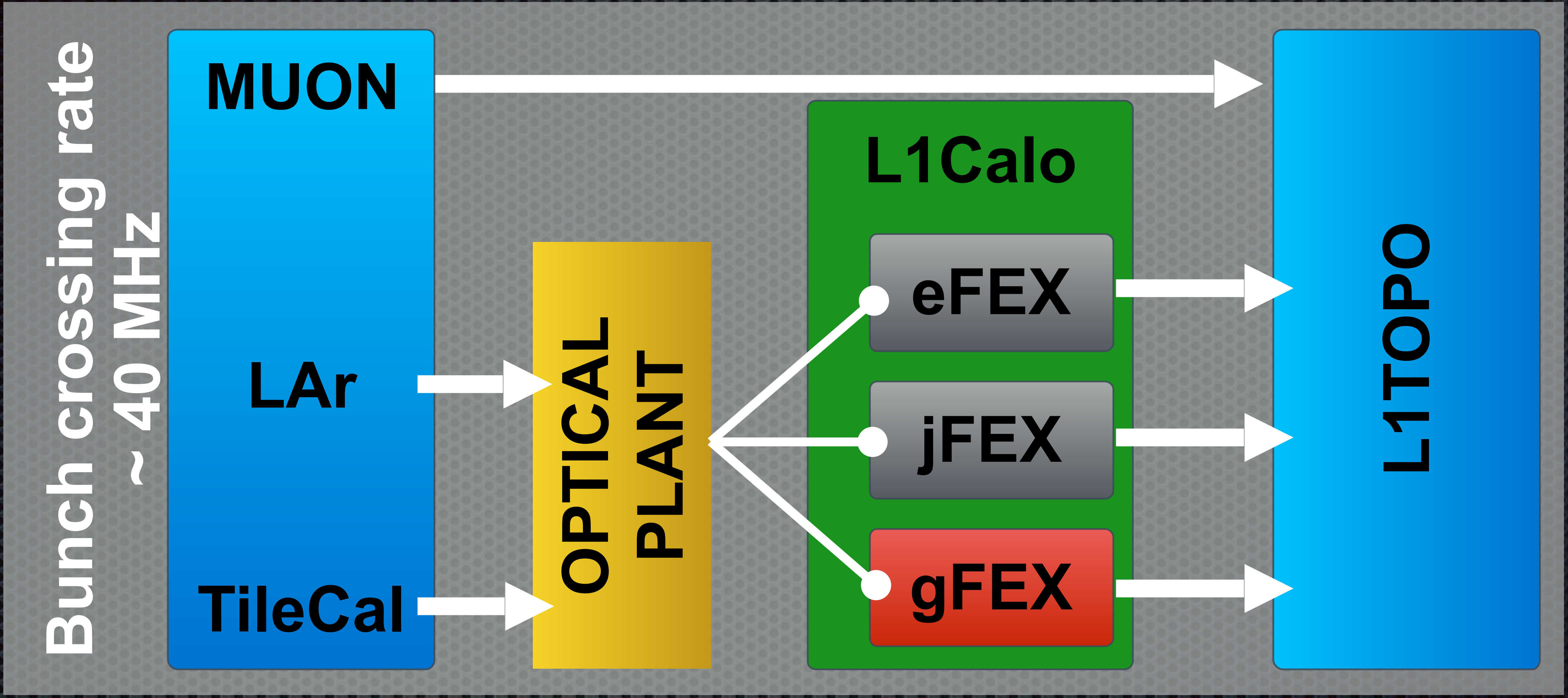
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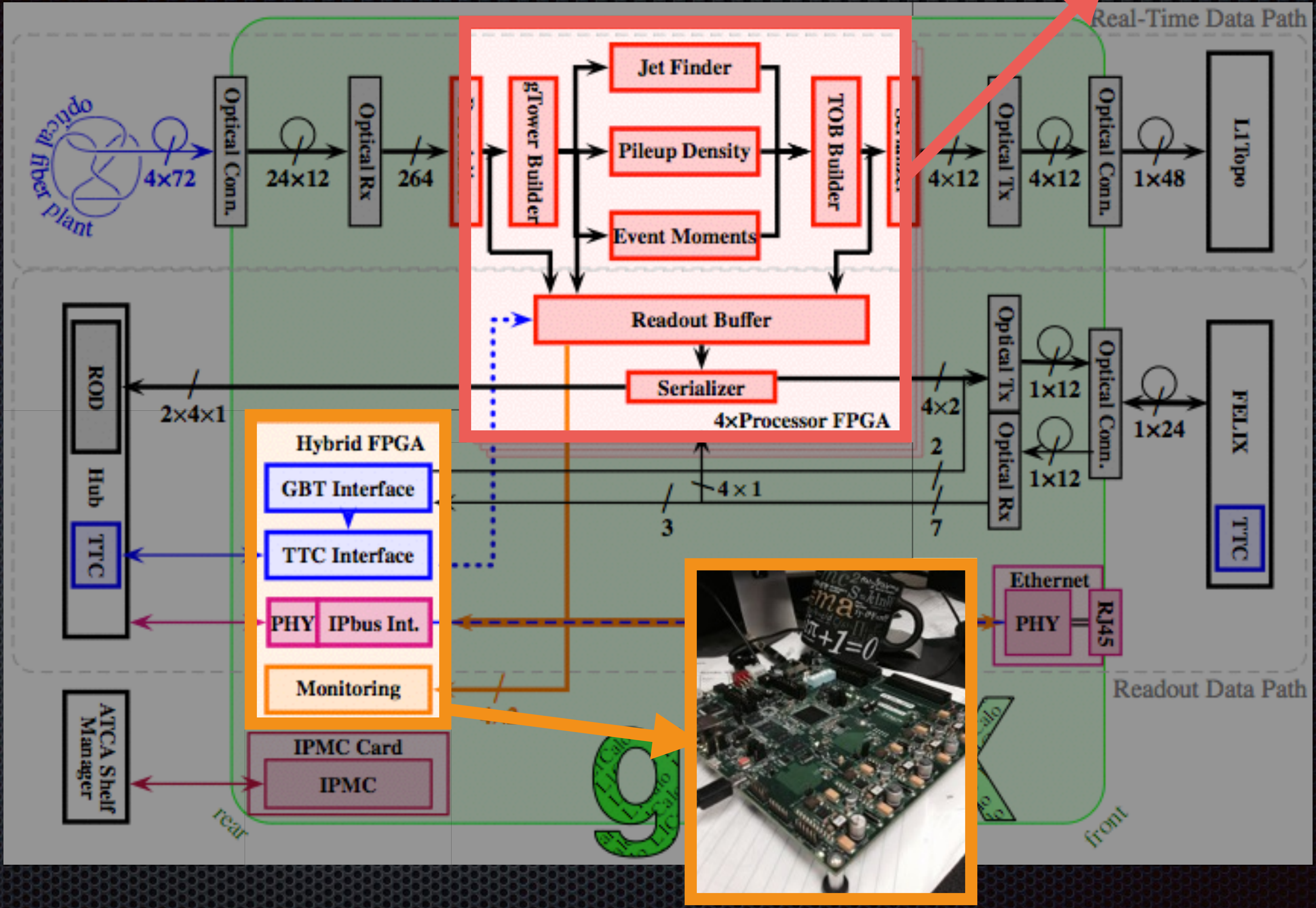
- **algorithms run within 5 bunch crossings** (125 ns), not including data input/output
- L1Topo/HLT get info about **jets above a threshold and pileup calculation** for other triggers
- **full calorimeter information on a single board** enables calculation of global event quantities

What's inside?

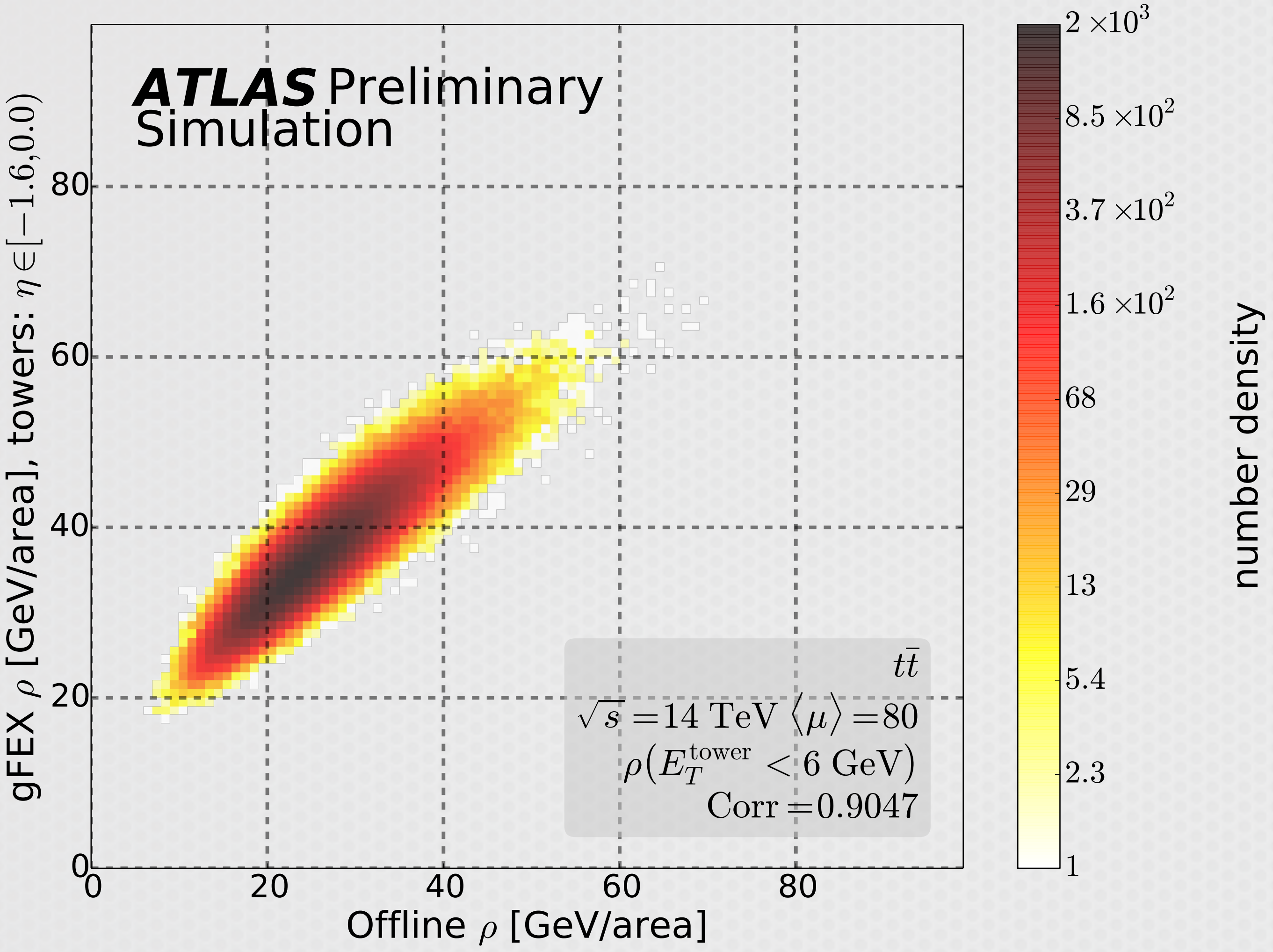
Algorithms Run On FPGAs


Real-Time Data Path
optical fiber plant
4×72
Optical Conn.
24×12
Optical Rx
264
gTower Builder
Jet Finder
Pileup Density
Event Moments
TOB Builder
4×12
Optical Tx
4×12
Optical Conn.
1×48
L1Topo
Readout Buffer
Serializer
4×Processor FPGA
ROD
2×4×1
Hub
TTC
Hybrid FPGA
GBT Interface
TTC Interface
PHY
IPbus Int.
Monitoring
4×2
2
4×1
3
7
Optical Tx
1×12
Optical Rx
1×12
Optical Conn.
1×24
FELIX
TTC
Ethernet
PHY
RJ45
Readout Data Path
ATCA Shelf Manager
IPMC Card
IPMC
rear
front

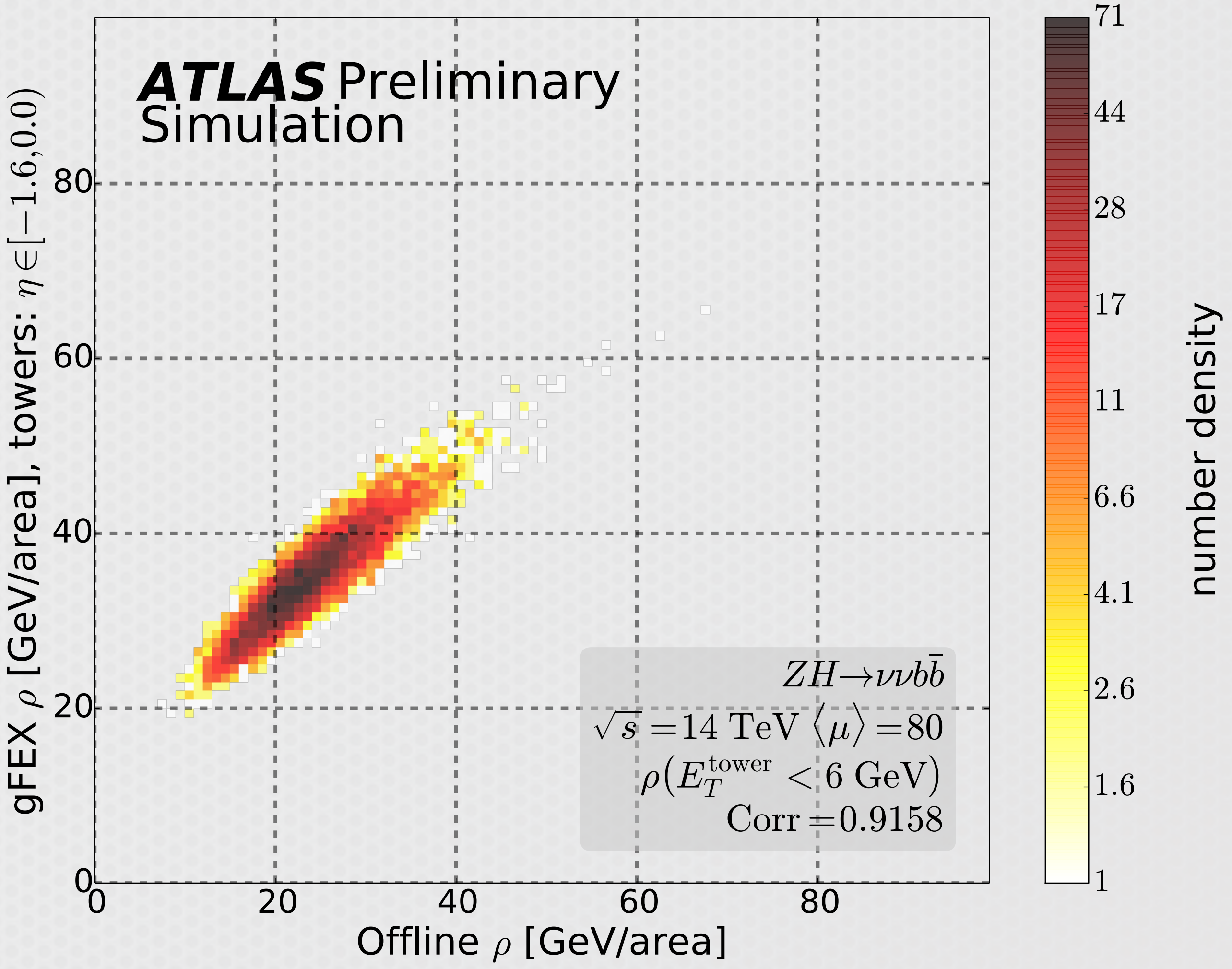
UChicago: Zynq Eval. Board — Slow Control and Monitoring

Pile-up Energy Density Calculations in the gFEX at the Level 1 Trigger

$t\bar{t}$



$ZH\rightarrow\nu\nu b\bar{b}$



How does our simplified calculation of pileup density match up to the corresponding offline calculation?

The pile-up does not depend on the physics processes we're studying.

Adapted from https://cds.cern.ch/record/1749167

The Takeaway

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- **What are we doing?**
  - Building a large-R jet trigger for Run 3 and beyond
  - Estimating pileup for jet-level corrections
- **Why are we doing it?**
  - We expect to see more jets with substructure in the future
- **What makes gFEX special?**
  - Full calorimeter on a single board
  - Maintains trigger efficiency for various jet substructures
  - **[ongoing]** 0.2 x 0.2 ($\eta \times \phi$) tower region can be used as a proxy for subjets