



BETHEL
UNIVERSITY

Event Selection

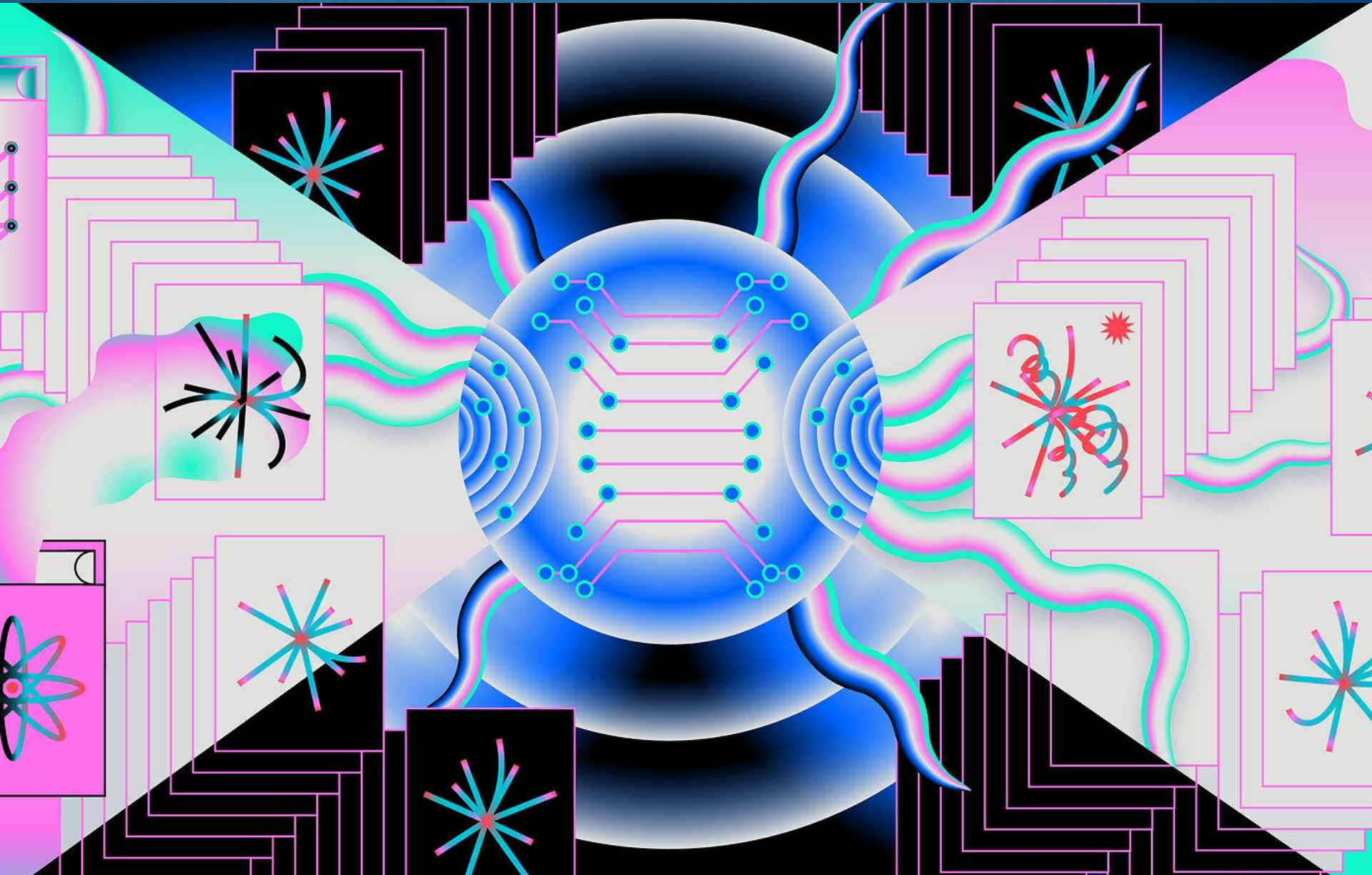
OPEN DATA WORKSHOP 2024

WHEPP CONFERENCE

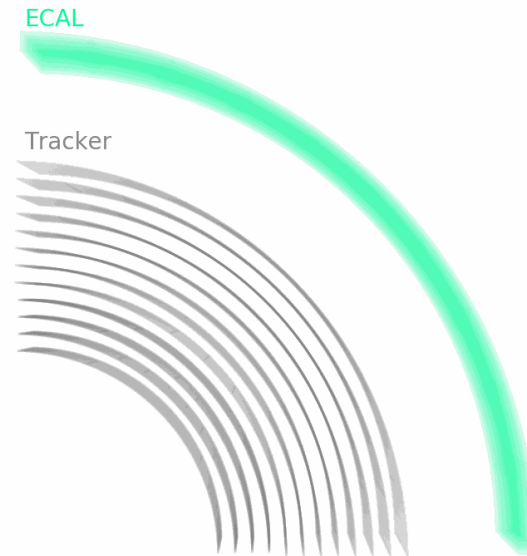
JULIE HOGAN

1/07/2024

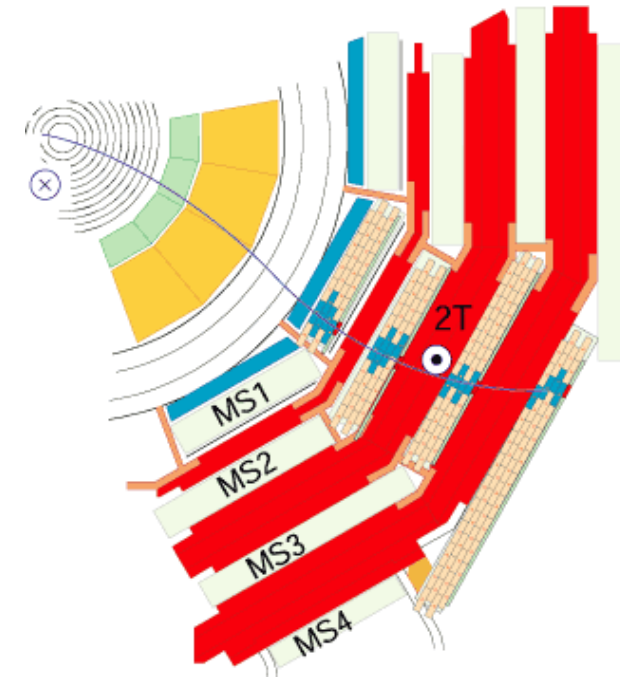
Symmetry on triggers



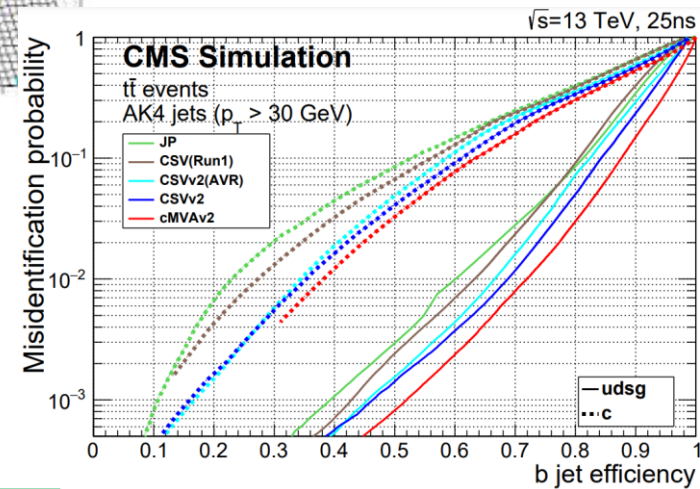
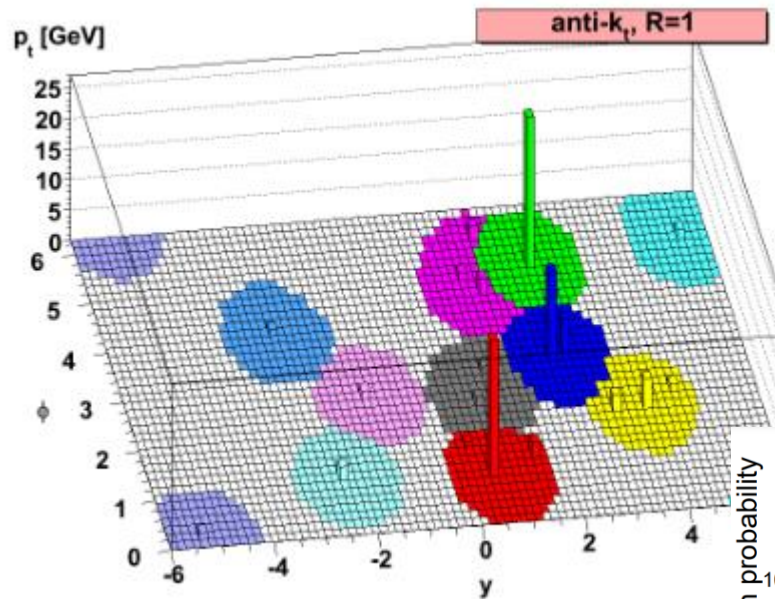
- ▶ Electrons & photons
- ▶ Muons
- ▶ Tau leptons



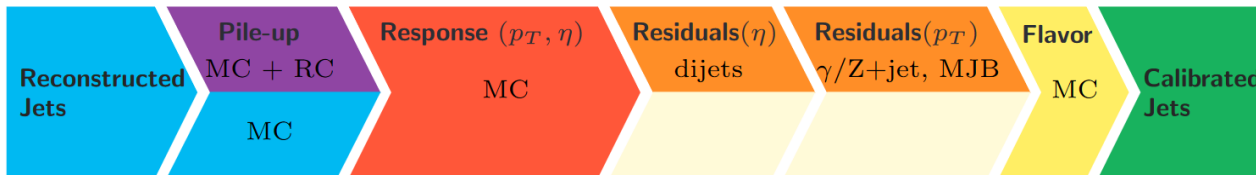
- electron
- ⋯ bremsstrahlung photon 1
- ⋯ bremsstrahlung photon 2



- ▶ Jets
- ▶ MET
- ▶ B-tagging
- ▶ Jet energy corrections



Applied on data →



Applied on MC →

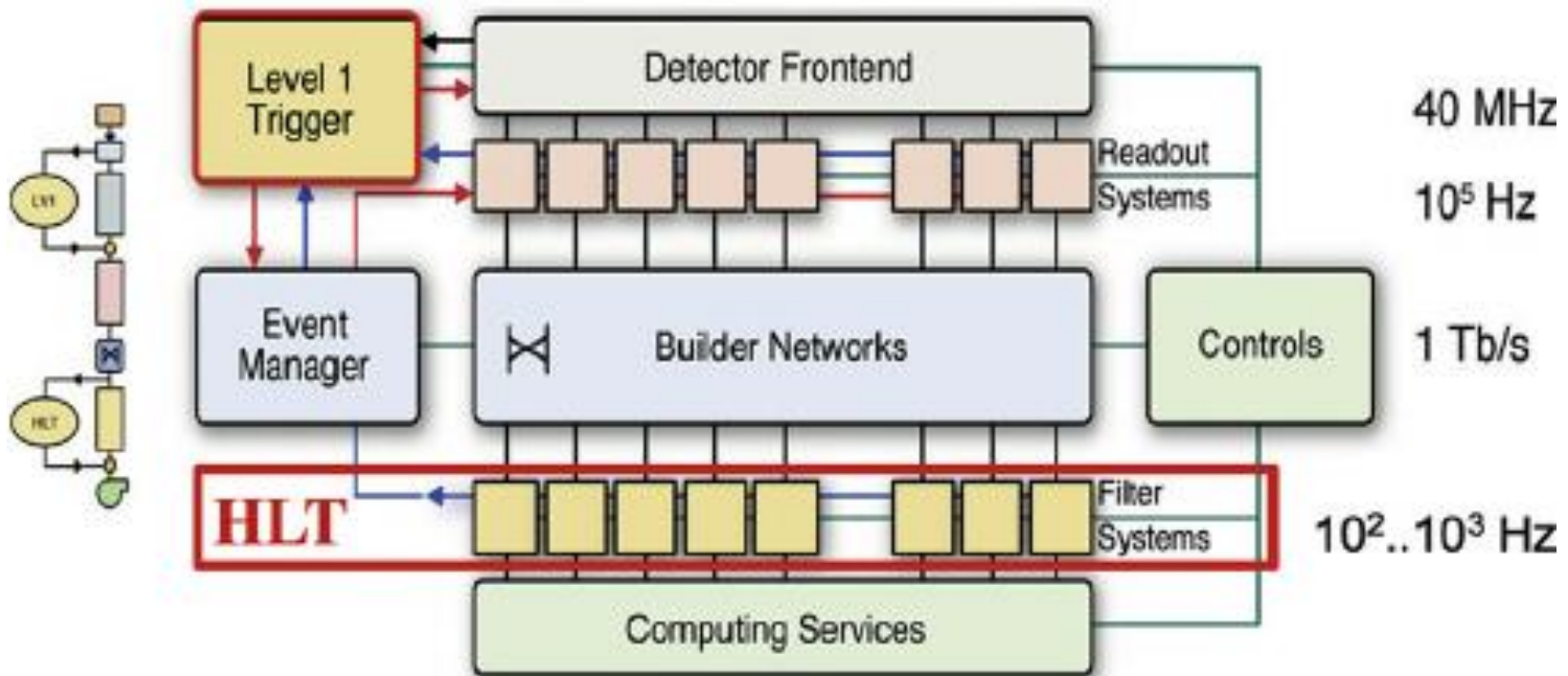
♥ Guiding principles

1. What physics objects should be present to represent the final state particles of my Feynman diagram?
Should any of the objects be related to each other in a special way?
2. What physics objects should NOT be present?
3. What will cue CMS to store the types of events I want to analyze?

▶ Discuss!

▶ Any nuances or other principles we should add?

► Level-1 trigger + high-level trigger



- ▶ Triggers are implemented in CMSSW as collections of **filters** on different event features

Python

```
process.HLT_Mu20_v2 = cms.Path( process.HLTBeginSequence + process.hltL1sL1SingleMu16 + process.hltPreMu20 + process.hltL1fL1sMu16L1Filtered0 + process.HLT2muonrecoSequence + process.hltL2fL1sMu16L1f0L2Filtered10Q + process.HLT3muonrecoSequence + process.hltL3fL1sMu16L1f0L2f10QL3Filtered20Q + process.HLTEndSequence )
```

- ▶ Triggers are fairly fluid and change over time:
 - ▶ Version numbers update pretty regularly
 - ▶ Some triggers' acceptance rates are tied to the overall "luminosity" of the detector
- ▶ Prescale = X means "1 out of X passing events are kept"

- ▶ Collision data is sorted into “streams” based on which triggers fired for each event
 - ▶ Convenient for analyzers!
 - ▶ Beware events appearing in multiple datasets
- ▶ Peak into Run 3:

ALCaLowPtJet
ALCaLumiPixelsCountsPrompt
ALCaP0
ALCaPPSPrompt
ALCaPhiSym
BTagMu
Commissioning
Cosmics
DisplacedJet
EGamma(0,1)
EphemeralHLTPhysics(0-19)
EphemeralZeroBias(0-19)

HLTPhysics
HcalINZS
IsolatedBunch
JetMET(0,1)
L1Accept
MiniDaq
MinimumBias
Muon(0,1)
MuonEG
NoBPTX
ParkingDoubleElectronLowMass
ParkingDoubleMuonLowMass(0-7)
ParkingHH

ParkingLLP
ParkingVBF(0-7)
RPCMonitor
ReservedDoubleMuonLowMass
ScoutingPFMonitor
ScoutingPFRun3
SpecialHLTPhysics(0-31)
SpecialRandom(0-19)
Tau
TestEnablesEcalHcal
ZeroBias,(0-19)
ZeroBiasNonColliding

- Prompt Reco switched to CMSSW_13_0_9, 18 hours ago

- ▶ How can I get the trigger info?!
 - ▶ Directly from information stored in MiniAOD Files – we’ll do this
 - ▶ From the CMS conditions database via “provider” classes – offline!

- ▶ WATCH JULIE – we will work through the lesson page, but the “doing” isn’t super exciting for everyone to do individually.

<https://cms-opendata-workshop.github.io/workshopwhepp-lesson-selection/03-miniaodtrigger/index.html>

► Let's design an analysis!

✦ Workshop analysis example: $t\bar{t} \rightarrow (bjj)(bl\nu)$ [↗](#)

Later in the workshop we will use a measurement of the top quark pair production cross section as an example analysis. The signal for this measurement is one top quark that decays hadronically, and one top quark that decays leptonically, to either a muon or an electron.

✦ Your analysis example

What is a physics process that you might study? Let's design a possible CMS event selection. If your process includes a particle with multiple possible decay modes, choose one (or a small group of very similar decay modes) as a test case for this challenge.

? Signal [↗](#)

Which final state particles would you expect to observe in the detector from your “signal” process?

Based on these particles, consider:

- Which trigger or triggers would be useful to make sure your signal events are represented in the dataset?
- Which objects should you require in each event?
- What kinematic criteria might you require for each object? (momentum, angular regions, etc)
- What quality criteria might you require for each object? (identification, isolation)
- Are there any correlations between your objects that you might exploit?

? Background

Which SM backgrounds could easily mimic your signal, given a few extra physics objects, or a few missing physics objects?

Based on these processes, consider:

- Which background simulations should you include in your study?
- Should you apply any upper or lower limits on the numbers of certain physics objects in your events?
- Are there any objects you should *veto* from your events?
- What quality criteria might you choose for vetoing objects?

- ▶ Walk through the decisions for the ttbar analysis on the tutorial webpage

<https://cms-opendata-workshop.github.io/workshopwhepp-lesson-selection/05-solutions/index.html>