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# Trigger Data Collection & Analysis

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on behalf of the ATLAS Trigger Group**

Based on previous tutorials/workshop intros by  
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ATLAS Software Tutorial



# Finding Information

- To find information about the trigger, a good start are the twiki pages:
  - [ATLAS Trigger twiki](#)
    - Meetings, Mailing lists, [Jira project \(ATR\)](#)
    - [Trigger Organisation](#) (coordinators of various areas)
    - Trigger recommendations, issues and scale factors for analyses
    - [Trigger developer pages](#)
    - Trigger Menu ([lowest unprescaled triggers](#), [menu evolution](#))
    - Signature group twikis
    - [Trigger Core Software Portal](#) with links to [Trigger analysis support](#), [TrigDecision Tool](#), [xAOD Trigger Object Matching](#)
    - [\*\*Trigger Recommendations for Analysis Groups\*\*](#)
- Trigger Help mailing list:
  - [atlas-trigger-help](#): post any general trigger related questions
- If any of the pages appear out of date, please contact me ([Marcus.Matthias.Morgenstern@cern.ch](mailto:Marcus.Matthias.Morgenstern@cern.ch)) to follow up on this or use the new feature to [report out-of-date twiki pages!](#)

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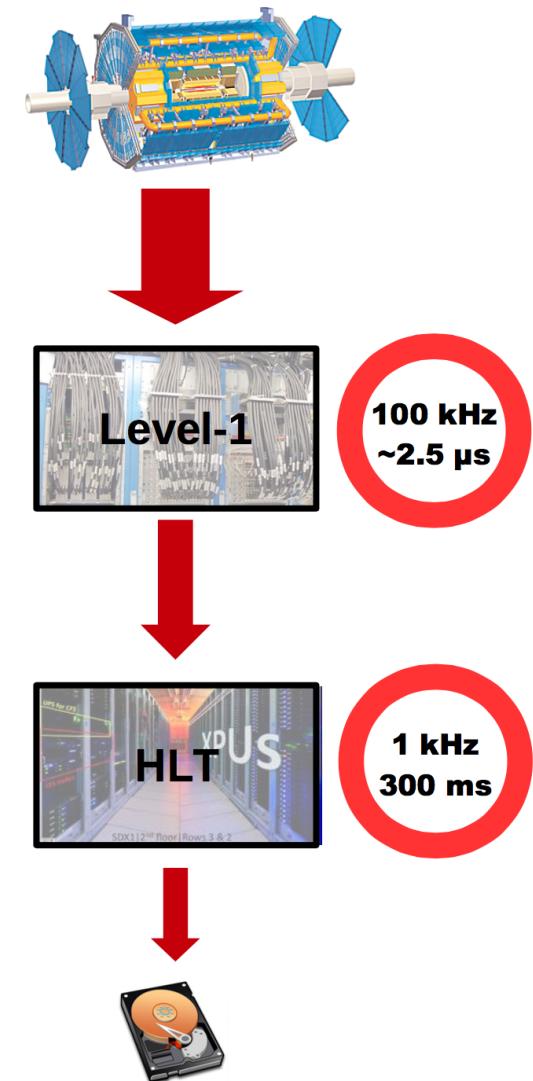
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# **ATLAS Trigger System**

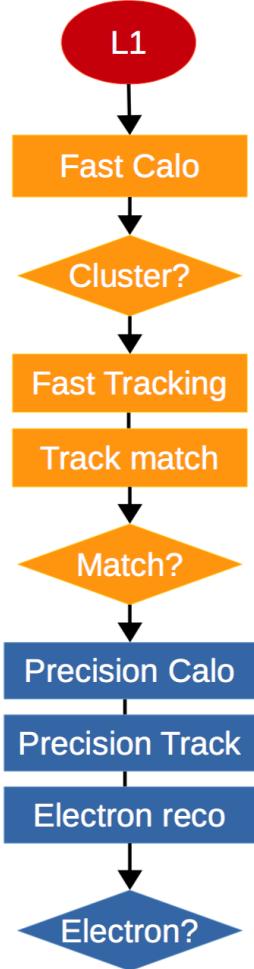
## **- Intro, Trigger Data & Execution Model -**

# Short Recap of the Trigger in ATLAS

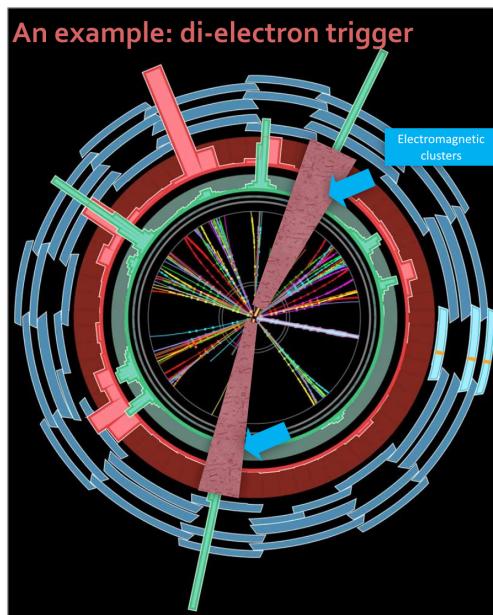
- ATLAS can't record all collision data delivered by the LHC
  - Rate reduction of  $O(10^4)$  from 40 MHz  $\rightarrow$  1 kHz
- **Level-1 (L1)**
  - Hard rate and latency limits set by detector & trigger hardware
  - Deadtime applied if limits are exceeded
- **High Level Trigger (HLT)**
  - Running specialised software on large commercial PC farm to stay within limits set by ATLAS Computing model (disk space, Tier0 size)
    - Running one athena application per physics CPU core
    - Events are processed independently
    - Networking based on commercial technologies
  - Average processing time set by HLT farm size
- Online data reconstruction system deciding whether event is written to disk: **bad trigger  $\rightarrow$  bad data**
  - Interesting events are selected based on a *trigger menu*
  - Design of trigger menu driven by physics priorities, rate limitations & online resources
- Trigger is often the first step in an Analysis



# HLT Algorithms



- Offline reconstruction in Run-2 too slow to be used directly
  - Takes > 10s per event but HLT needs < 1s
- Requires **step-wise** processing with **early rejection**
  - Fast reconstruction with algorithms that are either trigger-specific or a special configuration of offline algorithms, guided by L1 Regions-of-Interest (RoI)
  - Precision reconstruction with offline (or very close to) algorithms with the full detector data being available



**Level 1**

- L1 Calo Cluster Processor finds EM shower ( $E_T, \eta, \phi$ )
- Satisfied energy thresholds and Region of Interest (RoI) of L1 shower passed to HLT

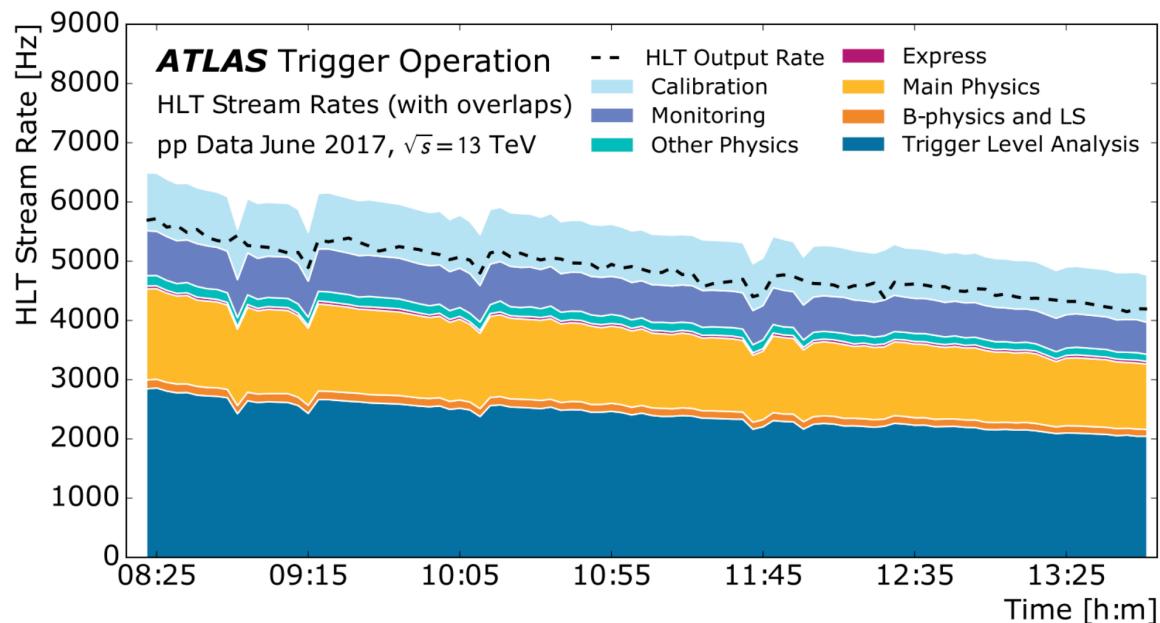
**HLT**

- Seeded by Level 1
- Reconstruction within RoI
- Mix of trigger specific (fast) and offline (more precise) reconstruction algorithms
- Trigger selection close to offline quality



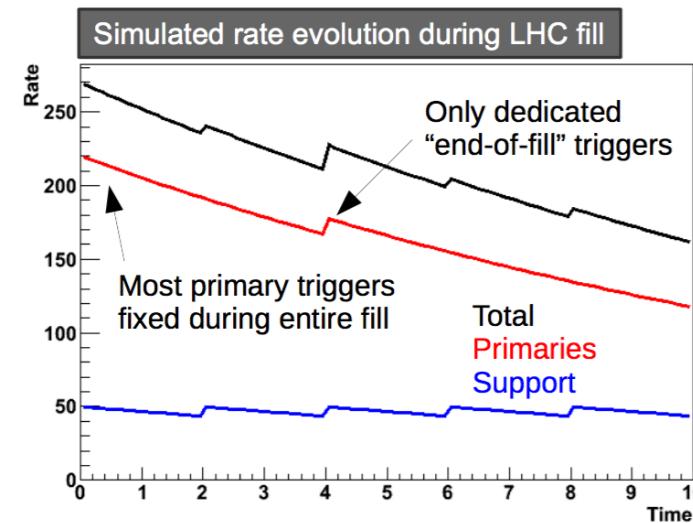
# Streaming

- Streaming: If any trigger chain passes, events are accepted and are written out to different streams depending on which chain passed
- **physics\_Main** (single stream used for most physics analyses)
- **Debug** (events that could not be processed at the HLT)
- Express, Delayed, Calibration, Trigger-Level Analysis



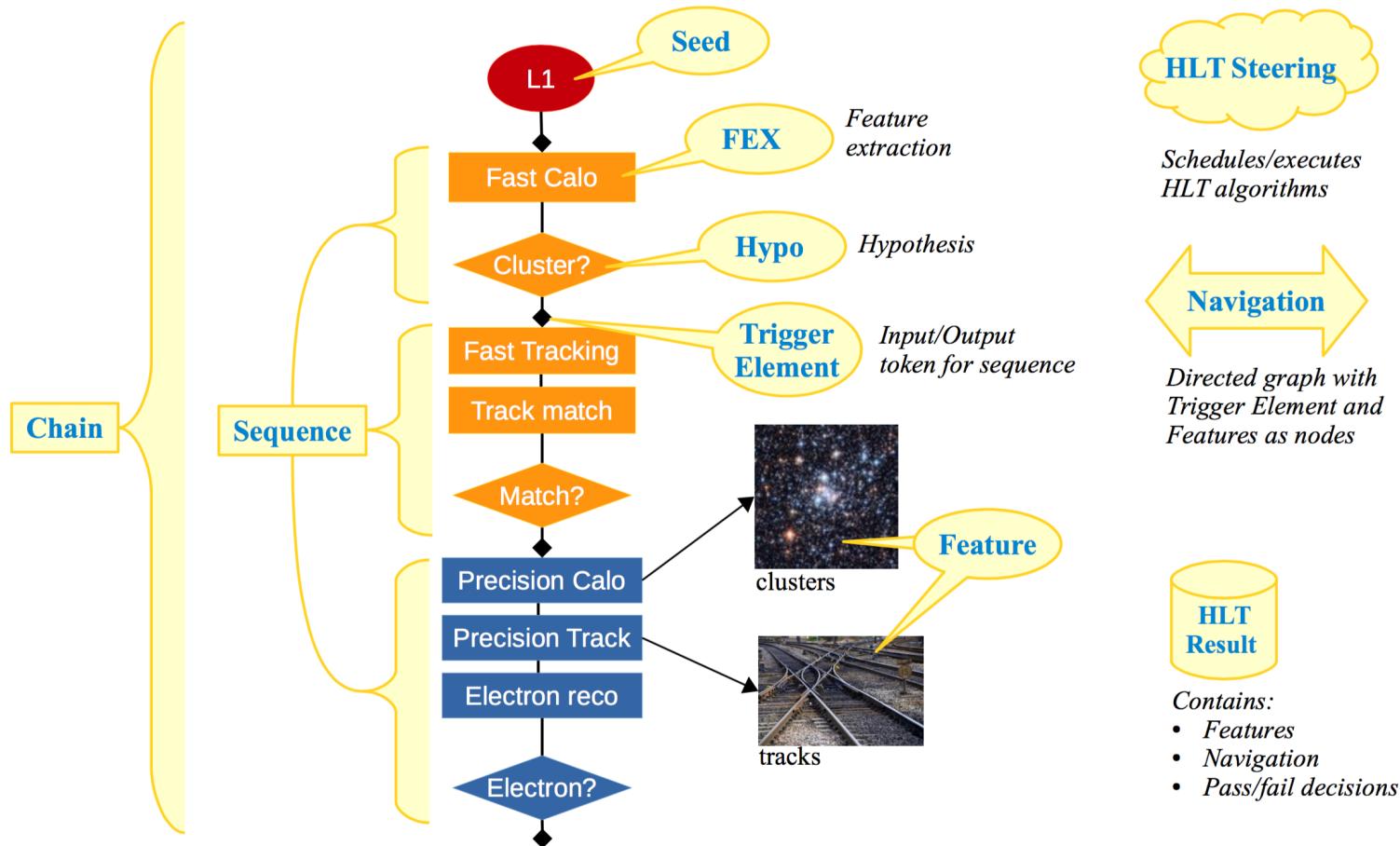
# Trigger Menu

- Defines the Physics program/reach of ATLAS
  - Each physics signature defines one or more trigger chains
  - **Collection of *trigger chains* is called the *trigger menu***
  - Contains in addition to primary physics triggers:
    - Support triggers (e.g. for efficiency measurement)
    - Triggers for detector calibration and monitoring
  - Run-2 menu with  $\sim$ 1800-2000 trigger chains
  - Organised by the Menu Coordination Group
- **Trigger menu varies with luminosity and time**
  - Constantly fine-tuned according to running conditions
  - **Prescales** are applied to individual trigger chains to reduce the rate
    - Not all triggers need to be run at full rate
    - Rate might be too high, subsample might be enough
    - Adding triggers when luminosity drops to make optimal use of resources
  - Re-run triggers: run HLT trigger on all accepted events, e.g. run lower threshold trigger on all events accepted by higher thresholds (useful for efficiency studies)
- New triggers can be requested: See [Trigger Request Policy twiki](#)

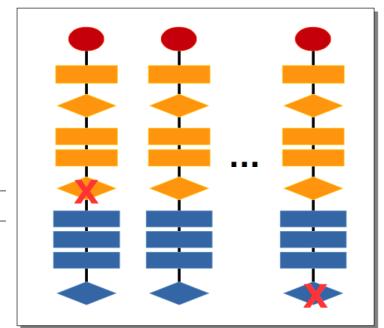


# HLT Jargon

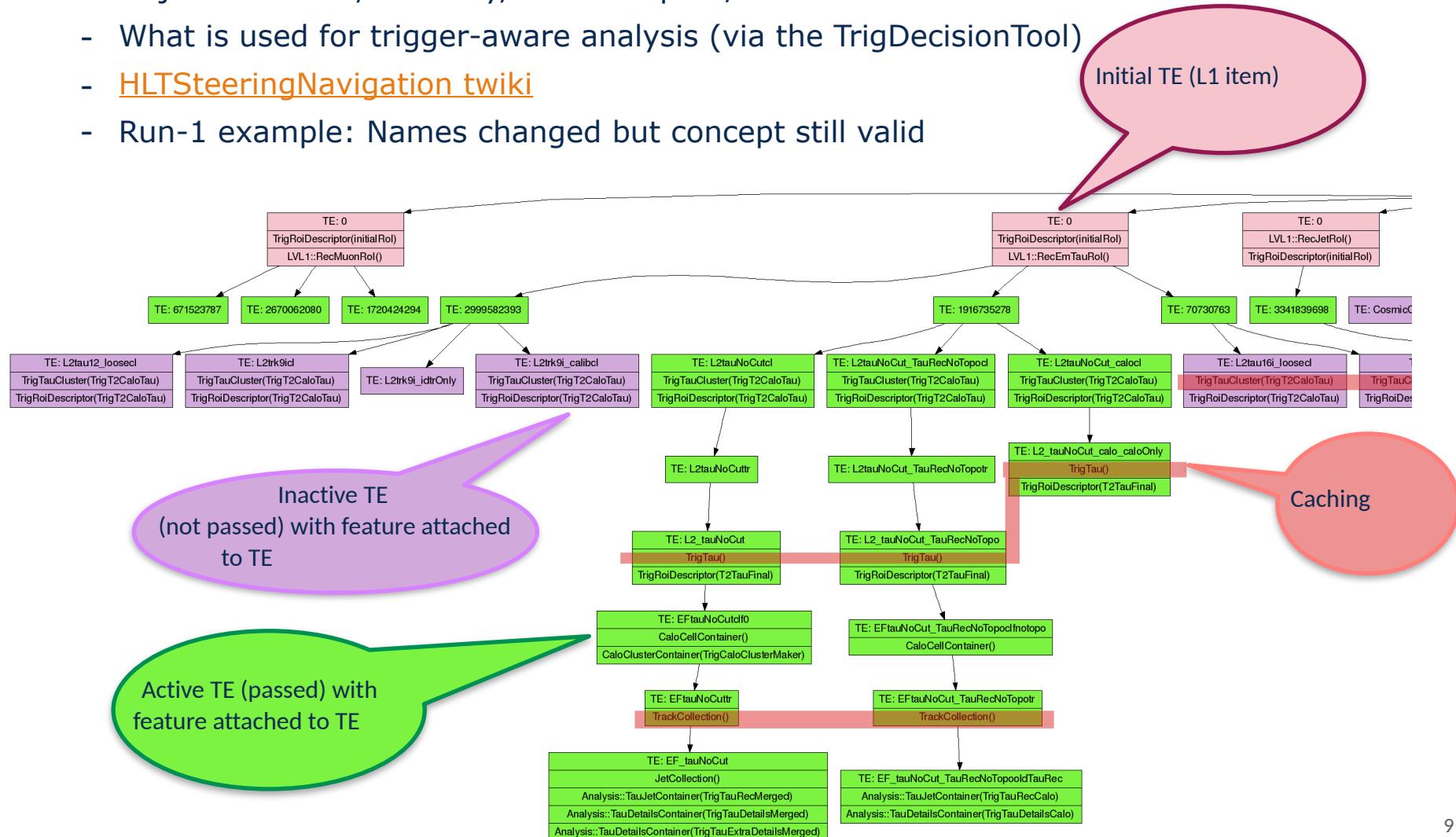
- As any respectable system, we have plenty of jargon to impress and confuse you (see [Trigger Glossary](#) and [HLTEnginedGlossary](#) for more!)
- **Trigger Chain:** Sequence of algorithms (Feature Extraction + Hypothesis)



# Trigger Navigation



- Keeps track of the trigger execution
  - Objects location, ancestry, selection pass/fail
  - What is used for trigger-aware analysis (via the TrigDecisionTool)
  - [HLTSteeringNavigation twiki](#)
  - Run-1 example: Names changed but concept still valid



# Trigger Data in ATLAS

- Three basic kinds of trigger data in ATLAS
  - **Trigger Configuration**
    - Trigger menu with trigger chain names and their configuration (pT cuts, isolation requirements), information summarised in SuperMasterKey (SMK)
      - Configuration constant per run/events in a file
    - L1/HLT prescales (can change on luminosity block boundaries)
  - **Trigger reconstruction objects (Features)**
    - Trigger Event Data Model (EDM)
    - Online reconstructed objects (e.g. tracks, clusters, ...) to reach decision
    - Used for trigger selection studies and matching
    - Different for each event
  - **Trigger Result**
    - Trigger decision data
    - What triggers passed and how the decision was reached
    - Varies with each event

**Access for trigger-aware analysis through the TrigDecisionTool (TDT)**

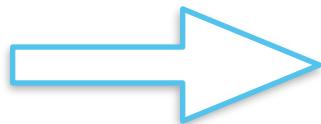
# **TrigDecisionTool**

## **...your access to the Trigger**

<https://twiki.cern.ch/twiki/bin/view/Atlas/TriggerAnalysisTools>

# TrigDecisionTool

- Recap: three main ingredients of trigger data
  - Decision
  - Navigation & Features
  - Configuration
- Trigger data is complicated to extract for non-experts on their own



- Therefore: Unified interface provided and supported by the Trigger Group: **TrigDecisionTool (TDT)**

- Git location: [/Trigger/TrigAnalysis/TrigDecisionTool](#)
- Your code should only talk to the TDT

# TrigDecisionTool - Usage in AthAnalysis

- [Release 21 tutorial](#)
- Setup is easy
  - Add TDT as data member through AnaToolHandle, a smart pointer to a tool
  - Configure and initialize before use in .cxx file, add the CHECK method to see if tool is initialized correctly
  - In execute() method, make use of the tool
  - For compilation, amend the CMakeLists.txt with TrigDecisionTool

In the header file

```
#include "AsgTools/AnaToolHandle.h"  
#include "TrigDecisionTool/TrigDecisionTool.h"
```

Inside the class definition add smart pointer to TDT

```
asg::AnaToolHandle<Trig::TrigDecisionTool> m_tdt;
```

In .cxx file, in initialize()

```
m_tdt.setTypeAndName("Trig::TrigDecisionTool/TrigDecisionTool");  
CHECK( m_tdt.initialize() );
```

In .cxx file, in execute()

```
auto allChains = m_tdt->getChainGroup(".*");  
std::cout << "Triggers that passed : "  
for(auto& trig : allChains->getListOfTriggers())  
    if(m_tdt->getChainGroup(trig)->isPassed())  
        std::cout << trig << ", "
```

# TrigDecisionTool - Usage in AnalysisBase (EventLoop)

- [Release 21 AnalysisBase tutorial](#)
- To make use of the TDT in EventLoop, have to make use of another tool TrigConf::xAODConfigTool which both need to be declared in the header file
  - Initialization requires some more steps than in AthAnalysis
  - For compilation, amend the CMakeLists.txt with TrigDecisionTool

## In the header file

```
// include files for using the trigger tools
#include <TrigConfInterfaces/ITrigConfigTool.h>
#include <TrigDecisionTool/TrigDecisionTool.h>
...
// trigger tools member variables
asg::AnaToolHandle<Trig::TrigDecisionTool> m_trigDecisionTool; //!
asg::AnaToolHandle<TrigConf::ITrigConfigTool> m_trigConfigTool; //!
```

## Initialization

```
MyxAODAnalysis :: MyxAODAnalysis ()
{
    m_trigConfigTool("TrigConf::xAODConfigTool/xAODConfigTool"),
    m_trigDecisionTool ("Trig::TrigDecisionTool/TrigDecisionTool")
{
...
    // Initialize and configure trigger tools
    ANA_CHECK (m_trigConfigTool.initialize());
    ANA_CHECK (m_trigDecisionTool.setProperty ("ConfigTool", m_trigConfigTool.getHandle()));
    // connect the TrigDecisionTool to the ConfigTool
    ANA_CHECK (m_trigDecisionTool.setProperty ("TrigDecisionKey", "xTrigDecision"));
    ANA_CHECK (m_trigDecisionTool.initialize());
```

## In CMakeLists.txt

```
LINK_LIBRARIES [...] TrigDecisionToolLib TrigConfInterfaces
```

# TrigDecisionTool - ChainGroups

- Basic Interface through ChainGroups
  - Interface to the L1, HLT trigger information accessed through the TDT
  - ChainGroups are NOT collections or containers of triggers
  - Defined by a pattern or set of patterns which is evaluated for each event (regular expression)
  - Encodes an OR of all matching chains, for example ChainGroup passes if any matching chain passes

```
// examine the HLT_xe80* chains, see if they passed/failed and their total prescale
auto chainGroup = m_trigDecisionTool->getChainGroup("HLT_xe80.*");
std::map<std::string,int> triggerCounts;
for(auto &trig : chainGroup->getListOfTriggers()) {
    auto cg = m_trigDecisionTool->getChainGroup(trig);
    std::string thisTrig = trig;
    ANA_MSG_INFO ("execute(): " << thisTrig << ", chain passed(1)/failed(0) = " << cg->isPassed() << ",
    total chain prescale (L1*HLT) = " << cg->getPrescale());
} // end for loop (C++11 style) over chain group matching "HLT_xe80*"
```

# TrigDecisionTool - ChainGroups & Features

- ChainGroups know about the signatures and thus about the output TE
  - can traverse the Navigation to get the attached Features
- Two types of Features:
  - Containers: e.g. all tracks in ROI
  - Single Object: e.g. MissingEt
- Access is straight forward

- access straight forward

```
// Get a chain group that represents the HLT trigger.~  
auto cg = trigDecTool.getChainGroup("HLT_e25_etcut");~  
auto fc = cg->features();~  
auto eleFeatureContainers = fc.containerFeature<TrigElectronContainer>();~  
hNContainers->Fill(eleFeatureContainers.size());~  
cout << "Looking at features for the event: " << endl;~  
for(auto &econt : eleFeatureContainers) ~  
... cout << "...-> TrigElectronContainer: " << econt.label() << endl;~  
... for (auto e : *econt.cptr()) ~  
... hElePt->Fill(e->pt()/1000.0);~  
... }~  
}
```



for single features  
use ::elementFeature<T>

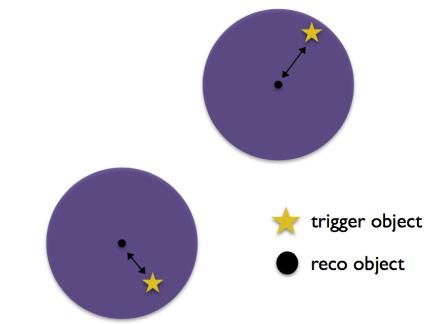
feature container is vector of  
Trig::Feature<T>. wraps  
additional info around bare  
feature of type T. such as  
originating TE etc.  
get bare Feature via ::cptr()

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# Trigger Matching Tool

# TriggerMatchingTool (TMT)

- Trigger Matching: identifying trigger-reconstructed particles (“online”) with reconstructed counterparts during full reconstruction (“offline”)
- Trigger matching needed in some analyses as they:
  - require object level trigger information (e.g. tag & probe)
  - have multiple objects of the same type and need matching for detailed efficiency estimation
- Matching framework available in [Trigger/TrigAnalysis/TriggerMatchingTool](#)
  - TMT matches based on delta-R metric (different metrics possible too)
  - Associates a set of particles to best possible set of trigger particles by minimising global sum of distances
- Twiki with detailed information for users and developers
  - <https://twiki.cern.ch/twiki/bin/view/Atlas/XAODMatchingTool>



# TriggerMatchingTool (TMT) - Setup

- Setup in

- AthAnalysis

```
ToolSvc += CfgMgr.Trig__MatchingTool("MyMatchingTool")
```

- AnalysisBase

```
Trig::TrigMatchingTool trigMatchTool("TrigMatchTool");
Trig::ITrigMatchingTool& itrig = trigMatchTool;
ASG_CHECK_SA("MyAnalysis",itrig.initialize());
```

- Main usage: prepare a vector of offline particles, call match()

```
for(uint i = 0; i < electrons->size(); i++) {
    myParticles.clear();
    myParticles.push_back( electrons->at(i) );
    bool eltrig_match = m_tmt->match(myParticles,"HLT_e17_lhloose",0.07 /*explicit dR threhsold*/);
    ATH_MSG_INFO("HLT_e17_lhloose Matching Decision = " << eltrig_match);

    // here's an example of a combined trigger
    // e-tau
    if(taus){
        for(uint j = 0; j < taus->size(); j++) {
            myParticles.clear();
            myParticles.push_back(electrons->at(i));
            myParticles.push_back(taus->at(j));
            bool el_tau_matchresult = m_tmt->match(myParticles,"HLT_e17_lhmedium_iloose_tau25_medium1_tracktwo");
            ATH_MSG_INFO("HLT_e17_lhmedium_iloose_tau25_medium1_tracktwo = " << el_tau_matchresult);
        }
    }
}
```

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# Other Tools & Webpages

# TriggerAPI

- [\*\*TriggerAPI\*\*](#): Python interface to obtain information about the **lowest-unprescaled triggers for a given signature and a given period**
  - Code location: [Trigger/TriggerCommon/TriggerMenu/python/api](#)
  - Available in:
    - **AthenaP1,21.1.22 or later**
    - **AthDerivation,21.2.17.0 or later**
    - Note: 21.2 releases can be behind 21.1 w.r.t. trigger menu developments
  - **Example script with detailed functionality:**  
[\*\*runTriggerAPIExample.py\*\*](#)
    - Retrieves the lowest-unprescaled items split by signatures for the different available periods
    - Output can be compared with [LowestUnprescaled](#)
    - Also shows some advanced features, e.g. retrieving only items matching a particular pattern or retrieving combined triggers

```
setupATLAS
asetup AthenaP1,21.1.22
python -c "from TriggerMenu.api.TriggerAPI import TriggerAPI
from TriggerMenu.api.TriggerEnums import TriggerPeriod, TriggerType
print TriggerAPI.getLowestUnprescaled(337833, TriggerType.mu_single)"
```

# Was my Trigger Chain Prescaled?

- Takes as input names of trigger and GRLS as input
  - `asetaup AthAnalysis,21.2,latest`
  - `lsetup pyAMI`
  - `checkForPrescaling.py -- triggers="HLT_2e15_lhvloose_nod0_L12EM13VH,HLT_e60_lhmedium_no d0" /cvmfs/atlas.cern.ch/repo/sw/database/GroupData/ GoodRunsLists/data16_13TeV/20170720/physics_25ns_20.7.xml`
  - See `--help` for extra options
  - E.g. can be used to generate GRLs for each trigger, then use a GRL tool for each one to basically decide if we should use a trigger for a given event

# Trigger Configuration Page (1/3)

- <https://atlas-trigconf.cern.ch/>
- Three possible searches:
  - Listing trigger keys by run
    - <https://twiki.cern.ch/twiki/bin/view/Atlas/StableBeamRuns2017>
  - Listing trigger configuration by SMK, prescales and DB
  - Listing bunch group keys
- Remember: Prescale keys can change during a run, but the SMK can't!

Trigger configuration for the ATLAS run(s)  
330079

run	SMK	Prescale Keys: L1 / HLT (LB Range)
330079	2579	<a href="#">15186/11219</a> (1- 45 ) <a href="#">15170/11219</a> (45- 65 ) <a href="#">15171/11219</a> (65- 76 ) <a href="#">15170/11219</a> (76- 89 ) <a href="#">15338/11308</a> (89- 93 ) <a href="#">15333/11303</a> (93- 112 ) <a href="#">15332/11302</a> (112- 127 ) <a href="#">15331/11301</a> (127- 151 ) <a href="#">15330/11300</a> (151- 212 ) <a href="#">15170/11219</a> (212- 0 ) <a href="#">prescales evolution</a>

### Listing of trigger keys by run

Examples: runs range: 150000-152000, specific run: 151178, open ended runs range: 151178-

### Listing trigger configurations by key

smk  L1 psk  and HLT psk  DB

Specify set of configuration keys and DB to display the trigger configuration.  
Suggestion should appear below the entry field for the L1 psk and HLT psk. You may scroll to it and pick one. If you enter the ":" all possible keys associated to the SMK will show up.  
For MC menus you may consult [MCTriggerDB](#) twiki.

### Listing trigger bunch groups by key

bunch group key   
Specify the bunch group configuration

# Trigger Configuration Page (2/3)

- <https://atlas-trigconf.cern.ch/>
  - Listing trigger configuration by SMK, prescales and DB

DB : run2 Release: 21.1.8  
SMK: 2579 name: Physics\_pp\_v7 comment: ATR-16675 all HLT components  
L1PSK: 15338 name: Physics\_pp\_v7\_165.0\_170.0e32\_2544b comment: version: 3 lumi: 0.0  
HLTPSK: 11308 name: Physics\_pp\_v7\_165.0\_170.0e32\_2544b comment: ~ version: 4  
L1 topo menu: [DB key 38 \(link to standalone display\)](#) name: Physics\_pp\_v7 version: 2 comment: ~  
Additional info: Configuration from the DB <run2> merged HLT, issues:

Streams: All Off All On  zdcCalib  BeamSpot  MinBias  BphysLS  Late  PixelNoise  Mistimed  IDMonitoring  Tile  DISCARD  Main  TgcNoiseBurst  HLTPassthrough  LArCellsEmpty  LArCells  CostMonitoring  
 Background  EnhancedBias  IDTracks  LArNoiseBurst  None  BphysPEB  L1Topo  Standby  L1CaloCalib  express  Muon\_Calibration  DataScouting\_03\_CosmicMuons  CSC  CosmicCalo  IDFwd  ALFACalib  
 CosmicMuons  HLT\_IDCosmic  DataScouting\_05\_Jets  L1Calo  AFP  IDCosmic  TauOverlay  SCTNoise  ExDelayed  IBLLumi  PixelBeam  VdM  RPCNoise  ZeroBias

Select predefined view:  main 1/1 ^ v x  
Hide disabled:   
Justifications load

HLT Chain	Prescale	Pass Through	Stream Prescale	Rerun Prescale	Details	L1 item	L1 prescale
<b>Main</b>							
HLT_g0_perf_L1EM3_EMPTY	-1.0	0.0	1.0	-1.0 Cond: 1	Groups: RATE:SinglePhoton BW:Egamma	L1_EM3_EMPTY	60.8
HLT_e0_perf_L1EM3_EMPTY	-1.0	0.0	1.0	-1.0 Cond: 1	Groups: RATE:SinglePhoton BW:Egamma	L1_EM3_EMPTY	60.8
HLT_g10_loose	3.9	8.0	1.0	1.0 Cond: 1	Groups: RATE:SinglePhoton BW:Egamma	L1_EM7	66313.1
HLT_g20_loose_L1EM15	0.0	0.0	1.0	1.0 Cond: 1	Groups: RATE:SinglePhoton BW:Egamma	L1_EM15	1277.97
HLT_g10_etcut	0.0	0.0	1.0	1.0 Cond: 1	Groups: RATE:SinglePhoton BW:Egamma	L1_EM7	66313.1
HLT_g20_etcut_L1EM12	0.0	0.0	1.0	1.0 Cond: 1	Groups: RATE:SinglePhoton BW:Egamma	L1_EM12	25078.05
HLT_g200_etcut	32.9	0.0	1.0	-1.0 Cond: 1	Groups: RATE:SinglePhoton BW:Egamma	L1_EM22VHI	1.0
HLT_g250_etcut	12.5	0.0	1.0	-1.0 Cond: 1	Groups: RATE:SinglePhoton BW:Egamma	L1_EM22VHI	1.0
HLT_g300_etcut	1.0	0.0	1.0	-1.0 Cond: 1	Groups: RATE:SinglePhoton BW:Egamma	L1_EM22VHI	1.0
HLT_g300_etcut_L1EM24VHI	1.0	0.0	1.0	-1.0 Cond: 1	Groups: RATE:SinglePhoton BW:Egamma	L1_EM24VHI	1.0
HLT_g300_etcut_L1EM24VHIM	1.0	0.0	1.0	-1.0 Cond: 1	Groups: RATE:SinglePhoton BW:Egamma	L1_EM24VHIM	1.0
HLT_g322_tight	0.0	0.0	1.0	1.0 Cond: 1	Groups: RATE:SinglePhoton BW:Egamma	L1_EM15VH	1599.96

Interactive! Click on +  
Will show you sequences, L1 logic etc

# Trigger Configuration Page (3/3)

- <https://atlas-trigconf.cern.ch/>
  - Listing trigger configuration by SMK, prescales and DB

DB : run2 Release: 21.1.8

SMK: 2579 name: Physics\_pp\_v7 comment: ATR-16675 all HLT components

L1PSK: 15338 name: Physics\_pp\_v7\_165.0\_170.0e32\_2544b comment: version: 3 lumi: 0.0

HLTPSK: 11308 name: Physics\_pp\_v7\_165.0\_170.0e32\_2544b comment: ~ version: 4

L1 topo menu: [DB key 38 \(link to standalone display\)](#) name: Physics\_pp\_v7 version: 2 comment: ~

Additional info: Configuration from the DB <run2> merged HLT, issues:

Streams: All Off All On  zdcCalib  BeamSpot  MinBias  BphysLS  Late  PixelNoise  Mistimed  IDMonitoring  Tile  DISCARD  Main  TgcNoiseBurst  HLTPassthrough  LArCellsEmpty  LArCells  CostMonitoring  
 Background  EnhancedBias  IDTracks  LArNoiseBurst  None  BphysPEB  L1Topo  Standby  L1CaloCalib  express  Muon\_Calibration  DataScouting\_03\_CosmicMuons  CSC  CosmicCalo  IDFwd  ALFACalib  
 CosmicMuons  HLT\_IDCosmic  DataScouting\_05\_Jets  L1Calo  AFP  IDCosmic  TauOverlay  SCTNoise  ExoDelayed  IBLLumi  PixelBeam  VdM  RPCNoise  ZeroBias

Select predefined view:  main 1/1 ^ v x

Hide disabled:

[Justifications](#) [load](#)

HLT Chain	Prescale	Pass Through	Stream Prescale	Rerun Prescale	Details	L1 item	L1 prescale
Main							
<span style="color: green;">+</span> HLT_g0_perf_L1EM3_EMPTY	-1.0	0.0	1.0	-1.0 Cond: 1	Groups: RATE:SinglePhoton BW:Egamma	L1_EM3_EMPTY	60.8
<span style="color: red;">-</span> HLT_g300_etcut	1.0	0.0	1.0	-1.0 Cond: 1	Groups: RATE:SinglePhoton BW:Egamma	L1_EM22VHI	1.0
Counter:15 Rerun PS: None ver: 9							
Earlier stages							
step: 1							
EM22VHI → T2CaloEgamma / T2CaloEgamma_Ringer (ver:6) TrigL2CaloHypo / L2CaloHypo_g_nocut (ver:6)							
→ L2_g200_etcut_L1_EM22VHI_cal (ver:6) × 1							
explicit sequence							
step: 2							
L2_g200_etcut_L1_EM22VHI_cal → TrigL2PhotonFex / L2PhotonFex_1 (ver:5) TrigL2PhotonHypo / L2PhotonHypo_g300_EtCut (ver:3)							
→ L2_g300_etcut_L1_EM22VHI (ver:4) × 1							
explicit sequence							
step: 3							
L2_g300_etcut_L1_EM22VHI → TrigCaloCellMaker / TrigCaloCellMaker_eGamma (ver:10) TrigCaloTowerMaker / TrigCaloTowerMaker_eGamma (ver:5) TrigCaloClusterMaker / TrigCaloClusterMaker_slw (ver:7)							
→ EF_g300_etcut_L1_EM22VHI_cal (ver:6) × 1							
explicit sequence							
step: 4							
EF_g300_etcut_L1_EM22VHI_cal → TrigEFCaloCalibFex / TrigEFCaloCalibFex_Photon (ver:8) TrigEFCaloHypo / TrigEFCaloHypo_g300_EtCut (ver:2)							
→ EF_g300_etcut_L1_EM22VHI_calocalib (ver:3) × 1							
explicit sequence							
step: 5							
EF_g300_etcut_L1_EM22VHI_calocalib → TrigEGammaRec / TrigEGammaRec_NoIDEF_eGamma (ver:11) TrigEFPPhotonHypo / TrigEFPPhotonHypo_g300_EtCut (ver:3)							
→ EF_g300_etcut_L1_EM22VHI (ver:5) × 1							
explicit sequence							

CTPID:11 TT:0x84 ver: 9  
Logic: (1&2&3)  
1 × EM22VHI  
1 × BGRP0  
1 × BGRP1

# Run-query Webpage

- <https://atlas-runquery.cern.ch/>

## ATLAS Run Queries

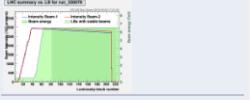
Current run Data Summary Trigger Configuration Query

**Run Search – Insert Your Query:** [ [cached link to this result page](#) ]

find run 330079 / show all

Show Runs

[ Default query condition ] [ Type 'f ... /show all' to see full info (except for DQ and trigger) ]

							LHC and online luminosity information					
Run	Links	#LB	Start and endtime (local)	#Events	Ready for physics	LHC Fill	Stable beams	Beam energy and intensities	Online del. Luminosity [ATLAS_PREFERRED]	Bunch structure		
330079 Period: C5,C AllYear	DS, RS, BS, AMI, DQ, ELOG, DCS:SoR/EoR, OKS	227 (56 s)	Wed Jul 19 2017 08:09:43 – 11:42:55	10,598,304 (828.5 Hz)	LB 1– 88: 0 LB 89–211: 1 LB 212–227: 0	LB 1–226: 5965 LB 227 : 5966	LB 1– 80: FALSE LB 81–221: TRUE LB 222–227: FALSE		Entire run: 9.853e+04 nb <sup>-1</sup> Stable beams: 9.769e+04 nb <sup>-1</sup> Maximum beam energy: 6499 GeV Peak lumi: 1.5e+04 e30 cm <sup>-2</sup> s <sup>-1</sup> Peak <μ>: 40.8 Approx. lifetime: 0.18 h	No. of coll. bunches: 2544 No. of bunch trains: 19 Bunch dist. in trains: 1 (25 ns)	[ Mouse over for train configuration. Click for full list of BCIDs ]	
Trigger information												
SMK			HLT Release	Prescale keys		Bunch group key	Data stream statistics					
2579 <a href="#">Physics_pp_v7 (v.71)</a> ATR-16675			21.1.8	LB range	L1	HLT	LB range	BGS	express_	debug_		
				1– 44: 15186   11219 45– 64: 15170   11219 65– 75: 15171   11219 76– 88: 15170   11219 89– 92: 15338   11308 93– 111: 15333   11303 112–126: 15332   11302 127–150: 15331   11301 151–211: 15330   11300 212–227: 15170   11219	1– 45:	1397	express	debug_HitTimeout				
				Prescale evolution...					113,087 (max: 18.85 Hz, ave: 16.25 Hz, 1.0%, 116.2 GB/run, 1.1 MB/evt)	1 (2.0 MB/run, 2.0 MB/evt [MON])		
									113,087 (116.2 GB)	1 (2.0 MB)		

# Resources and Help

- Trigger General Meeting (Wed, 14:00)
  - Main weekly trigger meeting [[Indico](#)]
- [Main Trigger Twiki](#)
  - [Trigger recommendations for analyses](#)
- Mailing lists
  - [atlas-trigger](#): Important announcements, meetings, etc.
  - [atlas-trigger-help](#): post any general trigger related questions
  - [atlas-trigger-operation](#): day-to-day trigger operations
  - [atlas-trigger-developers](#): technical questions regarding trigger development
  - + many more signature specific mailing lists (see our [TWiki](#))
- [ATR Jira tracker](#) to report any bugs

# Scale Factors & Efficiencies

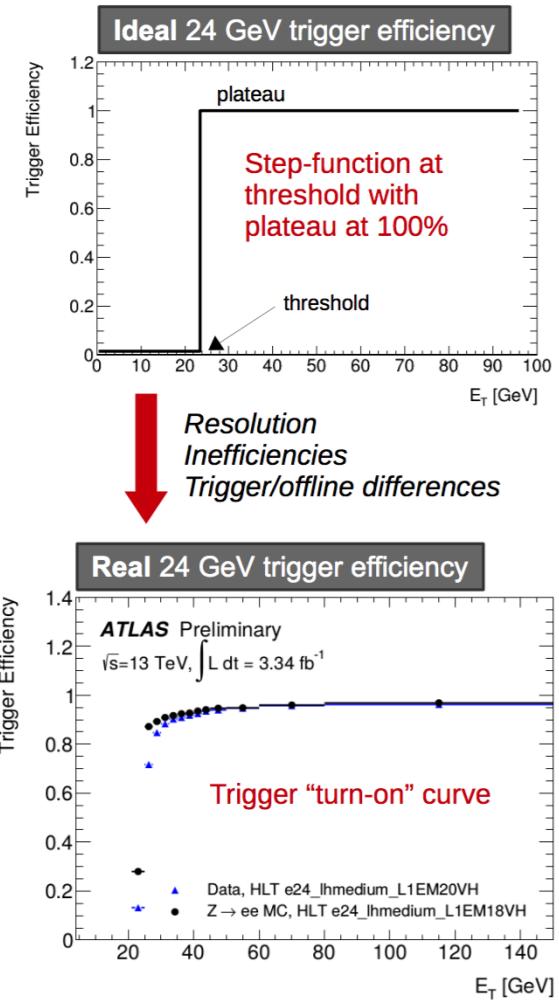
- Main Trigger Twiki
  - Trigger recommendations for analyses

# Monte Carlo & Scale Factors

- **Monte Carlo (MC)** samples are produced before data-taking starts
  - Contains **best-guess trigger menu** including backup triggers to emulate possible future triggers
  - **Differences between data & MC are unavoidable**
    - Changes in detector conditions
    - Improvements and/or bug-fixes in trigger code
    - New triggers, changes of trigger thresholds
- **Scale Factors (SF)**
  - **Correct MC to match data**
  - Provided by trigger signature groups as part of analysis release
  - Parameterized as needed in  $p_T$ ,  $\eta$ ,  $\Phi$
  - [Trigger twiki collecting SF recommendations](#)

# Efficiency

- **Efficiency for triggering/recording an event**
  - Using a trigger chain is essentially just another cut in the analysis event selection
  - Very important to measure efficiency for cross-section measurements, etc.
- **Trigger Efficiency usually measure w.r.t. offline reconstruction**
  - e.g. # triggered electrons vs # offline electrons
- Various methods possible
  - Tag & Probe: Trigger on particle form resonance and measure how often second particle (probe) passes trigger selection
  - Boot-strap: Use looser (prescaled) trigger to measure higher threshold trigger efficiency
  - Orthogonal trigger: Trigger on one physics signature, measure a different one
  - Simulation



# TrigGlobalEfficiencyCorrectionTool

- Tool to compute **event-level trigger scale factors** in events with **multiple leptons and/or logical Ors of several triggers**
- Uses as input the **trigger efficiencies and scale factors** measured per individual leptons and single trigger legs, provided by the egamma and muon trigger CP groups in the following packages
  - [AsgElectronEfficiencyCorrectionTool](#)
  - [MuonTriggerScaleFactors](#)
- Event-level efficiencies are computed with the fundamental assumption that trigger legs can be hierarchized so that a lepton firing a given leg also fires all looser legs
  - Hierarchy is based on online  $p_T$  thresholds and PID requirements, may vary with  $p_T$
- Twiki: <https://twiki.cern.ch/twiki/bin/viewauth/Atlas/TrigGlobalEfficiencyCorrectionTool>

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# Summary & References

# Summary

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- Trigger data is present in all kinds of formats throughout the production chain
- Unified access is provided mainly through the TrigDecisionTool
- Many other tools & webpages for finding information available
- In case you run into any problems, let us know via email ([atlas-trigger-help](#))!
  - Get in touch with your physics trigger liaison/signature experts in case of specific questions

# Collection of Material used

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- Oct 2014 Tutorial: <https://indico.cern.ch/event/329880/contributions/1718185/attachments/641560/882783/TriggerSWTutorialOct2014.pdf>
- May 2015 Tutorial: <https://indico.cern.ch/event/379324/contributions/1804277/attachments/756747/1038100/SoftwareTutorialTrigger.pdf>
- Trigger Workshop introduction: <https://indico.cern.ch/event/558579/contributions/2253609/attachments/1359832/2058795/20161025-TriggerWorkshop-Intro.pdf>

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# Backup

# Streams & Debug Streams

## Streams

### physics\_Main

- Single stream used for most physics analysis
  - Other small physics streams exist: MinBias (special runs), ZeroBias, cosmics, standby, Late (for searches), L1Calo (HW performance studies), etc.
- In Run-1 we had 3 separate streams: Muons, JetTauEtMiss, Egamma

### Express stream

- ~20Hz subset of physics\_Main used for calibration loop

### Delayed stream

- dedicated set of physics events for later reconstruction

### Calibration streams

- For detector calibrations

### Data Scouting

- Events containing only the HLT objects
- Used for Trigger-Level Analysis

### Debug streams

- Events that could not be processed at the HLT

Frank Winklmeier • Trigger for Physics Workshop • In

## Debug streams

### Possible problems during data-taking

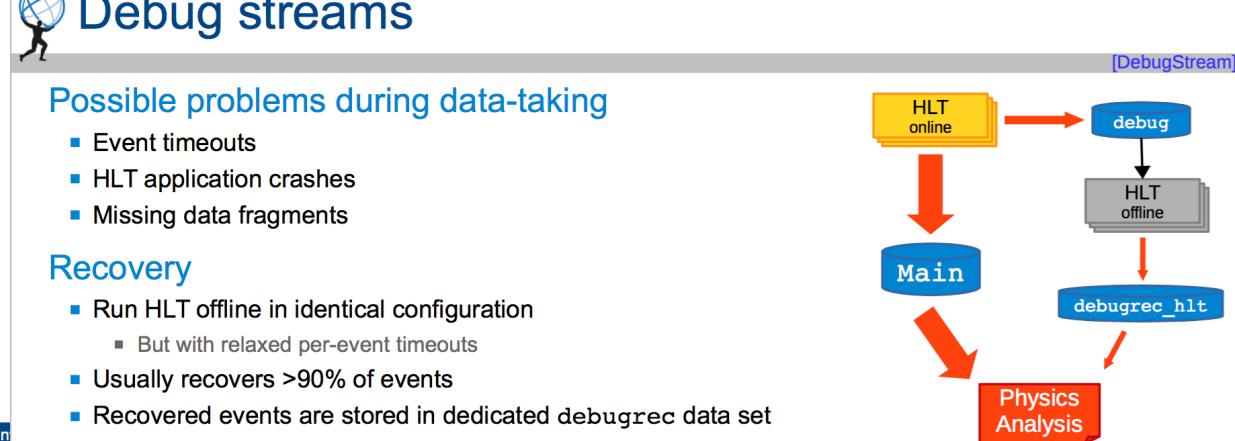
- Event timeouts
- HLT application crashes
- Missing data fragments

### Recovery

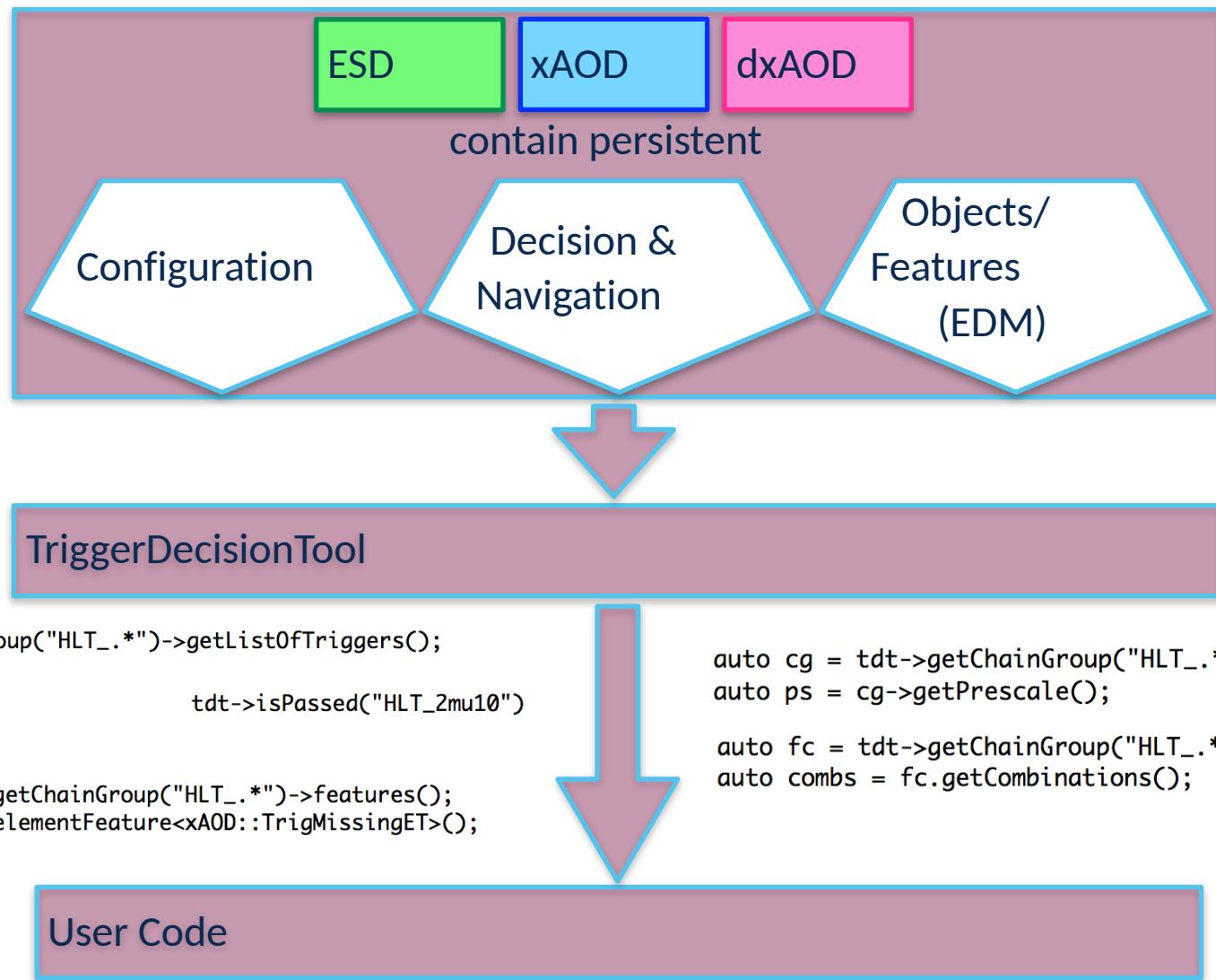
- Run HLT offline in identical configuration
  - But with relaxed per-event timeouts
- Usually recovers >90% of events
- Recovered events are stored in dedicated debugrec data set

### Physics analysis

- all analyses have to process the debug stream
  - 1) applying the trigger selections as typically done for the Main stream (default approach)
  - 2) without applying any trigger selection requirements
- Differences in the two approaches should derive from trigger turn-on effects.
- If any significant difference is observed, the trigger coordinators should be contacted!



# TrigDecisionTool



# TrigDecisionTool - Bringing it all together

