

Trigger Systems

TEAM PRESENTATION



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Student



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Structure

**Trigger
Systems**



**Trigger
API**



**Our contribution
&
Gained Experience**

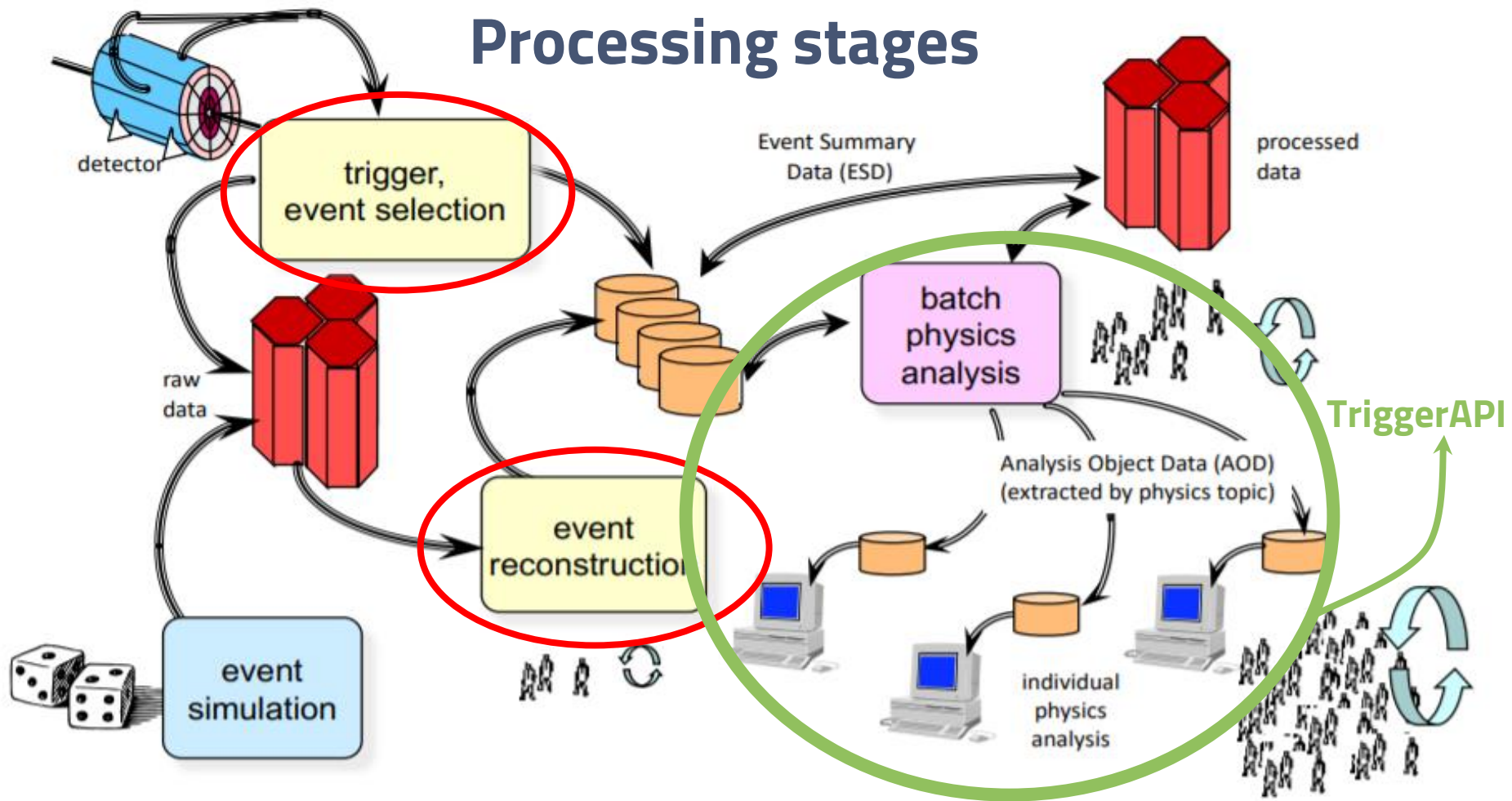
- How many collisions are taking place per second - LHC?
 - Approx. 4×10^7 collisions/second
- How much data does 1 event have?
 - 1 MB

$$4 \times 10^7 \text{ collisions/s} \times 1 \text{ Mbyte/collision} = 4 \times 10^{14} \text{ bytes/s}$$

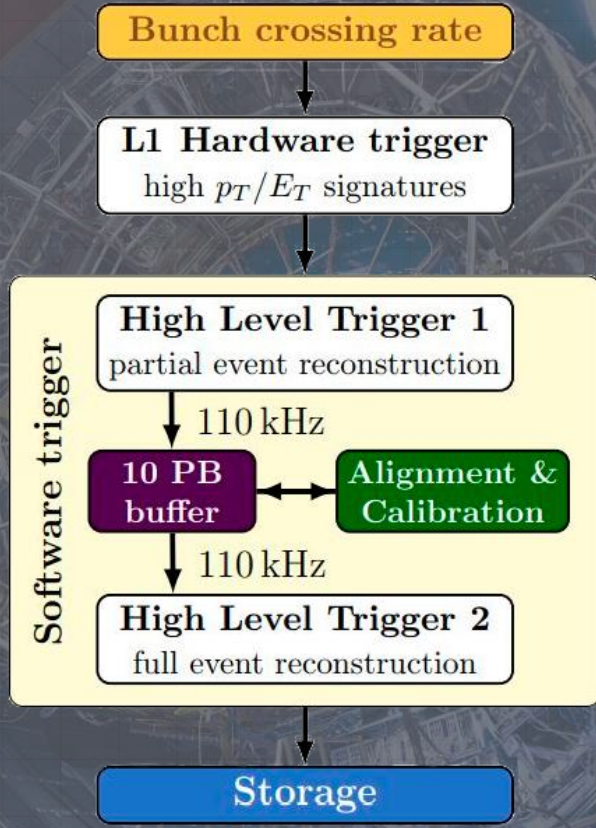
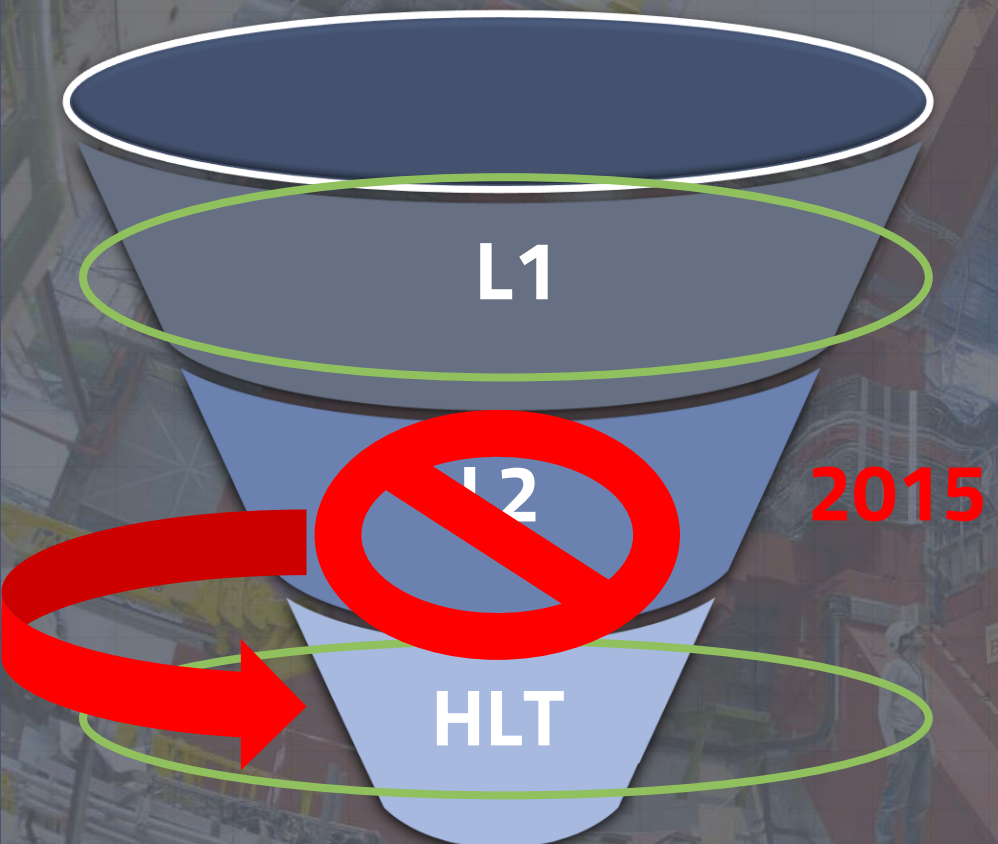
$$= 400 \text{ TB/s}$$

Available storage – 100Pb

Processing stages

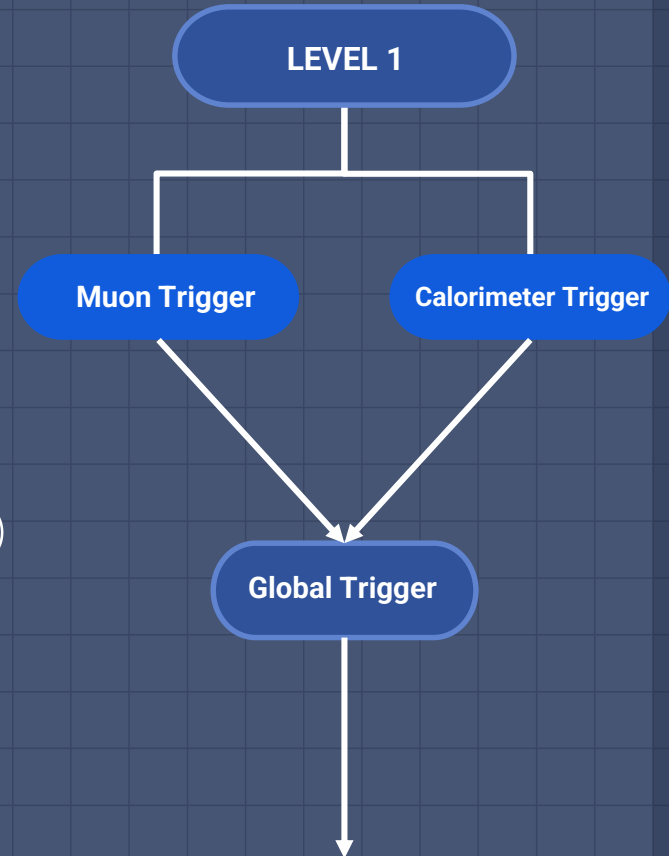


Trigger systems



Trigger Level 1

- Based on hardwired processors (ASIC, FPGA, ...)
- Enough buffer for 100 collisions
- Accepts max. 100kHz collision rate
- 2.5 μ s maximum decision time
- Minimal reconstruction - energy in calorimeter, muon spectrometer
- Reconstructs physics objects

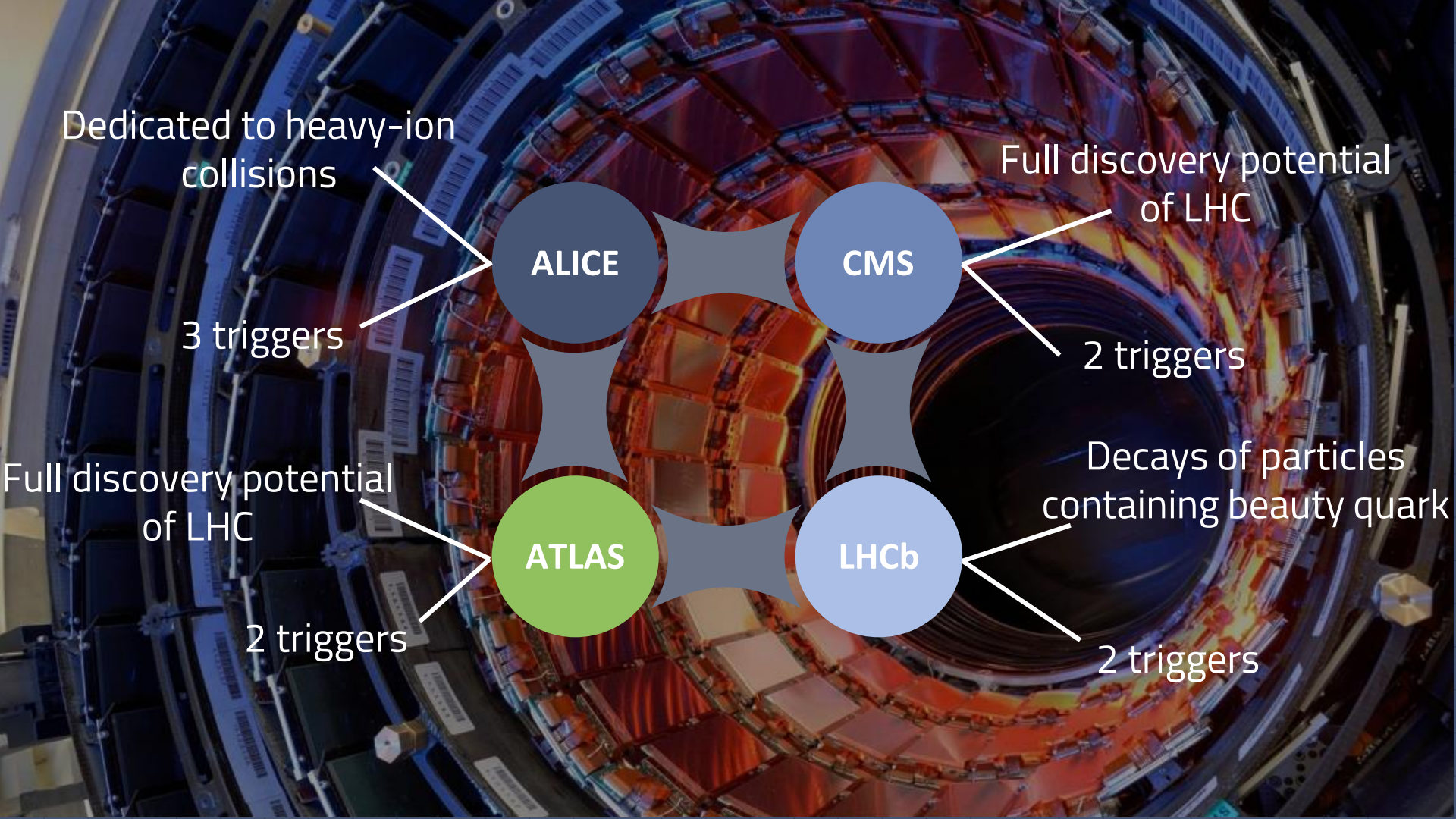


High Level Trigger

- Software-based
- Runs on 40.000 computers
- Reads and reconstructs L1 events
- Decides which to store
- Accepts max 1kHz event rate

Decision: Trigger Menu –
Defined criteria





Dedicated to heavy-ion collisions

ALICE

CMS

Full discovery potential of LHC

3 triggers

2 triggers

Full discovery potential of LHC

ATLAS

LHCb

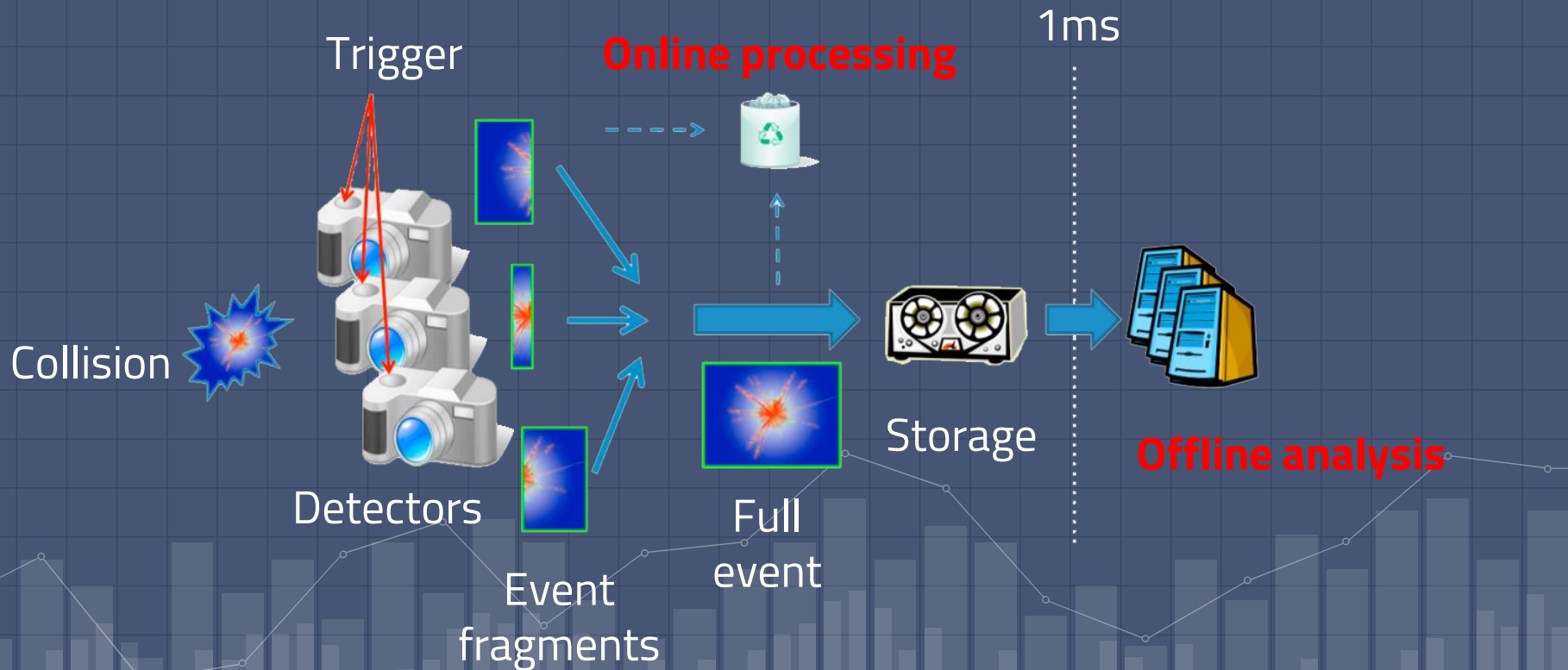
Decays of particles containing beauty quark

2 triggers

2 triggers

Data processing

10^6 - 10^8 sec



TriggerAPI

- Tool to retrieve information about triggers and prescales
- Offline analysis
- Part of athena framework - reconstruction of collisions
- Database storage
- Objects for categorization: type of particle, energy, period

Necessary knowledge

```

MINGW32-~/git
welcome to Git (version 1.8.3-preview20130601)

Run 'git help git' to display the help index.
Run 'git help <command>' to display help for specific commands.

Bacon@BACON ~
$ git clone https://github.com/msysgit/git.git
Cloning into 'git'...
remote: Counting objects: 177468, done.
remote: Compressing objects: 100% (52057/52057), done.
remote: Total 177468 (delta 133396), reused 166093 (delta 123576)
Receiving objects: 100% (177468/177468), 42.16 MiB | 1.84 MiB/s, done.
Resolving deltas: 100% (133396/133396), done.
Checking out files: 100% (2576/2576), done.

Bacon@BACON ~
$ cd git

Bacon@BACON ~/git (master)
$ git status
# On branch master
nothing to commit, working directory clean

Bacon@BACON ~/git (master)
$

```



```

bborcoma@lxplus774:~/work/athena/Trigger/TriggerCommon/TriggerMenuMT/python/Tr...
File Edit Options Buffers Tools Python Help
Copyright (C) 2002-2021 CERN for the benefit of the ATLAS collaboration

__author__ = 'Javier Montejo'
__version__ = "$Revision: 2.0 $"
__doc__ = "Class containing all the information of an HLT chain"

import re
from TriggerMenuMT.TriggerAPI.TriggerEnums import TriggerType, TriggerPeriod
from collections import Counter
import six
from AthenaCommon.Logging import logging
log = logging.getLogger(__name__)

class TriggerInfo:
    ''' Object containing all the HLT information related to a given period.
        Stores a list of TriggerChain objects and the functions to skim them
        ...
    def __init__(self, period=0, customGRL=None, release=None):
        self.triggerChains = []
        self.period = period
        self.totalLB = 0

--UU:---F1 TriggerInfo.py Top L1 Git-master triggerAPI development (Pyth
Loading vc-git...done

```

Our TriggerAPI journey

Comparison of gluino masses

**Switching type
Flag -Enums**

**Listing muons
unprescaled triggers -
2018 - heavy ions**

Inclusion of heavy-ions

Data Analysis – gluino masses

```
bborcoma@lxplus738:~/work/project
File Edit Options Buffers Tools Python Help
import json

with open('/afs/cern.ch/user/j/jmontejo/public/HSSIP/combinedCLs_RPV1L_GG_rpvHF.json') as json_file:
    data = json.load(json_file)
    #print("Type:", type(data))
    #print(data)

#print(data['GG_rpvHF_1700_200_br50']['mgluino'])

experiments=len(data)

mmaxforlife = {
}

for exp in data:
    #get all existing life values
    mmaxforlife[data[exp]['loglifetime']]=-1

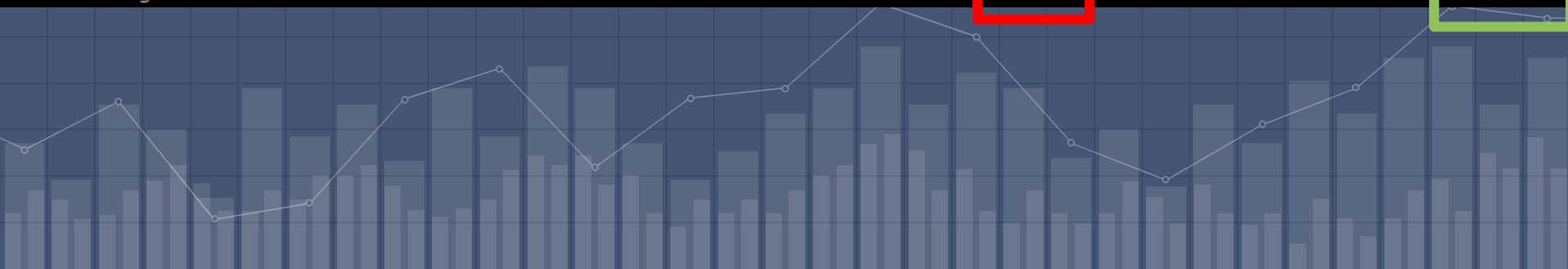
for exp in data:
    #working on experiment exp with traits loglifetime, mgluino and CLs
    #if CLs is low enough, check for a new maximum mass on this lifetime
    if data[exp]['CLs']<=0.05 :
        #the mass is a string for some reason, so i must convert to int before using max
        mmaxforlife[data[exp]['loglifetime']]=max(int(data[exp]['mgluino']), mmaxforlife[data[exp]['loglifetime']])

lifevals=len(mmaxforlife)

for life in mmaxforlife:
    #print all the maximum mass values (except for the init)
    if life!=1000000:
        print("For the gluino with a CLs value under 0.5 and a lifetime of: " + str(life) + " the maximum mass value is " + str(mmaxforlife[life]) )
```


Results

```
For the gluino with a CLs value under 0.5 and a lifetime of: -2.0 the maximum mass value is 1500
For the gluino with a CLs value under 0.5 and a lifetime of: 7 the maximum mass value is 1700
For the gluino with a CLs value under 0.5 and a lifetime of: 4 the maximum mass value is 2000
For the gluino with a CLs value under 0.5 and a lifetime of: 5 the maximum mass value is 2000
For the gluino with a CLs value under 0.5 and a lifetime of: 6 the maximum mass value is 1900
For the gluino with a CLs value under 0.5 and a lifetime of: -10 the maximum mass value is 1500
For the gluino with a CLs value under 0.5 and a lifetime of: 1.0 the maximum mass value is 2000
For the gluino with a CLs value under 0.5 and a lifetime of: -1.0 the maximum mass value is 1700
For the gluino with a CLs value under 0.5 and a lifetime of: 2.0 the maximum mass value is 2000
For the gluino with a CLs value under 0.5 and a lifetime of: -0.0 the maximum mass value is 1900
For the gluino with a CLs value under 0.5 and a lifetime of: 3 the maximum mass value is 2000
```



Unprescaled muons triggers – 2018 – Heavy Ions

Python script for Heavy Ions

```
File Edit Options Buffers Tools Python Help
from TriggerMenuMT.TriggerAPI.TriggerAPI import TriggerAPI
from TriggerMenuMT.TriggerAPI.TriggerEnums import TriggerPeriod, TriggerType

x =TriggerAPI.getLowestUnprescaled(TriggerPeriod.y2018, TriggerType.mu)
print(x)
```

Unprescaled
Triggers

Period - 2018

Muon Triggers

Results

File Edit Options Buffers Tools Help

```
[  
  'HLT_3mu6',  
  'HLT_mu20_ivarmedium_mu8noL1',  
  'HLT_3mu6_msonly',  
  'HLT_mu22_mu8noL1',  
  'HLT_mu13_mu13_idperf_Zmumu',  
  'HLT_mu6_dRl1_mu20_msonly_iloosems_mu6noL1_dRl1_msonly',  
  'HLT_4mu4',  
  'HLT_2mu14',  
  'HLT_mu20_2mu4noL1',  
  'HLT_mu60_0eta105_msonly',  
  'HLT_mu80_msonly_3layersEC',  
  'HLT_mu26_ivarmedium',  
  'HLT_mu50'  
]
```

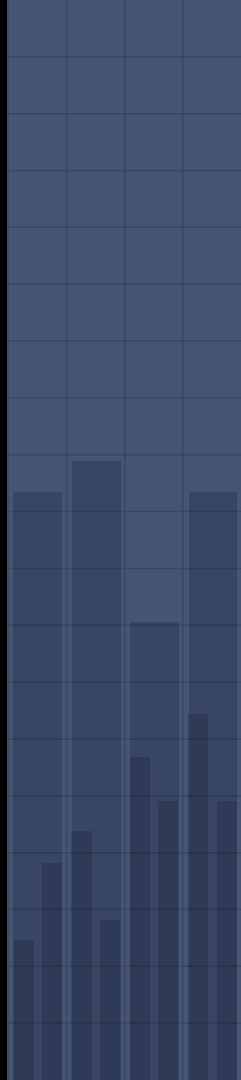
Expanding the functionality of TriggerAPI

- Switched Trigger Types and Periods to type Flag
- Included heavy ion run data in the API's library

```
class TriggerType(IntFlag):
    el_single = auto()
    el_multi = auto()
    mu_single = auto()
    mu_multi = auto()
    j_single = auto()
    j_multi = auto()
    bj_single = auto()
    bj_multi = auto()
    tau_single = auto()
    tau_multi = auto()
    g_single = auto()
    g_multi = auto()
    xe = auto()
    ht = auto()
    mu_bphys = auto()
    exotics = auto()
    afp = auto()
    upc = auto()
    ucc = auto()
    minbias = auto()

    el = el_single | el_multi
    mu = mu_single | mu_multi
    j = j_single | j_multi
    bj = bj_single | bj_multi
    tau = tau_single | tau_multi
    g = g_single | g_multi
```

```
grlbase = "/cvmfs/atlas.cern.ch/repo/sw/database/GroupData/GoodRunsLists/"
y2018grlpath = grlbase+"data18_13TeV/20181105/data18_13TeV.periodAllYear_DetStatus-v102-\
pro22-04_Unknown_PHYS_StandardGRL_All_Good_25ns_TriggerNo17e33prim.xml"
y2017grlpath = grlbase+"data17_13TeV/20180619/data17_13TeV.periodAllYear_DetStatus-v99-p\
ro22-01_Unknown_PHYS_StandardGRL_All_Good_25ns_TriggerNo17e33prim.xml"
y2016grlpath = grlbase+"data16_13TeV/20180129/data16_13TeV.periodAllYear_DetStatus-v89-p\
ro21-01_DQDefects-00-02-04_PHYS_StandardGRL_All_Good_25ns.xml"
y2015grlpath = grlbase+"data15_13TeV/20170619/data15_13TeV.periodAllYear_DetStatus-v89-p\
ro21-02_Unknown_PHYS_StandardGRL_All_Good_25ns.xml"
y2017lowmugrlpath = grlbase+"data17_13TeV/20180117/data17_13TeV.periodN_DetStatus-v98-pr\
o21-16_Unknown_PHYS_StandardGRL_All_Good_25ns_ignore_GLOBAL_LOWMU.xml"
y2018lowmugrlpath = grlbase+"data18_13TeV/20180830/data18_13TeV.periodG4J_MERGED_PHYS_St\
andardGRL_All_Good_25ns_ignore_GLOBAL_LOWMU.xml"
y2015_HI_PbPb_path = grlbase+"data15_hi/20190708/data15_hi.periodAllYear_DetStatus-v105-\
pro22-13_Unknown_PHYS_HeavyIonP_All_Good_tolerable_L1CALmisconfigSatBCID.xml"
y2016_5TeV_pPb_path = grlbase+"data16_hip/20190708/data16_hip5TeV.periodAllYear_DetStatu\
s-v105-pro22-13_Unknown_PHYS_HeavyIonP_All_Good.xml"
y2016_8TeV_pPb_path = grlbase+"data16_hip/20190708/data16_hip8TeV.periodAllYear_DetStatu\
s-v105-pro22-13_Unknown_PHYS_HeavyIonP_All_Good.xml"
y2017_HI_XeXe_path = grlbase+"data17_hi/20190706/data17_hi.periodAllYear_DetStatus-v105-\
pro22-13_Unknown_PHYS_StandardGRL_All_Good.xml"
y2018_HI_PbPb_path = grlbase+"data18_hi/20190731/data18_hi.periodAllYear_DetStatus-v106-\
pro22-14_Unknown_PHYS_HeavyIonP_All_Good.xml"
```

Results

```
Bjet combined items: ['HLT_2j25_gsc45_bmv2c1070_split_xe80_mht_L12J15_XE55', 'HLT_3j15_gsc35_bmv2c1077_split_xe60_mht_L13J15.0ETA25_XE40', 'HLT_j35_gsc55_bmv2c1050_split_ht700_L1HT190-J15s5.ETA21', 'HLT_j60_gsc100_bmv2c1050_split_xe80_mht_L1XE60', 'HLT_j80_bmv2c1050_split_xe60_L12J50_XE40', 'HLT_2j35_gsc55_bmv2c1050_split_ht300_L1HT190-J15s5.ETA21']
Ele combined items: ['HLT_e70_lhloose_nod0_xe70noL1', 'HLT_e5_lhmedium_nod0_mu4_j30_xe65_pufit_2dphi10_L1MU4_XE60', 'HLT_e5_lhvloose_nod0_mu4_j30_xe40_pufit_2dphi10_L1MU4_J30_XE40_DPFI-J20s2XE30', 'HLT_2e12_lhloose_nod0_mu10', 'HLT_mu20_mu8noL1_e9_lhvloose_nod0', 'HLT_mu20_mu8noL1_e9_lhvloose_nod0_L1EM7_MU20', 'HLT_e12_lhloose_nod0_2mul0', 'HLT_2e5_lhvloose_nod0_j40_xe70_pufit_2dphi10_L1XE60', 'HLT_2e5_lhvloose_nod0_j40_xe70_pufit_2dphi10_L1J40_XE50_DPFI-J20s2XE50', 'HLT_e17_lhmedium_nod0_ivarloose_tau25_medium1_tracktwo_L1DR-EM15TAU12I-J25', 'HLT_e17_lhmedium_nod0_ivarloose_tau25_medium1_tracktwo_L1EM15VHI_2TAU12IM_4J12', 'HLT_e17_lhmedium_nod0_ivarloose_tau25_medium1_tracktwo', 'HLT_e24_lhmedium_nod0_ivarloose_tau35_medium1_tracktwo', 'HLT_e5_lhloose_nod0_j50_xe70_pufit_2dphi10_L1J40_XE50_DPFI-J20s2XE50', 'HLT_e60_etcut_trkcut_L1EM24VHIM_xs30_j15_perf_xe30_6dphi15_mt35', 'HLT_e60_etcut_trkcut_L1EM24VHIM_j15_perf_xe60_6dphi15_mt35', 'HLT_e5_lhloose_nod0_j40_xe70_pufit_2dphi10_L1XE60', 'HLT_e24_lhmedium_nod0_L1EM20VH_g25_medium', 'HLT_e25_mergedtight_g35_medium_Heg', 'HLT_e25_mergedtight_ivarloose_g35_medium_icalovloose_Heg', 'HLT_e28_lhtight_nod0_ivarloose_j150_boffperf_split_j35_boffperf_split', 'HLT_e28_lhtight_nod0_ivarloose_j150_boffperf_j35_boffperf', 'HLT_e20_lhtight_nod0_ivarloose_3j20_L1EM18VHI_3J20', 'HLT_e28_lhtight_nod0_ivarloose_j110_gsc150_boffperf_split_j15_gsc35_boffperf_split', 'HLT_e26_lhmedium_nod0_mu8noL1', 'HLT_e17_lhloose_nod0_mu14', 'HLT_e7_lhmedium_nod0_mu24', 'HLT_e28_lhmedium_nod0_L1EM24VHI_mu8noL1_2j35_boffperf_split', 'HLT_e28_lhmedium_nod0_L1EM24VHI_mu8noL1_2j15_gsc35_boffperf_split', 'HLT_e28_lhmedium_nod0_L1EM24VHI_mu8noL1_2j35_boffperf', 'HLT_e17_lhmedium_nod0_tau25_medium1_tracktwo_xe50', 'HLT_e17_lhmedium_nod0_ivarloose_tau25_medium1_tracktwo_xe50', 'HLT_2e24_lhvloose_nod0_2j15_gsc35_boffperf_split', 'HLT_2e24_lhvloose_nod0_2j35_boffperf', 'HLT_2e24_lhvloose_nod0_2j35_boffperf_split', 'HLT_e24_lhmedium_nod0_2g12_loose']
Lowest in at least one period: ['HLT_3j50_gsc65_bmv2c1077_split_L13J35.0ETA23', 'HLT_4j15_gsc35_bmv2c2085_split_L14J15.0ETA25', 'HLT_2j15_gsc35_bmv2c1070_split_2j15_gsc35_bmv2c1085_split_L14J15.0ETA25', 'HLT_j150_gsc175_bmv2c1070_split_j45_gsc60_bmv2c1070_split', 'HLT_3j50_gsc65_bmv2c2077_split_L13J35.0ETA23', 'HLT_j150_gsc175_bmv2c2060_split_j45_gsc60_bmv2c2060_split', 'HLT_j150_gsc175_bmv2c1060_split_j45_gsc60_bmv2c1060_split', 'HLT_4j15_gsc35_bmv2c1077_split_L14J15.0ETA25']
Lowest j225_gsc with 100% data: ['HLT_j225_gsc420_boffperf_split']
Lowest j225_gsc with 95% data: ['HLT_j225_gsc400_boffperf_split']
Muon+jet+met items: ['HLT_mu4_j90_xe90_pufit_2dphi10_L1MU4_XE60', 'HLT_mu4_j90_xe90_pufit_2dphi10_L1MU4_J50_XE50_DPFI-J20s2XE30', 'HLT_2mu4_invml_j20_xe40_pufit_2dphi10_L12MU4_J20_XE30_DPFI-J20s2XE30', 'HLT_2mu4_invml_j20_xe60_pufit_2dphi10_L12MU4_J40_XE50']
Single muon lowest-unprescaled 2.0e34 items: ['HLT_mu26_ivarmedium_L1MU14FCH', 'HLT_mu50_L1MU14FCH', 'HLT_mu60_0eta105_msonly_L1MU14FCH', 'HLT_mu80_msonly_3layersEC_L1MU14FCH', 'HLT_mu24_LRT_d0loose_L1MU14FCH', 'HLT_mu20_L1MU5VF']
Single muon unprescaled 2.0e34 items: ['HLT_mu26_ivarmedium_L1MU14FCH', 'HLT_mu28_ivarmedium_L1MU14FCH', 'HLT_mu50_L1MU14FCH', 'HLT_mu60_0eta105_msonly_L1MU14FCH', 'HLT_mu60_L1MU14FCH', 'HLT_mu80_L1MU14FCH', 'HLT_mu80_msonly_3layersEC_L1MU14FCH', 'HLT_mu24_LRT_d0loose_L1MU14FCH', 'HLT_mu24_LRT_d0tight_L1MU14FCH', 'HLT_mu20_L1MU5VF']
```



Thank you for your
attention!