Simulation and Configuration of the ATLAS Level-1 Trigger

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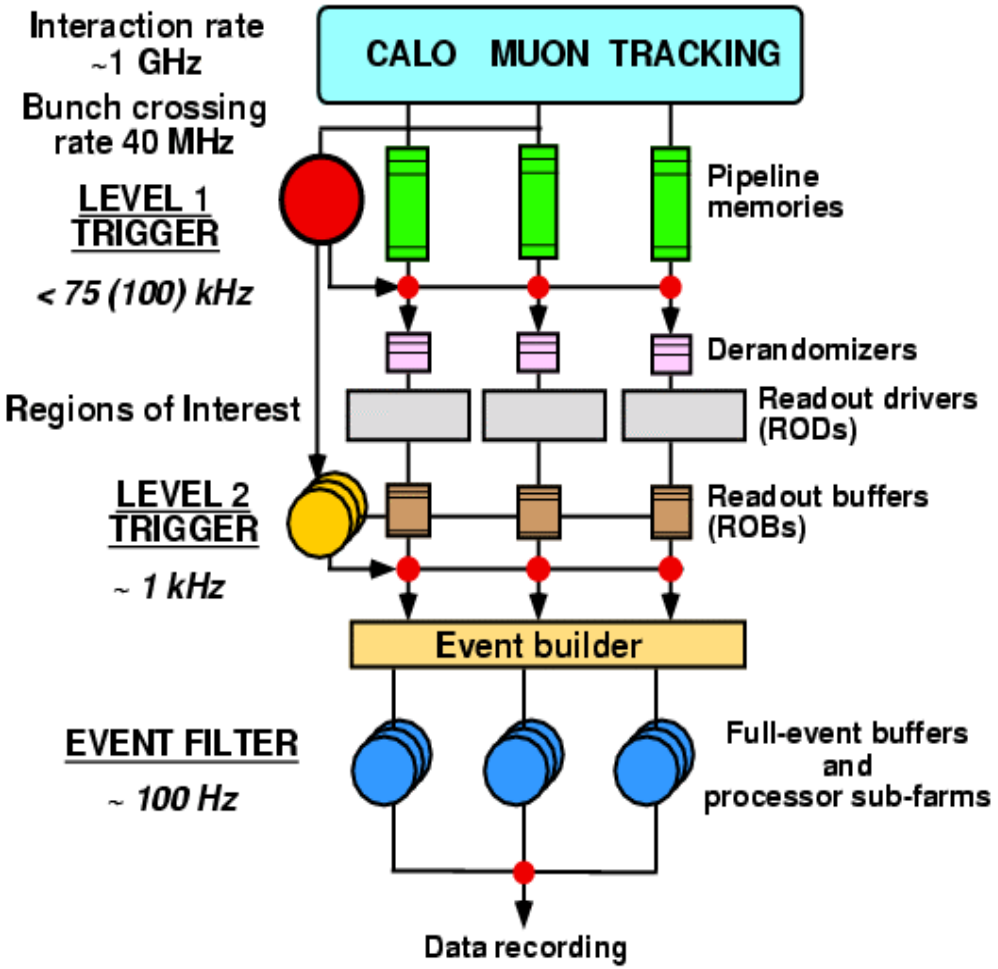
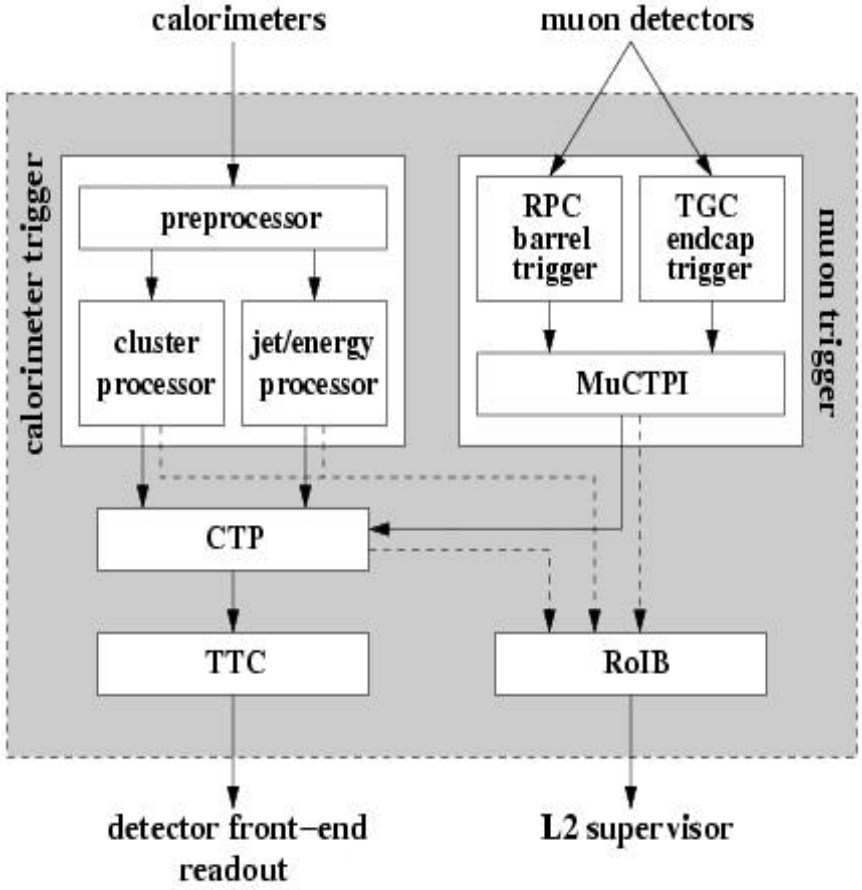
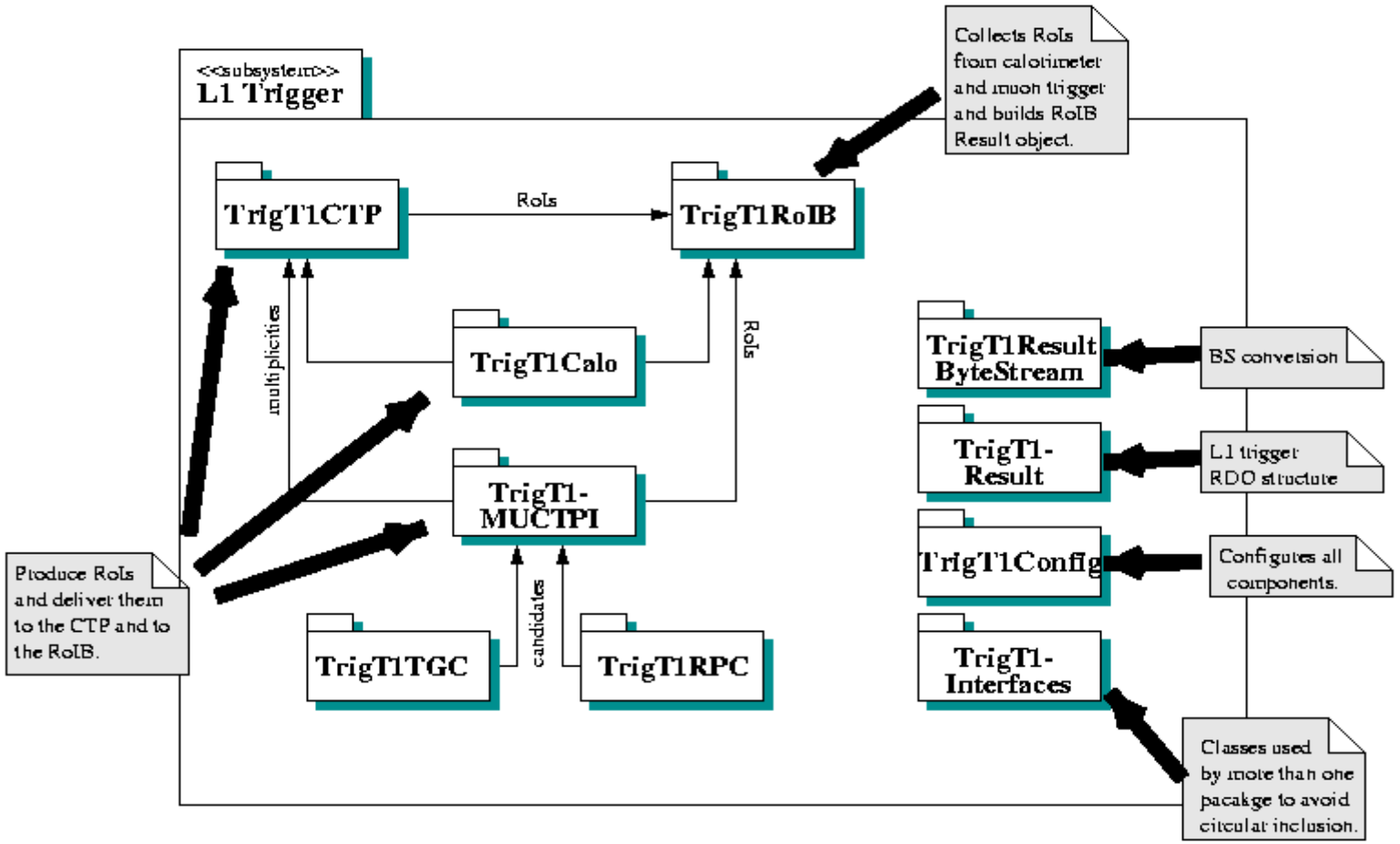
Calorimeter Trigger Meeting
Birmingham, 6-9 November 2002

The ATLAS (L1) Trigger



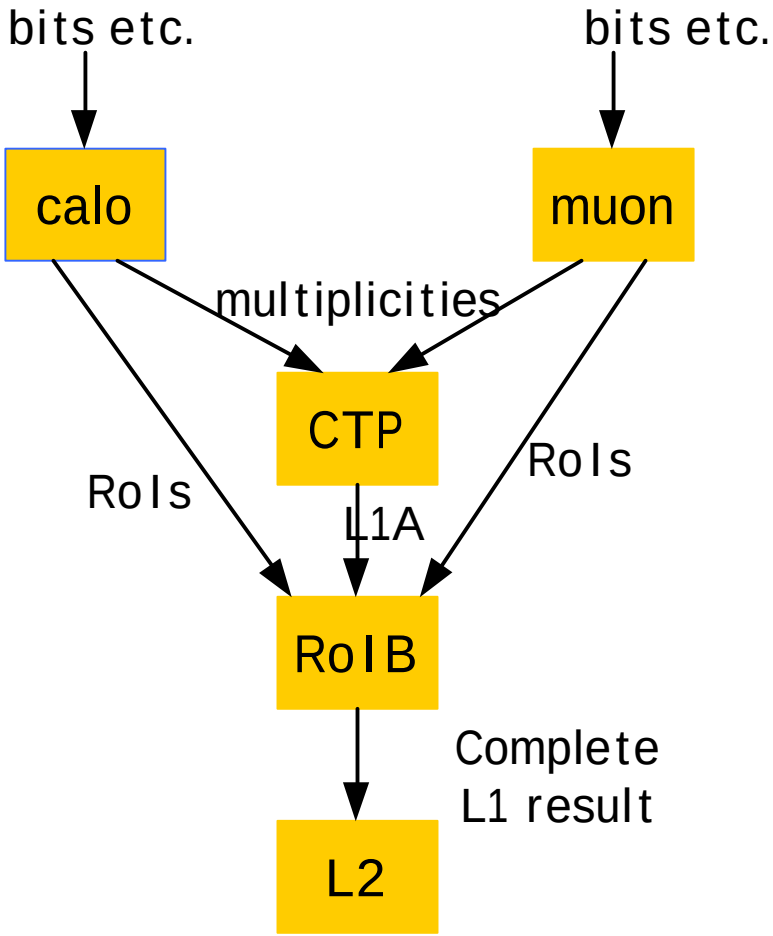


Simulation and Configuration



All data formats and interfaces defined in ATL-DA-ES-029 (TW/TSS).

Overview on Simulation



- Calo/muon triggers calculate
  - Multiplicites of candidate objects for required thresholds.
  - RoIs.
- CTP
  - Discriminates delivered multiplicities against conditions
  - Combines conditions to items
  - Calculates L1A ('OR' of items)
  - Creates CTP RoI fragment
- RoIB
  - Collects RoI information and concatenates it.

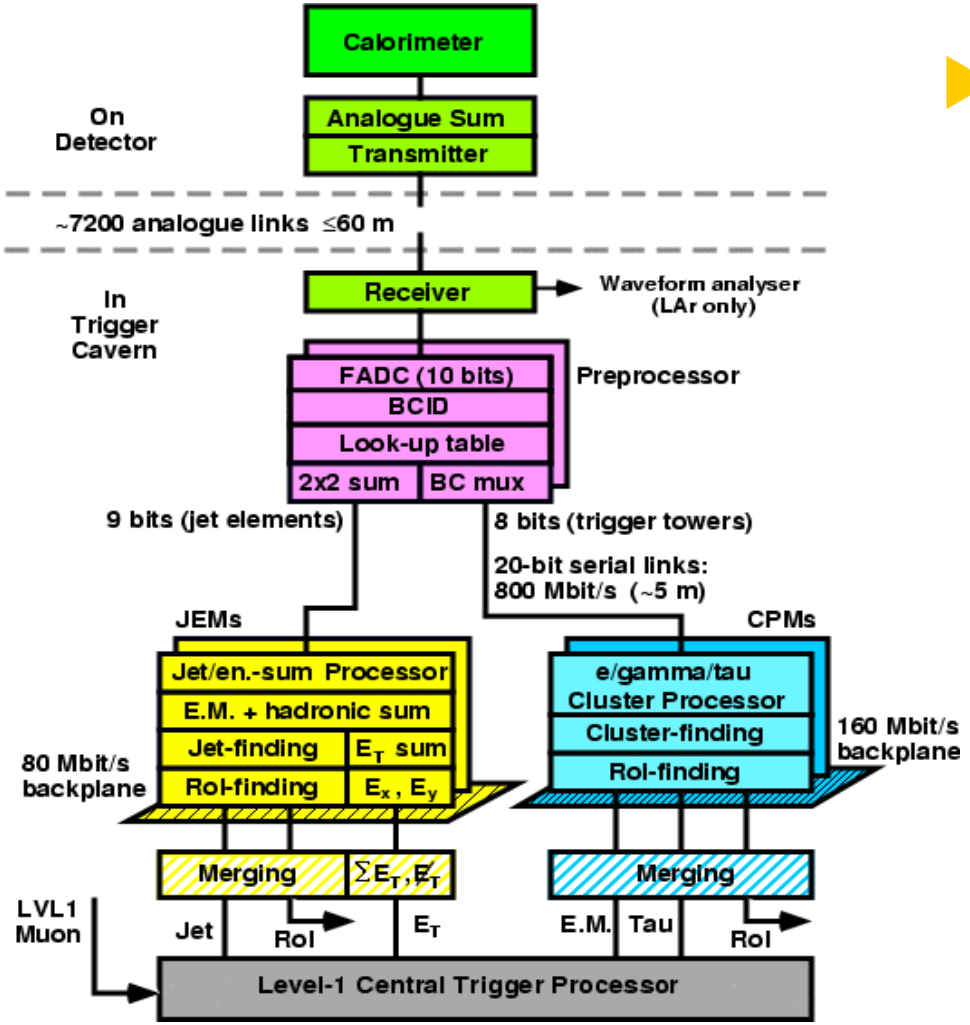
Framework: ATHENA.

See ATL-COM-DAQ-2002-021.

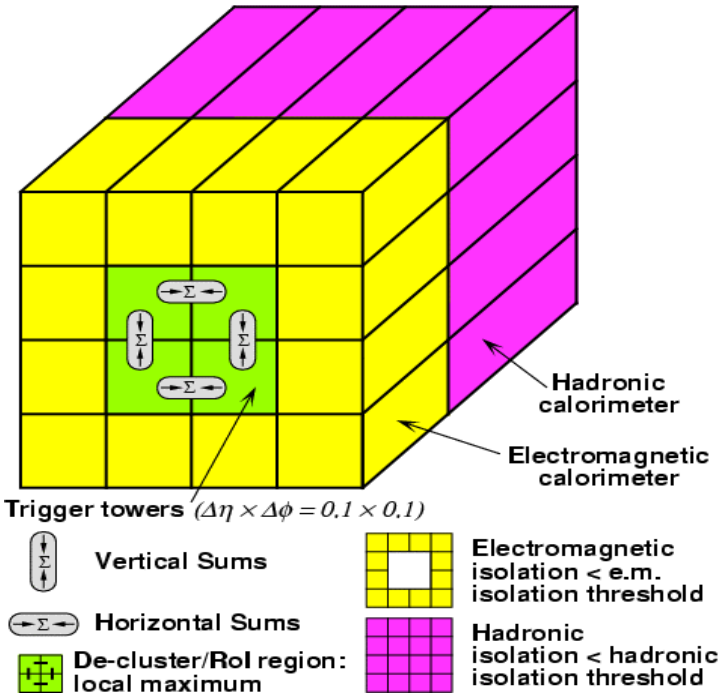
Simulation Result

EM/τ slink 1
EM/τ slink 2
EM/τ slink 3
EM/τ slink 4
JET/E slink 1
JET/E slink 2
Muon slink
CTP slink

The Calorimeter Trigger



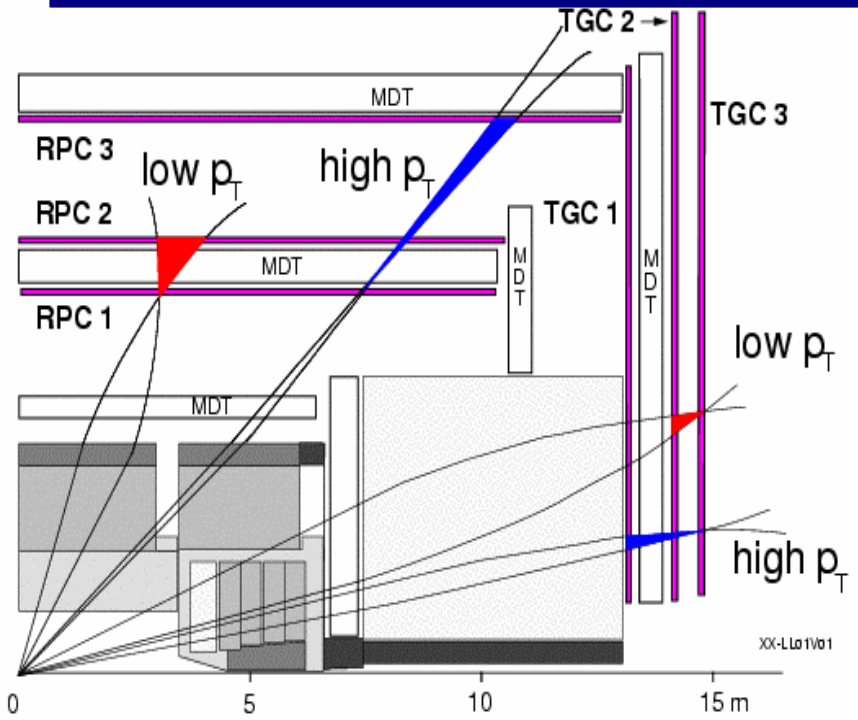
- 7200 trigger towers with 0.1*0.1 granularity (analogue sums of cells in EM/HA)

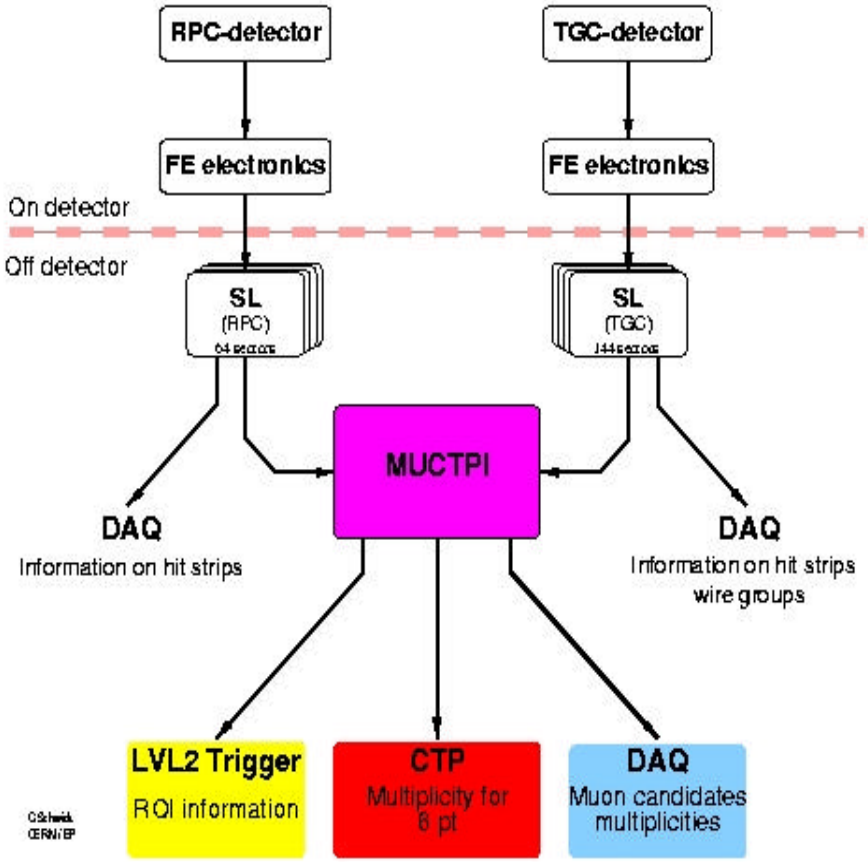


Calorimeter Trigger Simulation

See Ed's talk today!

The Muon Trigger (Chambers)





- Muon candidates from hit coincidences in successive chamber layers over 2/3 stations for low/high p_T. BCID (σ=1.5ns).

Muon Trigger Simulation: RPC and TGC

RPC

Detailed (L. Nisati) and fast simulation (A. DiMattia):

- Technical problems (coincidence matrix, cabling model). Hope to be ready with all details by end of year.
- Very soon something in CVS.

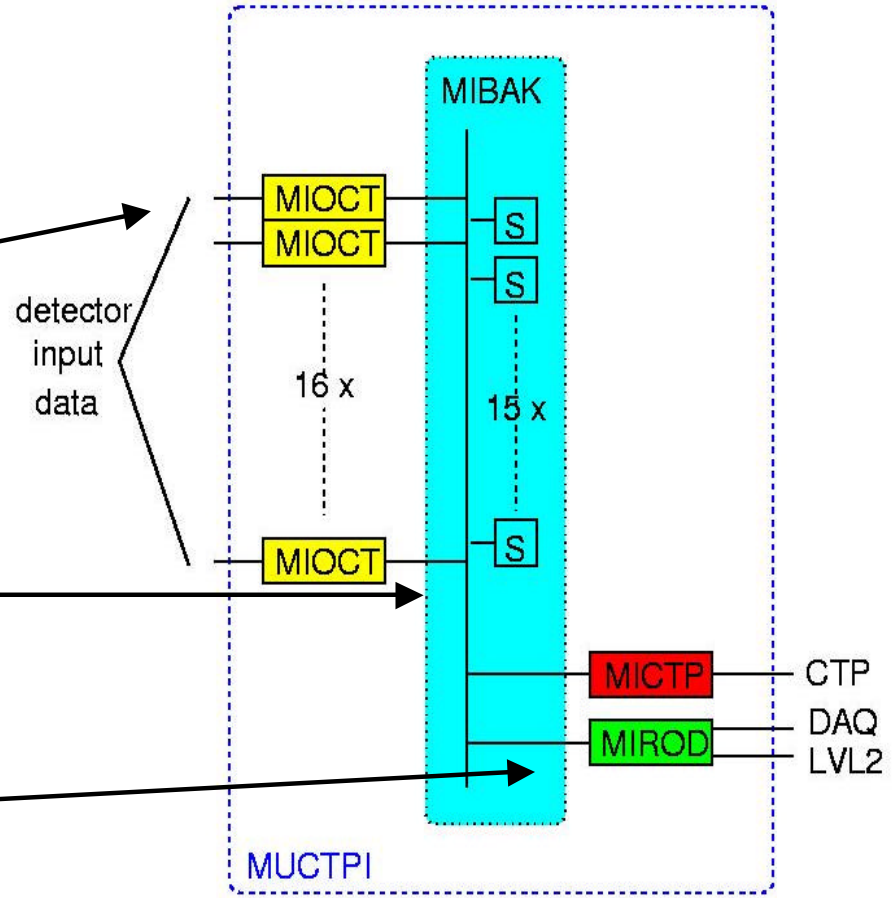
TGC

Up to now standalone C++ (H. Kurashige)

- Closely hardware-oriented, very detailed.
- Includes hit pattern generator ('digitizer', should be part of detector simulation)
- ATHENA-integration in progress (M. Ishino), currently learning to use L1 config scheme.

The MUCTPI

- Collects data from RPC and TGC chambers.
- 16 MIOCTs handle overlaps in barrel/between barrel and endcap.
- MIBAK builds CTP multiplicities for 6 p_T thresholds (sums over 16 MIOCTs).
- Sends RoIs to DAQ and RoIB.



Muon Trigger Simulation: MUCTPI

Content

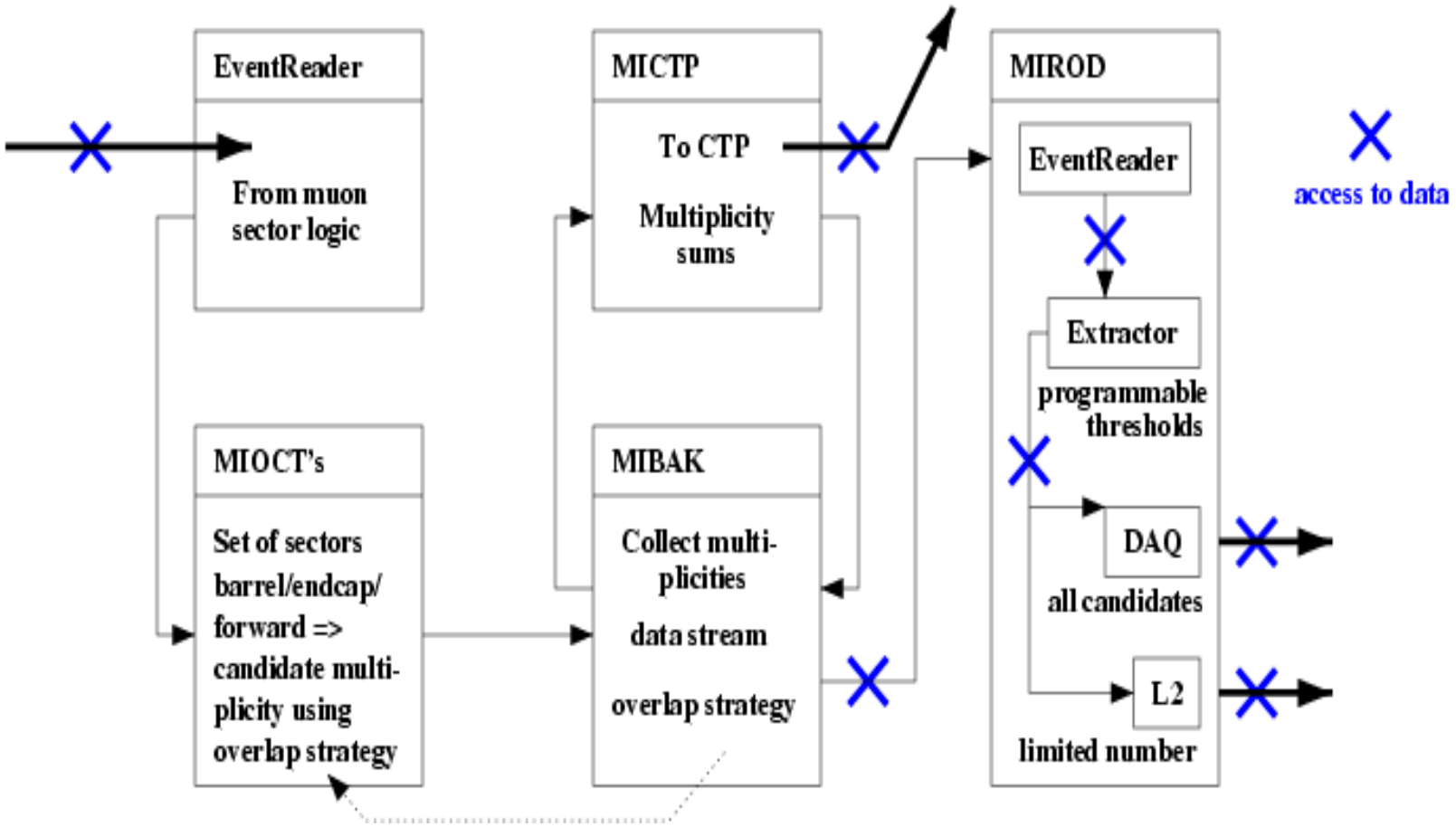
Detailed and flexible simulation

- Data flow as in hardware, many access points.
- Accomodates different overlap strategies, zero suppresion modes, event sources.
- Contains test pattern generator.
- Combined with hardware test library, now used for detailed hardware tests. Tests of using Run Control.

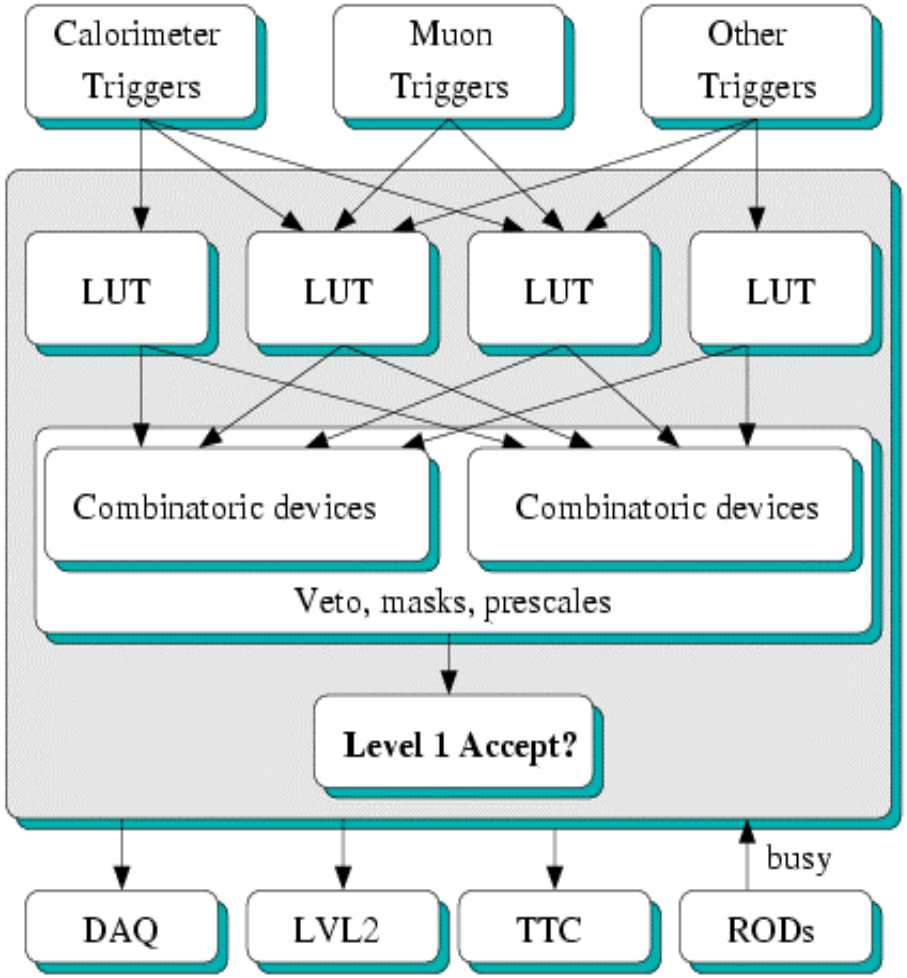
Status

ATHENA integration in progress, first combination with TGC simulation soon.

Muon Trigger Simulation: MUCTPI



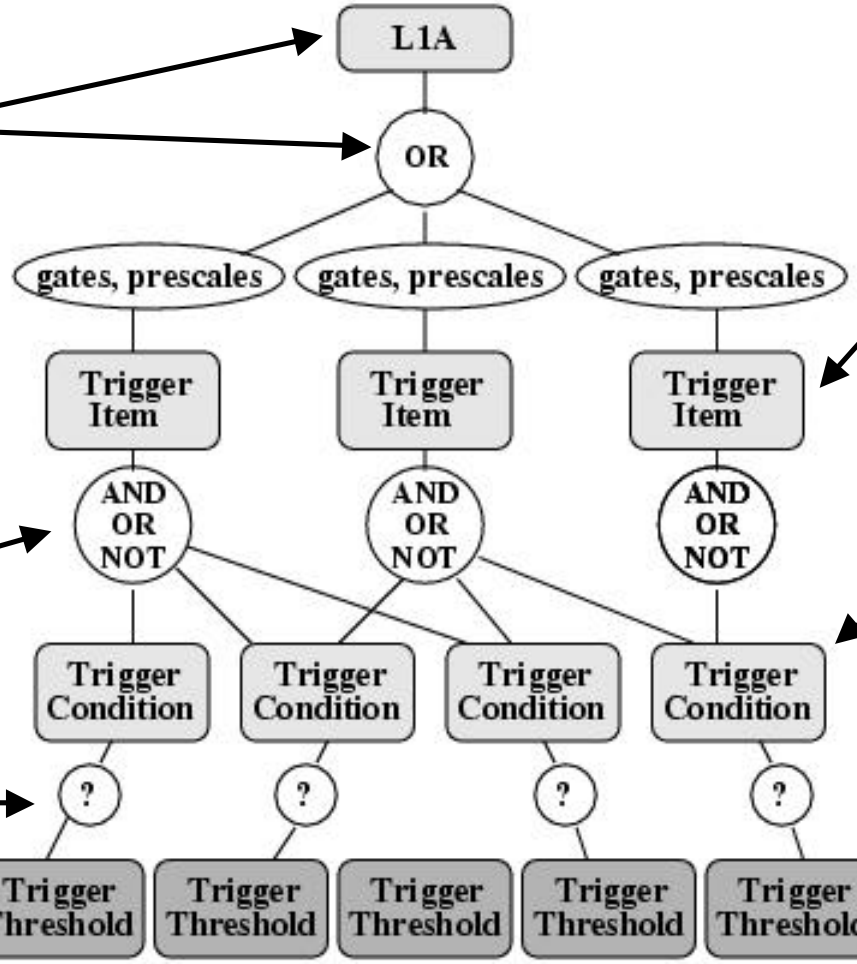
The Central Trigger Processor



- Combines calo and muon trigger info to L1 event decision.
- Existing: demonstrator CTPD with less capacity:
  - 2 LUTs, 2 CPLDs
  - 32 inputs, 32 outputs
- Final CTP: Design!
  - 160 inputs, 96 outs; one big FPGA?

Level-1 Event Decision

L1 accept signal is logical 'OR' of all trigger items



Trigger items are logical combinations of conditions

Conditions combined in programmable logic

Multiplicity requirements taken from trigger menu

Multiplicities discriminated in LUTs

Multiplicities delivered from calo and muon triggers

CTP Simulation

Purpose Fast simulation, not simulating h/w data flow.

- Class design follows logical elements rather than hardware elements.

Input Calorimeter (and muon) multiplicities or random numbers.

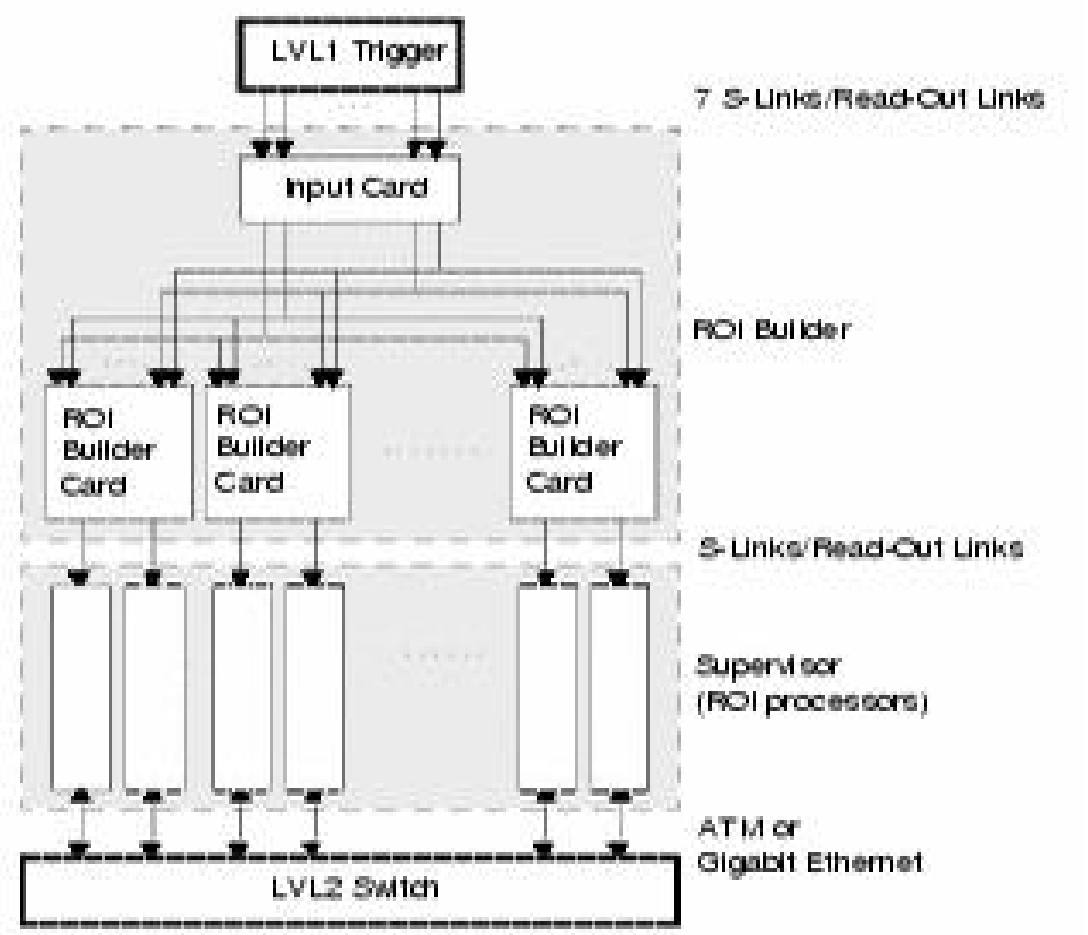
Output Trigger Items

- before vetos&deadtime logic,
- after vetos&deadtime logic and after prescales.
- Trigger type, L1 result, etc

Status 5/11/02: Ready to simulate CTP-D. Adaption to final CTP design needed.

The Region-of-Interest Builder

- Has to collect and synchronize the RoI fragments from the calo and muon triggers and the CTP.
- Has to operate at full 100kHz w/o introducing deadtime.



RoIB Simulation

Task

Collect RoI fragments (muon, calo, CTP) from StoreGate and concatenate them.

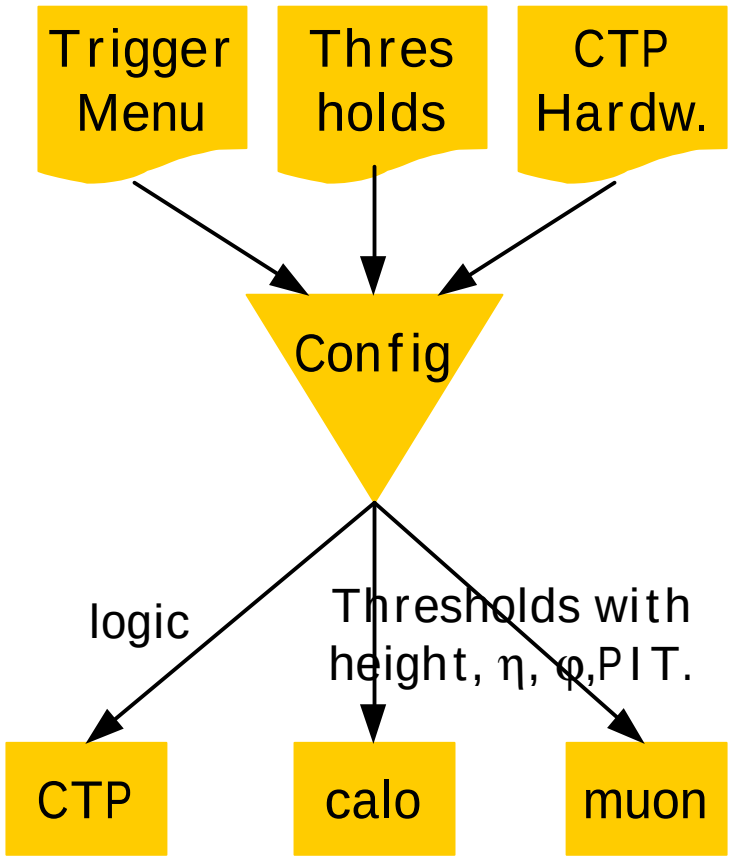
Result

- raw data objects (RDOs)
  (input to offline code and bytestream CnvSvc
- following ATL-DAQ-98-129 raw data format definition document v2.2.
- Keep eformat::ROBFragment as possible output for the time being (was once intended to be used in test beds).

Status

5/11/02: Ready (except for CnvSvc).

Overview on Configuration



- Distributes required thresholds (multiplicities) over CTP PITs.
- Relates thresholds with conditions for use in CTP (discrimination).
- Sets up logical combinations between conditions (giving trigger items) for use in CTP.
- Delivers list of required thresholds with corresponding PITs to calo and muon trigger.
- Checks setup consistency

Ingredients to configuration

- Trigger menu:

```
<TriggerItem mask="on" priority="low" prescale="1">
    <TriggerCondition triggerthreshold="EM10" mult="2"/>
</TriggerItem>
```

- Trigger thresholds information:

```
<TriggerThreshold name="EM10" bitnum="3">
    <TriggerThresholdValue value="10" ... />
</TriggerThreshold>
```

Using XERCES DOM XML API

- CTP hardware description:

```
<LUT>
    <PIT begin="0" end="15" />
    <MIO begin="0" end="8" />
</LUT>
```

```
<CMB>
    <MIO begin="0" end="15" />
    <TBV begin="0" end="15" />
</CMB>
```

Configuration Example (Muon)

Location

First, provide a location in DetectorStore:

```
#define DEFAULT_MuonTriggerConfig"/Run/MuonTrigConfig"
std::string m_CTPMuonConfigLocation;
m_CTPMuonConfigLocation = DEFAULT_MuonTriggerLocation;
```

Configu-ration

Then get the configuration vector:

```
const vector<TriggerThreshold*>&
    CTPCaloConfig::getCaloConfigFromCTP() const;
```

data

Members of TriggerThreshold:

PITs, #bits, multiplicity, vector of threshold values, threshold type and name (+OPL, confirmation flags, MUCTPI flags).

Level-1 Hardware Configuration

Why?

Test simulation vs. hardware and for consistent configuration strategy.

- Test functionality of LUTs, FPGAs; test CTP(D) design principles; test simulation.

What?

Have to calculate LUT files and generate VHDL code for FPGAs 'on the fly'

Status

- LUT: ~done (improvement probably not needed because of new CTP design ideas – one big FPGA).
- FPGAs: First test of the most simple configuration (1 in – 1 out) succesful. Risk of automatizing the process.

Hardware Configuration: Details

LUT files:

```
0000
0101
0202
0303
0404
0505
0606
0707
0808
0909
0a0a
.....
```

VHDL files:

```
.....

TBV[0] = MIO[0] & MIO[1] & !MIO[2]  &
         maskff[0] &
         !LOCADT[0] &
         !GLOBDT1[0] & !GLOBDT2[0] &
         !VETO

.....
```

Experiences and Results

July Test Bed

Calo trigger + CTP + RoIB simulations used for level-2 'july data flow test bed':

- Complete events including simulation result (RoIB result) written to data files.
- RoIB result interpreted using Ed's conversion from RoIs to trigger objects (η,φ,threshold).
- Calo RoIs used to seed L2 silicon algorithms.

Release2

Successful generation of L1 RDOs last Monday (Ed, TSS, Gianluca).

Release3

RDO ⇦⇨ bytestream for trigger in progress.

L1 Simulation in PESA Planning

Release 2

- Due End of October (but before Release 3)
- Creation of L1 trigger RDOs, extraction of RoIs and creation of L2 seeding TEs.
- Status (5/11): Done

Release 3

- Due 12/11 but (probably end november?)
- No specific L1 requirements (HLT region lookup, ROB access etc. as main goals).

Release 4

- Due 30/11.
- Cnv. of L1 trigger RDOs to byte stream.
- Basis for testbed activities.

- Offline release confusion? 5.0.0 postponed till 12/11.

ByteStream Conversion Service

Problem L2 needs interpretation of RoI information:

- RoIs contain bit patterns for crate, cluster processor, modul, threshold etc.
- L2 needs η, φ and threshold height (+ …)

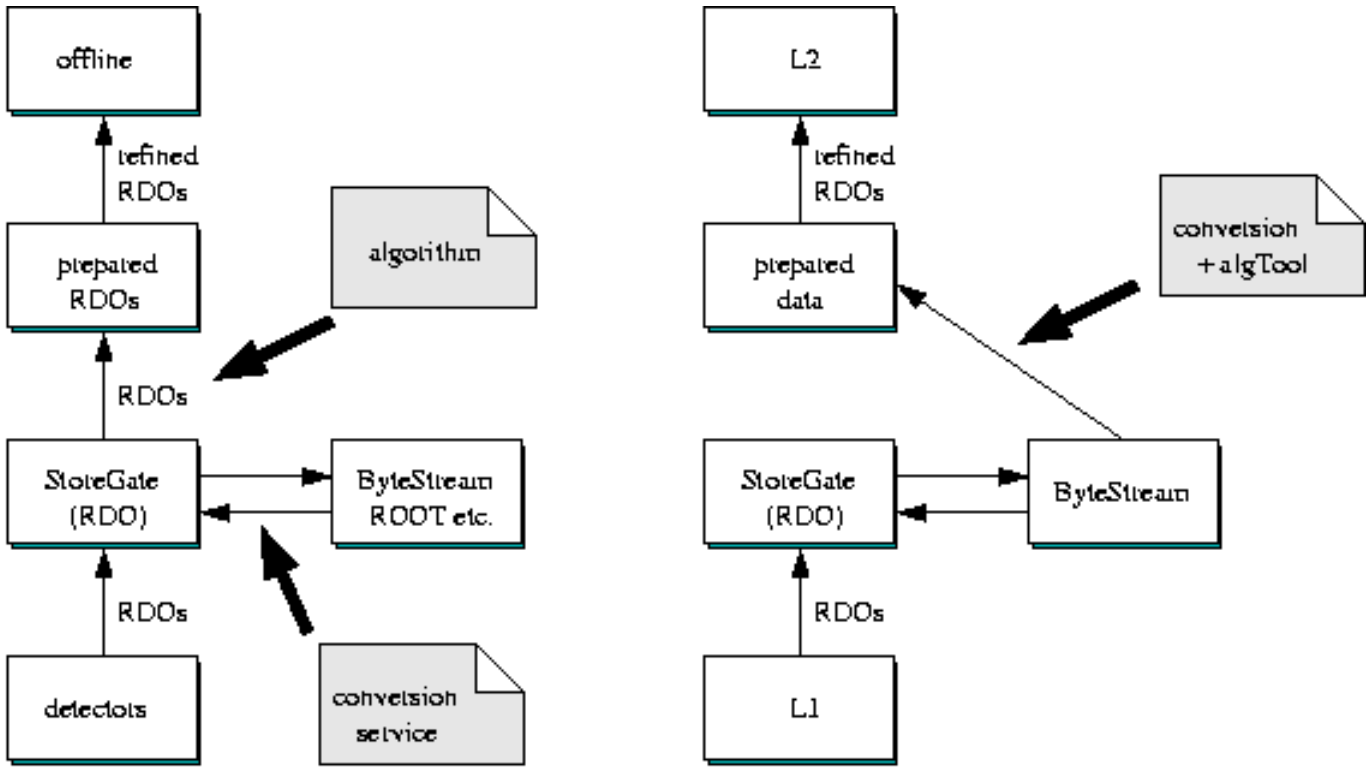
Ed provided conversion software for L2

- RoI (uint32_t) → L2 trigger object
- Used in L2 'july data flow test bed'.
- To be extended to jet/energy, muon, CTP.

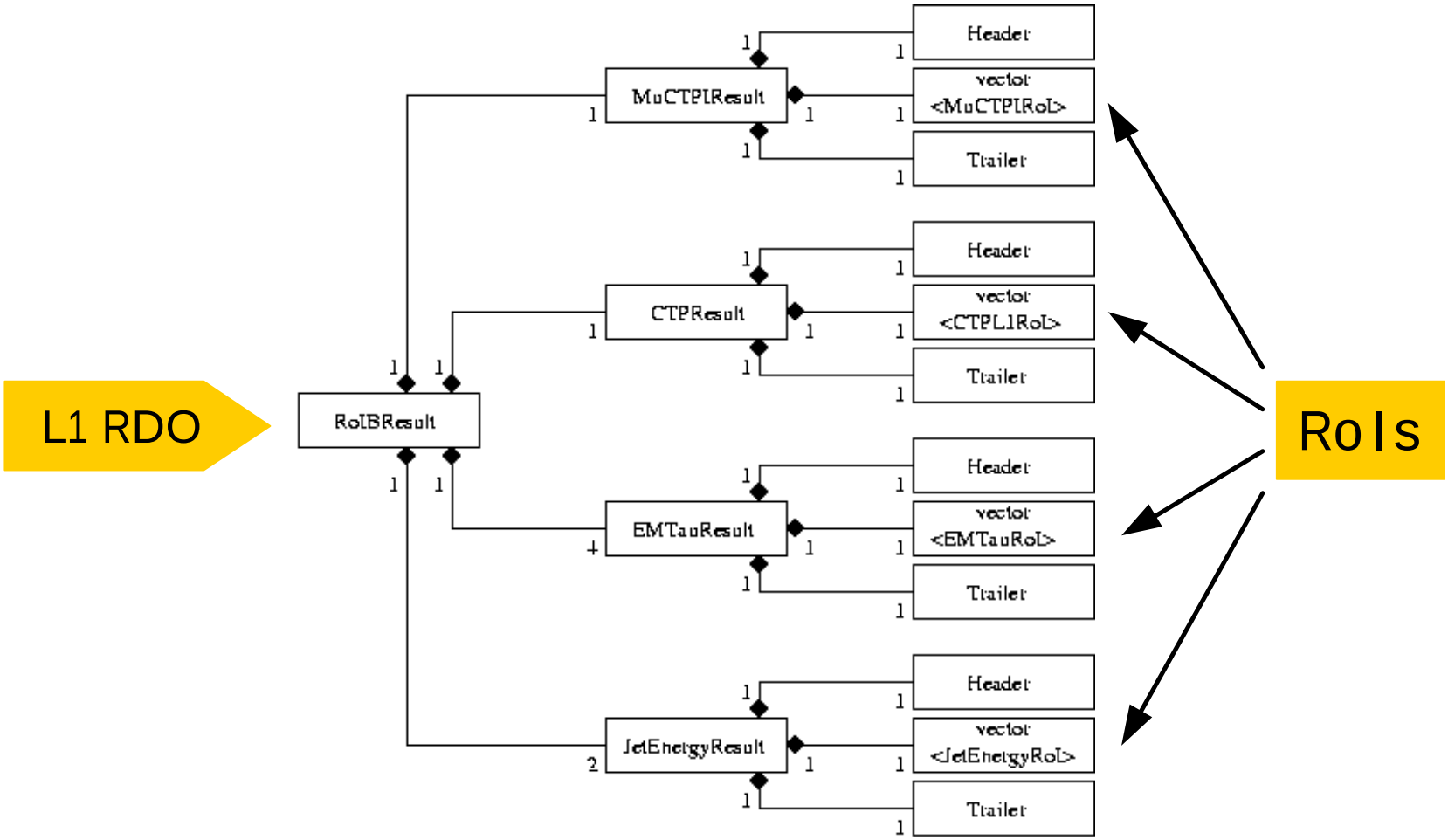
Needed Also needed: Conversion from RDOs (objectivity world) to bytestream (persistent world).

- Situation of ROOT persistency unclear.

ByteStream Conversion and RDOs



New L1 RDO Class Structure



L1 RDOs and BS Conversion

Trigger

Dealt with by RoIB. BS conversion in progress (TSS).

Readout

Up to individual detectors

- Have to provide their RDO object, CnvSvc.
- First experience from calorimeters and (slowly) RPC muons.
- Not trivial.

Summary and Outlook

Simul.

Level-1 trigger simulation well on the way

- Calorimeter trigger, CTP and RoIB ~done.
- Currently: Muon trigger (TGC, RPC, MUCTPI).

Config.

Current scheme used by calo + CTP software

- To be used by muon trigger software
- To be used by hardware?

Next

- Finalize simulation (Bytestream, QA, muons).
- CTP hardware and (calo) vertical slice tests.
- Combine L1 trigger and HLT configurations.
- Question of data bases!!!!