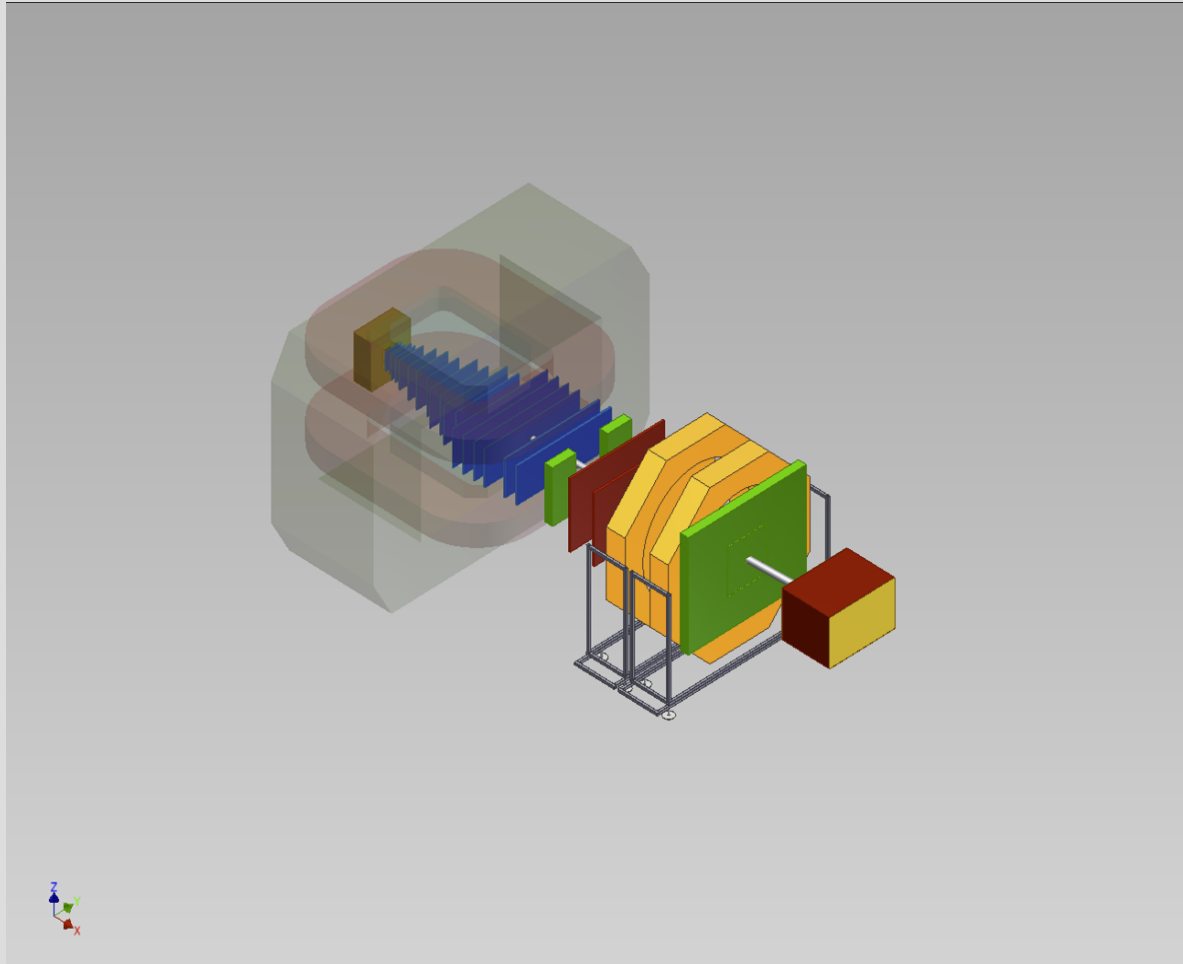


# DAQ System at BM@N facility

**BM@N DAQ group:** A. Baskakov, S. Bazylev, A. Fediunin, I. Filippov, S. Kuklin, Yu. Minaev, A. Shchipunov, A. Shutov, I. Slepnev, V. Slepnev, N. Tarasov, A. Terletskiy



# Hardware

## TDC modules

72 and 64-channel multihit timestamping TDCs

VME64x U6 boards

Based on HPTDC chips

Resolution:

- 25 ps for TDC72VHL and TDC64VHLE
- 100 ps for TDC64V

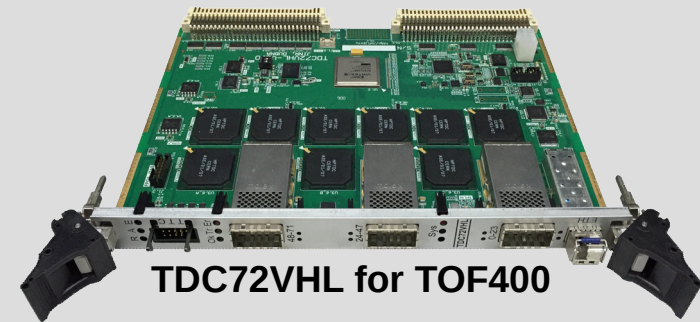
TTC Bus for synchronization into VME crate

Power supply via VME Bus

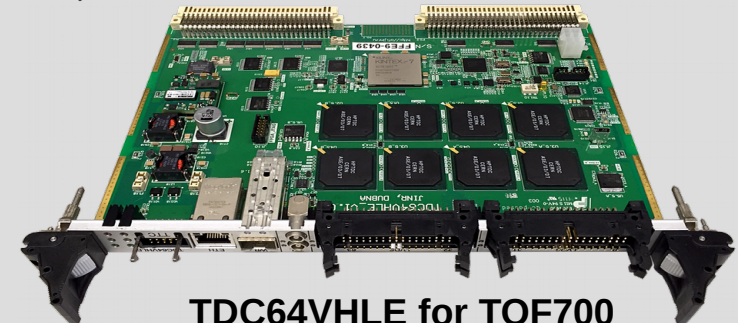
Data transferring via VME64x Bus

Input signals formats:

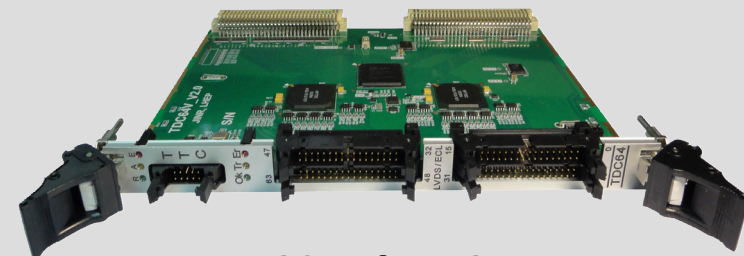
- LVDS for TDC72VHL and TDC64VHLE
- ECL, PECL or LVDS for TDC64V



**TDC72VHL for TOF400**



**TDC64VHLE for TOF700**



**TDC64V for DCH**

# Hardware

## ADC modules

62,5 Msps 12 bit 64-cannel ADC modules

DSP function:

- Zero suppression, Tail cancellation, Moving average filter for calorimetry
- + Sparse readout for GEM & STS

Power supply:

- External (Wiener Mpod) for ADC64s2
- VME Bus for ADC64VE

Data transfer:

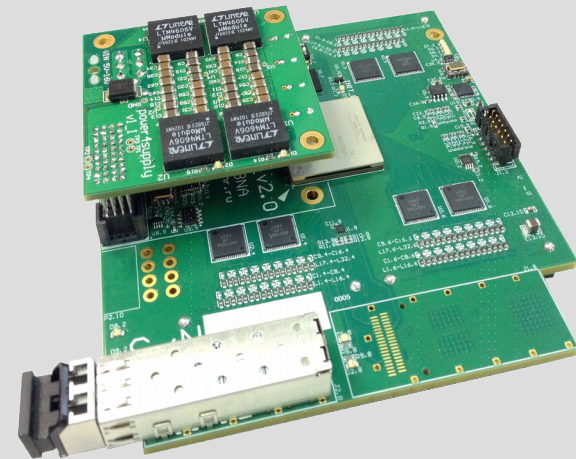
- WR link for ADC64s2 (Ethernet in future)
- Ethernet link for ADC64VE

Synchronization:

- Lemo TTL I/O for Trigger and XOFF signals
- WR Link for timing synchronization



ADC64VE for GEM, STS



ADC64s2 for Ecal, ZDC

# Hardware

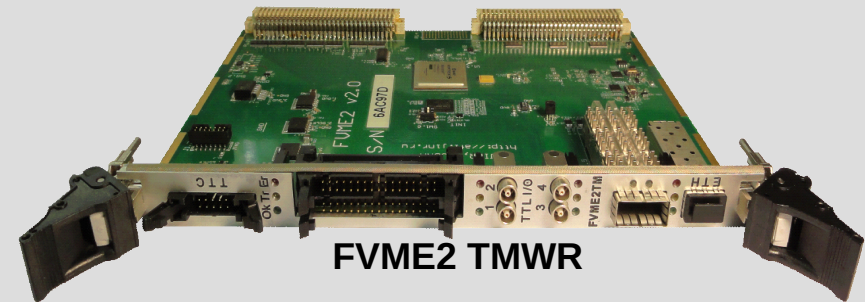
## VME64x control and interface modules

FVME2TMWR – Trigger, Timing and Control Module for VMEDAQ system

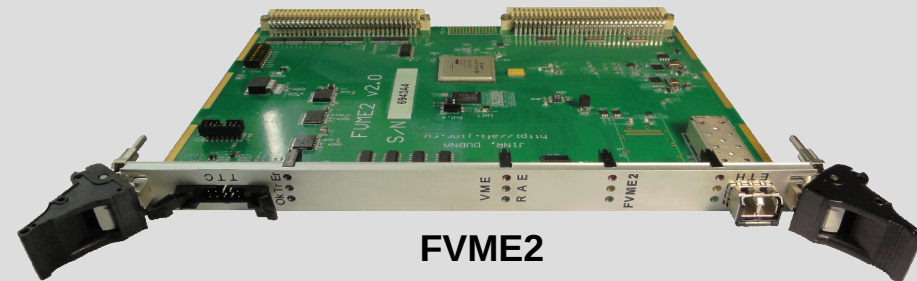
- TTC Bus master. Generate and distribute clock, trigger and spill signals
- WR synchronization
- 4 software configurable TLL I/O

FVME2 – VME64x Bus Master and system controller. Read out data from VME modules into the crate and transfer it by optical link to Pexml-4

Pexml-4 – PCI Express interface card with M-Link protocol



**FVME2 TMWR**



**FVME2**



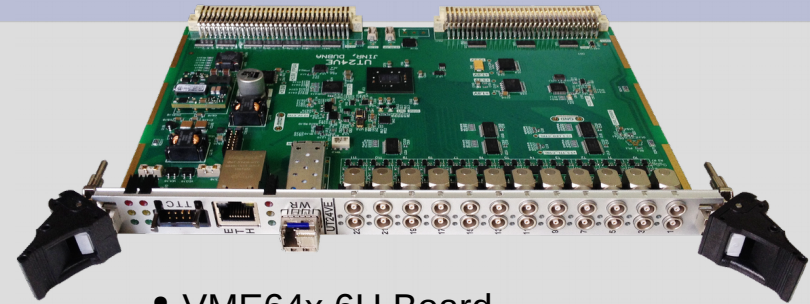
**Pexml-4**



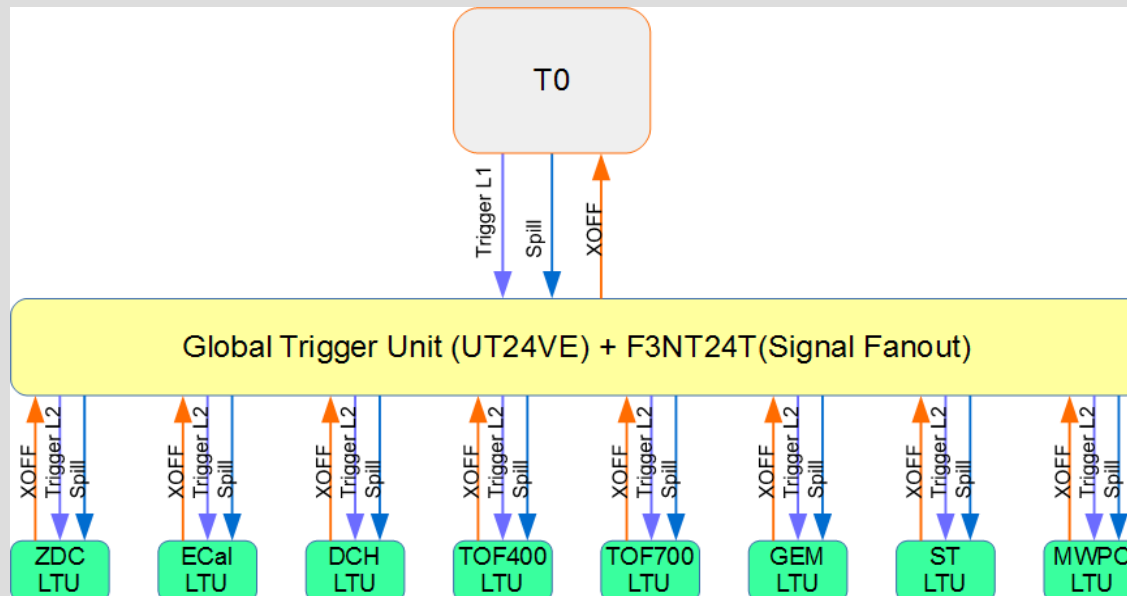
# Signal distribution and data transferring structure

## Global Trigger Unit

GTU based on UT24VE module. It distributes Trigger & Spill signals to all LTU and collects XOFF signals from them.



- VME64x 6U Board
- Ethernet Interface
- 24 LEMO I/O



Lemo I/O	Left side	Right side
23 24	Spill in	Spill out
21 22	Trig in4	XOFF out
19 20	Trig in3	Trig out3
17 18	Trig in2	Trig out2
15 16	Trig in1	Trig out1
13 14	XOFF in13	XOFF in14
.....		
1 2	XOFF in1	XOFF in2

# Signal distribution and data transferring structure

## Local Trigger Unit and DCH DAQ

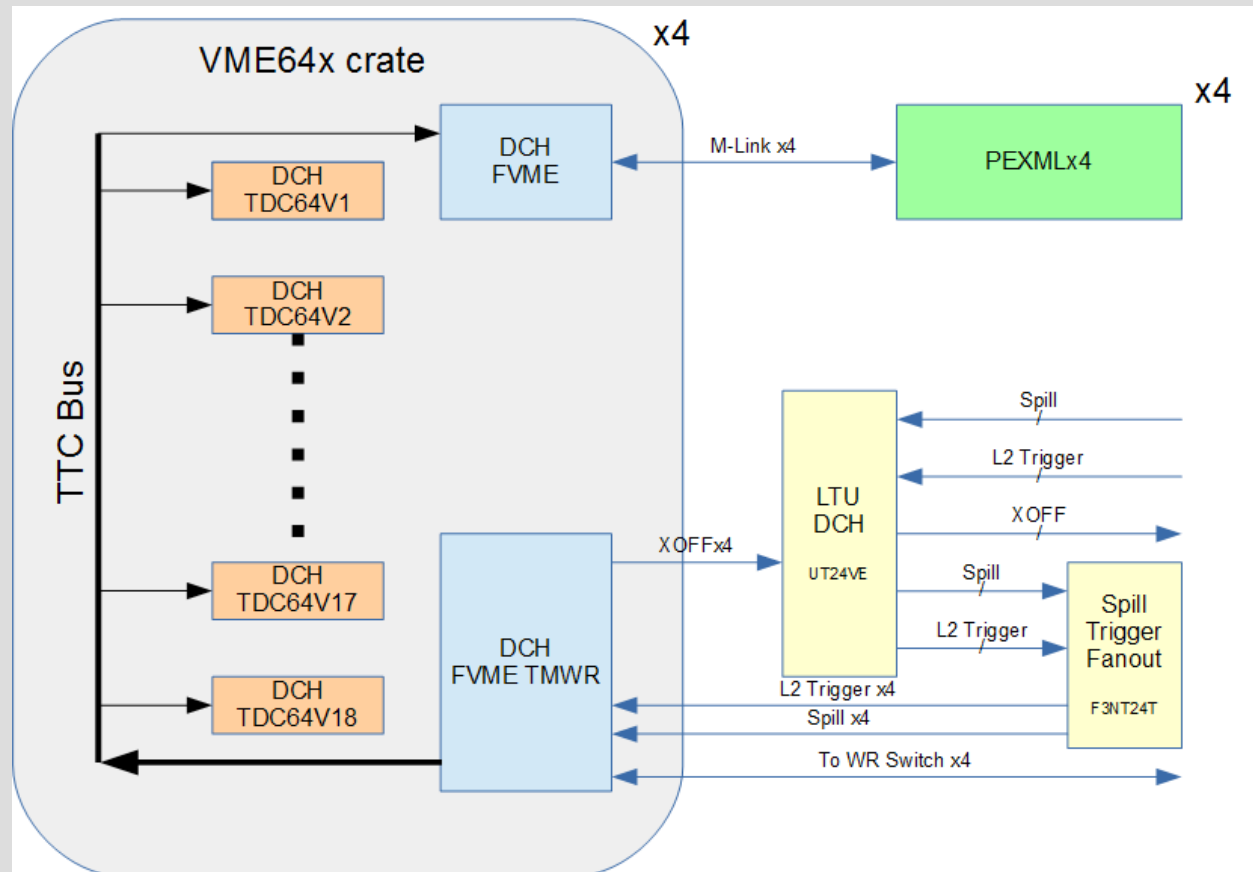
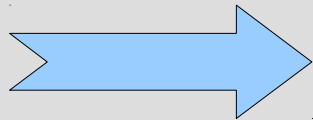
LTU also based on UT24VE module and distributes Trigger & Spill signals to subsystem's modules and collects XOFF signals from them.

### 3 kinds of signal distribution:

- VME64x crates systems
- Stand-alone and VME mixed systems

### VME64x crates systems:

- DCH
- TOF700
- TOF400



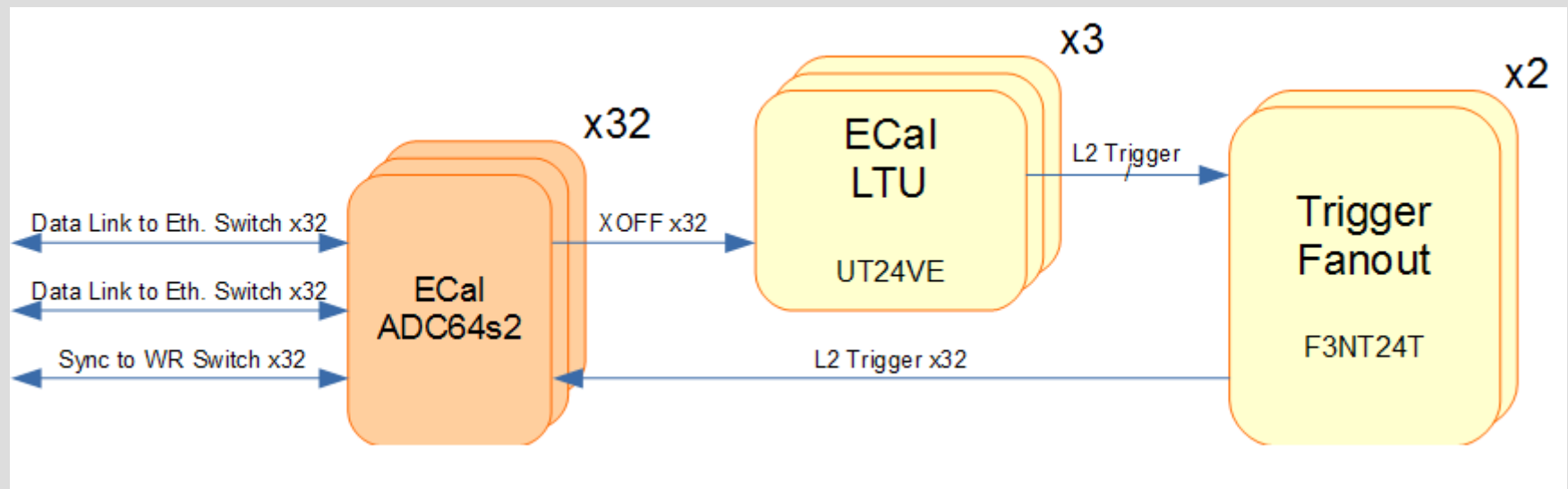
# Signal distribution and data transferring structure

## Ecal DAQ

- Trigger signals to each ADC64s2 board from cascaded Fanouts via coaxial cables.
- XOFF signals from each ADC64s2 board to cascaded LTUs.
- Every ADC64s2 connected to WR Switch for timing synchronization.
- Optical links to Ethernet switch for data transmission.

### Stand-alone systems:

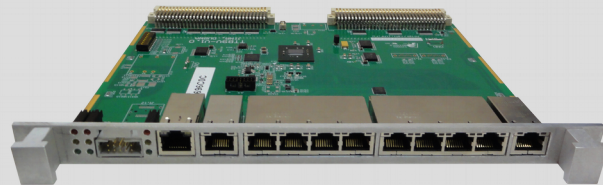
- ECal
- ZDC



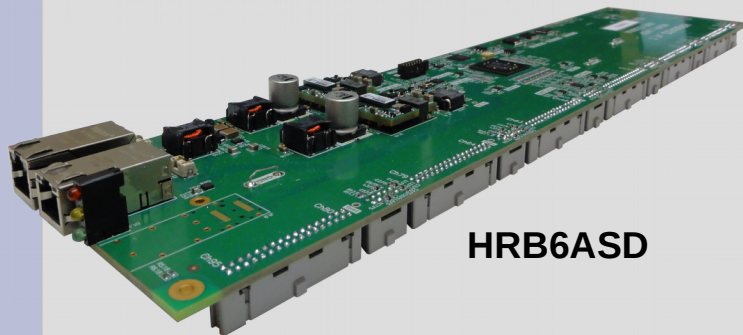
# Signal distribution and data transferring structure

## MWPC DAQ

- HRB6ASD modules located at MWPC
- TTB9V modules synchronize HRB6ASDs via HRB TTC Links
- Data transferring derives by Ethernet links



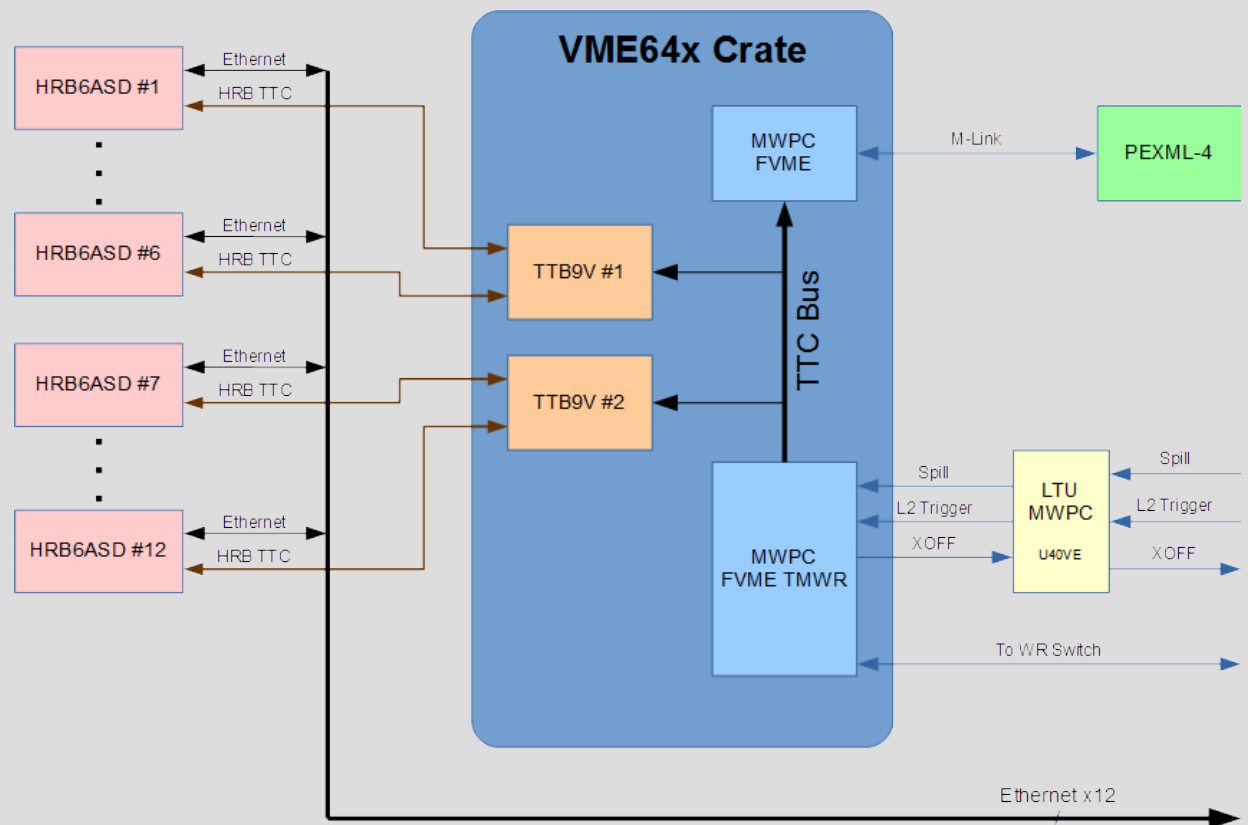
TTB9V



HRB6ASD

### Mixed systems:

- MWPC



# Signal distribution and data transferring structure

## GEM DAQ

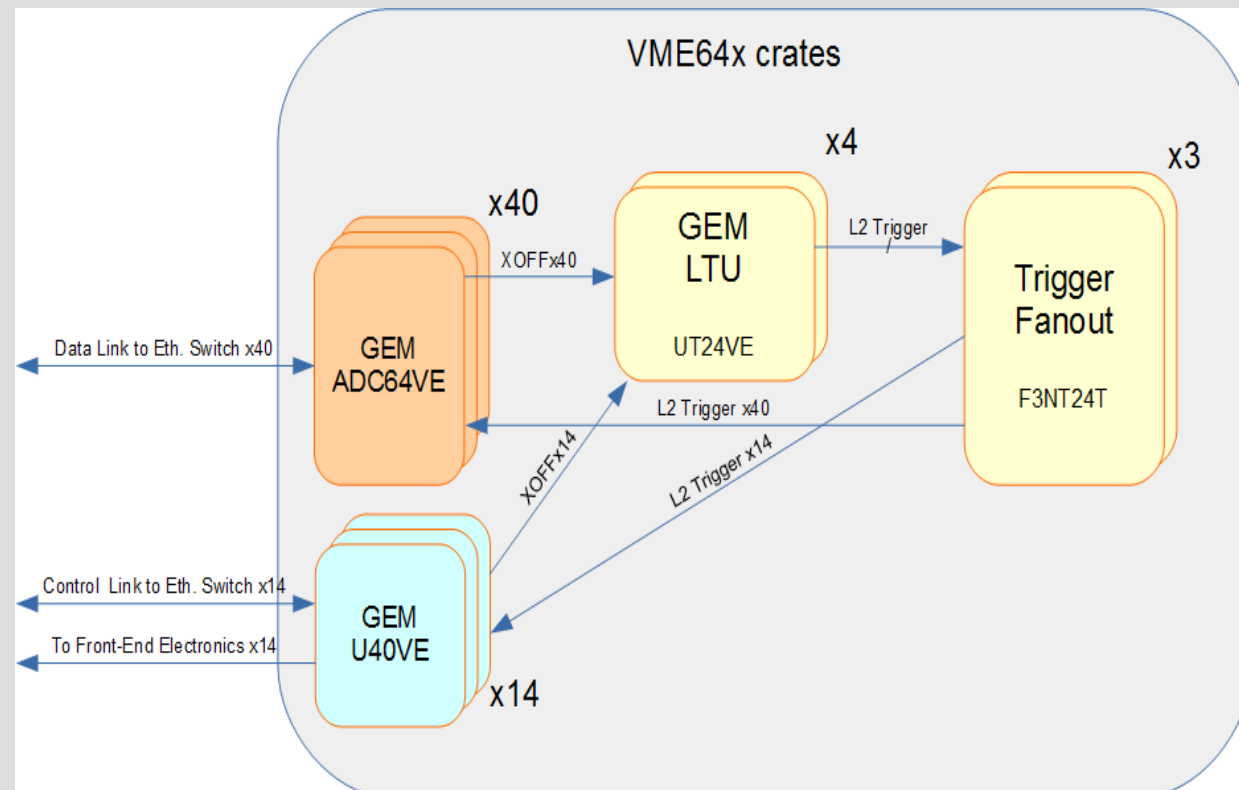
U40VE – universal logical module. It used for control detector's front-end electronics.

### Mixed systems:

- GEM
- STS

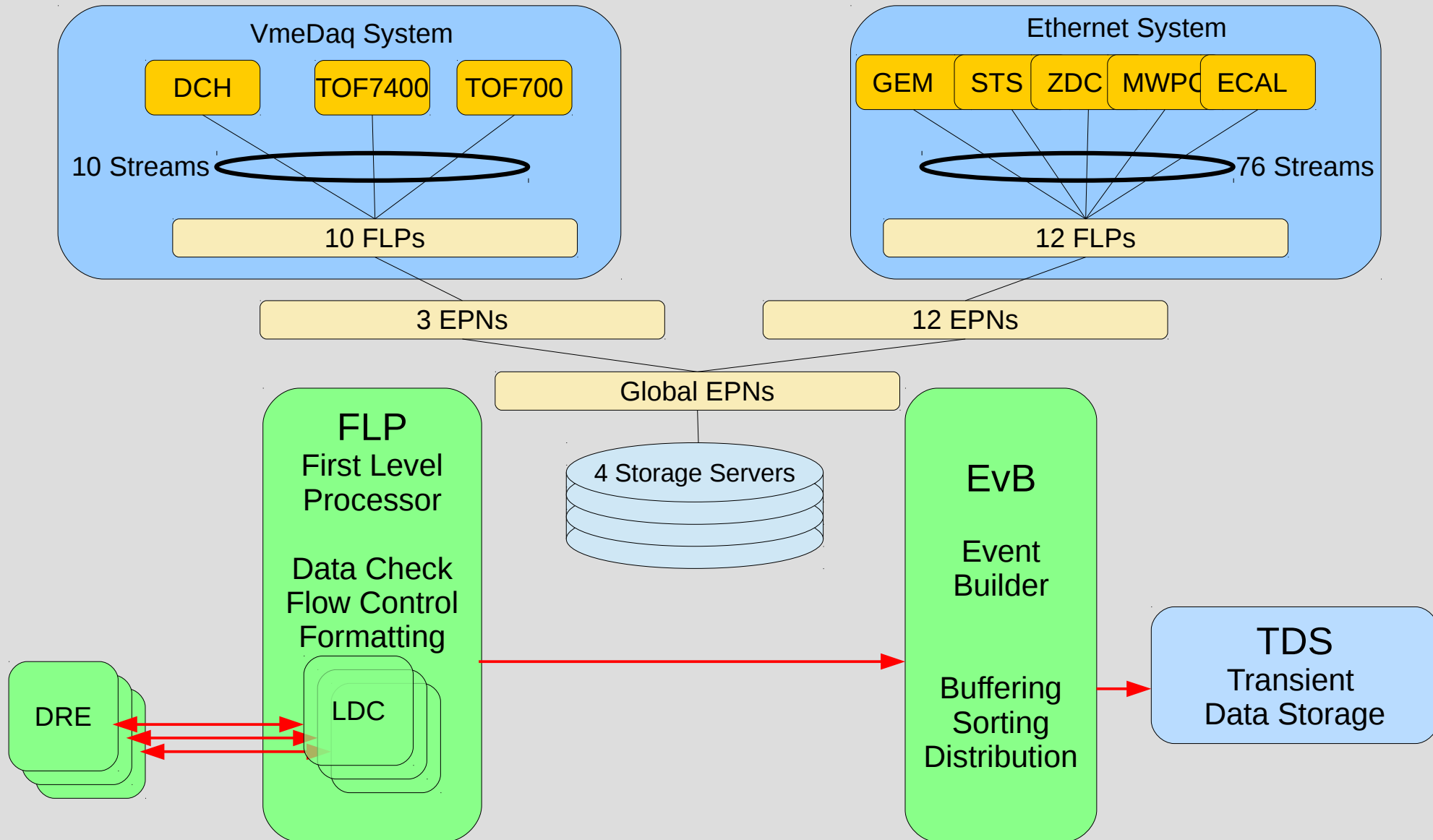


U40VE





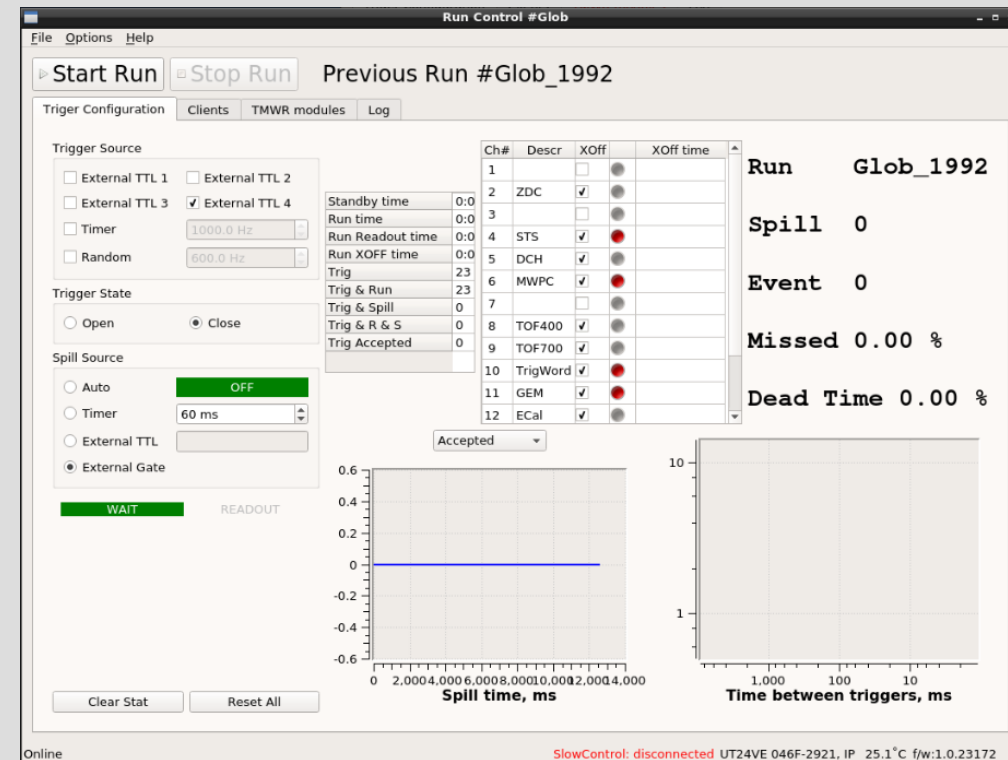
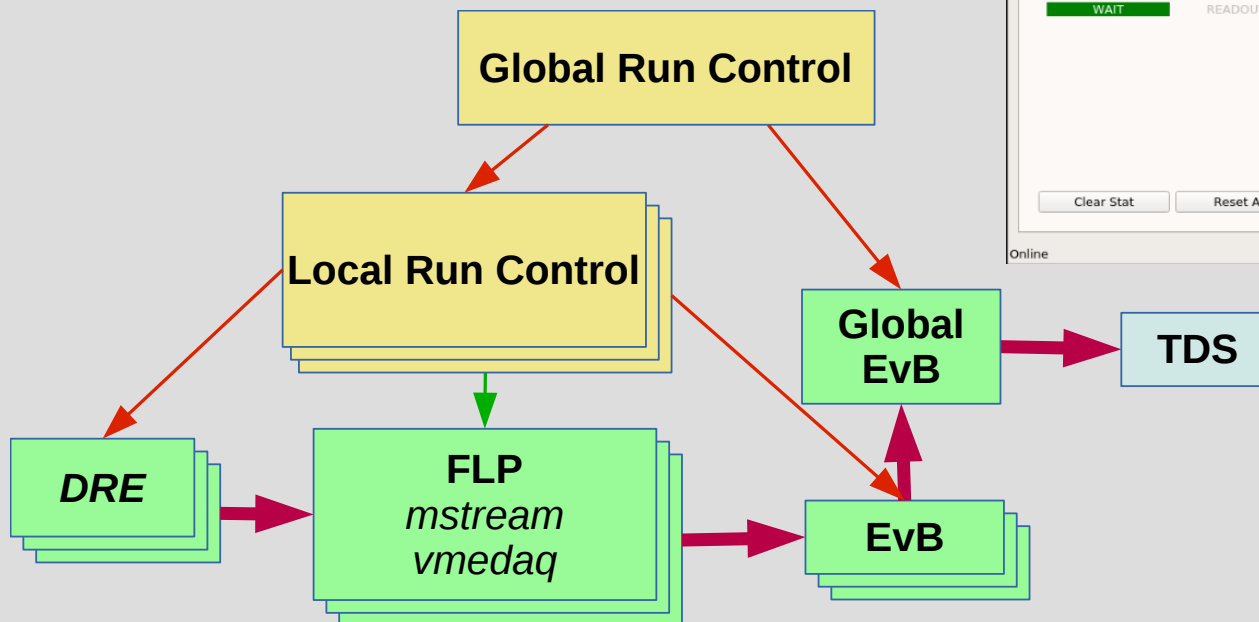
# Data flow



# Global Run Control

Run Control tasks:

- Configure Trigger Unit
- Start/stop run
- Send start/stop signals to all clients
- Check client's status.



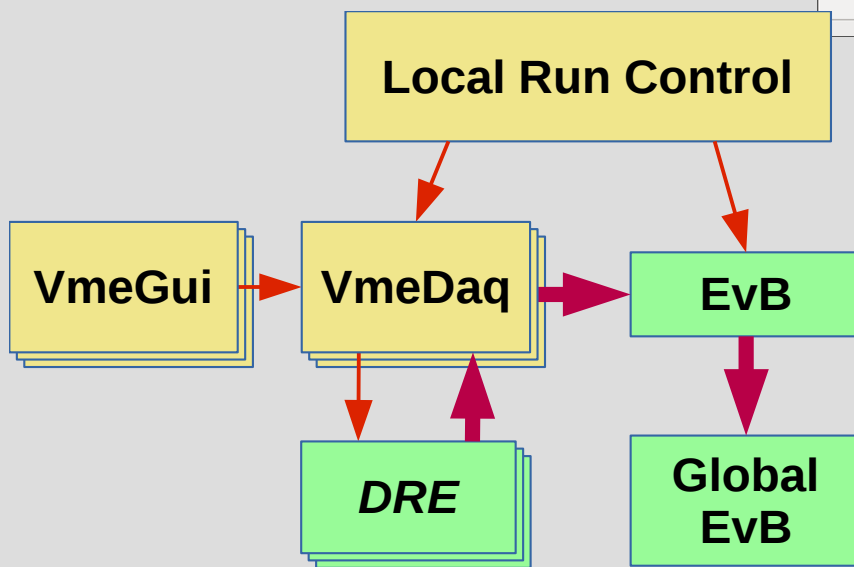
Clients of Run Control:

- Run Control
- VmeDag
- ADC64 System
- Hrb Status
- EvB

# VME Run Control

VmeDaq tasks:

- Receives start/stop signals from Run Control.
- Writes configuration into modules
- Retransmit data from DRE to EvB.



The screenshots show the VMEDAQ Control software interface. The top-left window displays the 'INIT' and 'RUN' buttons, along with a table of TDC hits. The top-right window shows the 'RUN (no storage)' mode with 'Spill' and 'Trigger Signal Shaper' settings. The bottom-right window shows 'Run Statistics' and a 'Data rate, MB/s' graph.

**Run Statistics**

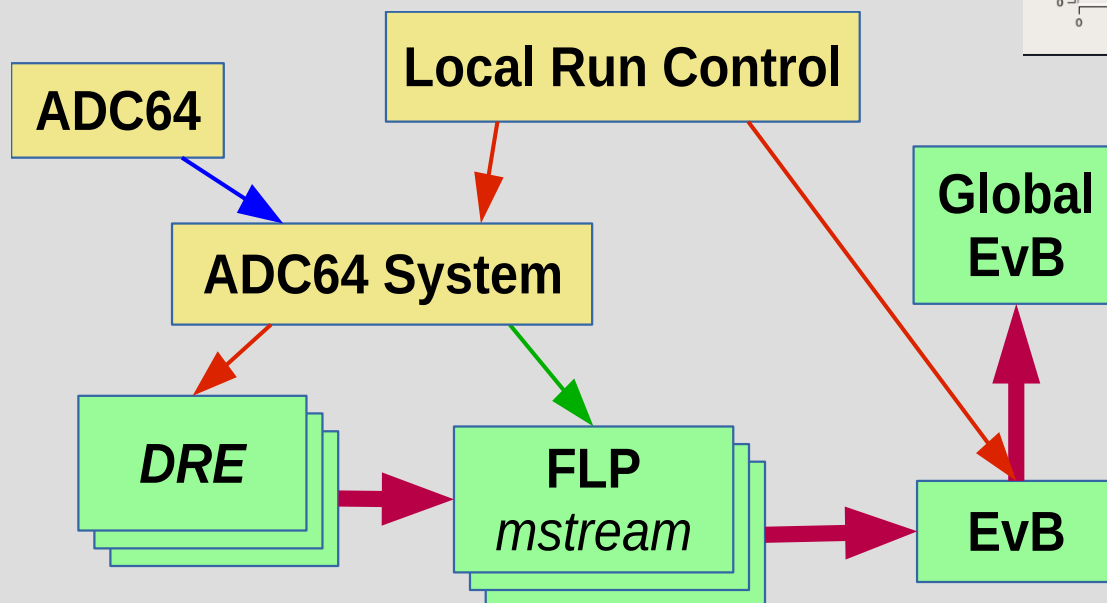
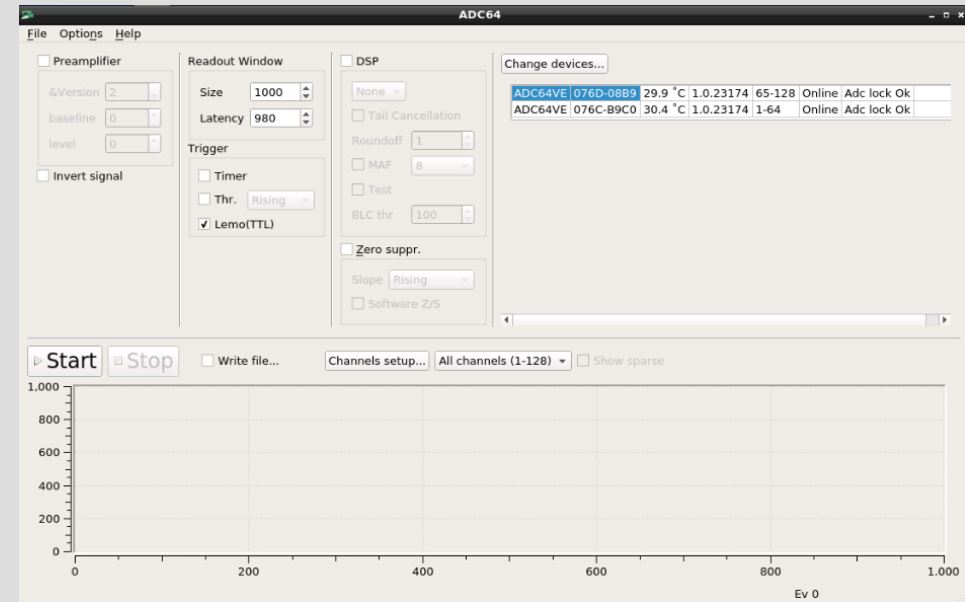
Name	Spill counts	Run counts
WallTime	0.000	0.000
DayTime	1.009	35.302
Event	1041	36456
XOFF	75919	2658706
MByte	0.294	10.3

**Data rate, MB/s**

# ADC64 Run Control

ADC64 System tasks:

- Write configuration into devices.
- Execute mstream program (perform FLP function).
- Check board's status.



The screenshot shows the ADC64 System #GEM log window. It contains a table of device status and a main log of events.

Type	Serial	Slot	IP Address	T °C	Event	Trig on XOFF	ADC Status	WR Time	Offset	Link	Unlock	RX Err	Event rate	Data rate	Up time	LM resets
1	ADC64VE	030D-CF31	7	10.18.40.146	ADC:24 PS:22	4	0	OK	0	0	0	0	0	0	601554	0
2	ADC64VE	076C-82BE	9	10.18.40.145	ADC:24 PS:22	4	0	OK	0	0	0	0	0	0	601554	0
3	ADC64VE	076C-8320	9	10.18.40.135	ADC:29 PS:25	4	0	OK	0	0	0	0	0	0	601553	0
4	ADC64VE	076C-A266	13	10.18.40.139	ADC:30 PS:27	4	0	OK	0	0	0	0	0	0	601553	0
5	ADC64VE	076C-A26F	19	10.18.40.143	ADC:32 PS:85	4	0	OK	0	0	0	0	0	0	601553	0
6	ADC64VE	076C-89C0	10	10.18.40.138	ADC:30 PS:25	4	0	OK	0	0	0	0	0	0	601553	0
7	ADC64VE	076C-8A88	5	10.18.40.144	ADC:31 PS:27	4	0	OK	0	0	0	0	0	0	601554	0
8	ADC64VE	076C-0410	7	10.18.40.140	ADC:29 PS:26	4	0	OK	0	0	0	0	0	0	601553	0
9	ADC64VE	076C-0411	10	10.18.40.137	ADC:26 PS:21	4	0	OK	0	0	0	0	0	0	601554	0
10	ADC64VE	076C-E3E5	5	10.18.40.141	ADC:26	4	0	OK	0	0	0	0	0	0	601555	0
11	ADC64VE	076C-E3EE	17	10.18.40.142	ADC:30 PS:26	4	0	OK	0	0	0	0	0	0	601553	0
12	ADC64VE	076D-08B9	14	10.18.40.136	ADC:29 PS:26	4	0	OK	0	0	0	0	0	0	601554	0

The main log shows the following events:

```

[14:30:31][Thread GUI] "076C-82BE" Device offline*
[14:31:08][Thread D4 076C-82BE] "ADC64VE 076C-82BE" connected to 10.18.40.145*
[14:31:08][Thread GUI] "076C-82BE" Device online*
[14:38:23][Thread D4 076C-82BE] "10.18.40.145: Going offline after 13 retry attempts*
[14:38:28][Thread D4 076C-82BE] "ADC64VE 076C-82BE" disconnected*
[14:38:28][Thread GUI] "076C-82BE" Device offline*
[14:38:36][Thread D4 076C-82BE] "ADC64VE 076C-82BE" connected to 10.18.40.145*
[14:38:36][Thread GUI] "076C-82BE" Device online*
[14:45:12][Thread D4 076C-82BE] "10.18.40.145: Going offline after 13 retry attempts*
[14:45:16][Thread D4 076C-82BE] "ADC64VE 076C-82BE" disconnected*
[14:45:16][Thread GUI] "076C-82BE" Device offline*
[14:45:26][Thread D4 076C-82BE] "ADC64VE 076C-82BE" Can't connect to 10.18.40.145*
[14:45:36][Thread D4 076C-82BE] "ADC64VE 076C-82BE" Can't connect to 10.18.40.145*
[14:46:14][Thread D4 076C-82BE] "ADC64VE 076C-82BE" connected to 10.18.40.145*
[14:46:14][Thread GUI] "076C-82BE" Device online*
[14:51:08][Thread D4 076C-82BE] "10.18.40.145: Going offline after 13 retry attempts*
[14:51:08][Thread D4 076C-82BE] "ADC64VE 076C-82BE" disconnected*
[14:51:08][Thread GUI] "076C-82BE" Device offline*
[14:51:30][Thread D4 076C-82BE] "ADC64VE 076C-82BE" connected to 10.18.40.145*
[14:51:30][Thread GUI] "076C-82BE" Device online*
  
```

# MWPC Run Control

Hrb Status tasks:

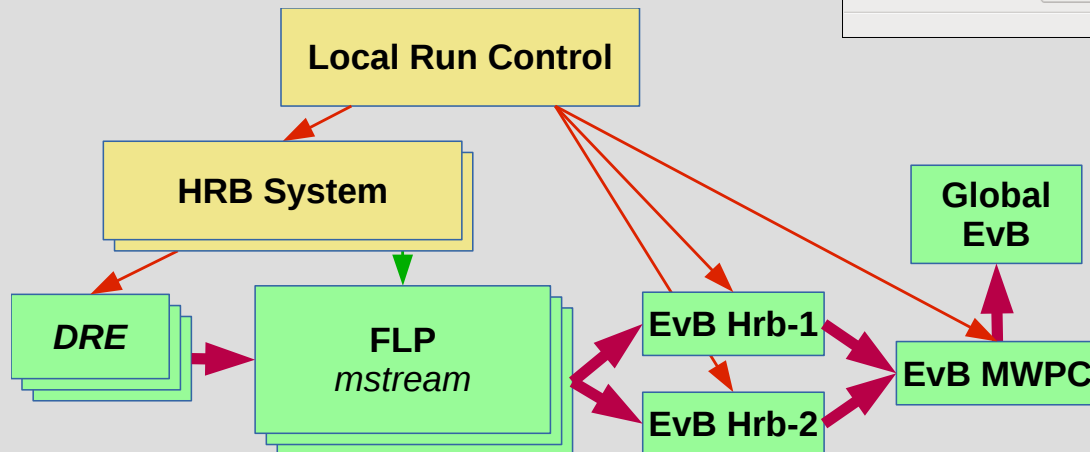
- Configure devices.
- Execute mstream program (perform FLP function).
- Check board's status.

The screenshot shows the 'Hrb Status' application window. It features a menu bar with 'File', 'Options', and 'Help'. Below the menu is a table with columns: Id, Ip, Time, Temp, Spill, Event, Write, ASD 0, ASD 1, ASD 2, ASD 3, ASD 4, ASD 5, Pass, and Block. Two rows of data are visible. Below the table are several control fields: Threshold, V (0.000), Latency, ns (24), Window, ns (80), Min hit dur, ns (8), Write Enable (checkbox), Run analyzer (checkbox), and Run number (0). A 'Reset' button is located below these fields. At the bottom, there is a log window with tabs for 'Main Log', '0x046f304f', and '0x046efa79'. The log contains several lines of text, including timestamps and device status updates.

Id	Ip	Time	Temp	Spill	Event	Write	ASD 0	ASD 1	ASD 2	ASD 3	ASD 4	ASD 5	Pass	Block	
1	0x046f304f	10.93.120.186	03:10:35	46.2C	0	0	✓	0.000	0.000	0.000	0.000	0.000	0.000	0	0
2	0x046efa79	10.93.120.171	03:10:38	46.7C	0	0	✓	0.000	0.000	0.000	0.000	0.000	0.000	0	0

Threshold, V: 0.000  
Latency, ns: 24  
Window, ns: 80  
Min hit dur, ns: 8  
Write Enable:   
Run analyzer:   
Run number: 0

Log entries:  
[15:11:50] [0x046efa79] set trig\_src=000e; latency=3(24ns); window=10(80ns); minHitDuration=4(8ns)  
[15:11:50] HRB-0 host updated: 10.93.120.186  
[15:11:50] [0x046f304f] Device HRB-0 online (10.93.120.186)  
[15:11:50] [0x046f304f] device connected fw=1.0.18658  
[15:11:50] [0x046f304f] set asd8 threshold 2048 (0 V)  
[15:11:50] [0x046f304f] set trig\_src=000e; latency=3(24ns); window=10(80ns); minHitDuration=4(8ns)  
[15:11:50] [0x046f304f] Timestamp mismatch count 0  
[15:11:50] [0x046f304f] Link 0 (RESET): sync errors 0, code errors 0  
[15:12:40] [RemoteControlServer] Established connection from 127.0.0.1:59115  
[15:12:40] [RemoteControlServer] Send to remote control: description Hrb Status

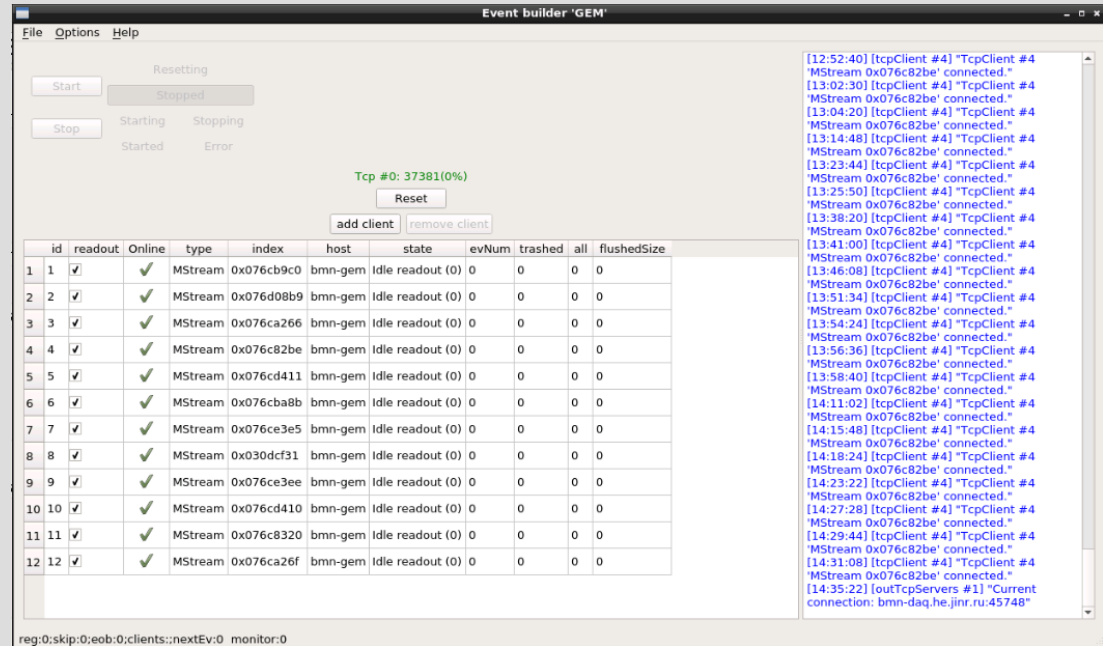




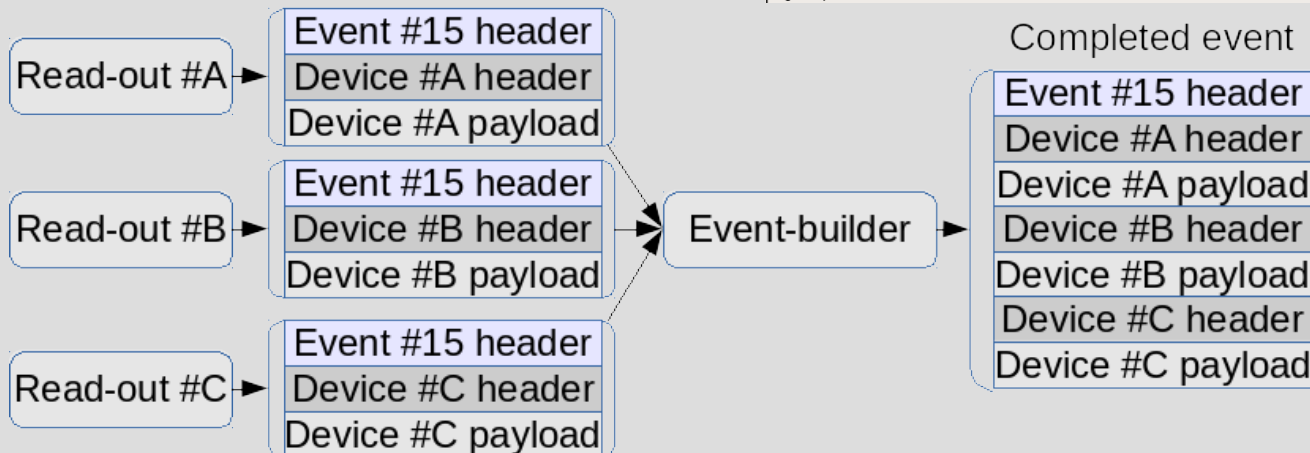
# Event Builder

## EvB tasks:

- Recive data from clients
- Construct Completed event from several sub-events
- Send to output
  - File in TDS
  - TCP-server (for upper EvB)



## Sub-events



## EvB clients:

- EvB
- MStream
- VmeDag

# MLDP and PNP

## Device description:

- Ip-address
- Firmware version / revision
- Model Id# / name
- Serial number
- Master Ip/port
- MStream Ip/port

## Program description:

- UUID
- App. type
- App. index
- Host address
- List of interfaces
  - Type/id
  - Host
  - Port
  - Free flag

Device Discovery Dialog

Type	Serial ID	Firmware	Slot	IP Address	Master	MStream
ADC64VE	076C-D410	01.00.23174	7	bmn-gem-adc02	bmn-gem:45510	bmn-gem:38315
ADC64VE	076D-08B9	01.00.23174	14	bmn-gem-adc06	bmn-gem:53703	bmn-gem:44449
ADC64VE	076C-D411	01.00.23174	10	bmn-gem-adc12	bmn-gem:38053	bmn-gem:56485
FVME2TMWR	046F-35A9	01.01.23970	5	bmn-tmwr-daq	free	free
HRB6ASD	06E9-B8BE	01.00.22544	52	bmn-hrb6-1-4	bmn-hrb-1:48820	bmn-hrb-1:52718
HRB6ASD	06E9-B820	01.00.22544	52	bmn-hrb6-1-3	bmn-hrb-1:39777	bmn-hrb-1:60112
HRB6ASD	046F-2950	01.00.22544	52	bmn-hrb6-1-2	bmn-hrb-1:49680	bmn-hrb-1:33445
HRB6ASD	06E9-B838	01.00.22544	52	bmn-hrb6-1-6	bmn-hrb-1:44133	bmn-hrb-1:36997
HRB6ASD	06E9-B83F	01.00.22544	52	bmn-hrb6-1-5	bmn-hrb-1:50678	bmn-hrb-1:39825
TTB9V	046F-06A0	01.00.22937	10	bmn-ttb9-2	bmn-hrb-2:44498	free
U40VE_SEQ2	0612-0DF8	01.00.22938	3	bmn-gem-seq01	bmn-gem:56713	free
U40VE_SEQ2	076C-9E38	01.00.22938	4	bmn-gem-seq02	bmn-gem:50058	free

Manual add...    ↓ Add    ↑ Remove

En	St	Type	Serial ID	Firmware	Slot	IP Address	Master	MStream
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	ADC64VE	076C-E3EE	01.00.23174	17	bmn-gem-adc07	bmn-gem:35498	bmn-gem:55024
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	ADC64VE	076C-E3E5	01.00.23174	5	bmn-gem-adc09	bmn-gem:45266	bmn-gem:35240
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	FVME2TMWR	076D-4265	01.01.23970	10	bmn-tmwr-tof400	bmn-tof400:47262	free
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	HRB6ASD	06E9-B78B	01.00.22544	52	bmn-hrb6-1-1	bmn-hrb-1:48082	bmn-hrb-1:42466
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	TTB9V	046F-06A7	01.00.22937	7	bmn-ttb9-1	bmn-hrb-1:45177	free

Available device types:

- ADC64VE
- FVME2TMWR
- HRB6ASD
- TTB9V
- U40VE\_SEQ2
- U40VE-SSPI
- U40VE-RC
- UT24VE-RC

**The end**

Thank you!

# Back-up

