OLYMPUS Technical Review

Electronics & DAQ

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universitätbonn

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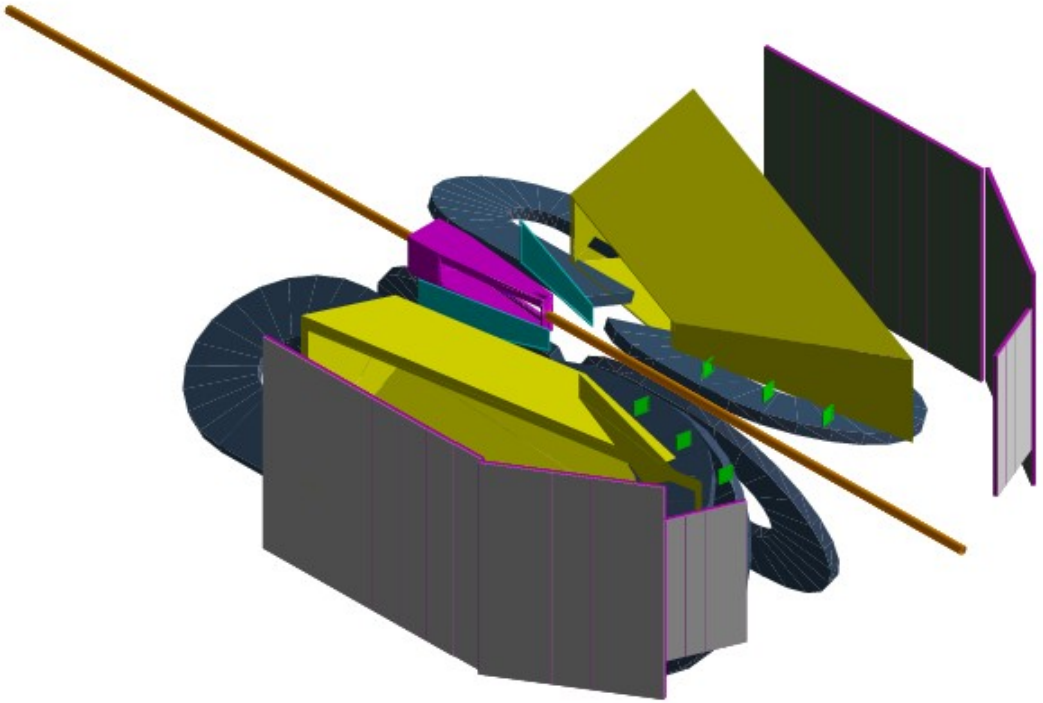
Overview

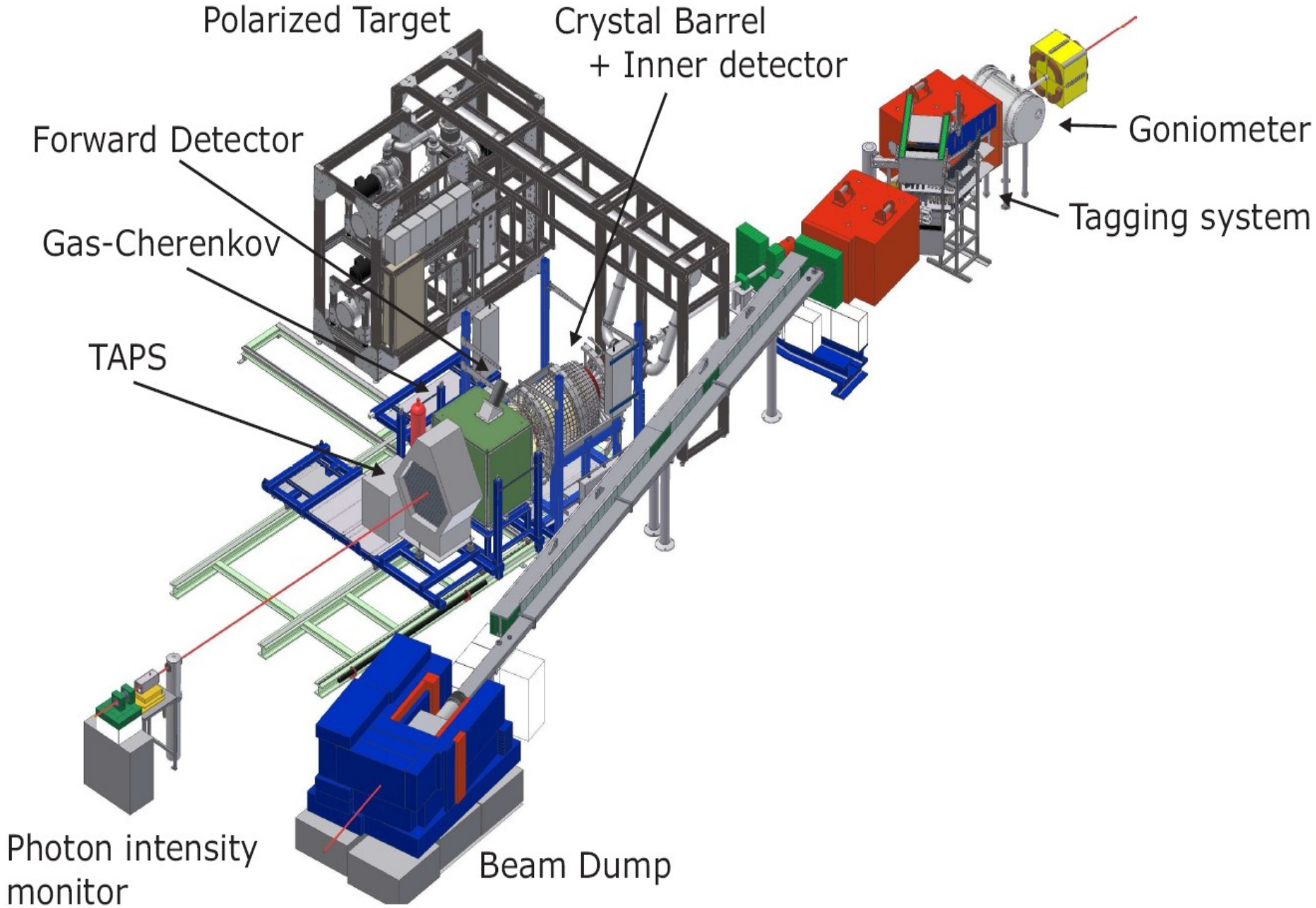
- Detector Overview
  - OLYMPUS detector components
  - Crystal Barrel detector components
- The Bonn DAQ
  - Software overview
  - User interface
  - Requirements
- The Bonn trigger
  - OLYMPUS trigger conditions
  - Hardware

OLYMPUS detector components



- GEM tracker
- Wire chambers
- Plastic scintillators
- Luminosity monitor

The Crystal Barrel Experiment



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Olympus Channel overview

Wire chambers:
- ~ 1000 TDC channels
- LRS1877S Fastbus TDCs
- Fastbus-VME Sequencer

Plastic scintillators
- ~ 100 TDC and ~100 ADC channels
- LRS1877S Fastbus TDCs
- LRS1881 Fastbus ADCs
- Fastbus-VME Sequencer

GEM Tracker
- ~ 2500 digital channels
- APV25 frontends
- Readout via VME/USB-digitizer

Luminosity Monitor
- ~ 2000 digital channels
- APV25 frontends
- Readout via VME/USB-digitizer

~5700 channels

Crystal Barrel overview

Calorimeter:
- ~ 1300 ADC channels
- VME-Fastbus

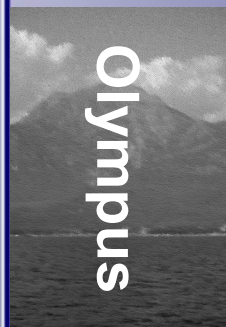
Tagging System:
- ~ 600 TDC channels and scalers VME

Inner detector:
- ~500 TDC channels
- VME readout

MiniTAPS:
- ~500 ADC and TDC channels VME

Other detectors:
- ~300 ADC and TDC channels VME/CAMAC

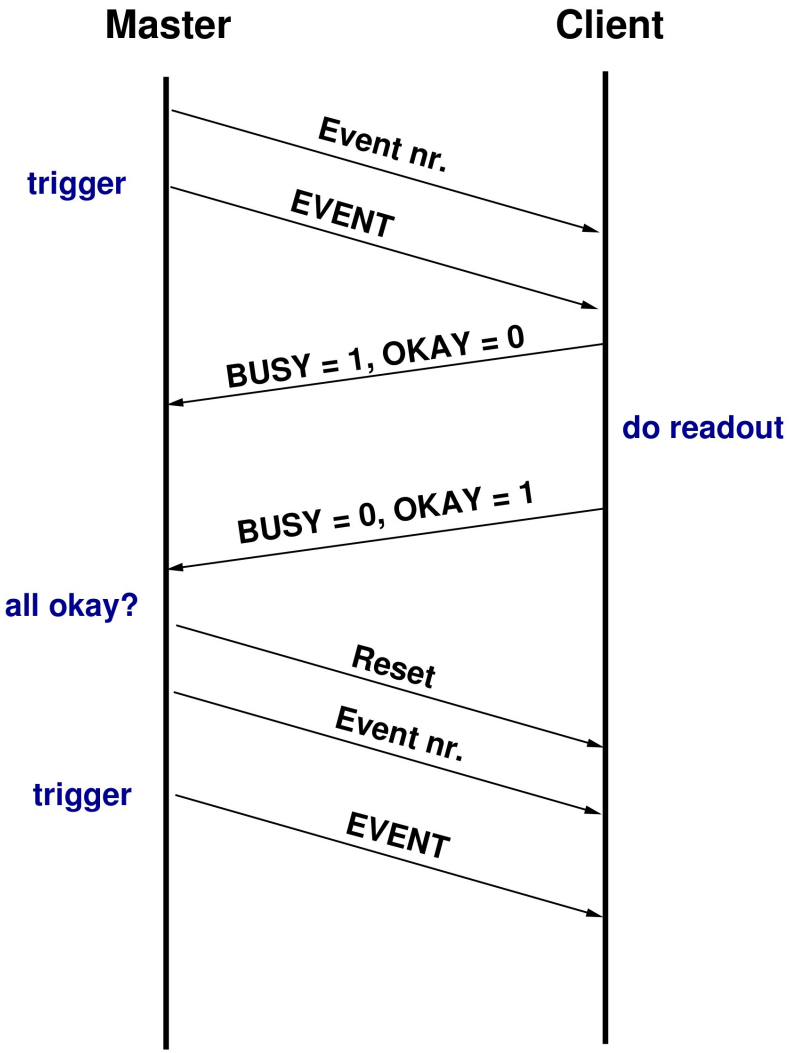
~3800 channels



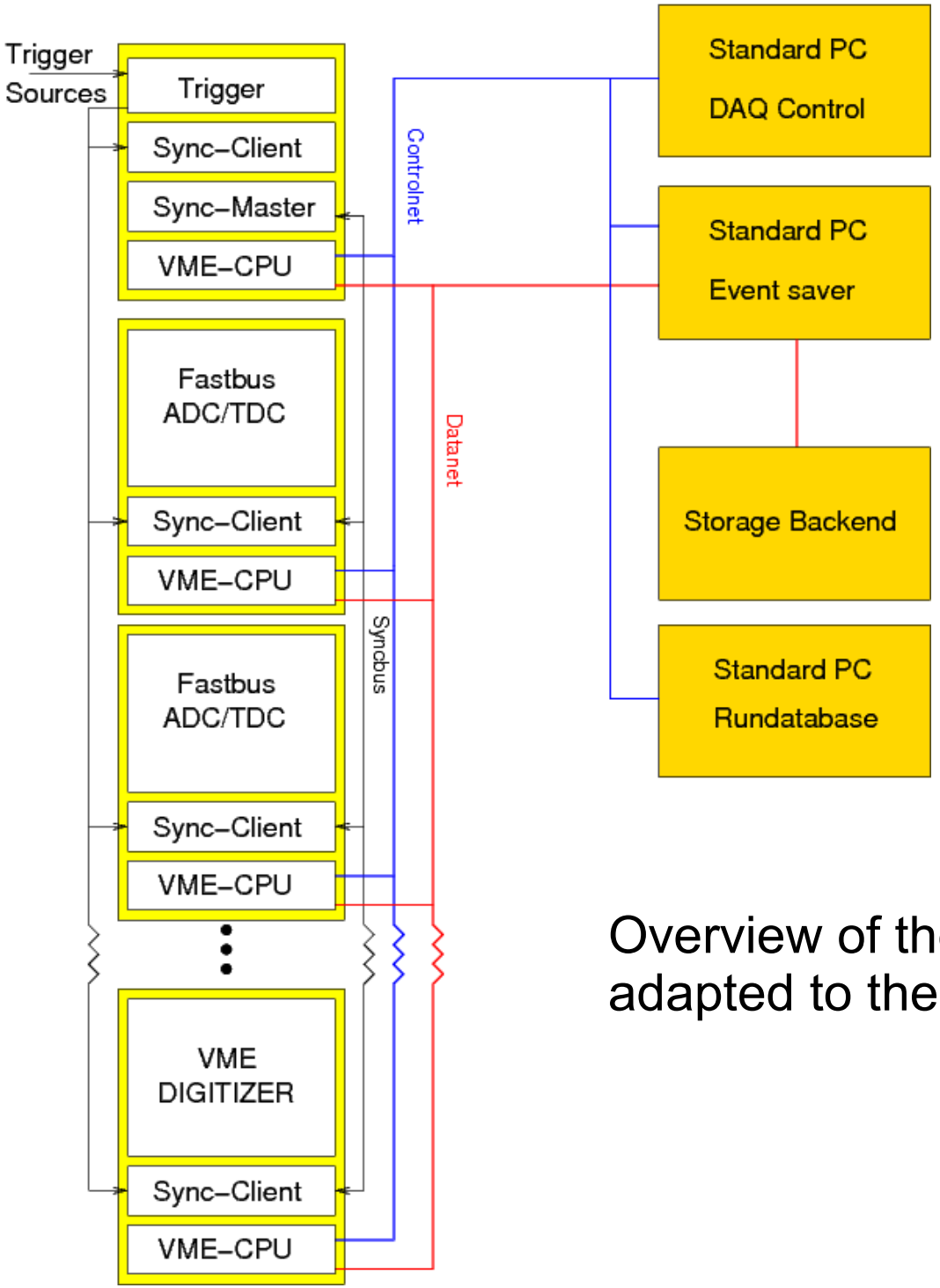
The Bonn DAQ

- Hardware
  - Synchronous design
  - Dedicated synchronization system
  - VME based custom FPGA hardware
- Software
  - Readout framework with pluggable readout and output modules
  - Developed in C++ on standard x86 CPUs using Linux

Readout Sequence



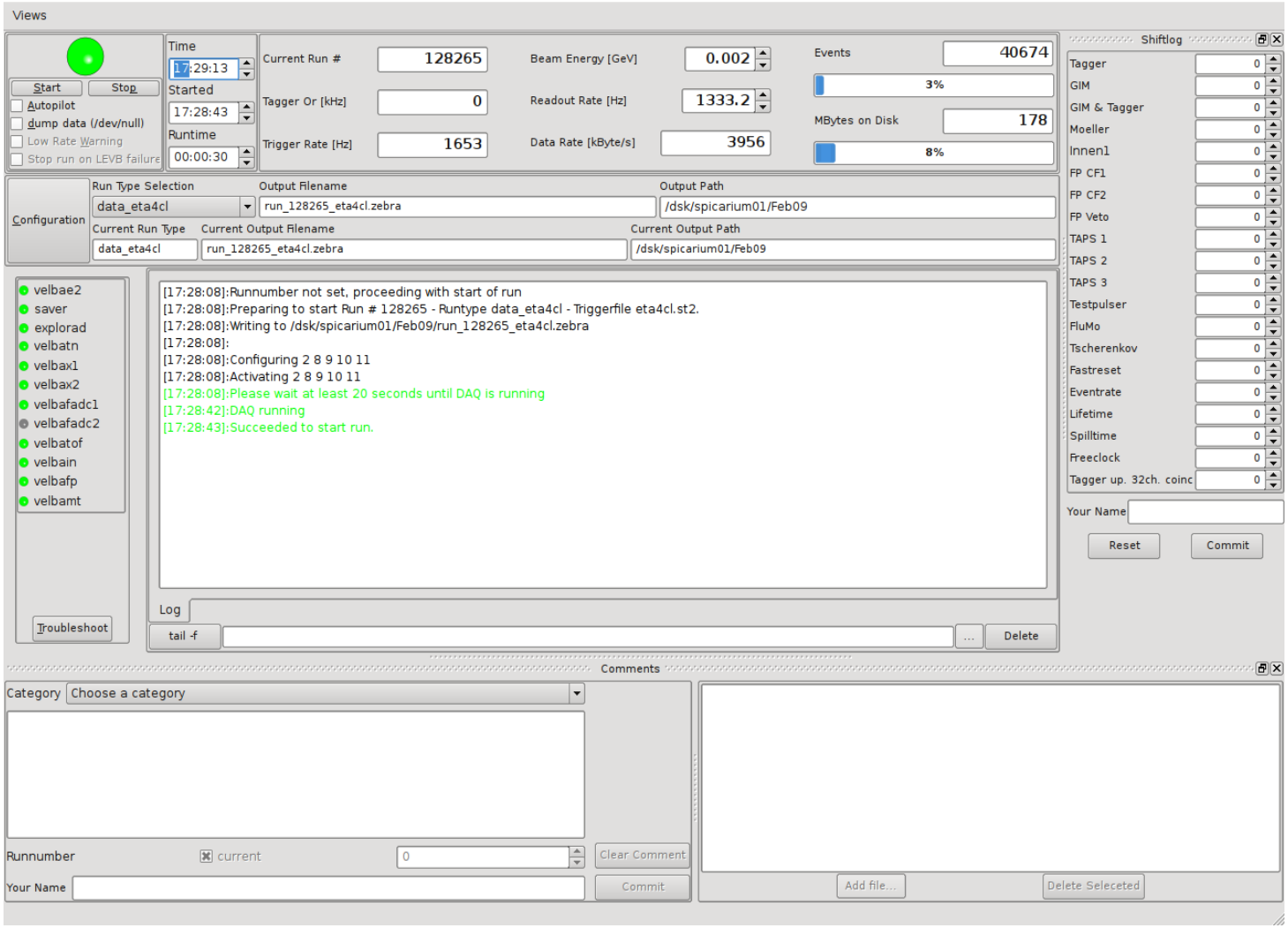
- Synchronous operation guarantees coherent data
- Master/Slave architecture provides scalability for a large number of subdetectors
- Detector-agnostic readout sequence
- Deterministic system
- Good scalability



Overview of the Bonn DAQ system adapted to the OLYMPUS setup

Olympus

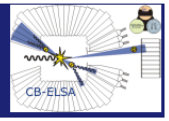
Runcontrol



Runcontrol with integrated logviewer, electronic shift log, and trigger control.

Rundatabase

Run Database



- Show Runs
- Only Comments
- Only Rates

- Auto refresh
- Show Comments
- Show Rates

<= Runnumber <=

-20 Clear +20

<= Beamenergy <=

<= Events <=

Select Radiator types:

ALL
3/1000
C50 Empty
Copper 12

Select Trigger types:

ALL
arbon_omega_prime.st2
blitzdings.st2
carbon.st2
carbon_omega.st2
carbon_omega_nc.st2
carbon_omega_nt.st2
carbon_omega_prime.st2
carbon_omega_prime_nc.st2

Select Target types:

ALL
BOFROST (pol)
BOFROST (unpol)
Carbon

Select number of entries:

8
20
50
100
1000

Apply CSV

Runnumber	Trigger	Events	Detectors	Radiator	Beam energy	Beam polarisation	Target	Target polarisation	Starting time	Ending time	Duration
129771	scaler.st2	1605	goniometer tagger trigger	Vert Wire	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 10:54:45	2009-08-19 10:57:26	00:02:40
129768	new_tagger_coinc_dt.st2	0	gim tagger tof trigger	Copper 50	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 10:43:58	0	00:00:00
129767	scaler.st2	1800	goniometer tagger trigger	Horiz Wire	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 10:30:07	2009-08-19 10:33:51	00:03:44
129766	scaler.st2	1607	goniometer tagger trigger	Vert Wire	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 10:23:17	2009-08-19 10:25:55	00:02:38
129765	ttt8.st2	66161	fp gim in mt tagger trigger x1 x2	Moeller -20(-21)	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 10:04:41	2009-08-19 10:11:40	00:06:58
129764	ttt7.st2	302476	fp gim in mt tagger trigger x1 x2	Moeller -20(-21)	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 09:44:41	2009-08-19 10:03:02	00:18:21
129763	ttt7.st2	33981	fp gim in mt tagger trigger x1 x2	Moeller -20(-21)	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 09:38:17	2009-08-19 09:41:19	00:03:01
129762	ttt7.st2	142322	fp gim in mt tagger trigger x1 x2	Moeller -20(-21)	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 08:59:24	2009-08-19 09:25:17	00:25:52
129762	Hardware: Catches	Catch exceptions, reload !							Schmitz	2009-08-19 09:29:05	
129761	ttt6.st2	331998	fp gim in mt tagger trigger x1 x2	Moeller -20(-21)	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 08:39:28	2009-08-19 08:56:42	00:17:14
129760	ttt12.st2	300640	fp gim in mt tagger trigger x1 x2	Moeller -20(-21)	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 07:44:42	2009-08-19 08:36:57	00:52:15
129759	ttt11.st2	84740	fp gim in mt tagger trigger x1 x2	Moeller -20(-21)	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 06:39:20	2009-08-19 07:43:20	01:04:00
129758	ttt10.st2	292308	fp gim in mt tagger trigger x1 x2	Moeller -20(-21)	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 05:31:35	2009-08-19 06:34:50	01:03:14
129757	ttt9.st2	260940	fp gim in mt tagger trigger x1 x2	Moeller -20(-21)	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 04:26:30	2009-08-19 05:30:29	01:03:59
129756	ttt8.st2	300357	fp gim in mt tagger trigger x1 x2	Moeller -20(-21)	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 03:56:46	2009-08-19 04:25:29	00:28:43
129755	ttt7.st2	300276	fp gim in mt tagger trigger x1 x2	Moeller -20(-21)	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 03:39:44	2009-08-19 03:55:45	00:16:00
129754	ttt6.st2	300450	fp gim in mt tagger trigger x1 x2	Moeller -20(-21)	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 03:24:52	2009-08-19 03:38:41	00:13:48
129753	ttt5.st2	300112	fp gim in mt tagger trigger x1 x2	Moeller -20(-21)	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 02:52:37	2009-08-19 03:23:49	00:31:11
129752	ttt4.st2	300408	fp gim in mt tagger trigger x1 x2	Moeller -20(-21)	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 02:28:28	2009-08-19 02:51:36	00:23:07
129751	ttt3.st2	196406	fp gim in mt tagger trigger x1 x2	Moeller -20(-21)	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 02:16:40	2009-08-19 02:26:20	00:09:39
129750	ttt2.st2	300457	fp gim in mt tagger trigger x1 x2	Moeller -20(-21)	2350	Unpolarised	Cosmics	NOT SET YET	2009-08-19 01:52:52	2009-08-19 02:15:40	00:22:47
# of runs	-	Total events	-	-	-	-	-	-	Total time		
20		3819044							07:49:20		
-20										+20	

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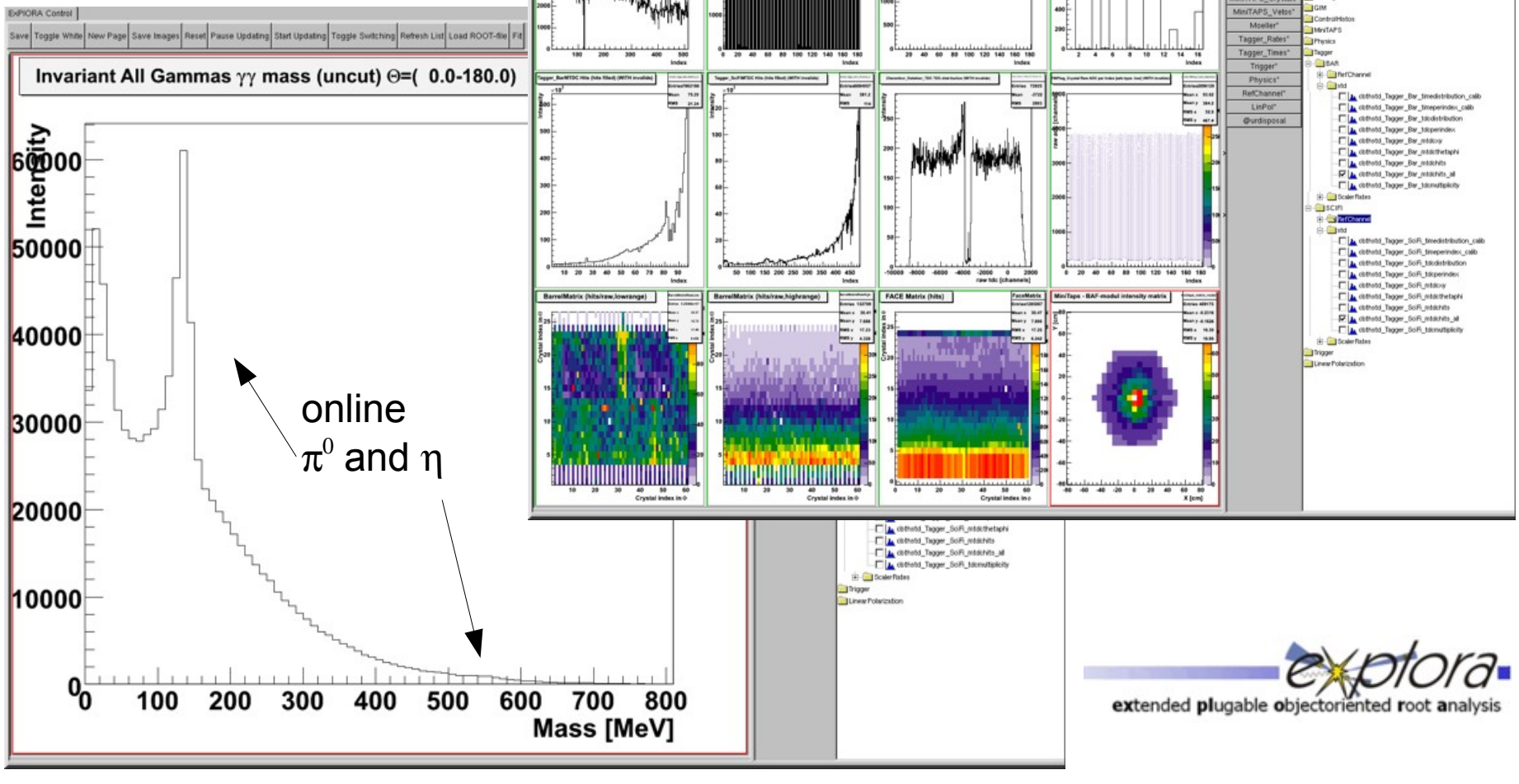
Online Monitor

root based online monitoring of incoming data (hitpattern / timing)

realtime (pre)analysis of data (using the **explora** framework); > 50Hz



explora
extended plugable objectoriented root analysis

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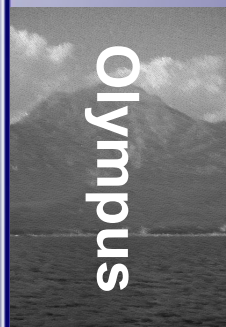
DAQ Performance

- 6 subdetectors capable of providing a 1st level trigger with a decision time of max. 250 ns
- Optional 2nd level trigger for slower hardware components
- Maximum single detector rate ~8 MHz (Tagger)
- 40 kHz maximum readout rate
- ~750 Hz readout rate under current experimental conditions
- Current event size ~ 6kb
- Reliable proven system
- Successfully used for datataking since 2001

- Technical Overview
  - Synchronous design
  - Master/Slave architecture
  - Dedicated Syncbus
  - C++ based extensible software
- Syncbus
  - Dedicated VME Master and Slave Modules
  - Connection over Twisted Pair ECL cables
- Eventbuilder
  - VME CPU based readout of subdetectors
  - communication/data transfer via TCP/IP
  - modular, easily adaptable software
- Eventsaver
  - Standard PC hardware
  - can support multiple output formats due to modular design
- Software
  - Objectoriented C++ framework
  - Central SQL rundatabase
  - QT-based graphical frontend

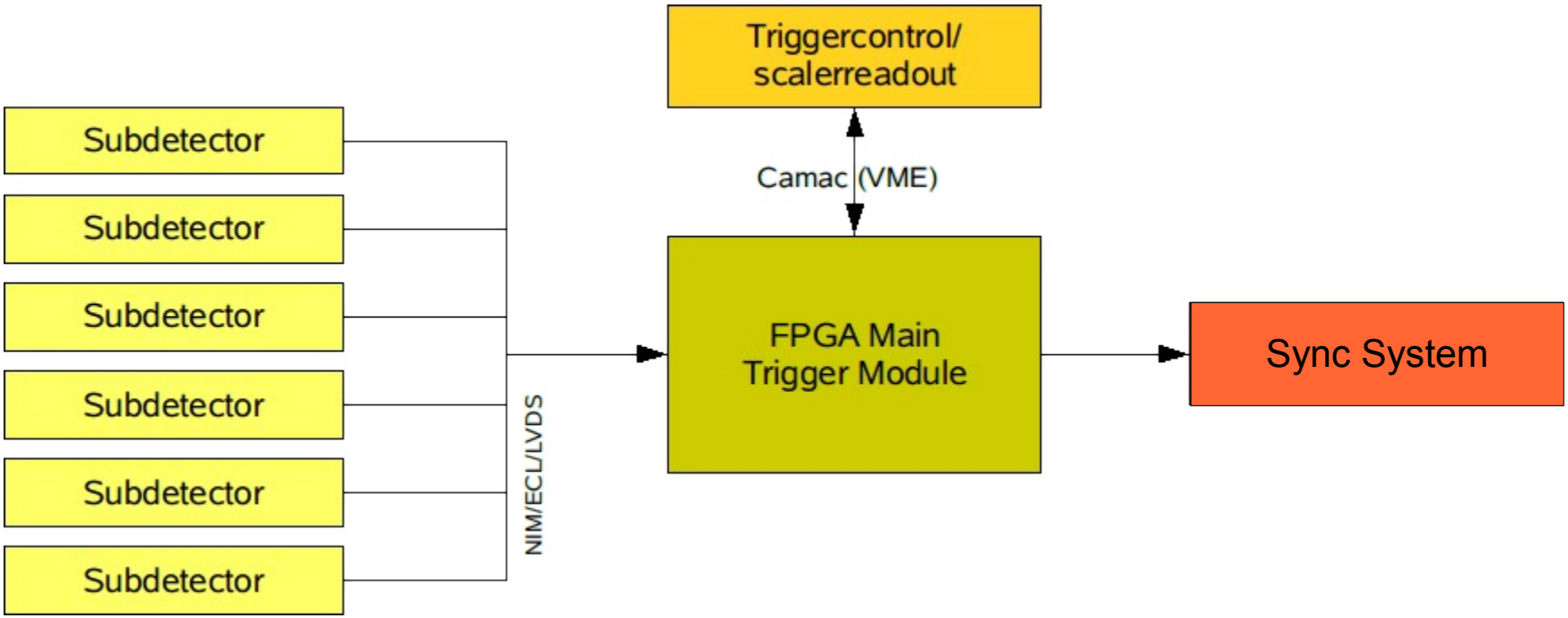


The Olympus trigger

- Goal: Efficient detection of elastic $e^{\pm}p$ events
- 1st level capable (fast) detectors:
  - ToF Plastic scintillators (ToF^{L} ToF^{R})
  - GEM stacks ($LuMi^{L}$, $LuMi^{R}$)
- Optional trigger on wire chambers

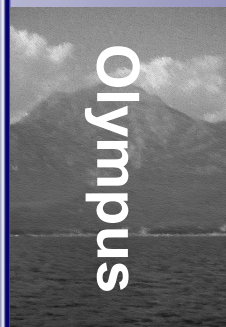
Trigger Condition	Sensitivity/Purpose	Prev. BLAST rates/ LuMi predictions
ToF^{L} AND ToF^{R}	$e^{\pm}p \rightarrow e^{\pm}p$	~30 Hz
$ToF^{L/R}$ AND $LuMI^{L/R}$	$e^{\pm}p \rightarrow e^{\pm}p$ (small angle)	~ 0.5 Hz (4.5 GeV) ~ 27 Hz (2 GeV)
ToF^{L} OR ToF^{R}	Tests/Debugging	760 kHz
$LuMi^{L}$ OR $LuMi^{R}$	Tests/Debugging	

The Bonn Trigger



(simplified overview)

- Technical Overview
  - freerunnig combinatorial trigger
  - versatile trigger conditions
  - Optional 2nd level trigger capability
  - global timing from a single detector (time reference)
- Main trigger module
  - FPGA based CAMAC module (VME in preparation)
  - tested rate stability up to 10 MHz
  - 16 trigger inputs
  - up to 8 different trigger conditions at the same time
  - integrated scalers for rates, life/deadtime measurement
- Trigger conditions
  - Programmable via VHDL
  - Custom Triggers can be implemented for tests etc.



Requirements

- Hardware
  - Existing electronics will be reused (ADC,TDC Logicmodules...)
  - New CPUs are needed (8 CPUs including spares)
  - Sync system is available
- Software
  - Necessary adaption of the software can be done by
    1 postdoc + 1 PhD student
  - All know-how concerning the used hardware and software is centered in Bonn
- Testing
  - All readout electronics can be tested in on site by the Bonn group

Summary

- The Bonn DAQ framework is ideally suited to support the OLYMPUS experiment.
- The Bonn trigger system fulfills all requirements for the OLYMPUS setup and seamlessly integrates with DAQ system
- The manpower required to implement this system is comparatively low and fits to the OLYMPUS time schedule
- The key developers of the abovementioned system are all part of the OLYMPUS collaboration or the Bonn group.