Concept of a Software Trigger for an Experiment at TESLA

CONTENT

TESLA

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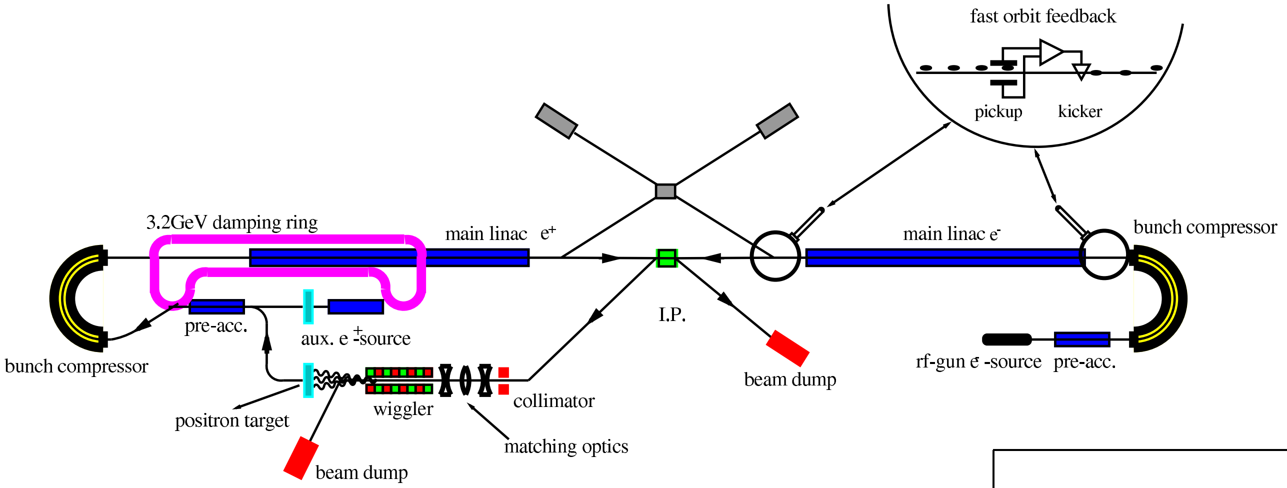
Conclusion

ECFA DESY
Linear Collider Workshop

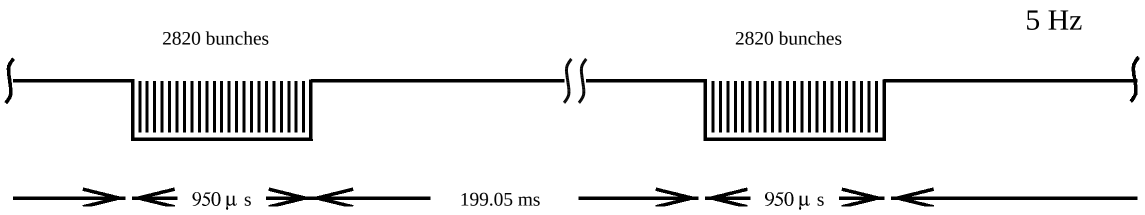
TESLA



- Options:
  - 90 < √s < 800 GeV
  - $e^+ e^-$, $e^- e^-$, $e\gamma$, $\gamma\gamma$
  - e(TESLA) p(HERA)

	500 GeV	800 GeV	unit
repetition rate	5	3	Hz
bunches per pulse	2820	4500	
pulse length	950	850	μsec
bunch spacing	337	189	nsec
luminosity	$3.1\ 10^{34}$	$5.0\ 10^{34}$	$cm^{-2}s^{-1}$

TESLA



- Relatively long time between pulses (bunch trains): 199 ms
- Rather long time between bunches: 337 ns
- Rather long bunch trains (same order as detector readout time): 1ms

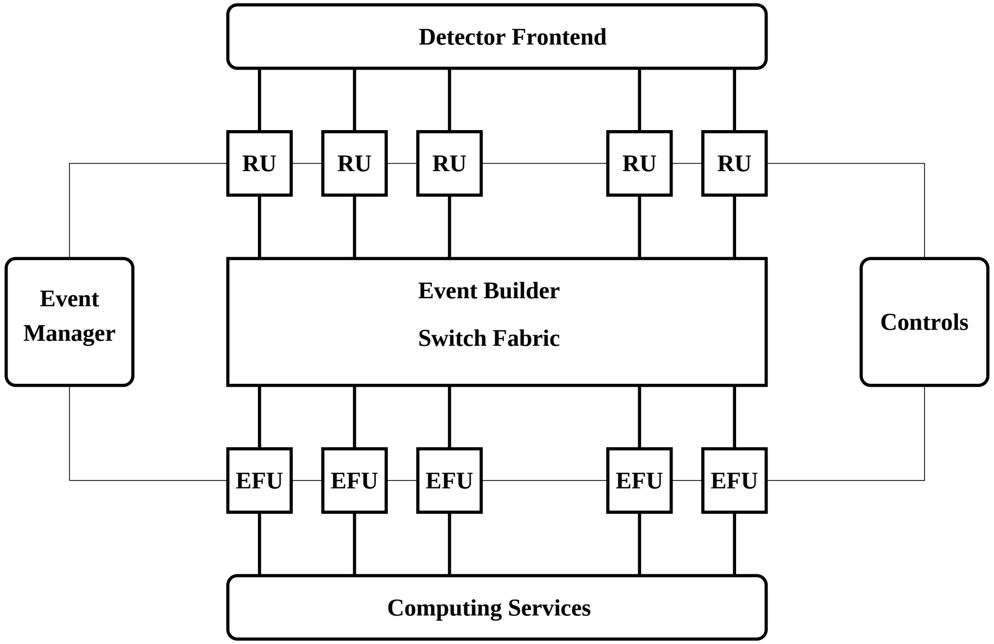
Trigger and DAQ Concept

- AIM:
  - fully efficient and flexible trigger
  - deadtime free readout

    ⟹ *no data loss*
  - easy maintenance
  - scalabilty
  - exploit TESLA operation mode

- CONCEPT:
  - readout and store data of complete bunch train into pipeline
    - no trigger interrupt
    - 1 ms active front-end pipeline
  - perform zero suppression and/or data compression
    - manageable data volumes online
  - apply software selection between pulses
    - full event data information of complete pulse available
    - store classified events according to (physics) needs

Trigger and DAQ Concept Overview



- 1 (or virtually 2) level trigger and DAQ system
  - deadtime free
  - no conventional L1
  - just one level of selection

Very similar to CMS architecture without L1

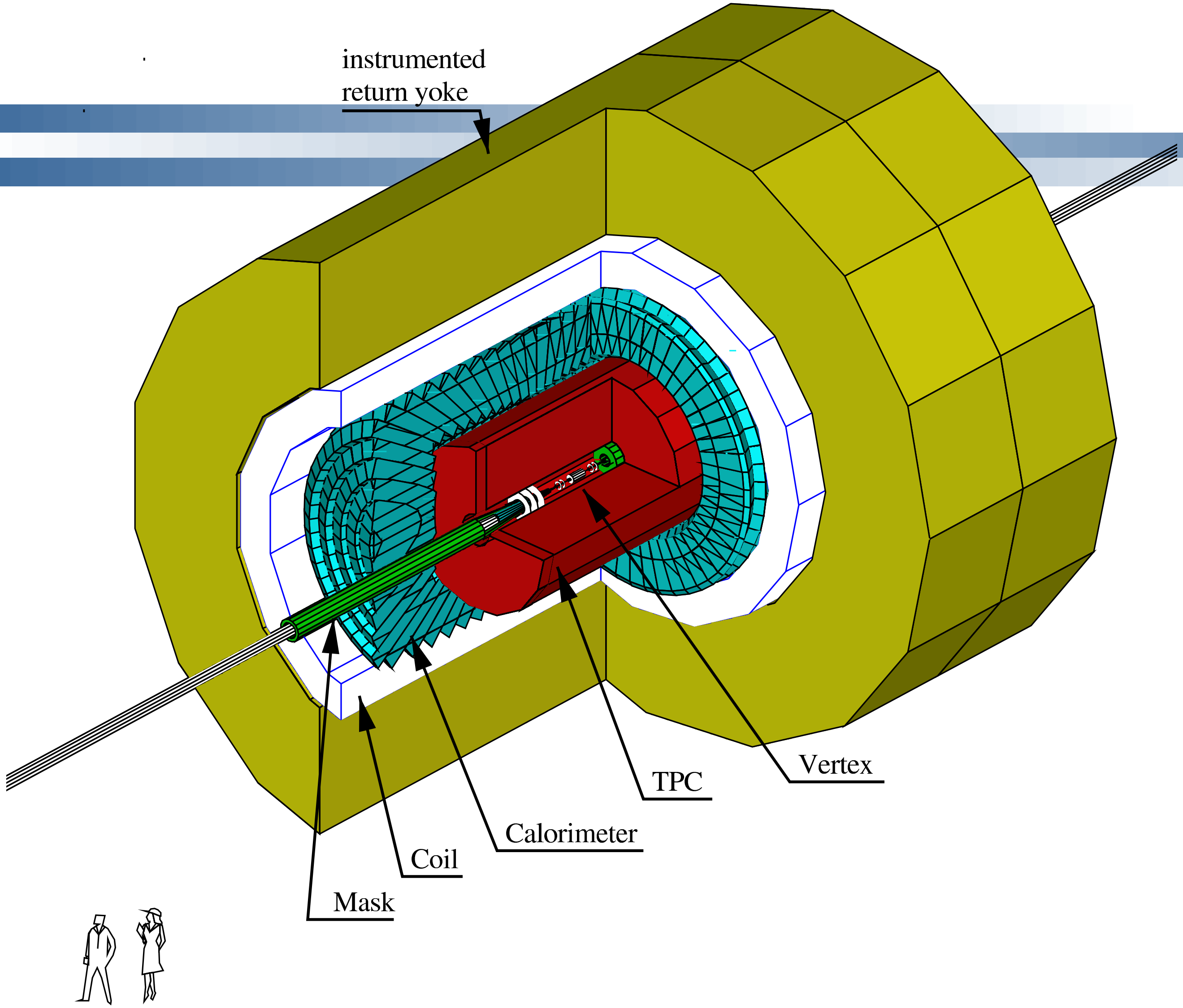
Trigger and DAQ Concept Advantages

- Flexibility
  - programmable to a large extent
  - full event information available
  - unforeseen (background or physics) rates easily accommodated
- Ease of maintenance (cost effectiveness)
  - off-the-shelf technology (memory, switches, processors, ...)
  - commonly used operating systems
  - high level programming languages
  - on-line computing resources usable for off-line applications
- Scalability
  - modular system
- Efficiency
  - all data is looked at
- Portability
  - off-line software in on-line environment

Trigger and DAQ Concept Implications

- Constraints on detector readout technologies
  - readout 1 ms continuously
    - digitising during pulse to keep occupancy small
    - no active gating for the TPC
    - ...
- Pattern recognition for complete pulses
  - parallel processing of trains
- Feasibility depends on occupancy, in particular in inner VXD layer (see below)
- High bandwidth in front-end and event builder
  - few GB/s

Detector Concept



General concept:

- large detector with
  - gaseous main tracking chamber
  - hermetic highly granular calorimeter
  - high precision vertex detector

Physics and Background Rates

Physics

$e^+ e^- \to X$	0.0002/BX
$e^+ e^- \to e^+ e^- X$ ($\gamma\gamma$)	0.7/BX

Background

- neutrons 1000n/BX
- e^+e^- pairs
  - ✯ VXD inner layer 500 hits/BX
  - ✯ ITC 100 hits/BX
  - ✯ TPC 10 hits/BX
- photons (~1000γ/BX)
  - ✯ TPC 40 tracks/BX

⇒ *Background dominated !*

Data Volume

component	channels $[10^3]$	hits per train $[10^6]$	MB per train
VXD	730 000	30	60
FTD	20 000	2	4
ITC	10 000	2	4
TPC	720	17	170
CAL	200	8	32
MUON	200	1	4
LAT	10	1	4
total	800 000		278

~300 MB per bunch train

Comparison with other Experiments

experiment / collider	bunch separation [ns]	channel count [k]	L1 accept rate [kHz]	event building [Mbit/s]	L3 accept rate [MB/s]	data volume [TB/y]
LEP	10000	150	–	10	0.2	2
H1/ZEUS	100	400	1	100	0.5	5
HERA-B	100	500	50	2000	2.5	25
BABAR	5	200	2	400	2.5	25
RHIC	–	250	–	–	20	250
COMPASS	–	250	–	–	35	350
TEVATRON	150	1000	25	5000	15	150
LHC	25	100000	100	500000	100	1000
JLC	3	100000	–	150000	100	1000
LC	350	100000	–	15000	15	150

Comparison with other Experiments

	present colliders	LHC	LC
event building	250 MB/s (HERA-B, . . .)	50 GB/s	1.5 GB/s
event processing (reconstruction, filter)	1 s (H1, HERA-B, . . .)	1 s	1 s
data volume	100 TB/y (Tevatron, . . .)	1 PB/y	150 TB/y
processing units for L2/L3	few hundred boxes (HERA-B)	few thousand boxes	few hundred boxes

- Requirements in the ballpark of experiments which come into operation shorty

Conclusions

Base-line Concept

Deadtime-free software selection

- Considerable flexibility both in design of physics algorithms and in the choice of data used by these algorithms
  - rare physics and unfavourable event topologies can be kept
  - event data storage under control of event filter algorithms written according to needs of physics groups
  - more efficient trigger
- Event bulding rates are much smaller than at LHC and comparable to those at present experiments
  - feasible - (almost) today
  - less demanding than for LHC
- expected development of computing technology very favourable
  - commodity hardware, high level programming languages and widely used OS will ease scalability and maintenance
  - merging on-line and off-line worlds results in more effective use of resources

⟹ *Better, more efficient trigger !*