

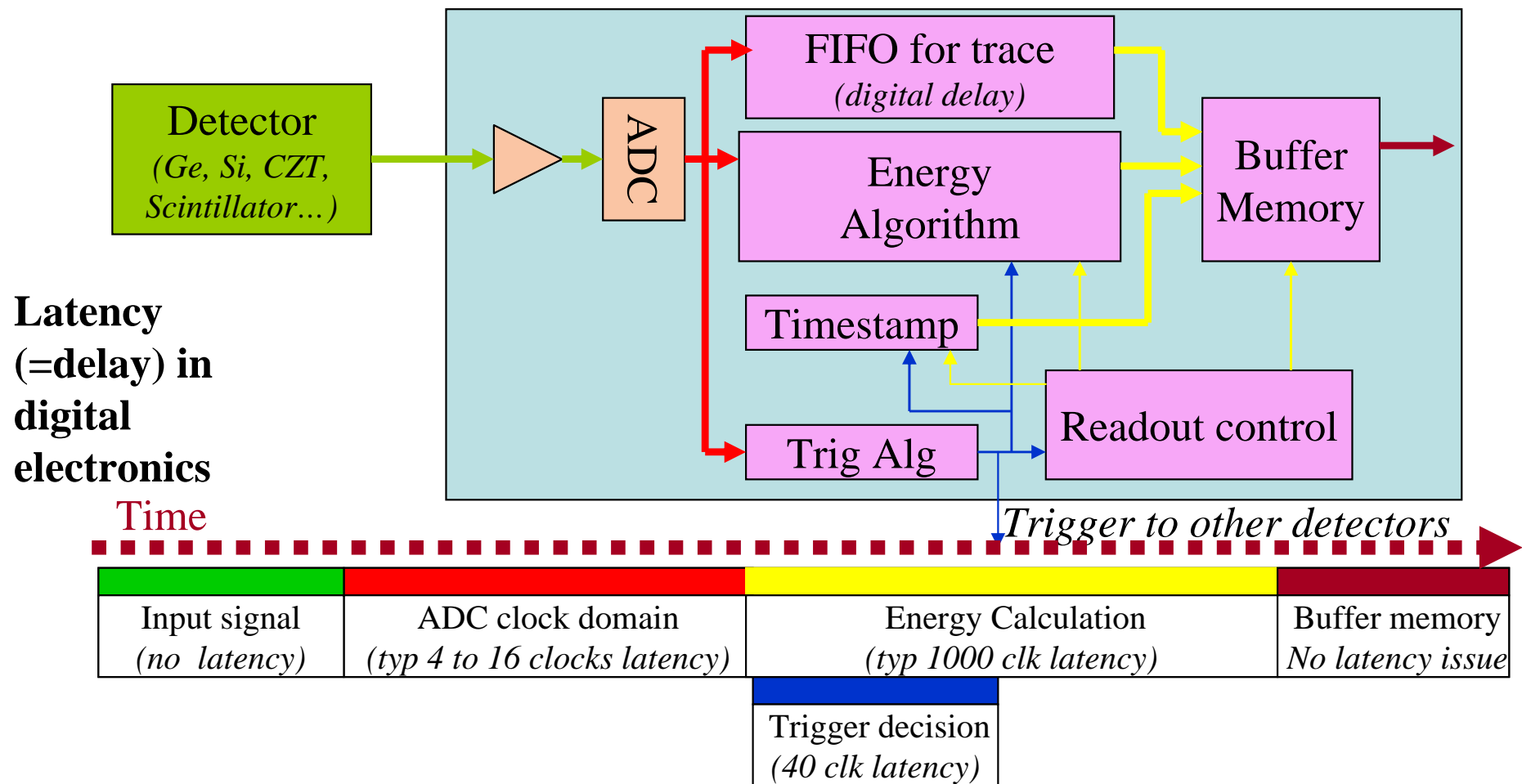
# **NUSTAR DAQ**

**Triggering, dead time and latency.**

*Ian Lazarus EXL/R3B meeting Oct 2006*

# Some definitions and comments

- **Latency**- a problem for mixed digital-analogue systems (or digital systems using different processing times). Digital systems can cope with delays as long as they are aligned in time. Analogue delays are not so easy. This is a mismatch.
- **Timestamping**- a basic requirement for self triggering (“triggerless”) front ends. Used for software coincidence and delayed coincidence triggers. Minimizes or removes deadtime.
- Timestamped systems can use either analogue or digital pulse processing.
- Timestamped systems do not preclude front-end local triggers. Trigger could be analogue or digital. **But, front end triggers (re)introduce deadtime so lose some of the advantage of timestamps.**



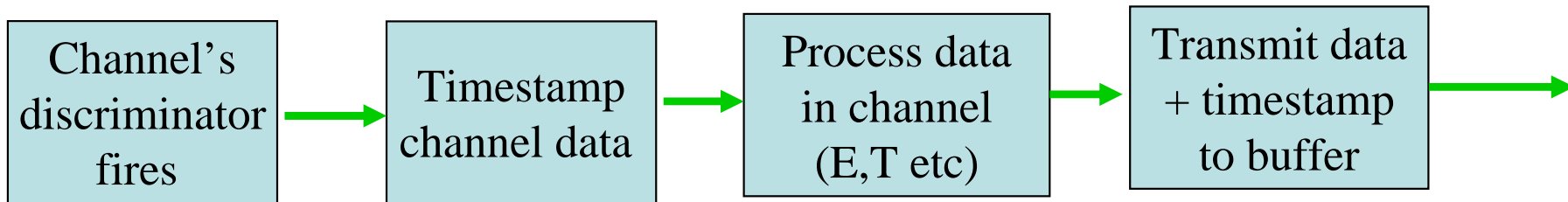
ADC has variable latency (40ns to 160ns @ 100MHz)

Trigger decision (assume digital version of TFA+CFD) adds 400ns@ 100MHz

**So earliest trigger out to analogue electronics is around 500ns@ 100MHz**

The energy algorithm needs around 10 $\mu$ s to operate; need to delay trace data to wait for the energy calculation to complete (or use circular buffer).

Once data is derandomised and in buffer memory there are no further latency issues as long as the memory is large enough.

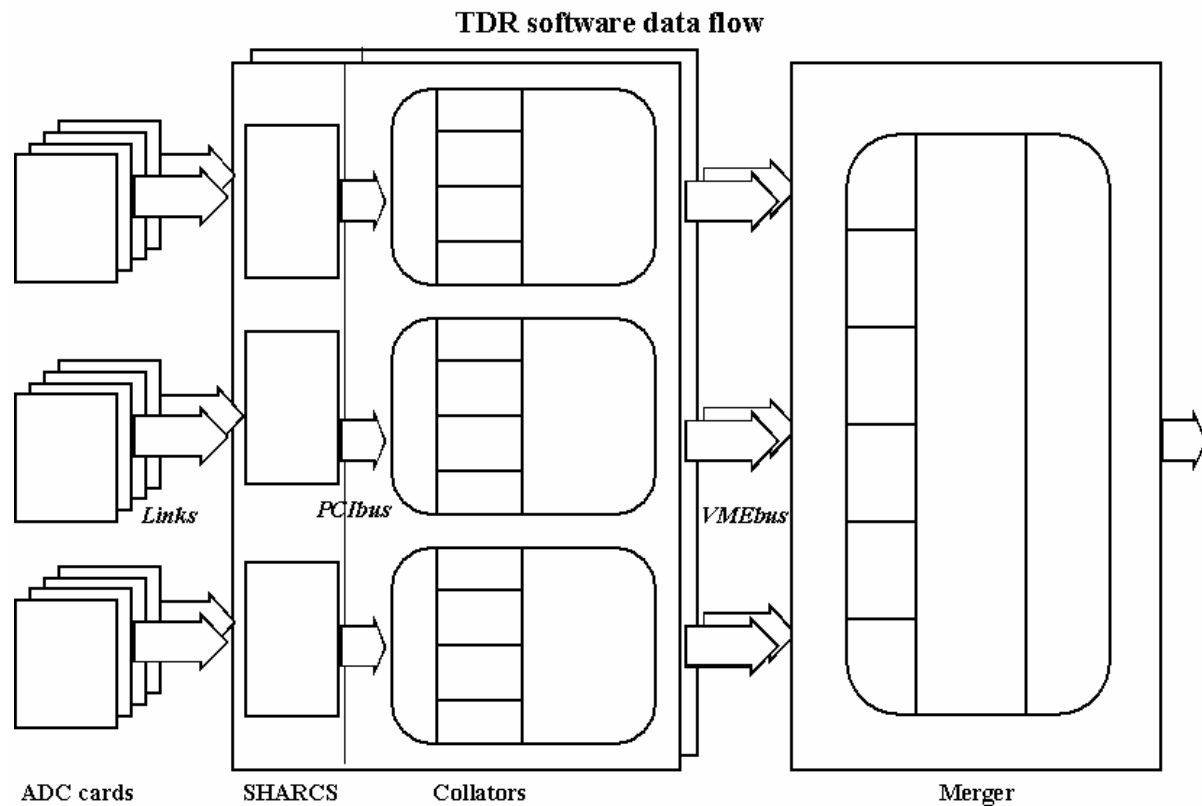


## Timestamping example 1

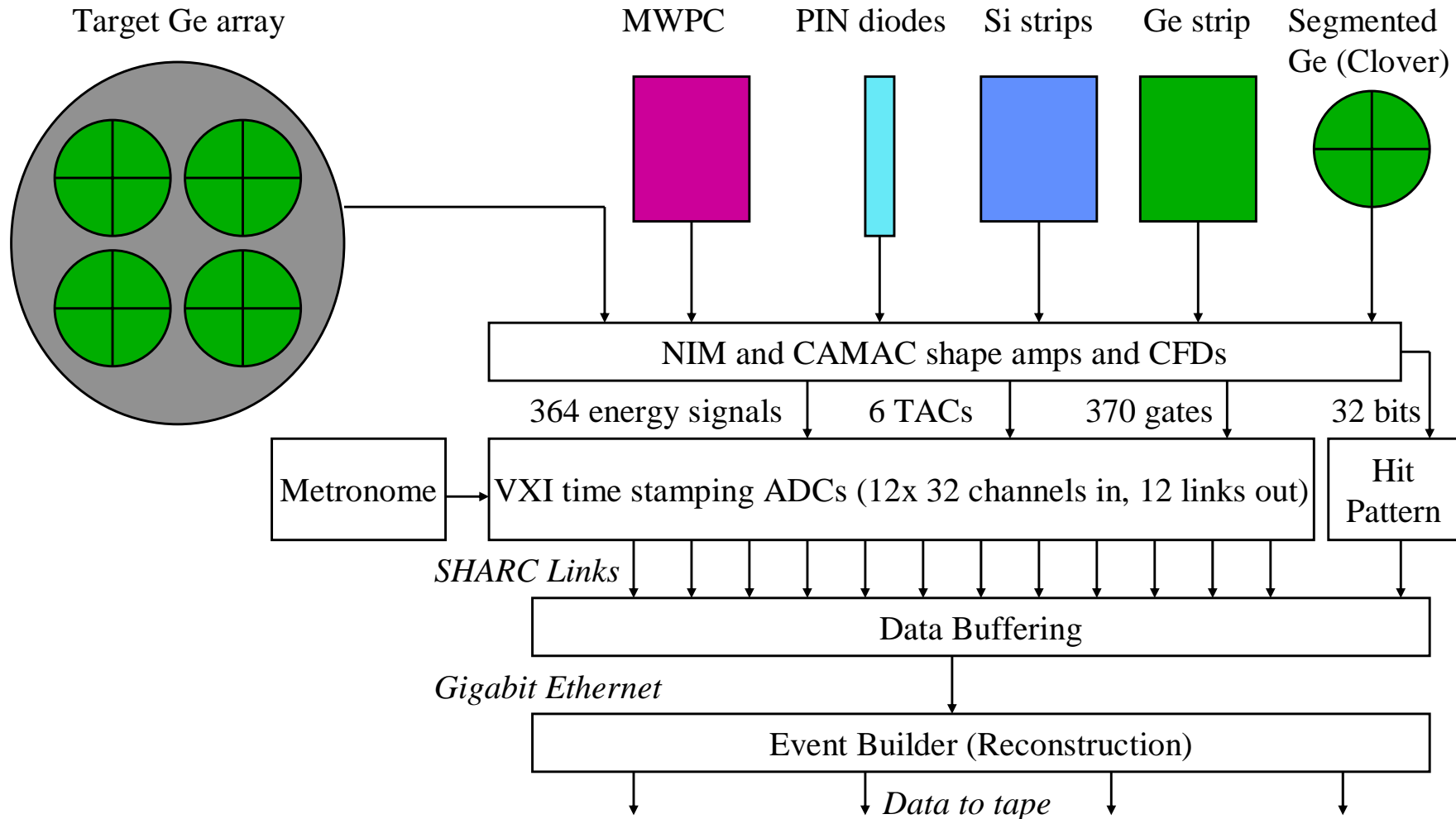
### GREAT

Connect using copper cables

Processing in channel could be analogue or digital (GREAT uses analogue).

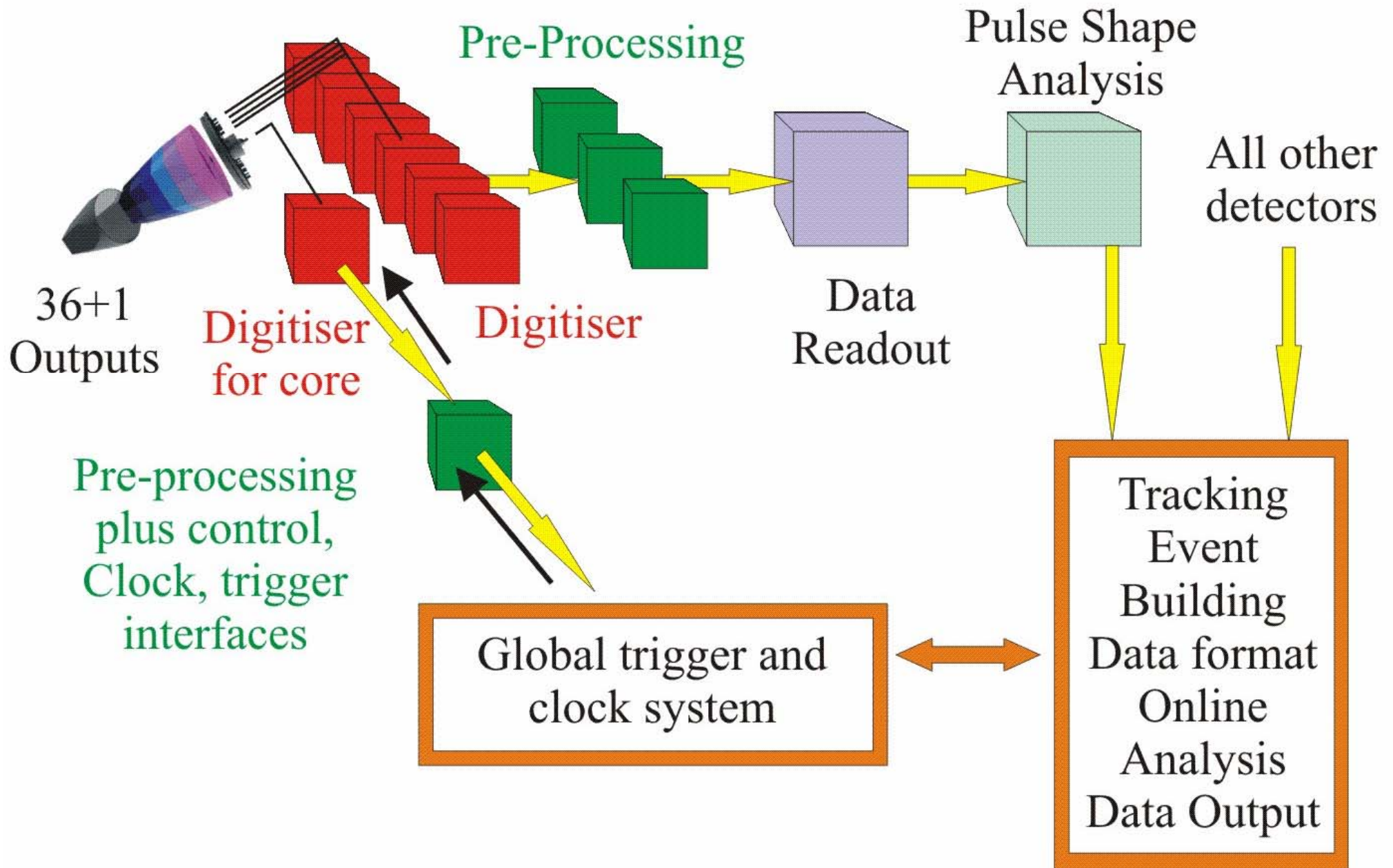


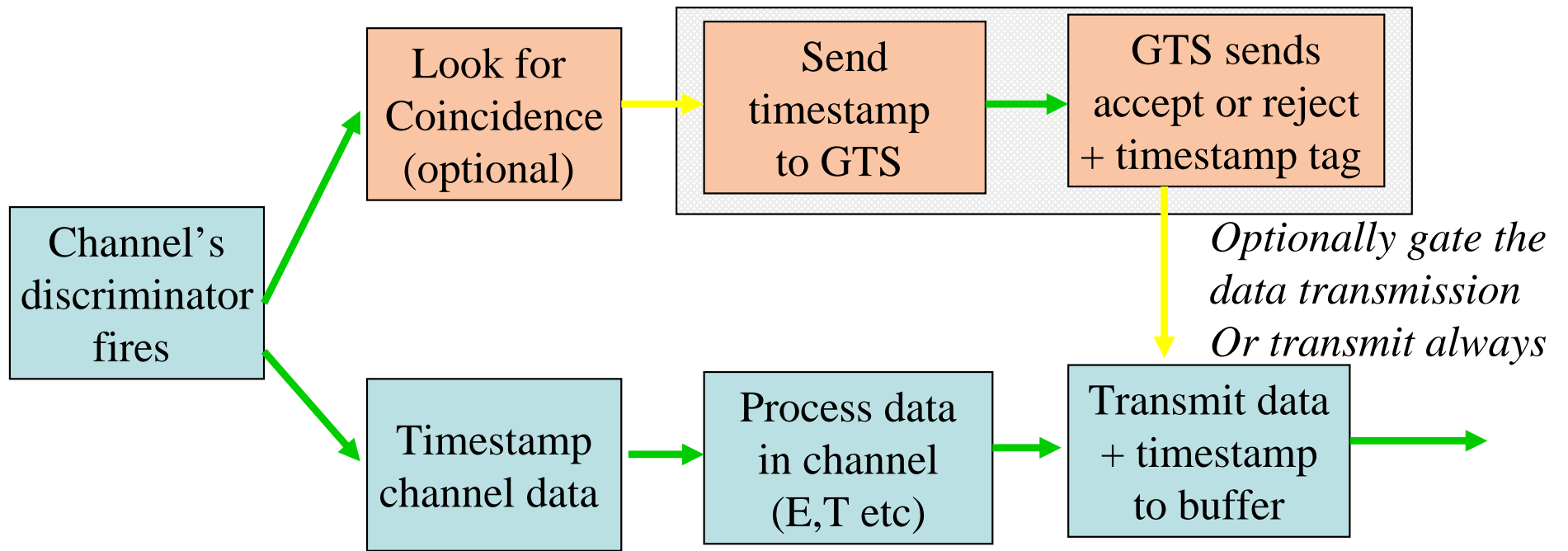
# The GREAT Triggerless Total Data Readout Conceptual block diagram



**TDR Method:**  
**Use 10ns timestamps to label data**  
**Read it all and correlate later in software**

# *Schematic of the Digital Electronics and Data Acquisition System for AGATA*



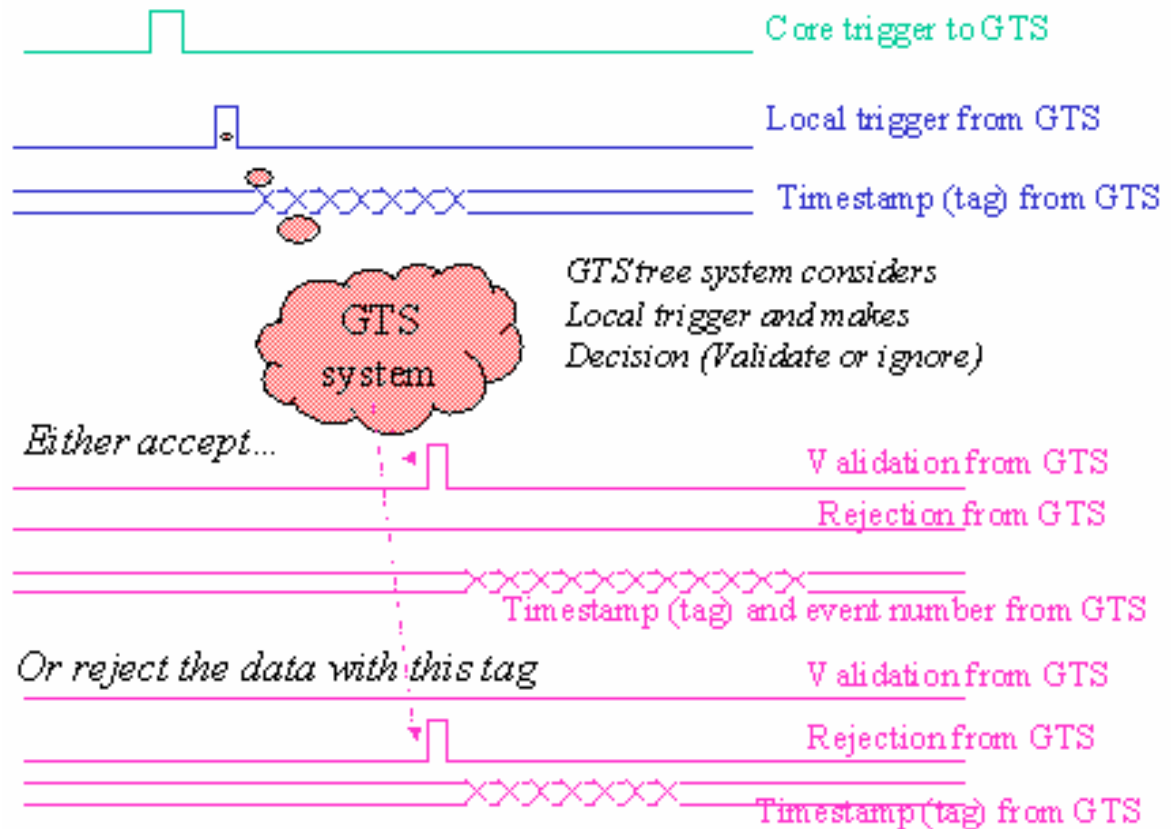


## Timestamping example 2

### AGATA GTS

Connect using fibres

Processing in channel could be analogue or digital (AGATA uses digital)



# Some comments on cabling

- Use fibres!!
- Why?
  - Significantly reduces number of connections
  - No grounding issues
- How?
  - Concentrate the signals as early as possible and use digital electronics where possible.
  - Timestamp the data with coherent global clock system (not just clock, but also synch and reset)
- Drawbacks
  - Power required in front end is higher due to digitisation and possibly processing of data prior to fibre concentration.



## Conclusion:

- NUSTAR DAQ is based on Timestamps (software uses this to correlate data from all the detector subsystems)
- Electronics can be analogue or digital
- Can have local trigger or be self triggering- depends on data rate and deadtime issues.
- But each channel **must** be time stamped.