



E U S O

Readout and Trigger Electronics Scheme

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Trigger (1)

- **TRIGGER** (in general)
In some part (at various levels) of the instrument there is an “activity”, due to incoming U.V. photons, that needs to be handled.
- A **MC_TRIGGER** is a **REQUEST** sent to the **SYSTEM TRIGGER**: it happens each time that an element (ex. a MacroCell) detects “enough activity” coming from the electronic chain in one GTU.

NOTE: GTU is the Gate Time Unit and its length will be programmable.



Trigger (2)

- **TRIGGER TUNED**

is issued at level of SYSTEM TRIGGER :

a minimum of “consecutive” active GTUs for a specific element is reached (persistence of the MC_Trigger Request)

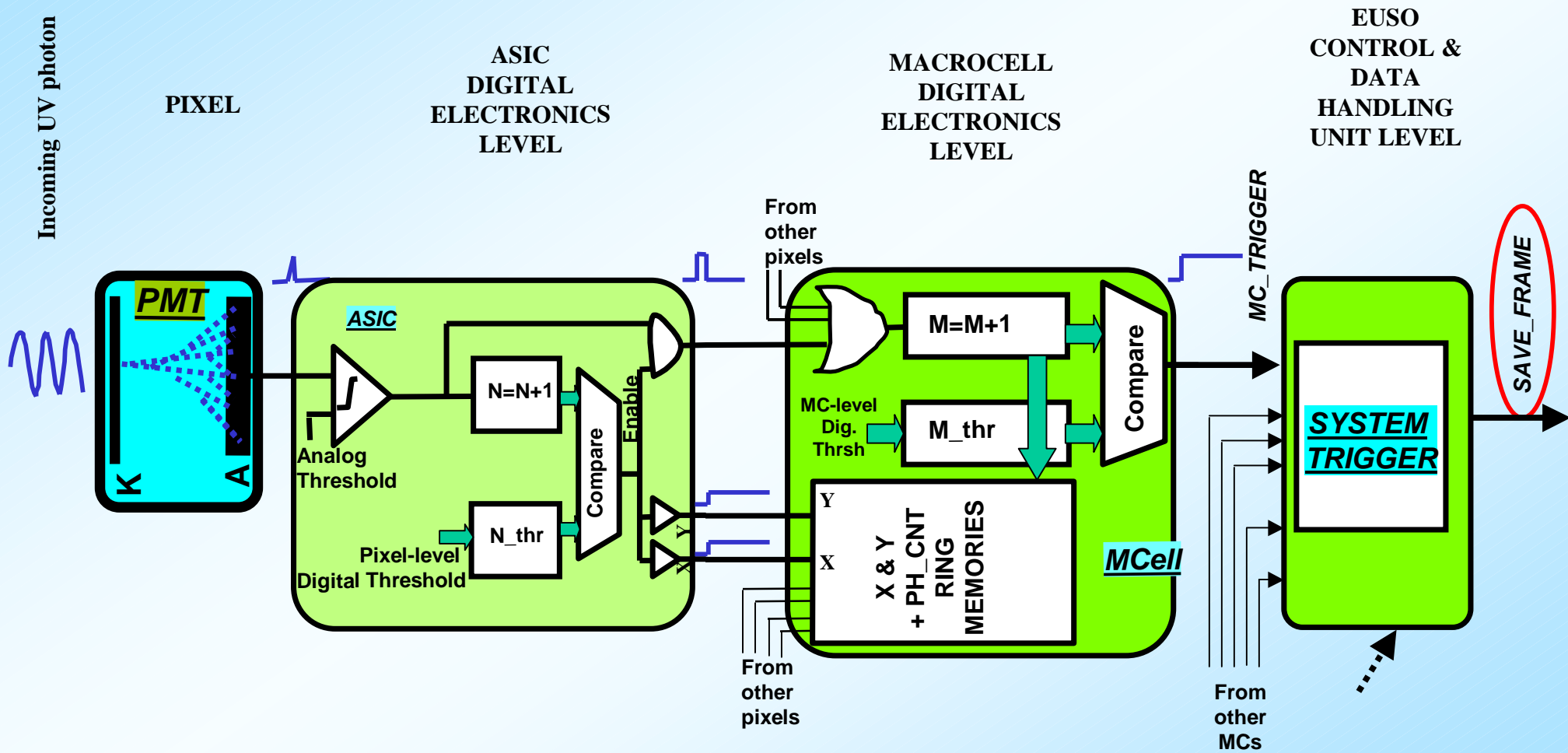
- **TRIGGER** (*decide and execute*)

is issued at level of SYSTEM TRIGGER after the “activity” for a specific element is stopped.

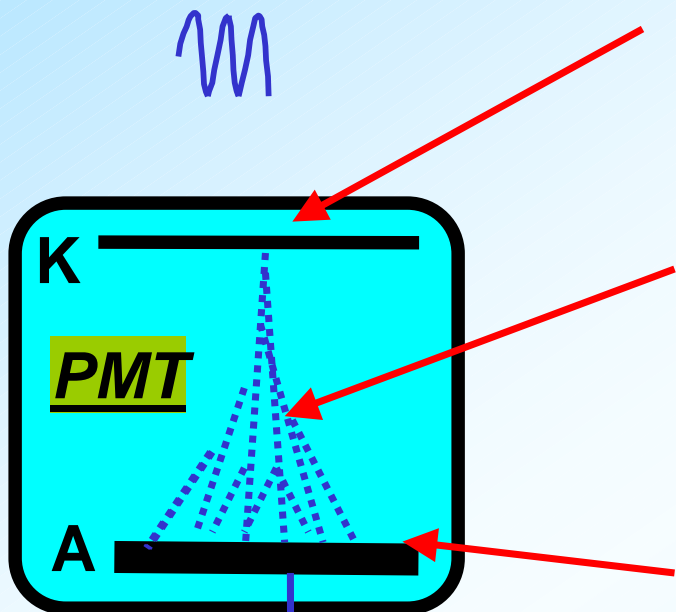
At this time data from Ring Memories are moved to Main Memory, equal to the duration of MC_Trigger Request in number of GTUs, plus a certain number to include some GTUs just before and after the event.

NOTE: At the same time a request will be sent to activate the LIDAR system.

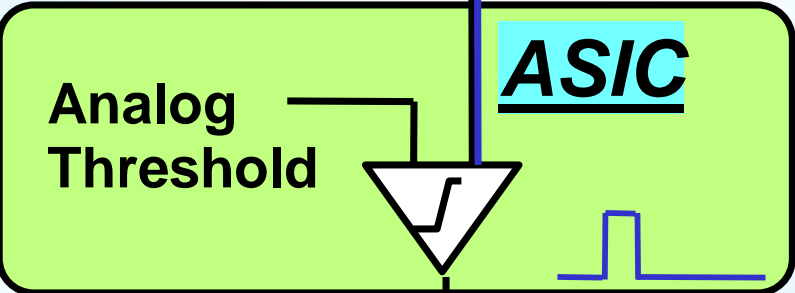
Location of trigger elements



Pixel Level

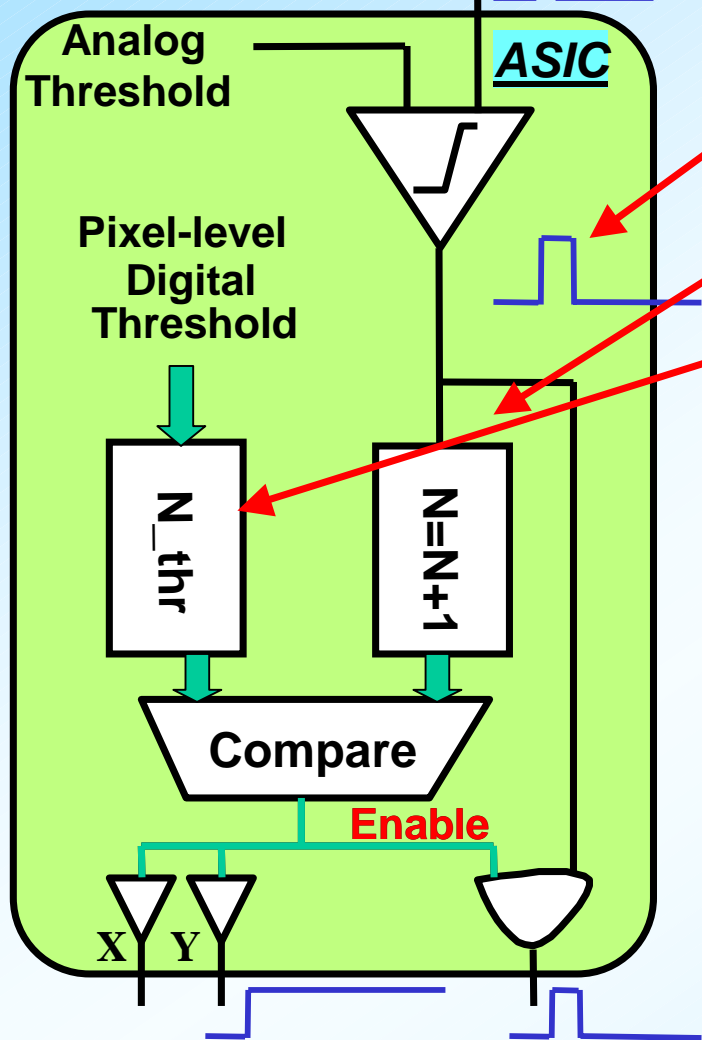


- 1) An UV photon impinges on the photocathode
- 2) An avalanche multiplication of photoelectrons is emitted by the photocathode
- 3) The electrons reach the opposite laying anode (one for each pixel). *The single-photoelectron pulse is around 10^6 electrons.*



NOTE: electronic noise floor is eliminated at this stage

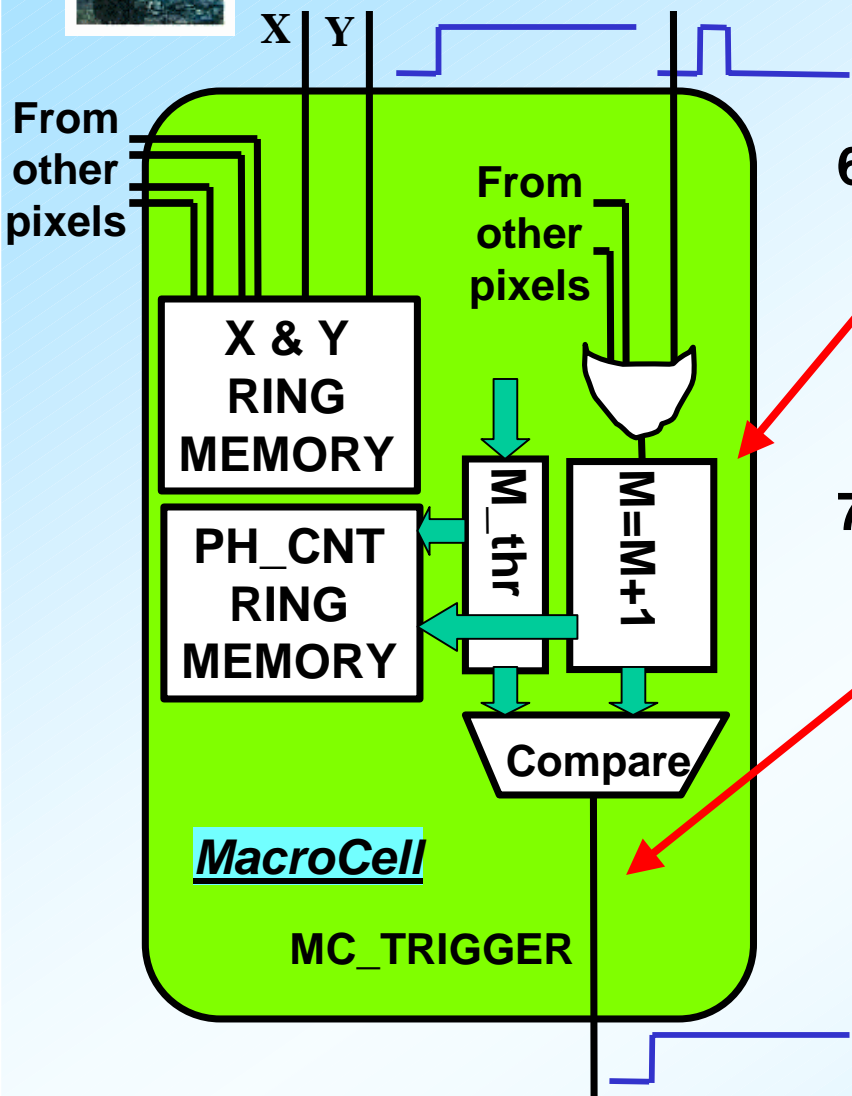
ASIC level



- 4) If the analog threshold is exceeded, a fast pulse is generated by the fast comparator:
 - a) the pulse is counted by a pixel-level counter and
 - b) the counter is compared with a preset value N_{thr} .
- 5) If the preset counter value is reached within a given GTU then:
 - a) the X,Y lines are marked into the X,Y memories and
 - b) the pulse counting output is **enabled** during the remaining GTU time.

NOTE: statistic noise (background) at pixel level is eliminated at this stage

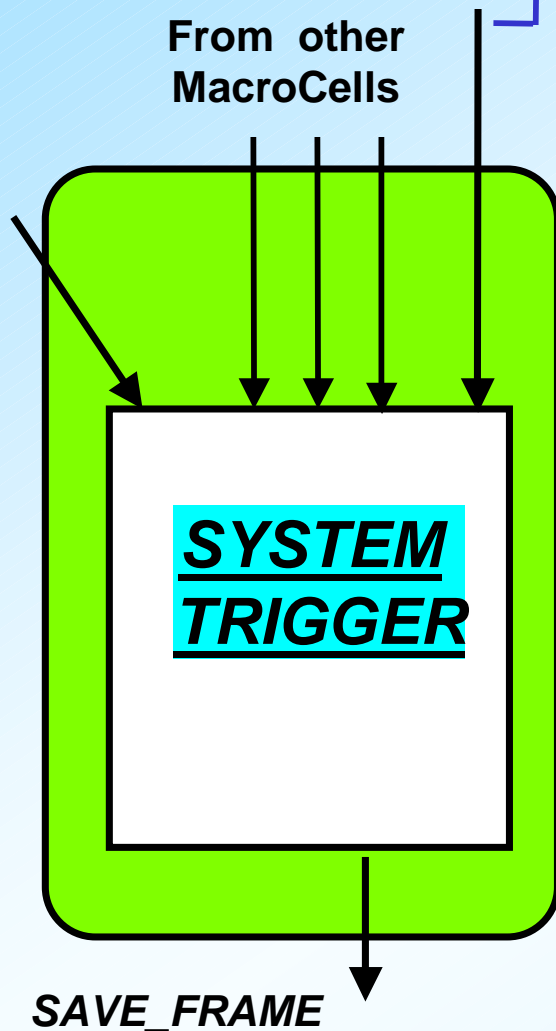
MacroCell level



- 6) The pulses coming from the ENABLED pixel are counted at MacroCell level (together with the pulses from all other enabled pixels of the same MC).
- 7) If the pre-set count value M_thr is reached within a GTU then a MacroCell-level trigger (MC_TRIGGER request) is issued lasting until the end of the GTU.

NOTE: statistic noise floor at MacroCell level is eliminated at this stage

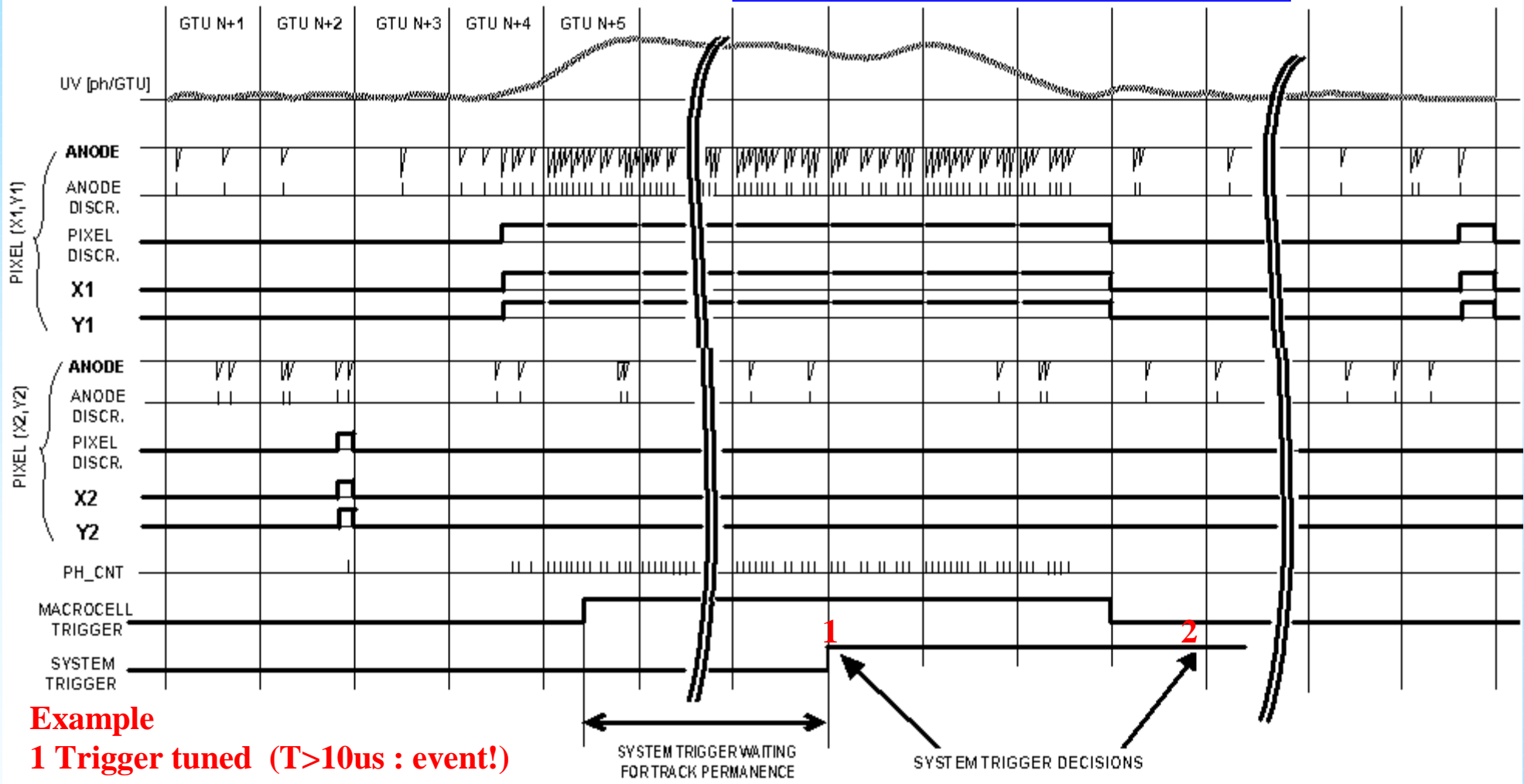
C&DH unit level



- 8) The **SYSTEM TRIGGER** continuously monitors the **MC_TRIGGERS** activity searching for valuable patterns (e.g. permanence of activity on a MC). The **SYSTEM TRIGGER** is s/w-reconfigurable for maximum flexibility in the *trigger philosophy*.
- 9) If the given (S/W) criteria for a valuable pattern are met then the **SYSTEM TRIGGER** issues a **SAVE_FRAME** command in order to start the data readout sequence.
The relevant memories are now downloaded.

NOTE: this is the final selection.
The valuable pattern should be related to scientifically interesting event only.
There should be no more random noise !

Timing of an event



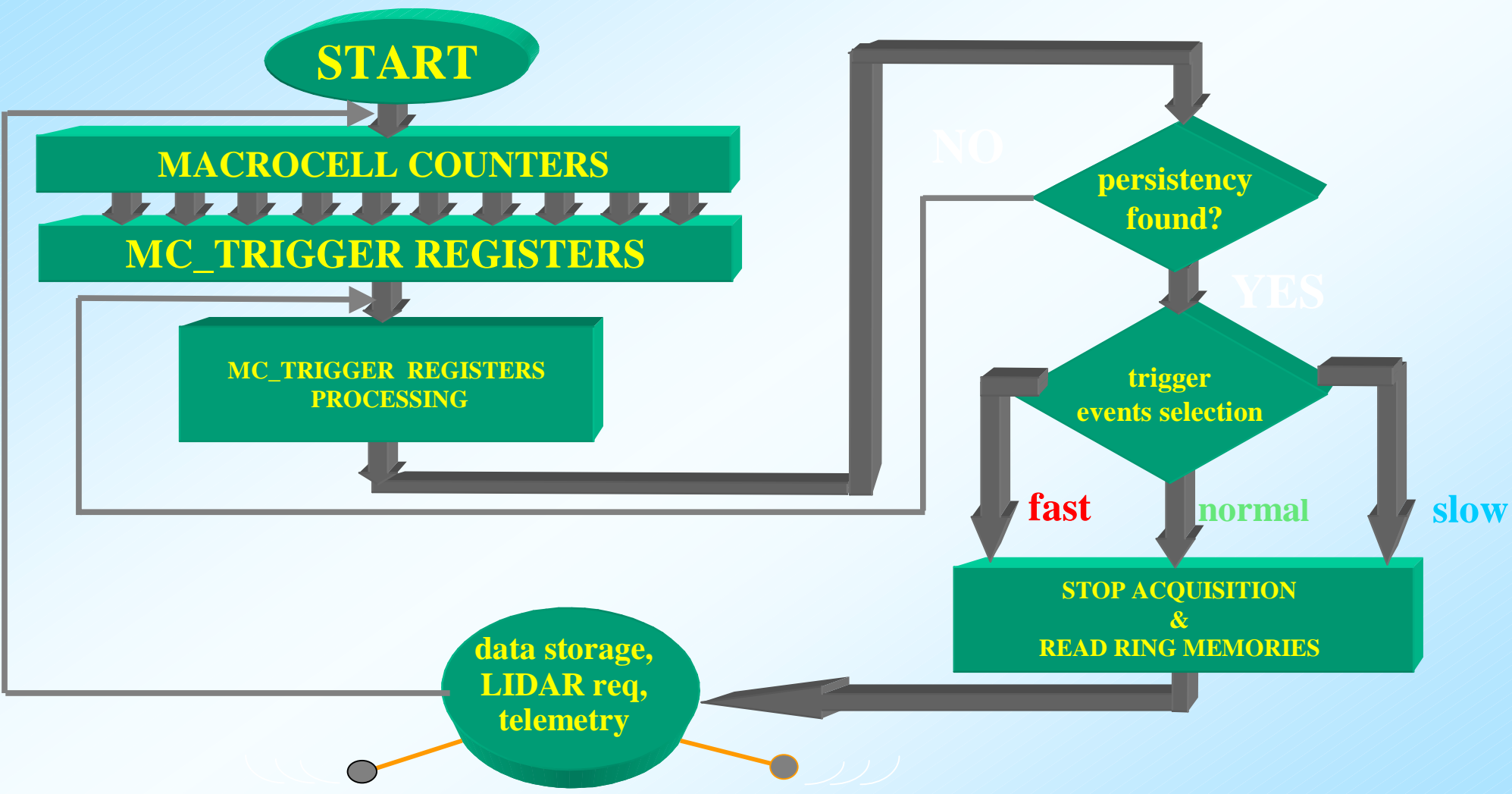
Example

1 Trigger tuned ($T > 10\mu s$: event!)

2 Trigger decide ($< 300\mu s$: EECR)



On-board System Trigger Flow Diagram

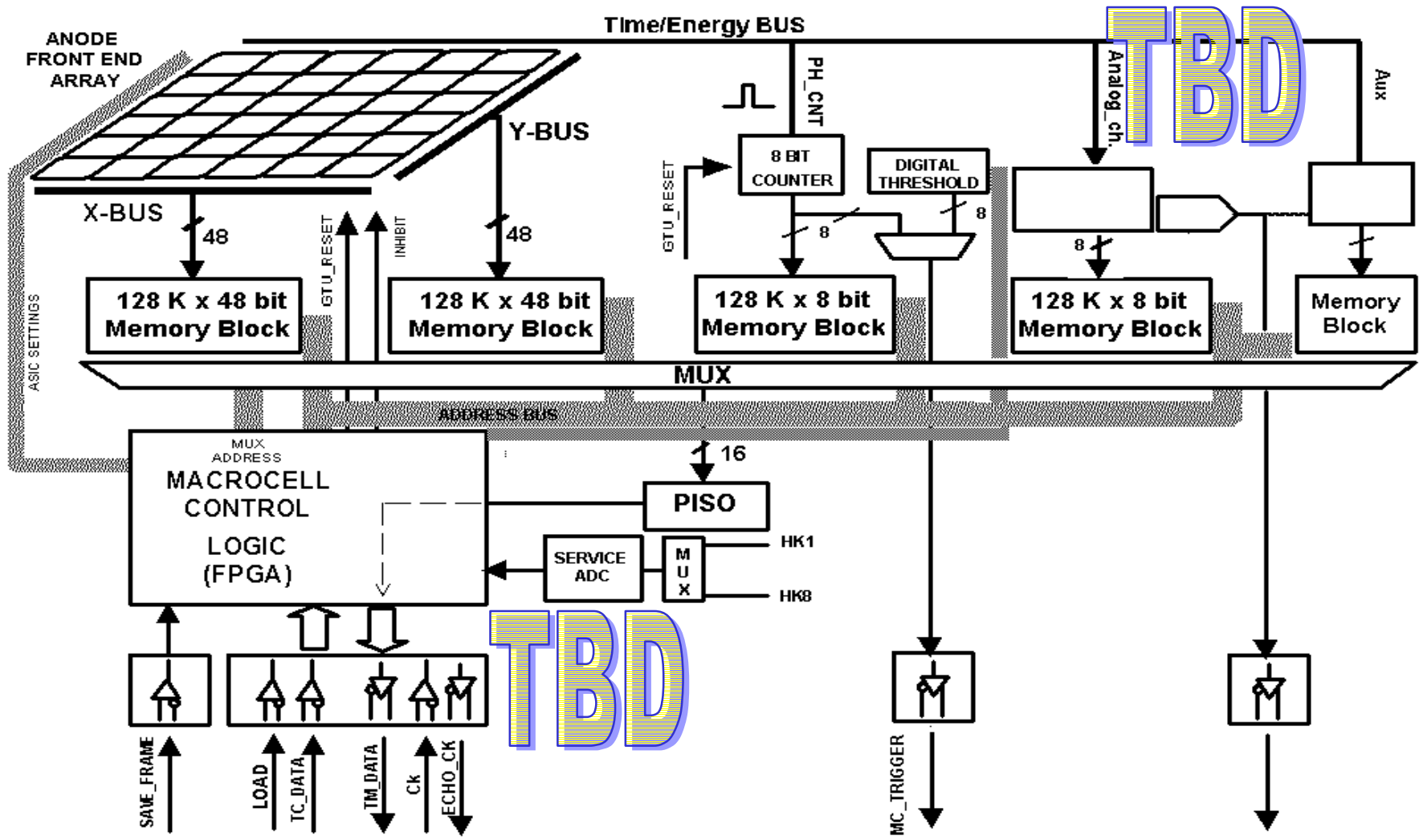




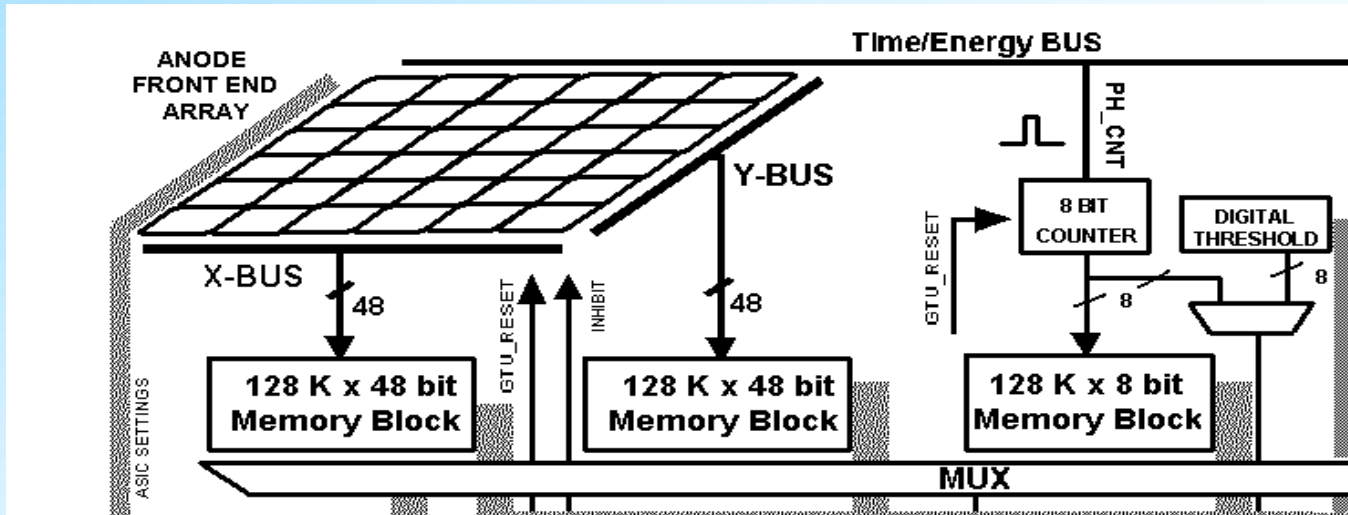
3 or more Trigger Modes

- **Trigger Mode 1 or *normal mode***
(EECRs up to 300 μ s, GTU=833ns)
- **Trigger Mode 2 or *slow mode***
(ex. Meteorizes up to 2 sec, GTU=833ns-->1ms)
- **Trigger Mode 3 or *fast mode***
(ex. Calibration, GTU=200ns)
- ...

Readout scheme (1)

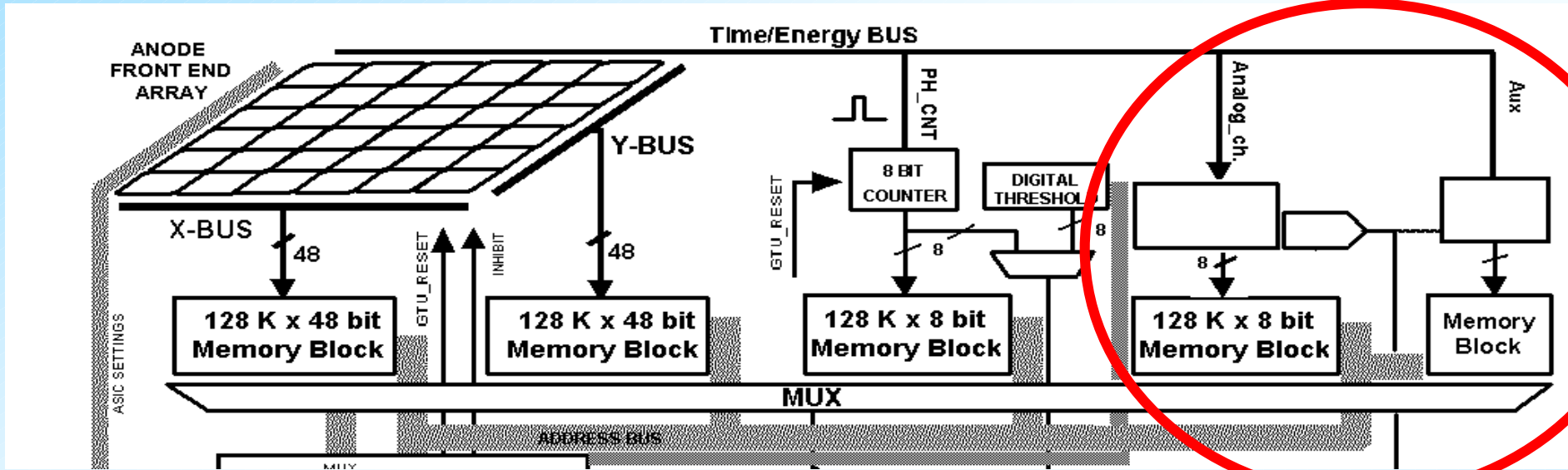


Readout scheme (2)



- 1) X, Y and PE_CNT ring memories are normally written at GTU rate during the acquisition,
- 2) then read at the best communication rate performed by the CDH unit (some Mbit/sec) after the *stop condition* due to TRIGGER was acknowledged.
- 3) The memory capacity is overestimated for EECRs case but will be redefined (x16) to consider *slow mode* case.

Readout scheme (3)



4) The analog channel is TBD, but it should be made of one more ring memory and treated in a similar way of PE_CNT part.

5) Some auxiliary readout section is needed?



Simulation traces

simulate