ALEPH 88-8
TRIGGER 88-1
M. Panter
HD, 15.12.1987, MP

MINUTES of the ALEPH TRIGGER MEETING

(Held at CERN on nov. 25th, 1987)

Present:

Barcelona:	
Bari:	A. Ranieri, P. Tempesta
Beijing:	
CERN:	M. Comin, M. Kasemann, J. May, M. Pilawa, E. Simopoulou, H. Wachsmuth
Clermont:	
Copenhagen:	J. D. Hansen, R. Møllerud, P. Munck
Demokritos:	A. Vayaki
Ecole Polytech.:	
Edinburgh:	
Frascati:	
Florida S. U. :	J. Streets
Glasgow:	K. Smith
Heidelberg:	R. Geiges, P. Hanke, M. Panter, B. Rensch, K. Tittel
Imp. College:	P. J. Dornan
Innsbruck:	
Lancaster:	
Mainz:	L. A. T. Bauerdick
Marseille:	
MPI München:	
Orsay:	R. L. Chase, J. F. Grivaz, V. Journé, J. Lefrançois
Pisa:	C. Bradaschia, L. Foa, J. Steinberger
Rutherford:	T. Jones, G. McPherson, J. Thompson,
R. H-way Coll.:	A. K. McKemey, M. Saich
Saclay:	A. Joudon
Sheffield:	M. Dinsdale
Siegen:	
Trieste:	E. Milotti, L. Rolandi
Wisconsin:	J. Hilgart

The aim of this meeting was to conclude on a cosmic trigger which fulfills all the important requirements for testing the detector components before and while LEP is operational.
To start the discussion B. Rensch presented the ideas and constraints on this trigger as they are seen by the trigger group. Copies of his transparencies are attached to these minutes.
The presentation was split up by the discussion of the different features of a cosmic trigger. The following summary just lists the problems and what was agreed upon to solve them. It doesn't reflect the discussion in detail.

(1) The cosmic trigger is needed as soon as the first modules of a subdetector are operational. This might be well before DAQ is running or even fastbus is installed. At this time the read out is the 'private' business of the group testing their piece of detector. Signals like trigger level YES/NO are not yet generated.
So there will be two types of cosmic triggers, one running on a passively used CAMAC logic independently of DAQ in phase I, and a second and final one , running under DAQ in phase II. The two trigger types might be identical in configuration and timing but are different in the electronical implementation. The one in phase II is more flexible and can be more complex using the full trigger system. It will be suitable for multidetector problems like alignment.

(2) In the last trigger meeting (16. 9. 87) it was decided to derive the trigger from the HCAL wire signals. Therefore questions about these signals were clarified first.

a) Since each double plane containing a hit adds a level to the final signal, the inverse of the noise rate has to be very large compared to the signal length (5 μsec). It was confirmed that this is the case.

b) The values on the transit time and the jitter of the signals were given and are listed in the table on the trigger timing below.

c) C. Bradaschia proposed a new way to process the wire information on the detector side. Instead of summing up the hit planes as levels and send the analog result to the trigger, he proposed to send the number of hit planes as four bits given by a PROM. Since nobody had strong objections or preferences for either solution, the decision was shifted to a small meeting among the involved experts (see addendum).

(3) The following questions concern the trigger itself

a) There was a general agreement that only tracks which cross the central region of the ALEPH detector are of interest. So a trigger based on HCAL modules opposite in ϕ could satisfy all needs. A separation between an endcap- and a barrel-trigger seems reasonable. All detector components which are interested in the barrel signals (ITC, TPC, ECAL- and HCAL-barrel) gain at most 10% more rate if they get coincidences between the endcaps A and B. For the endcaps of ECAL and HCAL barrel- barrel coincidences are of no use. In addition the barrel trigger can arrive 35 nsec earlier at the T0 logic because of shorter cables. This small gain is crucial for the ITC, which needs the T0 signal 400 nsec after particle passage at latest.
The described configuration should be the same in phase II until further experience leads to improvements.

b) Two rough estimates on expected trigger rates were given. They might agree if properly normalized. They are:

2 Hz	for 90^{o} muons on the full barrel
500 /hour	for one barrel module of ECAL

Some more work should go into the calculation of preciser numbers.

c) The following table contains all the delays, which were thought of, between the muon passage and the trigger signal arriving at the subdetector electronics. It should be kept in mind that the ITC insists on the integrated time to be less than 400 nsec:

time of flight of particle	10 nsec	
drifttime in the HCAL tubes	20 nsec	± 20 nsec * (see note)
propagation along the HCAL wire	15 nsec	± 15 nsec
cables HCAL tubes-electronics	10 nsec	
front-end electronics	20 nsec	
cable to barrack barrel	115 nsec	
endcap	150 nsec	
electronics in HCAL barrack	35 nsec	digital version
electronics in trigger barrack	25 nsec	"
the analog version shouldn't involve longer delays		
cable to trigger barrack	25 nsec	
T0 logic	60 nsec	
	335 nsec for the barrel	

The cable delay between the trigger logic and the subdetector electronic has to be added.

Note: * The arrival time, its jitter and their dependance on the penetration of the particle in the HCAL modules was presented by M. Panter as the result of a simple Monte Carlo program. A copy is attached to these minutes.

The signals from the different HCAL modules have to be timed with respect to each other. The time from particle passage until the arrival of the T0 at the electronics of a detector component can be measured with the TPC directly. Pulser signals on the HCAL wires can be used for the timing from the the HCAL front-end electronics onwards.

d) In phase I the T0 signal will be distributed to the different detector components by direct cables, in phase II on the official way for trigger signals except for the ITC, which still needs a direct cable.

e) There was quite some discussion on the schedule. Phase I should start whenever HCAL is ready. From the following dates:

HCAL	start of installation	~ sept 88	operational	~nov 88
ECAL	start of installation	~ nov 88	op. few month later	
TPC	start of installation	~ nov 88	op. few month later	

gas available ~oct 88 (see addendum)

the starting date 31. 12. 88 for phase I was concluded.

Phase II should start whenever DAQ is installed to run with at least two detectors simultanously. This date was not known but will be asked for. TPC will be able to produce a second level trigger around end of february 89. A different point of view was raised: If we want to be ready to accept beam in october 89, how much time is needed to run the system in beforehand? People agreed on a time intervall in the order of half a year, so february or march 89 seems a good date to start phase II.

(4) Some more requests related to a cosmics trigger were discussed.

a) The TPC needs an EGBX to open its gate. For the cosmic trigger this could arrive simultanously with T0, being identical to GBX. Even so nobody objected, the other subdetector groups should verify that this doesn't disturb them.

b) The only detector component which asks for an independent T0 signal during DAQ is the ITC.

c) Both calorimeters have cycles of dead and open time. They are:

HCAL	2 μsec dead	5 μsec open
ECAL	14 μsec dead	up to about 100 μsec open

There are two ways to take data with the calorimeters involved:

i) An ECAL cycle is synchronized with a number of HCAL cycles. The 'OR' of their 'BUSYs' blocks the data taking. This leads to a dead time of about 40%.

ii) All events are taken but the calorimeters are ignored whenever their 'BUSY' is on. In this way 30% of the events don't contain HCAL, 15% don't contain ECAL information.

d) For pedestal studies a random trigger was requested. The down-scaled GBX should satisfy this need.

ADDENDUM:

I. The question on whether to transmit analog or digital signals from the HCAL wires to the trigger system was decided in favour of analog signals. The reason was that the trigger group has standardized their input stage to receive the signals of all subdetectors involved by analog mixers and discriminators. The solution with digital signal shows no functional advantage over the analog solution.

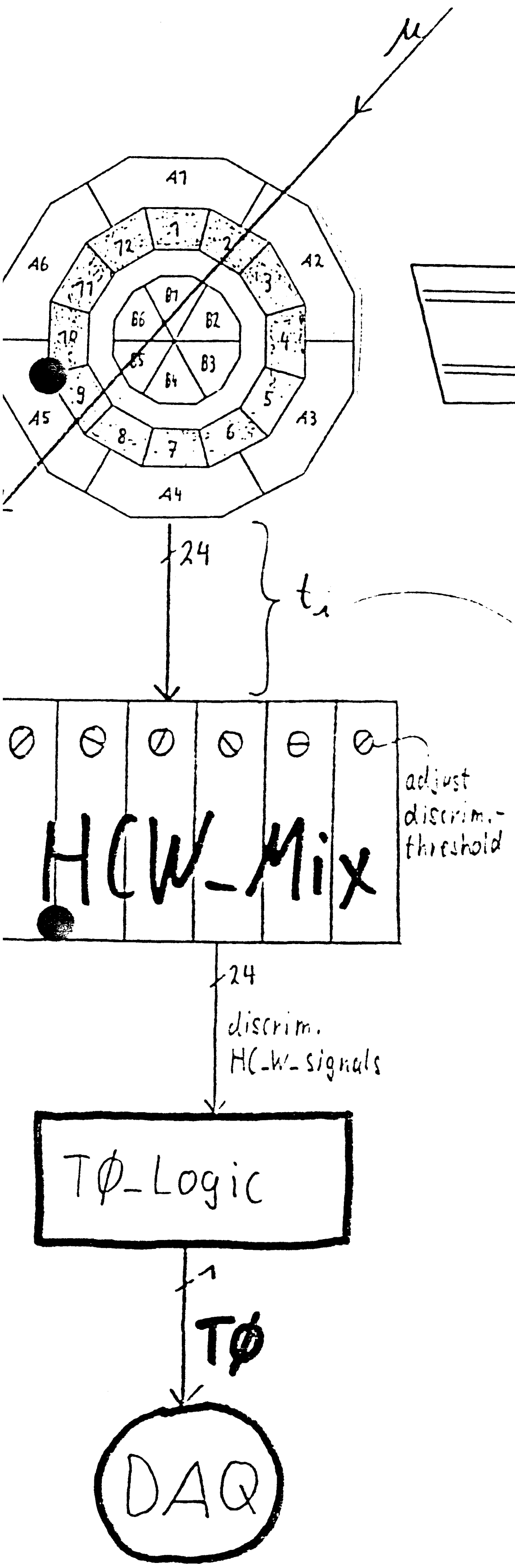
II. In the same meeting the signal length of the HCAL wire signals was discussed. There is no problem to adjust the signal within a range of .5 to 5 μsec according to the needs of the T0 logic.

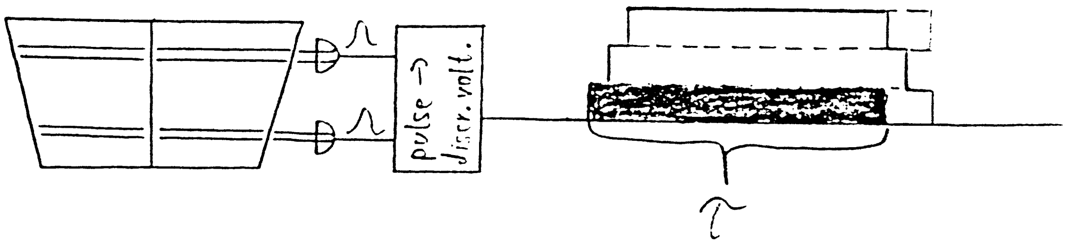
III. In the plenary meeting (26.11.) P. Lazeyras announced, that the HCAL will not have gas before march 89 for safety reasons. This obviously has severe effects on the scheduling mentioned above.

Next Meeting: WED., 17th February 1988
at 9. 30 h
in CERN
place: bat. 32, 1 - A 24

Cosmics_Trigger

- Time_reference **TΦ** derived from HC_Wire_signals



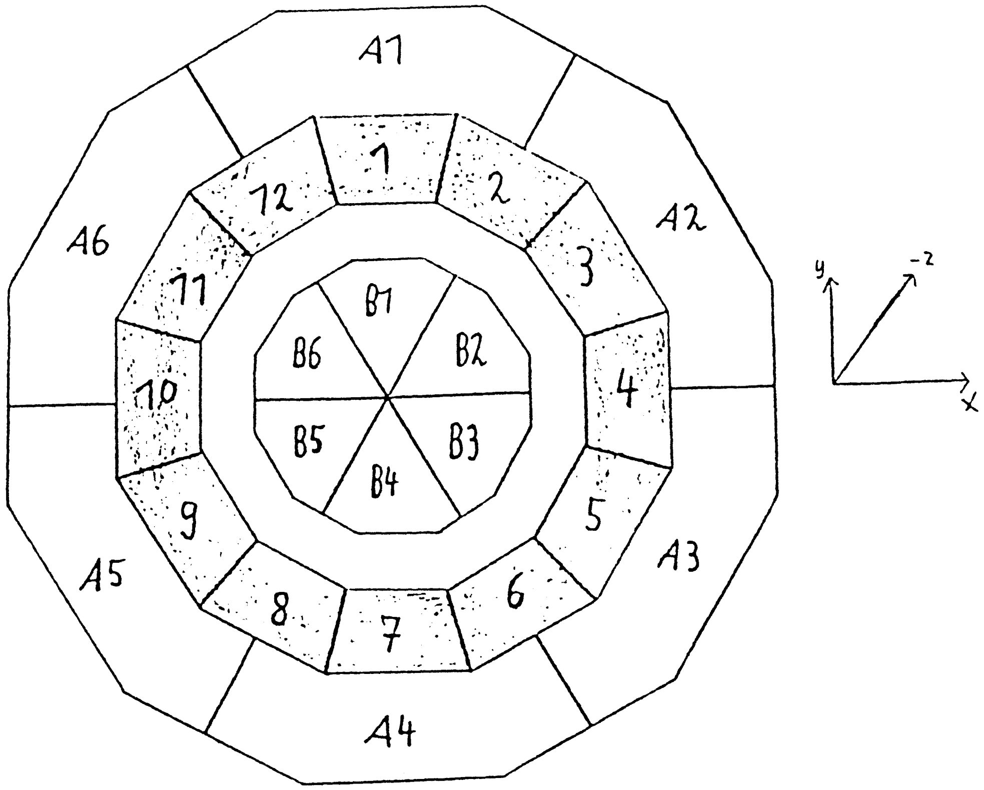


$\tau \ll \frac{1}{\nu_{noise}}$?

↳ no pile_up

Signal's travel_time from HCAL to Mixers
Identical for all modules ?

How/by whom will this be verified/adjusted?



TØ

<u>Phase I</u>: Trigger has no Fastbus-access
↳ use passive CAMAC-modules ECLine 4516, 4532, 4564

1) Majority $\sum_{i=1}^{24} H(W_i \geq n \quad n = 1,2$

2) 'back-to-back' $1 \cdot 7 + 2 \cdot 8 + \ldots + A1 \cdot B4 + A2 \cdot B5 + \ldots$

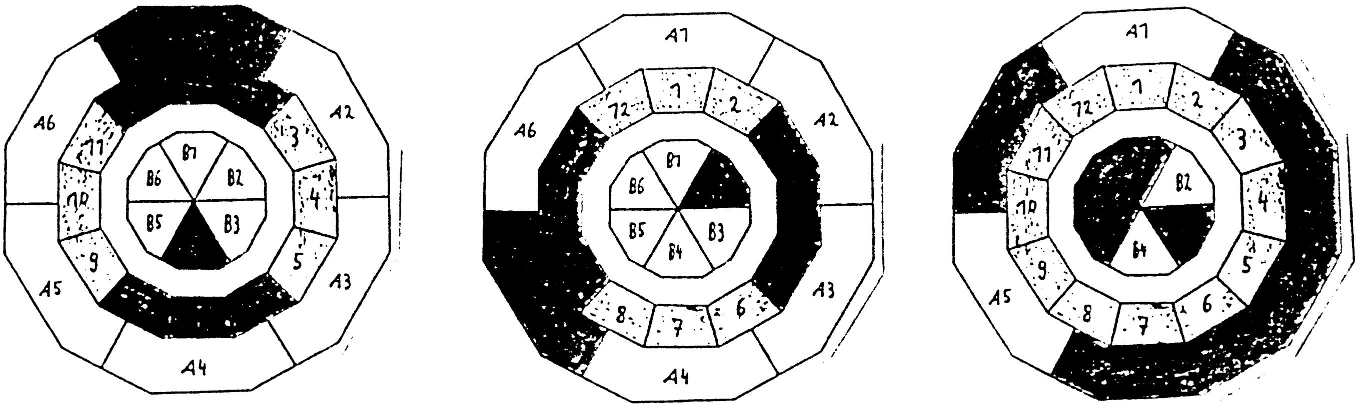
3) upper vs. lower hemisphere $(A6 + A1 + A2 + B6 + B1 + B2 + 11 + 12 + \ldots + 4) \cdot$ compl.

4) vertical-horizontal $(A1 + B1 + 12 + 1 + 2) \cdot (A4 + B4 + 6 + 7 + 8) + (+ +) \cdot (+ +)$

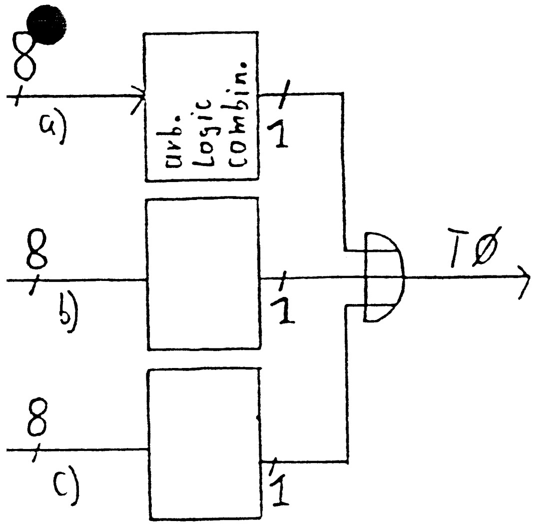
We want one and only one Trigger ¿?

Phase II : new Fb-access

↳ use FIO-Box



a) b) c)

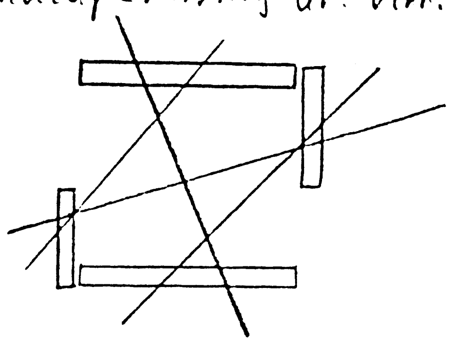


Divide 24 HCW into 3 octets

One division → several triggers
- select by software
- one at a time

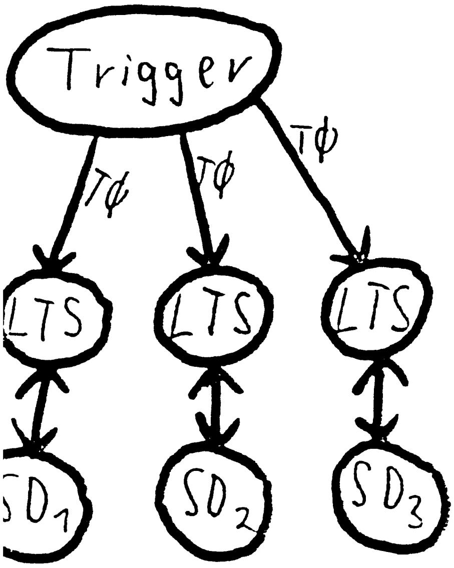
Division as above :

- $\sum_i HCW_i \geq 1$
- 'back-to-back'
- enlarge segments around vert./horiz. axis
- Barrel-Endcap-Mixing ar. vert. axis



TΦ → DAQ

ase I: several independent partitions

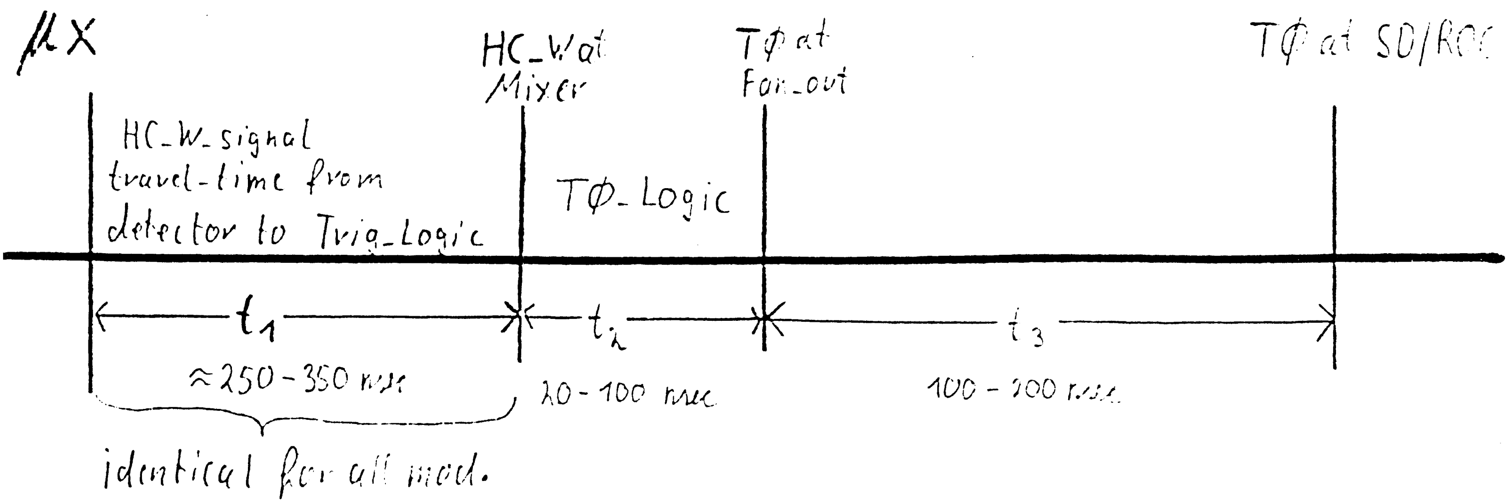


- Trigger delivers TΦ only

How?
- Phase I – wild cables
  – FIO_Boxes available
- Phase II – via FIO_Boxes = def. cable-path

- All further problems stay with SDs
  - fold TΦ with local Trigger-cycle
  - use TΦ as BX for LTS
  (LTS in Trigger-Bypass-Mode (BX_Timer disabled) → every 2nd TΦ lost)

Timing



Total: 370 - 650 nsec

Some questions

1) Length of quasi_analog HCW-signals –1–

$\tau \ll \frac{1}{\nu_{noise}}$

2) HCW_signal's travel_time fr. detector → Trigger
identical? verify/adjust –1–/–4–

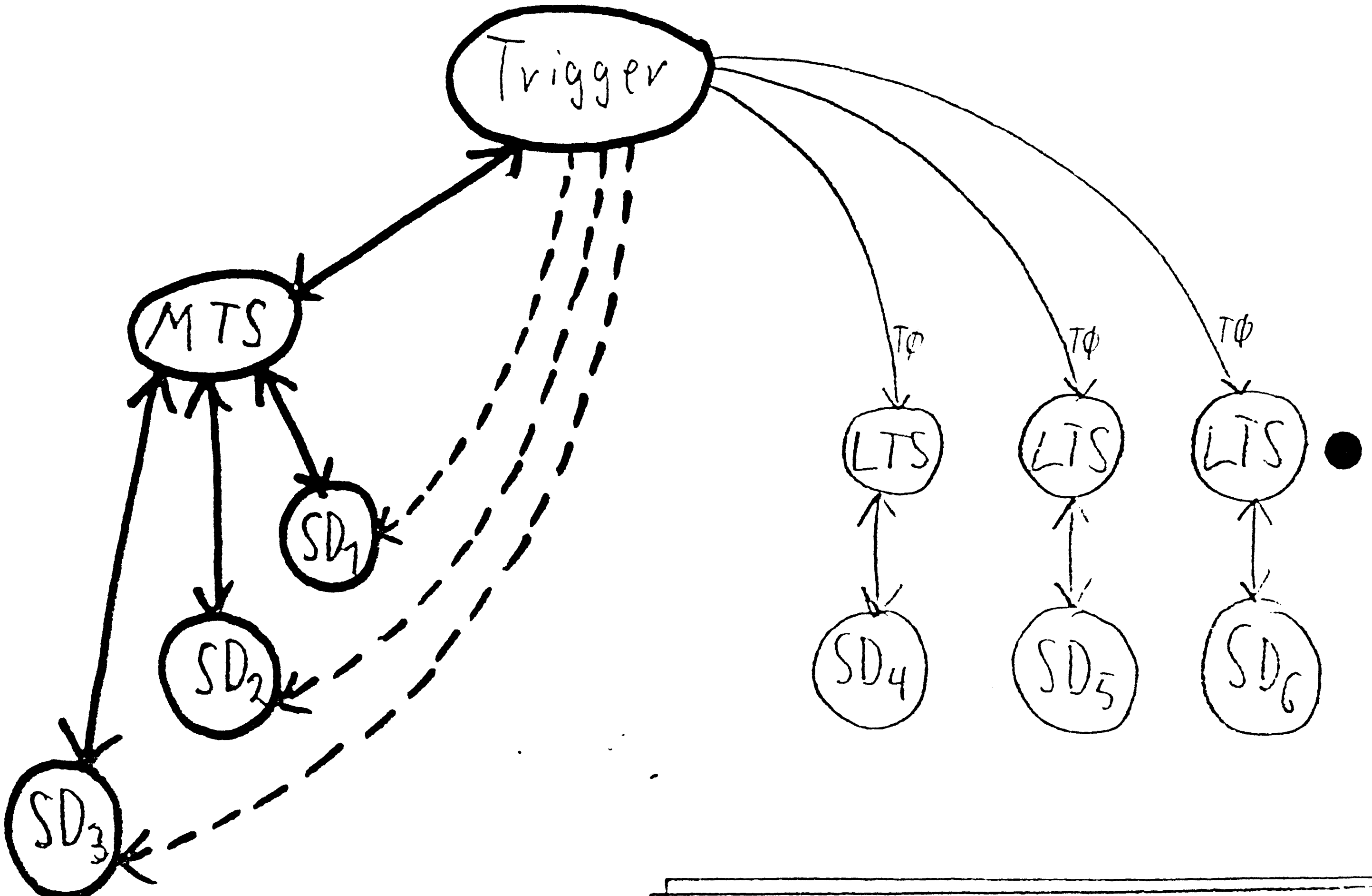
3) TΦ_logic in test_phase (Phase I) –2–
- which solution
- is one enough

4) TΦ_logic in Phase II
- which division / if more complex → HCW_fanout
- again: is one trigger at a time enough –3–

5) How will TΦ be carried from Trigger to SDs –4–
- FIO_Box / FB_access
- wild cables

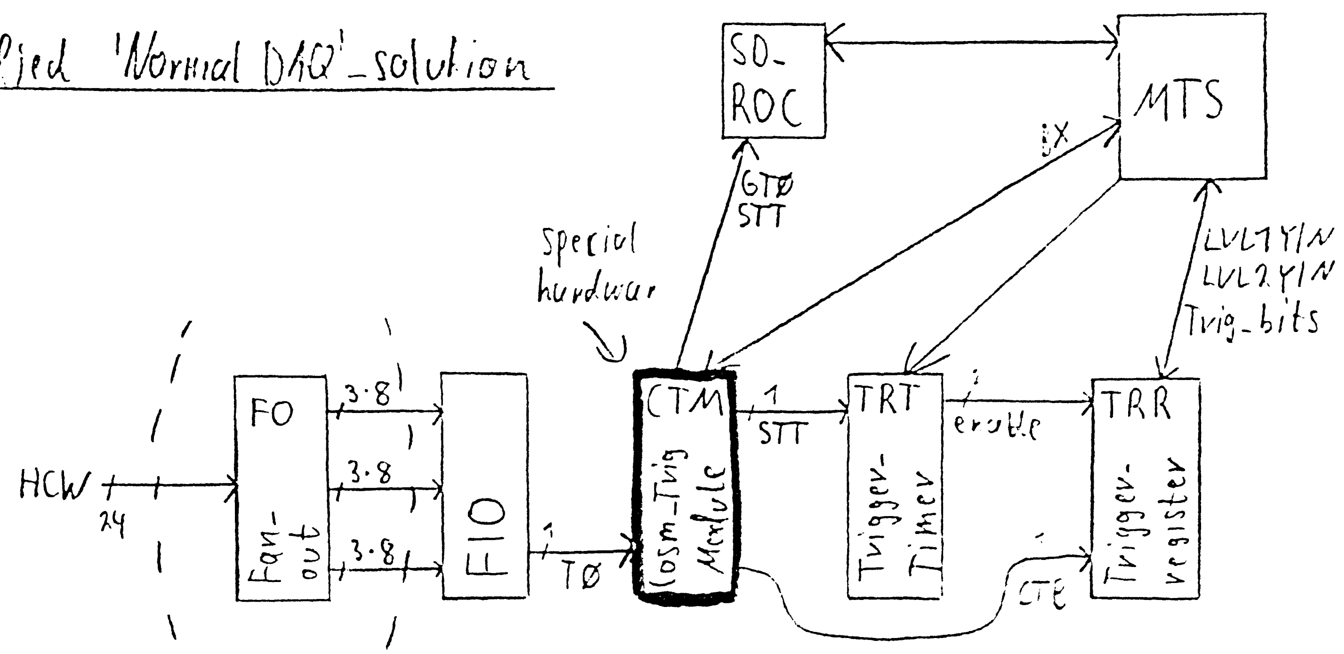
6) Timing

Case II several partitions merged into Main-Partition



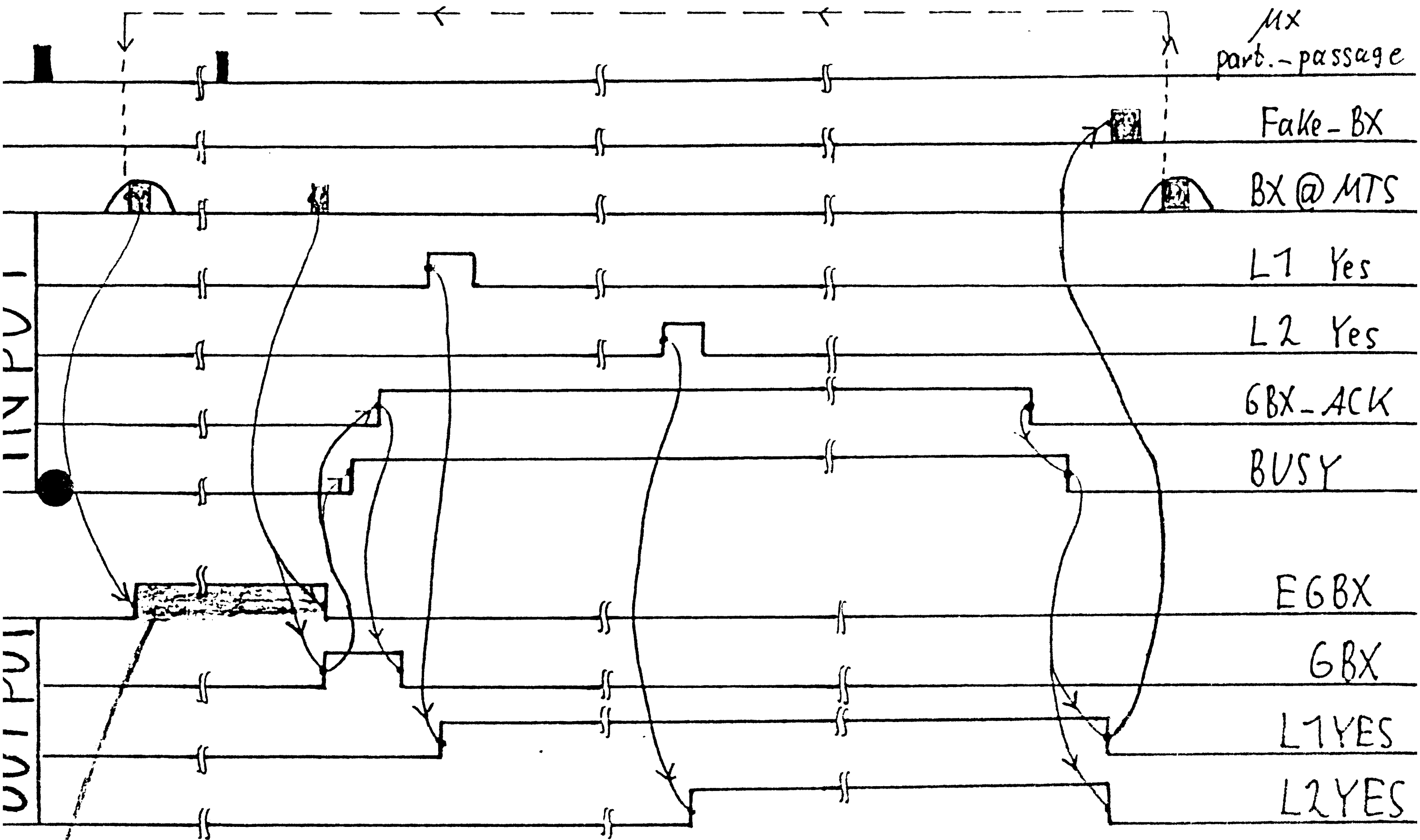
Next-to-nothing-solution

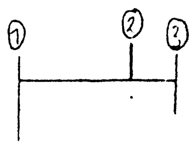
Modified 'Normal DAQ'-solution



Case II: Next-to-nothing-solution

- use T$\emptyset$ as BX for MTS

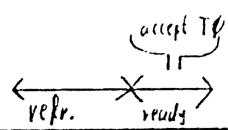




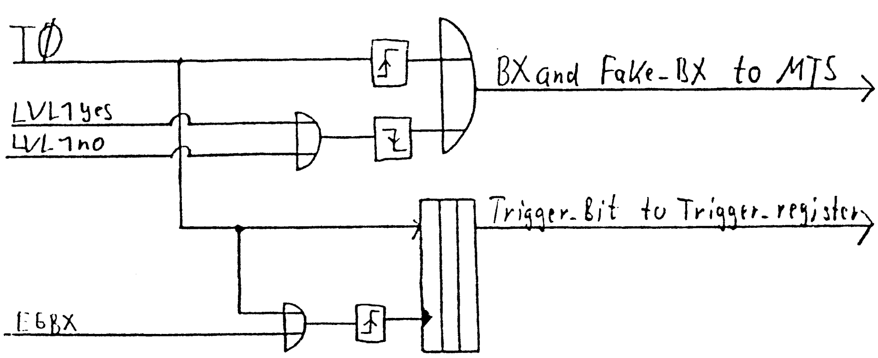
① μ passes detector while EGBX asserted
② MTS generates GBX ≈ 300 - 500 nsec after ①
③ GBX @ ROC ≈ 100-200 nsec after ② ≈ 400 - 700 nsec after ① = μX

Most time spent in this state: EGBX
↳ Are SDs ready
↳ Are HC-W-signals available or disabled

ECAL cannot share this cycle: Baseline-drift; what then?
local refresh_ready_cycle



Does it work?



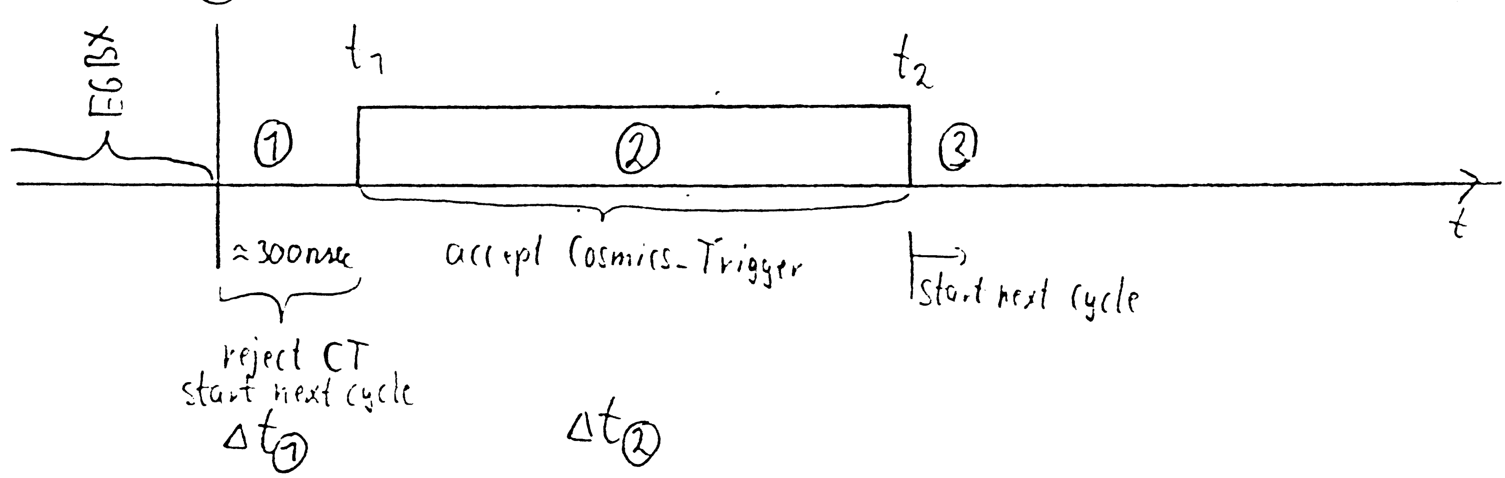
additional Hardware for Trigger-System

Simplest (best?) solution for case II : [Modif. 'Normal DAQ']

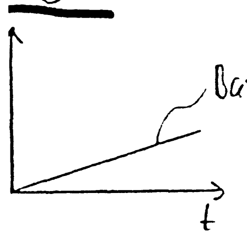
'Normal DAQ'
- EGBX
- GBX & GBX_Ack
  - ↳ synchronize SD
- ⋮

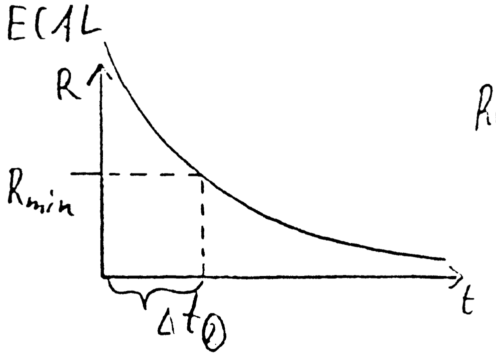
plus minor modifications

1.) BX from Trigger (¬ machine)
2.) Trigger-system starts not with GBX, but with TΦ
3.) Level 1_decision not after fixed Δt with resp. to GBX, but within a time-window after GBX
    ↳ need a further time-reference
    $GBX' = GT\phi = \mu X + \text{fixed } \Delta t$ @ ROC
4.) Level 1_Timer (MTS) disabled



$t_{②}$ determined by ECAL





$$R(t) = \frac{\text{Sign}(\text{EC\_Pads; mip})}{\text{Baseline}(t)} \overset{?}{\propto} \frac{1}{t}$$

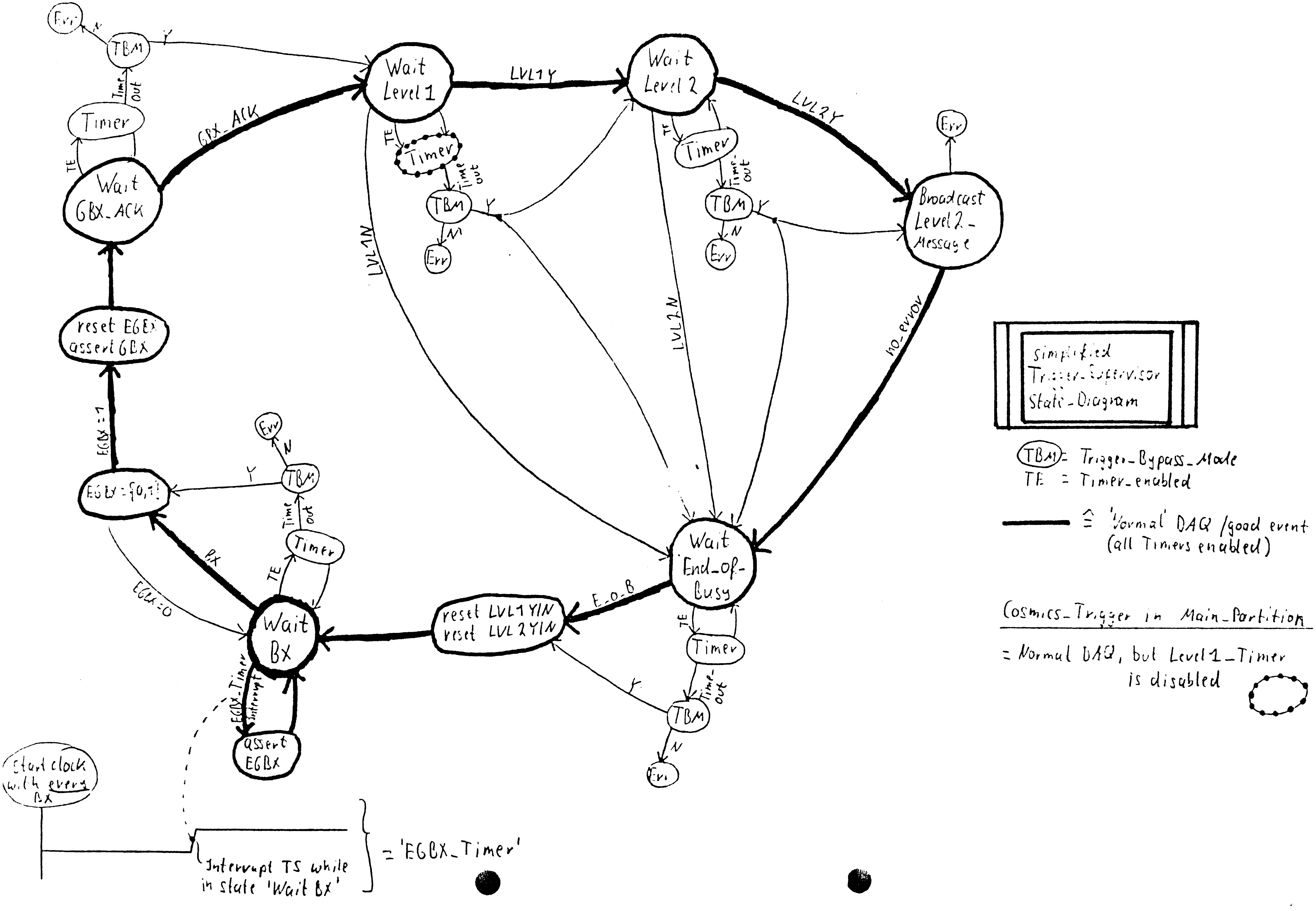
$$R(t_2) \gg 1$$

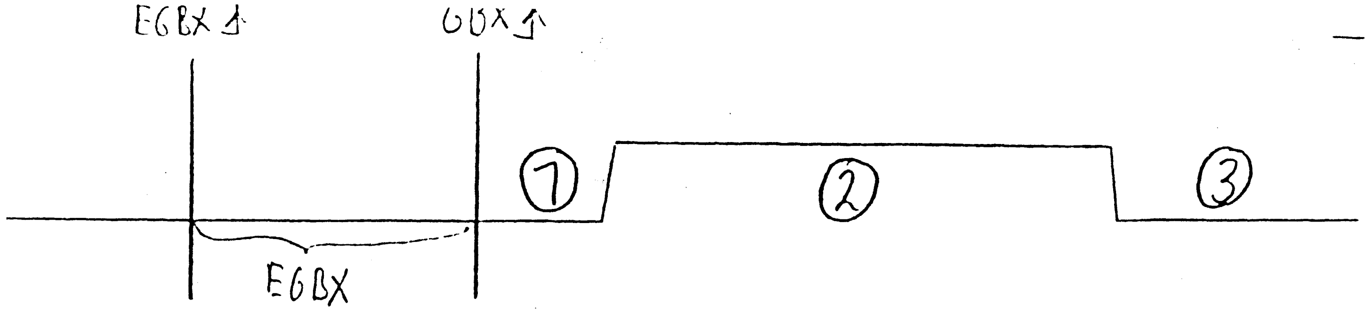
Dead_Time $= \dfrac{C}{\Delta t_{②} + C}$

$C \approx \Delta t_{EGBX} + \Delta t_{①} + \Delta t$ (LVL1N until End-of-Busy)

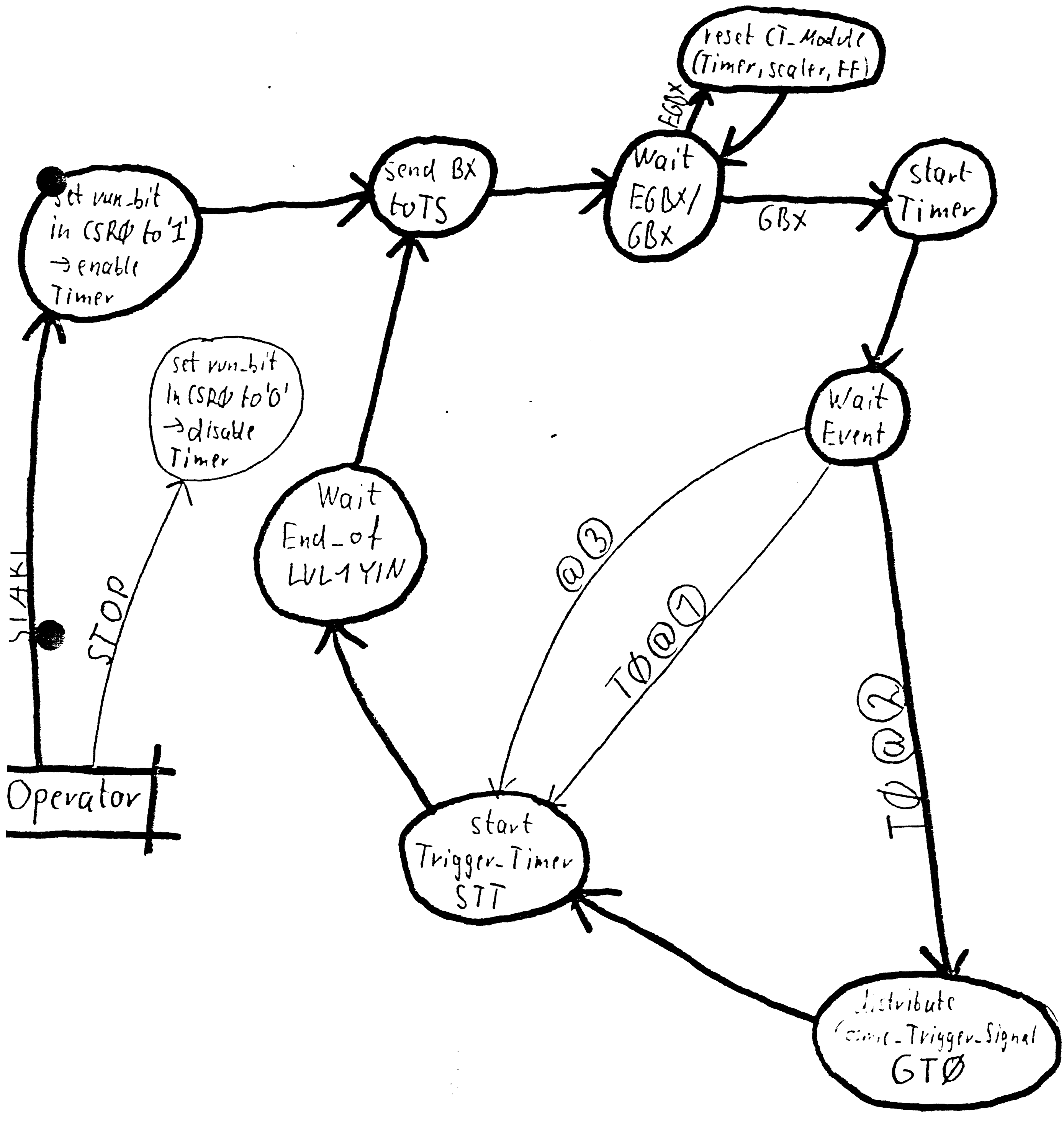
$C \lesssim 10\,\mu sec$

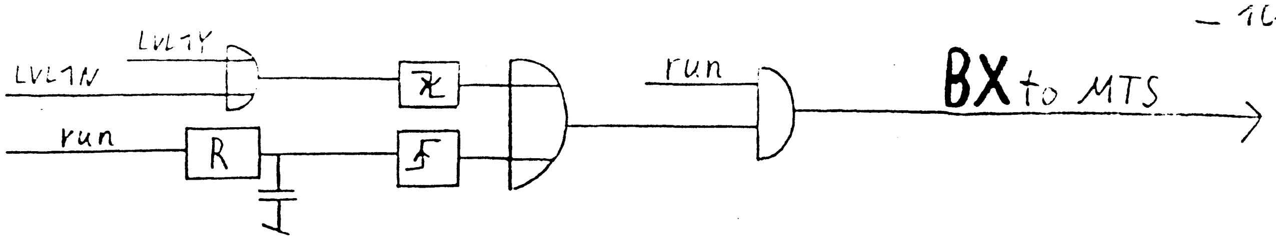
$t_2 = 10\mu$	→	DT = 50%
20		30
30		25

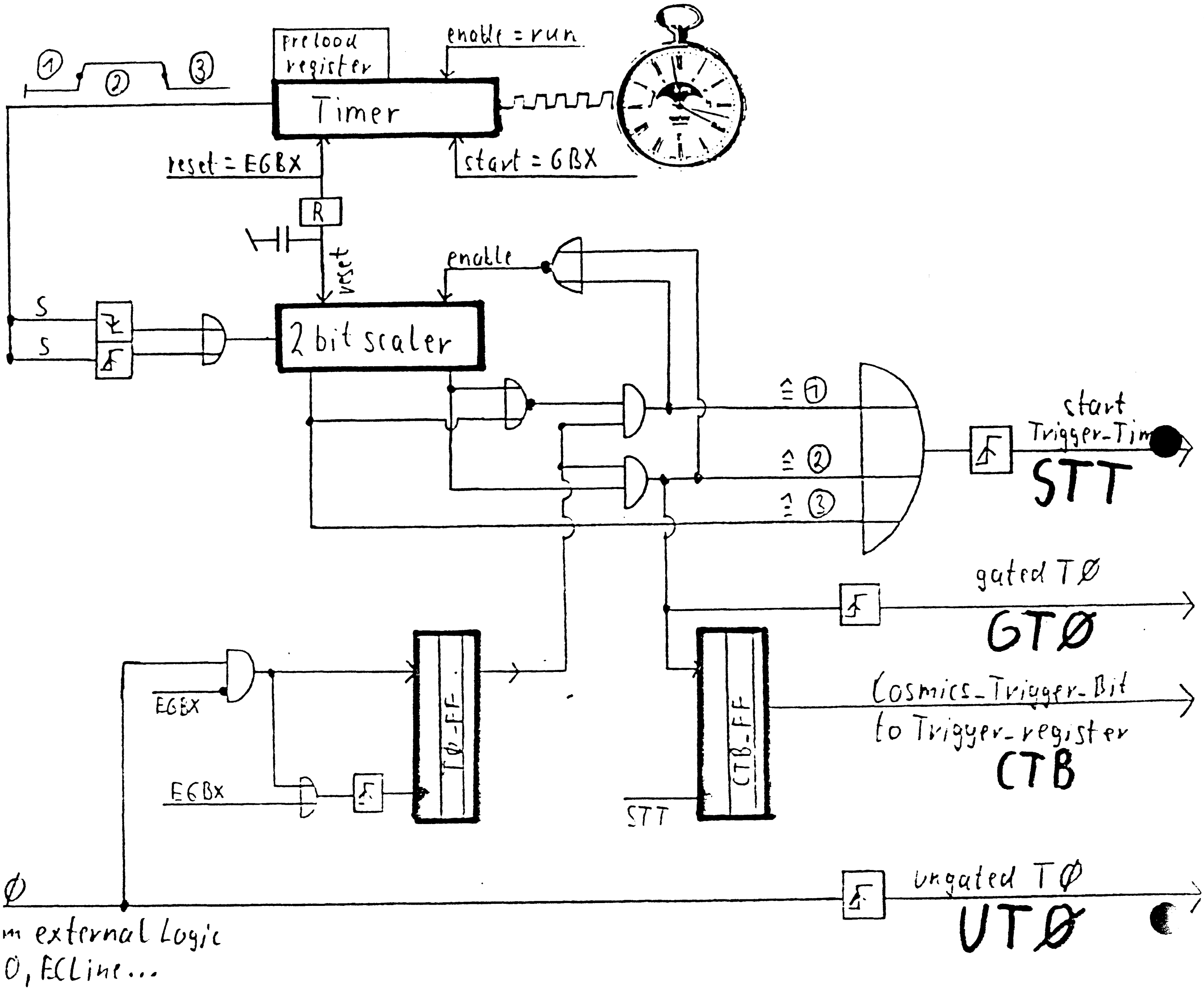

simplified Trigger-Supervisor State-Diagram
Wait Level 1
LVL1Y
Wait Level 2
LVL2Y
Broadcast Level 2-Message
no_error
Wait End_of_Busy
E_o_B
reset LVL1Y/N reset LVL2Y/N
Wait BX
BX
EGBX={0,1}
EGBX=1
EGBX=0
reset EGBX assert GBX
Wait GBX_ACK
GBX_ACK
LVL1N
LVL2N
Timer
TBM
TE
Time-out
Y
N
Err
assert EGBX
EGBX_Timer interrupt
Start clock with every BX
Interrupt TS while in state 'Wait BX'
= 'EGBX_Timer'
TBM = Trigger_Bypass_Mode
TE = Timer_enabled
≙ 'Normal' DAQ / good event (all Timers enabled)
Cosmics_Trigger in Main_Partition
= Normal DAQ, but Level1_Timer is disabled



TM_State_diagram (cf. to -6-)







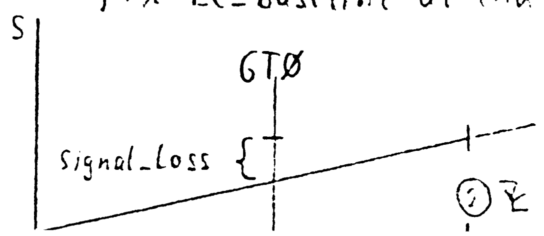
ıput:

EGBX from MTS
 GBX from MTS
TØ from ext. logic

Output:

- BX to MTS
- UTØ to SD (those outside Main-Partition)
- GTØ to SD (Time_reference = μx + fixed Δt)
- CTB to Trigger-System
- STT to Trigger_System & SD

e.g. fix EC_baseline at end of ②



25.11.87
M.P.

μ-jitter for the HCAL-wires
max. drift time 100 nsec
23 planes = 10 double planes
+1 triple plane
efficiency per plane : 90% (geometry)