



# The Old CHOD Task Force

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#### Outline

## A way to (re-)use the old CHOD in early NA62 run

Many thanks to all contributors: F. Hahn, G. Lamanna, R. Piandani, M. Piccini, M. Raggi, G. Ruggiero, P. Valente, R. Wanke.

## The Old CHOD detector: a reminder – I

#### THE DETECTOR:

Two planes of vertical and horizontal plastic scintillators (64 counters/plane, 128 ch. in total). Inner radius: 12,8 cm (full efficiency @ R>15 cm). A plane contains a circle with R=121 cm.

#### THE MECHANICS:

Accuracy of 1 mm in x and y and on the relative alignment of the 2 planes ( $\rightarrow$  trigger efficiency)

#### PLASTIC SCINTILLATOR:

BC408 (was NA110 before): new plane in 1997; new H-plane in 1998.



Physical Properties: 1 ns rise time, 4.2 ns pulse FWHM and 400 cm attenuation length

Counter dimensions: length from 121 cm (closest to the beam pipe) to 60 cm; width: 6,5 cm (closest to the beam pipe) and 9,9 cm; thickness: 2 cm ( $\approx 0.1 X_0$ )

## The Old CHOD detector: a reminder - II

#### FAST LOGIC:

Each plane consists of 4 quadrants (16 counters per quadrant).

Each quadrant is logically divided into 2 parts in order to build 4 sub-coincidences among the vertical and horizontal counters of two consecutive quadrants:  $\rightarrow$  16 sub-coincidences in total  $\rightarrow$  Q1(Q2):  $\geq$  1(2) sub-coincidence hit

**PM:** Philips XP2262B (12 stages, Sb K Cs cathod; gain@2500V  $\approx$  7 × 10<sup>7</sup>; rise time: 2 ns; transit time jitter: 0.7 ns)

Analogue signal (1 MIP) set at 300 mV Discrimination threshold: 30 mV (1/10 of a MIP); width: 30 ns (40 MHz clock) Dynamic range: ≈10 mV to ≈1 V (3 MIP);

Time resolution (slewing and impact point corrected offilne):  $\sigma_t^{\text{counter}} < 200 \text{ ps per counter}$  $\rightarrow$  event time resolution:  $\sigma_t < 200 \text{ ps}$ 



## The Old CHOD: present status

- The detector is installed on its yellow support, along the K12 beam line;
- Signal and HV cables (non-halogen free) are plugged on PMs and hanged to the detector;
- A patch panel is available to interface signal cables (BNC) to front-end electronics (Lemo);



- The old HV system (CAEN SY403) is obsolete: not DCS compatible, only RS232 stand-alone control is available;
- The old read-out (PMB), front-end and trigger logic (CAMAC) systems of CHOD are not available anymore: not existing or not compatible with NA62 requirements.
- A rack to host new front-end/read-out/pretrigger electronics can be installed close to the detector (wall side)



## A CHOD for early NA62 run (<2013)

It seems possible to use the Old CHOD as TDAQ element (L0) in early NA62 run, after some refurbishment

#### Parts of the detector can be re-used with some warning:

- Scintillators + light guides: attenuation lenghts (≤ 1.5 m) and counter efficiency acceptable for early runs (a few of them must be checked);
- Holding support ok (precision adjustment on transverse coordinates)
- PM + voltage dividers: spare PM available; voltage dividers working but obsolete (no spare unless recuperation: to be checked);
- Signal and HV cables (non-halogen free);
- Patch panel to interface signal cables (BNC) to the front-end electronics (Lemo) is available but probably obsolete.
- ➔ A new HV system and new electronics (front-end, read-out and pretrigger) is needed, hopefully as parts of the final systems.

### A new HV System for the CHOD

- → Make use of the recent market survey for LAV; (P. Valente)
- → ISEG HV System, already used at CERN, identified as a general tool for NA62 (LAV + possibly MUV, SAC, CEDAR);
- → it seems well-suited also as HV system for the CHOD
- Specific components of ISEG HV System:
  - Crate ISEG ECH 238\_1200W: 8 slots, CANbus control;
  - HV module EDS 20 130n\_504: 32 channel (0-3KV, 500 mA/ch.), CANbus control via backplane, floating ground, 1 slot;
- A possible HV System for the CHOD (128 channels):
  - 1 Crate ISEG ECH 238\_1200W (3680 €)
  - 4 HV module EDS 20 130n\_504 (3380€ per module)
  - If possible, borrow the system for early run (discussion needed)
  - Cost of a CHOD (128 ch) dedicated system (no rebate): 17200 €

#### New FE and RO Electronics for the CHOD

- → TEL62/TDCB based (1 TDCB hosts 128 ch.);
- ➔ T.O.T. technique for online slewing correction (pulse height from trailing-leading edge difference);
- → double threshold for multiple hit online identification;

#### → LAV electronics seems to be well suited for the CHOD:

(M. Raggi)

- dynamic range smaller than the LAV one
- time resolution of few hundreds ps per counter
- charge resolution better than ~10% in the CHOD MIP range (up to 3 MIP)
- manage the expected rate/counter (~250 KHz/counter assuming 15 MHz on the CHOD; probability of a double hit ~1,25% assuming a double pulse resolution of 50 ns; identify double hits with double threshold feature)
- 32 ch modularity good for the CHOD geometry
- connectors from old CHOD (BNC/Lemo) to be adapted to DB37 connectors (input of LAV FEE): patch panel or patch cables

→ if possible, borrow the systems for early run (discussion needed)

### A new Charged Pretrigger

- The online time resolution of the NA48 CHOD pretrigger coincidences (QX, Q1, Q2) was ~4-5 ns, limited by counter geometry (no correction for impact point and/or slewing).
- Easy definition of an improved pretrigger signal: build 1024 sub-coincidences between H and V counters of consecutive quadrants applying online time corrections.
- An online time resolution better that 1 ns of the NA62 CHOD, used as positive time reference in the trigger, in addition or alternatively to the RICH, could be achieved in the following way:
  - 1 (TEL62/)TDCB board (128 ch.) can be used to digitize data;
  - The slewing correction to the hit time can be handled in the TEL62 FPGA with the LAV FEE features;
  - The time correction for impact point can also be applied in the TEL62 FPGA: define the impact point as the center of the 1024 sub-coincidences between H and V planes and correct time using values from a look-up-table;
  - Signals can be handled, in priciple, by 1 PP–FPGA, firmware development is needed but the implementation of the trigger logic seems to be a feasible task.

(G. Lamanna, M. Piccini)

## Independent FE, RO and pretrigger electronics systems for CHOD in early NA62 run: the overview





Need 4 LAV FEE board (32ch in each)

- 1 TEL62 (or even TELL1)
- 1 or 2 TDC boards (SCSII connection)
- 1 LAV Wiener crate (9U J1 only)

Each LAV FEE board will house 2 CHOD quadrants

One TDC could house the whole CHOD

The TEL62 will house the whole CHOD with pretrigger logic (online timing corrections are possible)

Type of equipment	Ν	Cost/1pcs
LAV FEE board (32ch in each)	4	3 K€
TDC boards	2	0.5 K€
LAV Wiener crate 9U	1	7 K€
TEL62	1	4 K€
Total		~ 24 K€

#### (M. Raggi, G. Lamanna, M. Piccini)

### Outlook: why a CHOD in NA62

Basic requirements: work @11 MHz rate with an online time resolution better than 1 ns, matching MUV acceptance (requirements to be better quantifyed with MC simulation: G. Ruggiero)

Tasks:

- Veto photon conversions or photonuclear interactions producing low energy hadrons in RICH material: complement LKr photon detection capability at low energy (hopefully both offline and online, at trigger level).
- Timing capability: complement RICH in identifying charged tracks both offline and online at trigger level.
- Match MUV acceptance: complement RICH in identifying muons within MUV acceptance at trigger level.

➔ Given the development of the new TDAQ system in NA62, a strip design for the NA62 CHOD similar to the old NA48 one, with light collection on one side, appropriate dimensions and a slighly higher number of channels (×2?) to get rid of rate, could be envisaged as an easy solution for NA62, to be carefully investigated.

→ Better quantification is needed via MC simulation and available data analyses

→ The 2012 early run could also be a good opportunity to verify this approach

### Conclusions

- Possible solutions for the use of the Old CHOD in NA62 early run have been identified;
- According to that, what is actually needed in view of an early run is:
  - Move the Old CHOD in the final position and install electronics racks;
  - Check counters functioning and HV adjustment (starting from known values);
  - HV System:
    - Borrow the HV System (4 modules + 1 crate) and maintain it;
  - FE/RO/Pretrigger electronics:
    - Borrow 1 VME (mini-)crate for housing the new electronics,
    - Borrow FEE from LAV (4 modules),
    - Borrow 1 TEL62 (also Tell1)+TDCB,
    - Develop the pretrigger firmware and maintain the electronics.

A discussion within the NA62 Collaboration is mandatory in order to get an agreement on the schedule for the CHOD and to define responsibilities

 Merge this job within a wider New CHOD Working Group to proceed toward the final detector implementation