The Old CHOD Task Force

Patrizia Cenci

INFN Perugia

SC Meeting

April 8th, 2011

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.

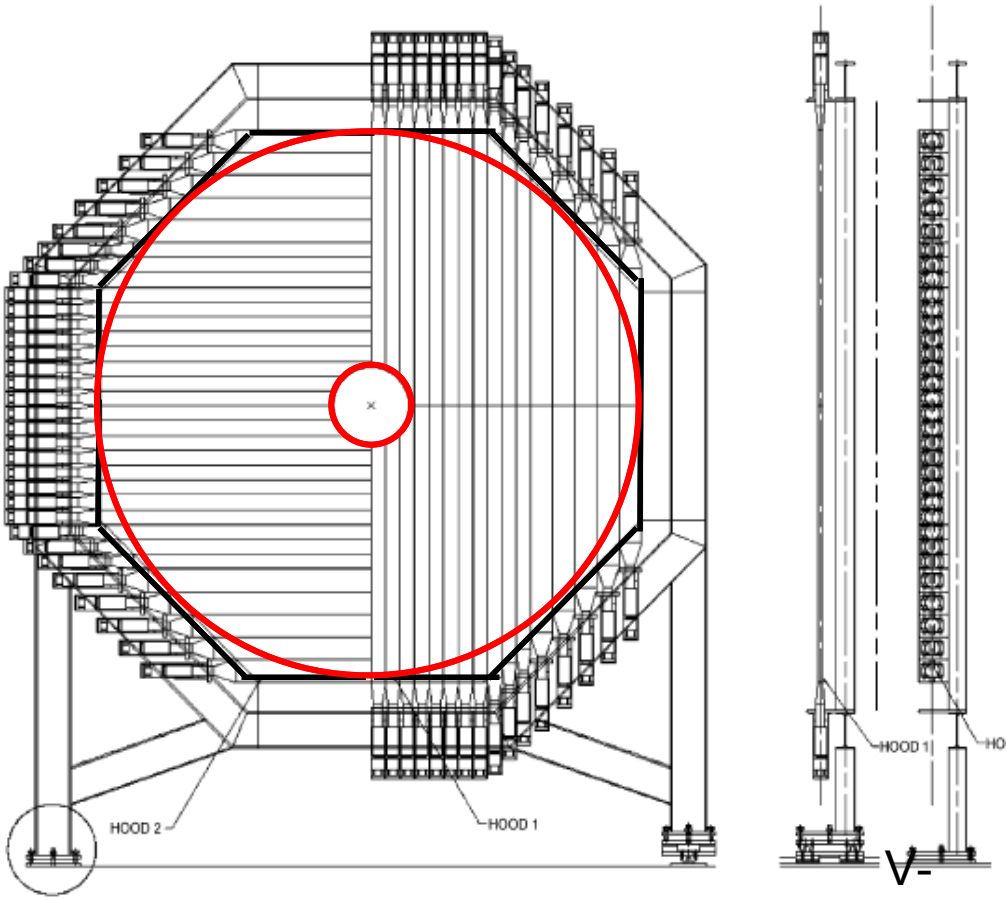
The Old CHOD detector: a reminder – I

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 (➔ 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

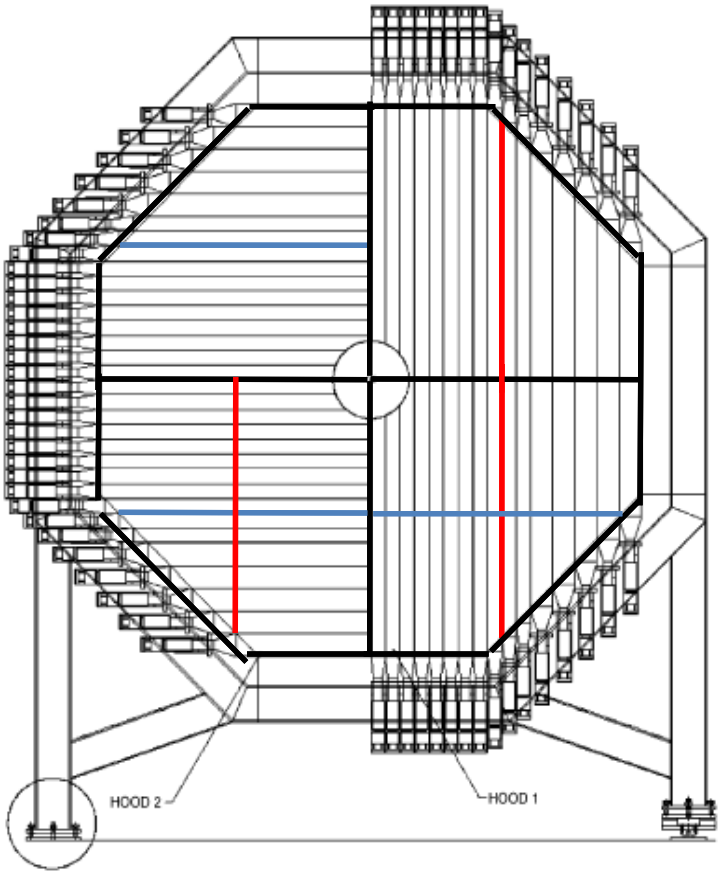
Counter dimensions: length from 121 cm (closest to the beam pipe) to 60 cm; width: 6,5 cm (closest to the beam pipe) and 9,9 cm; thickness: 2 cm (≅0.1 X_0)

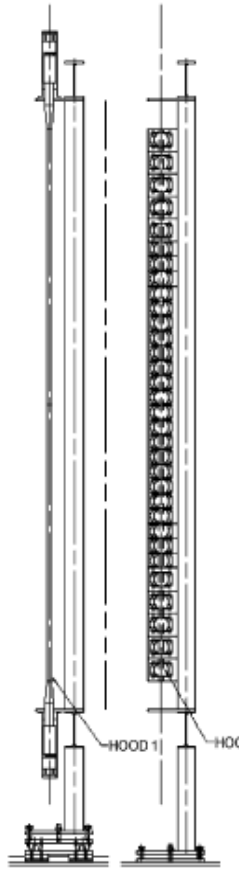
The Old CHOD detector: a reminder - II

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:
➔ 16 sub-coincidences in total
➔ Q1(Q2): ≥ 1(2) sub-coincidence hit





PM: Philips XP2262B (12 stages,
Sb K Cs cathod; gain@2500V ≈ 7×10^7;
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): $\sigma_t^{counter} < 200$ ps per counter
➔ event time resolution: $\sigma_t < 200$ 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:**

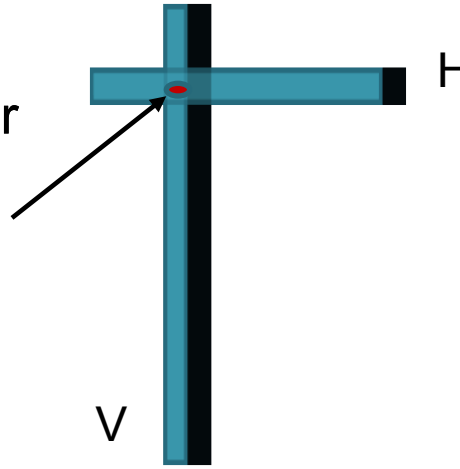
(M. Raggi)

- *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:

(G. Lamanna, M. Piccini)

  - *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.*

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

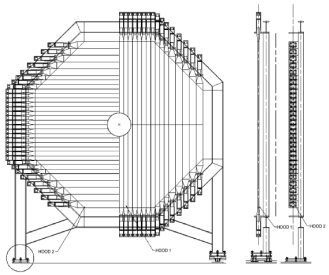
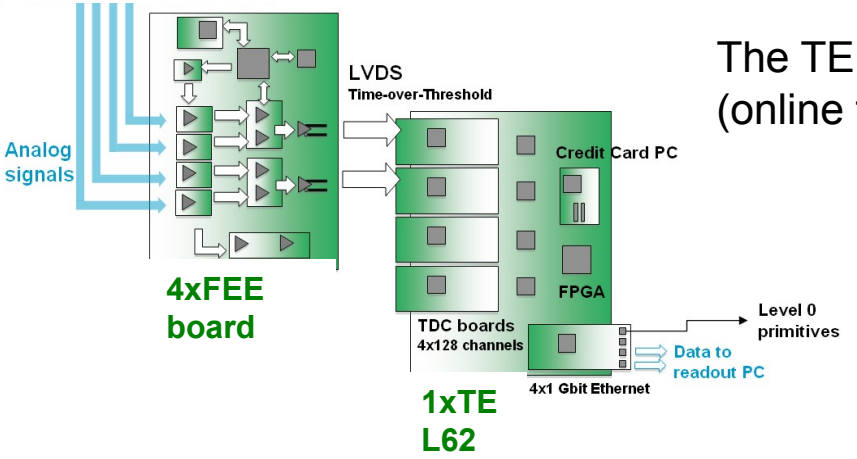


Fig. 20. Charged hodoscope.



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	N	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