ROB OPERATION BEYOND NORMAL CONDITIONS

CMS Week June 2002

Cristina Fernández Bedoya **CIEMAT**

ROB STATUS

Prototype throughly tested:

- ROB functionality verified, design **ready for production**.
- Moreover characterization of ROB *operation limits*:
  - decreased and increased regulators output voltage,
  - crosstalk between ROB channels,
  - clock jitter (still under test),
  - temperature influence...

Issues:

- HPTDCs v1.1 has problems with low voltage $\Delta V \sim 150$ mV (waiting for 2^{nd} Engineering run)

From: Jorgen Christiansen <jorgen.christiansen@cern.ch
To: giovanni valenti <giovanni.valenti@cern.ch; crispin williams <crispin.williams@cern.ch; Pietro Antonioli <Pietro.Antonioli@bo.infn.it; Carlos Willmott <carlos@ciemat.es
Sent: Monday, June 03, 2002 1:53 PM
Subject: Re-submission of HPTDC

Dear all
We have now made all the changes needed to resolve the problems in the HPTDC that became apparent in the last HPTDC prototype:
DLL lock problem above 2.7v (in some chips also seen at low Vdd).
Hit register loss of data below 2.35v.
Changed powering scheme of TDC channels to improve INL in high resolution modes.
We have received the official offer from IBM of a re-spin of the previous version with some minor changes in 5 masks.

Respin with 2 wafers: 57,200$
3 additional wafers: 3 * 3,610$
Total 5 wafers: 68,030 $

As usual we propose a 50% - 50% split between CMS and ALICE giving 34015$ each.
The submission will be made as soon as you give us the acceptance of this offer and let us know from which CERN account we can transfer the money.
To arrive at packaged chips you will later be requested to pair your share of the packaging (estimated 10k$).
Hope to hear from you soon.

Jorgen

HPTDC STATUS REPORT

Testbeams in GIF at CERN:

* P2B (14/Oct./01): 6000 triggers/spill (~3 10^6 events total).
* P2C (26-27/Oct./01): { 26000 triggers/spill (~5 10^6 events total).
  25 ns structured

- No significant errors found in HPTDC v1.0.
- TDC stands high hit rates, even with noisy channels. (~MHz.)
- Noisy channels only affect one group (8 channels) and buffer full is flagged.
- Loss of data has been understood: wrong bunch reset timing.

8 HPTDC irradiated at LLN (Dec. 01)

- 60 MeV protons, total fluence of $5x10^{10}$ $p.cm^{-2}$
- Operation was continuosly monitored and checked.
- One SEU was observed in the setup register of one device.
- Recovery after reprogramming.
- Expected error rate due to SEU <1/day in the whole detector.

ROB TESTING SUMMARY

Several tests have been performed to validate ROB design and insure proper operation even in adverse conditions.

+ Irradiation of some devices at Cyclotron Research Centre (UCL):

$5x10^{10}$ p.cm^{-2} of 60 MeV protons.

- Differential receivers (DS90LV048A): **No SEU**.
- Regulators (MIC29151-3.3BU, MIC39151-2.5BU): D**V < 1%.**
- HPTDC v.1.1: Recoverable SEU rate expected **<1/day** in the whole detector.

+ Neighbour channels crosstalk:

Time measurement shift in one ROB channel due to neighbour channel signals.

- Always below half HPTDC bin resolution: **< ±0.35 ns** (set-up resolution).

+ LV regulators temperature dependence:

- Negligible variations due to temperature **(< 5mV/30ºC).**

+ Temperature cycling

Small slope cycles: 5 min/ ºC.
Ambient temperature from 0ºC to 70ºC.
ROB continuously operated and monitored.

- All devices bear perfectly temperature conditions.
- Small time shift: **900 ps/70ºC**. Max. Variation **~40ps/ºC.**

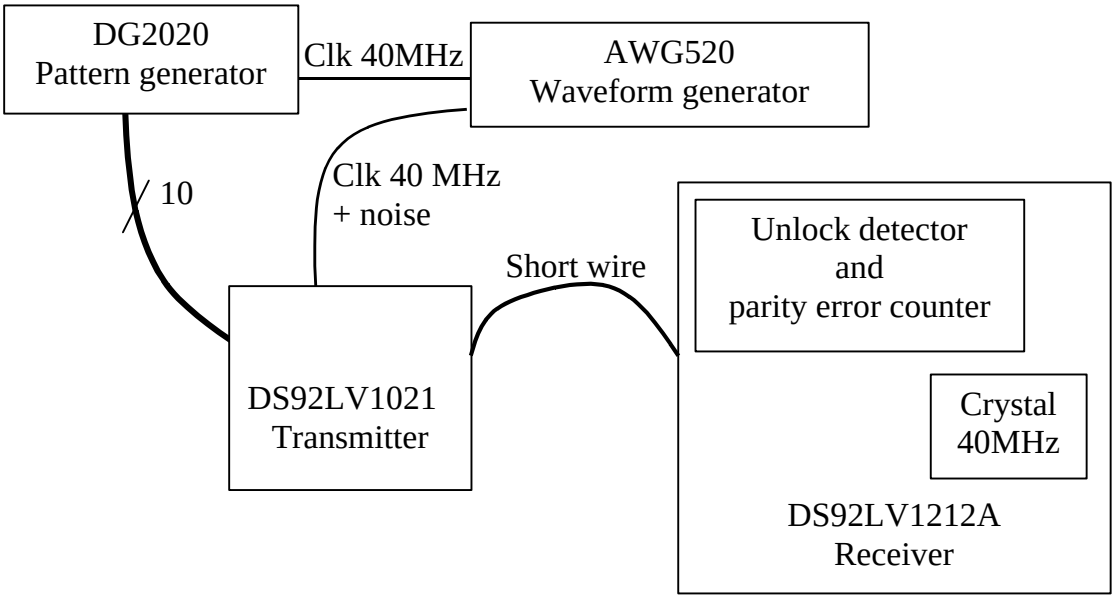
+ Lifetime test:

- ROB fully operational at 105ºC ambient temperature going on at the moment.
- Frequently operated and status monitored.

+ LVDS link (DS92LV1021 - DS92LV1212A) jitter tolerance:

Operation at 40 MHz ⇒ 480 Mb/s

Max. jitter	Rms	Failure rate
± 600 ps	130 ps	$< 5\ 10^{-13}$
± 800 ps	170 ps	$= 5\ 10^{-12}$
± 900 ps	190 ps	$= 10^{-9}$



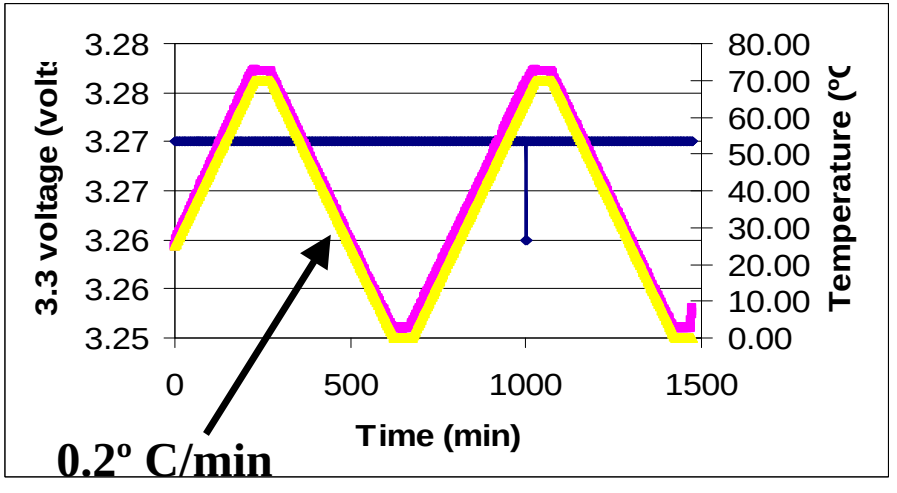

DI-100

Environmental chamber

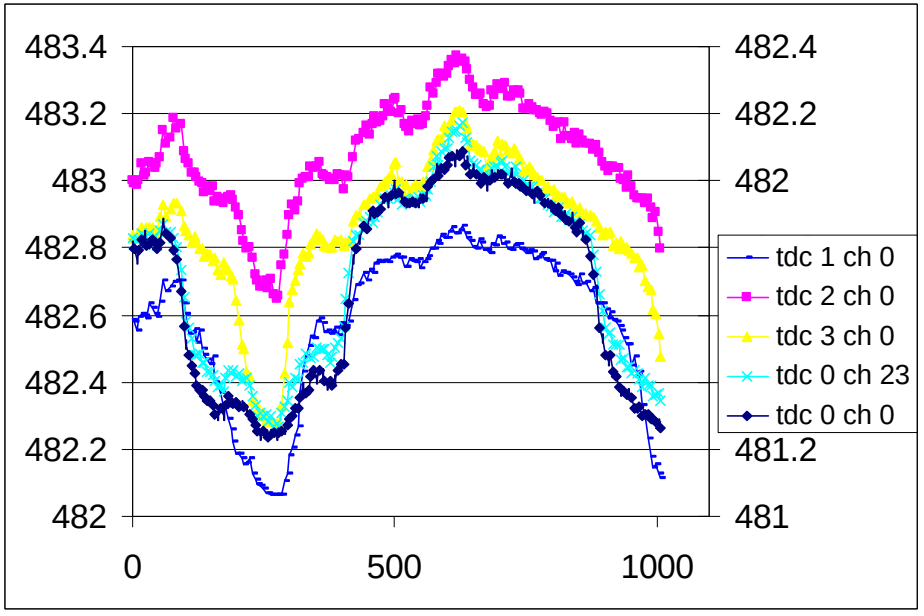
ROB can be fully operated and monitored.

- **Soft temperature cycling**
  - Within every component safety margin: 0º to 70º
  - Not to exceed device specs just to find any variation due to temperature

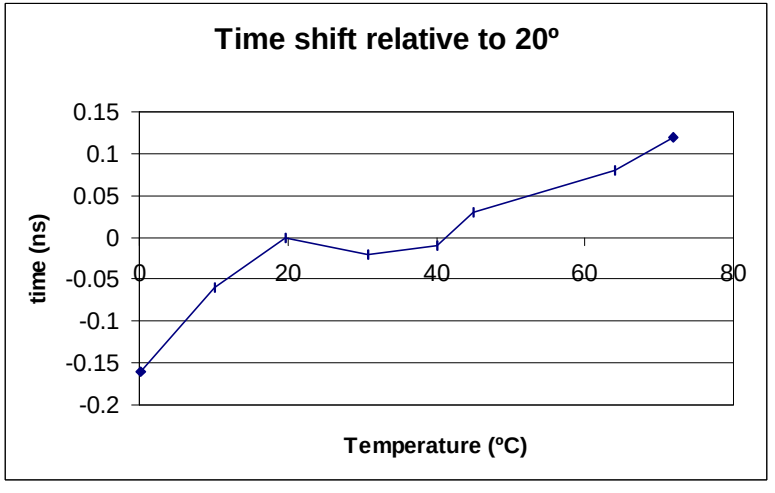
- **Life time test** of one board at a time at 105ºC
  - Find out failure mechanisms with an accelerated stress test
  - May give us an idea of the most probable failure modes
  - At the moment: *400 hours* and all devices are working properly.



- MICx9 regulator specifications: $\Delta V < 0.1mV/ºC$
- Board temperature and voltage: sensor DS2438 (±10mV)
- *No variation with temperature*.



- Time measurement variations:
  max 1 ns from 0ºC to 70ºC
  max slope ~ 45ps/ºC
  Slope at 25ºC ~ 10ps/ºC
- Higher temperature - faster signals
- Slightly different behaviour depending on each TDC



~30% of the time shift is due to DS90LV048A differential line receivers

PRODUCTION PLANS

- **PCB´s** : - produce and assemble 30 PCBs upgraded according to previous results.
  - Then we will launch the final production of 1500 PCB´s.

- **Assembly** will be split in several stages during this and next year:

  30 u. May-June 2002 → TEST
  100 u. September 2002
  620 u. November 2002
  750 u. March 2003

  ñ Staged assembly will let us introduce any modification mainly in the production chain.

- **Testing** of these robs will be made at two levels:

  INDUSTRY: Acceptance test

  CIEMAT: Validation and insure proper operation.

ROB burn in plan

Burn in will be done initially in our Lab using a rack specially developed for this purpose:

- 70ºC / 1 month
- 168 ROB's per batch
- Powered and clocked
- Basic check once every day
- Full test every 2 weeks with test pulses and triggers
- Dead boards repaired, re- burn in and put in spare box
- Learn on the process (failure modes, rates) and adjust timing