Front end Hybrid Industrial Tester

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http://www.fynu.ucl.ac.be/themes/he/cms/activities/tracker/hybrids.html

LHC project

Introduction

Large Hadron Collider

Before LHC : LEP

new physics at 1 *TeV* scale ?

LHC performance

pp collider (7-on-7 *TeV*)

high luminosity : up to $10^{34}\ cm^{-2}s^{-1}$

bunch crossing every 25 *ns*

LHC design

superconducting magnets : 8 *T* to bend the beams

1.9*K* superfluid helium cooling bath

CMS, LHCb, Alice, Atlas experiments

LHC project

CMS experiment

Compact Muon Solenoid

General purpose detector

Searches for Higgs boson...

Biggest magnet ever built

B ~ 4 T, R ~ 3.4 m, L ~ 12.5 m

CMS structure

tracker

electromagnetic calorimeter

hadronic calorimeter

solenoid

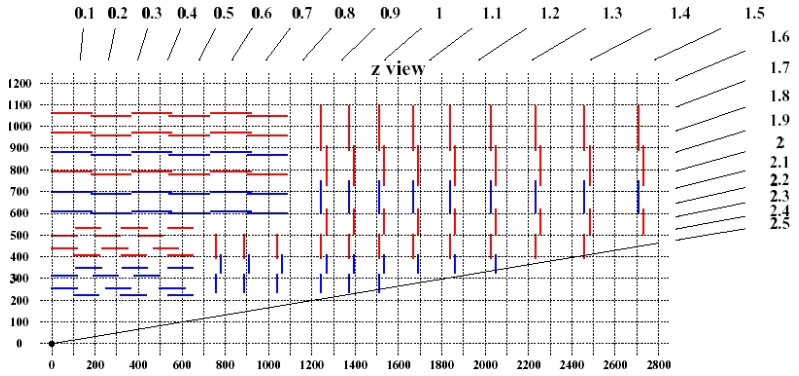
magnet yoke

μ chambers

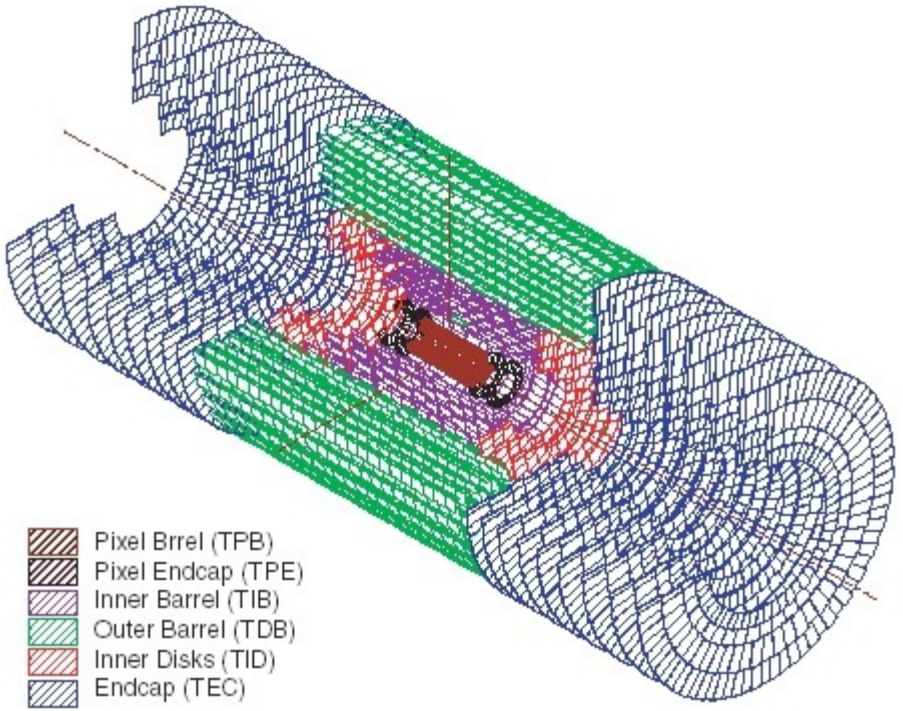
Disposition

→ détecteurs à pixels → 5 10^7 canaux
→ senseurs Si : ~ 223 m² → 10^7 *strips* → 78 000 APVs

couches mono ou stéréo



cylindres / disques



Eléments : modules

Module

FEH
pitch adapter
senseurs Si (2 en *daisy-chain*)
structure en fibre de carbone → sur circuit de refroidissement

CMS Tracker

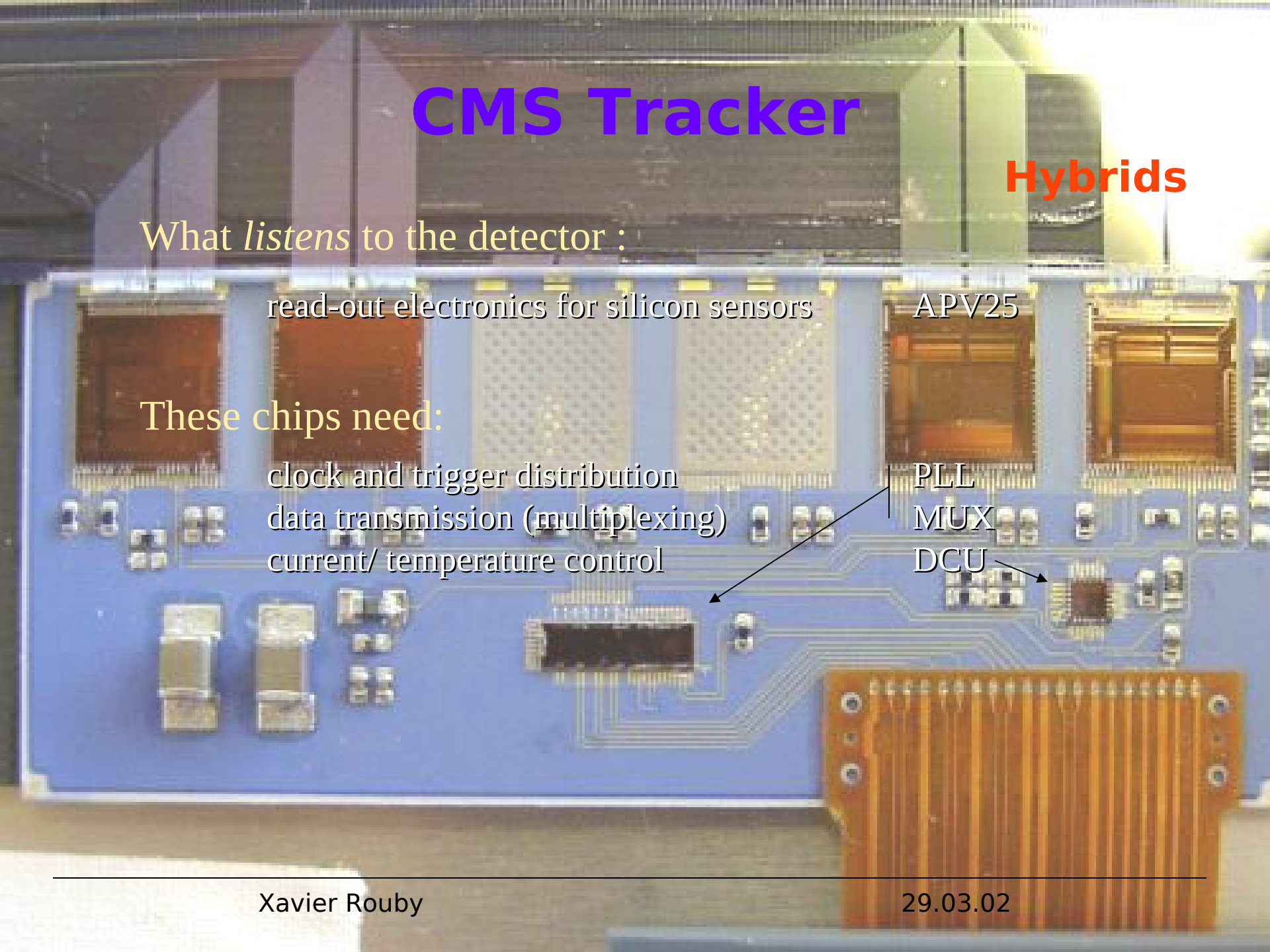
Hybrids

What *listens* to the detector :

read-out electronics for silicon sensors — APV25

These chips need:

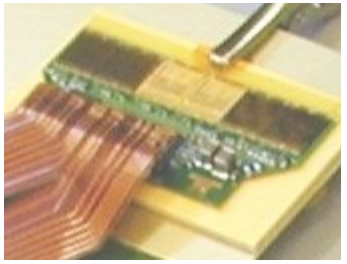
clock and trigger distribution — PLL
data transmission (multiplexing) — MUX
current/ temperature control — DCU



Front end Hybrid Industrial Tester

Three complementary tests of different natures :

Connectivity Test (CT)
Electrical Test (ET)
Functional Test (FT)



mono-FHIT

power supply

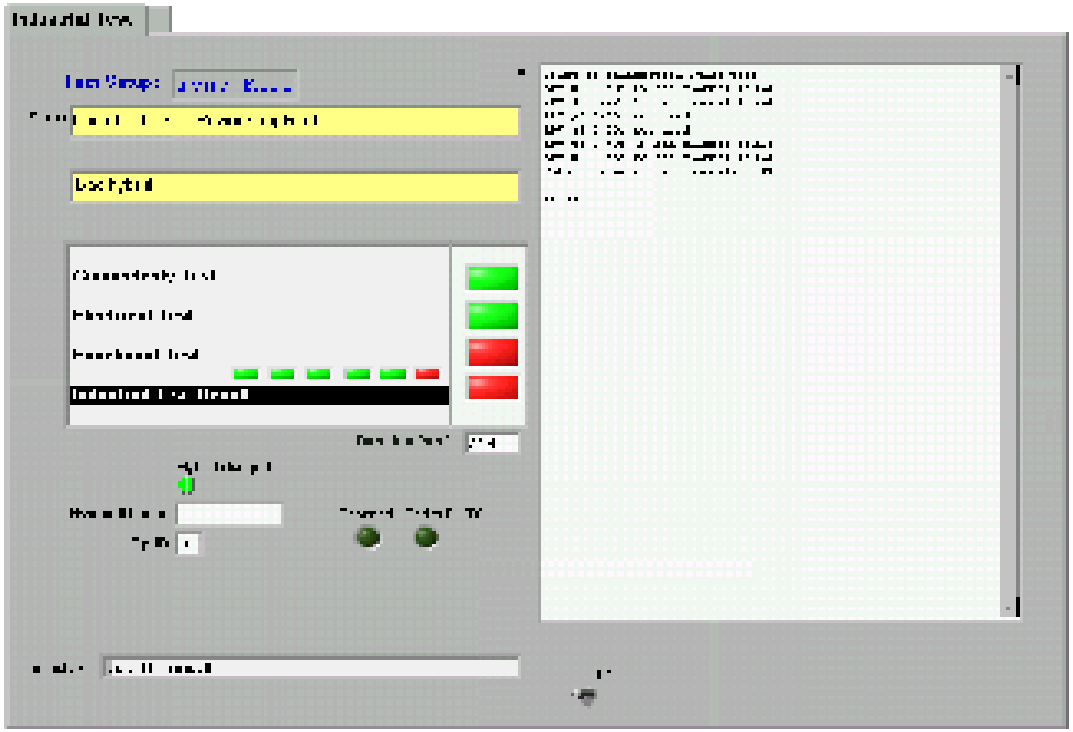
dual-FHIT

FHIT software

→ test sequence, results and detected errors

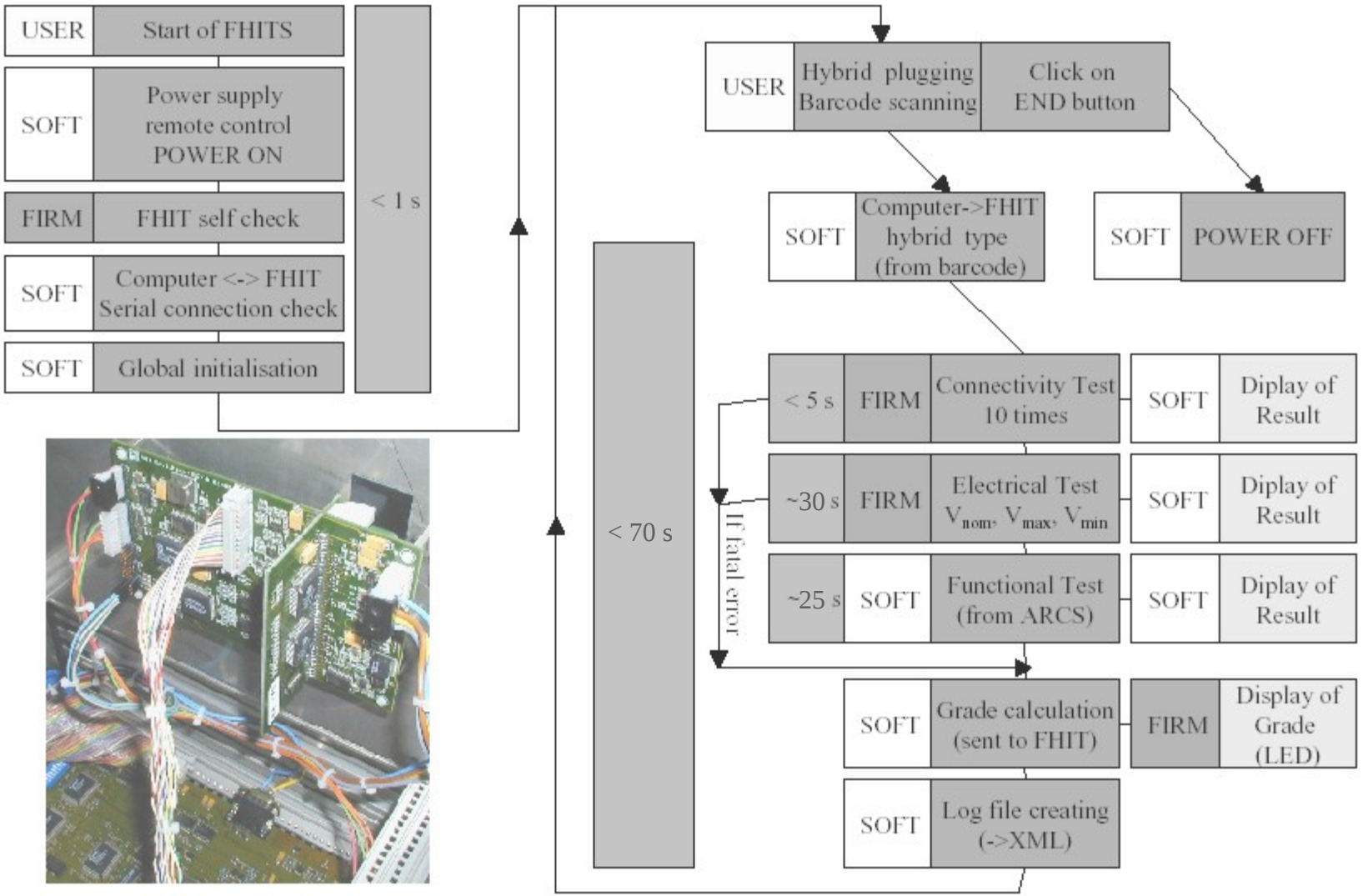
→ power supply control

→ barcode scanning



LabVIEW interface

Block diagram



Data acquisition

data acquisition in real (industrial like) conditions

62 FEH tested in Strasbourg

and 51 FEH passed CT and ET successfully

FEH types : 1663, 1664, 1665 = TOB/TEC top-4, bot-4, top-6

FHIT setup proved to be reliable

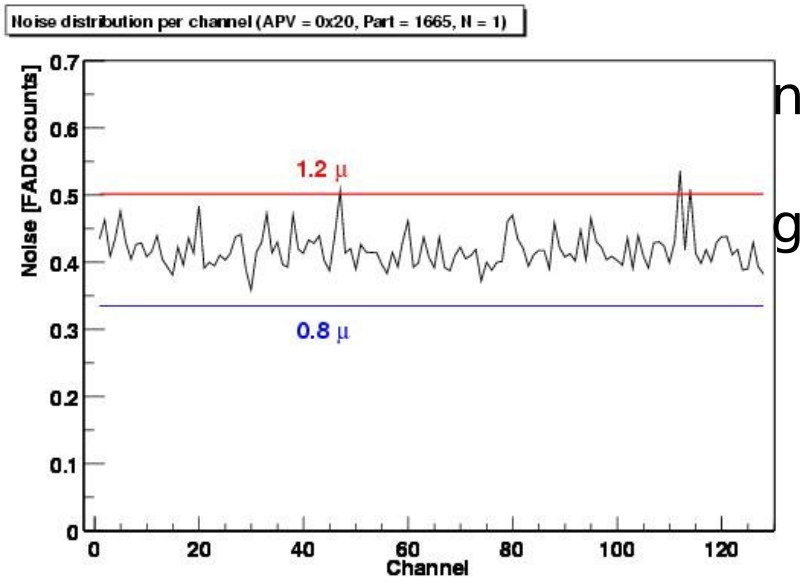
rapidity : dual-FHIT used

test ~ 70 seconds > time needed to handle FEH

analysis :

APV25s currents, DCU calibration, APVMUX resistors, pedestal, noise and gain measurements.

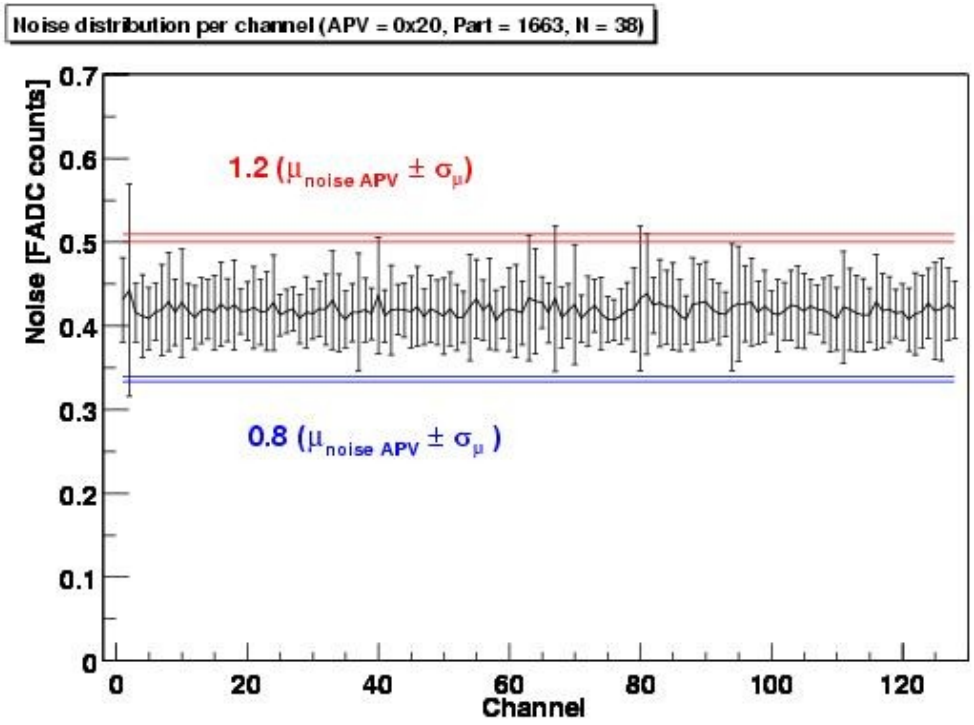
Data analysis : noise (FT)



noise per channel for an APV of one FEH

good/bad channels selection criterion :

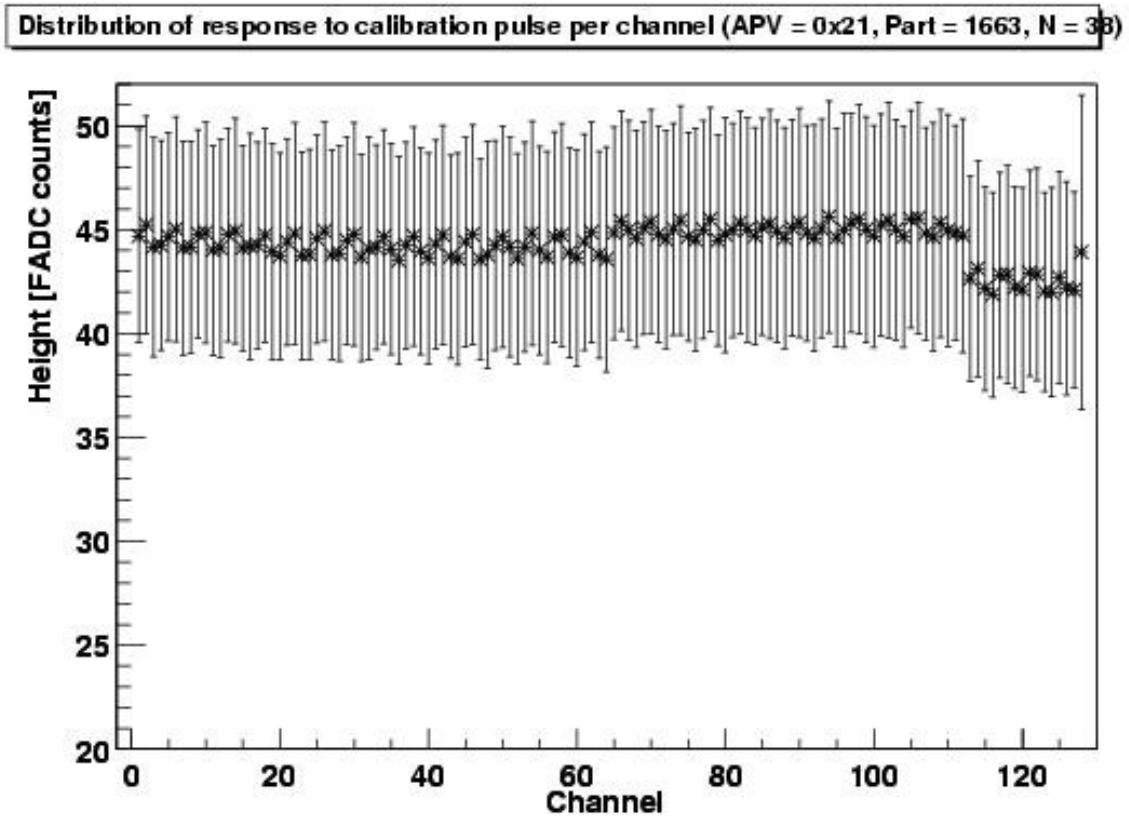
$0.8\ \mu < N_i < 1.2\ \mu$



distribution of noise per channel for an APV address and for the sample of a given FEH type

criterion too restrictive !

Data analysis : gain (FT)

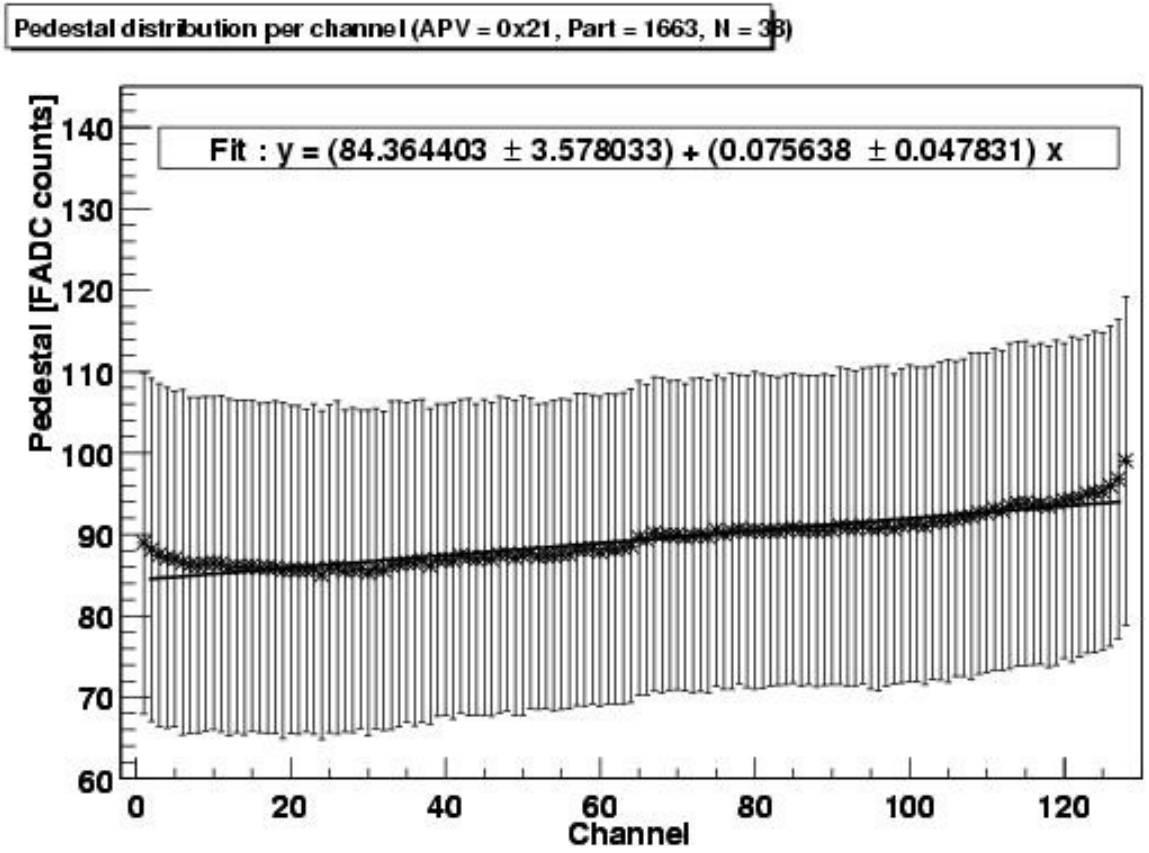


visible structures :
- 3 thresholds
- groups of 4 channels

channels NOT in order

gain distribution per channel for an APV address and the sample of a given FEH type

Data analysis : pedestal (FT)



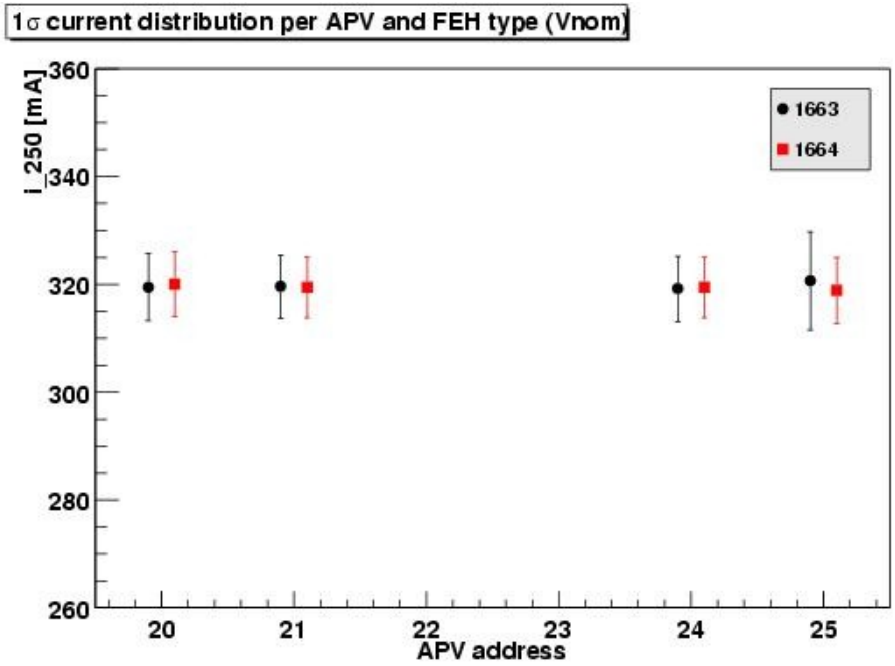
Pedestal distribution per channel for an APV address and for the sample of a given FEH type

visible structures :

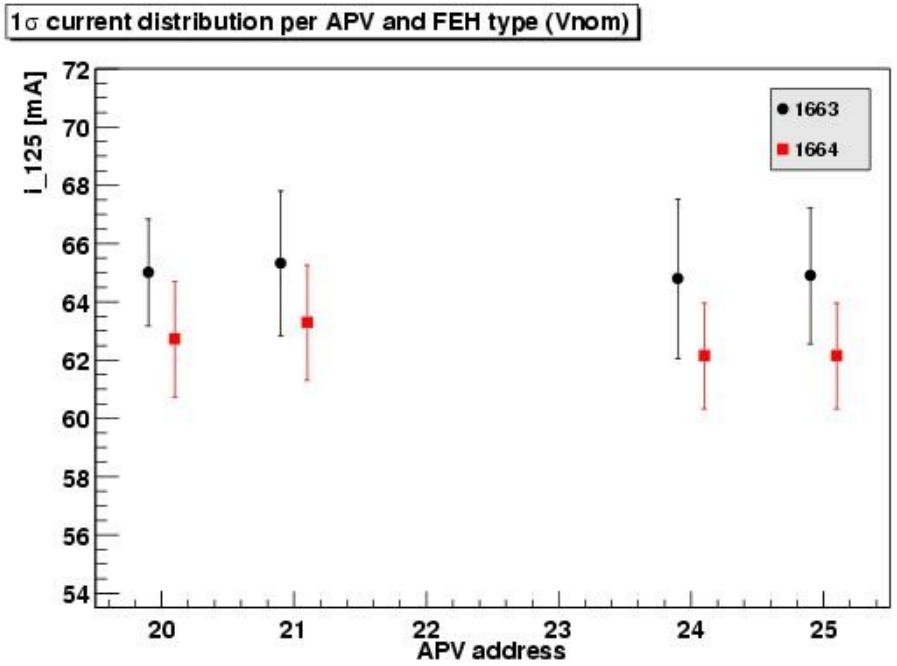
- linear increase
- border effects

for each FEH : strong correlation between channels

Data analysis : currents (ET)



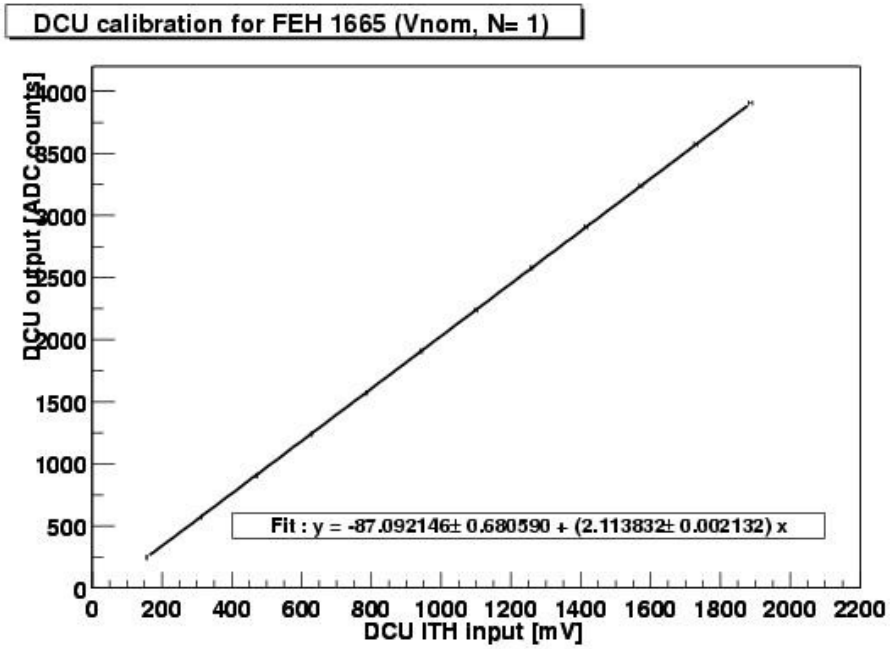
I_250



I_125

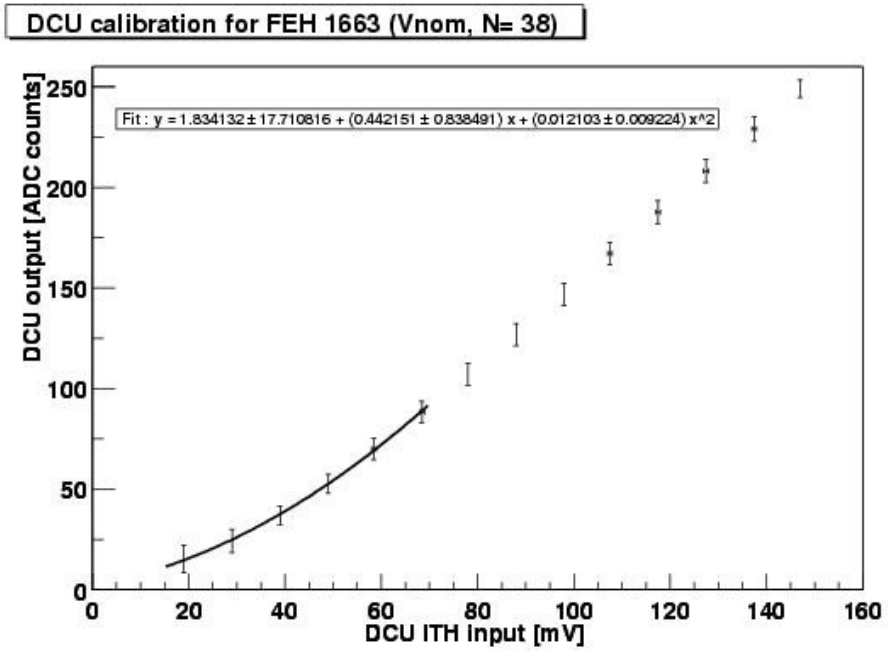
APV current consumption distribution for an APV address and a sample of a given FEH type

Data analysis : DCU (ET)



linear and non-linear regions

DCU calibration for an APV address
and a given FEH



Conclusions

FHIT & FHITS : realised and tested

data acquisition in *industrial* conditions

first data analysis : caracterization of hybrids

FHIT quick reference guide available

http://www.fynu.ucl.ac.be/themes/he/cms/activities/tracker/hybrids.html