General Electronics for Time projection chambers

Un système basé sur le µTCA.0

mais entièrement compatible avec

le µTCA.4 (µTCA for Physics)

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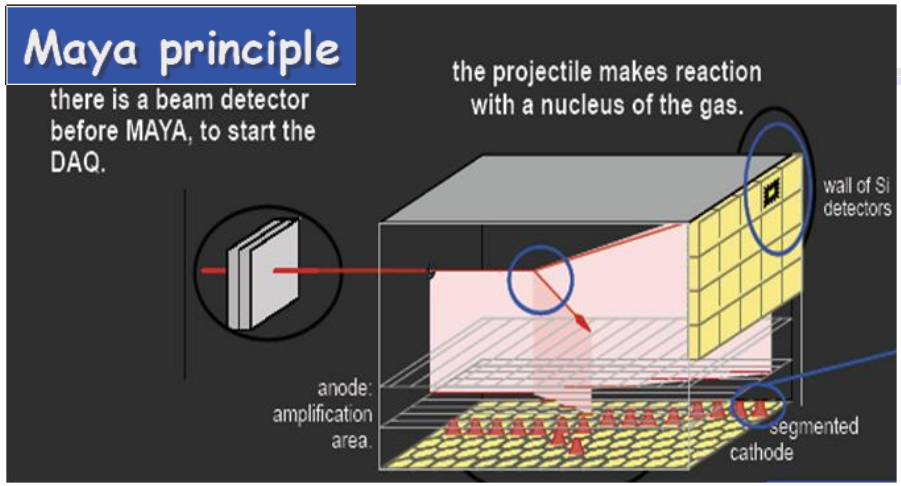
MAYA TPC: 32x32 = 1024 voies

Etat des lieux au GANIL en 2009 …



Système d'acquisition basé sur l'ASIC GASSIPLEX

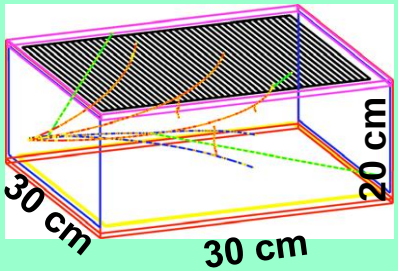
- ⇨ **Temps mort important** (taux de comptage max. ≈ 100 Hz)
- ⇨ **Faible intégration** (16 voies/circuit)
- ⇨ **Technologie ancienne** (Disponibilité, Quantité?)

Ne convient pas aux besoins des nouvelles TPC

➔ **Grand nombre de voies (> 5000)**

➔ **+ un ordre de grandeur en termes de taux de comptage**

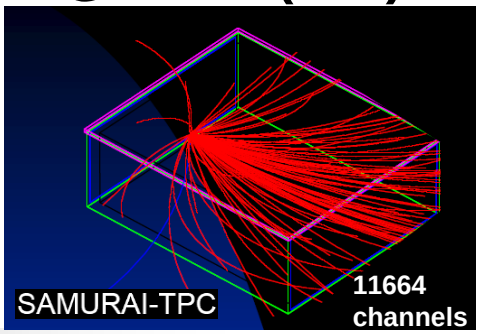
ACTAR_TPC = 16384 channels @ GANIL

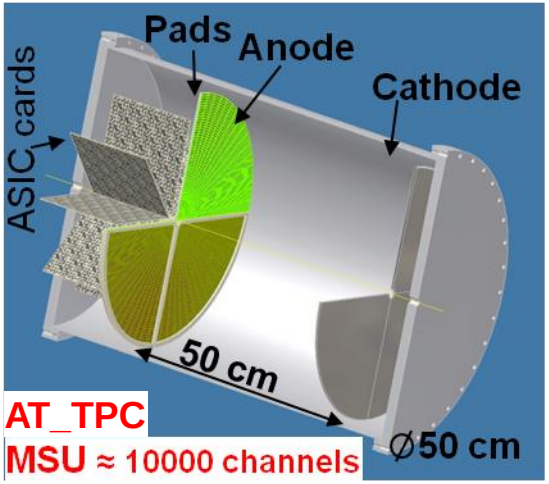


Demain:

10000 voies ou plus …

@ 1KHz (ICR)





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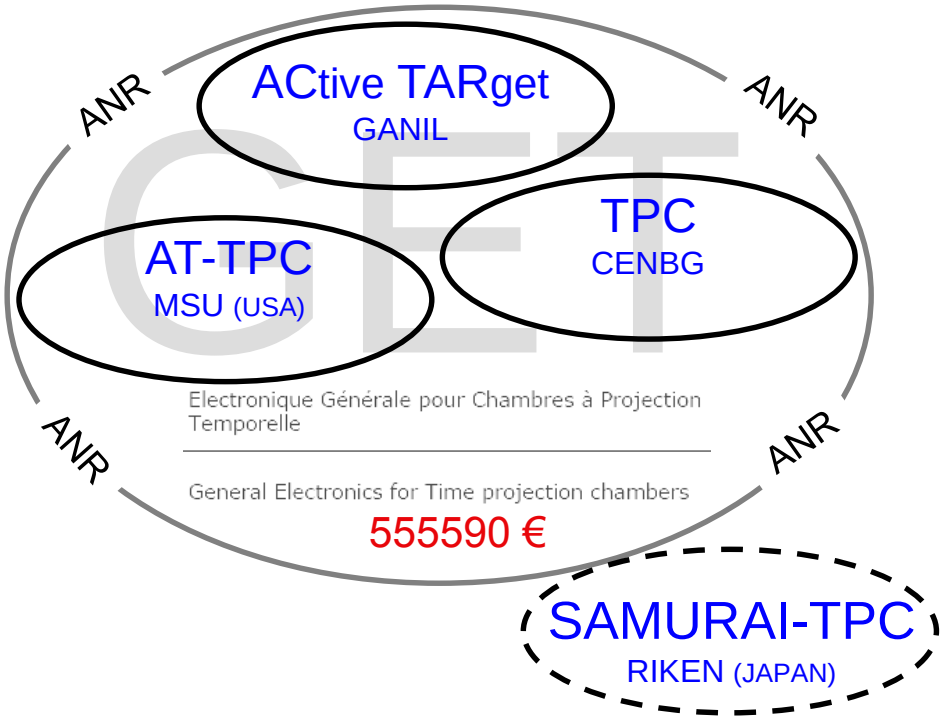
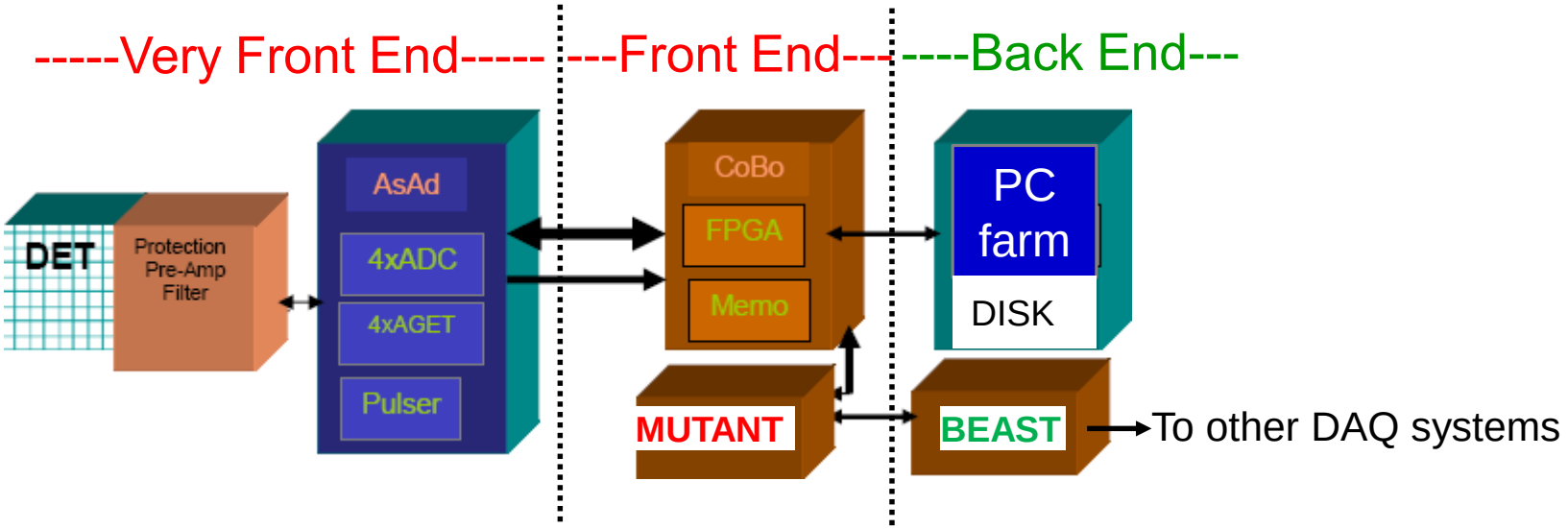


collaboration based on an "ANR" grant for the French labs (2009-2014)

Reminder of DAQ block diagram



AGET: Asic for GET – 64 analog channels - 512 cells/channel **IRFU**

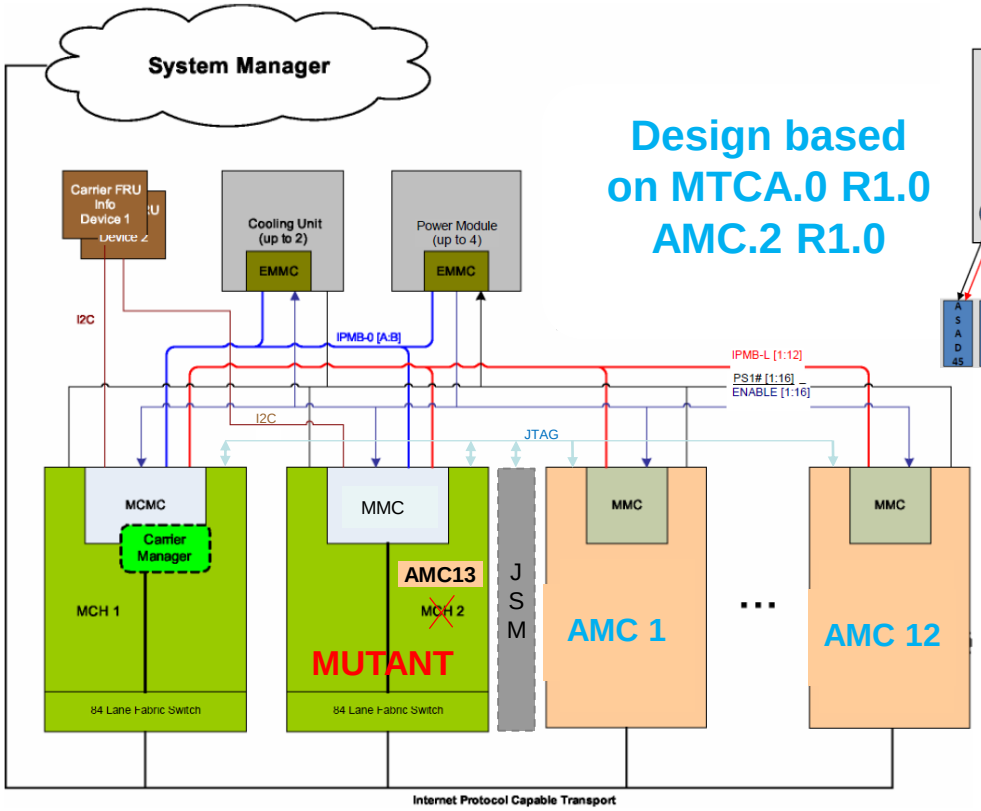
ASAD: ASic and Analog to Digital converter - 4 AGET + 4 ch. ADC **CENBG**

COBO: COncentration BOard – 4 ASAD - 1024 digital channels **NSCL/MSU**

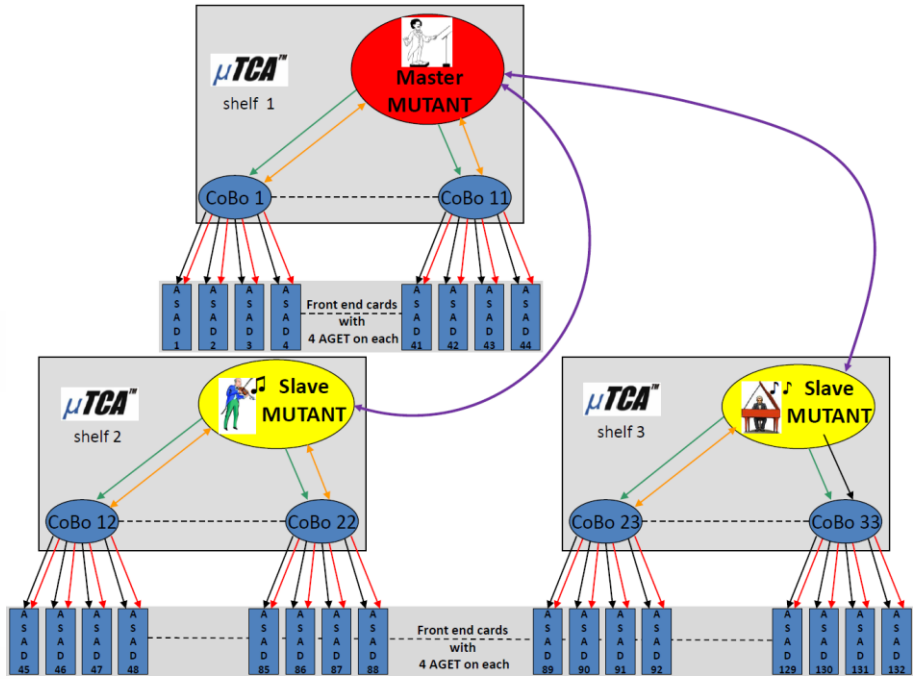
MUTANT: MUtiplicity, Trigger ANd Time (3 trigger levels)

BEAST: Back End Adaptor for Synchronization by Timestamping

Short reminder about the global architecture



Design based on MTCA.0 R1.0 AMC.2 R1.0



1024 ch. x 11 slots x 3 shelves = 33792 channels

(Vadatech VT893)

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Components of the full GET system

AsAd board – 256 channels
(4 AGET chips)

CoBo board – 1024 channels
(managing 4 AsAd boards)

MUTANT module – up to 12288 channels
(12 CoBo boards / 48 AsAd boards)

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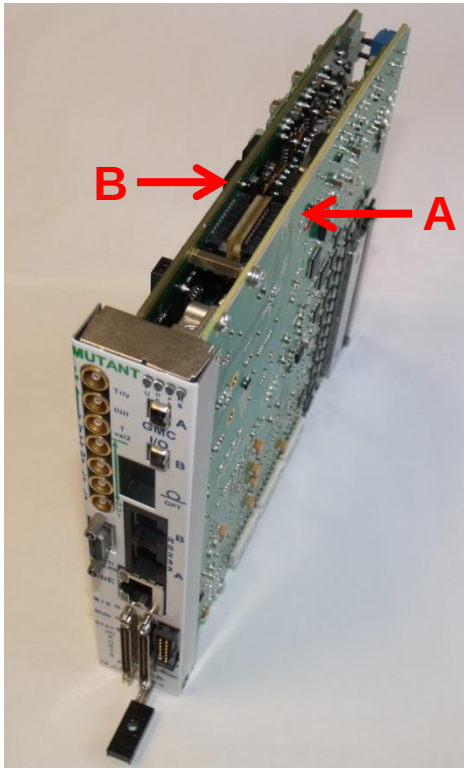
MUTANT, the maestro of the GET electronics

MuTanT

Multiplicity **Trigger** (L0,L1,L2) **and Time** (+ Event Number)

1 module – 2 boards



Board B: - Trigger/timestamper engine

Board A: - GMC/WSCA distribution
- Embedded system (Linux)

L0: External trigger
L1: Multiplicity trigger
L2: Trigger on hit pattern

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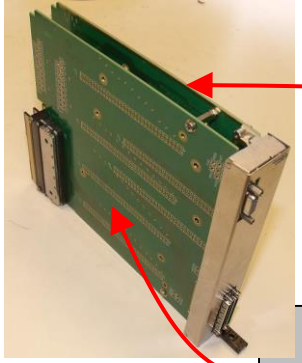
Synoptique et assemblage de MUTANT



Port A +Fat Pipe
(Ports D,E,F,G)
X 10
Tongue 3 & 4
(200 signals)

MUTANT
Master/Slave
Front panel
VHDCI link

CENTRUM/SCALERS
Front panel Interface

TRIGGER I/O
Front panel Interface

LVDS buffers

LVDS/
LVPECL
buffers

NECL
buffers

buffers

XILINX-V5FX70T

PowerPC 440 Processor

TRIGGER &
TIME STAMPER
ENGINE

DDR2

FLASH

B

Tongue 1

VT026
AMC management

GbE
RS232

Front panel

XILINX-V5FX30T

OPTICAL
transceivers
ribbon fibbers

Optical link

EMC

ICE

VxWorks

PowerPC 440 Processor

FLASH

DDR2

A

TDC

Global Master Clock
Management/Distribution

Tongue 2

Front panel

2 cartes à développer !

Carte B

Carte A

TONGUE
4
3
2
1

2 PCBs 14 couches
avec épaisseur max de 1,6 mm

1 tongue = 2 x 85 pins
4 tongues à gérer
= 680 pins!

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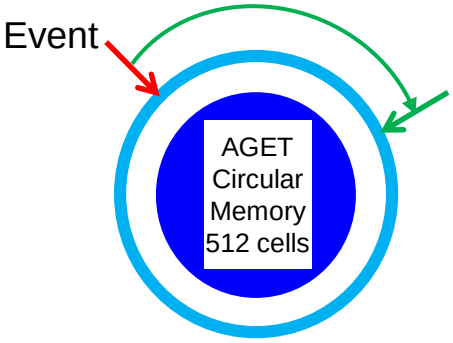
MUTANT- CoBos data exchanges
main time values

AGET: Sampling Frequency = 1-100 MHz
Trigger roundtrip: 512 x 10 ns = 5.12 µs
to 512 x 1µs = 512 µs

Full memory

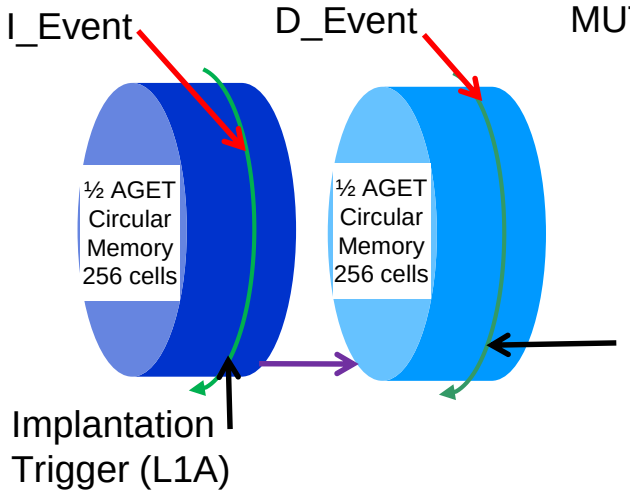


MUTANT Programmable Delay & Gates are 16 bits wide
Attached to GMC (10 ns)

CoBo to MUTANT : L1: new multiplicity value @ 25 MHz max
nothing to do @ MUTANT level for lower frequency
L2: 1.3µs to receive the TPC hit pattern (one shelf)
12.8 µs for added shelves

MUTANT trigger "OK" to CoBo "STOP": -LØ : 30 ns/655 µs max
- L1 : 80 ns /655 µs max
- L2 : depends on the algorithm !

2 x half-memories (2p decay)



MUTANT information's to CoBo:
- L2 mask pattern: 1.3 µs
- Time stamp + Event Number: 120 ns
- Time stamp only: 80 ns

Decay Trigger (L1B) or
Time-out (programmable)

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Summary of what to do to be compatible with MUTANT

- 1) In terms of clock/clock_enable networks (M-LVDS electrical standard)

  MUTANT distributes a 100 MHz clock to every CoBo of each crate, phase aligned (skew< 1ns - TDC) ⇨ **µTCA-CLK1**

  MUTANT distributes a synchronous start/stop sampling (phase aligned) ⇨ **µTCA-CLK2**

- 2) In terms of hardware data transfers (LVDS electrical standard)

  MUTANT exchanges data with the CoBo @ 800 Mbit/s
  ⇨ 5 µTCA ports (TX/RX)

  - 1 tx bit clock + 4 tx data (DDR)
  - 1 rx bit clock + 4 rx data (DDR)

- 3) In terms of communication protocol
  - Multiplicity received every 40 ns from CoBo's
  - Event Number and Timestamp transmitted to all CoBo's in 120 ns

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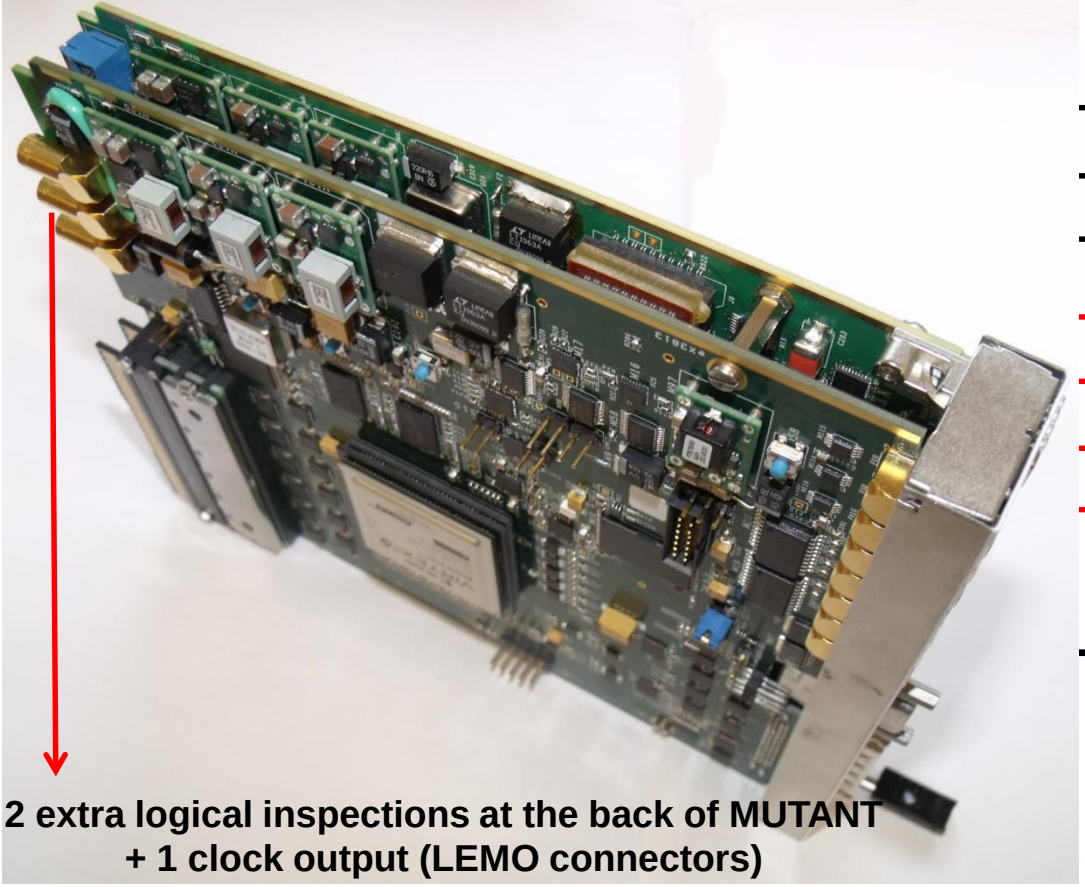
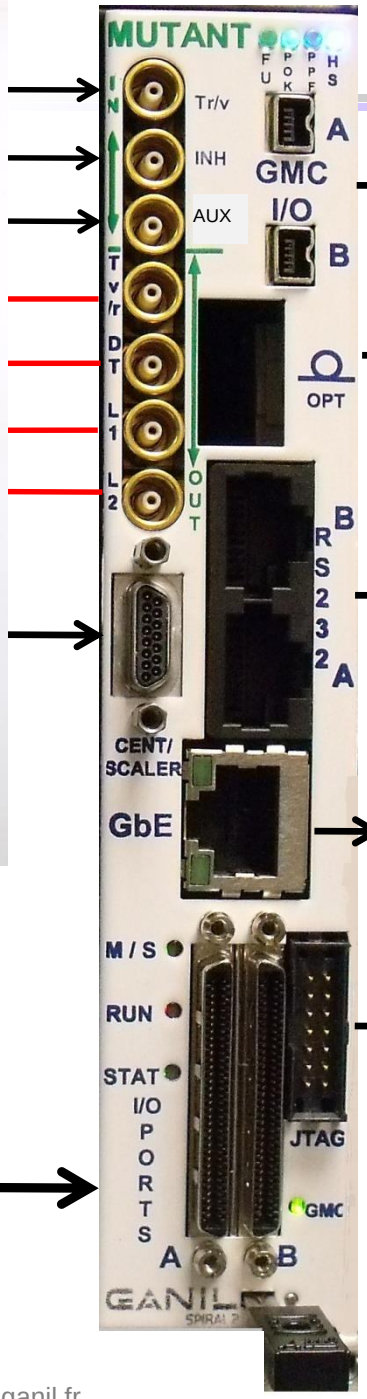


2 extra logical inspections at the back of MUTANT
+ 1 clock output (LEMO connectors)



Copper Clock I/O

Optical Coupling
(with clock)

Serial ports attached to each PPC440

To network

Front panel JTAG
(2 JTAG chains for A&B boards update)

Inter shelves connection
(between Master MUTANT et slave MUTANT)

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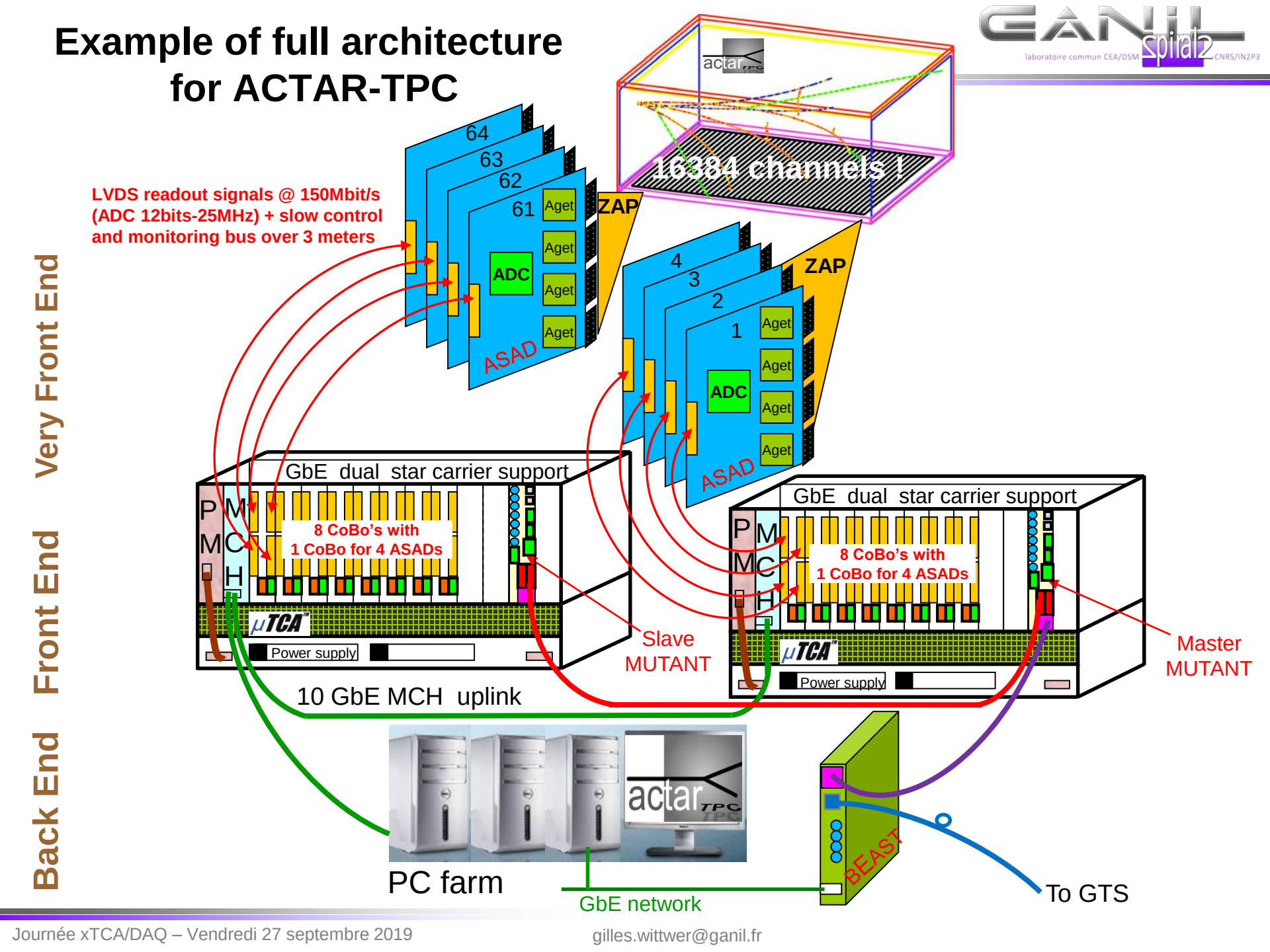
Example of full architecture for ACTAR-TPC



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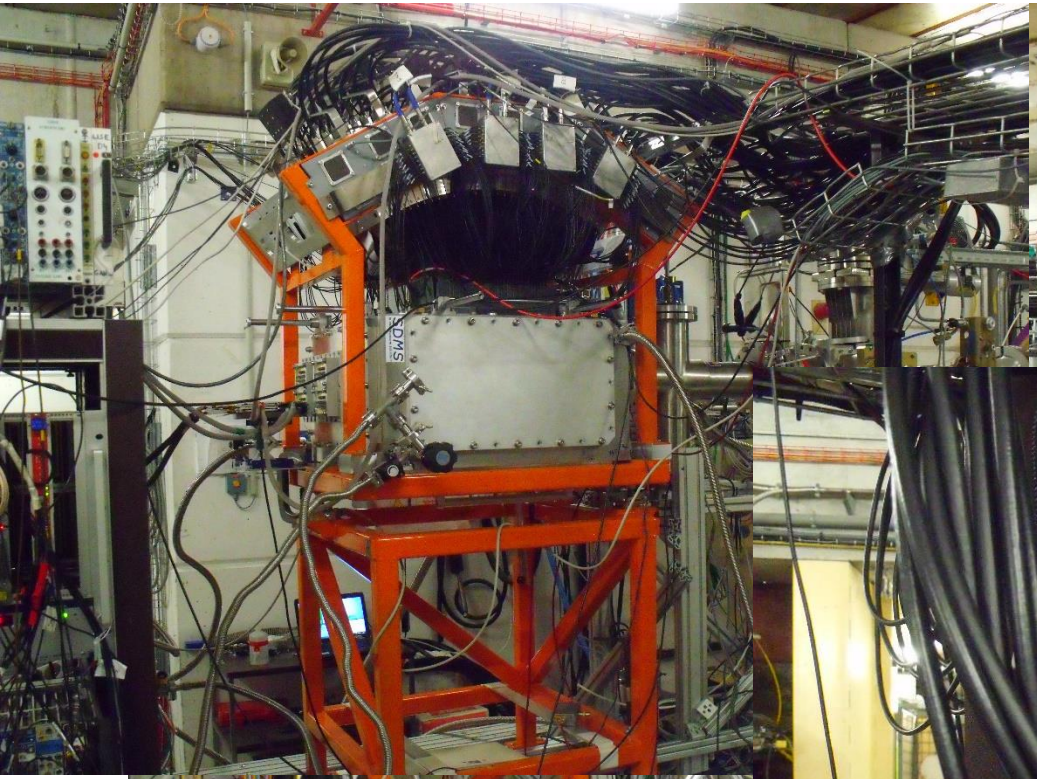
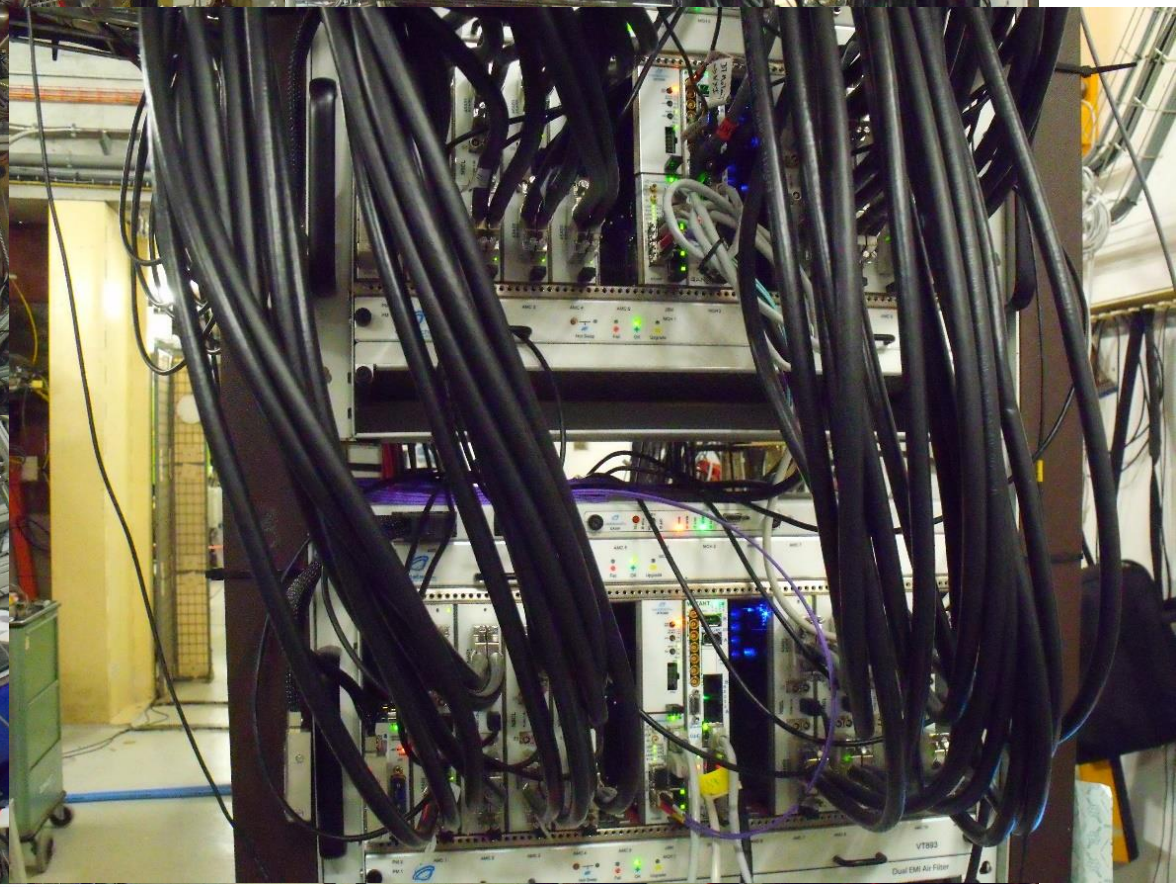
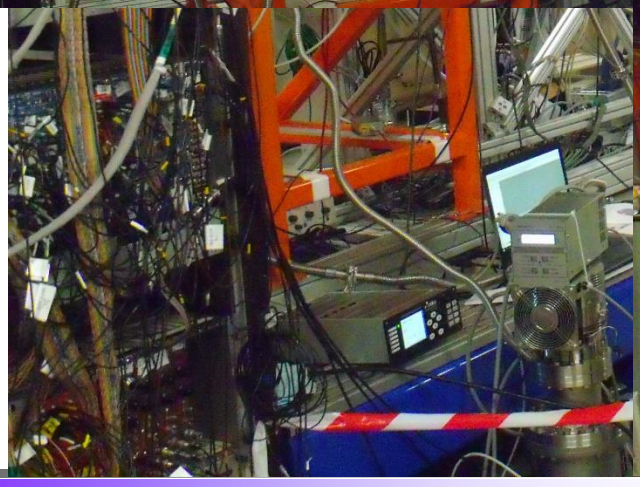
Campagne 2019 -- ACTAR-TPC en salle D6







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Conclusion

Caen, Saclay, Bordeaux

Michigan, Texas,Indiana

Catania, Legnaro

Riken, JPARC

Daejeon

Leuven

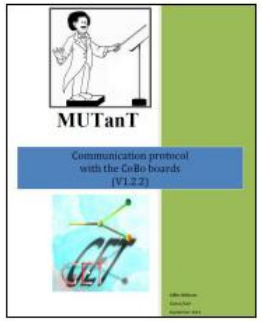
Shanghai, Hong Kong, Lanzhou

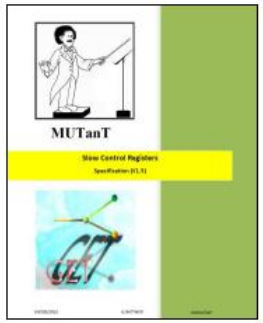
- Un grand projet (>7 ans) pour notre groupe, à tous les niveaux (technique, social, …)
  - Appréhension complète d'un nouveau standard et des systèmes embarqués
  - Renouvellement important de nos bibliothèques CAO/Cadence

- MUTANT - Première production en 2015 avec 15 modules construits et tous vendus
  - Un second et dernier lot de 20 modules produit en 2016 pour GANIL et les laboratoires extérieurs (≈ 20 projets dans 15 laboratoires)
  - Valorisation avec bénéfice de 130 k€ pour GANIL

- Le choix du µTCA.0 parfois mal compris en 2009, aujourd'hui bien ancré dans les labos IN2P3 et les projets pour plusieurs raisons:
  - Arrivée du µTCA.4 (µTCA for Physics - 2011)
  - Recommandation IN2P3/IRFU (Journées de prospectives - Février 2012)
  - Obsolescence définitive des bus // (VME/VXI …)
  - …

- Un système de documentation complet pour les utilisateurs avec des formations adaptées et un support.





Le groupe DELTA continue avec BEAST aujourd'hui et surtout propose SMART pour demain …

Merci de votre attention.

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