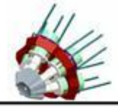
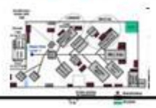
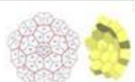
Trends of FEE instrumentations for SPIRAL2 detectors

Detector	Hardware representative	DAQ representative
ACTAR 	Frédéric DRUILLOLE	Frédéric SAILLANT
AGATA 	Michel TRIPON	Eric LEGAY
DESIR 		Etienne LIENARD
EXOGAM2 	Abderrahman BOUJRAD	Gregory LEBERTRE
FAZIA 	Pierre EDELBRUCK	Antonio ORDINE
GASPAR 	Emmanuel POLLACO	Shebli ANVAR
NEDA 	Michel TRIPON	
NFS 	Xavier LEDOUX	
PARIS 	Adam CZERMARK	Xavier GRAVE
S3 	Nabil KARKOUR	Frédéric SAILLANT

NUSTAR Representative
Haik SIMON

a) The Instrumentation Coordination Committee has created two Technical Working Groups
- DAQ Working Group
- Electronic working Group

b) ICCEG aims to find synergies in:
- Hardware
- Firmware
- Embedded software

http://www.spiral2pp.eu/icc/technical-groups/meetings/twg-meeting

Trends of FEE instrumentations for SPIRAL2 detectors

Extract of the template of specifications for SP2 detectors

(FEEDAQ , SPIRAL2 week, ICC meetings)

	ExogamII	DESIR	ACTAR	PARIS	AGATA	FAZIA	GASPARD	S3	NEDA
1.Number of Channels (+/-20%)	512	A few hundred	10000	1000	6840	5000-20000	15000	1603	200
2.How many detector types are you considering?	HPGe (BGO, CsI)	Plastic scintillators, gas detectors, germaniums, silicons, BaF2,	Gas detector (Si, CsI, LaBr)	Scintillators: LaBr3, CsI(Na) or BaF2	AGATA (will be coupled to additional Detectors)	Si/Si/CsI(Tl)	Thin DSSD,Si,LaBr3	SHE : Si (<300), 100Sn : Si(<650), Ge(<50) Tr(<200, charge) + (< 3, times)	Liquid scintillator
1. For each please reply to the following questions									
3. Geometry description									
1. Distance between pick-off signal	_			Depends on APD or PMT		< 10 cm	_	Si <10 cm	<10 cm
2. Capacitance Min & Max	10 pF		~0.1 pF per pad	_		100-500 pF	1-100 pF	10-15 pF	Depends use of PMT, APD, SPM or MCP-PMT
3. Radiation damage for electronics – is this a problem?	To be studied	No	No	No	No	No	No	No	No
4. Gamma absorption – is this a problem?	No	No	Possibly	Possible	Yes (add. Detectors)	No	Yes	Yes	No, but neutron scattering and absorption must be minimized
5. In what environment for the electronics	_	_	_	?	_	_	_	-	
i. Vacuum	No	No			No	Yes	Yes	yes (Ion dis. & heating)	No
ii. Gas (flammable?)	No	No			No	No	No	he/h2 if gas sep.	No
iii.Where will you put the electronics?	Preamps in the detector modules. Digitizers in NIM crates at 5-10 meters. Preprocessing	In air	Outside the gas volume, in air (preamp in gas ???)	In air	Preamps in the detector modules. Digitizers at 5-10 meters. Preprocessing (ATCA) at any distance	FEE in Vaccum+ cooling	Preamp close to detectors, rest at the back of the last stage	Si: possibly in chamber, Ge: outside, Tr : in chamber	PMT, APD, SiPM or MCP-PMT with preamps mounted at the rear of the detectors, digitizers 5-10 m from the detectors. Preprocessing at any
4. Impedance between channels	_	_				?	No cross talk	?	?
5. Channel Polarisation									
1. +/- ve	+3500V for core electrode, 0 for segments	Both	Both	Both	+5000 for core elect. 0 for segments	+100-300	50-300	Si :100V, Ge : 3000V	PMT: -2 kV; SiPM < 100 V, APD < 500 V, MCP-PMT: 2 kV
2. Current drawn	<< 1nA			?	<< 1nA	< 1mA	1-100nA	?	<5 mA
6. Counting Rate	For Core								
1. Mean event rate on detector	Not applicable	Not more than 1000 pps	1000 to 100000	1000 to 100000	Few Khz	<1000 per s	Few 100 -few 10e4	SHE Si, Tr:10hz -5 Khz, ^{100}Sn, Tr 10Khz, Ge : 1 hz-1 Khz	<= 300 kHz
2. Total data rate	3Mb/s per Crystal 30Mb/s (10 Crystals)	1000 ppss	< 1000	< 1000	100 MB/s (after tracking)	< Gb/s		?	<= 500 MB/s after PSA, OR of all detectors, no external trigger
3. Max counting rate/channel	100 Khz	1000 ppss	100	100- 1000	10-50 Khz	<5000 per s	Few 100	Si, Tr:1 Khz, Ge:100hz	10 kHz
4. Min counting rate/channel	0.001	0 pps	0	0		1 per s	1	1/month	100 Hz (typical low background rate)
5. Average counting rate/channel	_	10-100 pps	Few /s	few/s	10 Khz	< 100 per s	01/10/08	Si, Tr:200 hz - 1khz	Typical counting rates: 5 kHz with stable beams, 1 kHz with RIB (most of 1 kHz from background)
6. Are you considering RDT?	Yes	No	No	Possibly	Yes	?		Yes	Yes
7. What kind of Pre-amp Current or Charge	PAC	Mainly Charge	Charge	?	Charge	Current & charge	Both	Current & Charge	PMT (current), APD, SiPM or MCP-PMT (charge)
8. Resolution needed	**1.2 keV for 200 KeV 2.3 KeV for 1.33 MeV**	1/10000	600 e rms	?	1/1000	50 to 100 KeV	(2 KeV-30 KeV/Si) (<50KeV / 1MeV)	Si : 0.25%, ~1 ns(TDC) E: 20KeV@5MeV alpha / 1MeV for 500 MeV Heavy ions; Ge:0.1%~1ns (time),2.3 KeV@1.3	Time resolution: FWHM of about 2 ns between detector signals and external time reference taken from the time pickoff system of a pulsed beam.
9. Linearities									
1. Integral non linearity	5 LSB		< 2 %	< 5 %		< 0.001	Few 10e4	?	5 LSB
2. Differential non linearity	2.5 LSB	5,00E-005			5,00E-005	? LSB		Ge:5e-5	3 LSB

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Trends of FEE instrumentations for SPIRAL2 detectors

Template of specifications for SP2 detectors (FEEDAQ, SPIRAL2 week, ICC meetings)

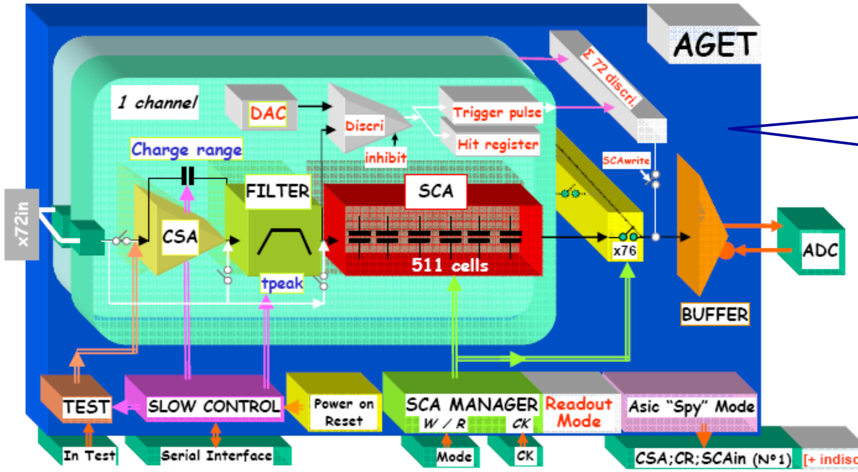
- **Detectors:**
  - Types and geometry
  - Number of channels
  - Bias voltage and current
  - Environment
- **Rates:**
  - Counting rate
  - Data readout rate
- **Very Front End**
  - Charge or current preamps, APD, PMT
  - Technology
- **Data processing**
  - Dynamic, resolution and linearity
  - Sampling rate
  - Parameters: E, T, PSA
- **Trigger**
  - Number of levels
  - Time stamping
  - Coupling
- **Dead time**
- **Remote control**

Trends of FEE instrumentations for SPIRAL2 detectors

From the template and from ICCEG works, it is worth to notice:

Two instrumentation architectures are emerging

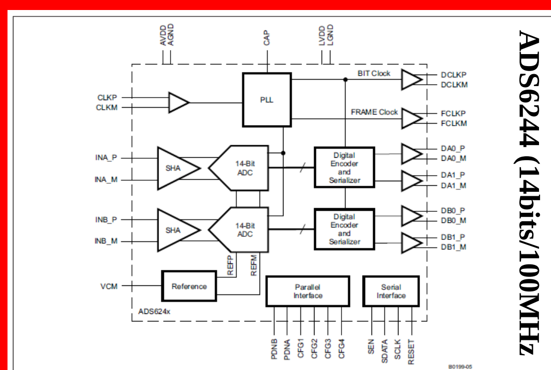
a) ASIC based architecture



Analog Processing

b) FADC based architecture

Detector + CSP or PMT or APD



ADS6244 (14bits/100MHz)

Flash Analog to Digital Conversion

Digital Processing

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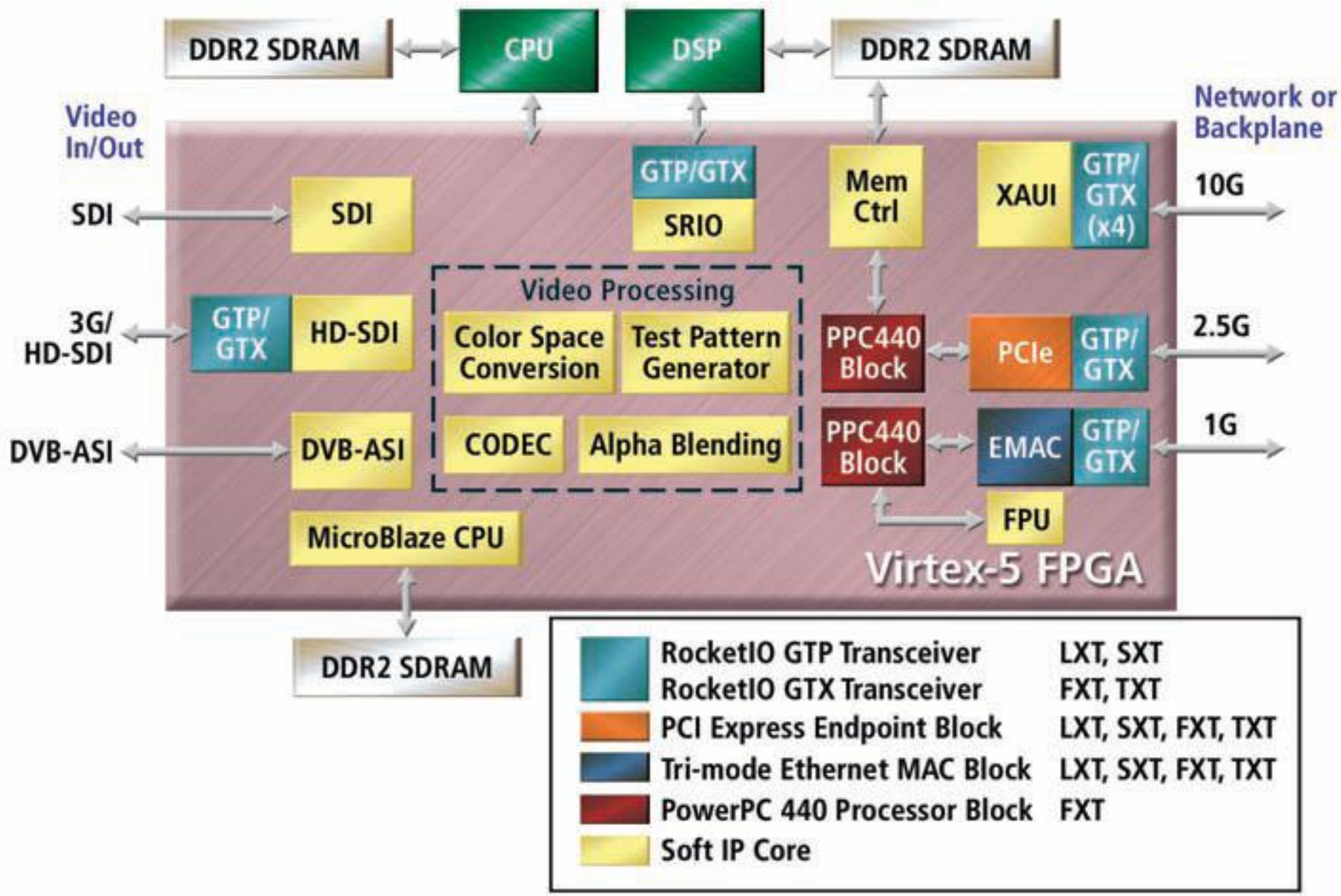
Trends of FEE instrumentations for SPIRAL2 detectors

From the template and from ICCEG works, it is worth to notice:
Fast serial communication protocols such as GbEthernet, PCIe, Aurora and UDP in Xilinx Virtex5FXT are widely deployed



Trends of FEE instrumentations for SPIRAL2 detectors

From the template and from ICCEG works, it is worth to notice:

➢ **The choice of the electronic standard is widely open**
- Customized racks for the very front end and front end: ACTAR, AGATA
=> specific mechanical and thermal studies
- NIM and CPCI standard for the front end and back end: EXOGAM2, NEDA, PARIS, S3
- ATCA and µTCA standard for the back end: AGATA, ACTAR

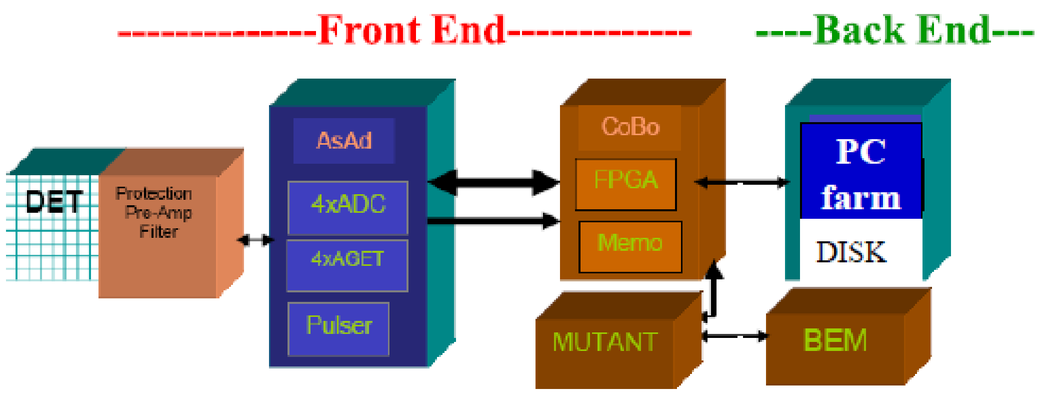
➢ **A system which**
- provides a reference clock (200MHz) and time stamp parameters
- returns trigger decisions
is required

Trends of FEE instrumentations for SPIRAL2 detectors

ACTAR Instrumentation:

GANIL Spiral2

Synoptique de la chaîne d'acquisition



AGET: Asic for GET – 64 analog channels - 512 cells/channel	IRFU
ASAD: AGET Support for Analog to Digital – 4 AGET	CENBG
COBO: COllection BOard – 4 ASAD - 1024 digital channels	MSU
MUTANT: MUtiplicity, Trigger ANd Time (3 trigger levels)	GANIL
BEM: Back End Module (coupling, logical inspections, …)	GANIL

Trends of FEE instrumentations for SPIRAL2 detectors

ACTAR Instrumentation:

Implementation of the µTCA standard

(Micro Telecommunications Computing Architecture)

- **COBO and MUTANT modules are in µTCA form**
- **GANIL has taken in charge the µTCA deployment:**
  - Choice of the µTCA form
  - Design of µTCA architecture for ACTAR instrumentation
  - Choice of the AMC.2 specifications
  - Choice of the MCH (MicroTCA Carrier Hub

Is µTCA a long term solution ?
µTCA is not suitable for AD stages !

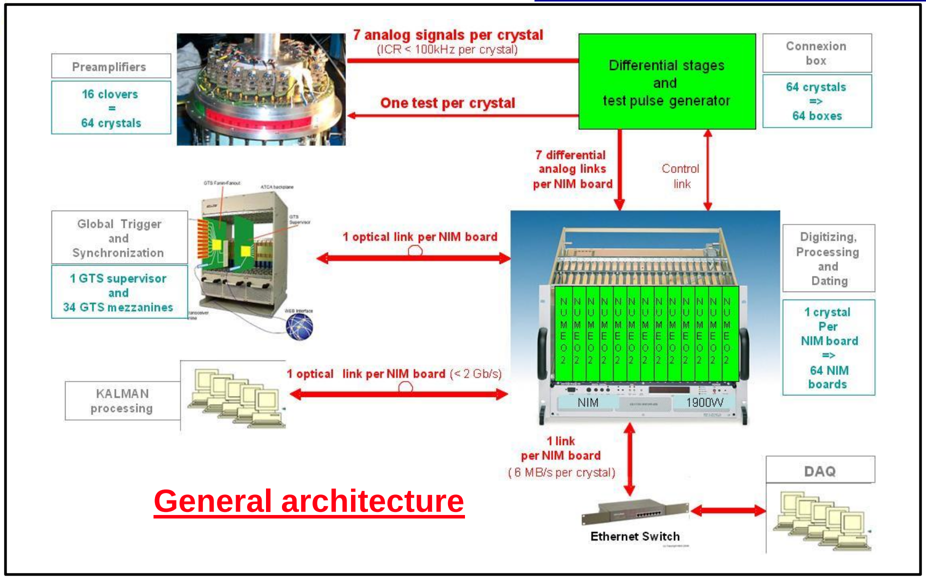
Specific Trigger and Time Stamp Distribution modules

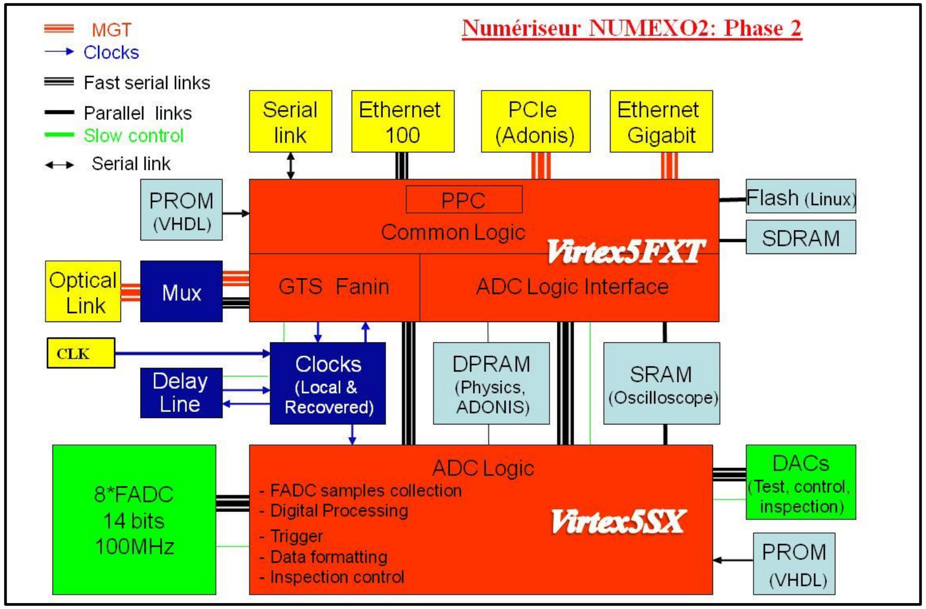
- **GANIL has taken in charge MUTANT and BEM designs**
- **Xilinx Virtex5FXT is the basic component**

What are the Virtex5 and its peripherals longevity?

Trends of FEE instrumentations for SPIRAL2 detectors

EXOGAM2 Instrumentation:





Synergies:

- **AGATA**
  - **GTS deployment**
- **NEDA, PARIS, S3**
  - **NUMEXO2 digitizer**
    FADC mezzanines
    Firmware in Virtex5SX
- **ACTAR**
  - **Virtex5TX70T**
    Linux
    Firmware
    Embedded software
    Base System Builder

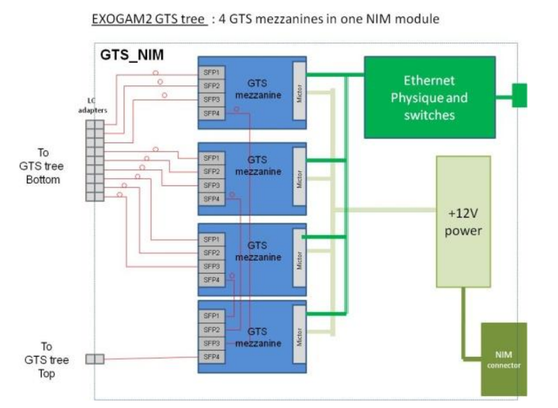
A system for coupling detectors:

Requirements:

- 200 MHz clock source and distribution
- Time stamping
- Messages broadcasting
- Trigger (validation, rejection)

DETECTOR INSTRUMNENTATION

GTS tree



µTCA AMCs

BUTIS (clock)

GANIL suggests a system based on GTS and BUTIS

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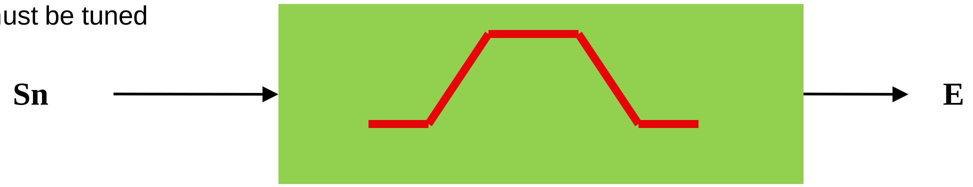
Trends of FEE instrumentations for SPIRAL2 detectors

A new algorithm in gamma spectroscopy

- Moving Window Deconvolution

k, m must be tuned



Co60@45kHz

FWHM = 3,9keV and 85% dead time

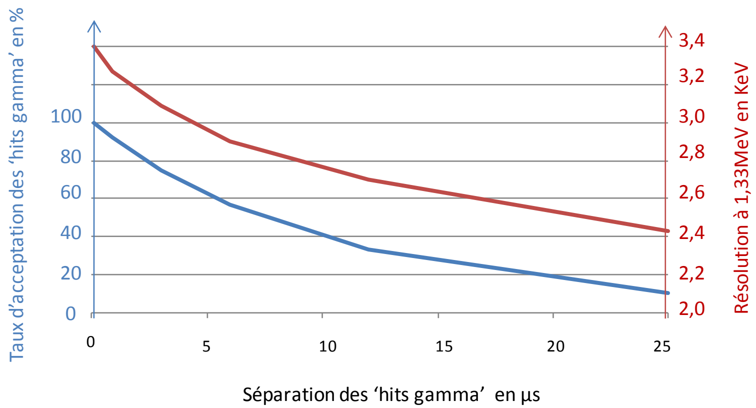
-A new algorithm based on the Kalman filter, powerful and efficient

No tuning and no dead time

Sn → E

$$\begin{cases} p_{k+1} & = & r_k\, w_k^p \\ b_{k+1} & = & b_k + w_k^b \\ n_{k+1} & = & -\alpha\, w_{k-1}^n + w_k^n \\ s_{k+1} & = & \beta\, s_k + p_k + b_k + n_k \\ y_k & = & s_k \end{cases}$$

Source Co60, Taux de comptage 45kHz
Détecteur Ge SO3, inner A (Rf = 500MΩ, Cf = 1pF)



Co60@45kHz

FWHM = 3,4keV and 0% dead time
FWHM = 2,4keV and 90% dead time