
GANIL

SMART Project

Management & Status

Outline

GANIL & Timestamping Solutions

Today, the GANIL Acquisition group manages **multiple timestamping systems**, ensuring synchronization across diverse DAQ setups.

Timestamp Sources

- **CENTRUM** (Clock Event Number Transmitter Receiver Universal Module) – used with **VME** and **VXI** DAQ modules
- **MUTANT** (Multiplicity, Trigger And Time) – dedicated to **GET** (Generic Electronics for TPCs)
- **GTS** (Global Trigger and Synchronization)

Gateways & Interfaces

- **TGV** (Trigger Générique VME) – now replaced by **VTC** (VME Trigger CENTRUM)
- **BEAST** (Back-End Adapter for Synchronization by Timestamping) – current standard interface
- **AGAVA** (AGATA VME Adapter) – legacy, replaced by BEAST in all DAQ setups

“48-bit timestamp @ 10 ns & 32-bit event number:
The universal backbone ensuring time correlation across all systems”

Objectives & Guidelines

Objectives :

The SMART project represents an **upgrade** of the GTS tree with an up to date hardware to guarantee **reliable continuity.**

User requirements :

The SMART Project will ensure GTS essentials services :

- Synchronous 100 MHz clock
- 48-bit timestamp @ 10 ns resolution for event tagging
- Trigger decision to manage and reduce data throughput

Sfp connectivity and
Microtca for
Advanced
Remote
Trigger

Technicals constraints :

The SMART system, at the endpoint level must be :

- Hardware-compatible with existing GTS implementations.
- Firmware-implementable as a drop-in replacement for the GTS LEAF IP

System architecture - PBS

Sfp connectivity and **M**icrotca for **A**dvanced **R**emote **T**rigger

1 — 2 — 3 — 4 — 5

SMART_EP

Integration of SMART ENDPOINTs in DAQ electronic

SMART_AMC

µTCA AMC modules to address up to 240 ENDPOINTs

SMARTree

Application software to manage SMART system

SMART_MCH

µTCA MCH modules to address up to 480 ENDPOINTs and host trigger logic

SMART_TRIGGER

SMART trigger logic firmware

System architecture – SMART_EP

SMART_EP concept

- A backward compatibility with GTS hardware
- A single VHDL IP to manage timestamp & clock distribution

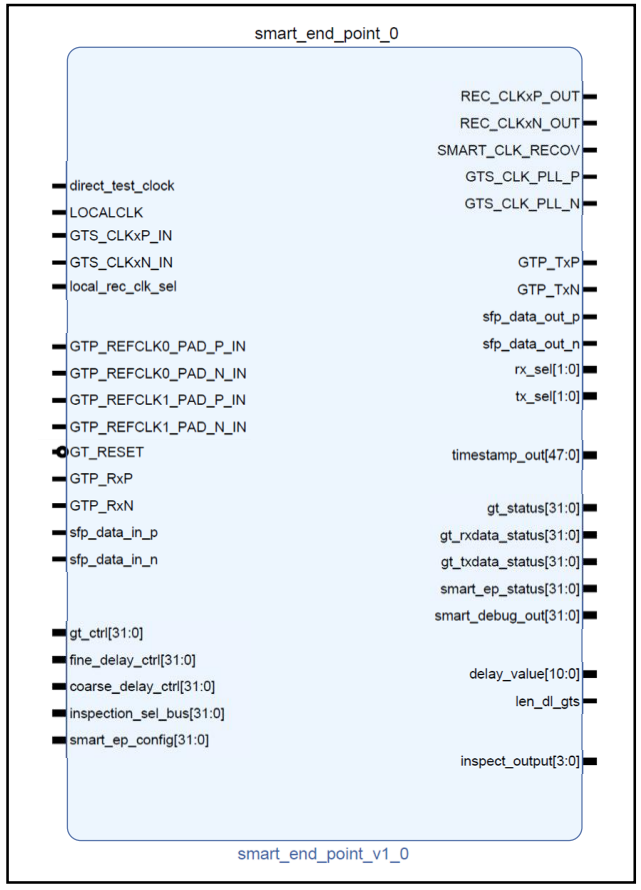


Fig. 2 : ENDPOINT IP FW top level

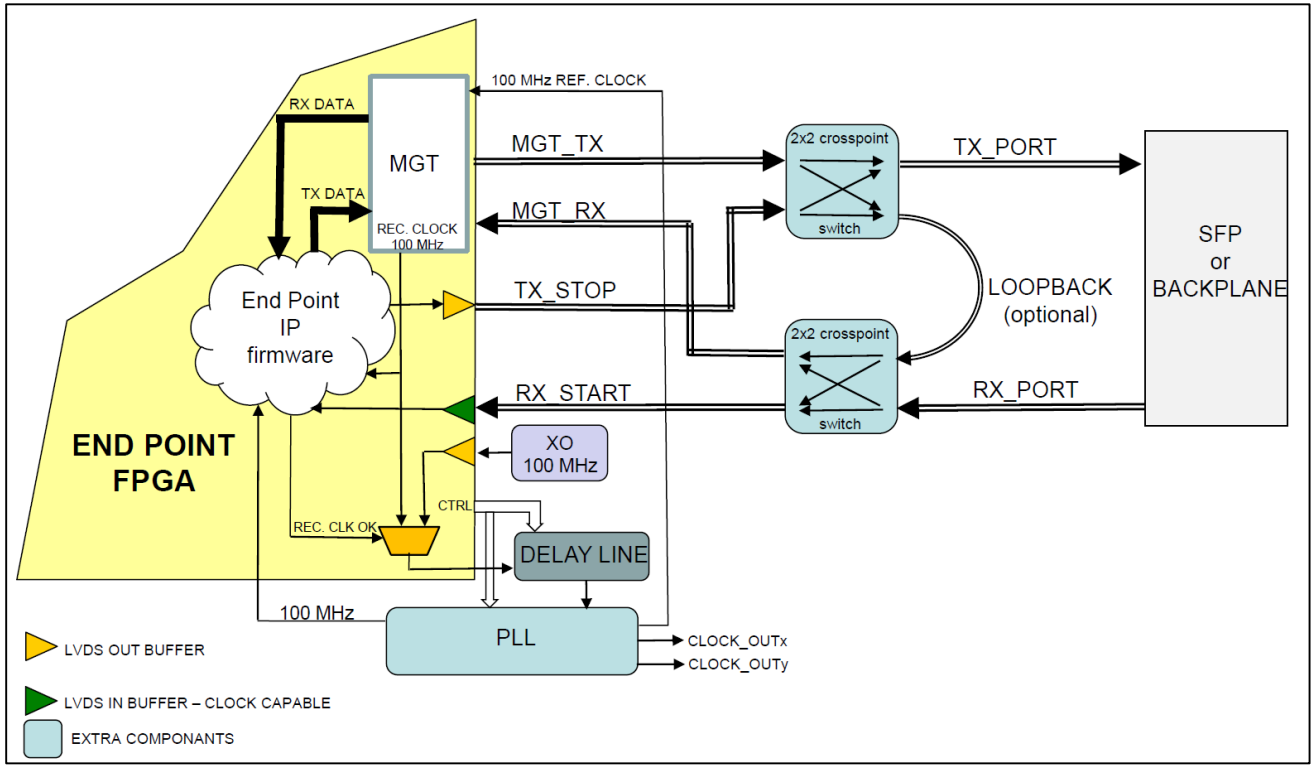


Fig. 1 : ENDPOINT hardware block diagram

SMART_EP implementations

- GANIL **BEAST** Gateway module (For VXI/VME systems)
- GANIL **NUMEXO2** digitizer (REA, VAMOS, EXOGAM)
- LPC **FASTER_V2** system (With MASTER A10 gateway)
- **AGATA** PACE module

System architecture – SMART_AMC

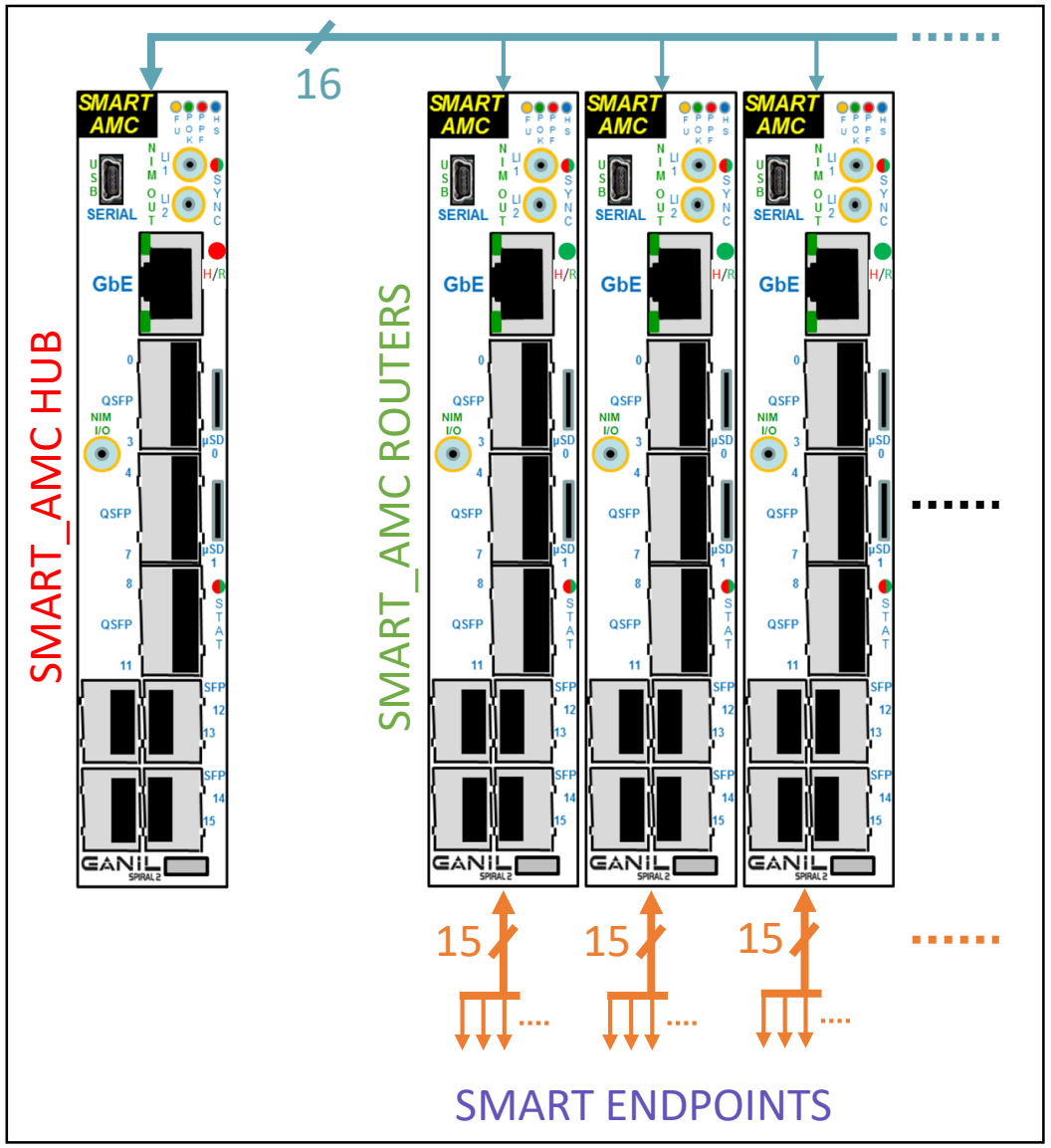


Fig. 3 : A tree example with SMART_AMC elements

SMART_AMC concept

- Up to **240** digitizers or boards synchronized by **17** AMC's (1 HUB & 16 ROUTERS) housed in 2 µTCA shelves.
- **3 SMART_AMC** modules (1 HUB + 2 ROUTER) can synchronize up to **30 endpoints.** Equivalent to 14 GTS mezzanines hosted in 5 GTS NIM carriers

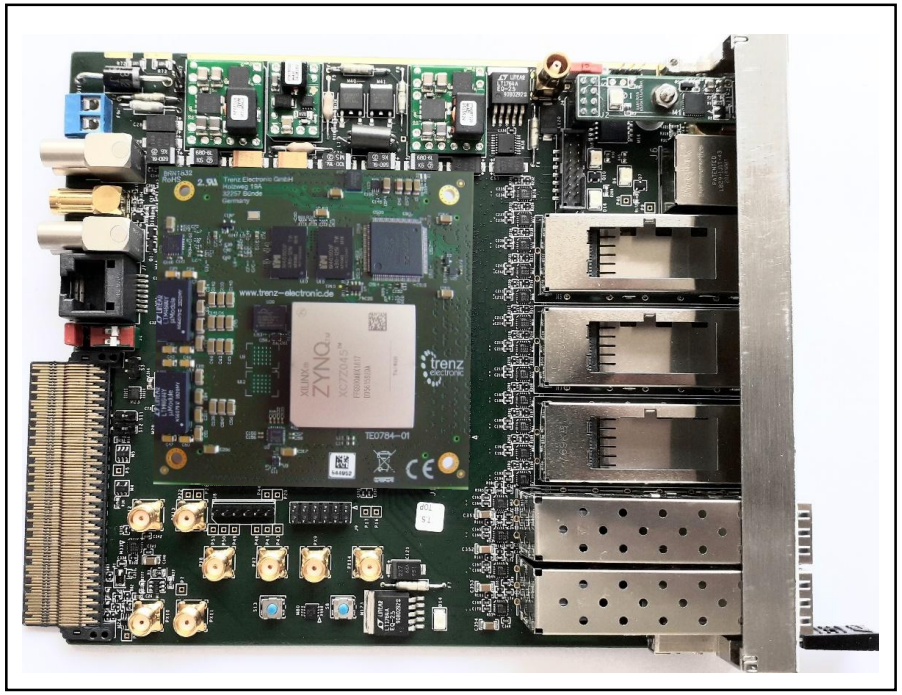


Fig. 4 : SMART_AMC complete module

System architecture – SMARTree

SMARTree : the alignment and configuration software

- **Autonomous system**
- Executed on SMART_AMC_HUB
- Setup via **ssh** on nodes
- Based on shell **scripts**
- POC **validated** with BEAST

```
#!/bin/bash

#desc.: [SMART] smart discover and alignment suite
#usage: $0
#usage: $0 smart_tree.txt

version="v0.1.0"

#static port map between hub and routers
cfg=smart_tree.txt
cfg=$0

#check running on hub
if [ ! -e "/__SMART_AMC_HUB__" ]
then
  echo "error: this script should be running on SMART hub !"
  exit
fi

#clean
sudo ./clean.sh full
```

Fig. 5 : SMARTree bash script example

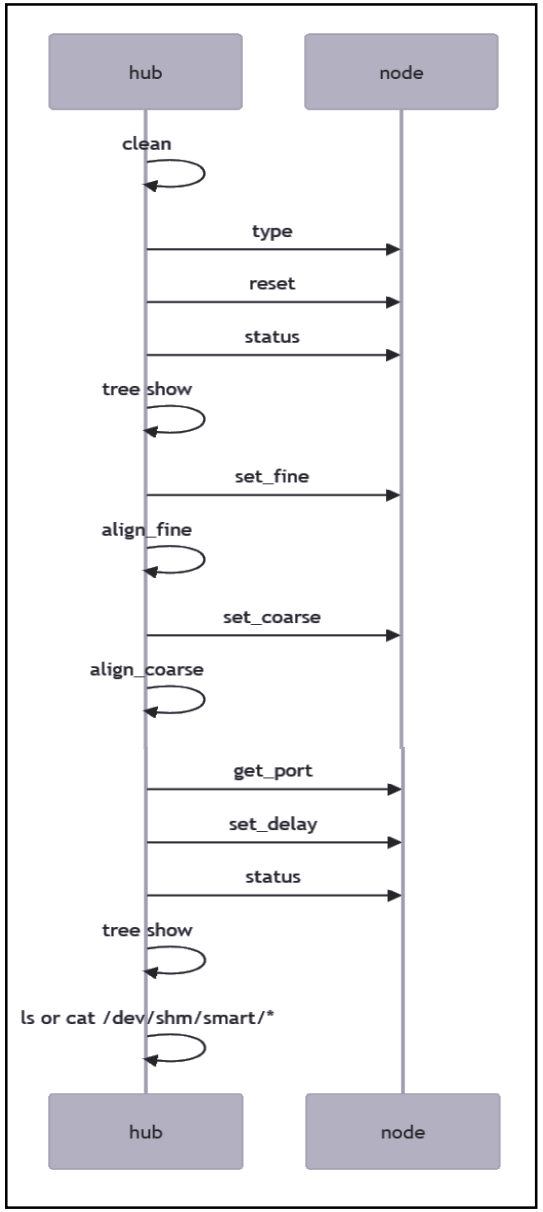


Fig. 6 : SMARTree alignment sequence

System architecture – SMART_MCH

SMART_MCH concept

- Up to **480** End Points synchronized by 32 SMART_AMC ROUTER and 1 SMART_MCH housed in 3 µTCA shelves
- Hosts the **SMART_TRIGGER** firmware

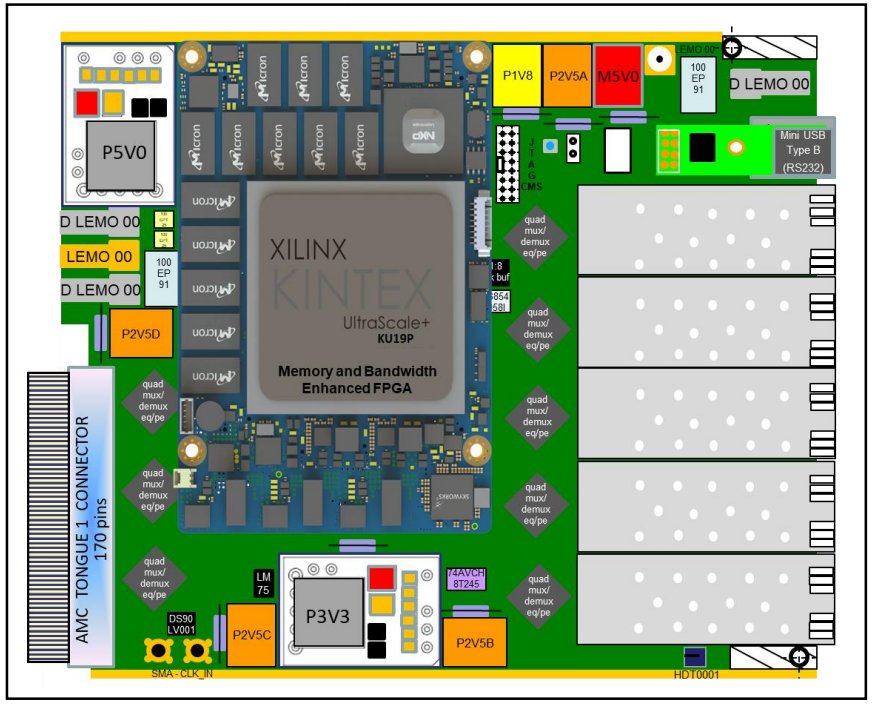


Fig. 7 : SMART_MCH hardware block diagram

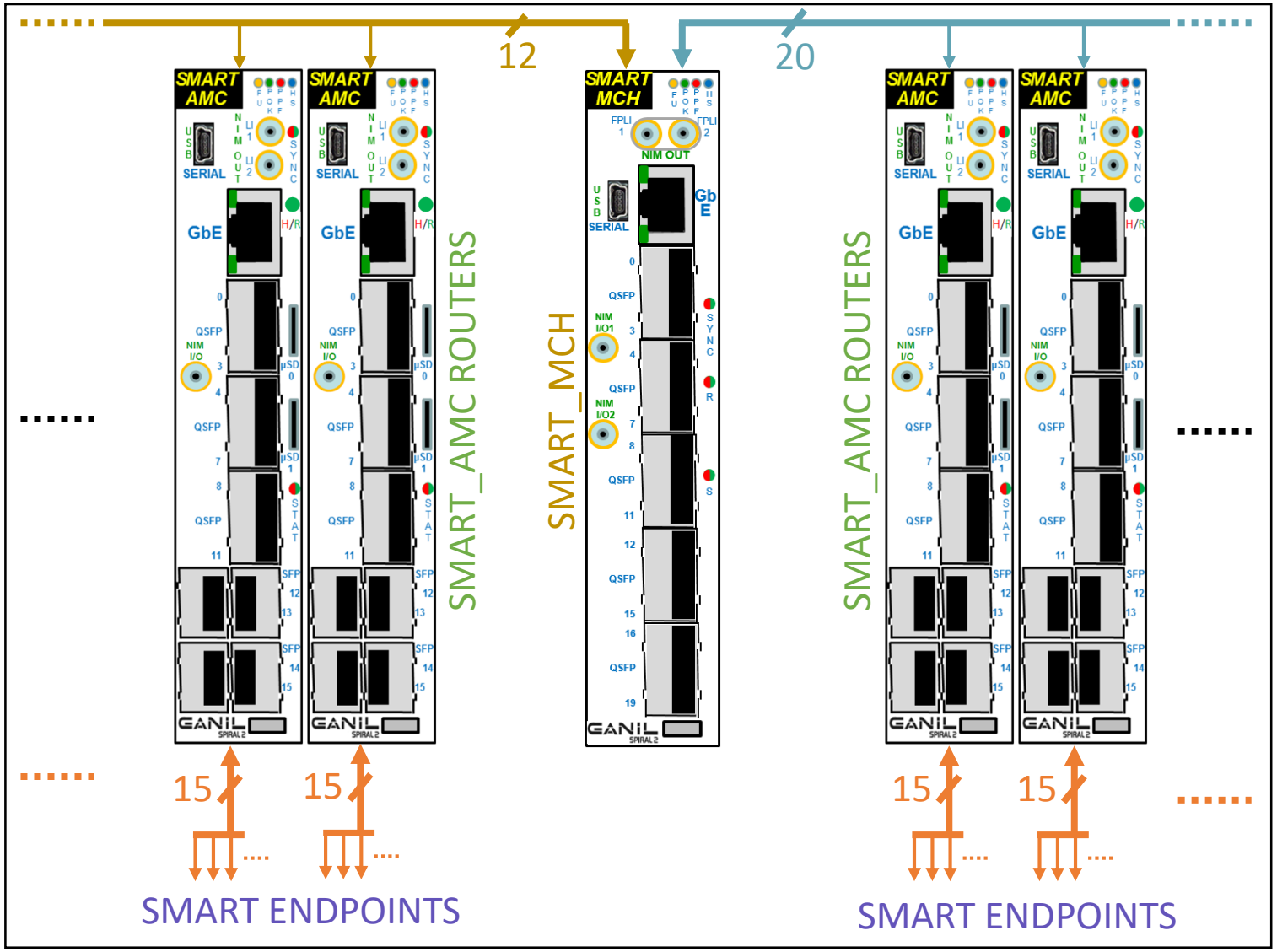
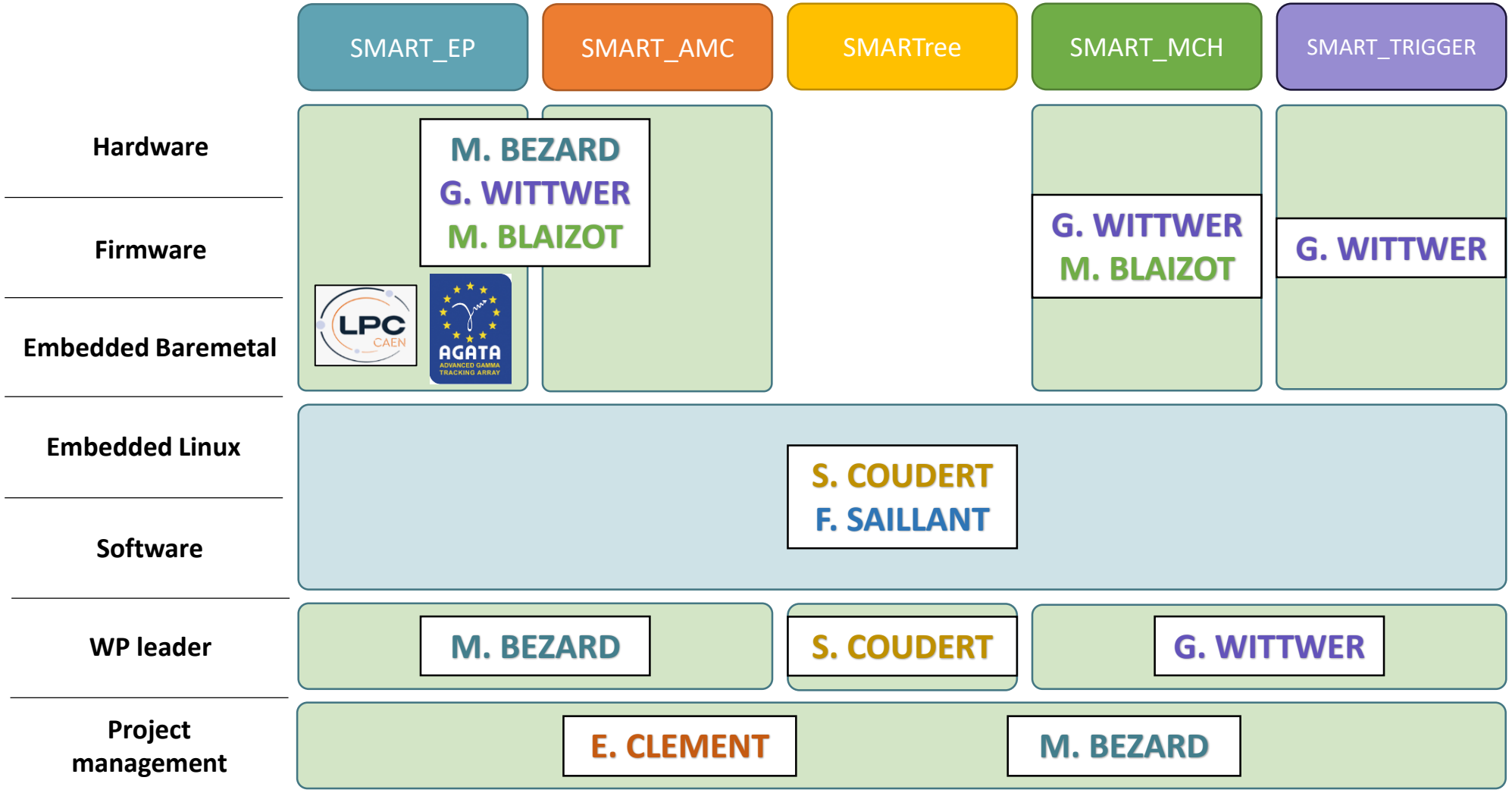


Fig. 8 : A tree example with SMART_MCH & SMART_AMC elements

Project management - Manpower



M. BEZARD

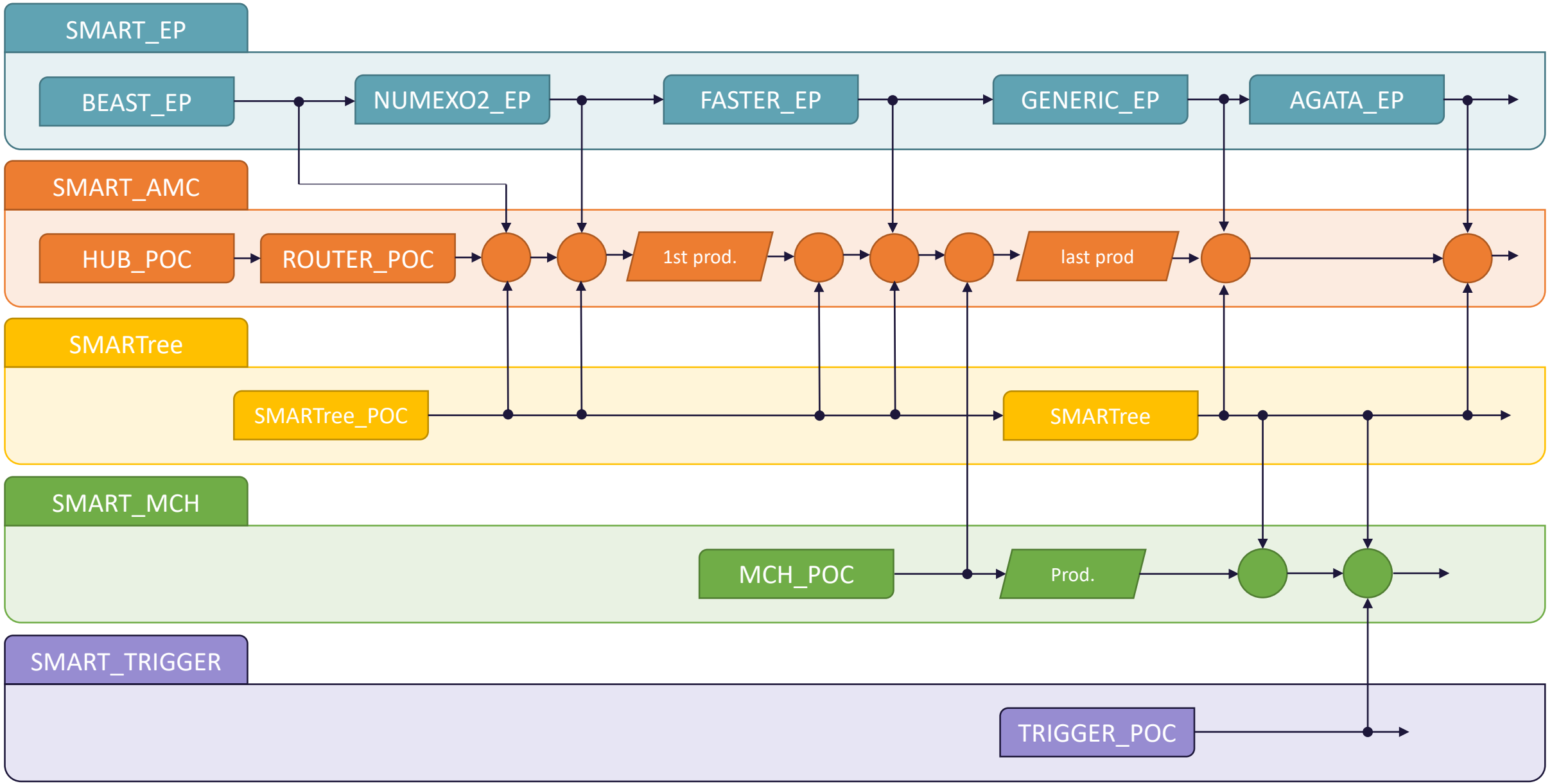
G. WITTWER

M. BLAIZOT

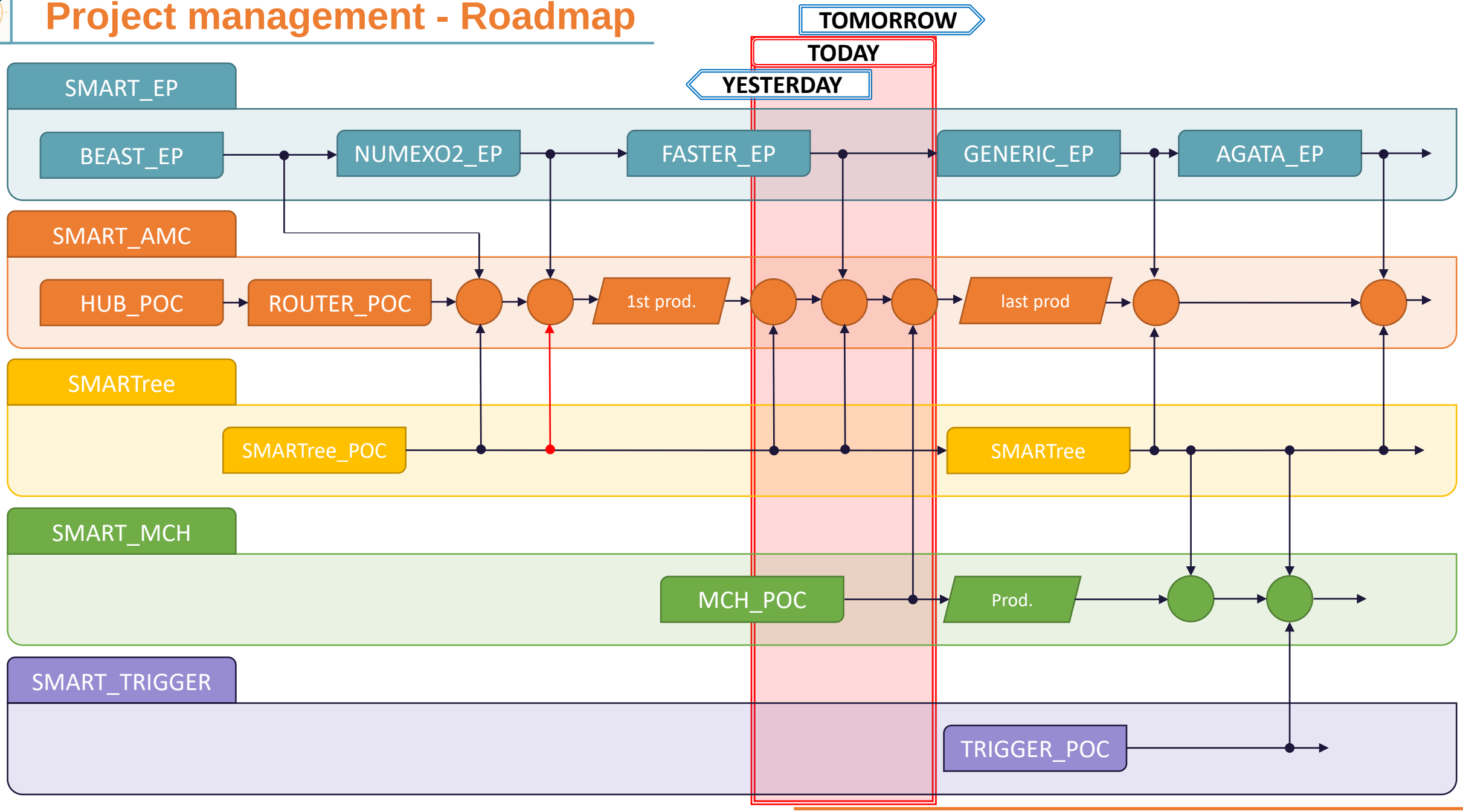
S. COUDERT

F. SAILLANT

Project management - Roadmap



Project management - Roadmap



Project management - Milestones

SMART_AMC deployment strategy

- **Milestone 1 :** Q3/2025 : An experimental setup with **NUMEXO2_REA**
  - 🎯 Validation of the **SMARTree** software and **SMART_ENDPOINT** on NUMEXO2
- **Milestone 2 :** Q3/2025 : An experimental setup with **FASTER** and NUMEXO2_REA
  - 🎯 Validation of SMART_ENDPOINT in FASTER coupled with NUMEXO2 for **TAS experiment**
- **Milestone 3 :** Q1/2026 : Deploy **SMART in VAMOS-EXOGAM** setup
  - 🎯 Validation of a setup with NUMEXO2 and **BEAST/VTC as gateway** towards MESYTEC VME modules
- **Milestone 4 :** **Q?/2026** : Integration of SMART_ENDPOINT in **AGATA PACE module**
  - 🎯 Validation of the last endpoint implementation for AGATA-GRIT-VAMOS

Project status – KANBAN Board

	BACKLOG	PLANNED	ONGOING	DONE	VALIDATED
EP	AGATA_EP FW	GENERIC_EP FW GENERIC_EP HW	FASTER_EP FW	NUMEXO2_EP FW	BEAST_EP FW
AMC		Last AMC HW prod.	Deployment@GANIL	1st AMC HW prod.	AMC_ROUTER HW + FW AMC_HUB HW + FW Deployment@LPC for FASTER
SMARTree	GENERIC_EP int AGATA_EP int. SMART_MCH int SMART_TRIGGER int.		FASTER_EP int. Numexo2 int. SMART_AMC int.	BEAST int.	
MCH	MCH last prod.	MCH / AMC int.	MCH 1st prod.	MCH HW + FW	
TRIGGER	SMART_TRIGGER FW	Needs & Specifications			

Project status – News from Normandy

Fig. 9 : SMART_AMC first production batch, ready on the shelf

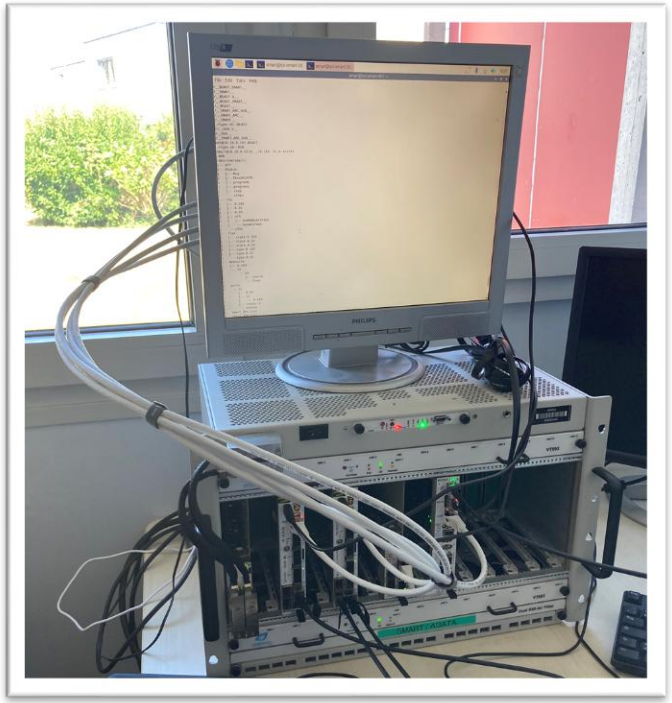


Fig. 10 : SMART testbench deploy on LPC lab

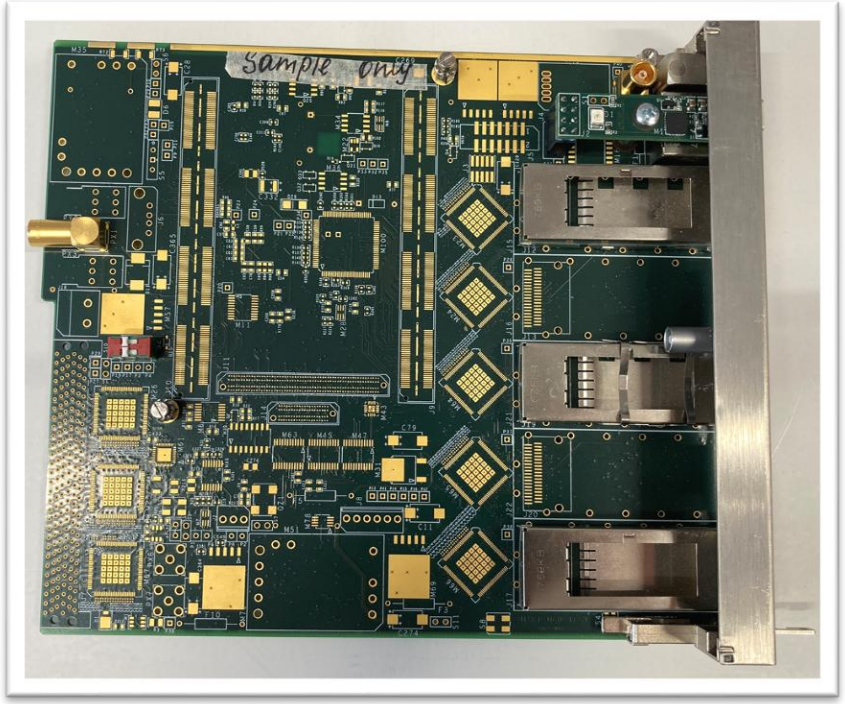


Fig. 11 : SMART_MCH POC PCB

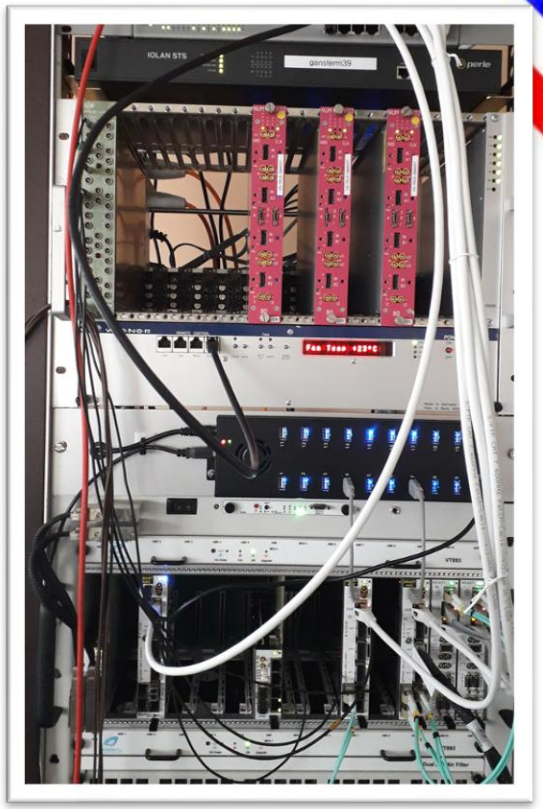


Fig. 12 : SMART NUMEXO2_EP testbench

Project status – Risk Assessment

Risk #1 : **Two retirements** in the manpower board (Maria BLAIZOT & Gilles WITTWER)

Knowledge transfer, succession planning, involvement of new staff in GANIL

Risk #2 : **SMART_TRIGGER specifications** not yet defined

Early definition workshop with stakeholders, freeze requirements before design

Risk #3 : Workload & opportunity cost of the **SMART_MCH** work package for the **software team**

Careful resource allocation, re-schedule SMART_MCH delivery

Risk #4 : **Endpoint integration** in LPC FASTER and AGATA PACE depending on **collaboration**

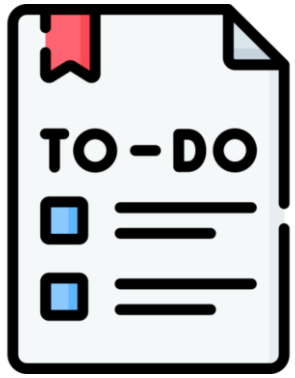
Involve (more) collaborations in SMART project, redundancy in GANIL team on critical points

Conclusion

From GANIL point of view

- SMART with **NUMEXO2** will be validated on **experimental setup for next month**
- **FASTER_EP** is on a good way to be tested with SMART before the **end of 2025**
- **SMART_MCH** HW and FW is **done** and will be validated before Gilles and Maria retire
- We have to **maintain effort on software** tasks to achieve our own goals

From AGATA point of view



- Plan the integration of SMART_ENDPOINT in **AGATA PACE module**
- Define the **SMART_TRIGGER specifications,** if needed
- Define the **needs** of SMART_AMC and SMART_MCH **for last production batches**
- Specify **needs and use cases of SMART_MCH** modules (480 endpoints)

Thanks for your attention ! Questions ?