

GANIL

Status of the SMART development



S_{fp connectivity and} **M**_{icrotca for} **A**_{dvanced} **R**_{emote} **T**_{rigger}

Phase 1: SMART AMC
Phase 2: SMART MCH

A minimum of 6 people in GTA group involved in the project:

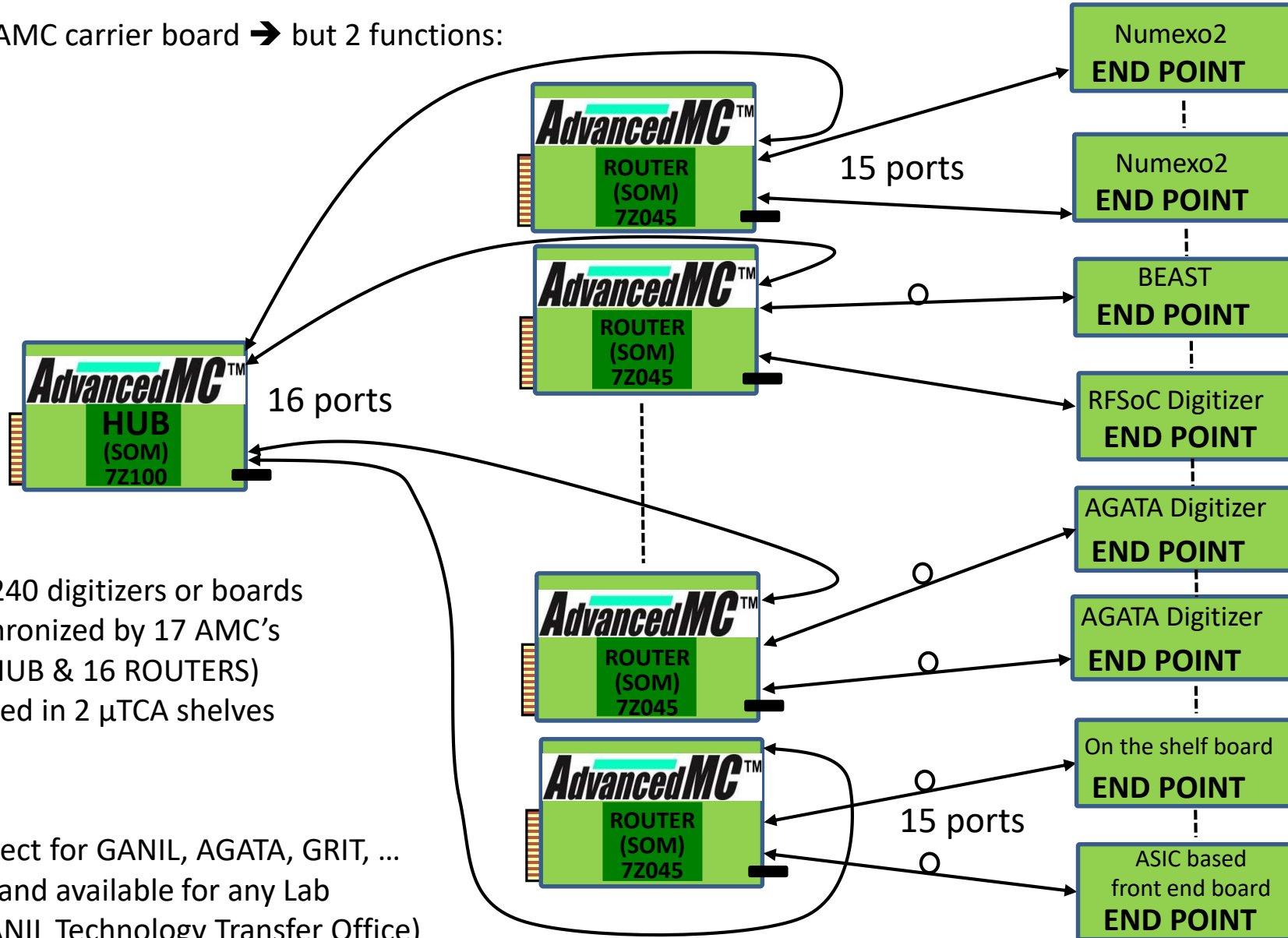
- Project leader, global architecture, firmware, software, CAD:.....Gilles Wittwer
- PCB Routing, component ordering, manufacturing follow-up:Maria Blaizot
- SMART IP in NUMEXO2, SMART production tests, triggerMatthieu Bezard
- Embedded software (Linux OS, slow control, automatic alignment):Sébastien Coudert/Frédéric Saillant
- SMART GUI (trigger part):Blandine Duclos

Phase 1: Architecture & terminology reminder



Only one AMC carrier board → but 2 functions:

- HUB
- ROUTER



Up to 240 digitizers or boards synchronized by 17 AMC's (1 HUB & 16 ROUTERS) housed in 2 μTCA shelves

A project for GANIL, AGATA, GRIT, ... and available for any Lab (see GANIL Technology Transfer Office)

Phase 1 - Main characteristics



COMMUNICATION RATES

- **HUB ↔ ROUTER**: Line Rate = 4 Gb/s; Payload Data Rate = 400 MB/s; Reference Clock = 100 MHz
- **ROUTER ↔ EP's**: Line Rate = 2 Gb/s; Payload Data Rate = 200 MB/s; Reference Clock = 100 MHz

AUTOMATIC ALIGNMENT

- **HUB to EP's** : with a dedicated TDC chip on HUB board

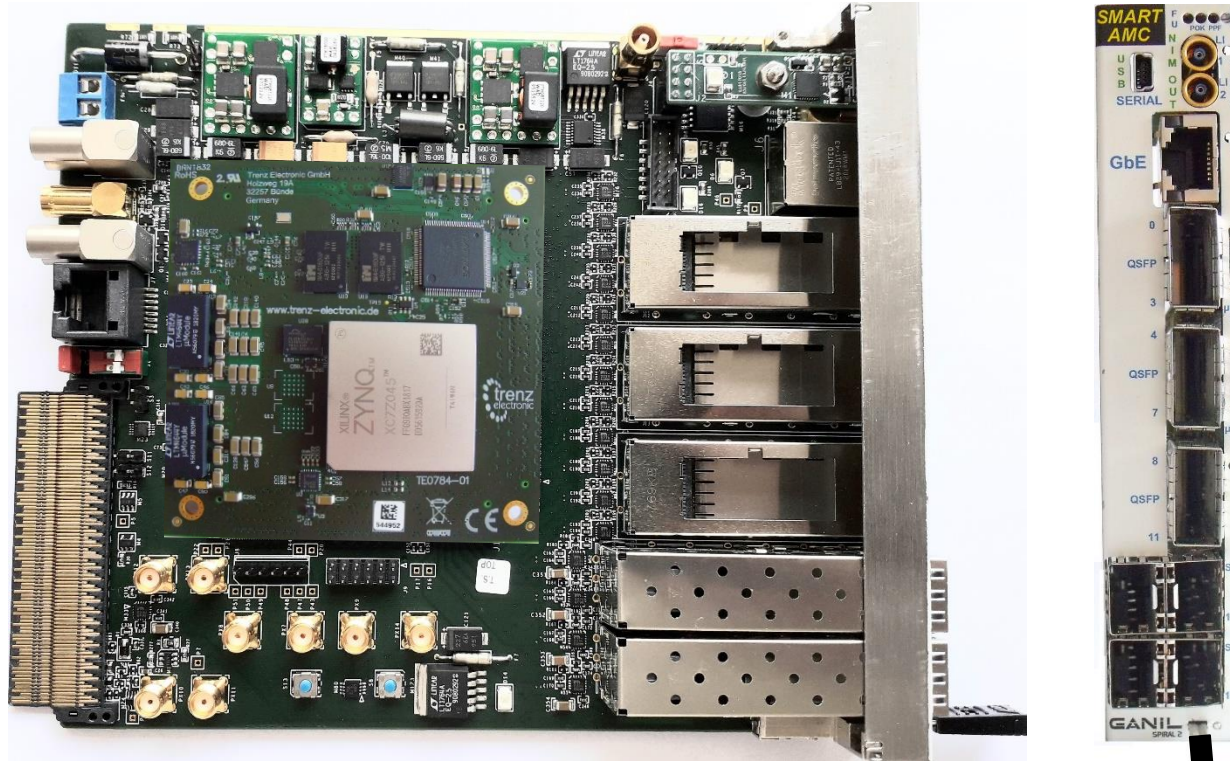
CLOCK & TIMESTAMPING

- **HUB to ROUTER (to EP's)** : 8B/10B encoding/decoding with Recovered Clock = 100 MHz;
TS on 48 bits/10ns (more than 1 month of experiment)

TRIGGER @ HUB LEVEL

- **Trigger req./val.** : based on uplink and downlink frames (build with ID recognition/digitizer type)
- **Multi-partitions** : 240, 480, up to 720 digitizer channels (typically 45x16ch-NUMEXO2 boards)
- **Multiplicity** : threshold by partition
- **Acceptance window**: for late channels arriving during a trigger cycle
- **Logic Equation** : (OR/AND/NOT) between partitions for the final decision (ACCEPT/REJECT)
- **32 bit Event Number** : for accepted returned frames
- **Max 208 KHz/channel – Total trigger rate @HUB level: 800 Mtrig_req/s**

Phase 1: SMART_AMC - Production in progress



SOM and SOC USED on SMART AMC BOARD (Phase 1)

- **HUB**: TE0784-01 from TRENZ Company with Xilinx XC7Z100-2FFG900I
- **ROUTER** : TE0784-01 from TRENZ Company with Xilinx XC7Z045-2FFG900I

Production: 26 SOM ordered in March 2023 for GANIL (2H/10R) and AGATA (14R) have been delivered 2 weeks ago !



Phase 1: Updated schedule



Main tasks

- 6 SMART AMC prototypes tested and SMART concept validated
- Final firmware versions ready for HUB and ROUTER (CLK & TS)
- Green light for SMART AMC production over 2 years (SOM, active components and μ TCA FP mechanics purchase)
- Specifications ready for “French public market” production
- Subcontractor selected for assembly of 26 SMART AMC boards
- **Launch of SMART AMC production**
- **Embedded Linux with automatic alignment ready**
- Delivery by subcontractor of SMART AMC production
- SMART_AMC production ready to use

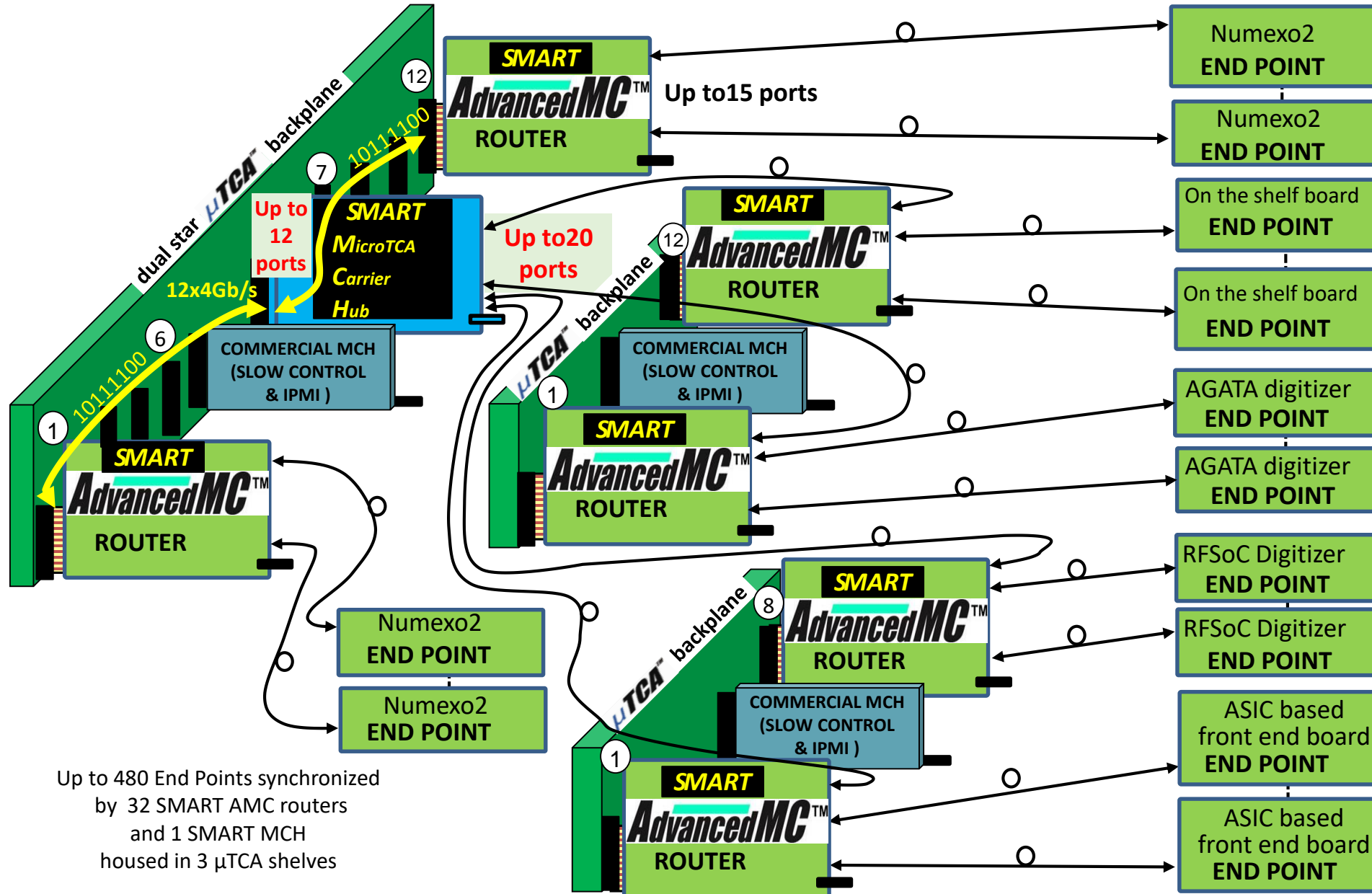
Main key dates

- June 2022
- July 2023
- April -> December 2023
- February 2024
- June 2024
- **September 2024**
- **November 2024**
- December 2024
- March 2025



Test bench with SMART_AMC system synchronizing 2 BEAST modules (AMC's) and 3 NUMEXO2 digitizers

Phase 2: SMART_MCH Full Architecture



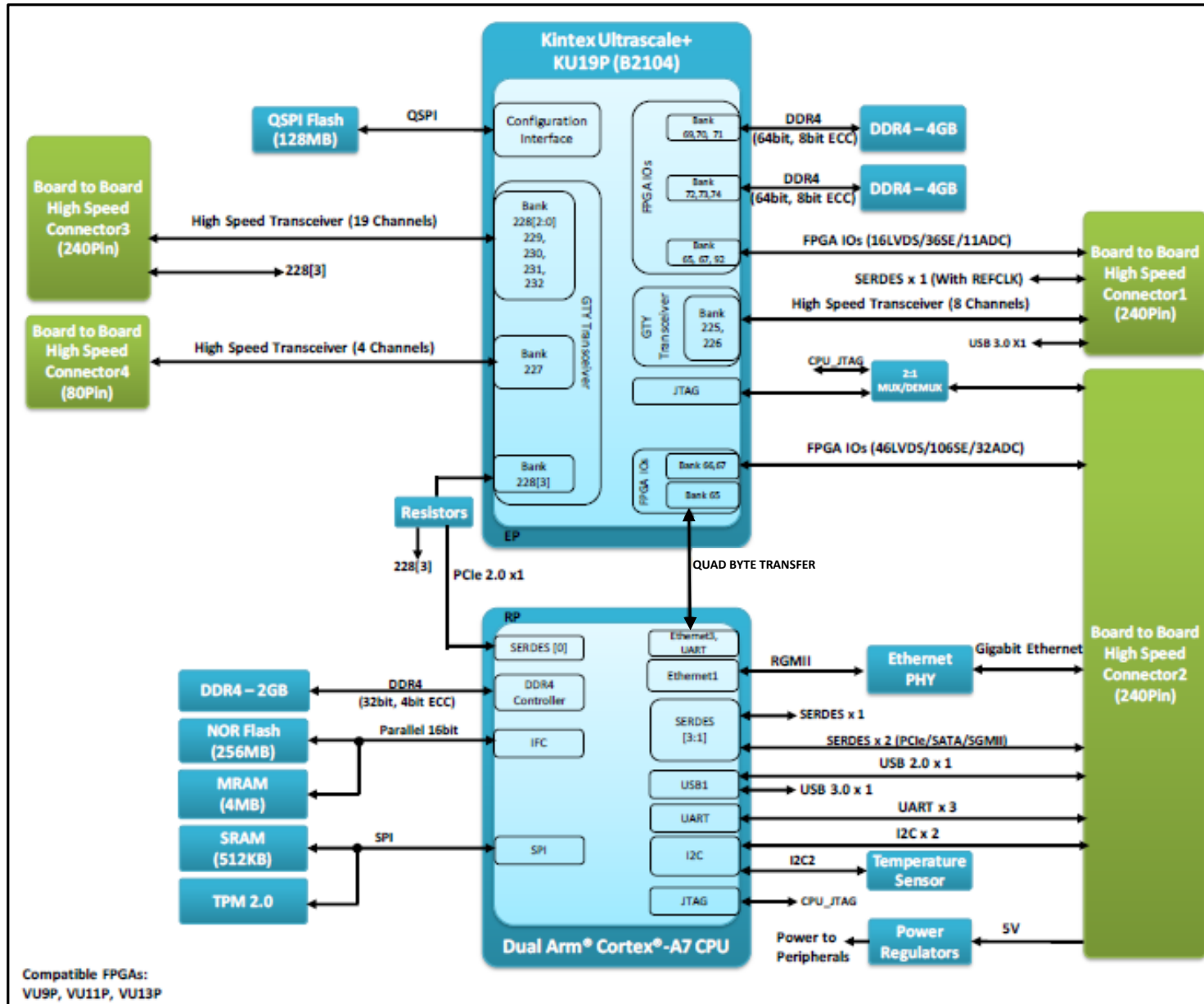


XILINX® PREFERRED SOM PARTNERS

Robust Ecosystem of SoC and FPGA based System-on-Modules



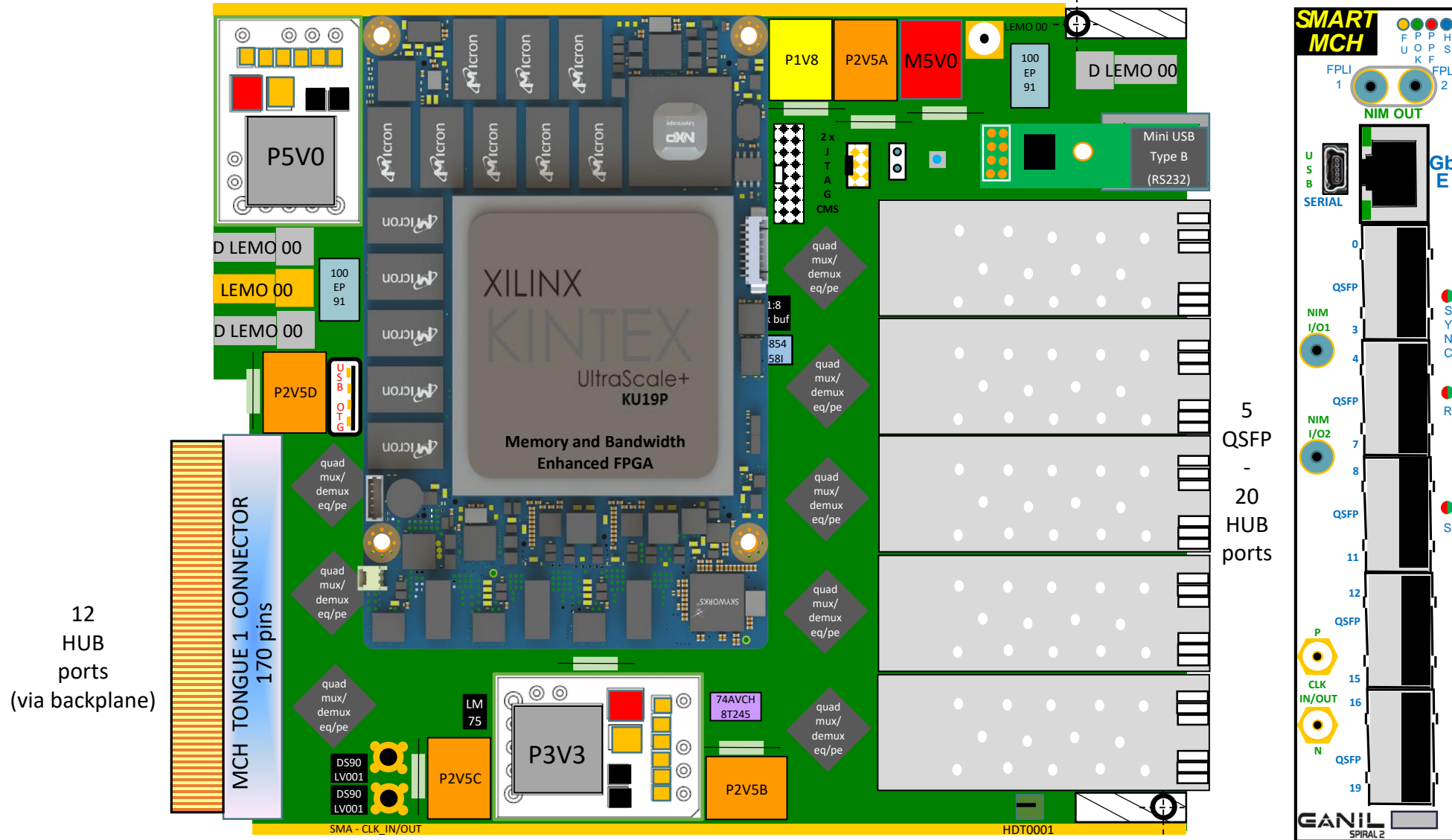
Phase 2: SMART_MCH – SOM Block diagram



Phase 2: SMART_MCH implantation

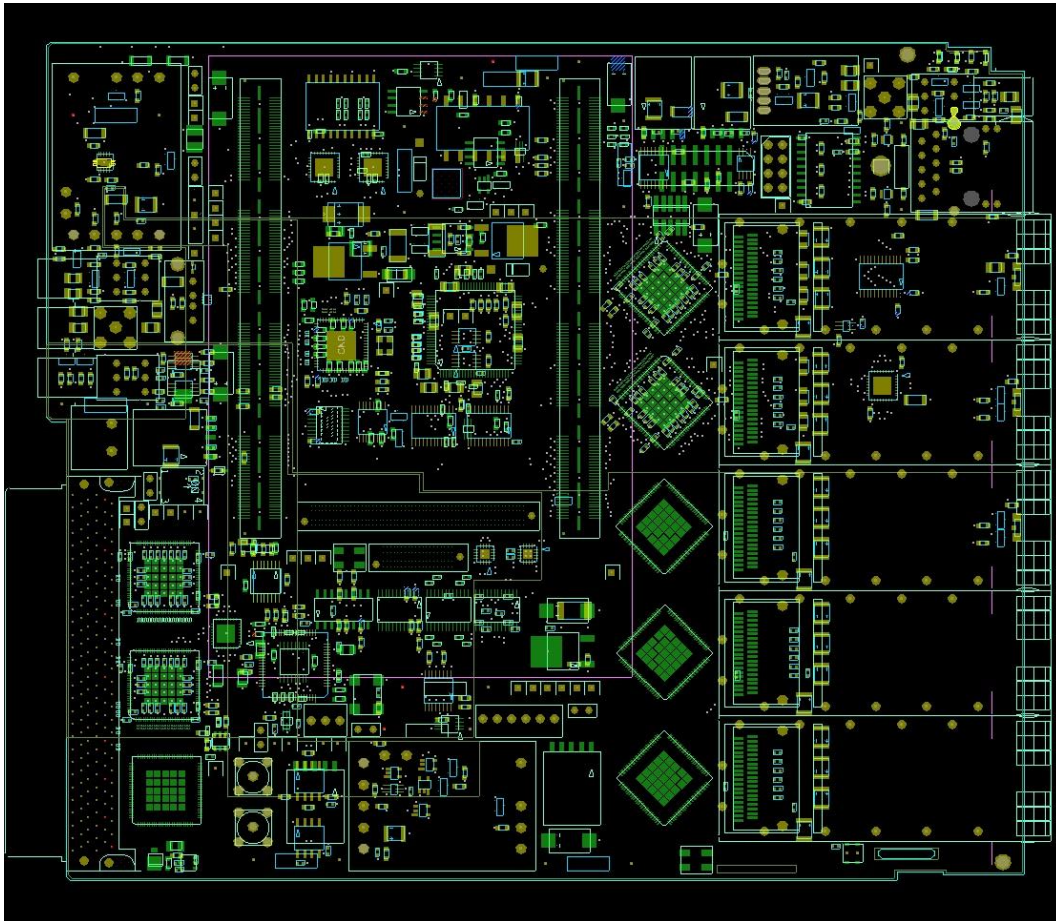
μTCA™

GANIL

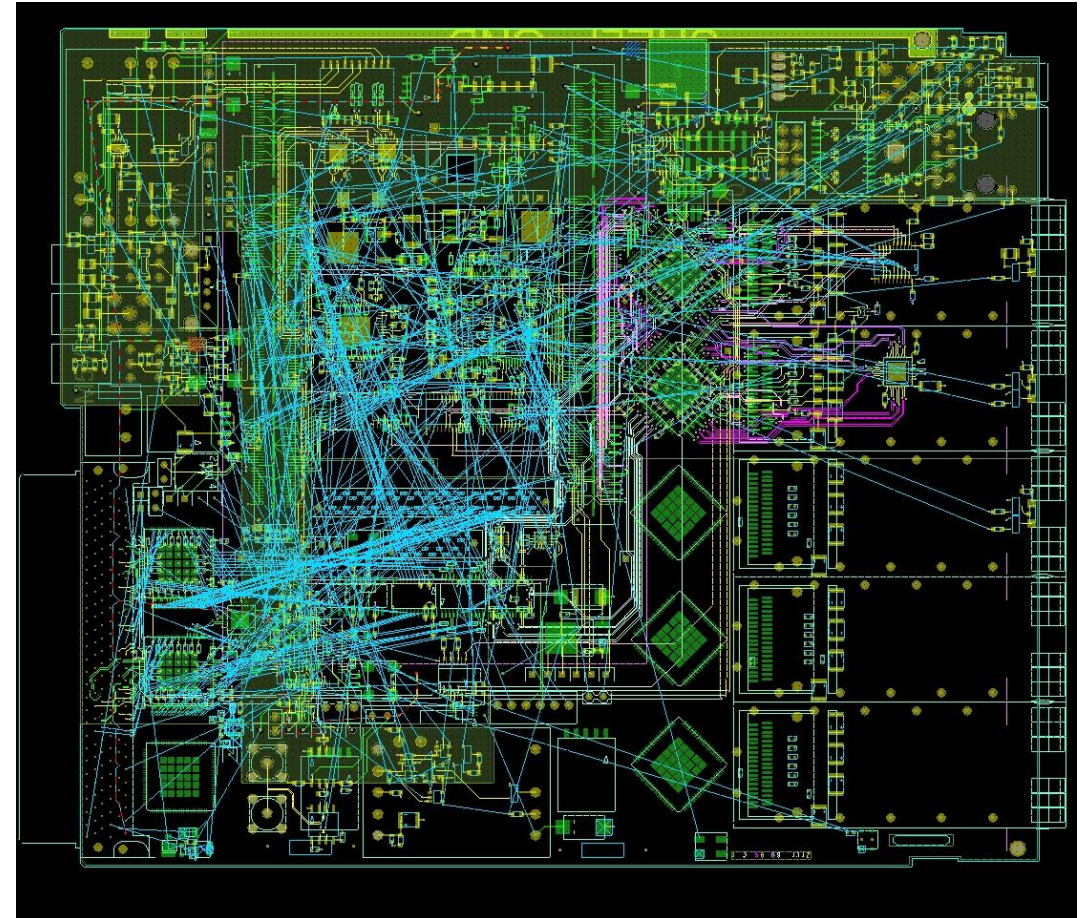


Phase 2: SMART_MCH – PCB design (14 layers)

PCB layout is quite ready (up to 1000 elements)



Routing has started (with up to 4000 connections)



Main tasks

- Global architecture defined
- SOM Iwave iW-Rainbow-G47M chosen and ordered
- 1st SOM + Development platform delivered
- Embedded bare metal C code developed and tested on kit for required peripherals (LS1021A processor – Code Warrior suite)
- 19 new symbols developed for CAD tools (Cadence-Concept)
- 2 Iwave SOM ordered for AGATA -> 2 SMART MCH prototypes
- 1st firmware developed for KU19P FPGA (Xilinx-Vivado 2022.1)
- 19 new footprints prepared for CAD tools (Cadence-Allegro)
- SMART MCH schematics
- **SMART MCH prototype routing**
- SMART MCH prototype assembly
- SMART MCH prototype for tests (hardware, firmware, software)
- SMART MCH prototype to production update (schematics, routing, ...)
- SMART MCH production (2 for AGATA & 2 for GANIL)
- SMART MCH ready to use (automatic alignment + first trigger version)

Main key dates

- September 2022
- October 2022
- January 2023

- Mai 2023
- July 2023
- August 2023
- November 2023
- January 2024
- March 2024
- **July 2024**
- December 2024
- February 2025
- May 2025
- September 2025
- March 2026

SMART Documentation

fp connectivity and
microtca for
advanced
emote
rigger

written

SMART

**COMMUNICATION PROTOCOL
V1.0**

SMART AMC → up to 240 End Points
SMART MCH → up to 480 End Points

GANIL/PHY/DELTA September 2020 Gilles WITTWER

SMART

written

Few hints* to implement a SMART
End Point IP in your FPGA

at the hardware and firmware point of view ...

* Non exhaustive list

SMART END POINT IP GUIDE – V1.0 – April 2020 Gilles Wittwer 1



fp connectivity and
microtca for
advanced
emote
rigger

written

AMC ROUTER Slow Control User Manual

AdvancedMC™

GANIL/PHY/DELTA SMART ROUTER – V1.0 - September 2020 Gilles Wittwer

fp connectivity and
microtca for
advanced
emote
rigger

written

AMC HUB Slow Control User Manual
Volume 1 – Clock & Timestamping

AdvancedMC™

GANIL/PHY/DELTA SMART HUB Vol.1 – V1.0 - September 2020 Gilles Wittwer

fp connectivity and
microtca for
advanced
emote
rigger

to be written

AMC HUB Slow Control User Manual
Volume 2 – Trigger

AdvancedMC™

Gilles Wittwer

fp connectivity and
microtca for
advanced
emote
rigger

to be written

AMC HUB and ROUTER User Guide

AdvancedMC™

Gilles Wittwer

fp connectivity and
microtca for
advanced
emote
rigger

writing in progress

MCH Slow Control User Manual
Volume 1 – Clock & Timestamping

AdvancedMC™

GANIL/PHY/GTA SMART MCH Vol.1 – V1.0 - September 2024 Gilles Wittwer

SMART Production costs summary

(last update: August 2023)



	SMART_AMC ROUTER	SMART_AMC HUB	SMART_MCH
PCB (14 layers)	640+150(VAT)	640+150(VAT)	~1000(estimation)
Front panel kit	20	20	20
+ Drilling	50	50	50
+ Silkscreen	70	70	70
Assembly + Passive components	850	850	900
Active components (provided)	600	600	700
SOM	2300	2600	9000
UART2USB board	120	120	120
Price/Unit (€)	4800	5100	11860

Thank you for your attention

