Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
INAF ISTITUTO NAZIONALE DI ASTROFISICA

BUILDING A NEW DATA PROCESSING SYSTEM

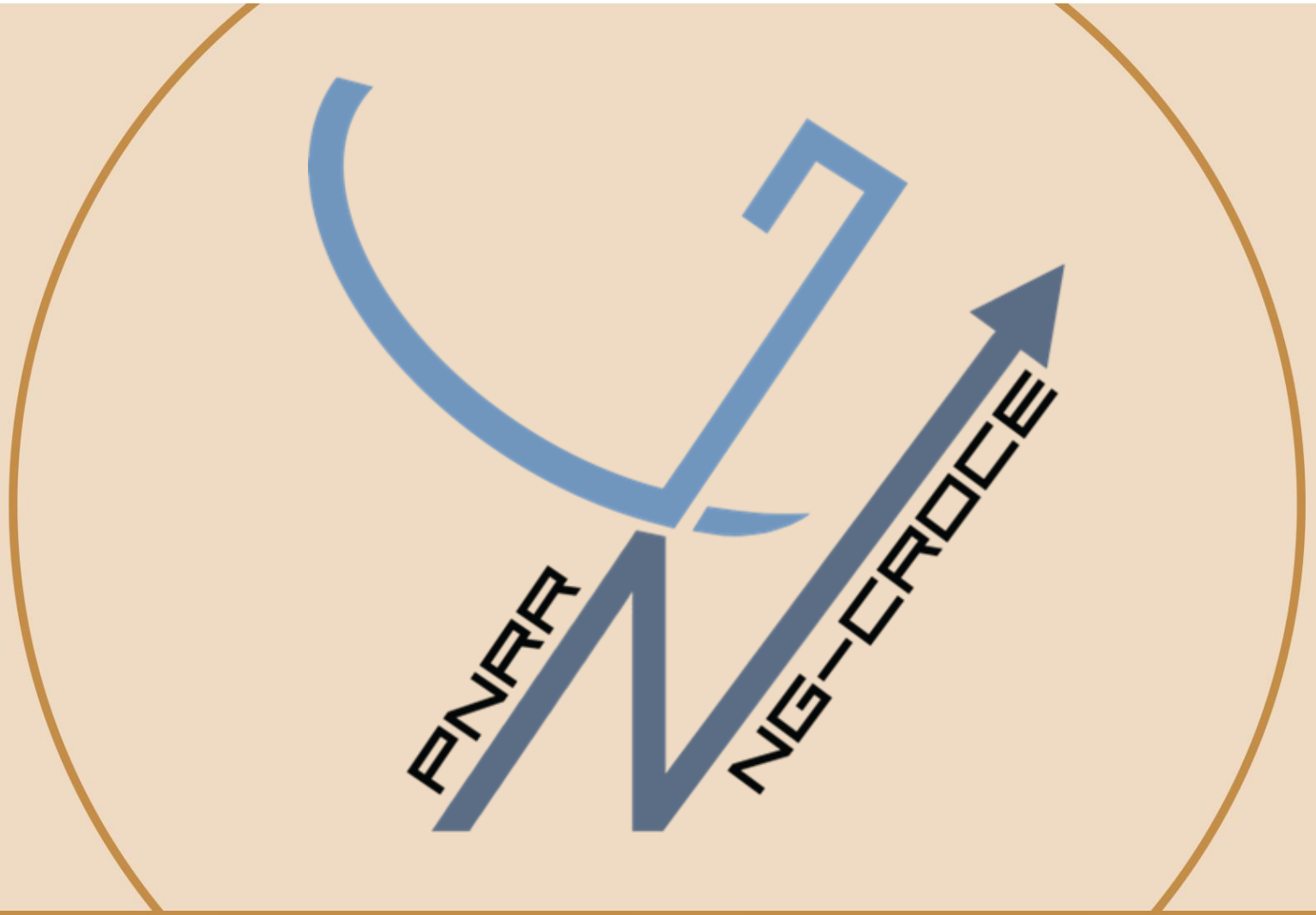
Training Meeting

NG-Croce

Monday 12th May - Thursday 15th May

Medicina Radiotelescopes

IRA - Bologna



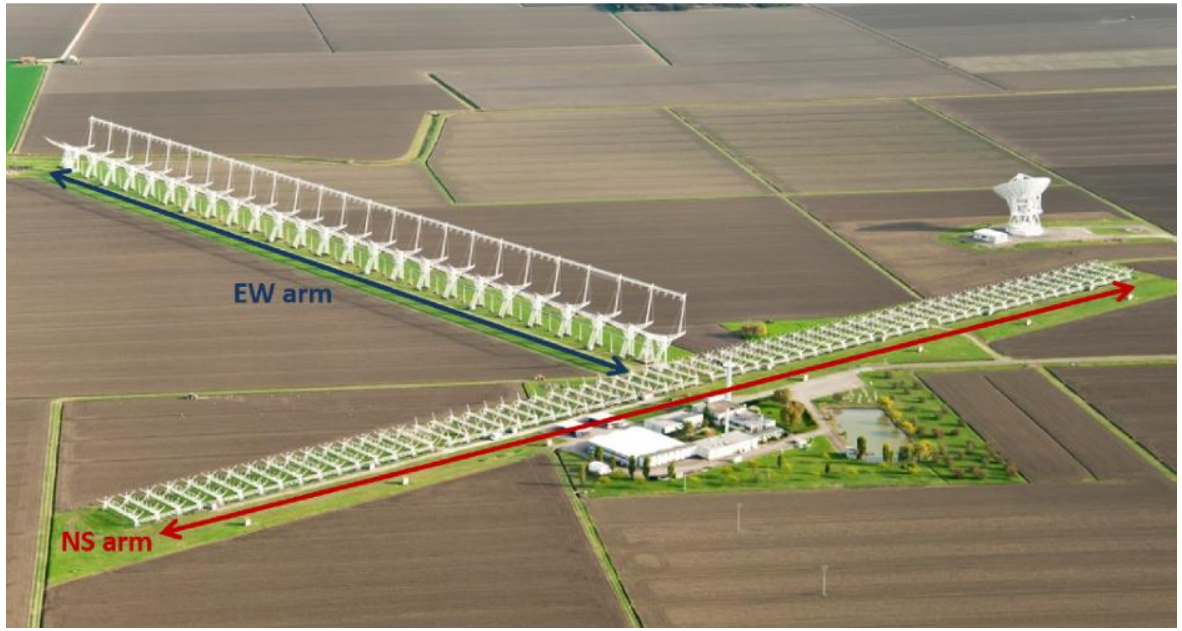
Giovanni Naldi

Outline

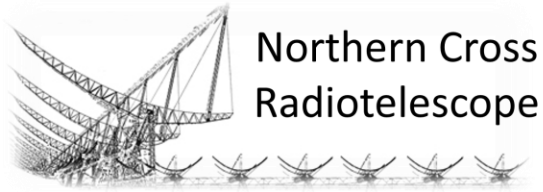
- Review of the task's purposes
- Hardware components of the system:
  - Back-end boards
  - HPC Cluster
- Contracts for development activities:
  - Firmware
  - Software
- Other ongoing activities
- Conclusions

Goal of the Task

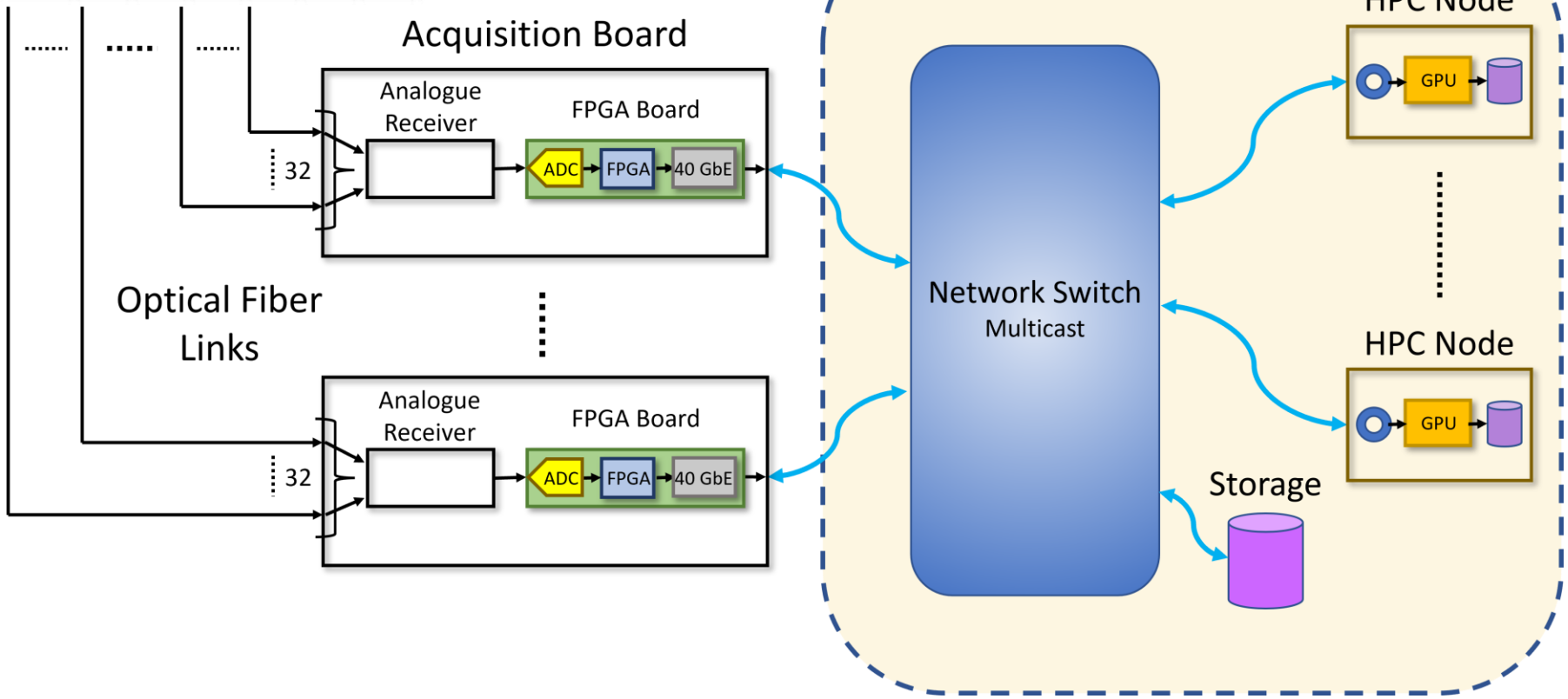
- **To equip the upgraded Northern Cross Radiotelescope with a new digital acquisition and processing system for data coming from both arms (North-South and East-West)**
  - ➢ System components:
    - ❑ FPGA boards (digital backend)
    - ❑ High Performance Computing (HPC) cluster
- **Software/Firmware Development**
  - ➢ Applications:
    - ❑ monitoring of LEO space objects (space debris, SD)
    - ❑ detection of the Fast Radio Bursts (FRBs) radio transients



General Scheme



Northern Cross Radiotelescope



Hardware components: FPGA boards

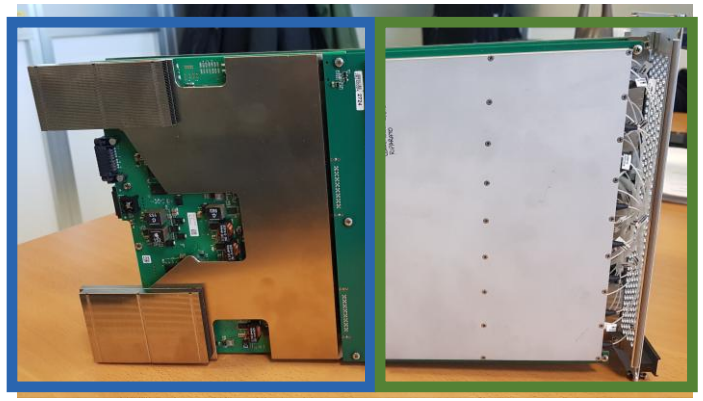
- 21 FPGA boards arranged in 6 sub-racks
- Main characteristics of the FPGA board:

Dimension	6U
Number of RF input signals	32
Analog to Digital Converter	16 dual, 14-bit ADCs
FPGA device	2 Xilinx Ultrascale+
RAM memory	32 GB
40 GbE interface	2 QSFP (1 per FPGA)

- Status of the procedure:
  - Contract issued ✅
  - Material delivered ✅
  - Procedure about to be closed (next month)

Tile Processing Module

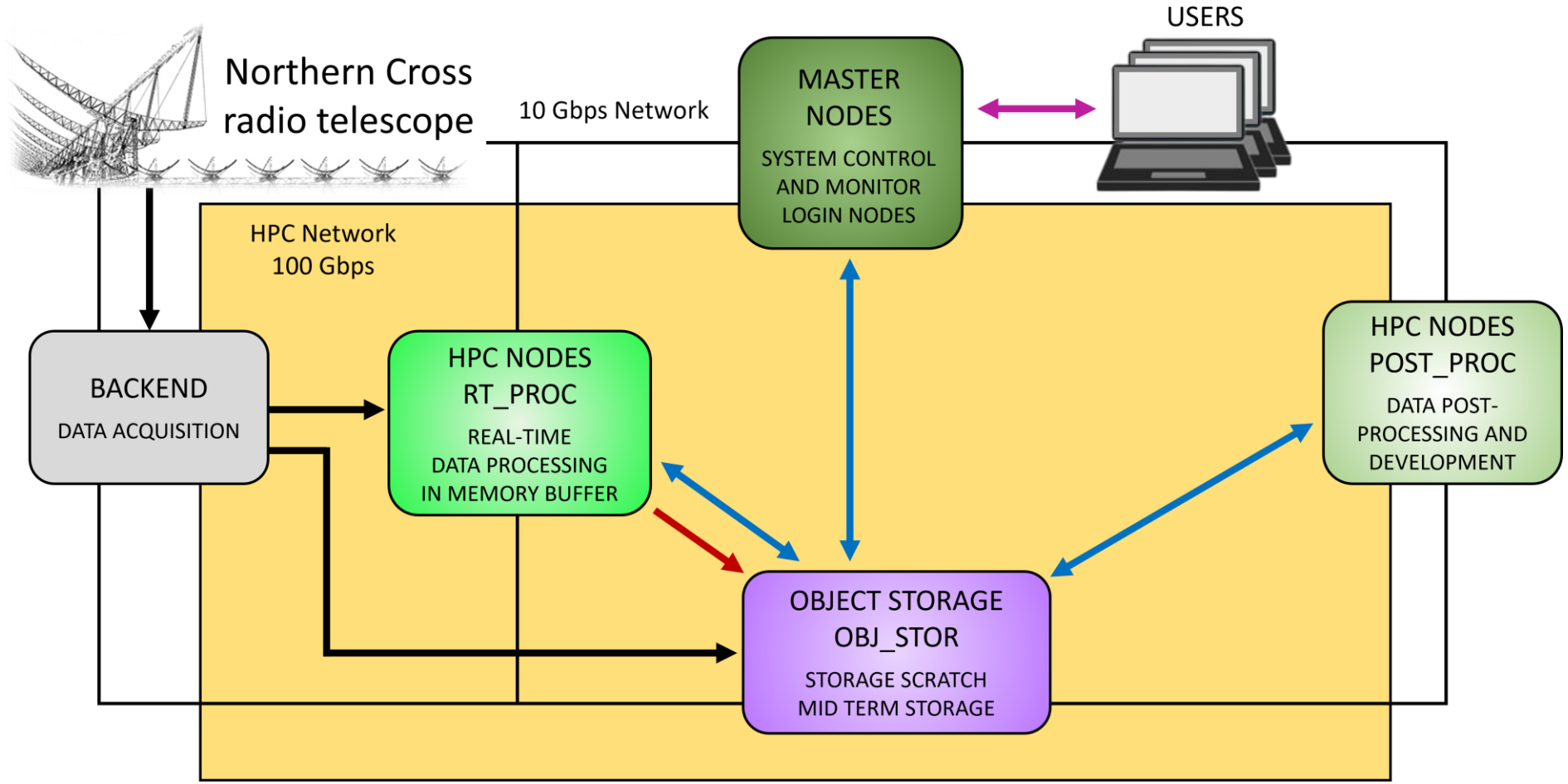
1x FPGA Board



2x Analogue Receivers

Sub-rack

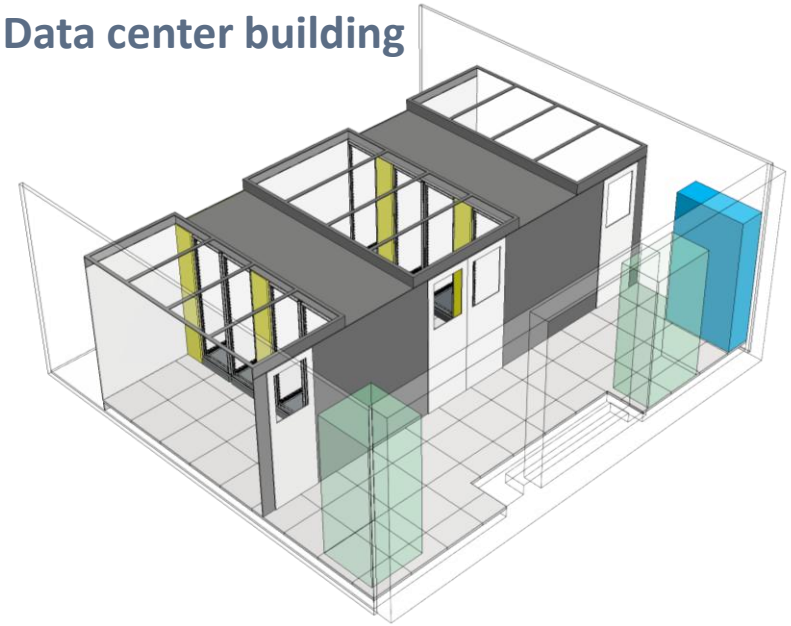
Hardware components: HPC Cluster



Hardware components: HPC Cluster

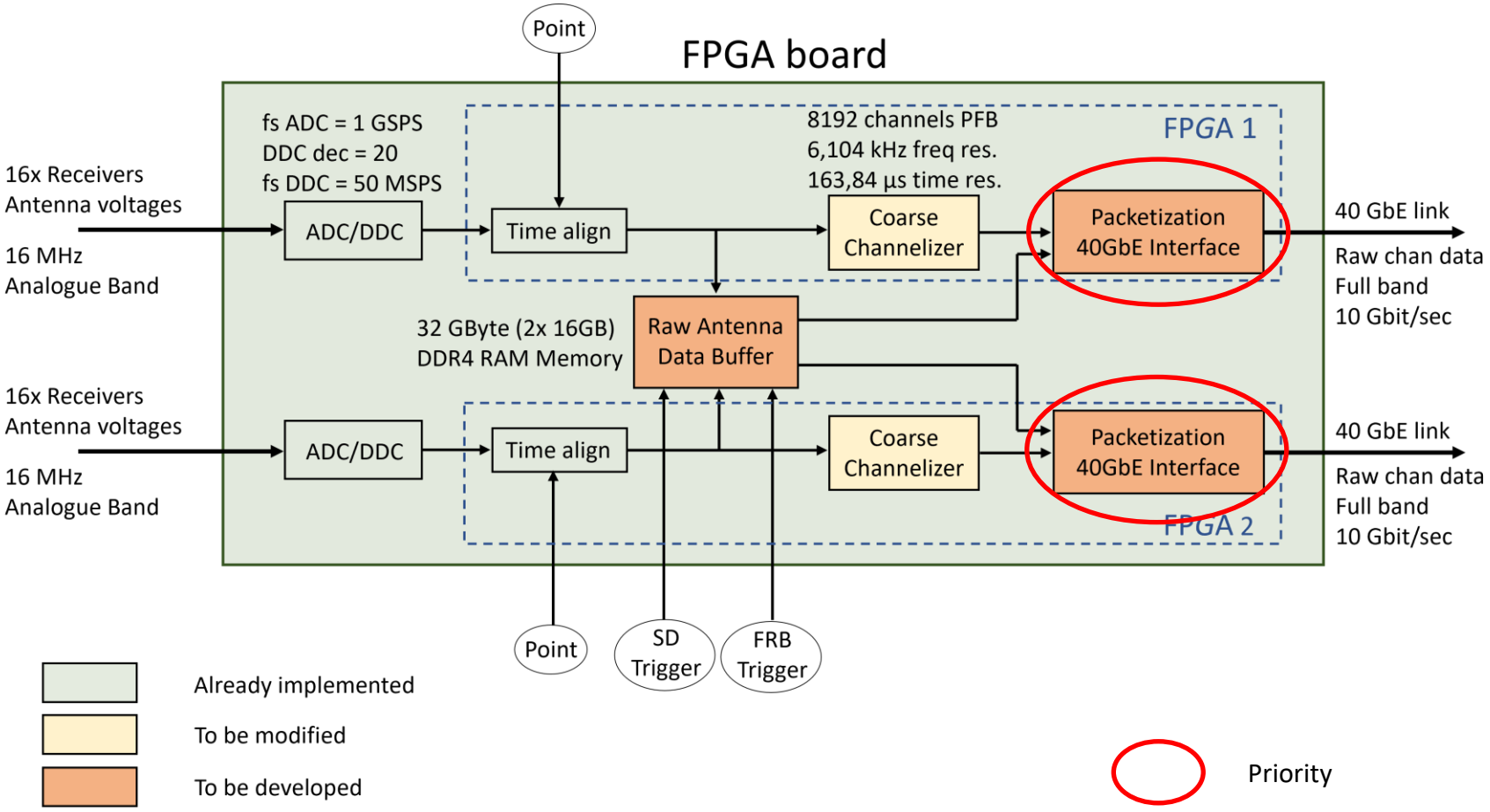
3x Master Nodes	18x HPC Nodes	9x Object Storage Nodes
System management (monitor and control)	Massive and parallel computing	Mid term storage for processed and reduced data
Login Nodes	Dual CPU (multi-core)	Raw data to be post-processed and post-analysed
	2x NVIDIA L40S GPU	8 PB of total disk space
	2 TB RAM	30GB/s writing; 45GB/s reading (aggregate)
	2x SSD (3 TB each)	
	2x NIC (dual-port) 100Gb/s	

Data center building



- Status of the procedure:
  - Tender concluded ☑
  - Supplier awarded ☑
  - Contract about to be signed

Firmware Development



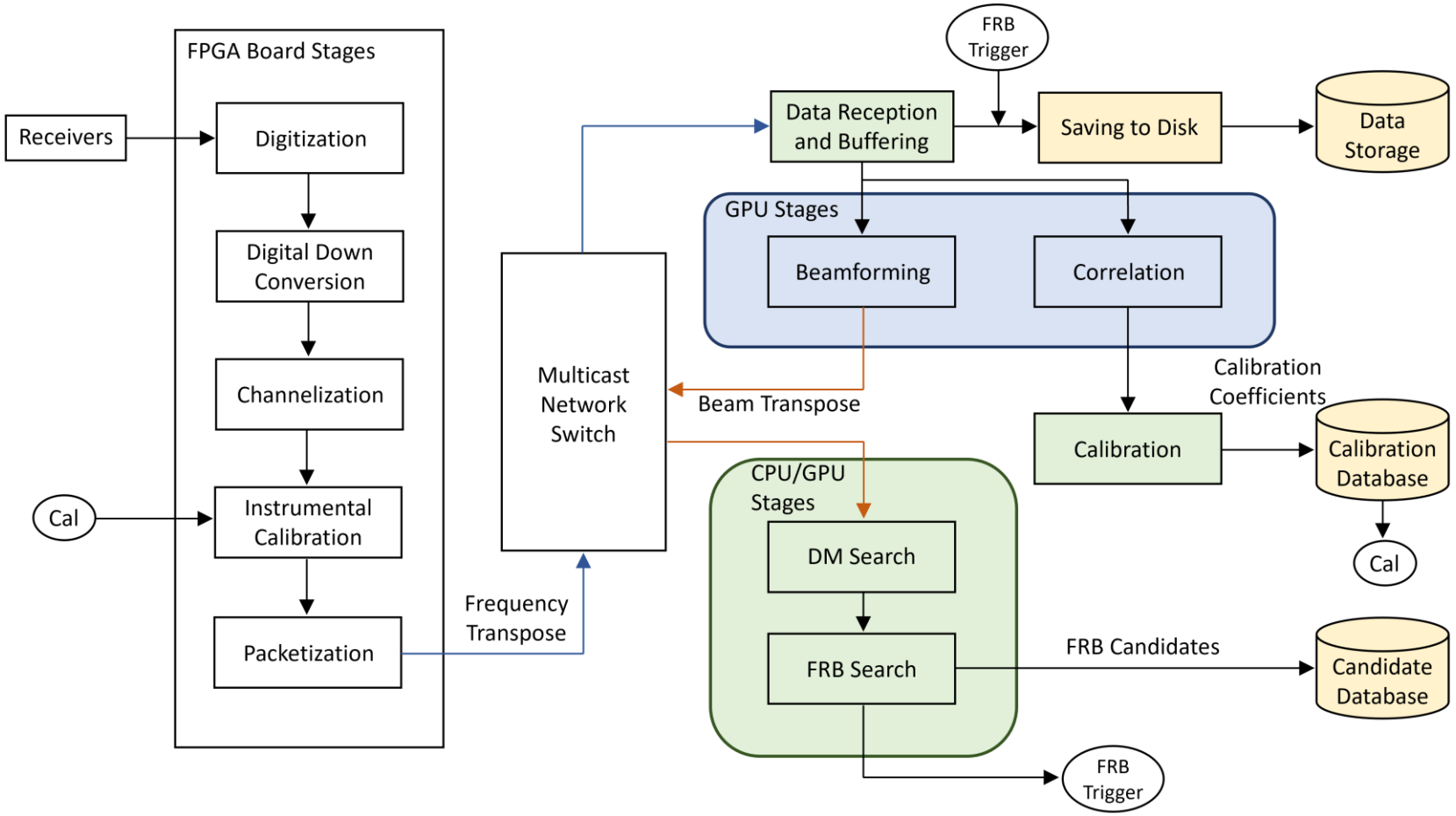
Firmware Development: Contract

- The work must complete a design already started and in an advanced phase
- Added the design for the Noto Radiotelescope (many common parts to be reused)
- 3 main Milestones:

Milestone	*Description*	*Deadline*
MS1	Packetiser and 40 GbE interface included in the design for NCR	T_0+1month
MS2	FW design for NCR completed	T_0+4months
MS3	FW design for Noto Radiotelescope completed	T_0+6months

- Status of the procedure:
  - SoW completed ☑
  - Contract to be written and signed

Software Development



See Alessio's Talk…

Software Development: Contract

- Approach: building the system gradually, releasing step by step new features with respect to the system currently in use
- 4 main Milestones:

Milestone	*Description*	*Deadline*
MS1	Initial Firmware and Software Tests	T_0+1month
MS2	64 (or 32) cylinders, 1 Beam, No Real-Time	T_0+3months
MS3	64 (or 32) cylinders, 1 Beam, Real-Time	T_0+6months
MS4	64 cylinders (or 32), Multi-Beam, Real-Time	T_0+8months

- Status of the procedure:
  - SoW completed ☑
  - Contract written ☑
  - Contract to be signed

Ongoing Activities

- Efforts to make the currently used data analysis pipelines portable
  - Containerization (Docker, Podman) of:
    - FETCH (deep-learning based classifier)
    - FRB Baseband (pipeline to post-process the data of Noto RT)

- Set up of a Gitlab server hosted in Medicina
  - Code repository (distributed revision control system)
  - Collaborative software development platform
  - Enable CI/CD automation
  - Mirroring in INAF Trieste (disaster recovery)

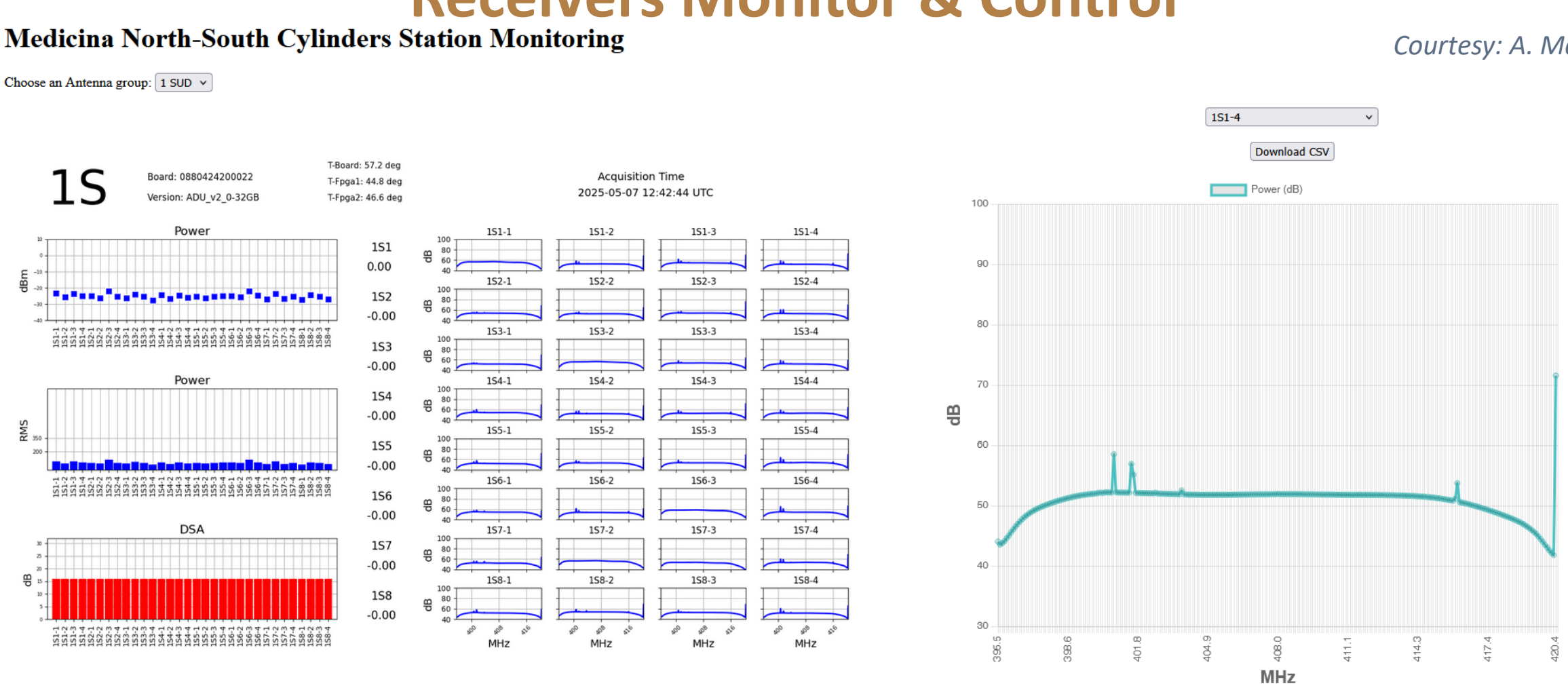
Ongoing Activities

- Set up of a secure remote access system to Medicina servers
  - Through VPN
  - Using isolated VLAN with access to the desired service

- Software tools for the monitoring and control of:
  - Analogue receivers
    - Configuration set-up (DSA)
    - Power levels check
    - RFI monitoring
    - ADC clipping monitoring
  - Digital boards
    - Power on/off
    - FPGA programming
    - Temperature monitoring
    - Synchronization check

Receivers Monitor & Control

Courtesy: A. Mattana



(Some) Criticalities and Strategies to Mitigate them

- Tender for HPC Cluster: long and complex procedure
  - It could affect the development of other activities depending on it
- Purchased a computing node with GPUs and a storage system
  - it will be used to deploy the system for 32 cylinders (first 2 milestones of SW development)

- Difficulties in awarding contracts for FW/SW development
- Some activities already started

- Few people for many and complex tasks (with a tight timeline!)
- Efforts to find additional manpower
  - Internship (5/6 months) for Master in HPC
  - PhD proposal (FRB search pipeline with HPC platforms)
- Investigate possible synergies with CHORD?

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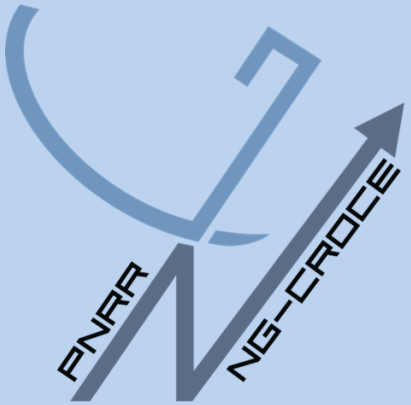
THANKS
FOR THE ATTENTION



Next Generation – Croce del Nord

IR0000026
Intervento finanziato nell'ambito del PNRR - Piano Nazionale di Ripresa e Resilienza

M4C2
Missione 4 - *Istruzione e Ricerca* Componente 2 - *Dalla Ricerca alla Impresa*
Linea di Investimento 3.1 - *Rafforzamento e creazione di Infrastrutture di Ricerca*

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