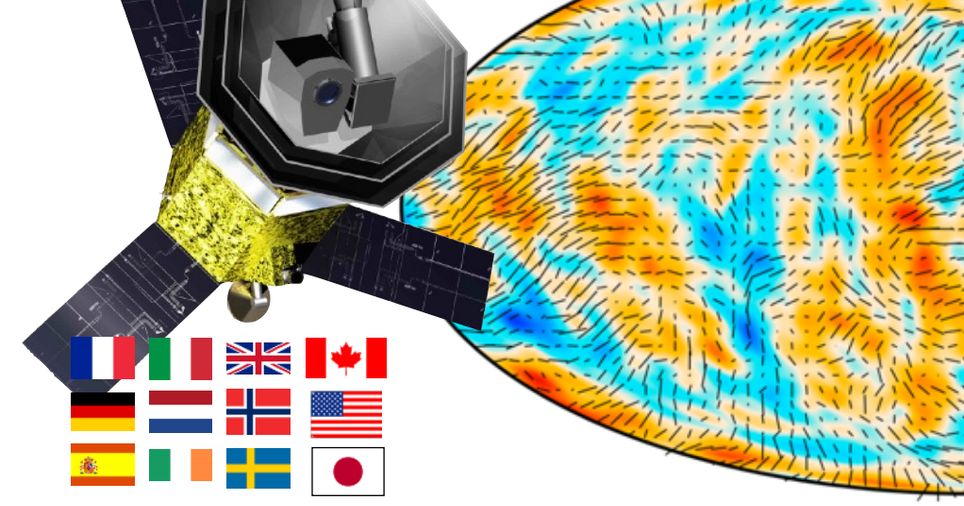
Preventivi 2023
LITEBIRD

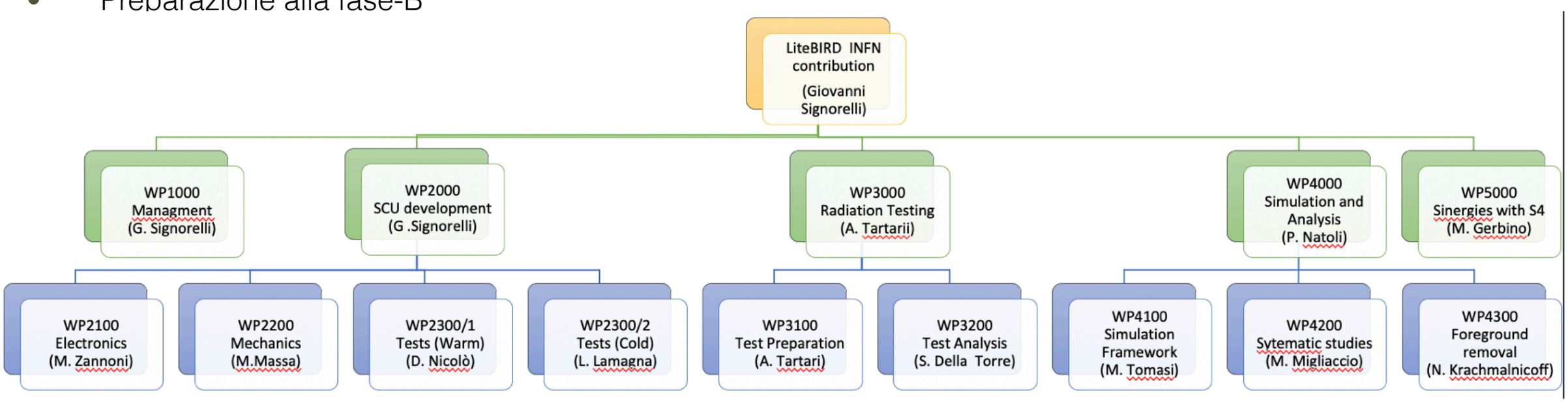
Giovanni Signorelli
INFN Sezione di Pisa

4 Luglio 2022

LiteBIRD

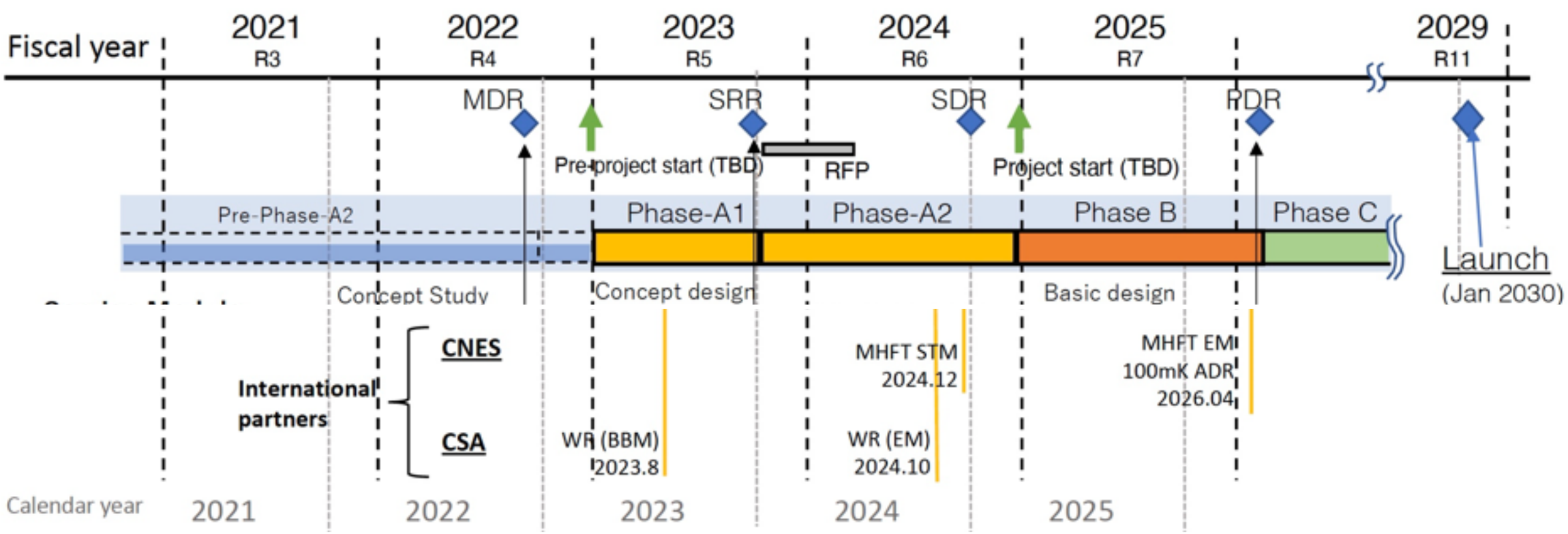


- Misura della polarizzazione della CMB
  - (→smoking gun dell'inflazione), Σ masse dei neutrini…
  - 5000 bolometri TES letti da SQUID
  - Satellite to-be-launched nel 2029
- INFN fornisce le SQUID contol unit (elettronica di readout) + Contributi alla simulazione e analisi + test di rad-hard di componenti selezionati per lo spazio
  - 2021: Sezioni di Pisa (G. Signorelli Resp. Nazionale), MIB, FE, RM1, TS, MI, RM2
  - 2022: Ingresso della sezione di LNF (R.L. Luca Porcelli) → space qualification
- Attività nel 2022
  - Fase-A finisce alla fine del 2022 → Review CNES (EU) fine 2022-inizio 2023.
    - Consegna del Demonstration Model di elettronica + enclosure
      - test dell'elettronica e della meccanica (sync w/Canada)
- Attività nel 2023
  - Chiusura "ufficiale" della fase-A
  - Preparazione alla fase-B



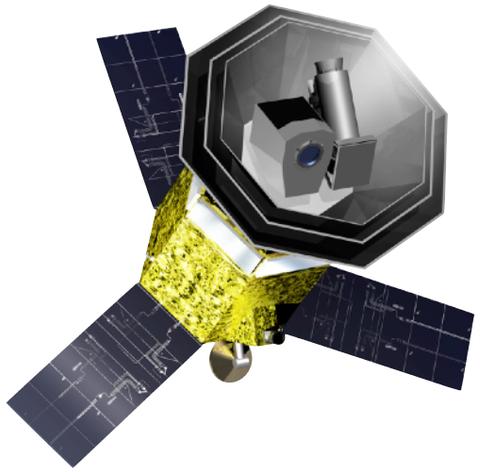
News and schedule

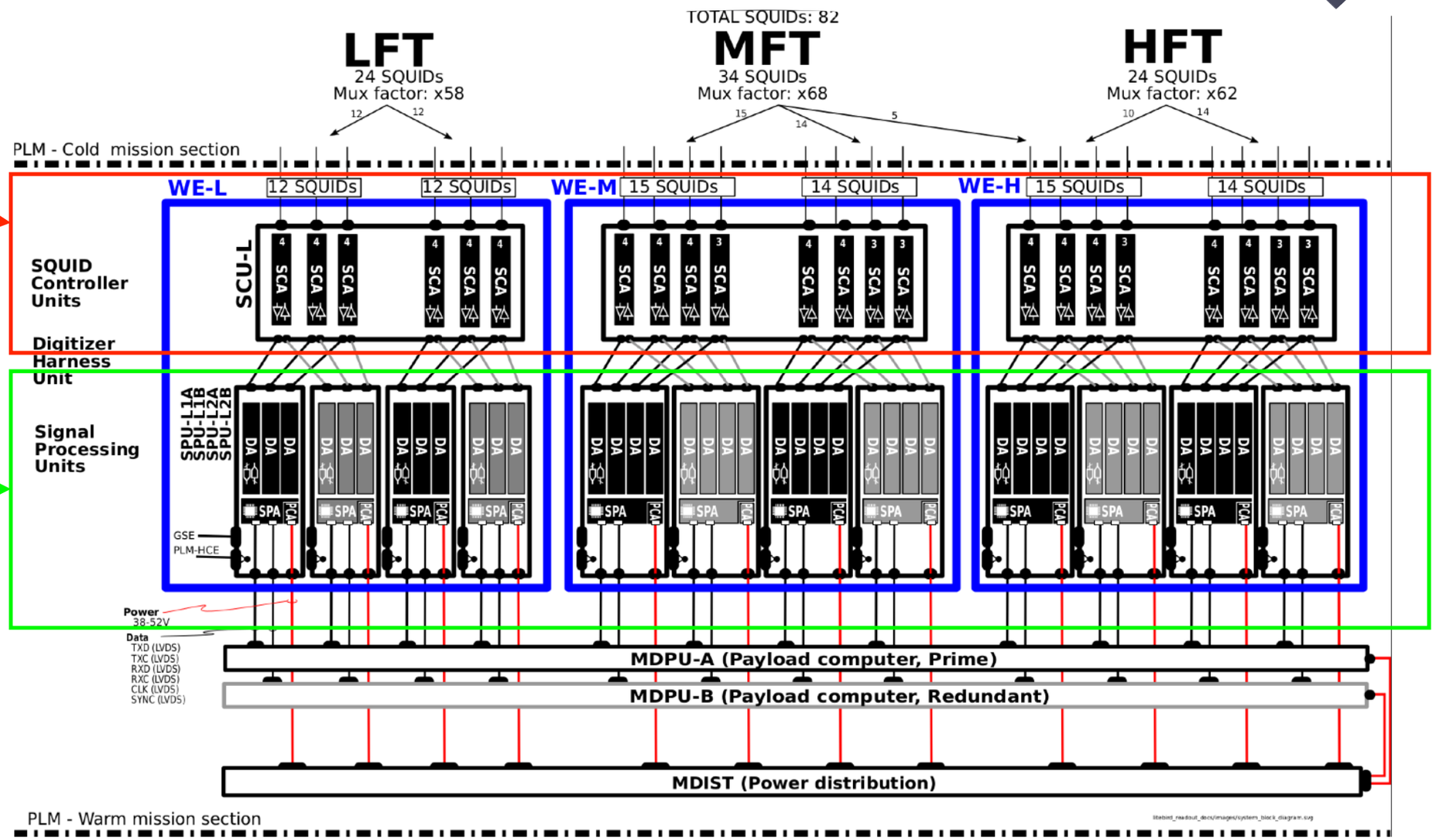
- LiteBIRD received top level recommendation from Japanese government
  - Launch in JFY 2029 (=2030)
- KEK science advisory committee recommended LiteBIRD as one of the projects to be carried out by KEK
  - 25M$ + QUP institute (International Center for Quantum-field Measurement Systems for Studies of the Universe and Particles)
- USA
  - to provide focal planes as part of QUP
- Canada
  - CSA budget requested. JAXA-CSA interactions ongoing
- EUROPE
  - MHFT. ASI-CNES contribution (+ minor contributions) with CNES lead
  - ESA as MoO



Description

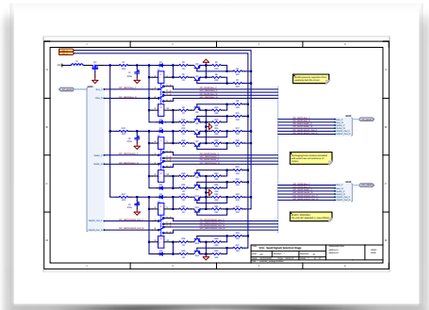
- SCU is part of the Warm Readout
  - Warm Readout is common to all three telescopes
  - Carried out in synergy between Italy and Canada
    - INFN/ASI (Italy) provides SQUID Control Units for the three telescopes
    - McGill/VIctoria/CSA (Canada) provides Signal Processing Unit for the three telescopes
  - Warm Readout activities proceed in sync between Canada and Italy



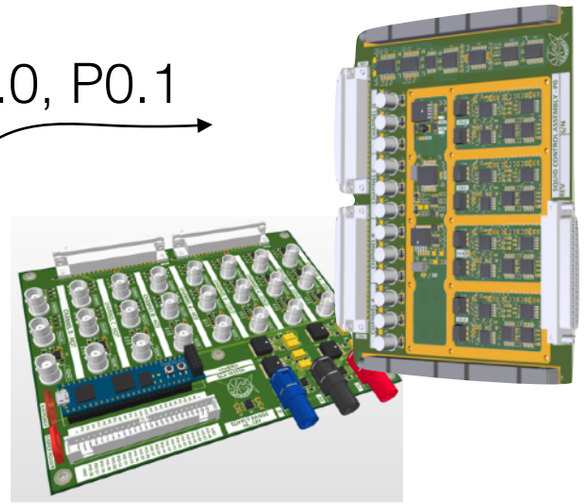


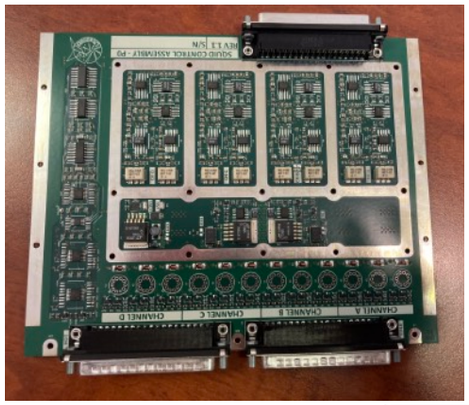
SCA activity in 2022

- Electronics
  - P0.0 e P0.1 → designed - electrically tested - delivered to McGill

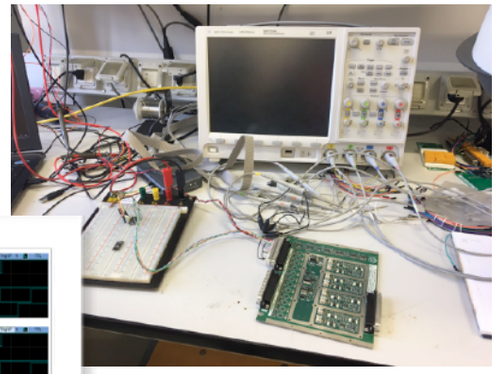


P0.0, P0.1

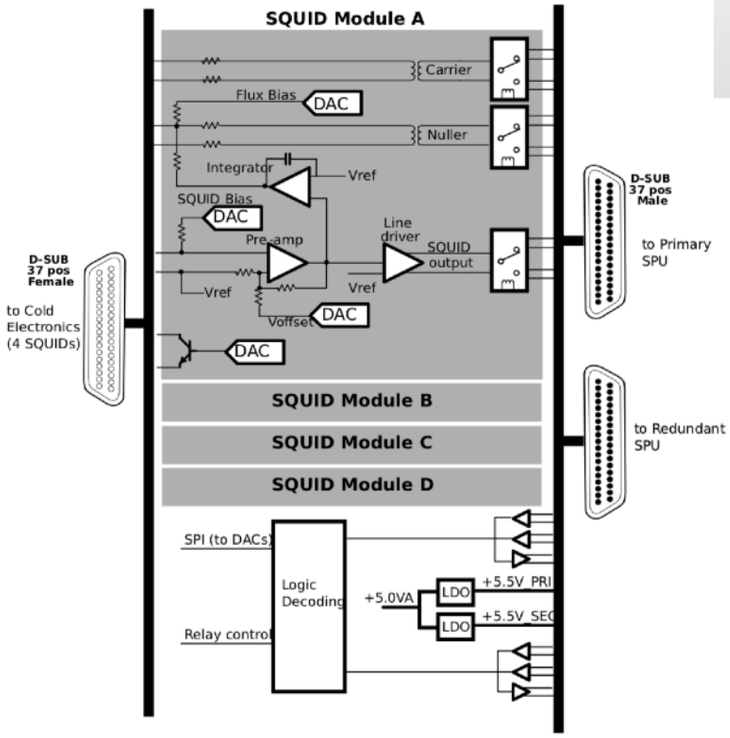




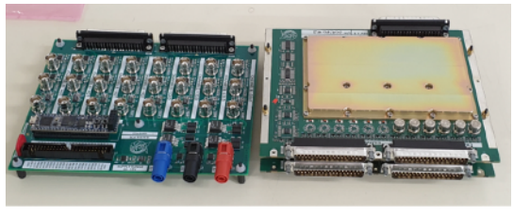
INFN/MIB

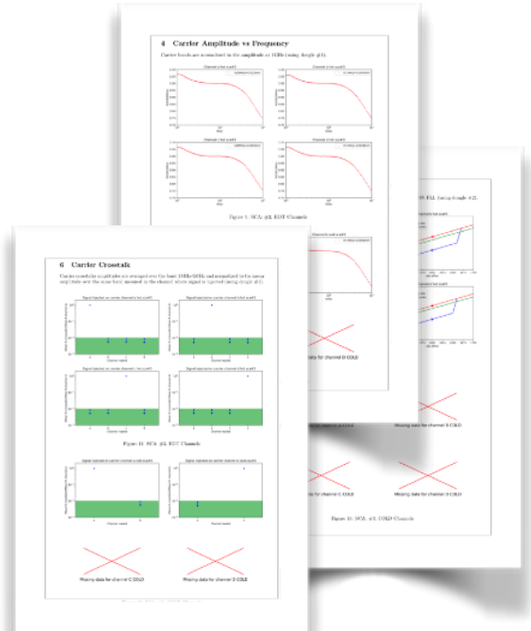


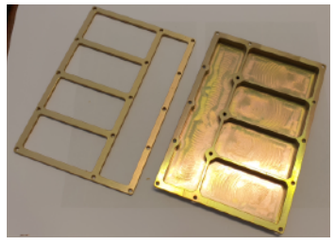
To INFN/PI

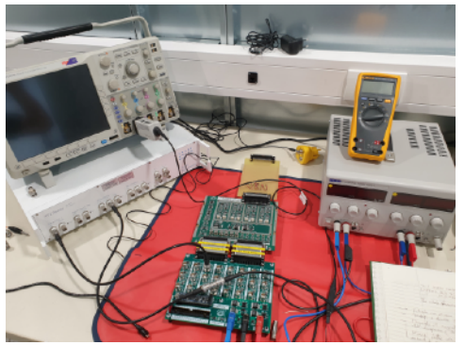


To McGill



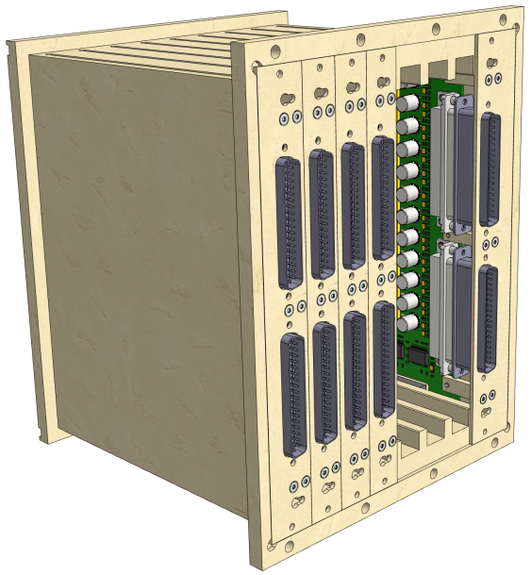


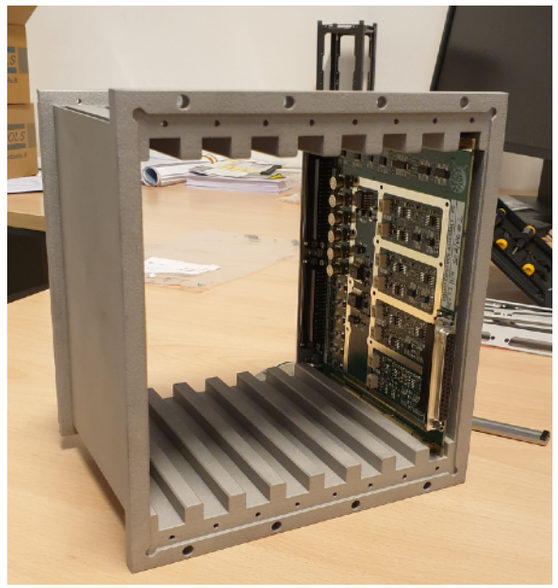


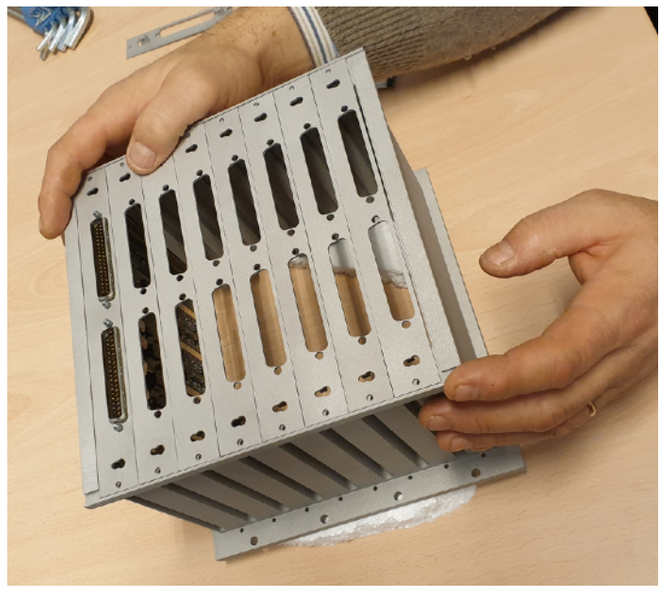


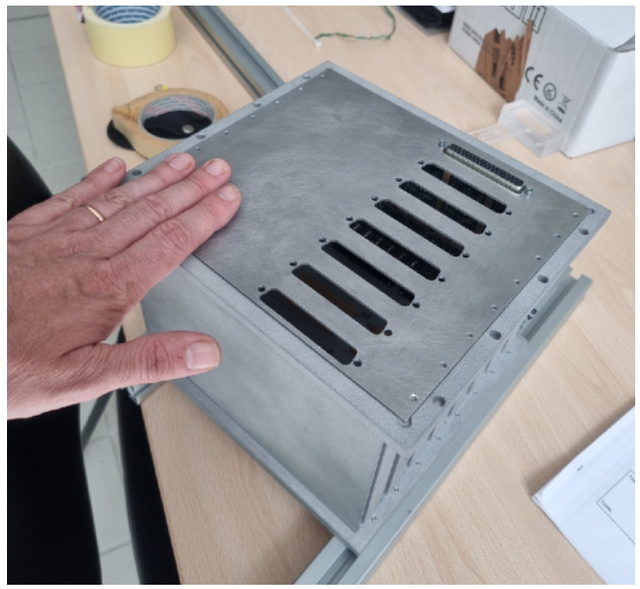
SCE Activity in 2022

- P0 (two way insertion) machined (3D printed) ad optimization ongoing for EDM
  - Plan to do three identical 8-slot crates for AIV and engineering optimization

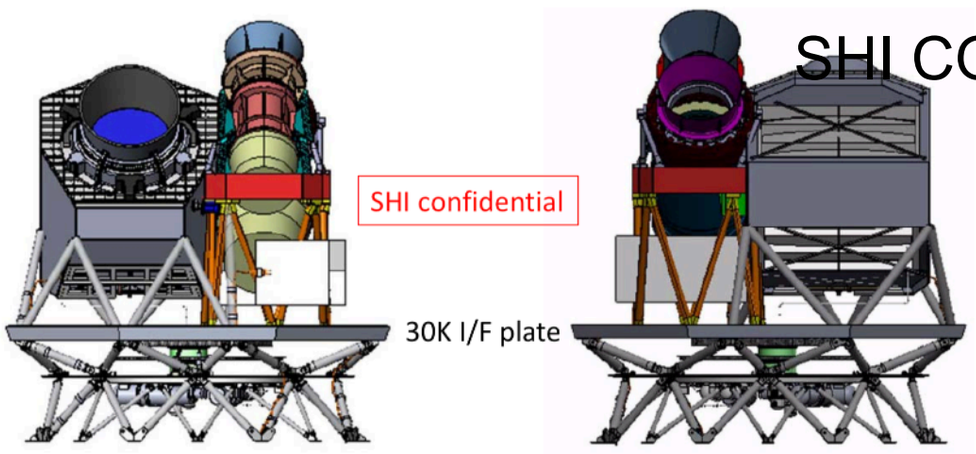


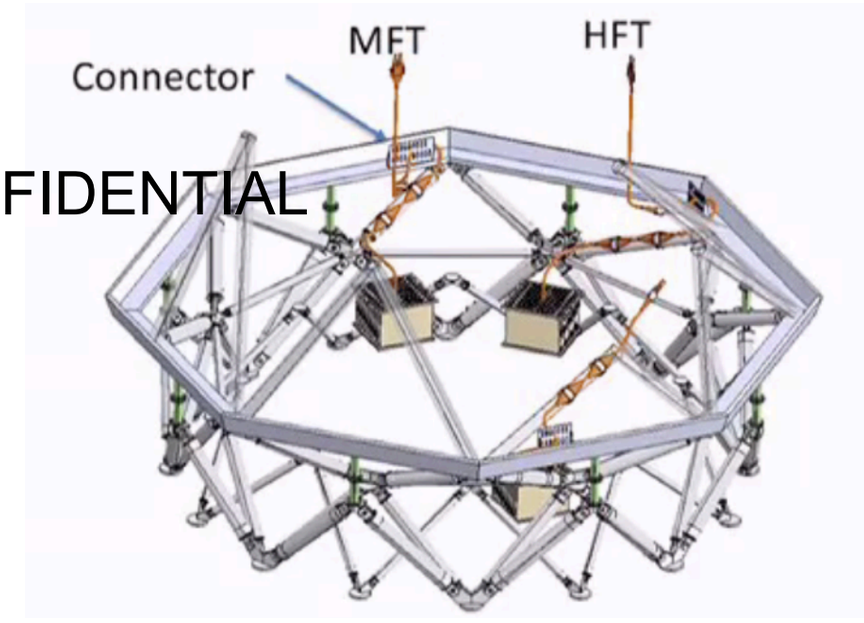






- Assuming the present "best design" of the SVM/PLM interface we started a design to be discussed
- Different from the rest of the electronics SVM → PLM

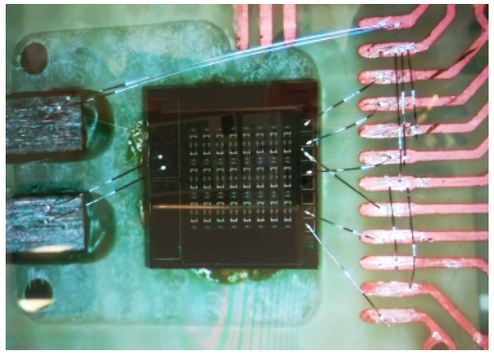


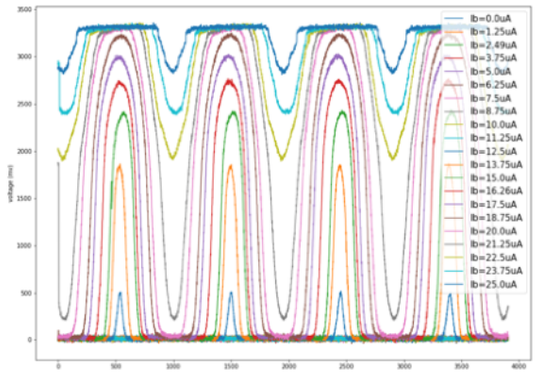


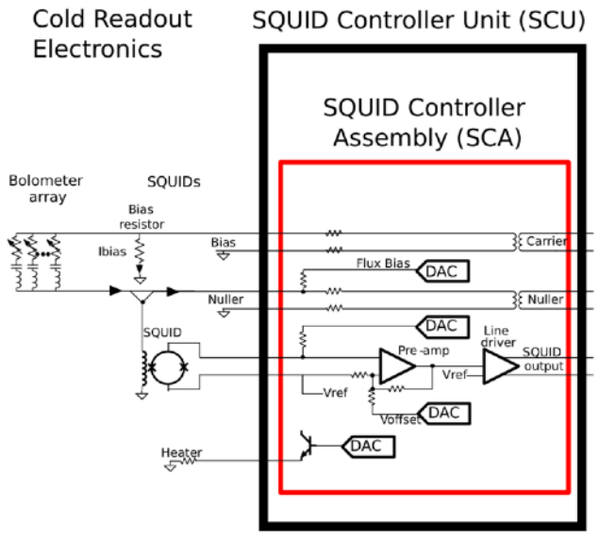
SHI CONFIDENTIAL

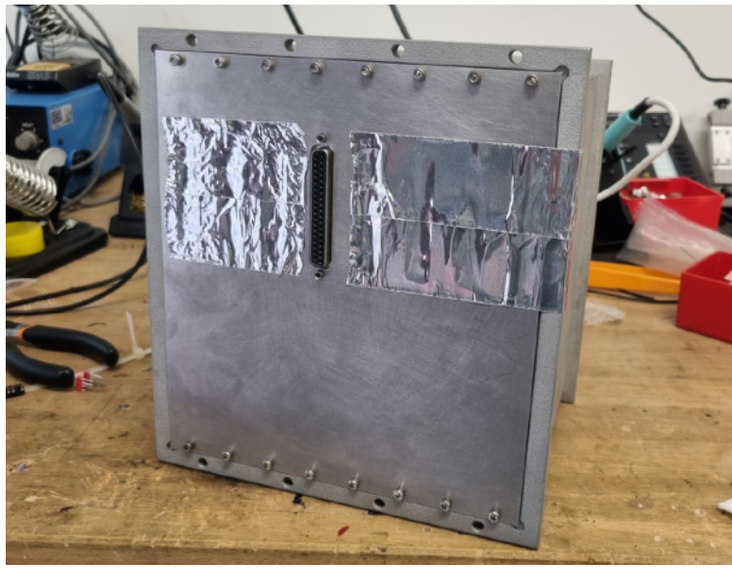
Cold tests

- Due to COVID restrictions the combined SCU+SPU test has been postponed to July 2022
- We assembled a preliminary test station in our cryostat @INFN/PI
  - StarCryo AR4825. 48 SSA with V/A ~ 300
    - 12 μA I_c,1.5 mV p-p, transimpedance >300 V/A

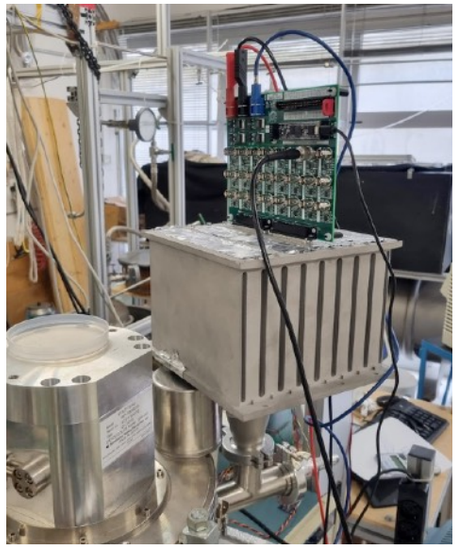


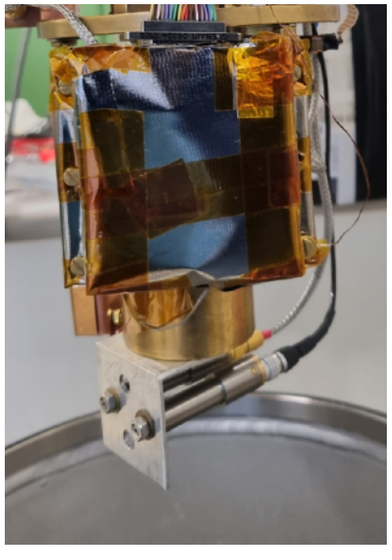


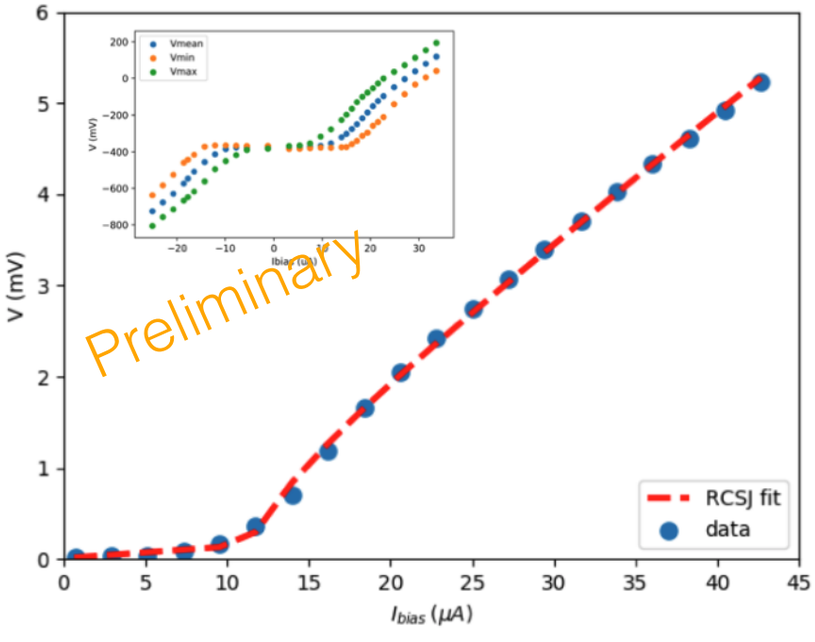




- Ongoing tests: SQUID signal is somehow noisy in INFN/PI setup
  - SCU = SCA + SCE prototypes first measurement!
  - we could measure SQUID I-V characteristics by averaging a large number of measurements
  - curves are consistent with twin SQUID + commercial electronics (Magnicon)



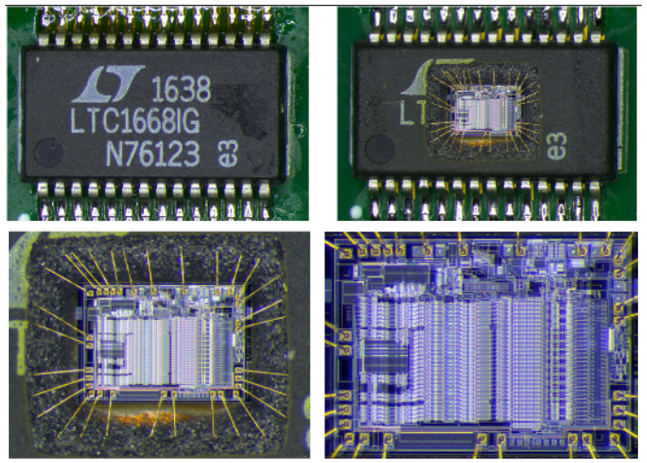


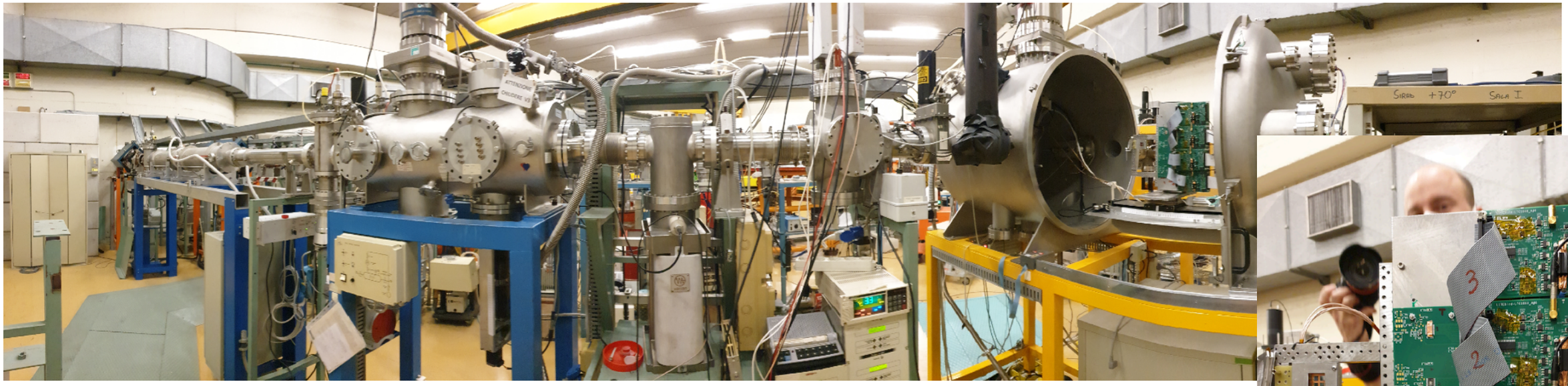


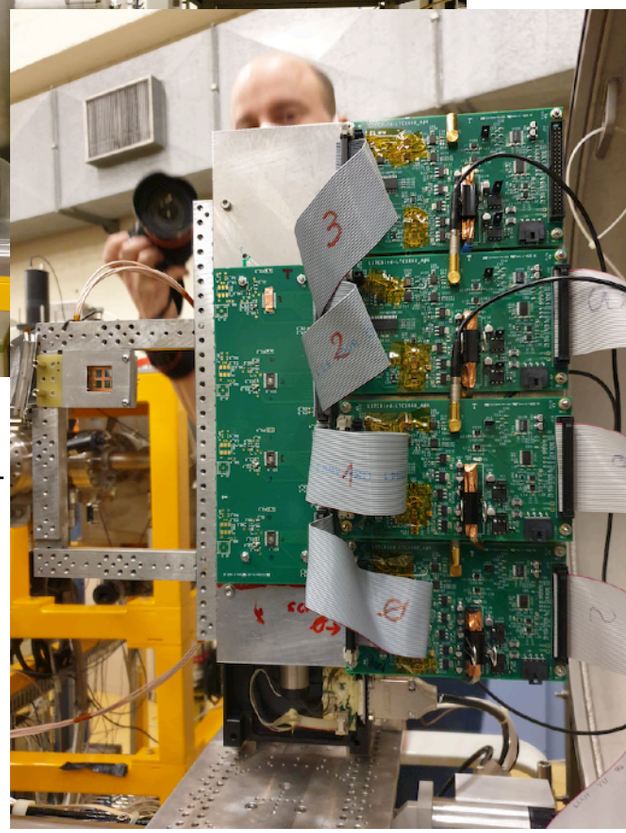
- Combined WR test @McGill (Montreal) 10-23 July 2022
  - PI + MIB ⇒ fundamental to clarify requests for 2023

Radiation hardness test

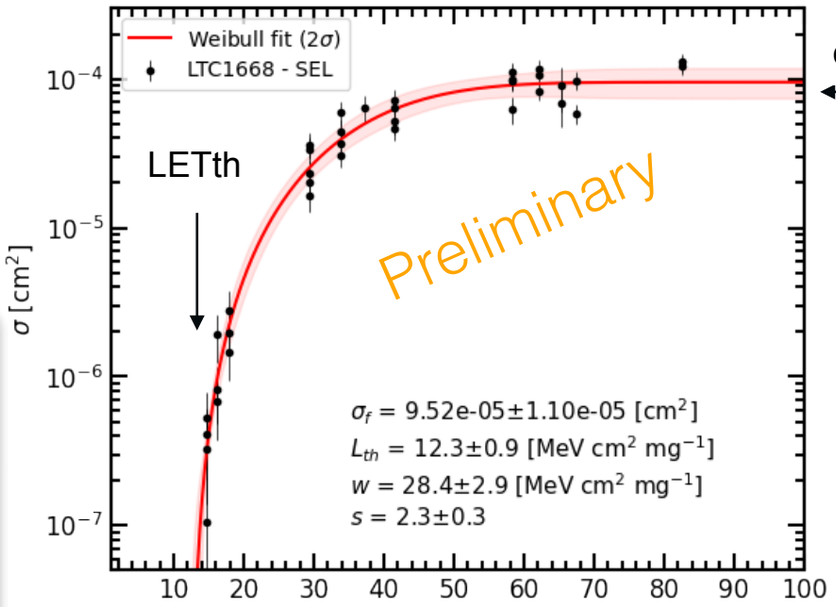
- We organized and performed a radiation hardness test for space qualification of DAC LTC1668 to be used in LiteBIRD Warm Readout
- Collaboration between Pisa, Ferrara and Milano Bicocca
- Tests performed at INFN Legnaro National Laboratory with Ion beams
- The SIRAD facility at LNL provides an ideal environment
- Primary goals:
  - Determine LET threshold and saturating cross sections for SEL, SEU, SET

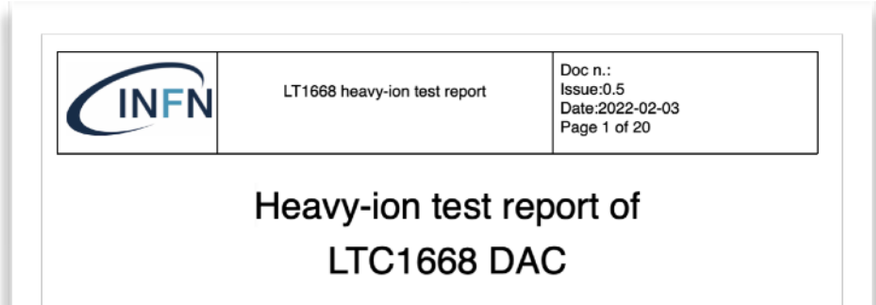






- Data analysis finalized
- Preliminary results
- Just had data-taking day on Jun 28/2022



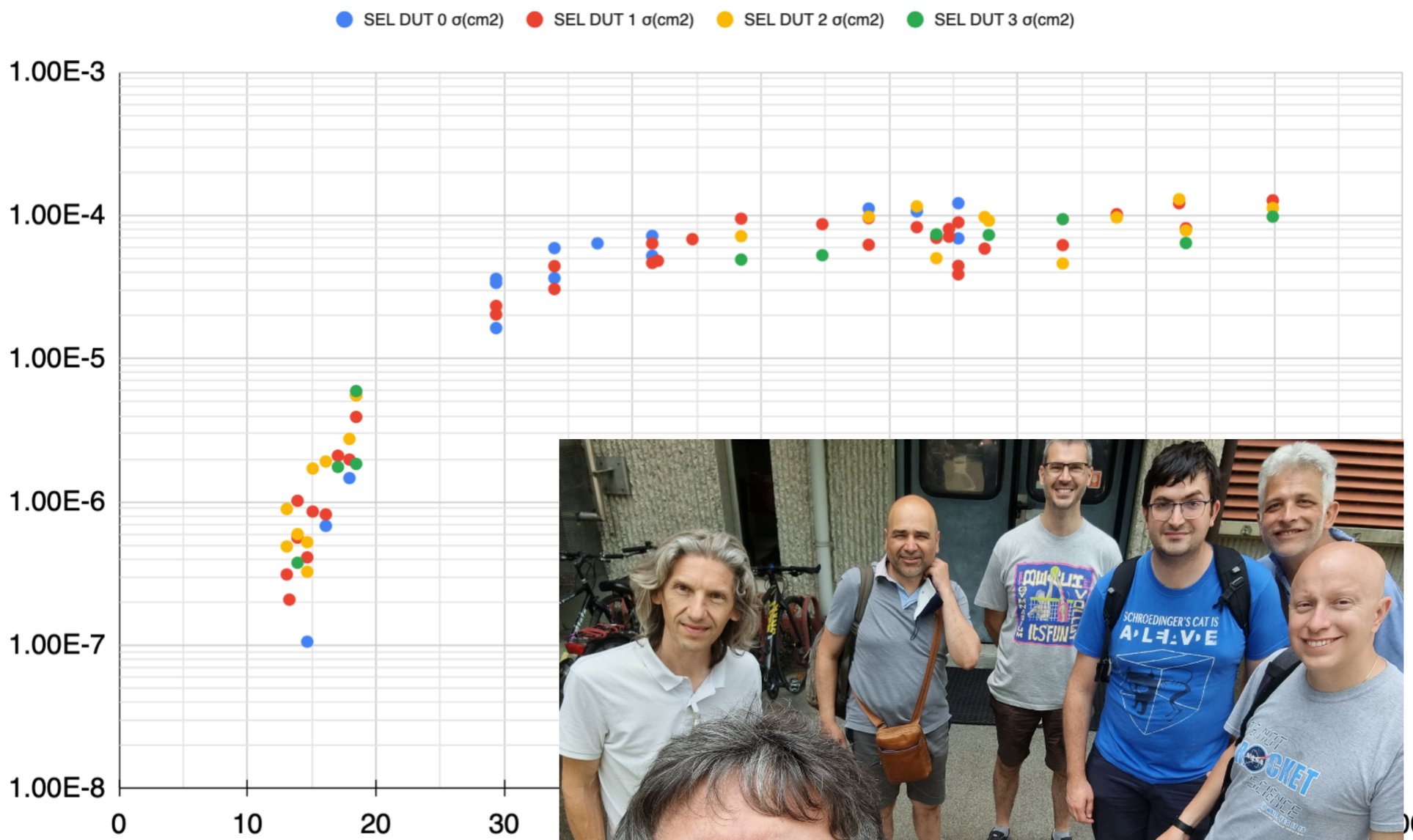


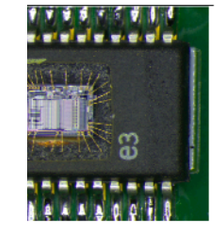
INFN	LT1668 heavy-ion test report	Doc n.: Issue:0.5 Date:2022-02-03 Page 1 of 20

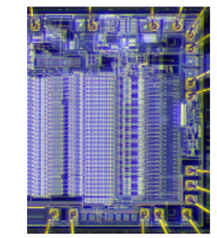
Heavy-ion test report of
LTC1668 DAC

Radiation hardness test

- We orga … e used in LiteBIRD
- Collabor…
- Tests pe…
- The SIRA…
- Primary …
  - Dete…







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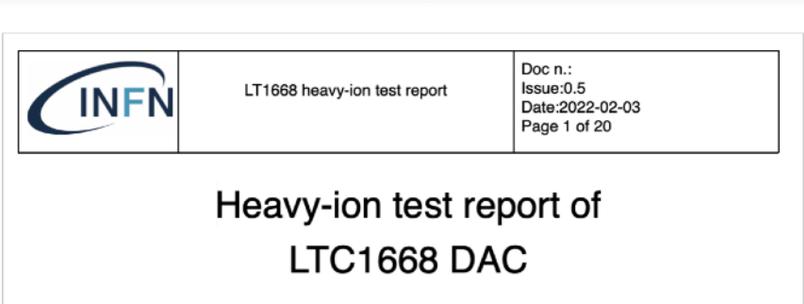
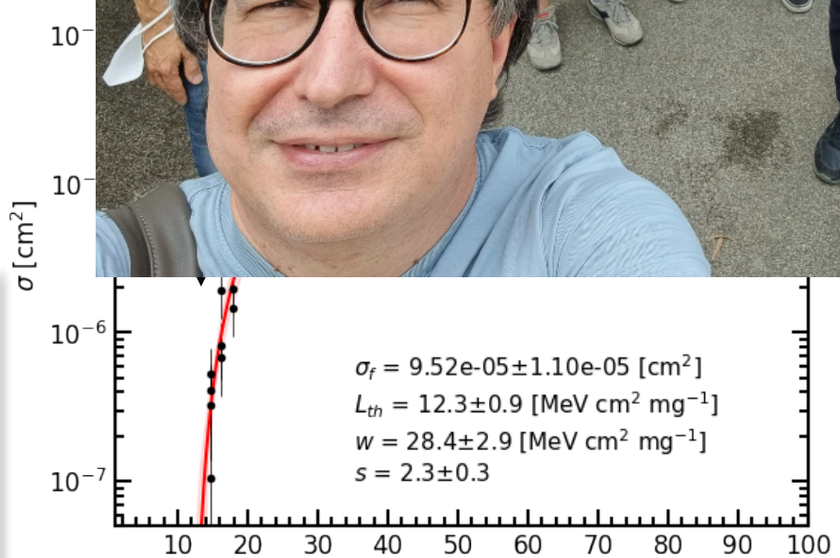


INFN	LT1668 heavy-ion test report	Doc n.: Issue:0.5 Date:2022-02-03 Page 1 of 20

Heavy-ion test report of
LTC1668 DAC



Attività 2023

- Completare la fase A
  - Fase-A finisce a fine 2022
  - CNES review → documents, documents, documents.
  - Demonstration model for
    - SCU = SCA + SCE delivered to consortium
    - studiare fattibilità di test a freddo
    - produrre alcuni prototipi per testare LFT, MFT, HFT (USA, Canada, JAP, Italy)
  - Set-up cryo-lab @INFN/Pisa

Major Milestones

- 2021: Prototype HFT
- 2021-2022: End CNES Phase-A2
- 2022: Selection for Phase B CNES
- 2025: EM Delivery EM
- 2027: FM Delivery
- 2029: Launch
- 2032: End of survey (3 years)

Assembly Name	Dev Models					EQM	ProtoFlight Models (or QM+FMs)			Flight Spare	Total qty	
	GSE LFT	GSE MFT	GSE HFT	EM (3)	Spare (EM ?)		LFT	MFT	HFT		COTS ver	Flight Quality
SQUID Controller Assembly	6	8	8	3 (4)	1 (4)	4	6	8	8	4	26 (30)	30
SCU Enclosure	1*	1	1	1*		1*	1*	1	1	1*	2+2*	2+3*
Digitizers	6	8	8	12 (4)	4	8	12	16	16	4	38 (30)	56
Signal Processing Assembly	2	2	2	3 (1)	1	2	4	4	4	1	10 (8)	15
Power Conditioning Unit	2	2	2	3 (1)	1	2	4	4	4	1	10 (8)	15

*SCU Enclosure slots = 8 (default) for 4/6/8 SCAs Units

- Rad hard test con protoni per LTC1668

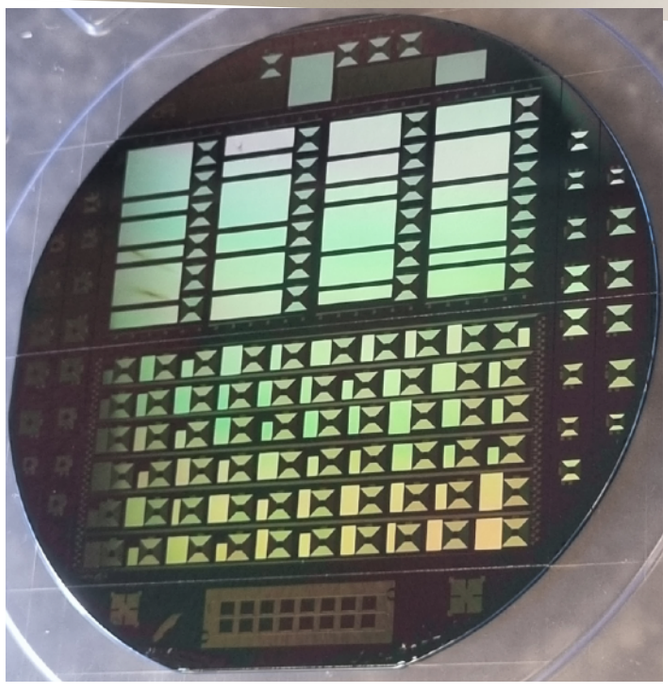
Anagrafica Pisa LITEBIRD

RICERCATORI		
Giovanni Signorelli	**0.60**	Resp. locale e Resp. Nazionale
Fabrizio Cei	**0.30**	
Donato Nicolò	**0.30**	
Luca Galli	**0.20**	
TECNOLOGI / TECNICI		
Andrea Tartari	**0.50**	Co-Lead CR Calibration
Franco Spinella (Tecnol. Elettronico)	**0.05**	
Maurizio Massa (Progett. Meccanica)	**0.20**	
Moggi Andrea (‘’)	**0.10**	
Michele Pinchera (‘’)	**0.30**	
Laureandi		
Paolo Dal Bo		
Eugenia Di Giorgi		
TOTALE	**2.55**	

Richieste alla sezione

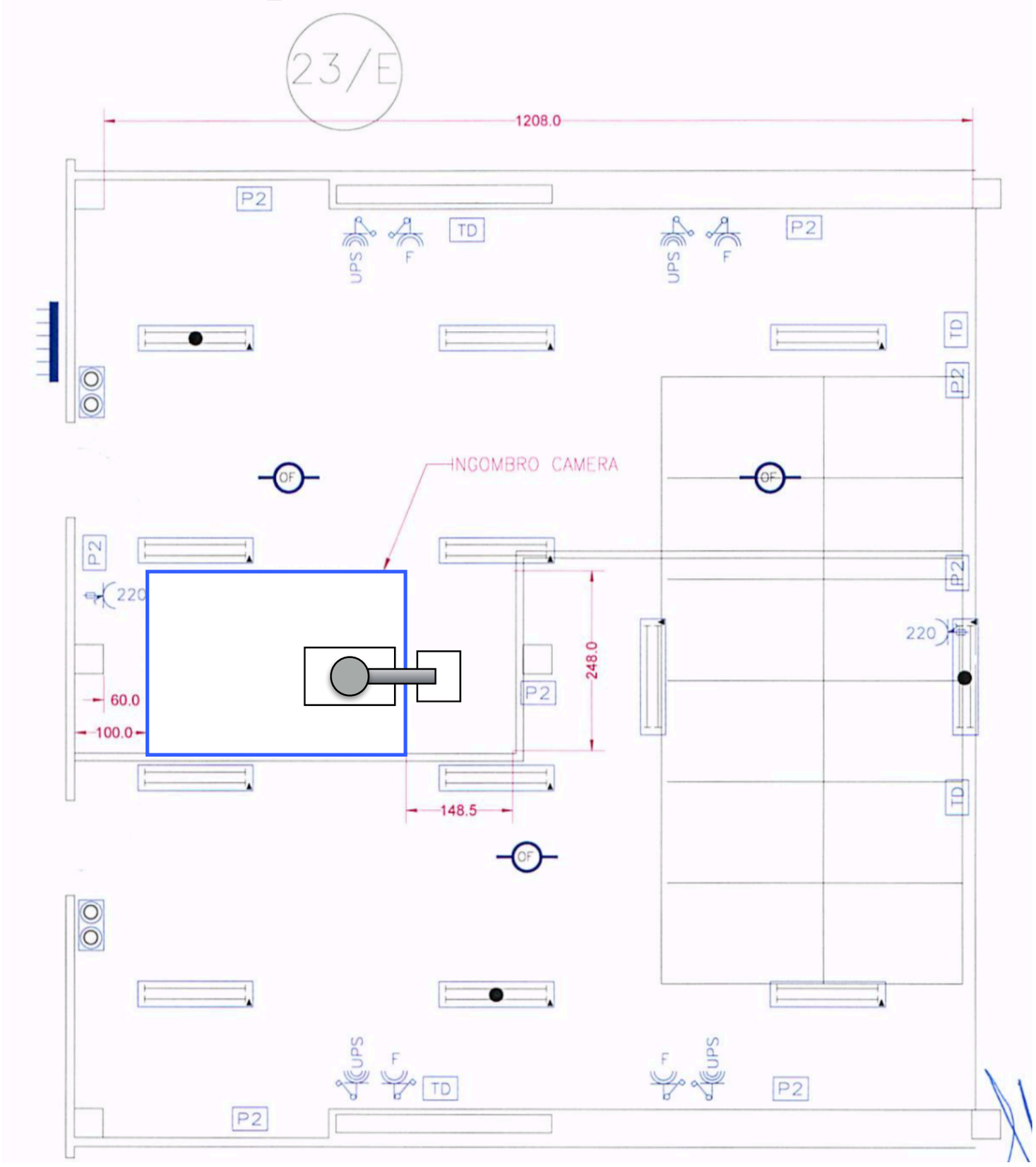
- Sinergia con finanziamenti ASI:
  - LiteBIRD/ASI 2020-2023
    - 1/2 RTDA UniPI + 20k€
  - Premiale ASI/INFN 2015 (sviluppo di elettronica e rivelatori per CMB)
    - 1/2 RTDA UniPI + 2 AR Tecnologici + Criostato (270k€) + consumables
- Laboratorio di misure elettroniche criogeniche a basso rumore
  - Camera EMI shielded
  - Criostato a Diluizione <30 mK

- Costruzione del prototipo (DM) della meccanica di volo
  - 3 m.u. officina meccanica
    - Crate 4U x 8 schede
      - preferibilmente in casa. All'esterno solo come back-up solution
    - shield EMI per schede elettroniche.
- Supporto per set-up laboratorio di criogenia
- Supporto elettronica per spazializzazione P1
- Uso sporadico di Camera Pulita per montaggi e Micro-Bonding
- Uso esclusivo del laboratorio criogenico.
- Preparazione documentazione per CNES phase-A exit review.
- Project management



INFN-PI CryoLab

- Gara (quasi) conclusa…. mesi!



Responsibilities/duties

- GS
  - resp. SCU
  - member IPB
- Project Office:
  - Francesco Piacentini (RM1): Instrument Scientist
  - P. de Bernardis (RM1): PO Lead
  - M. Zannoni (MIB): Warm readout subsystem lead
  - GS: Warm Readout system lead
  - A. Tartari (PI): Calibration co-lead
- Paolo Natoli: Chair European Steering Committee