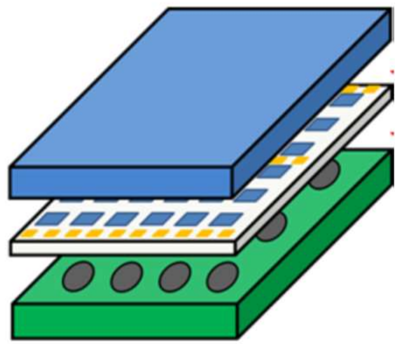
Medipix4

Ferrara, LNS, Napoli, Pisa e Trieste

The proposal is based on the development of a detection system realized assembling of a Timepix4 photon counting chip (energy sensitive; time resolving readout circuits; 4-side buttlable; ~ 7cm^2 area; 512x448 pixels ;~ 10^6 hits/mm2/s mod-Data driven;~ 10^9 hits/mm2/s, mode-Frame based); bump-bonded to Si or Cd-Te sensors of various thiknesses.

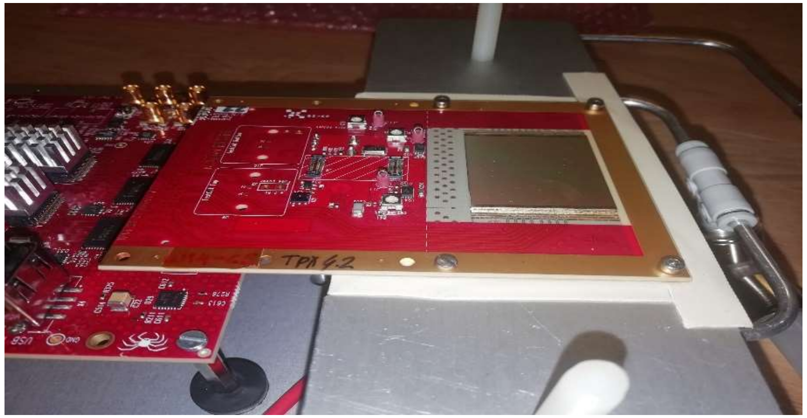
The spectral capabilities of detection system will be applied to:

- Dosimetry in mammography
- μ-CT
- Spectral imaging

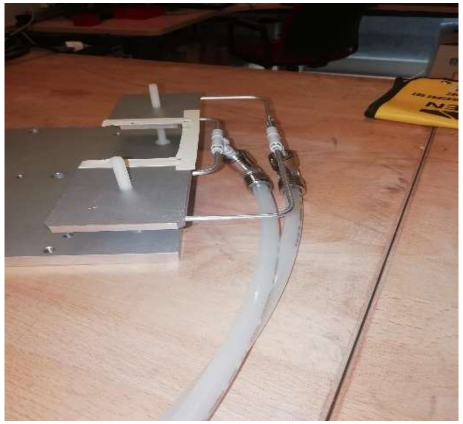


Cooling set-up

Ferrara and Pisa



- Bare Timepix4 v2 (no sensor installed)
- Timepix4 v2 mounted on NIKHEF chipboard
- Chipboard connected directly to SPIDR4
- Cold plate connected to chipboard



Hotspots

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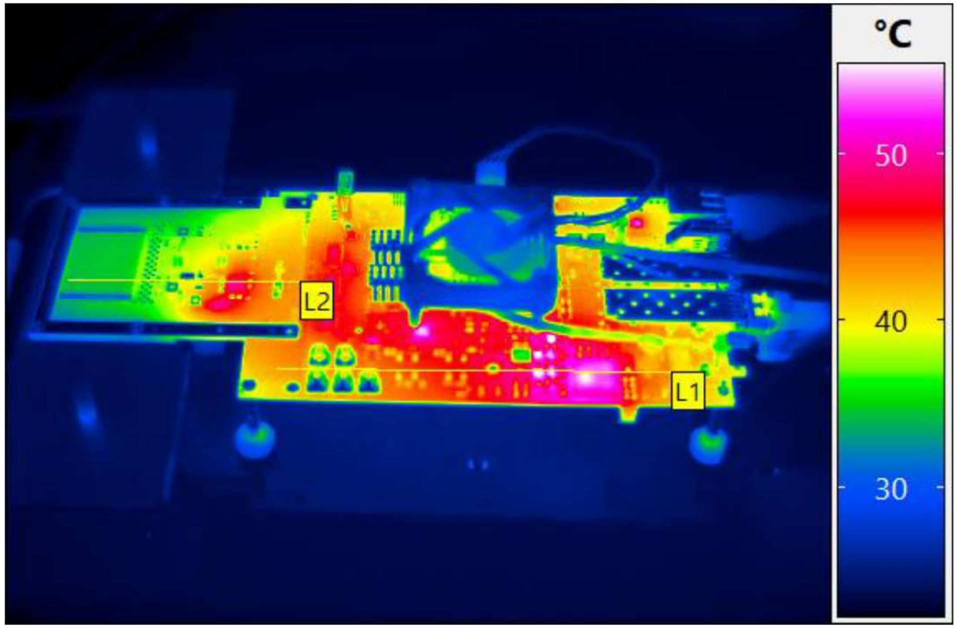


Thermoscan in low power settings

Temperatures are indicative (to be interpreted as relative measure)

Chipboard (left)

- hotspot on bottom due to VDD voltage regulator
- similar hotspot on other side due to VDD_A voltage when switching to High power mode

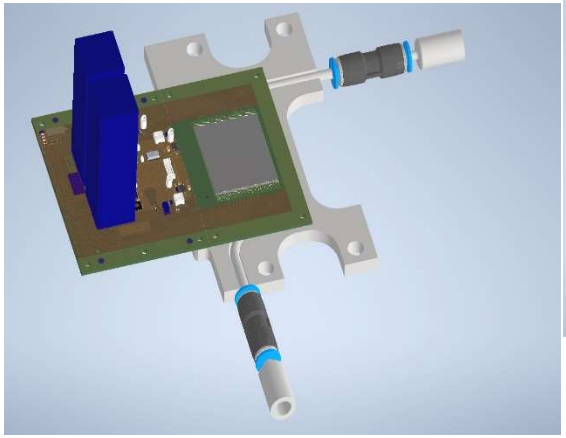
SPIDR4 (right)

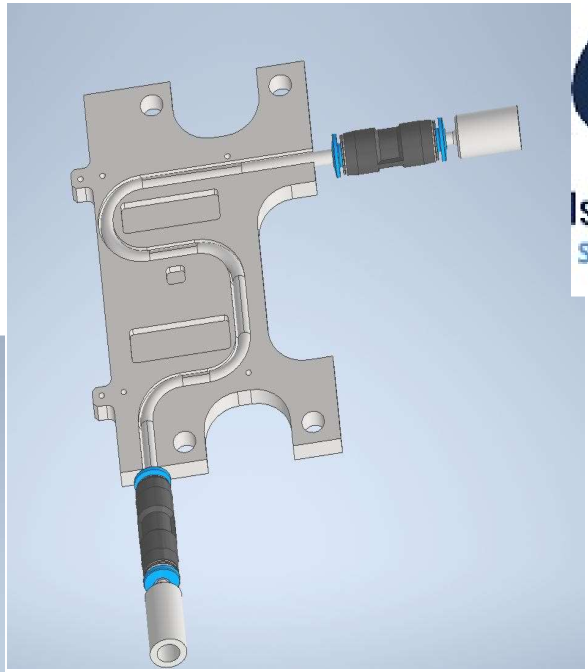
- hotspots on voltage regulators and clock manager
- board design details not known

New Prototypes

New in-house prototype available soon

- maximise area of contact
- simplify manufacturing process
  - reuse existing hardware





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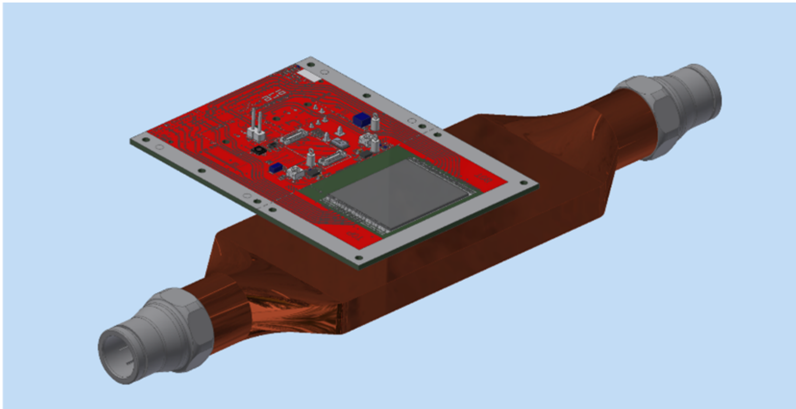
Final design being finalised

built in-house
- machined from copper
- high area for heat exchange
- no thermal resistance due to pipe glueing, etc.

- 3D printed
  - Long lead time
    - machine set-up for Copper
  - Optimal vorticity/performance



RICHIESTE III anno

La consegna dei sistemi (assembly/RO) è in ritardo

Missioni	4kE	Misure presso le altre sezioni partecipanti
	2kE	Riunioni al CERN
Strumentaz.	--	
Consumo	1kE	contributo per licenze SW
	2kE	produzione board-Cu

- Richiesta di servizi: 3 settimane uomo in OFFICINA MECCANICA, per la realizzazione del sistema di raffreddamento
- 2 settimane Alte Tecnologie, per collegamento al chiller e test termici in aria per verifica delle temperature di funzionamento

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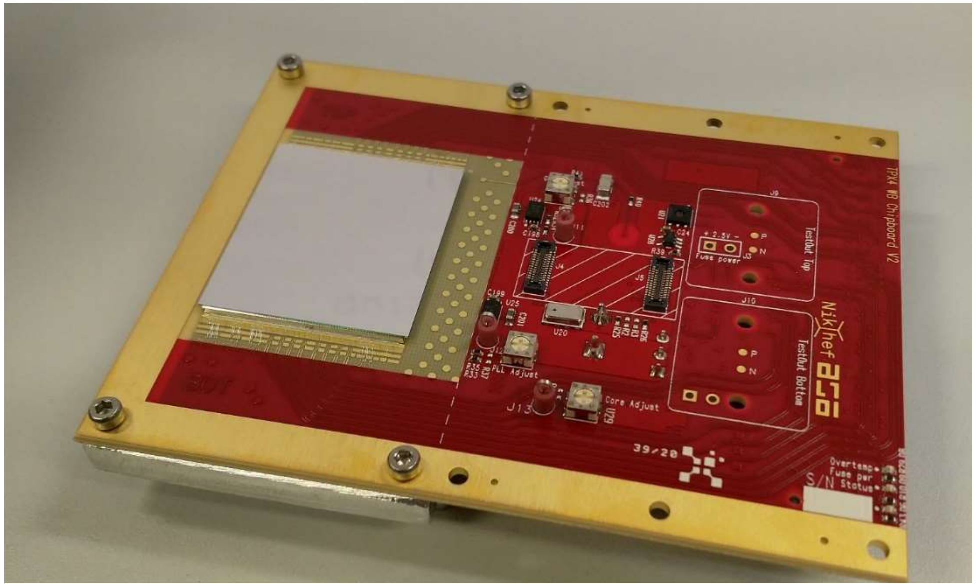
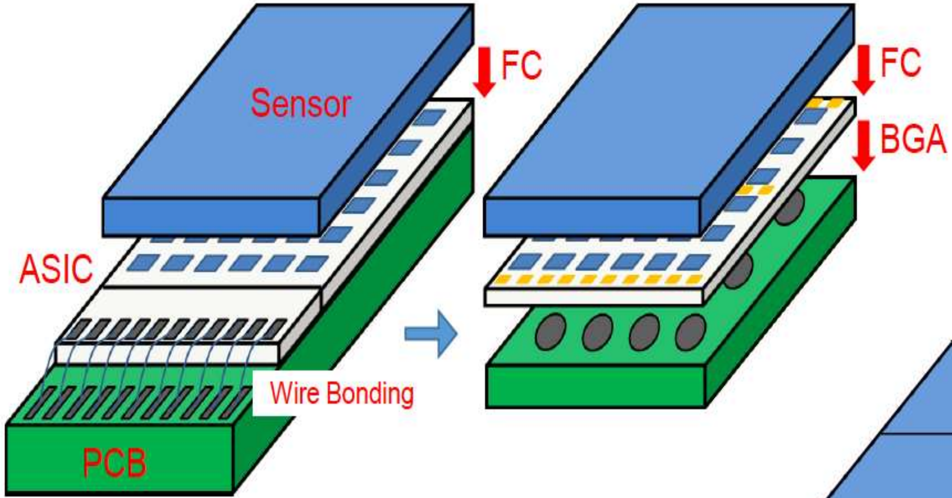
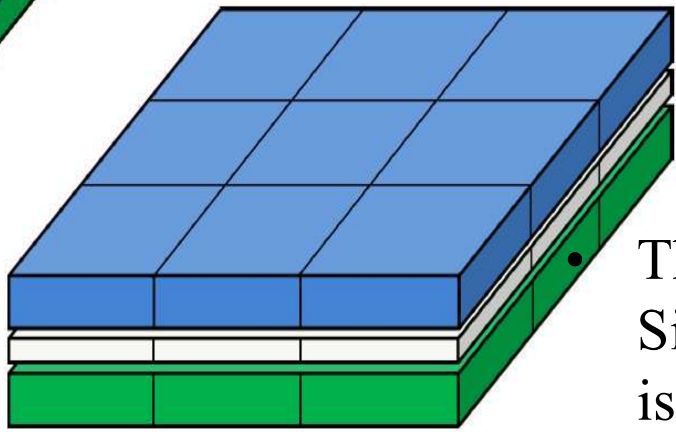
	Posizione	Medipix4 (%)	
P. Delogu	PA	20	
E. Ciarrocchi	RTDA	20	
M.E. Fantacci	PA	20	
V. Rosso	PO	40	Local coord.
M.G. Bisogni	PA	20	
G. Sportelli	RTDB	40	
N. Belcari	PA	20	
D. Panetta	Ric. CNR	20	
		2.0 FTE	



Timepix4 + 300µm thick p-on-n sensors from Advacam, mounted on Nikhef readout board

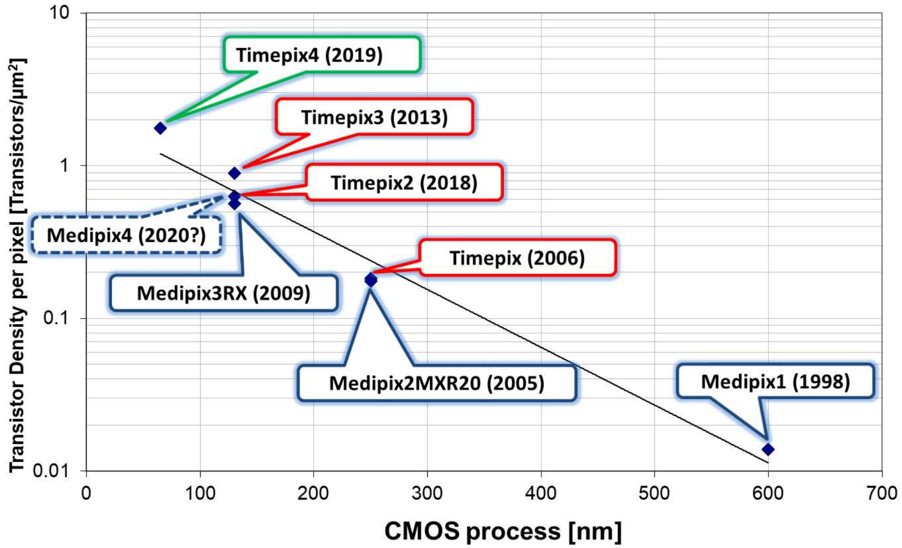


- 4-side buttable pixel arrangement
  - Target to build large area detectors by combining smaller modules
- The Through-Silicon Vias (TSVs) is the key technology



The MEDIPIX4 project

- Medipix4 Collaboration at CERN
  - 15 members
  - 2 ASICs to be designed
- Timepix4 ASIC
  - 4-side buttable large single-threshold particle tracking detector chip with improved energy and time resolution and with high-rate imaging capabilities
  - Produced at the beginning of 2020 in TSMC 65 nm CMOS
- Medipix4 ASIC
  - Will target spectroscopic X-ray imaging at rates compatible with medical CT scans (under design)



Courtesy X. Llopart (CERN)

- The ”MEDIPIX4” INFN project will exploit this cutting-edge technology in a wide range of applications, and make it available to the INFN community

Timepix4 ASIC

			Timepix3 (2013)	Timepix4 (2019)	
Technology			130nm – 8 metal	65nm – 10 metal	
Pixel Size			55 x 55 μm	55 x 55 μm	
Pixel arrangement			3-side buttable 256 x 256	4-side buttable 512 x 448	3.5x
Sensitive area			1.98 cm^2	**6.94 cm^2**	
Readout Modes	Data driven (Tracking)	Mode	TOT and TOA		
		Event Packet	48-bit	64-bit	33%
		Max rate	0.43×10^6 hits/mm^2/s	**3.58×10^6 hits/mm^2/s**	8x
		Max Pix rate	1.3 KHz/pixel	**10.8 KHz/pixel**	
	Frame based (Imaging)	Mode	PC (10-bit) and iTOT (14-bit)	CRW: PC (8 or 16-bit)	
		Frame	Zero-suppressed (with pixel addr)	Full Frame (without pixel addr)	
		Max count rate	~0.82×10^9 hits/mm^2/s	~5×10^9 hits/mm^2/s	5x
TOT energy resolution			< 2KeV	< **1Kev**	2x
TOA binning resolution			1.56ns	**195ps**	8x
TOA dynamic range			409.6 μs (14-bits @ 40MHz)	**1.6384 ms** (16-bits @ 40MHz)	4x
Readout bandwidth			≤5.12Gb (8x SLVS@640 Mbps)	**≤163.84 Gbps** (16x @10.24 Gbps)	32x
Target global minimum threshold			<500 e^-	<500 e^-	

Courtesy X. Llopart (CERN)