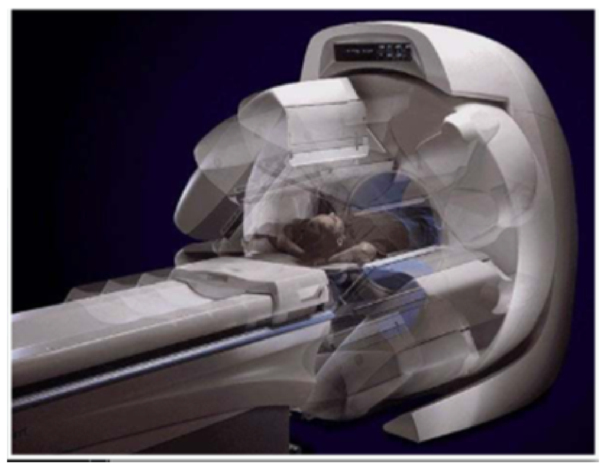
SPECTRE

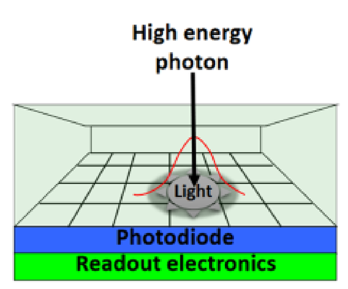
SPECT READOUT ELECTRONICS

SPECT from Hal Anger's gamma cameras to CZT sensors

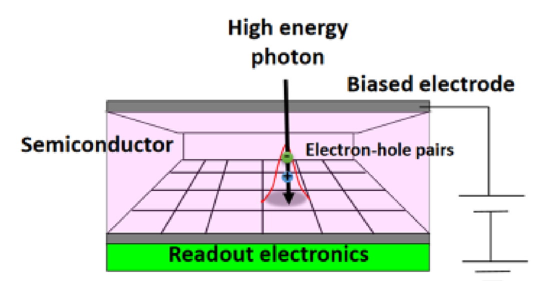
It uses gamma-emitting radioisotopes into compounds administered into the patient's body to study molecular processes that can be visualized, quantified and tracked over time so that a healthy tissue can be distinguished from diseased tissue with a high degree of certainty

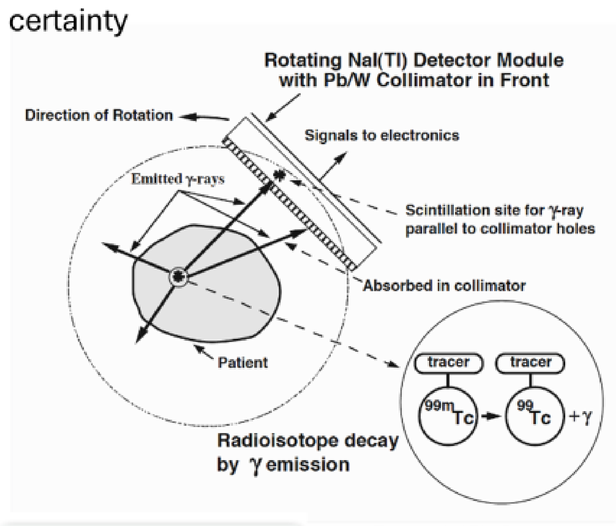


Indirect conversion



Direct conversion

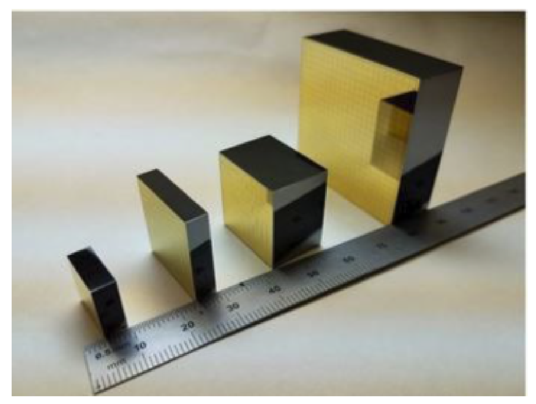




Traini, INFN Roma

Radiotracer	Half-life (hours)
^{99m}Tc	6.0
^{67}Ga	76.8
^{201}Tl	72
^{133}Xe	127.2
^{111}In	67.2

CdTe and CZT are among the most established room temperature semiconductors for the detection of ionizing radiation.
They offer a higher energy resolution than the Anger technique (5% compared to 10% at 140 keV). In addition, the linear attenuation coefficient of CZT is higher than that of NaI(Tl) (3 cm^{-1} versus 2 cm^{-1} at 140 keV), possibly leading to a higher sensitivity for gamma photons



https://www.kromek.com/czt/

Very FAST readout electronics

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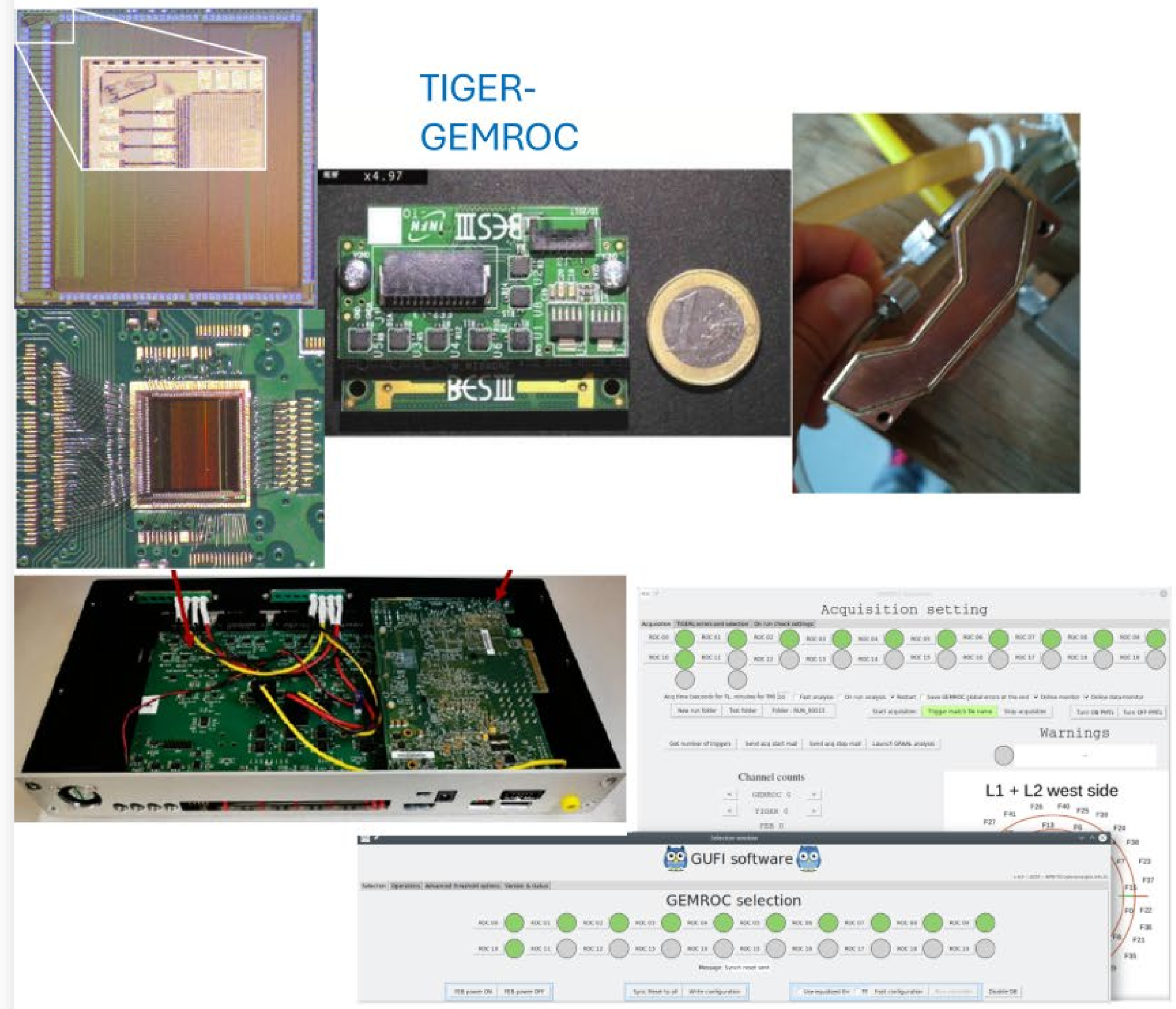

Proposal:
To apply **existing readout electronics** (from FEE to DAQ) **developed @INFN-Torino and Ferrara** within BESIII, CSN1 experiment, to readout **CZT sensors**

The existing readout circuit is compact, modular, and meets the high-speed requirements of CZT sensors for spectroscopic applications.

The whole INFN readout chain can be customized to improve performance compared to market-ready solutions.

A key element is the **scalability** which has already been tested by the applicants on large systems (BESIII_CGEM).

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Sensor and electronics simulation

Market survey of CZT sensors

- Pixellated
- virtual Frisch-grid (VFG)
- Frish grid

study of CZT sensor signals and measurement noise using

Finite Element (FE) analysis, Monte Carlo tools

TCAD Sentaurus

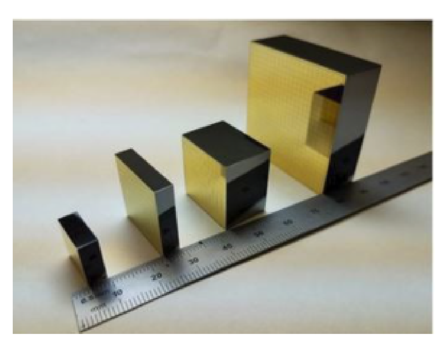
- simulation of point source of 140 keV with a defined activity (e.g. 37 MBq)
- inclusion of photoelectric effect, Compton, as well as X-ray fluorescence
- Study of Vdepth, induced charge
- Study of charge sharing
- charge induction efficiency-> signal shape

Deconvolution of TIGER response

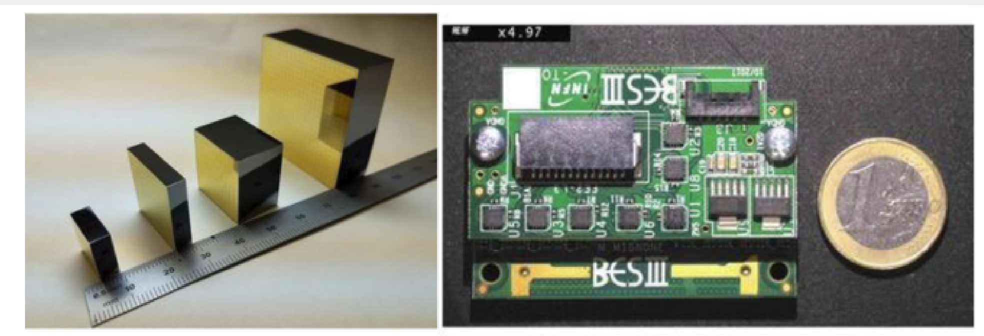
fine tuning of TIGER channel configuration parameters

Performance evaluation by simulation

CZT Sensor acquisition



System design and construction)



1) CZT Sensor characterization
Detector calibration:
I-V behaviour @T- H

2) READOUT (TIGER+GEMROC) +CZT sensor
Noise characterization @T, HV using the TEST boards for fine tuning of TIGER channel configuration parameters) (dark current, thr levels, noise rate)
Spectral response with Am-241, Co-57, Ba-133, Cs-137 sources:
single channel, all channels @T, HV, distance/angle at INFN-To/Fe
Intrinsic count rate performance
Evaluation of S/N, energy resolution/linearity and homogeneity;
Comparison with MC studies

3) Construction of mechanical base module
4) READOUT (TIGER+GEMROC) +CZT sensor
Spectral response with Tc-99 @AOU Città della Salute;

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PROPOSTA TESI TRIENNALE

PROPOSTA TESI MAGISTRALE

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