

***Attività di Fisica Medica in collaborazione
con JHM - John Hopkins Medical***



Convenzione INFN - JHM

- Convenzione biennale per attività di fisica medica in ambito SPECT e dosimetria radioterapica (finanziamento annuo **35k€** da INFN e **50k\$** da JHM)



Il gruppo:

- 1 Professore senior
- 3 Post-Doc (Fondazione Roma)
- 2 Ph.D (Fondazione Roma – Tor Vergata)

Le competenze:

- Elettronica di lettura per PMT e per dosimetri in diamante sintetico
- Cristalli scintillanti per imaging
- Algoritmi event positioining per immagini scintigrafiche 2D
- Sensori in diamante sintetico (Tor Vergata)

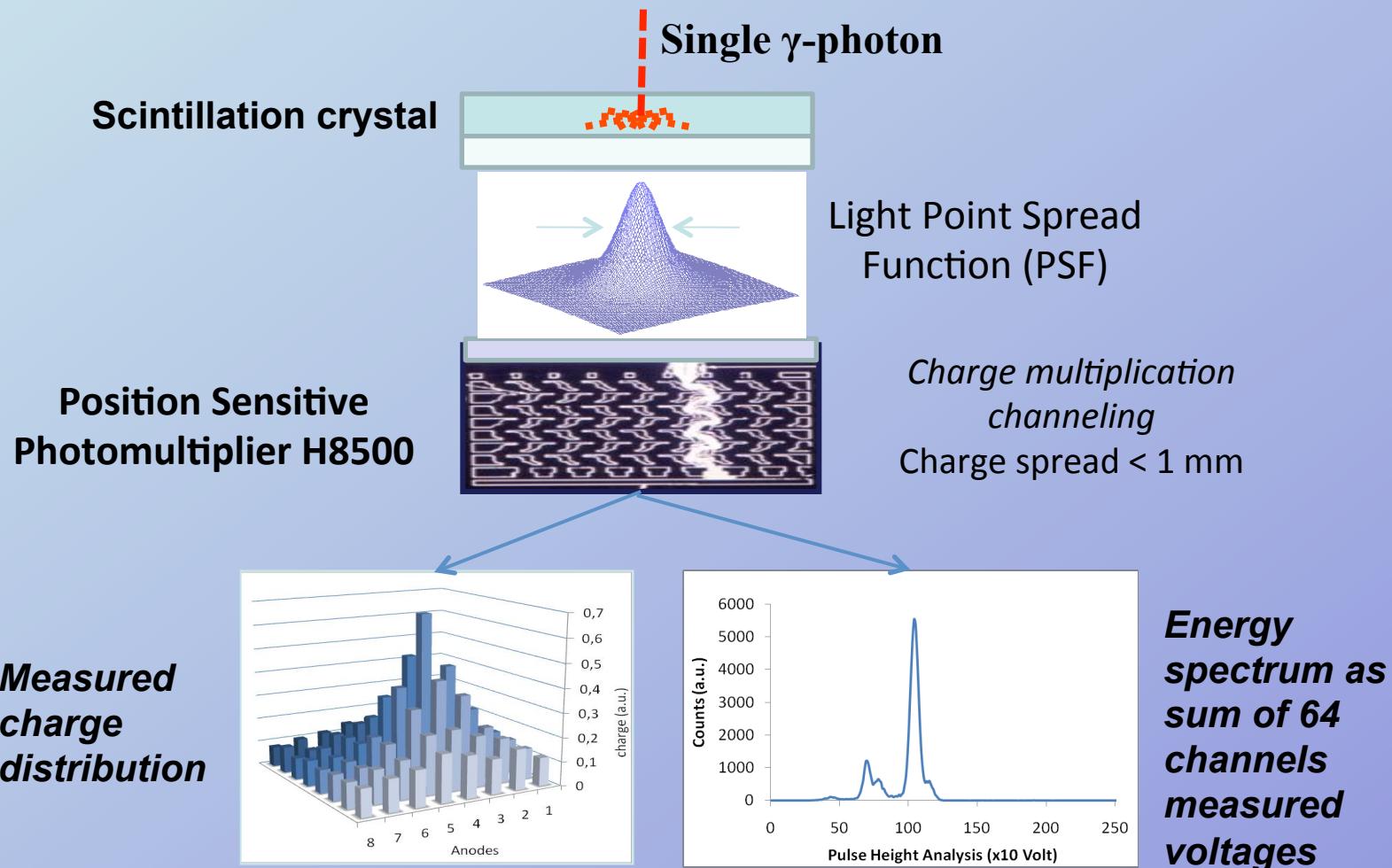
JHM: un po' di numeri

- ~1,8 mld \$ di finanziamenti pubblici (2012)
- ~55 mila pubblicazioni e ~1.5 milioni di citazioni nel decennio 2000-2010

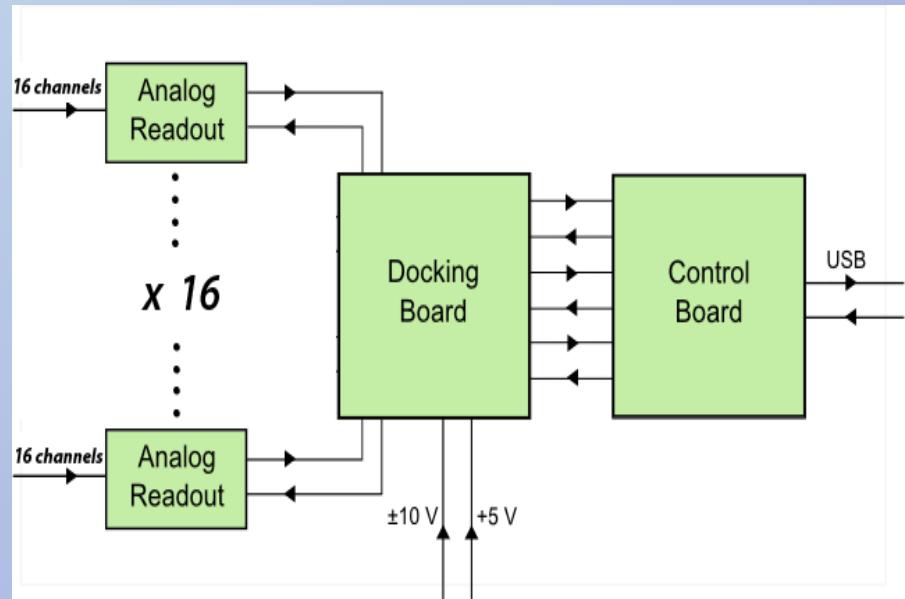
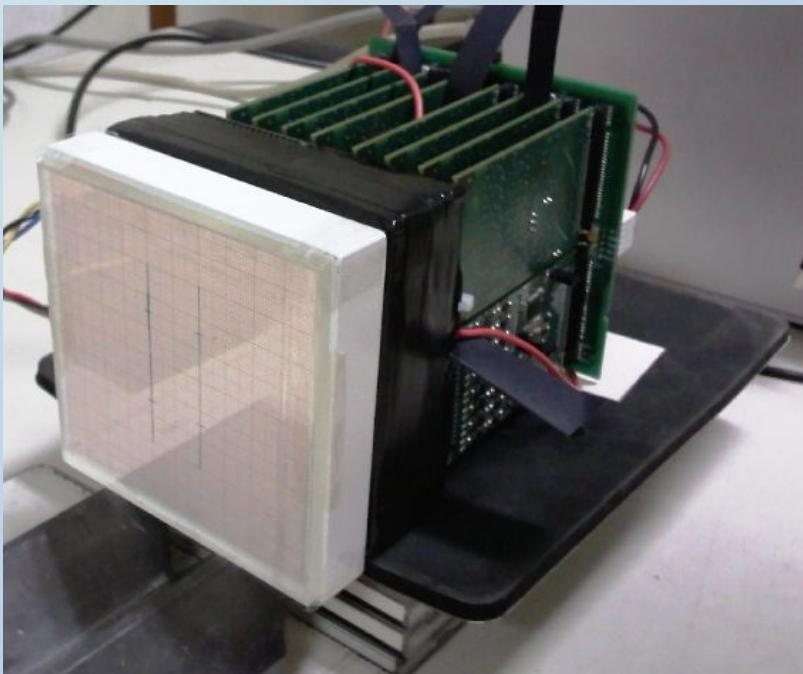
Divisione di Medical Imaging Physics:

- 12 strutturati, 7 Post Doc, 19 Ph.D student
- Collaborazioni con Siemens e Thosiba
- Software in licenza su macchine TAC General Electrics

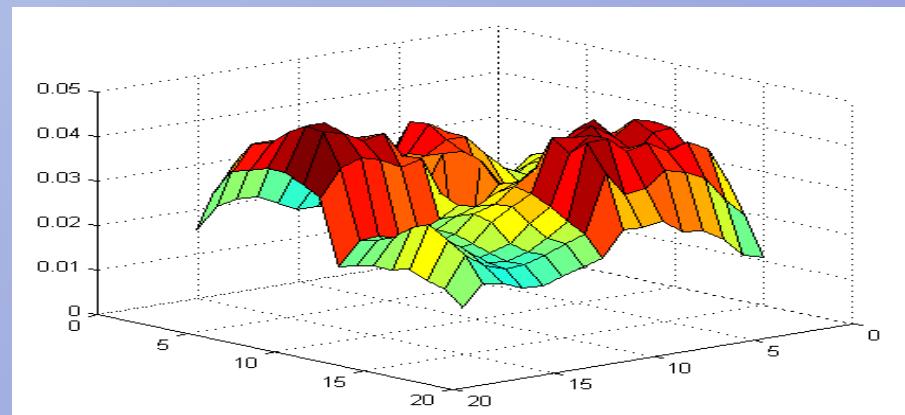
Scintillation camera principle



10 cm x 10 cm Field of View Camera

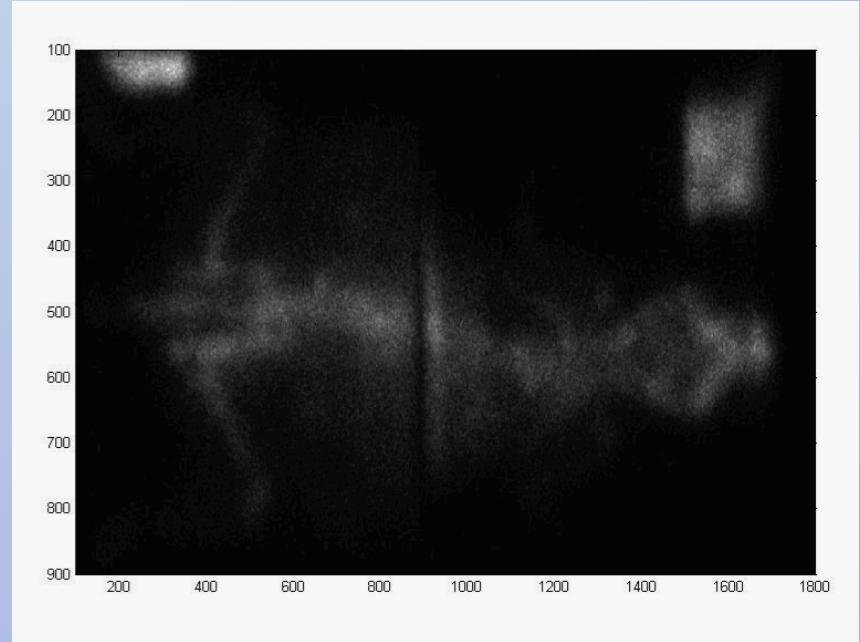


- 256 low noise front-end
- 14 bit ADC resolution
- Less than 1pC injected charge
- 100MHz FPGA clock frequency
- 250 kHz/s sampling rate
- USB 2.0 PC connection

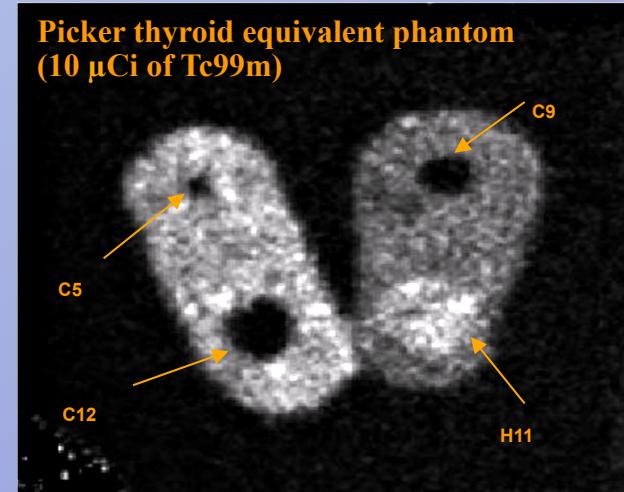
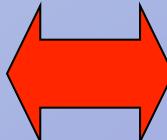
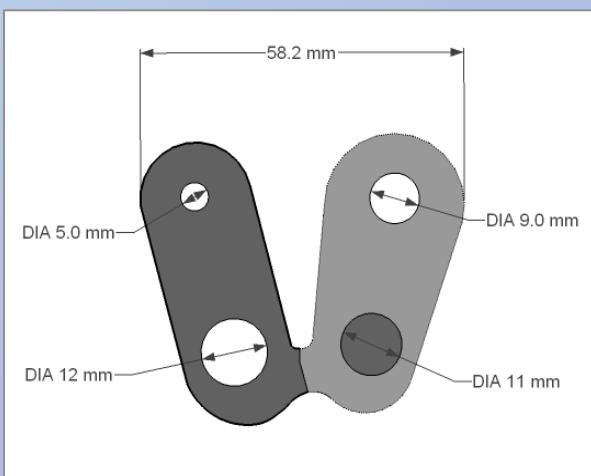


Immagini 2D

*Camera 5 cm x 5 cm
(due immagini affiancate)*

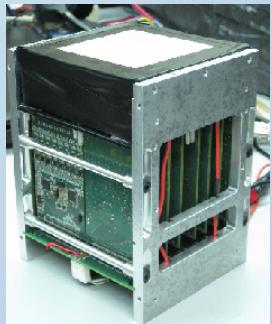


*Camera 10 cm x 10 cm
fantoccio tiroideo (Picker phantom)*



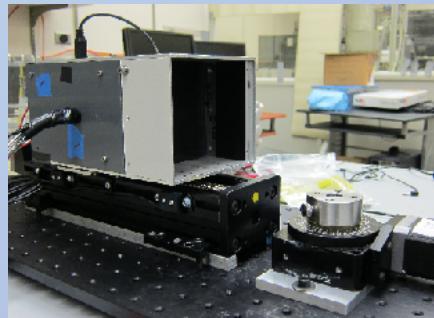
Misure Preliminari al JHM

Planar Gamma Camera

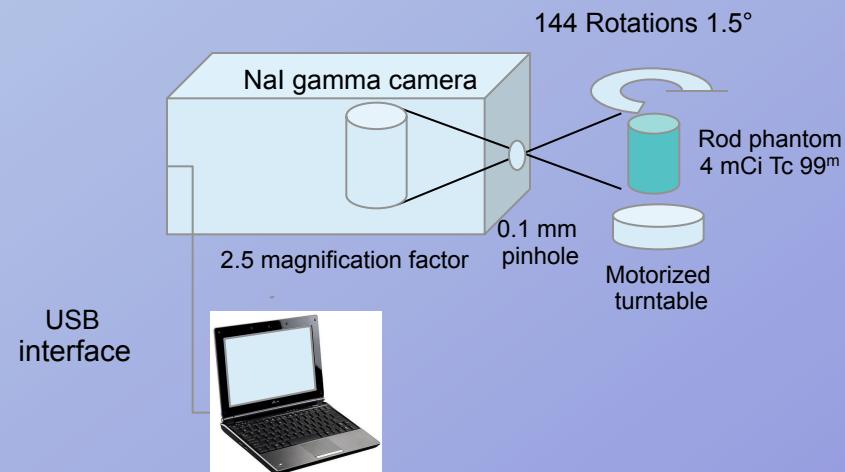
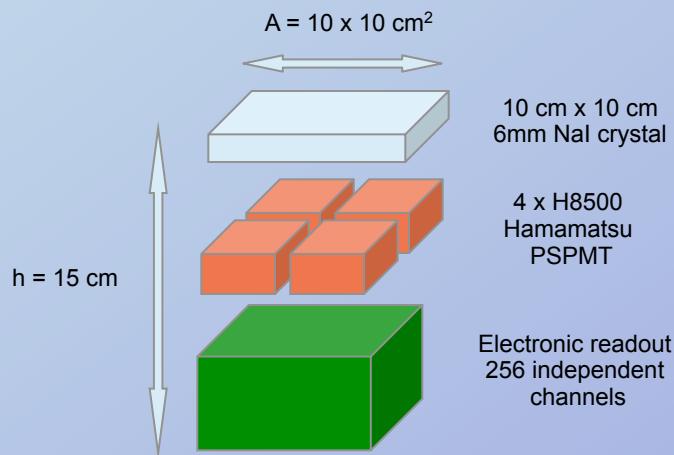


The gamma camera is composed by a 10 cm by 10 cm scintillation crystal, coupled to 4 H8500 PSPMT and the electronic readout. The intrinsic resolution is 1.0 mm over the 95% of the camera FoV

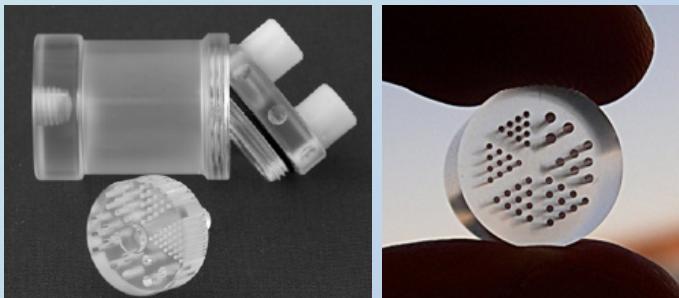
SPECT Measurement Setup



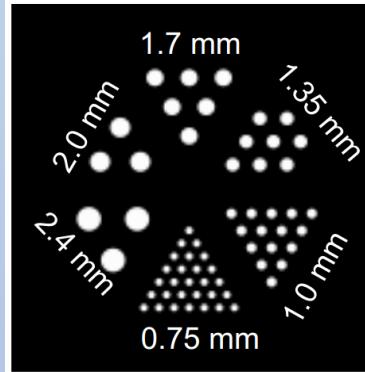
A rod phantom, filled with 4 mCi of Tc99 was put in front to the gamma camera, 22 planar images were taken, rotating the phantom 1.5° at every step. The camera was equipped with a 0.1 mm pinhole, and the distance between the pinhole and the rotation axis was 10 cm. The magnification factor is 2.5



Misure Preliminari al JHM



Rod Phantom

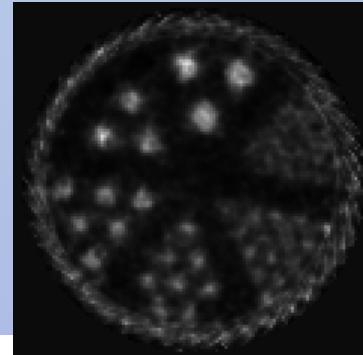


Rod dimension

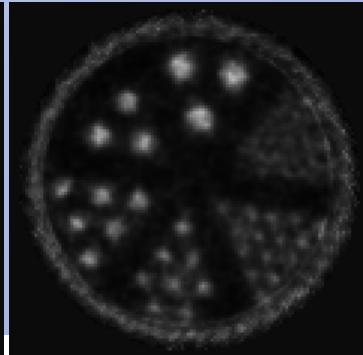
Preliminary phantom studies with 4 mCi of Tc99m in a ultra micro hot rod phantom.

A single pinhole ML-EM algorithm shows very good results on the reconstructed volume, without any artifacts.

48 views



72 views



144 views

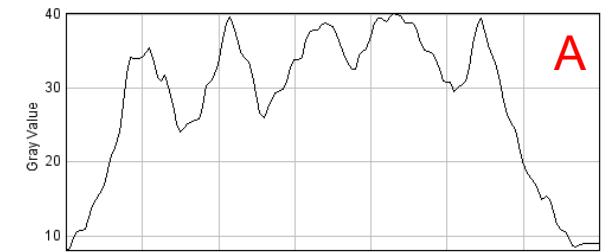
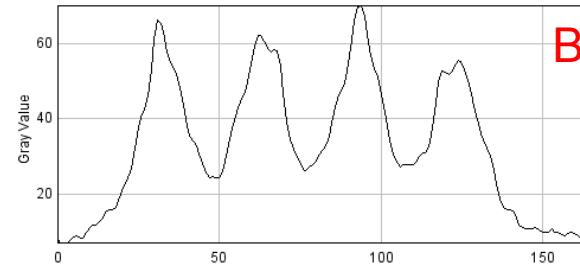
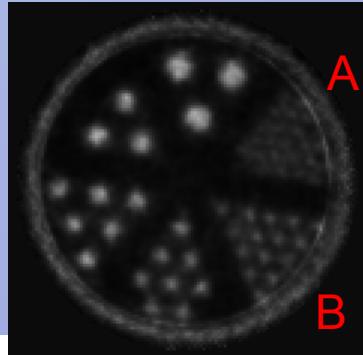


Image profiles over 1 mm rods (left) and 0.75 mm rods (right)

Nuovo apparato SPECT

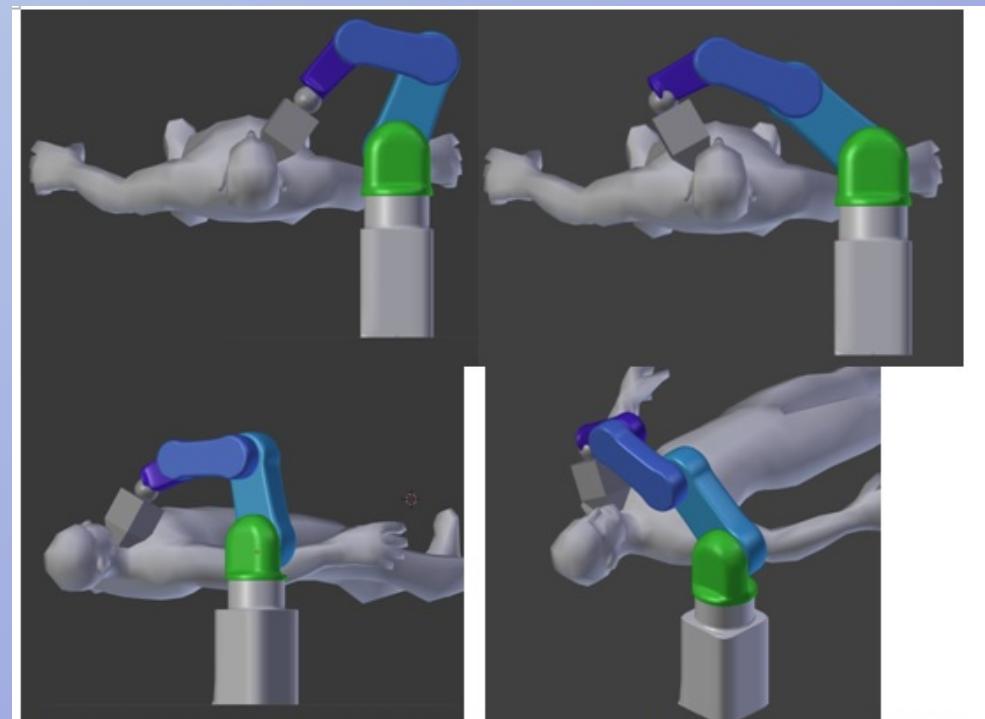
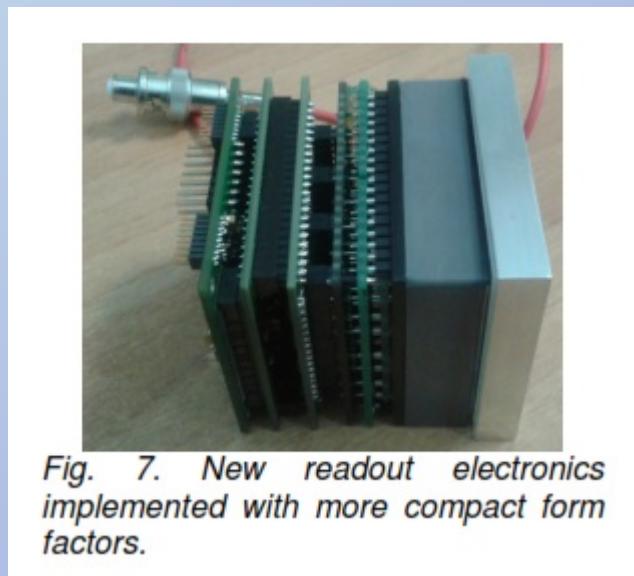
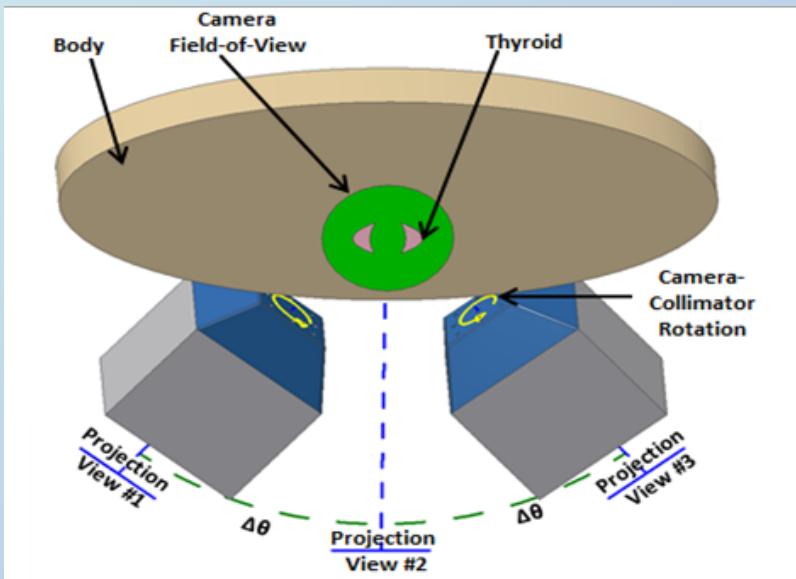
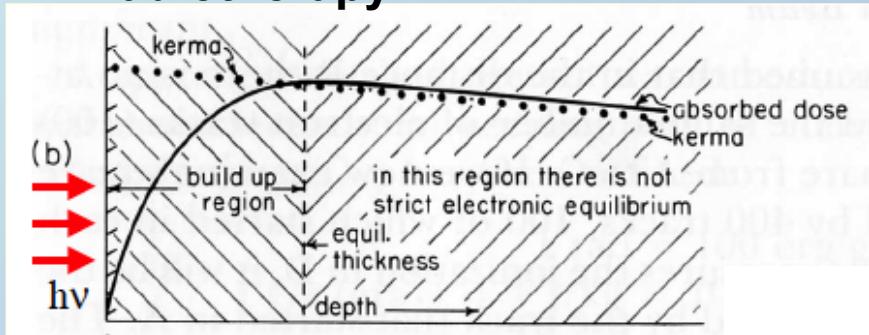


Fig. 8. Example of camera positions around the neck of a patient for a thyroid gland imaging.

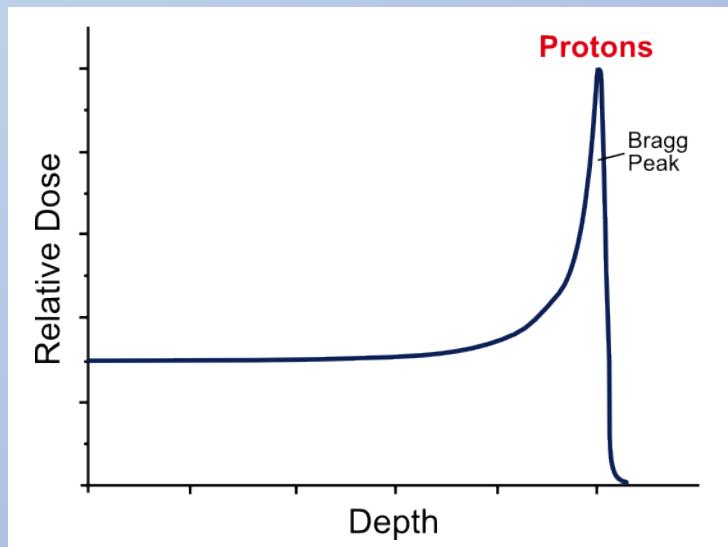
*Attività monitoraggio fasci
radioterapici*

Dose measurements for radiotherapy and adrotherapy

Radiotherapy



Adrotherapy



Linac al Policlinico Tor Vergata

Dose measurements for radiotherapy and adrotherapy

Modern radiotherapy techniques can deliver very collimated beams ($1 \times 1 \text{ cm}^2$ or smaller) and complex beam shape with the presence of high dose gradients (IMRT).

Ionization Chambers

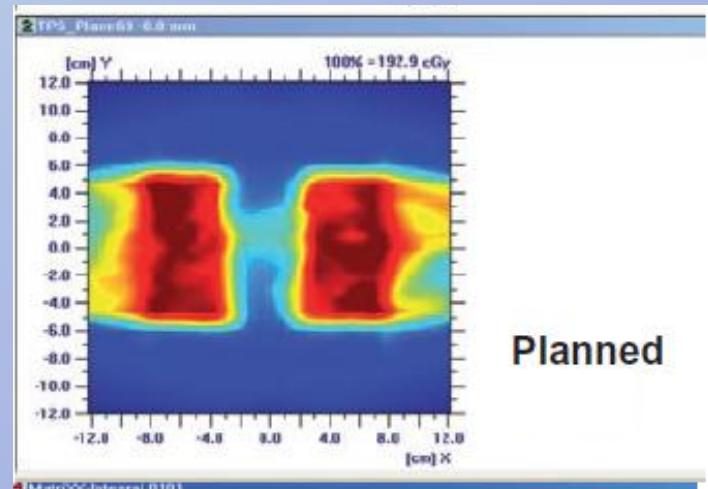
- Low sensitivity per unit volume
- Polarization effects when reducing the size

Silicon diodes

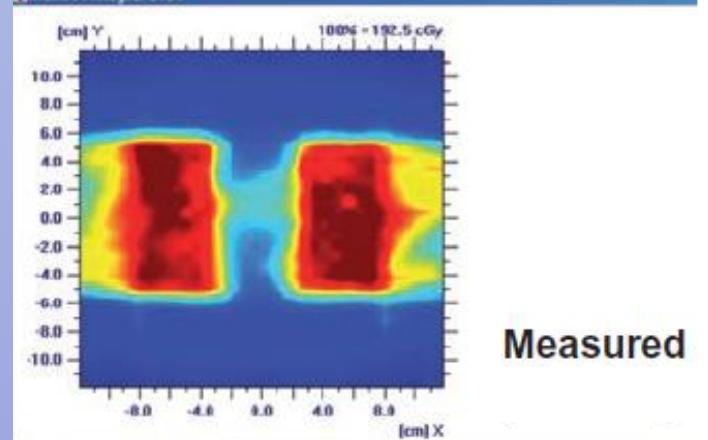
- Not "tissue equivalent"
- High energy dependence
- Not radiation hard

Diamond

- Tissue equivalent
- High sensitivity per unit volume
- Radiation hardness
- Low temperature dependence
- Photovoltaic regime operation



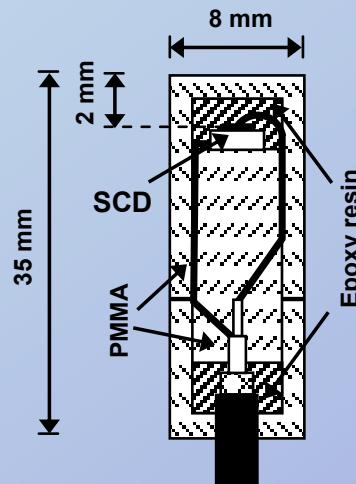
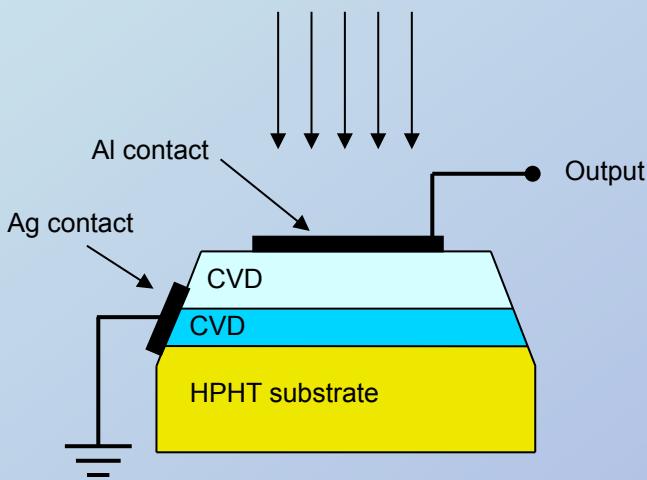
Planned



Measured

Single Crystal Synthetic Diamond Dosimeter

Electrons, Photons, Protons



microDiamond
Type 60019

Diamond Detector for dosimetry in high-energy photon and electron beams, especially useful for small field dosimetry

Materials and measures:
Entrance window 0.3 mm RW3
0.6 mm Epoxy
0.01 mm Al 99.5

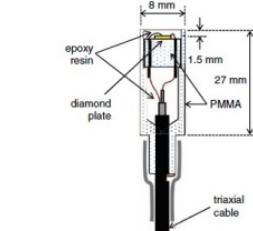
Total window area density 101 mg/cm²

Water-equivalent window thickness 1.0 mm

Sensitive volume radius 1.1 mm, circular, thickness 1 μm

Outer dimensions diameter 7 mm, length 45.5 mm

Useful ranges:
Radiation quality 100 keV ... 25 MV photons (6 ... 25) MeV electrons
Field size² (1 x 1) cm² ... (40 x 40) cm²
Temperature (10 ... 35) °C, (50 ... 95) °F
Humidity range (10 ... 80) %, max 20 g/m³



- ✓ **Single crystal diamond**
- ✓ **Volume: < 0.1 mm³**
- ✓ **Sens.: 1-8 nC/Gy**
- ✓ **V bias: 0 V**
- ✓ **Waterproof**

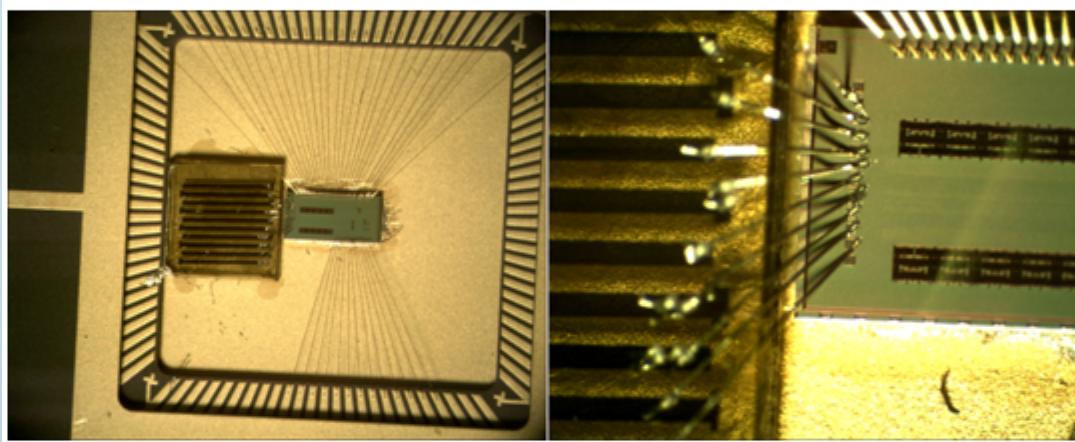


Brochure of Microdiamond: technical specification.

Many SCDDs are routinely fabricated at Industrial Engineering Department of "Tor Vergata" University in Rome

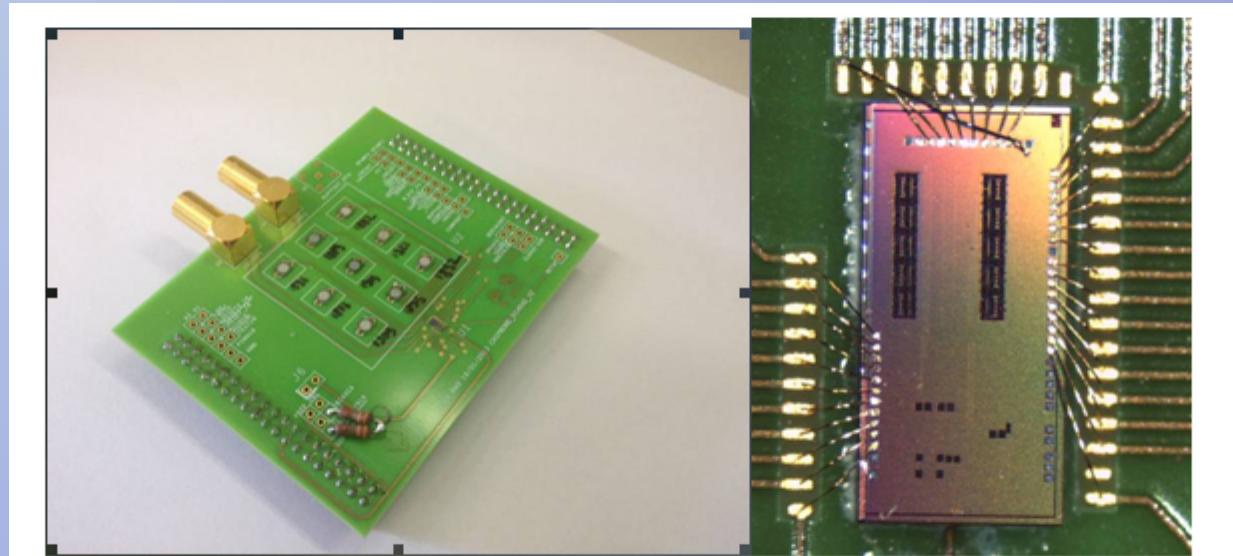
Longitudinal cross section of the encapsulated diamond detector

DIARAD_V2 – Integrated multi channel readout electronic

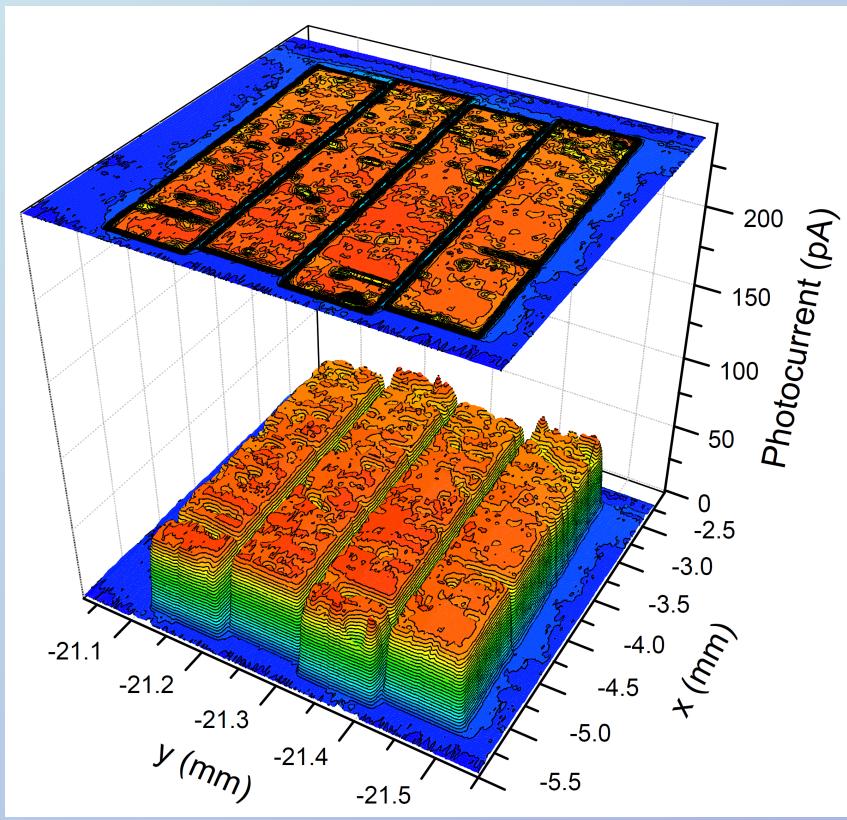


*Single Diamond
Dosimeter with
multichannel contact
strips*

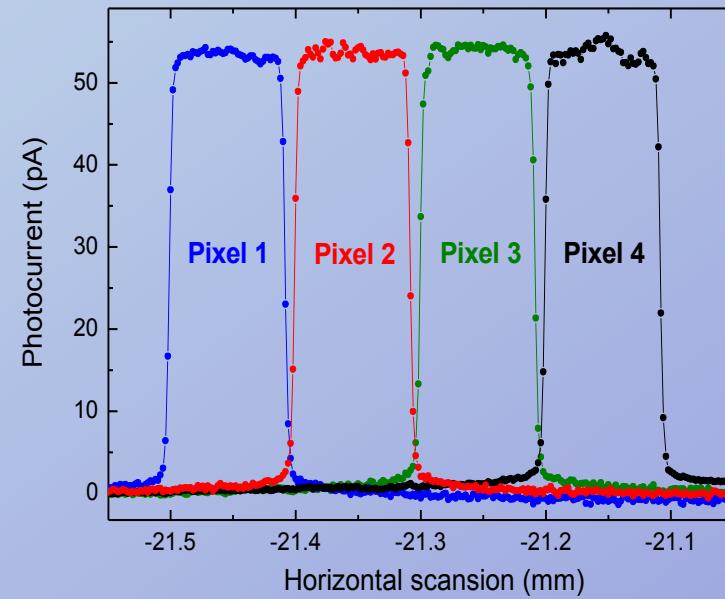
*9 diamond
dosimeter
system*



Tests at DLS – focused beam

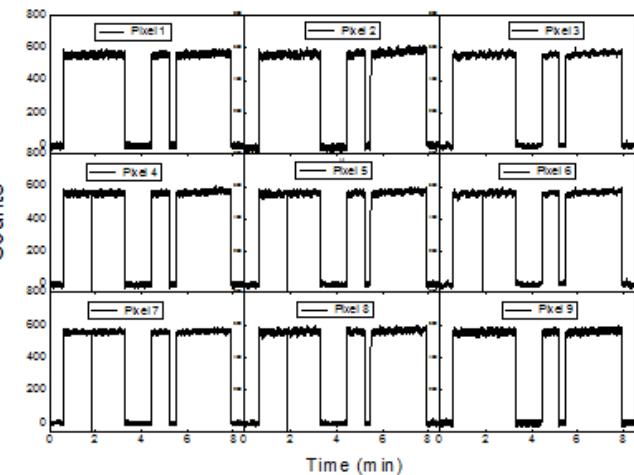


3D map and contour plot of the device response measured by a raster scan of four pixels with the 10 keV micro-focused XR beam.

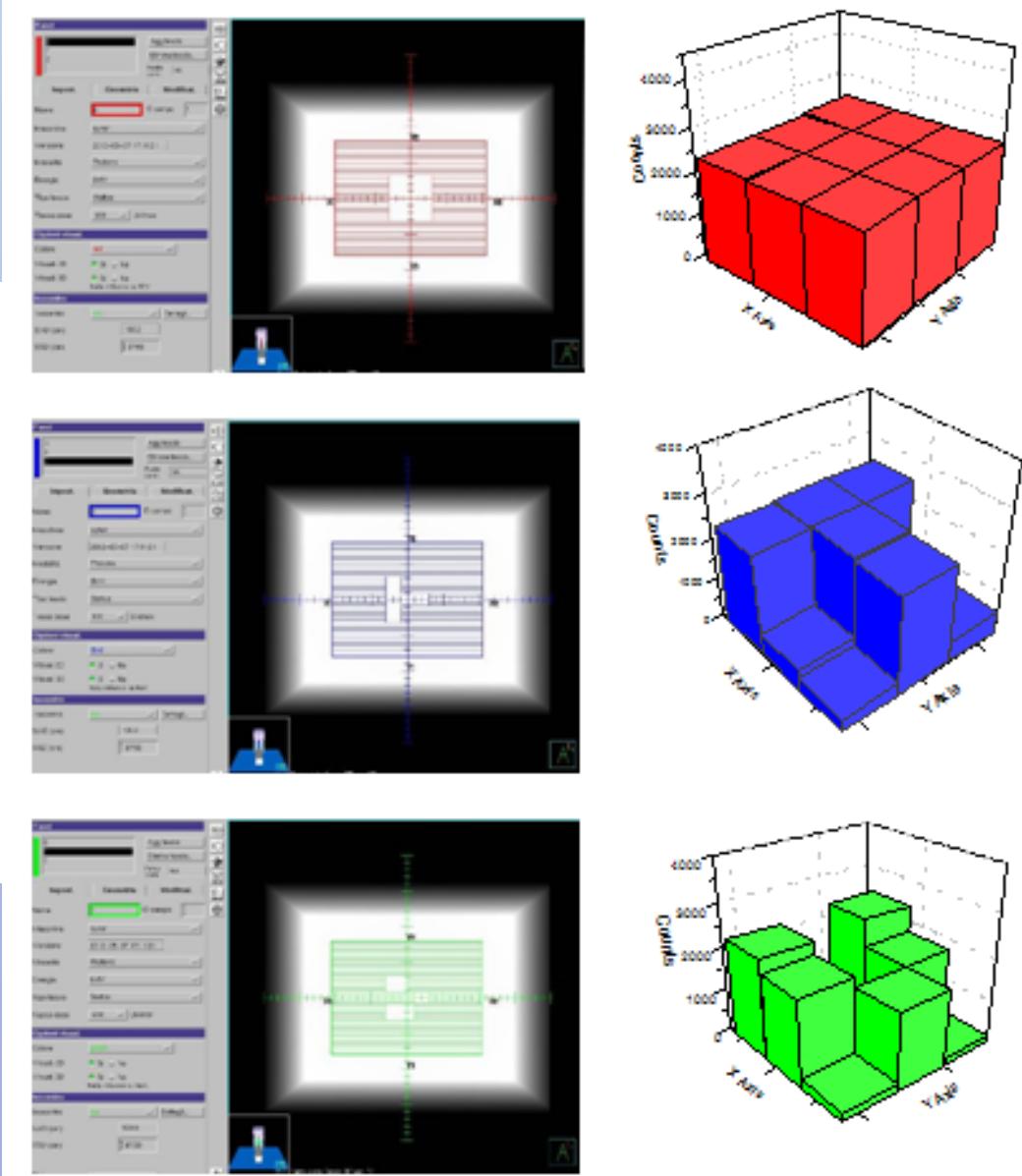


- **1% variation in the pixel to pixel mean signal**
- **6% average signal fluctuation along each strip**
- **No overlapping between pixel current and a high discrimination between adjacent strips**
- **Sensitive region extending approximately 4.3 μ m out of the contact (size of the microfocused beam 2.6 μ m).**

Tests at Radiotherapeutic Policlinico Tor Vergata



signals from each diamond during photon irradiation



- **Prossime Attività:**

- Realizzazione nuova generazione testa scintigrafica per SPECT
- Pianificazione misure pre cliniche presso JHM con testa scintigrafica esistente
- Pianificazione misure su fasci terapici presso JHM
- Valutazione utilizzo dosimetri in diamante per misura dose nelle TAC

- **Prospettive:**

- 1 contratto tecnologo INFN su fondi convenzione
- Soggiorni di studio presso JHM per dottorati e post-doc (fondi?)
- Progetti Europei, GRANT Americani ...

E' in corso una richiesta di finanziamento alla Fondazione Roma per il proseguo del progetto DIARAD, nel budget sono previsti 3 contratti RTD e 2 assegni di ricerca triennali