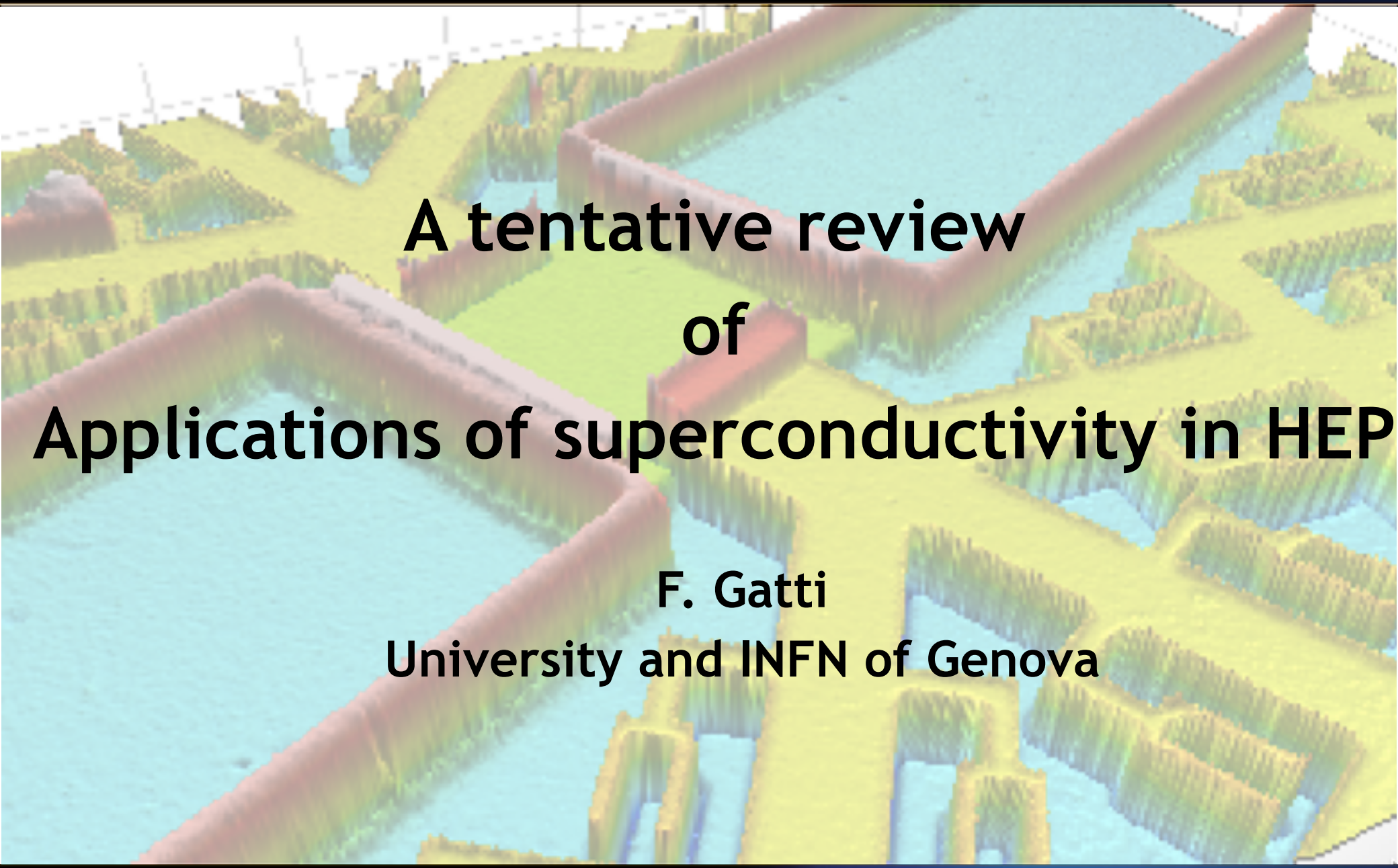


A tentative review of Applications of superconductivity in HEP

F. Gatti
University and INFN of Genova

Two topics:

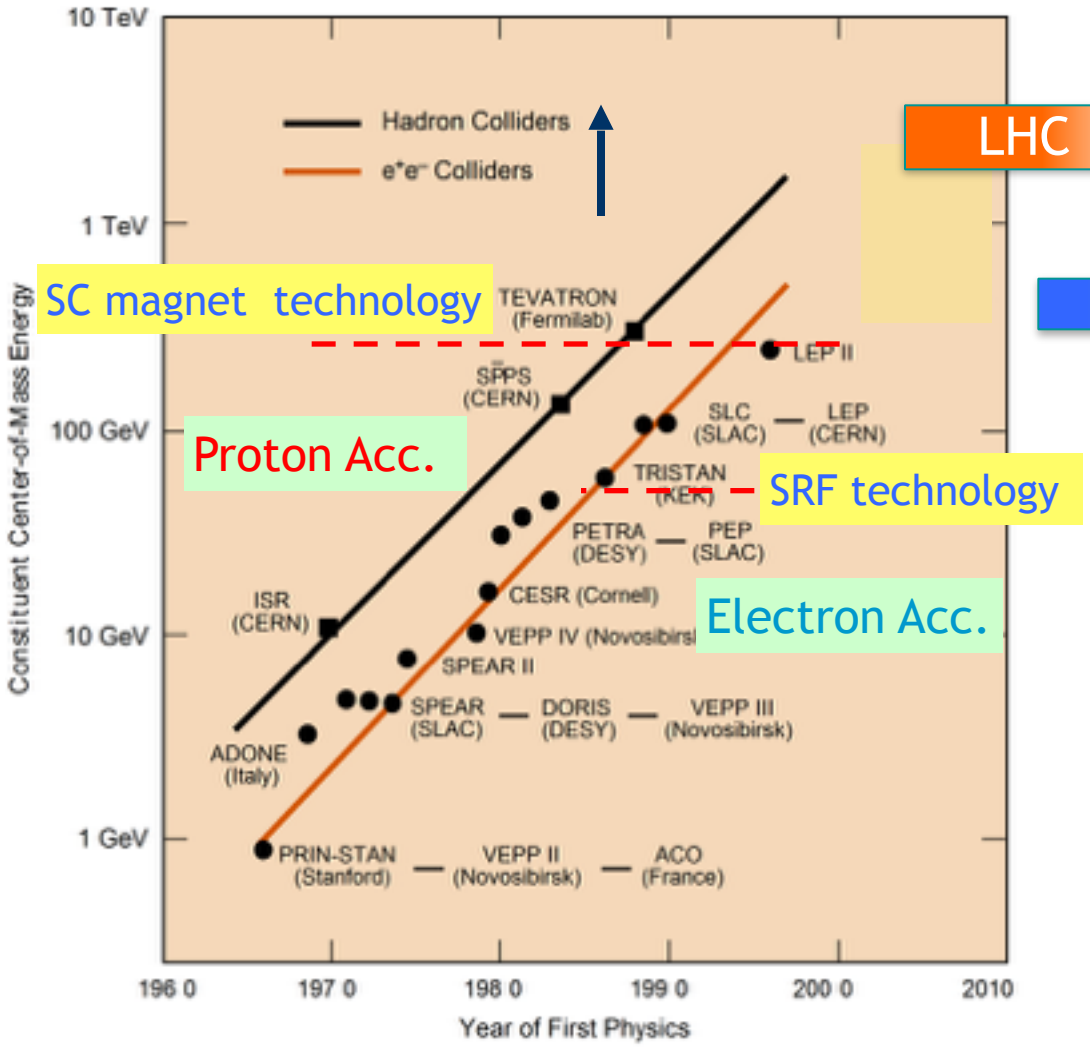
High Power, High Scale, Large Facility

Cables,Magnets,Cavities,Sup.Acc.

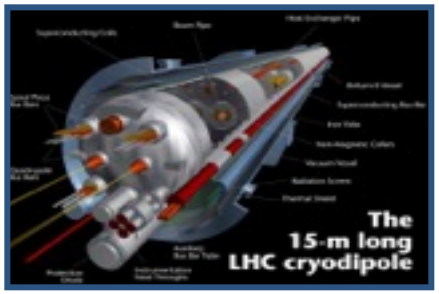
nano-power, micro-scale, room-size facility

Nano-wire, KIDs, bolometers,SSPD,TES

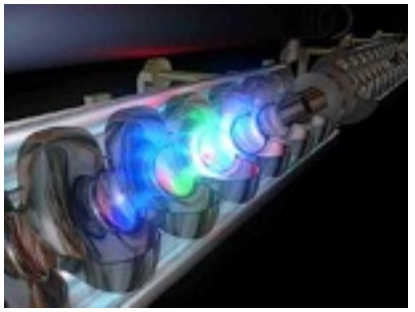
Superconductivity is mandatory in HE Accelerator



LHC



ILC



A.Yamamoto

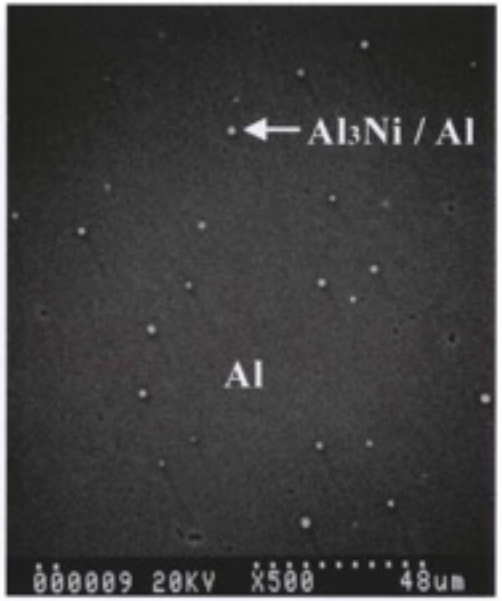
ATLAS Approach

Al-stabilizer using

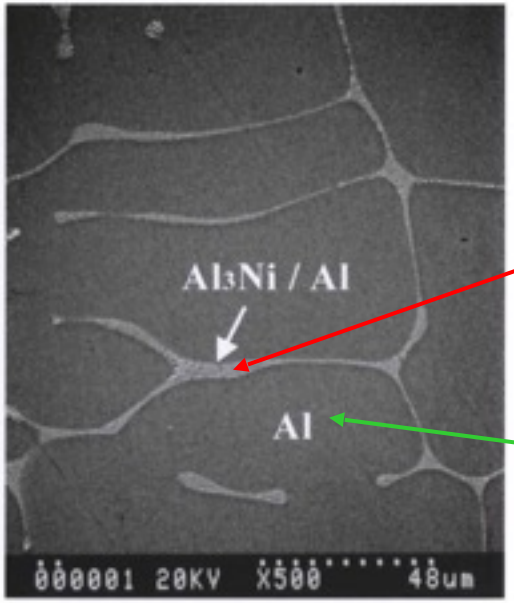
Micro-alloying and precipitation

A.Yamamoto

Ni>> High



a) Al-0.1wt%Ni Alloy



b) Al-0.5wt%Ni Alloy

Al_3Ni precipitated
Contributes as structural component

Pure-Al region
Keep low resistivity

Magnet “without coil”

A.Yamamoto

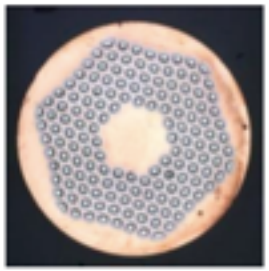
0.2%

0.34%

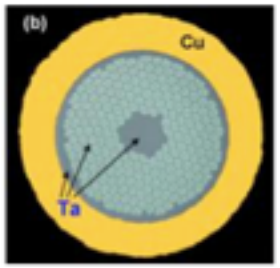
Nb_3Sn points to higher fields

E. Z. Barzi

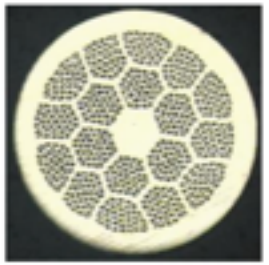
Strands



Nb_3Sn

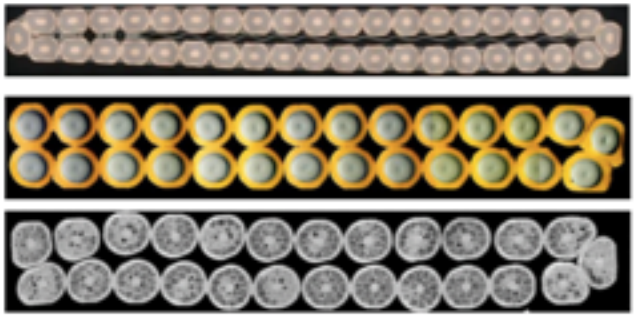


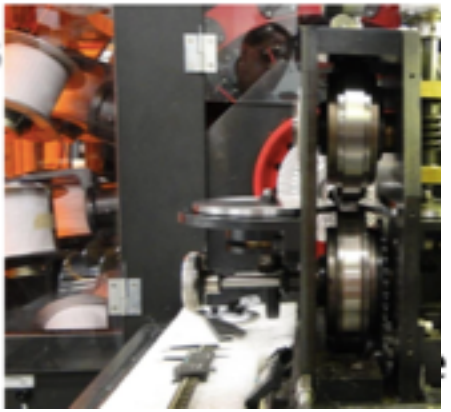
Nb_3Al

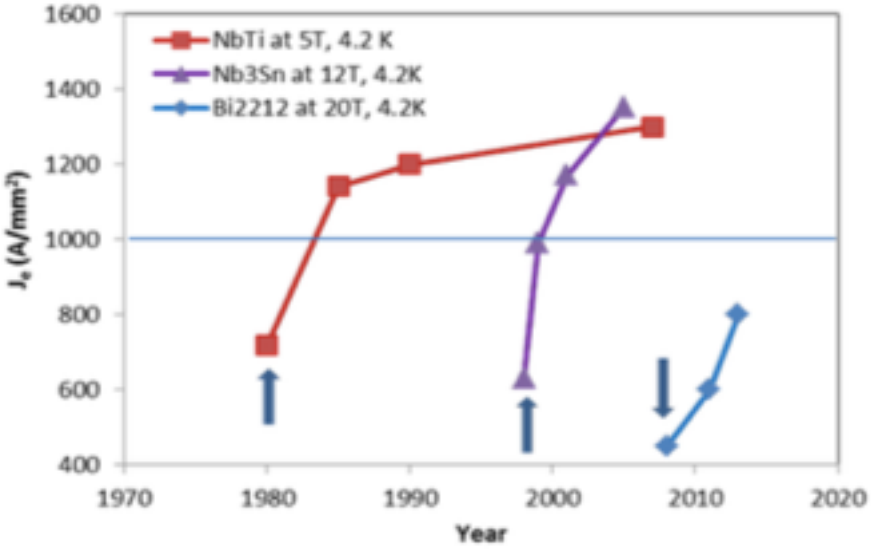


Bi-2212

Rutherford-type Cables



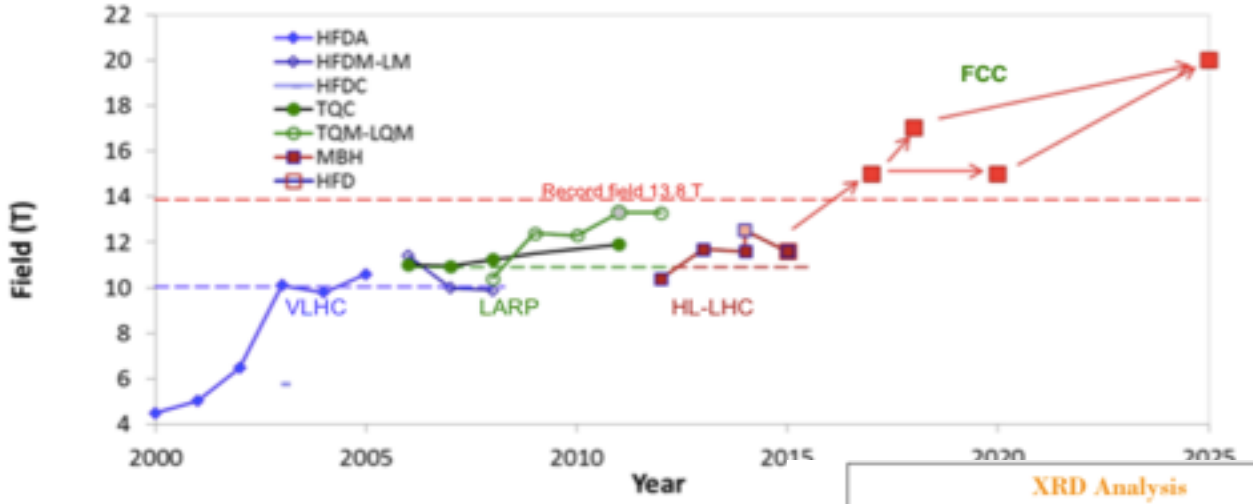


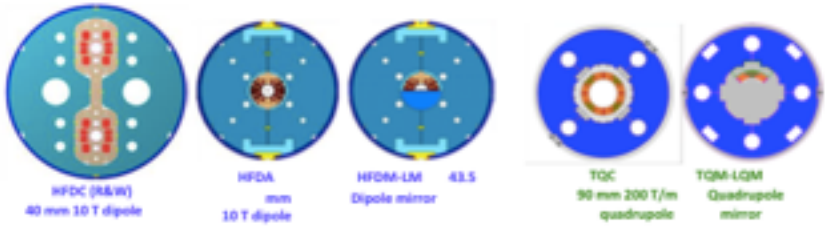


Towards 17 T dipole

Magnet R&D Summary and Plans

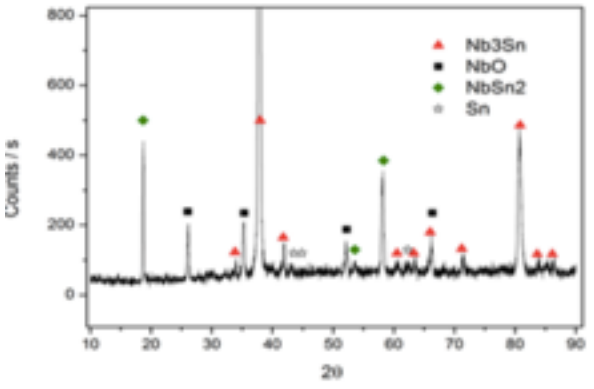
E. Z. Barzi





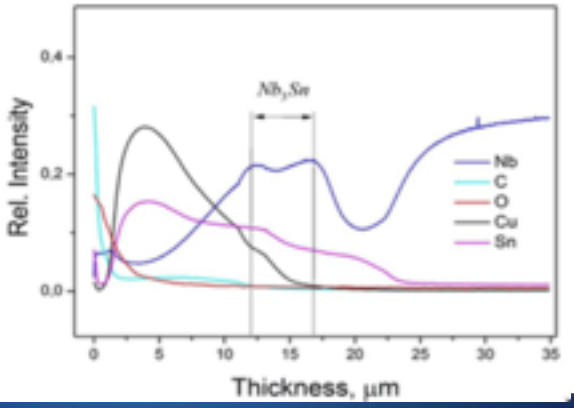
XRD Analysis

- **Superconductive Nb_3Sn**
- Non superconductive **$NbSn_2$**
- Niobium **oxides** are present on the surface



GDOES Analysis

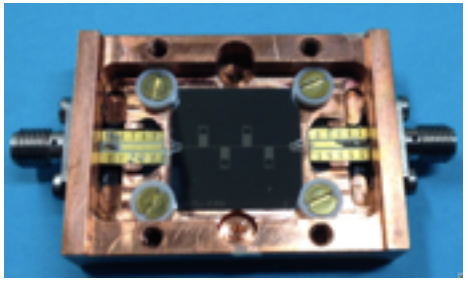
- Sn and Nb **overlapping** is observed, Nb_3Sn phase thickness: ≈ **5 µm**
- **Oxygen** detected close to the surface.



The superconducting detector technologies in this session

- Kinetic Inductance Device (KID)

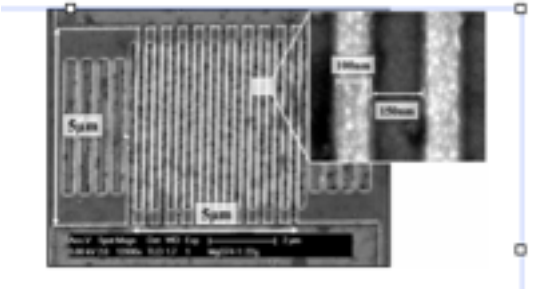
CALDER: Cryogenic light detectors for neutrino and dark matter searches
Speaker: Marco Vignati (ROMA1)



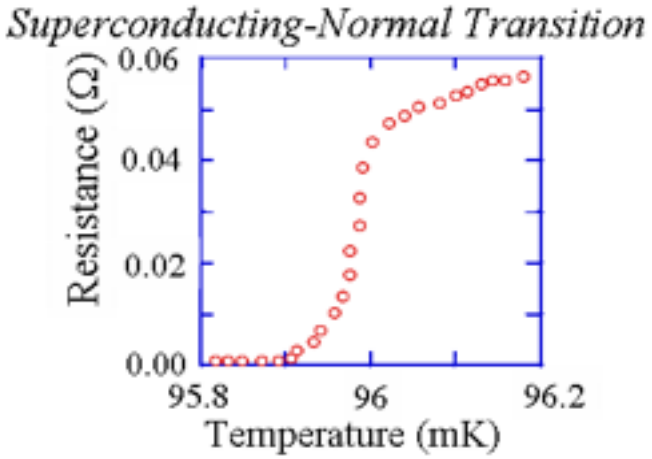
Superconducting Kinetic Inductance Detectors for kilopixel intruments at Radiotelescopes
Speaker:
Dr. Martino Calvo (Institut Néel, CNRS Grenoble)

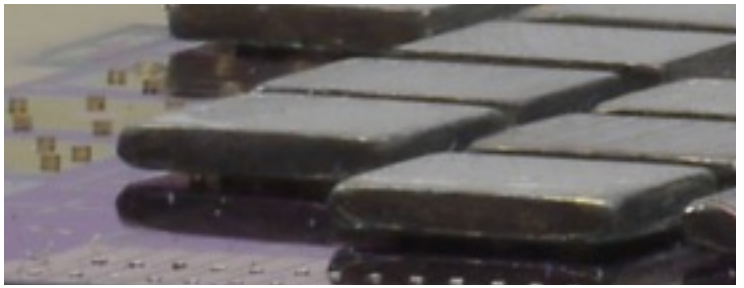
- SSNPD

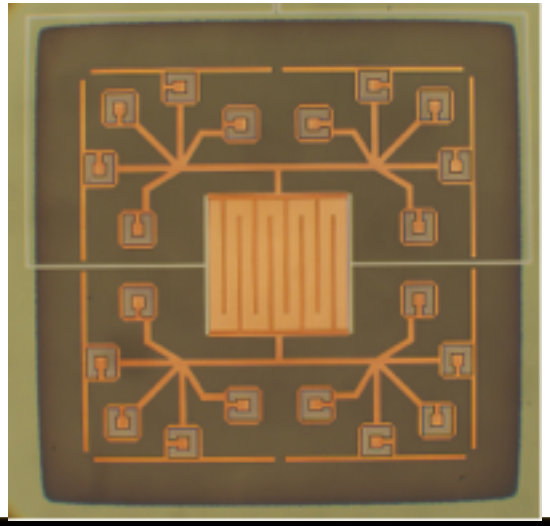
Superconducting Nanowires Detecting Single Photons for Integrated Quantum Photonics
Speaker:
Dr. Roberto Leoni

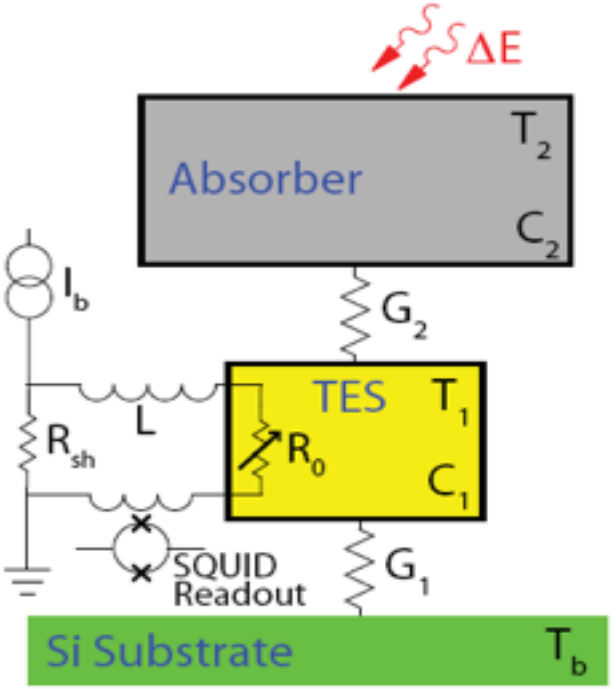


What about TES (transition edge sensors)? A technology at the edge of maturity.

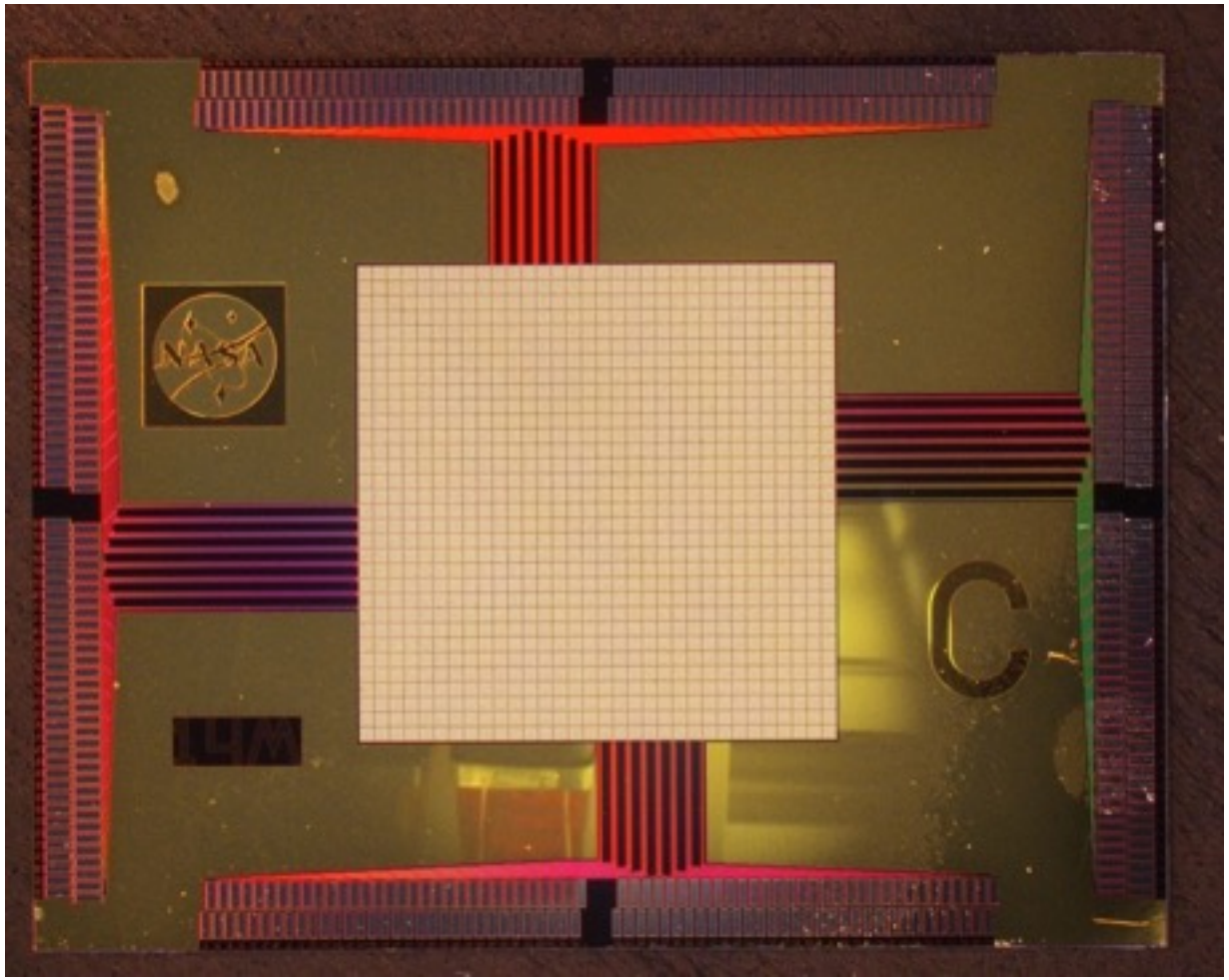


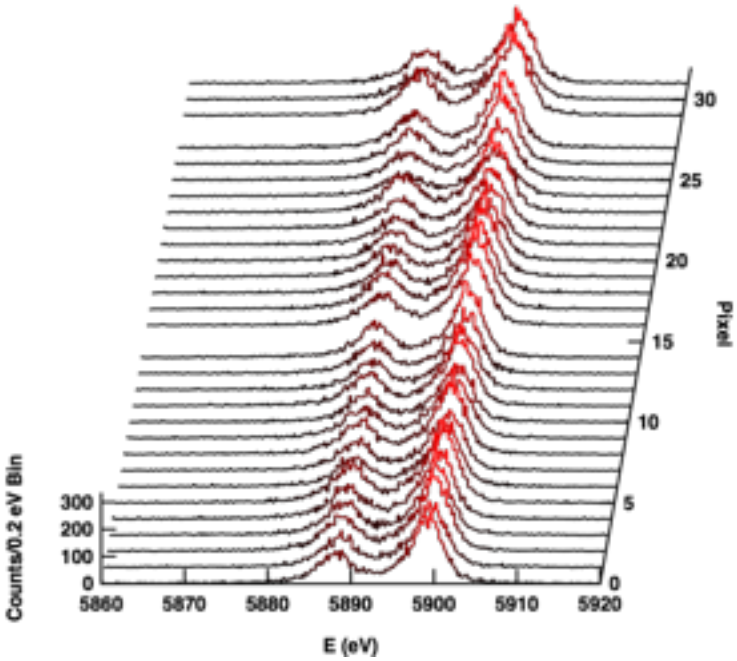




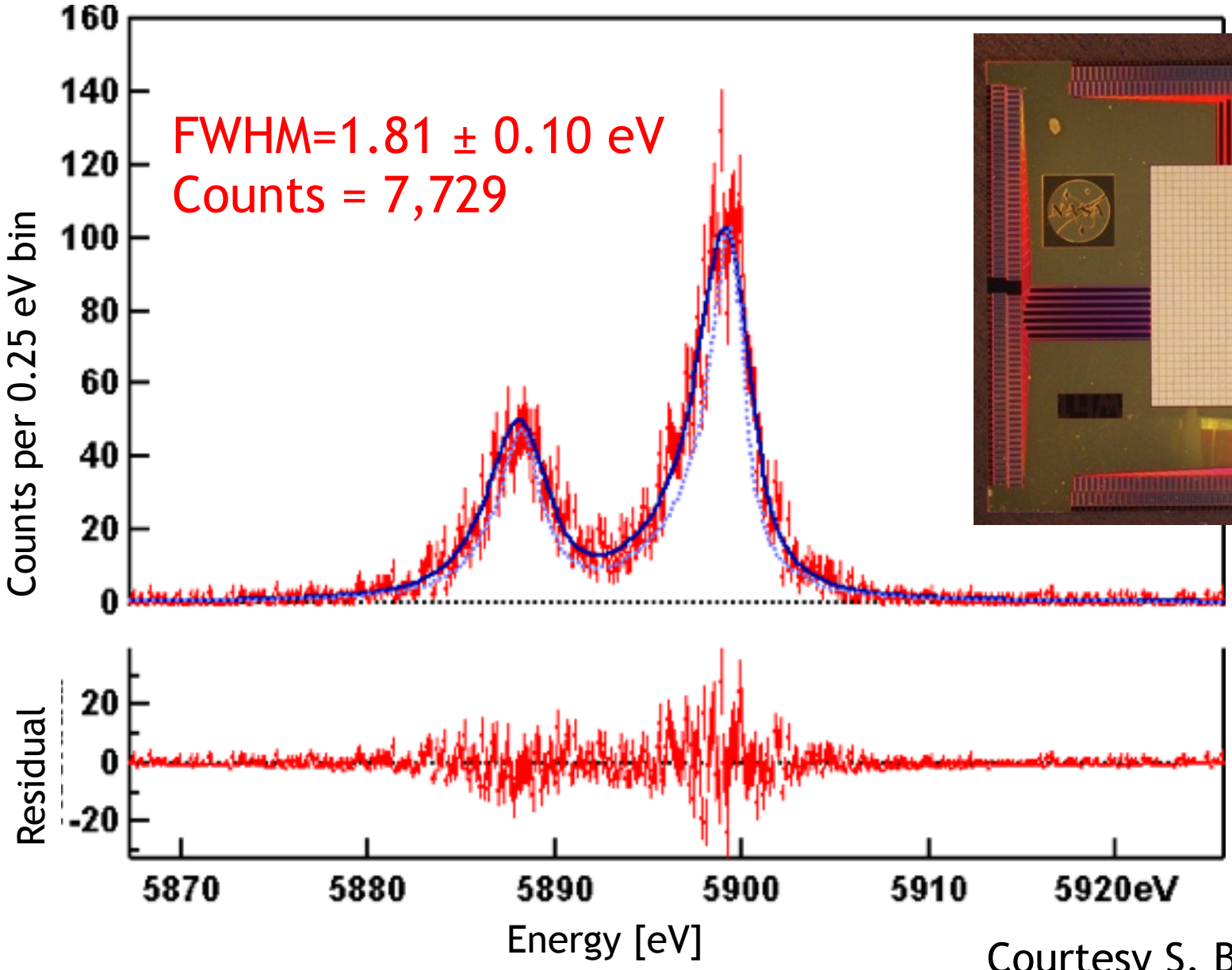


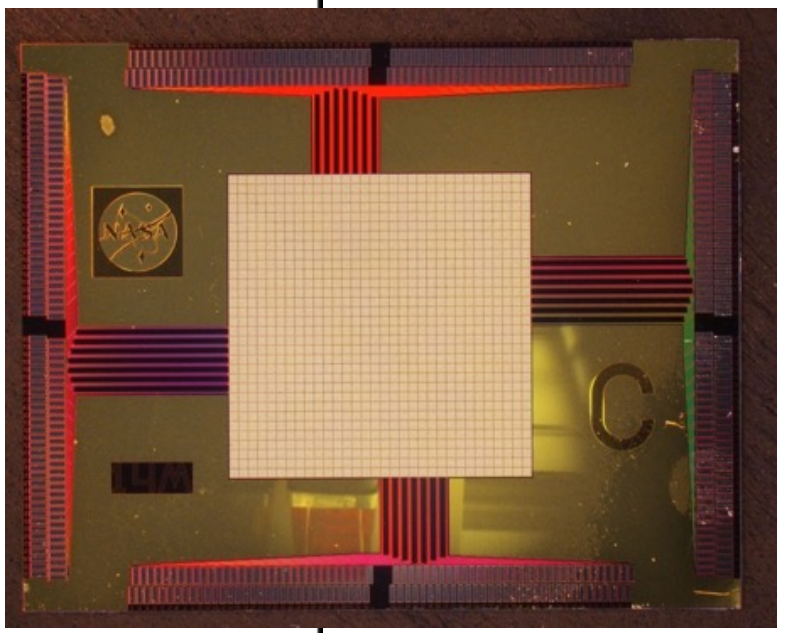
1K-pixels TES array for EDXS



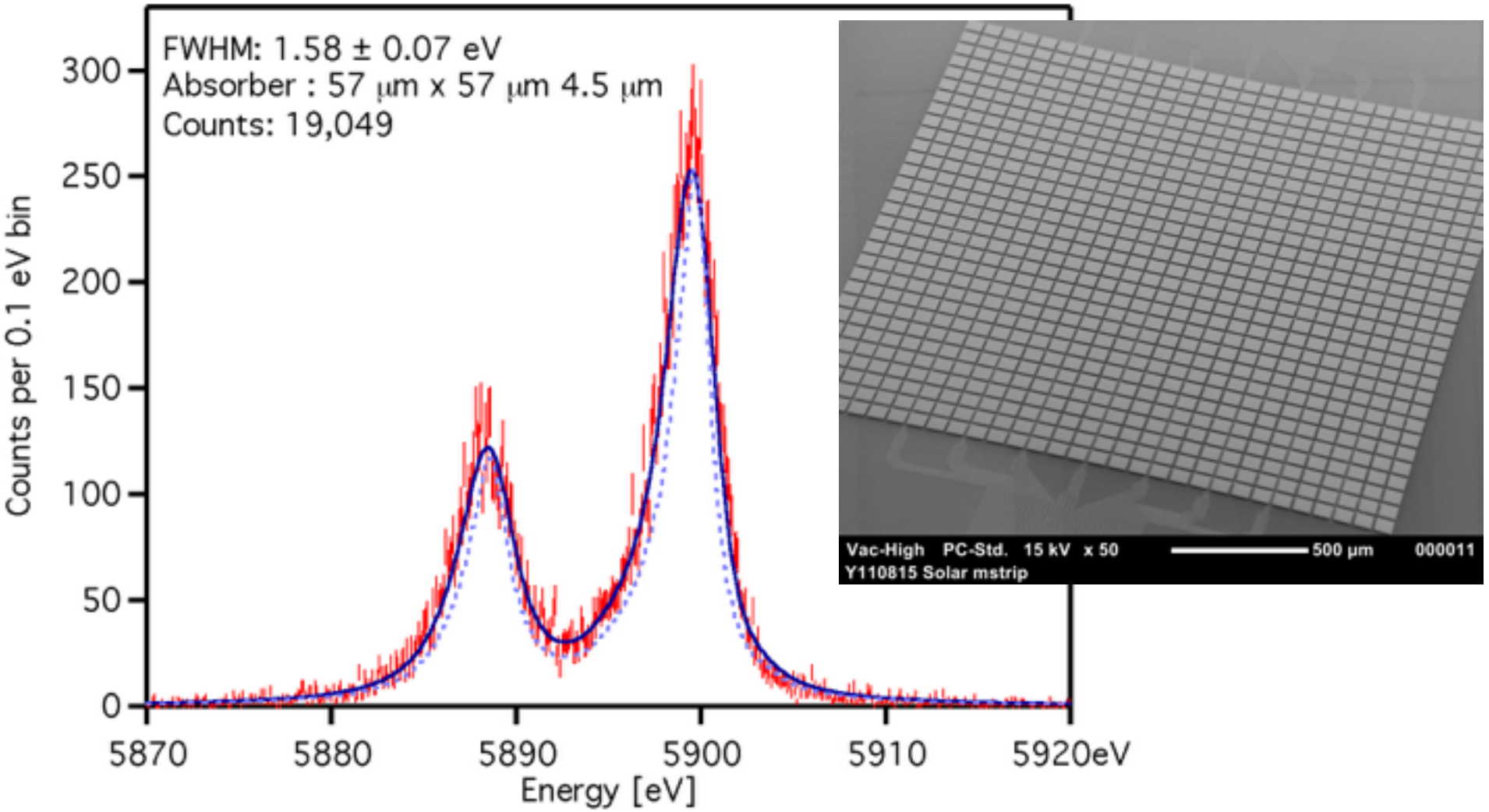


Courtesy S. Bandler - GSFC-NASA





Courtesy S. Bandler - GSFC-NASA



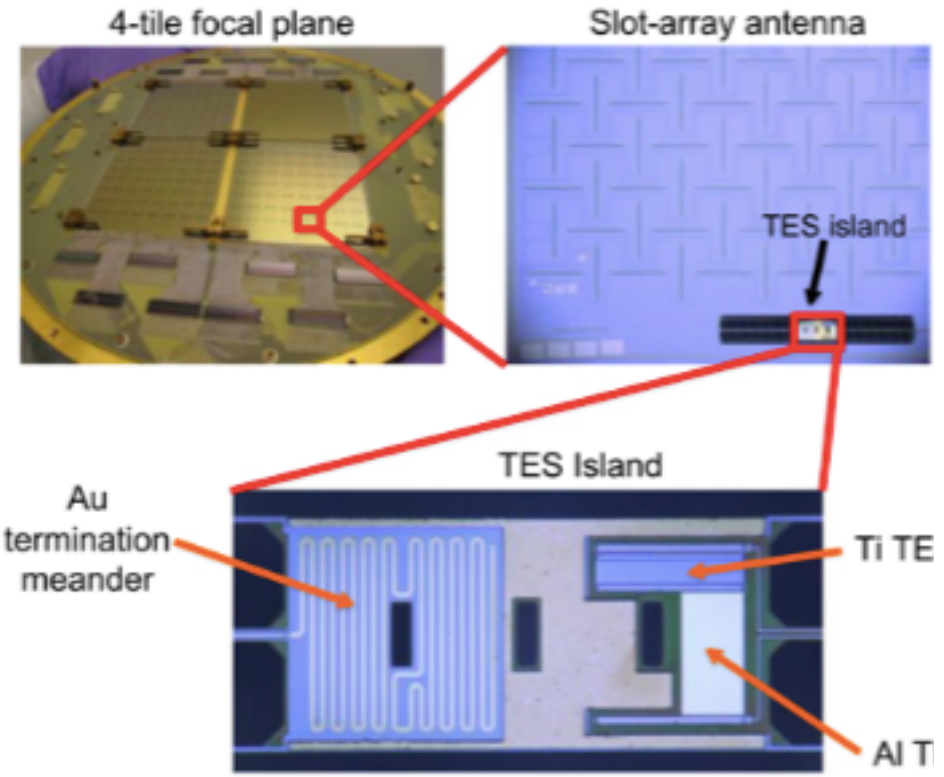
- Best energy resolution detecting 6 keV x-rays (non-dispersive detector)
- Decay time – 200 μs

Courtesy S. Bandler - GSFC-NASA

The most sensitive μwave TES bolometer

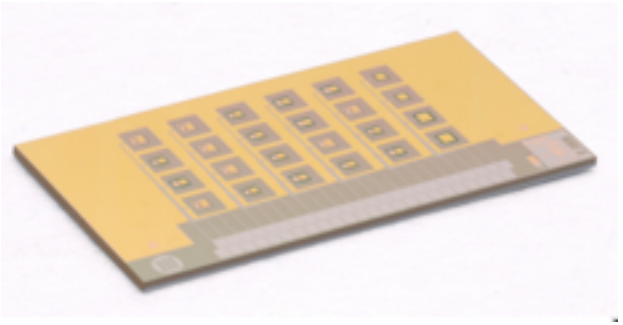
BICEP2-Keck-Array

TES-antenna coupled bolometer

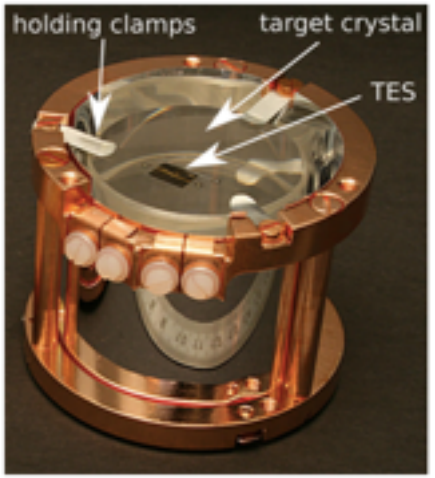


In this tech.framework

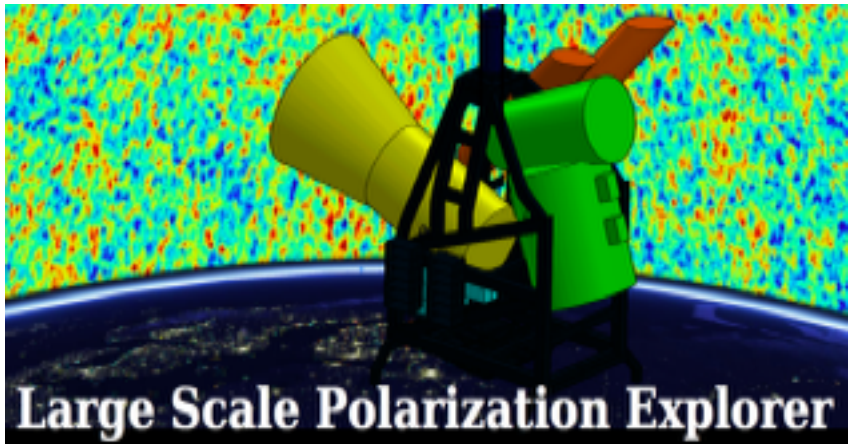
- HOLMES neutrino mass direct search with TES micro-calorimeter arrays (INFN-ERC)

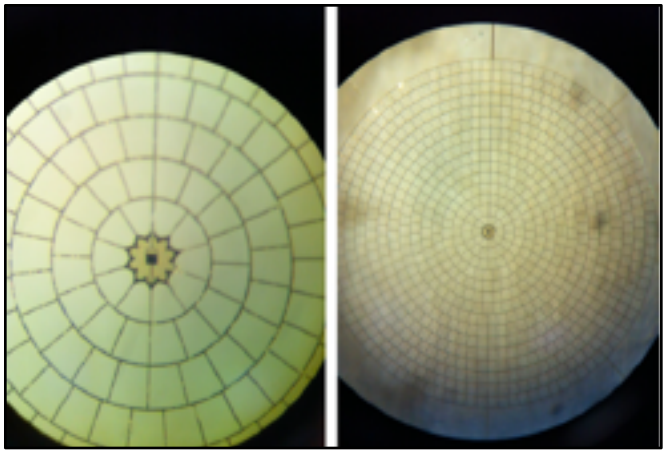


- CRESST for DM direct search

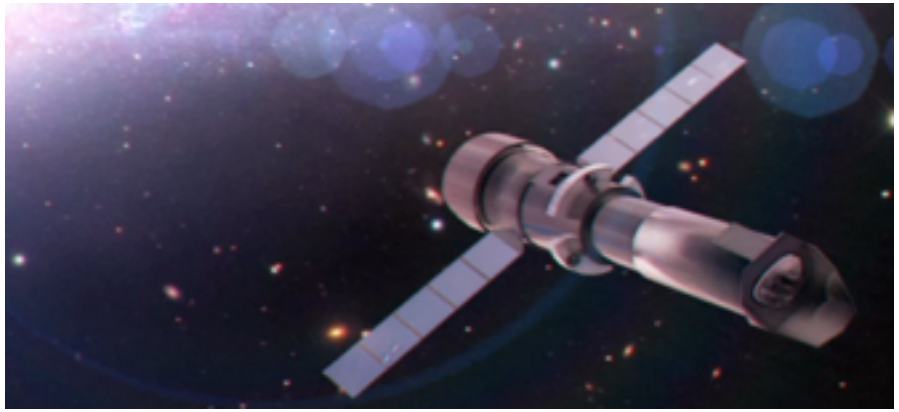


- LSPE (large scale polarisation explorer) ballon borne CMB Telescope

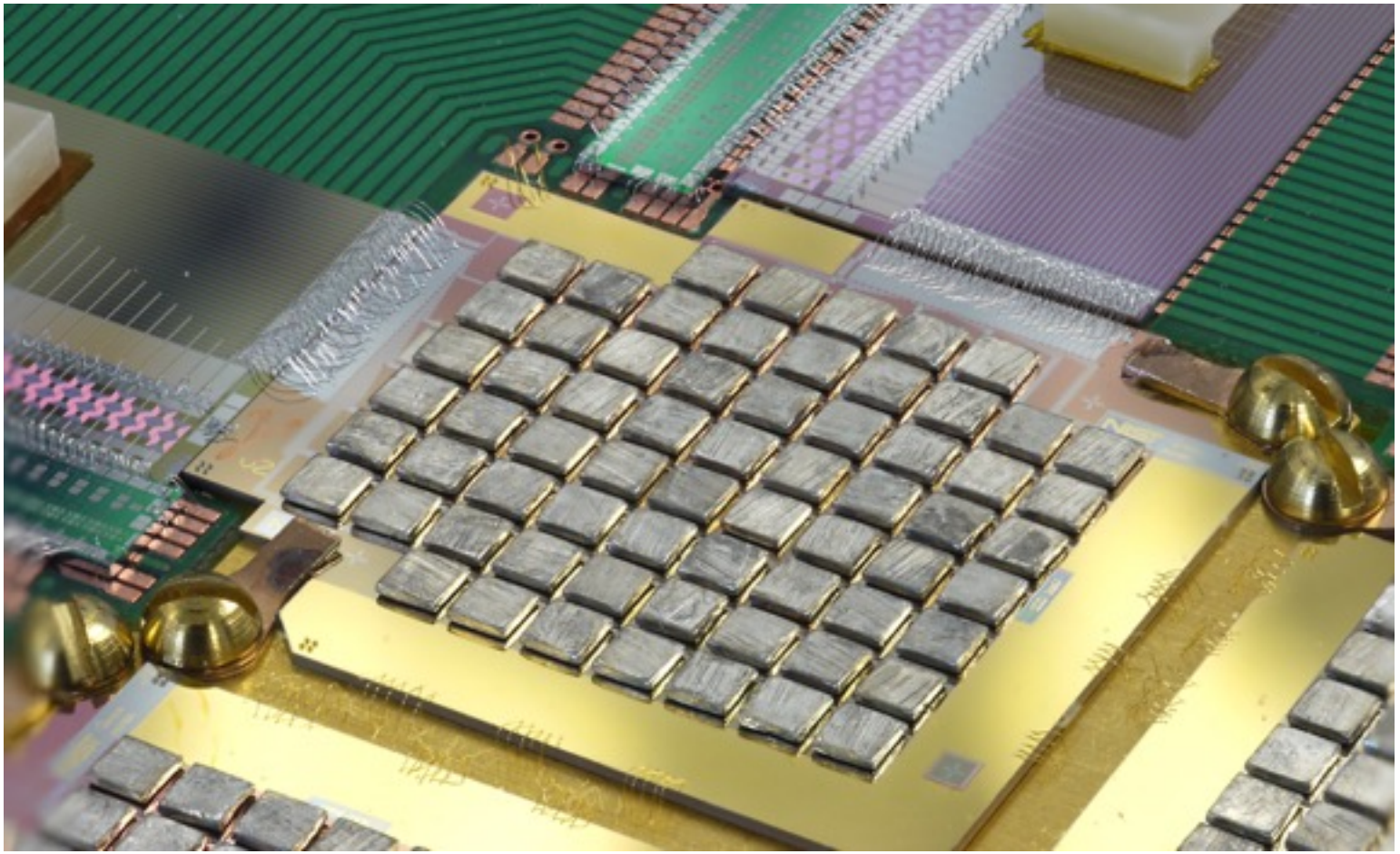




- ATHENA (ESA-ASI-INAF-Uni Genova) x-Ray observatory that will host the largest TES array working at 50 mK in L2 orbit (See talk of Luciano Gottardi Friday)

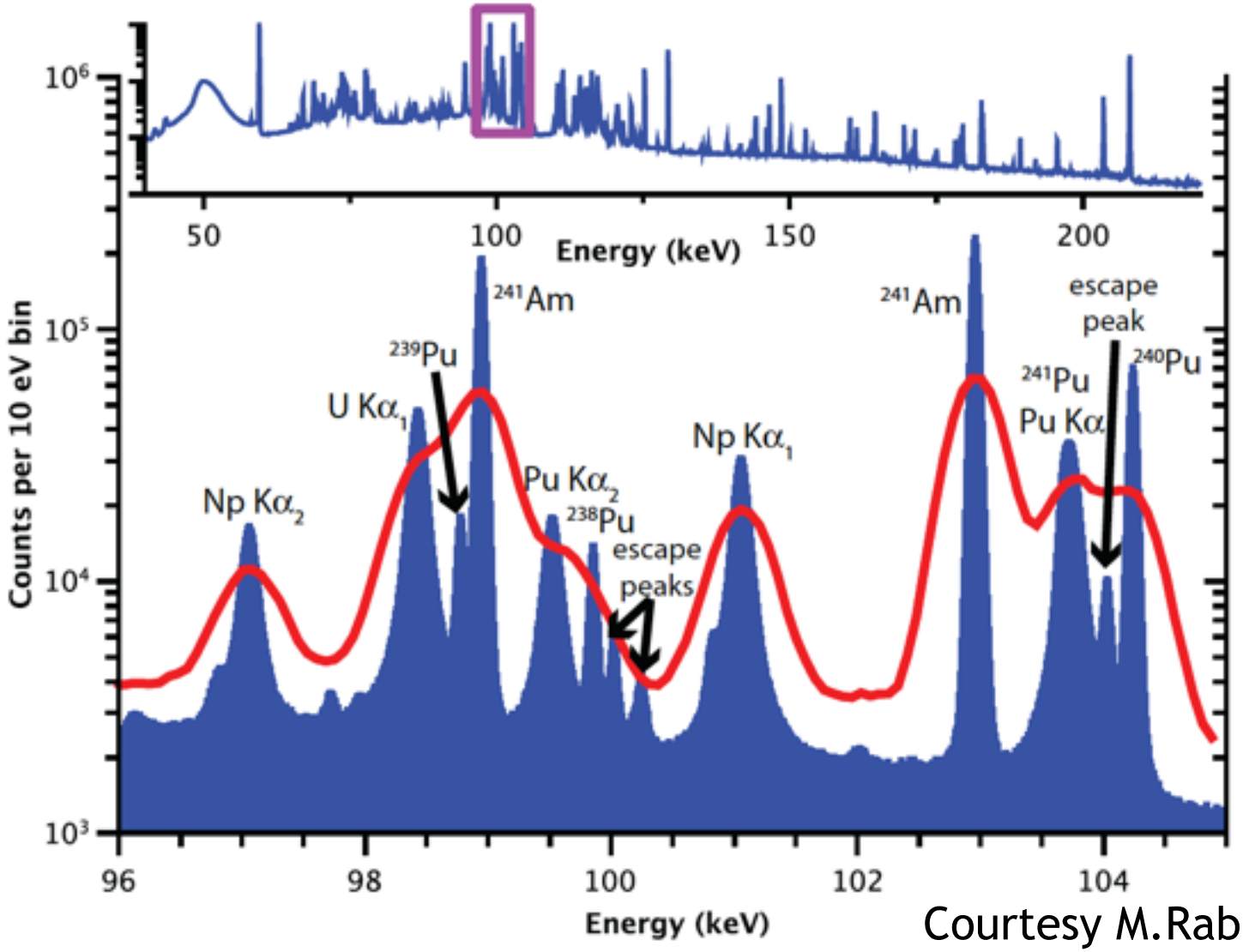


4x64 pixels array for γ-ray



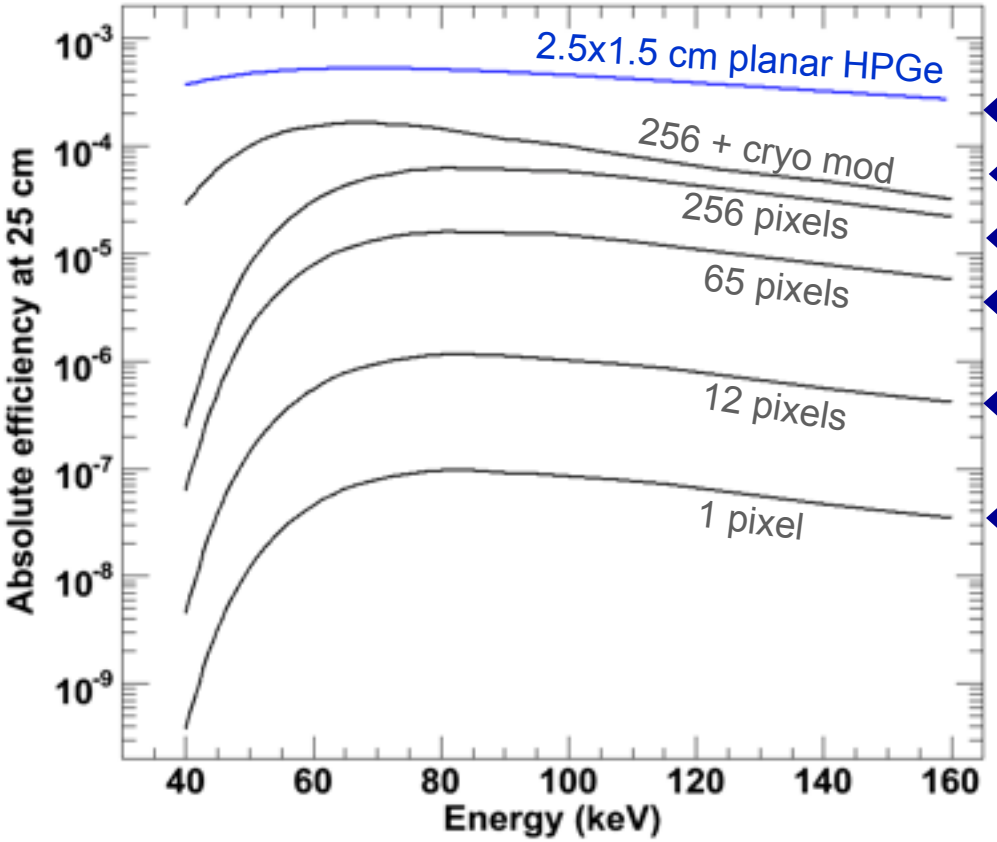
Courtesy J Ullom - NIST Boulder Co

Nuclear spectroscopy: Pu in U enrichment



Courtesy M.Rabin - LANL

TES vs HPGe



alternate absorber material

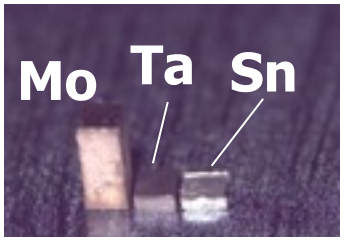
2012 (cryostat thinning + absorber thickness increase)

2010

2008

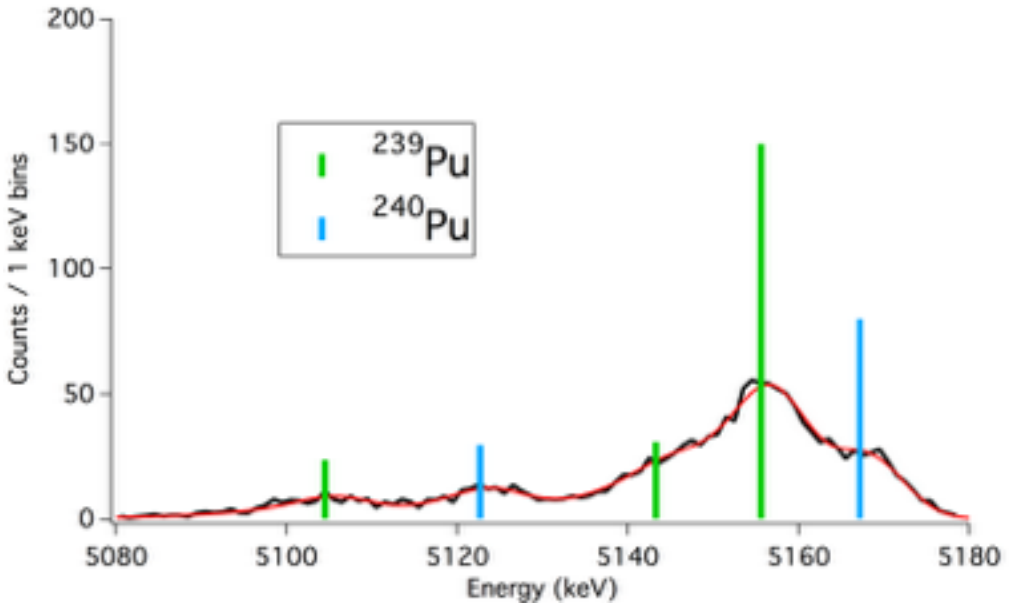
2007

2006

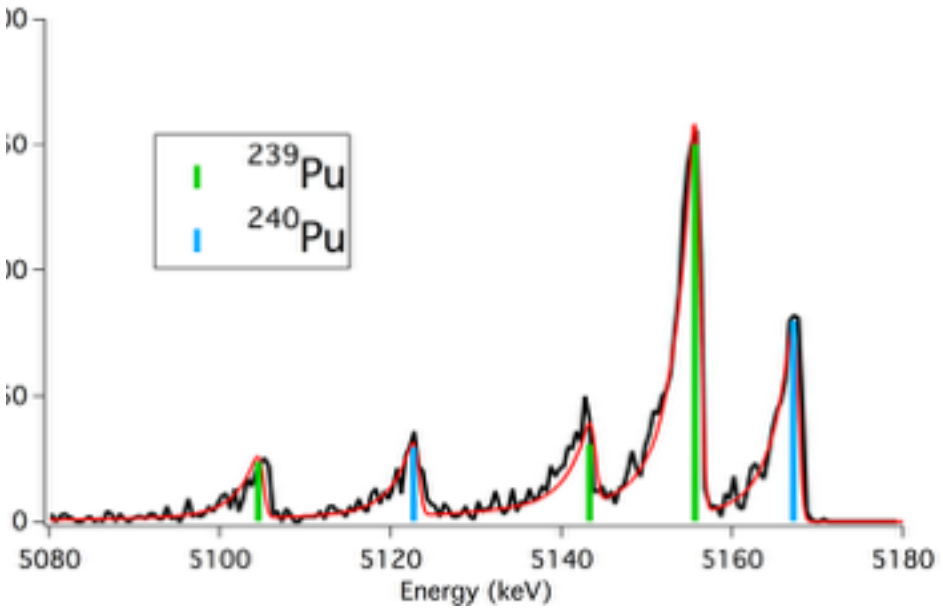


Courtesy J Ullom - NIST Boulder Co

Alpha spectroscopy



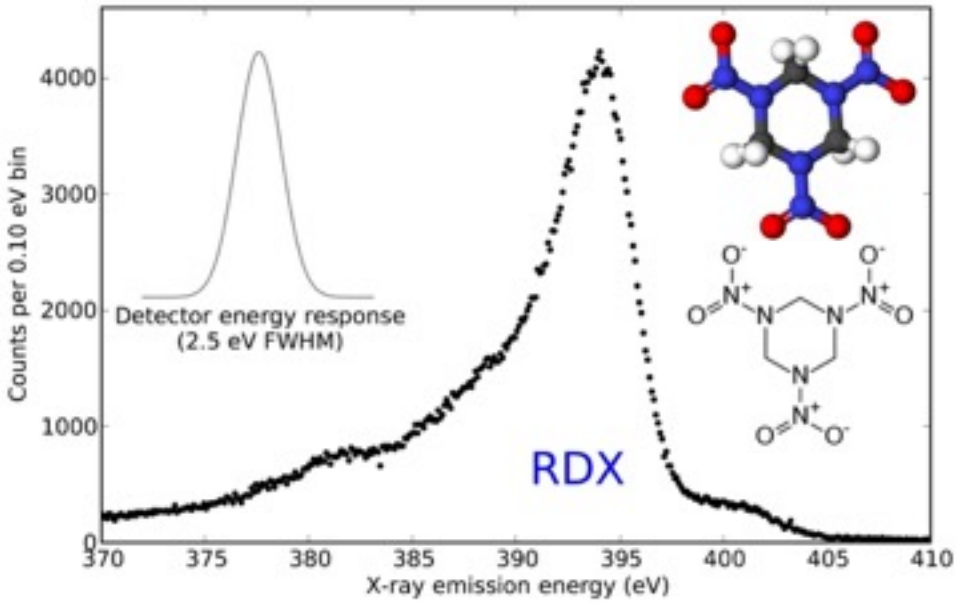
Silicon: ~8-10 keV FWHM

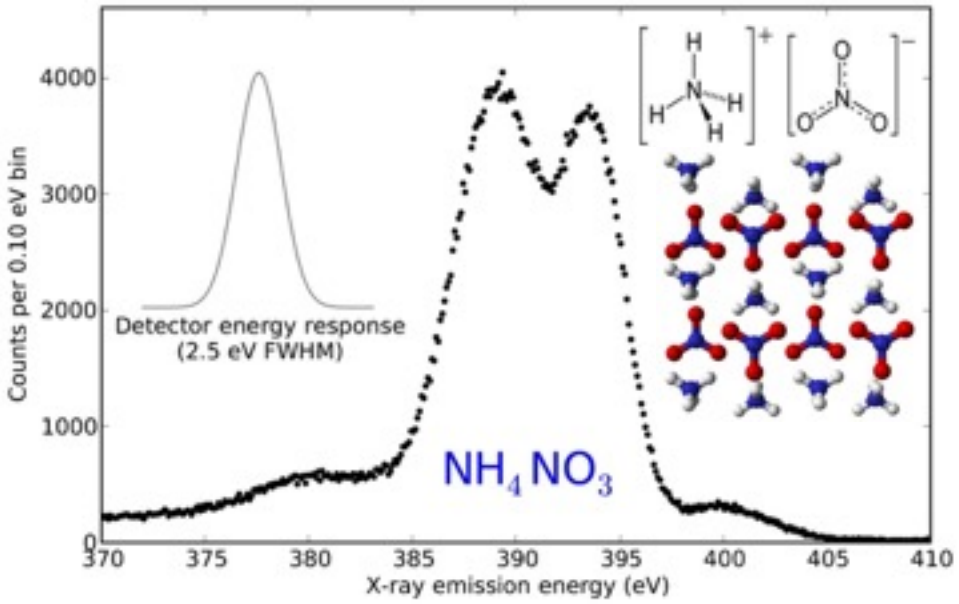


Microcal: 0.75 keV FWHM

TES results from LANL/NIST

chemical-shift XES

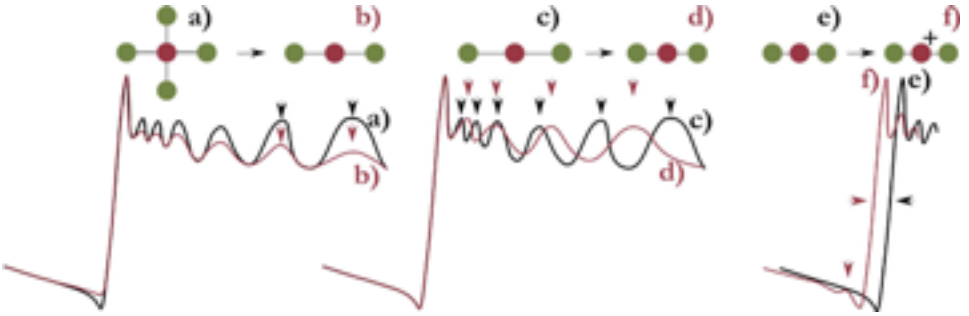


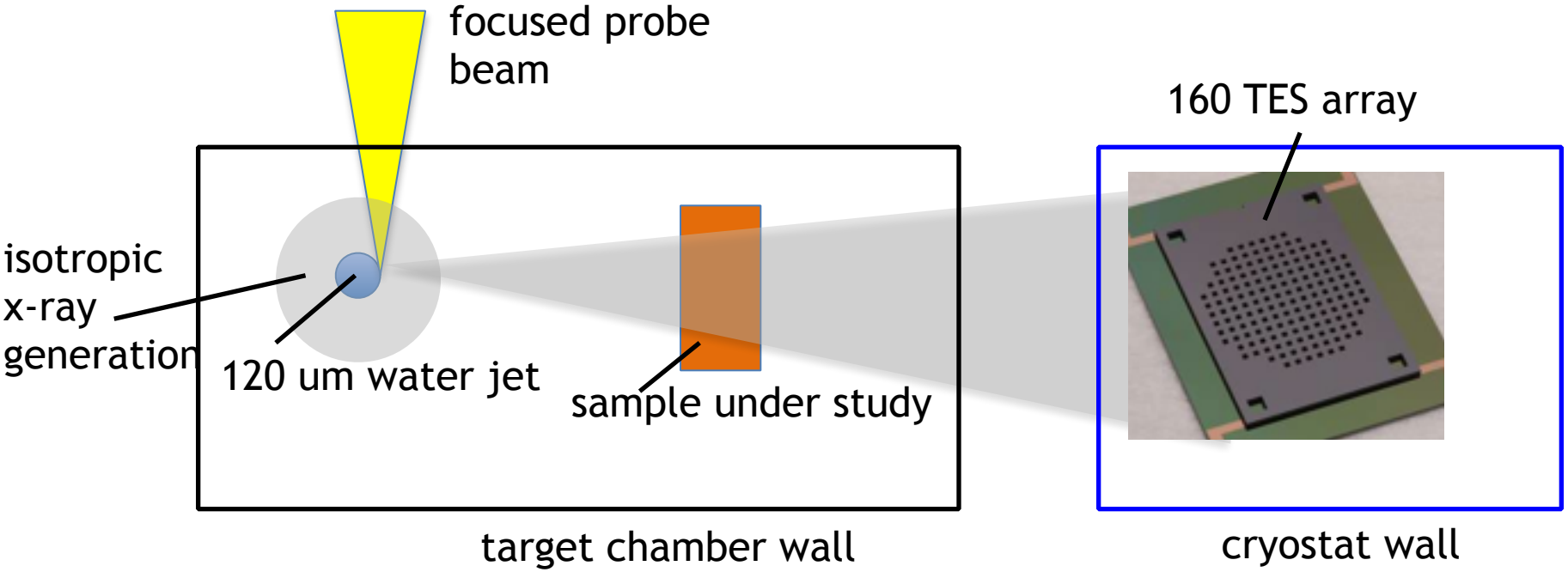


RDX is clearly distinguishable from NH_4NO_3.

(Excellent agreement with F.D. Vila, et al., *J Phys. Chem. A*, 115, 3243-3250 [2011])

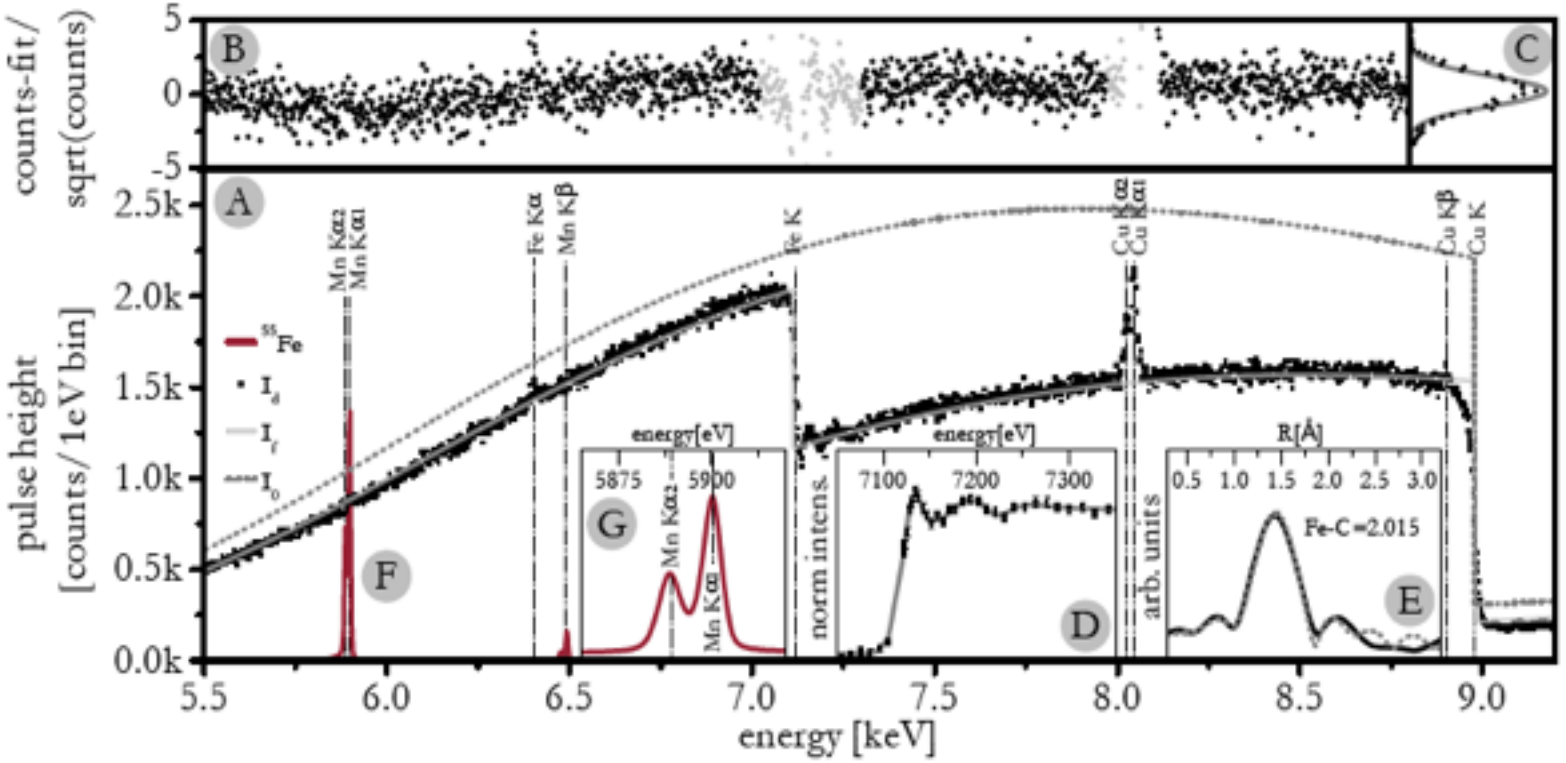
Ultrafast (fs-ps) structural measurements





- Lund-Jyväskylä-NIST

Ultrafast (fs-ps) structural measurements



- Lund-Jyväskylä-NIST

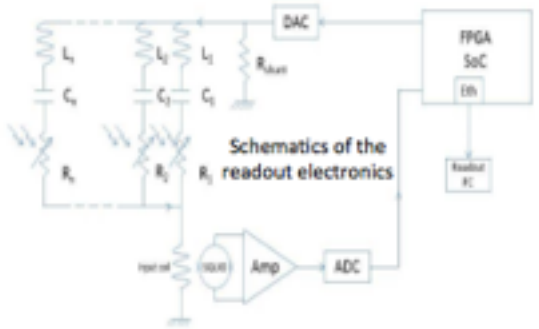
Summary

- This session has covered argument of applied superconductivity to fundamental particle and astroparticle physics as well as in other disciplines (nuclear, medical, quantum optics,….)
- The community of “applied superconductivity scientists” is quite large and, in particular, due to the successful achievements of the last decades is continuously growing.
- This the case of superconducting devices like TES, KID, SSPD and others that in less than 20 years from the conceptual schemes or first prototypes are presently reaching the maturity for applications in large scale projects as well in new innovative instruments.
- This continuous growth is confirmed by the large sessions dedicate to these arguments at ASC, LTD, EUCASS, SPW…
- I encourage the organizers of this wonderful conference to continue to host a dedicated session on this field.

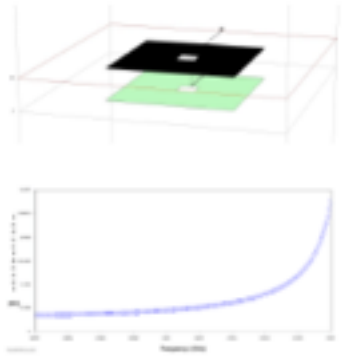
Poster Highlights - FDM TES readout

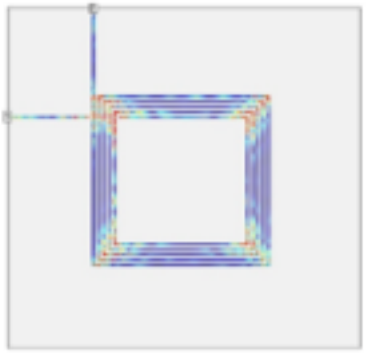
A 16 channel frequency domain modulation readout system with custom superconducting LC filters for the SWIPE instrument of the balloon-borne LSPE experiment

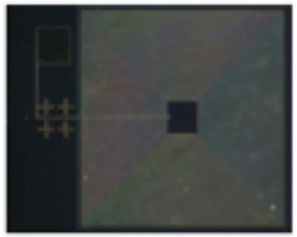
A.M. Baldini, C. Bemporad, M. Biasotti, F. Cei, V. Ceriale, D. Corsini, F. Fontanelli, G. Gallucci, L. Galli, F. Gatti, M. Grassi, M. Incagli, D. Nicolò, G. Signorelli, F . Spinella, D. Vaccaro, M. Venturini
INFN & University Pisa, INFN & University Genova



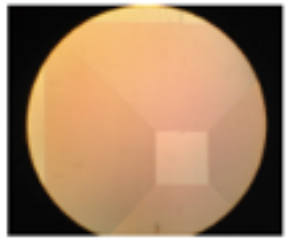
SmartFusion2 demo board and design of the FDM interface mezzanine







Microscope views of two prototype inductors realized at INFN Genova



LC filters

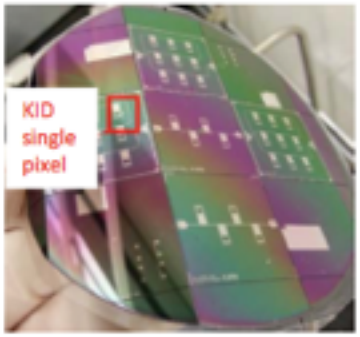
Poster Highlights- KID light Detector

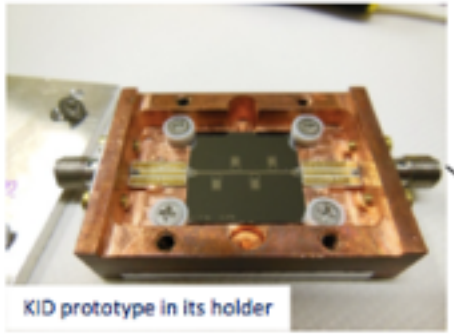
Cryogenic light detectors for the search of neutrinoless double beta decay

European Research Council
Established by the European Commission

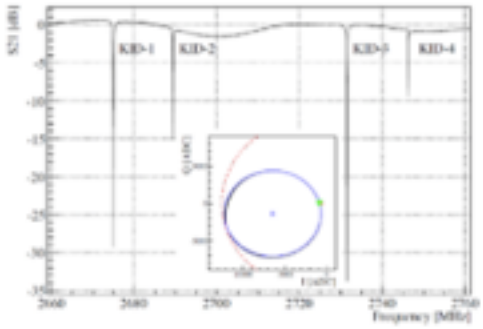
I. Colantoni [a,d], F. Bellini [a,b], L. Cardani [a,c], N. Casali [a,b], M.G. Castellano [d], A. Coppolecchia [a], C. Cosmelli [a,b], A. Cruciani [a,b], A. D'Addabbo [e], S. Di Domizio [f,g], M. Martinez[a], C. Tomei [b] and M. Vignati [a,b]*

a) Physics Department, Sapienza University of Rome, Rome, Italy – b) INFN – Sezione di Roma, Rome, Italy – c) Physics department, Princeton university, Princeton, NJ USA – d) IFN-CNR, Rome, Italy – e) INFN Laboratori Nazionali del Gran Sasso, Assergi (AQ) Italy – f) Physics department, Genova University, Genova, Italy – g) INFN – Sezione di Genova, Genova, Italy





Cryogenic setup 15 mK dilution refrigerator



Resonances And circle fit

Poster Highlights -TES bolometer

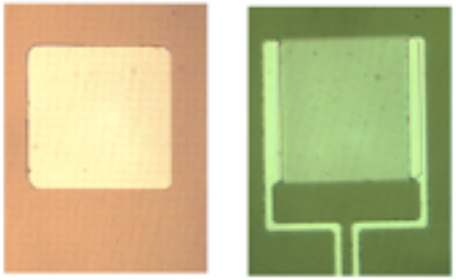
Fabrication and test of a large area spider-web bolometer for CMB polarization experiment.

M. Biasotti[1,2], D.Corsini[1,2], M. De Gerone[2], F. Gatti[1,2], G. Pizzigoni[1,2]
1 - Università di Genova Italy; 2 – INFN sez. Genova,

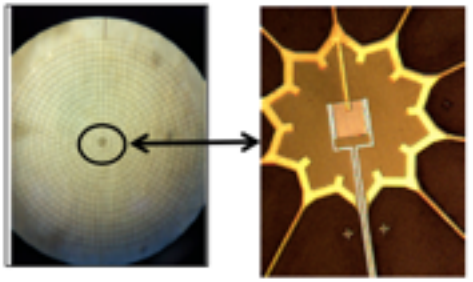
Università degli studi di Genova

Istituto Nazionale di Fisica Nucleare

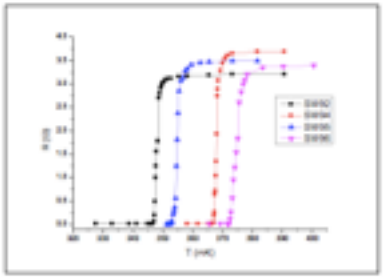
TES deposition and lift off (Ti)



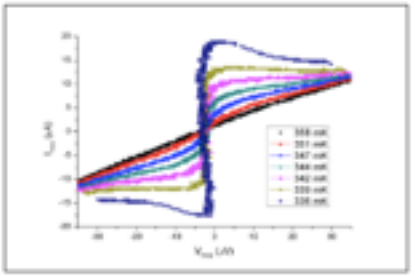
RIE back wafer etching and suspension of spider web structure



different samples Transitions (Ti/Au)



I-V curves @different Temperature (Ti/Au)

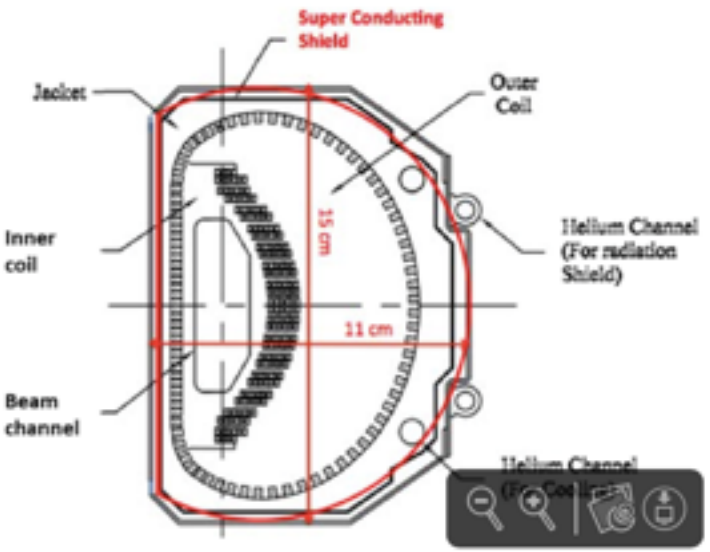


Poster Highlights - Magnets

Feasibility Study of Hybrid Magnetic Cloak for Accelerator Magnets

E. Barzi, D. Turrioni, V. Kashikhin, H. Nguyen, FNAL,
Batavia, IL 60510, USA

G. Giunchi, Materials Science Consultant, 20131
Milano, Italy

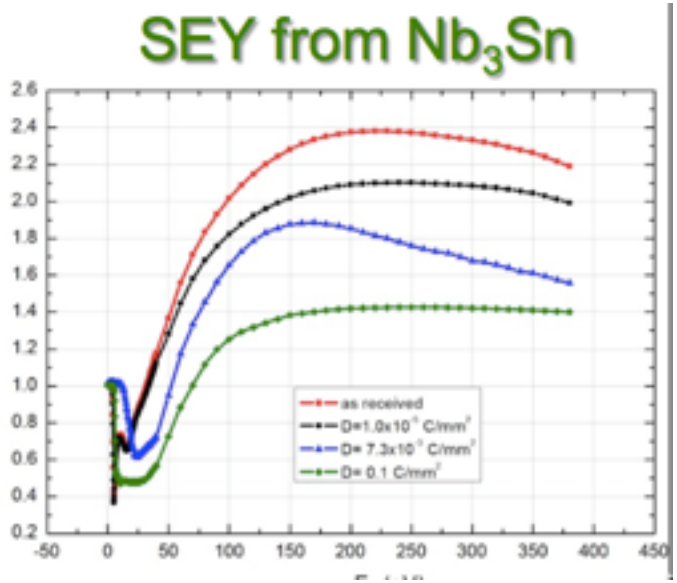


Poster Highlights - Superconducting coating

Superconductors as accelerators wall coatings in FCC-hh: impedance and compatibility with collective effects issues.

R. Cimino, LNF-INFN, Frascati, Italy and CERN, Geneva, Switzerland.
V. Corato, Enea, Frascati, Italy;
A. Di Gaspare, LNF-INFN, Frascati Italy;
A. Di Trolio and R. Larciprete, CNR-ISC, Roma, and LNF-INFN, Italy
M. Migliorati INFN Roma1 - University "la Sapienza", Rome, Italy;
U. Gambardella, M. R. Masullo and V. G. Vaccaro, INFN-Na, Napoli, Italy.

parameter	LHC	HL-LHC	FCC-hh
c.m. energy [TeV]	14		100
dipole magnet field [T]	8.33		16 (20)
circumference [km]	36.7		100 (83)
luminosity [10^{34} cm^{-2}s^{-1}]	1	5	5 [→20?]
bunch spacing [ns]	25		25 {5}
events / bunch crossing	27	135	170 {34}
bunch population [10^{11}]	1.15	2.2	1 {0.2}
norm. transverse emitt. [μm]	3.75	2.5	2.2 {0.44}
IP beta-function [m]	0.55	0.15	1.1
IP beam size [μm]	16.7	7.1	6.8 {3}
synchrotron rad. [W/m/aperture]	0.17	0.33	28 (44)
critical energy [keV]	0.044		4.3 (5.5)
total syn.rad. power [MW]	0.0072	0.0146	4.8 (5.8)
longitudinal damping time [h]	12.9		0.54 (0.32)

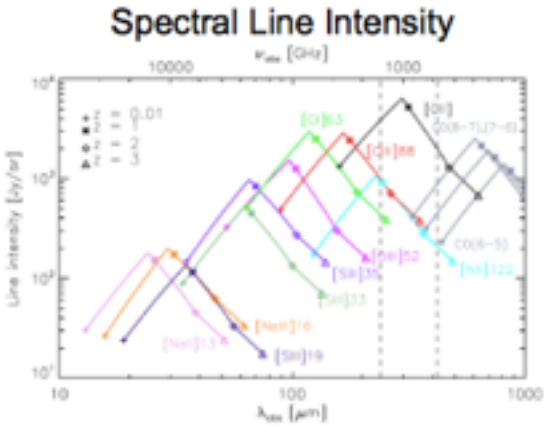


Poster Highlights - KID for astrophysics

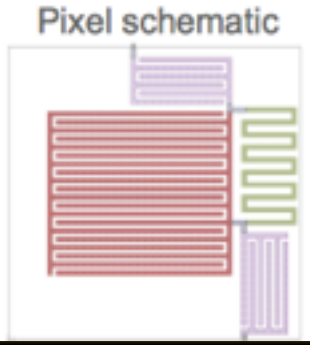
Kinetic Inductance Detectors for Far-Infrared Spectroscopy

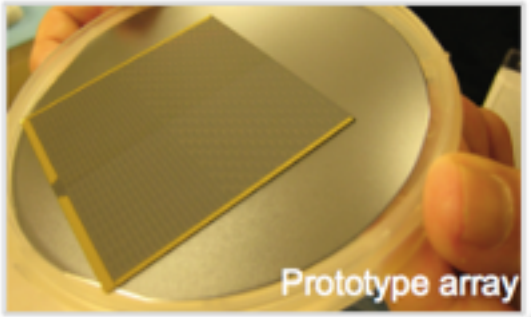
Alyssa Barlis, Univ. of Pennsylvania & NASA Space Technology Research Fellow;
James Aguirre, Univ. of Pennsylvania; Thomas Stevenson, NASA Goddard Space Flight Center

s Balloon gondola



rs





Poster Highlights - TES FDM readout neutrino mass exp.

Microwave multiplex read out for superconducting sensors

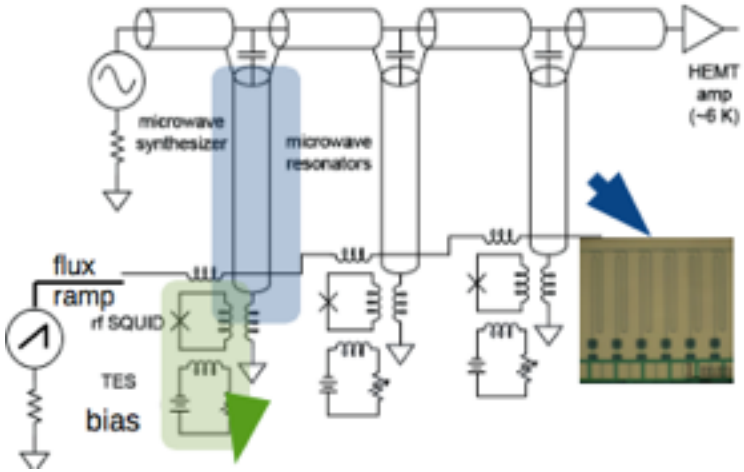
E. Ferri[1], D. Becker[2], D. Bennett[2], M. Faverzani[1], J. Fowler[2], J. Gard[2], A. Giachero[1], J. Hays-Wehle[2], J. Hilton[2], M. Maino[1], J. Mates[2], A. Puiu[1], A. Nucciotti[1], D. Schmidt[2], D. Swetz[2], J. Ullom[2], L. Vale[2]

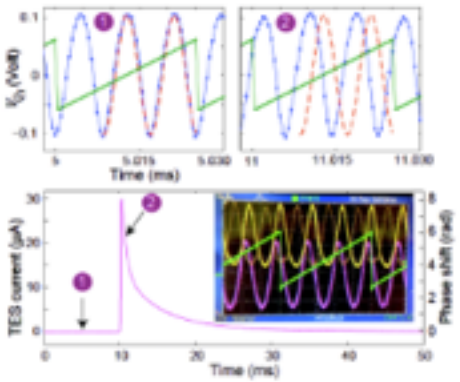
ERC – Advanced Grant 2013
GA n. 340321
PI: S. Ragazzi, HI:INFN

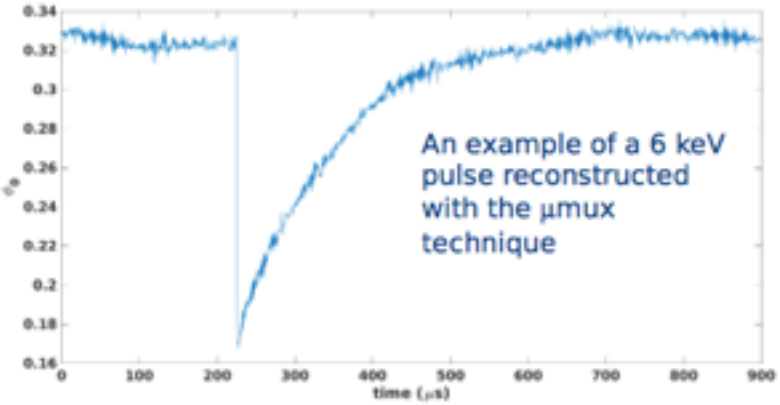
Rf-SQUID read out with microwawe multiplexing

- DC biased TES
- SQUID coupled with TES and a resonator circuit
- microwave rf-SQUID read out with flux ramp demodulation (common flux line inductively coupled to all SQUIDs

GHz LC resonator







Poster Highlights - Neutrino Mass Exp. with TES

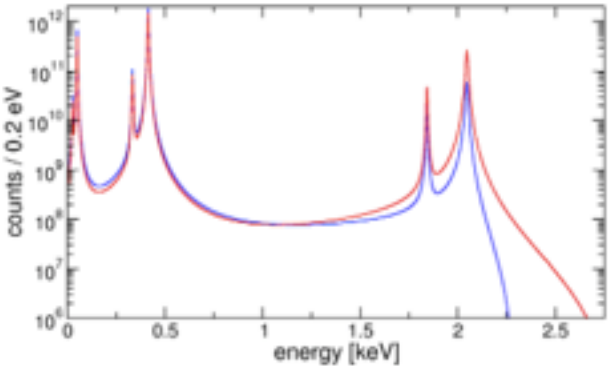
Status of the HOLMES detector development

A. Nucciotti on behalf of the HOLMES collaboration
Dip. di Fisica "G. Occhialini", Univ. Milano-Bicocca, Italia
INFN - Sezione di Milano Bicocca, Italia

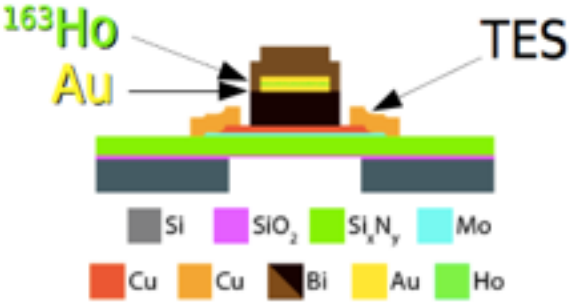
ERC-ADG 2013
PI: Stefano Ragazzi
Host Institution: INFN

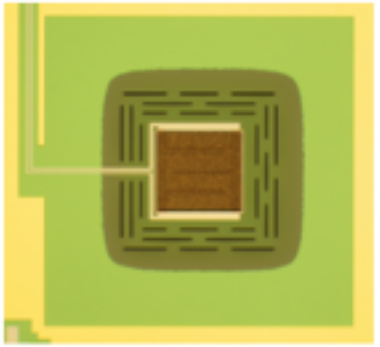
HOLMES is a new experiment to directly measure the neutrino mass with a sensitivity as low as 0.4 eV. **HOLMES** will perform a calorimetric measurement of the energy released in the electron capture decay of ^{163}Ho (A. De Rujula and M. Lusignoli, Phys. Lett. B 118 (1982) 429). The calorimetric measurement eliminates systematic uncertainties arising from the use of external beta sources, as in experiments with beta spectrometers. **HOLMES** will deploy a large array of low temperature microcalorimeters with implanted ^{163}Ho nuclei.

$^{163}Ho + e^- \rightarrow {}^{163}Dy^* + \nu_e$



- **TES detectors R&D**

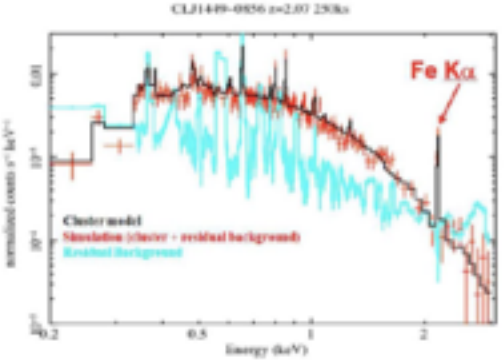


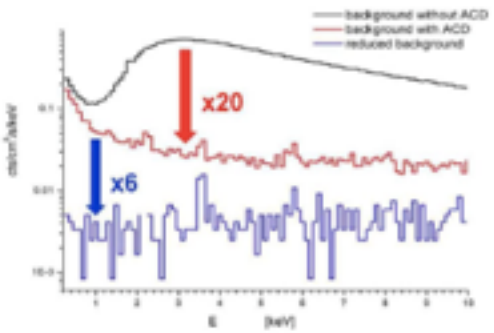


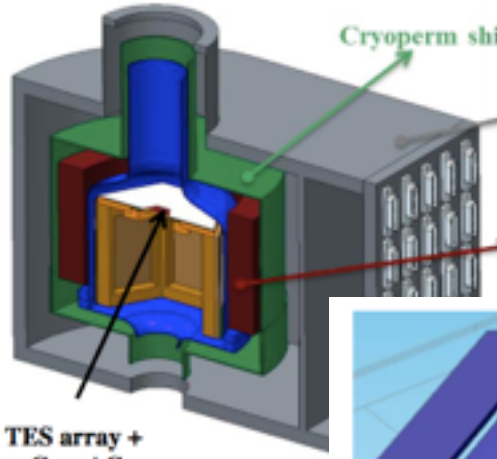
Poster Highlights - TES for X-ray Space Observatory

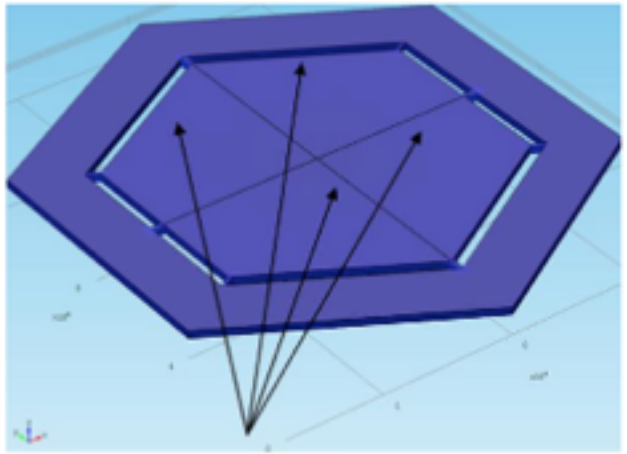
Superconducting TES array for large area cryogenic anti-coincidence detector for the ATHENA space mission

Needs for an anticoincidence detector to disentangle fake signals produced by cosmics (protons mostly) and obtain high energy resolution on single elements' lines









TES patterns on surfaces

Poster Highlights - TES for DM searches

Phonon-Light Detectors for the CRESST Dark Matter search

Anja Tanzke on behalf of the CRESST collaboration