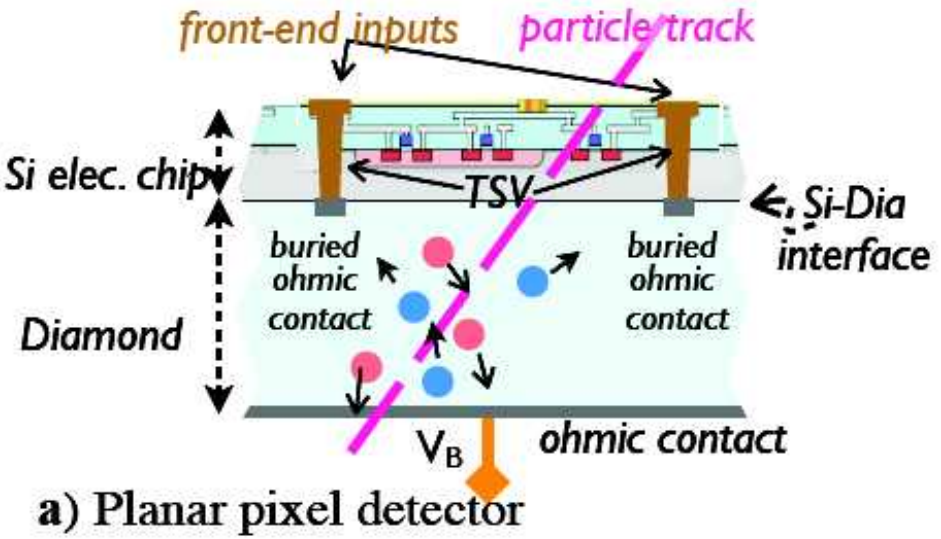
Esperimento CHIPSODIA stato dell'arte a marzo 2013

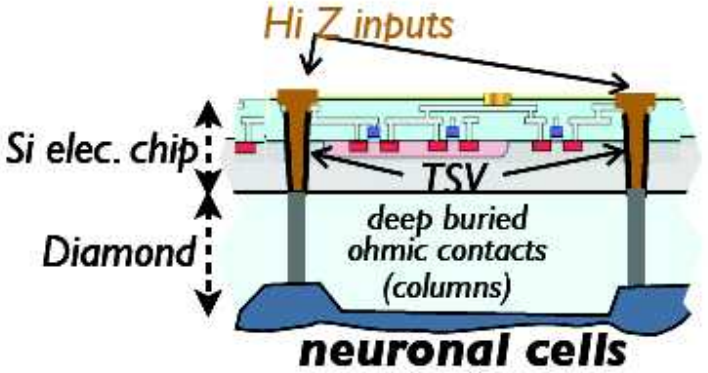
Durata
2010 sj
2011-2012
2013 WP6 di DIAPIX

Gruppi di Ricerca
Sezioni INFN di Firenze, Perugia, Bari
LENS, Istituto Nazionale di Ottica di Firenze
Istituto Italiano di Tecnologia di Genova

CHIPSODIA finalità



a) Planar pixel detector



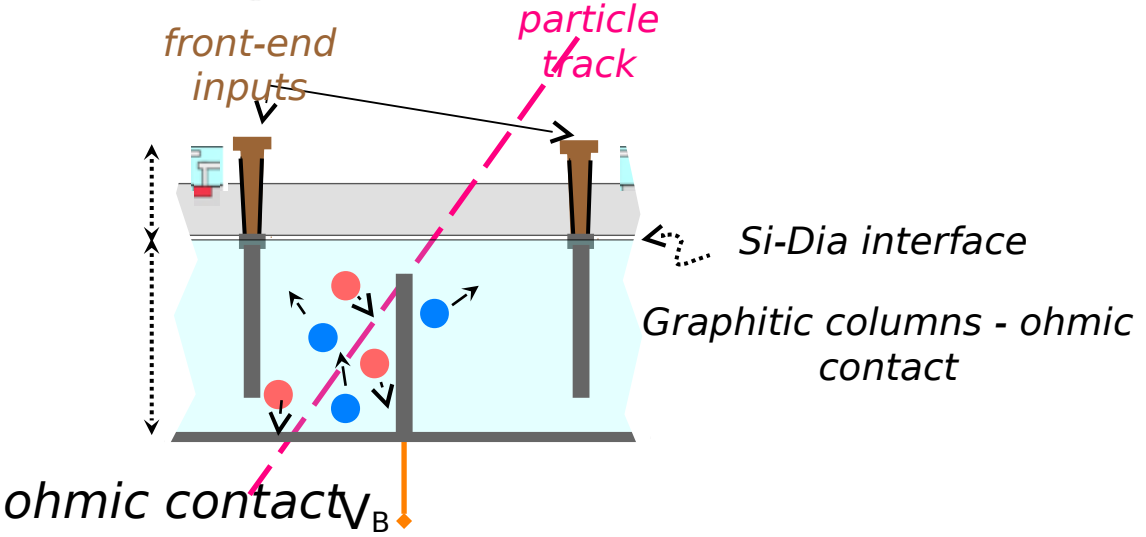
b) MEA

Saldatura laser di chip on diamond

TSV di collegamento elettronica diamante

Fabbricazione laser di colonne grafitiche 3dim

Fabbricazione laser di contatti ohmici superficiali



3D detector

CHIPSODIA attività

Silicon-on-diamond-bonding (SOD)- Firenze

Grafitizzazioni di superficie e 3dim - Firenze

Realizzazione di Through Silicon Vias - IIT

Realizzazione di bio-dispositivi - IIT

Simulazioni, metallizzazioni - INFN Pg

Progettazione/realizzazione chip elettronica - INFN Bari

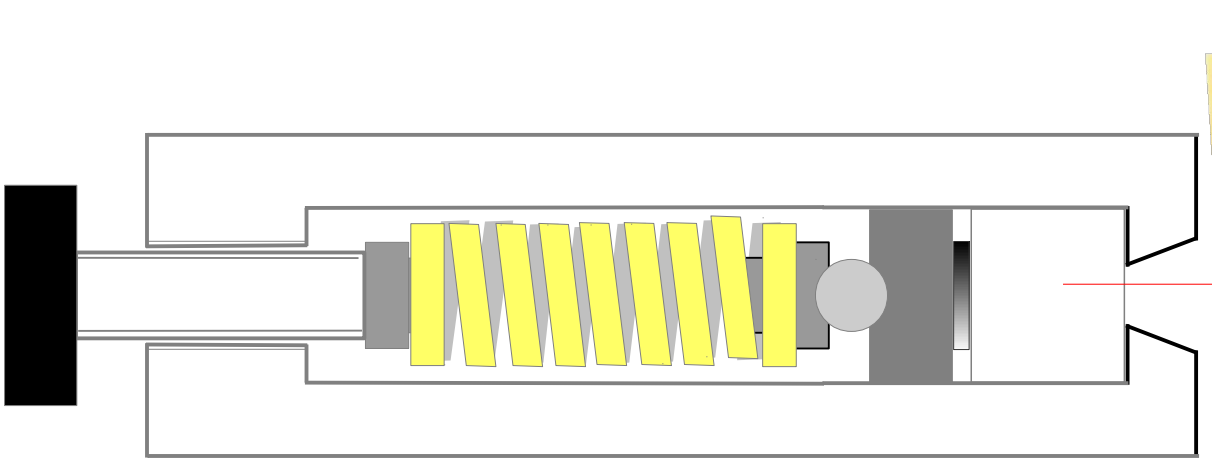
Silicon-on-diamond-bonding (SOD)

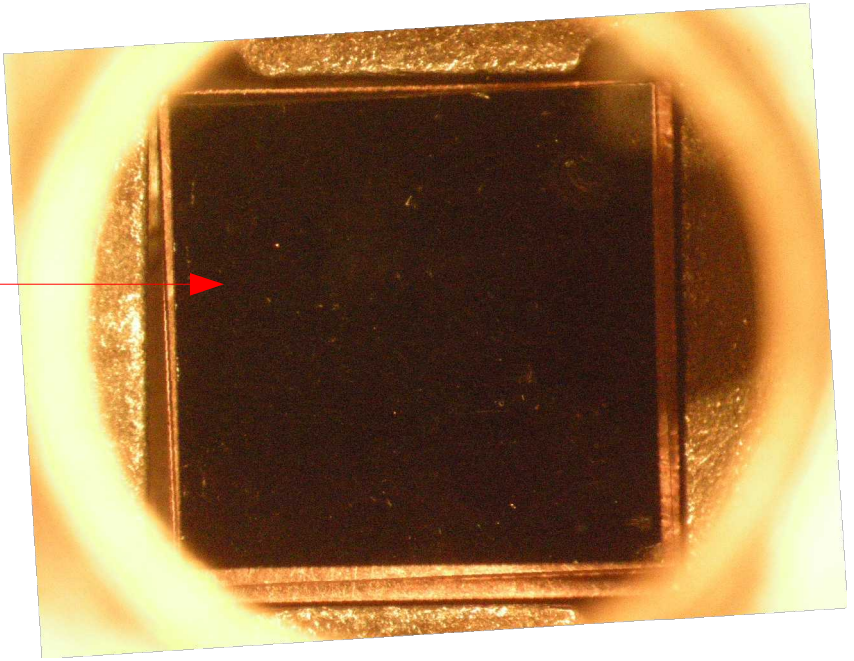
Silicon On Diamond Fabrication: Cleaning and mounting

Si & D plates are cleaned in a white chamber in ultrasonic bath assembled in a laminar flow hood

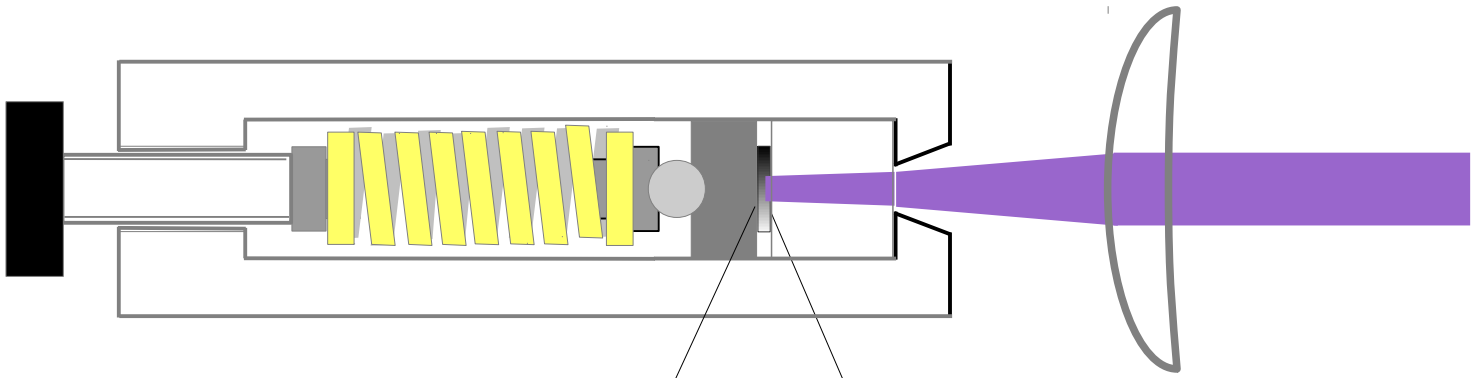
Attualmente
Camera pulita INO
Sperabilmente INFN

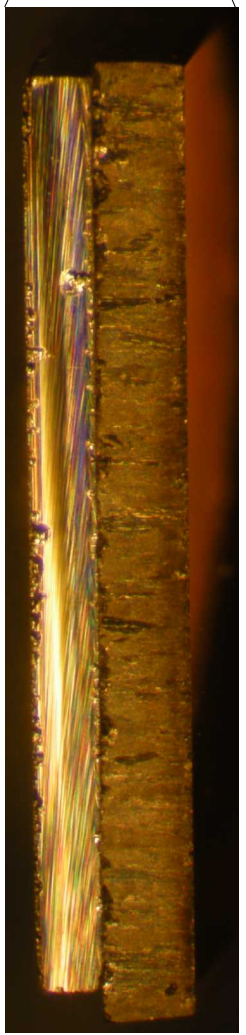
Diamond 5 ×5 mm^2 plate over silicon seen through the fused silica viewport





Silicon On Diamond Fabrication: Laser bonding





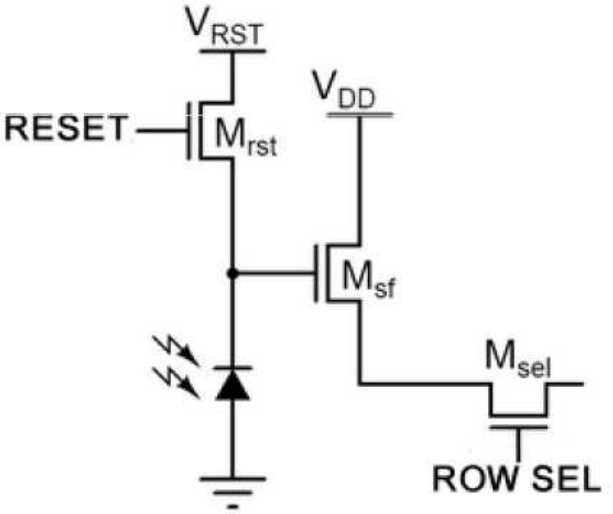
Uniaxial stress: 800 atm needed* for 90 % adhesion with the present R_a~5 nm

The diamond silicon interface is irradiated by UV laser pulses
λ=355 nm
τ=20 ps
Energy density = 2-0.5 J/cm^2

*Stefano Lagomarsino Ph,D Thesis
http://hep.fi.infn.it/sciortino/Research/dissertation_Lagomarsino.pdf

Laser: LENS
Laboratorio Prof Roberto Bini

RAPS on DIAMOND:
succesfully tested by INFN Perugia

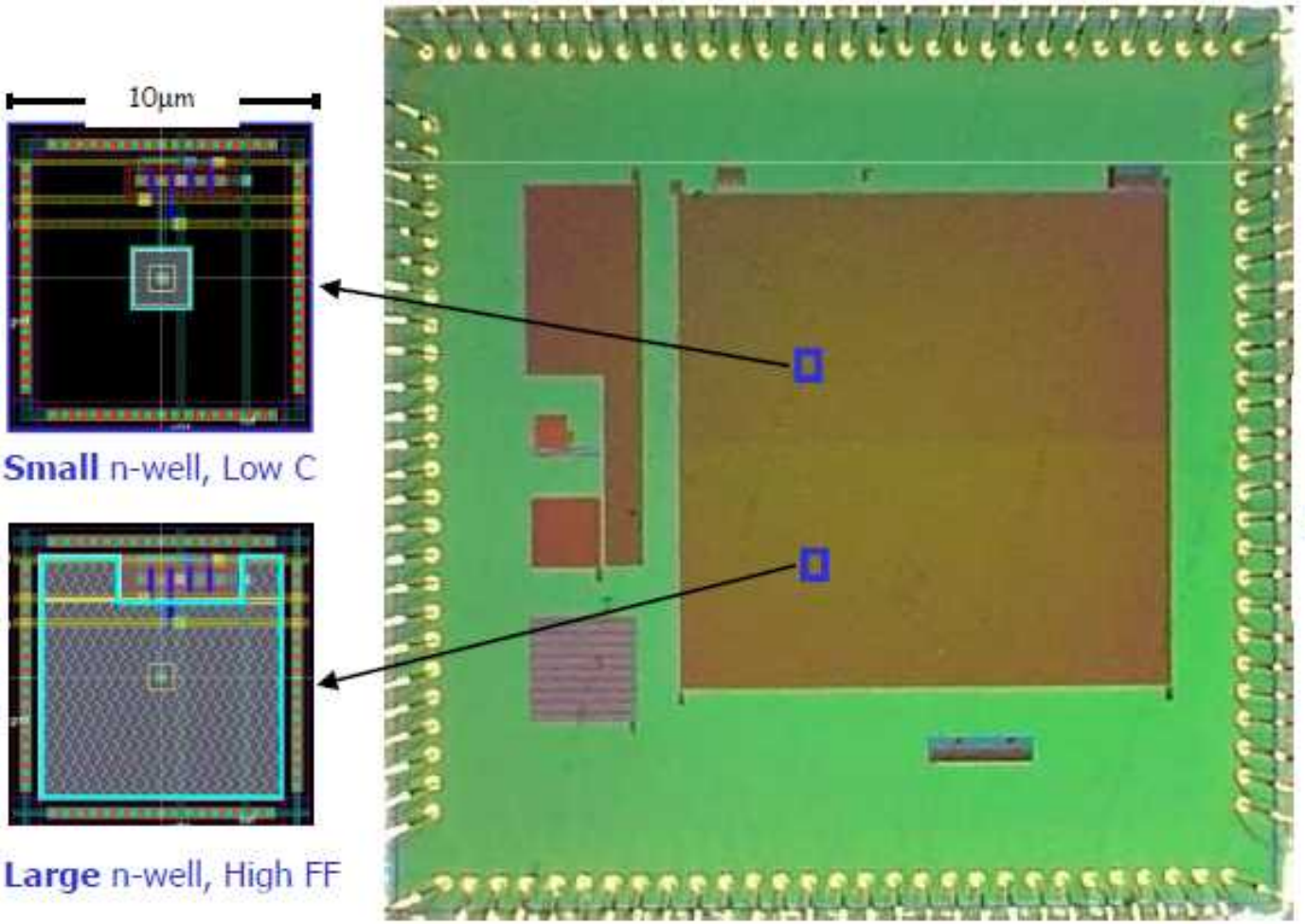


GOAL:

To test the functionality of a real chip

After ⇒ thinning (down to 40 μm)

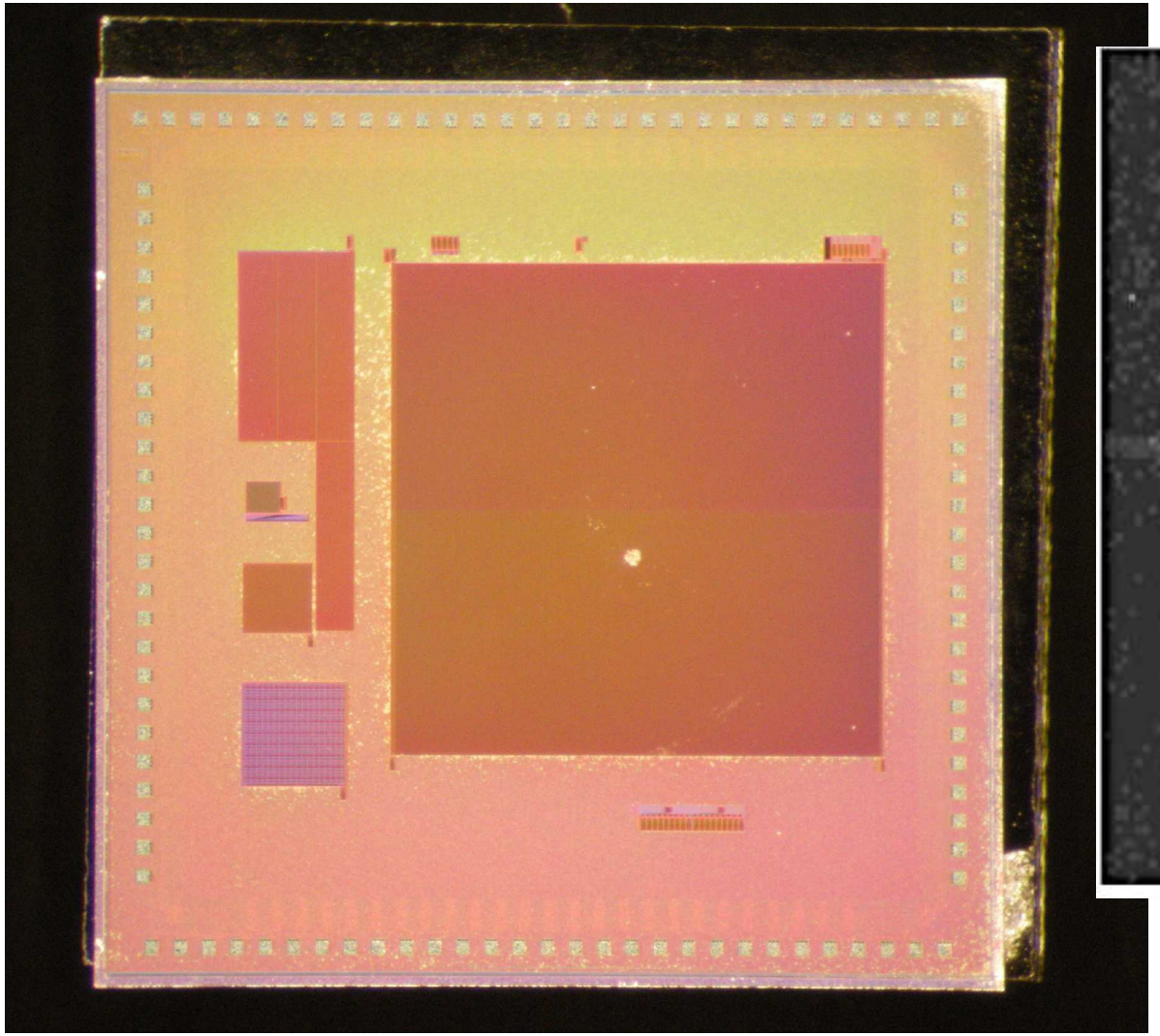
and⇒ bonding to diamond

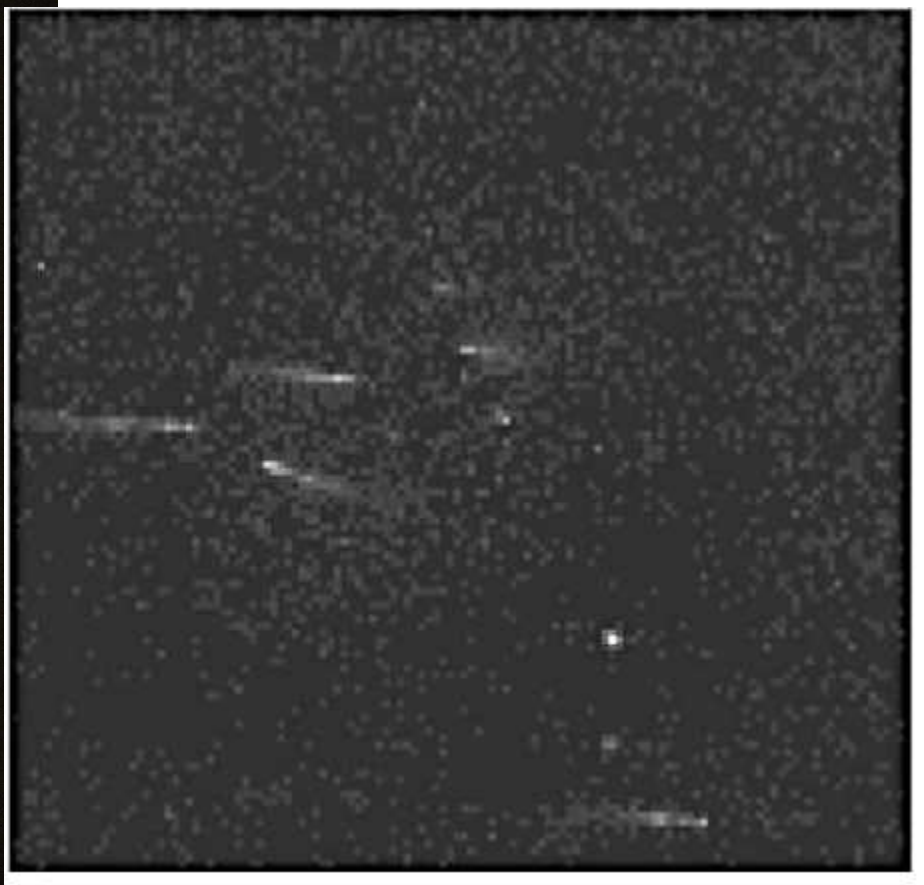


CMOS Active Pixel Sensors

256 × 256 matrix

RAPS bonded on diamond (SOD_34) successfully tested



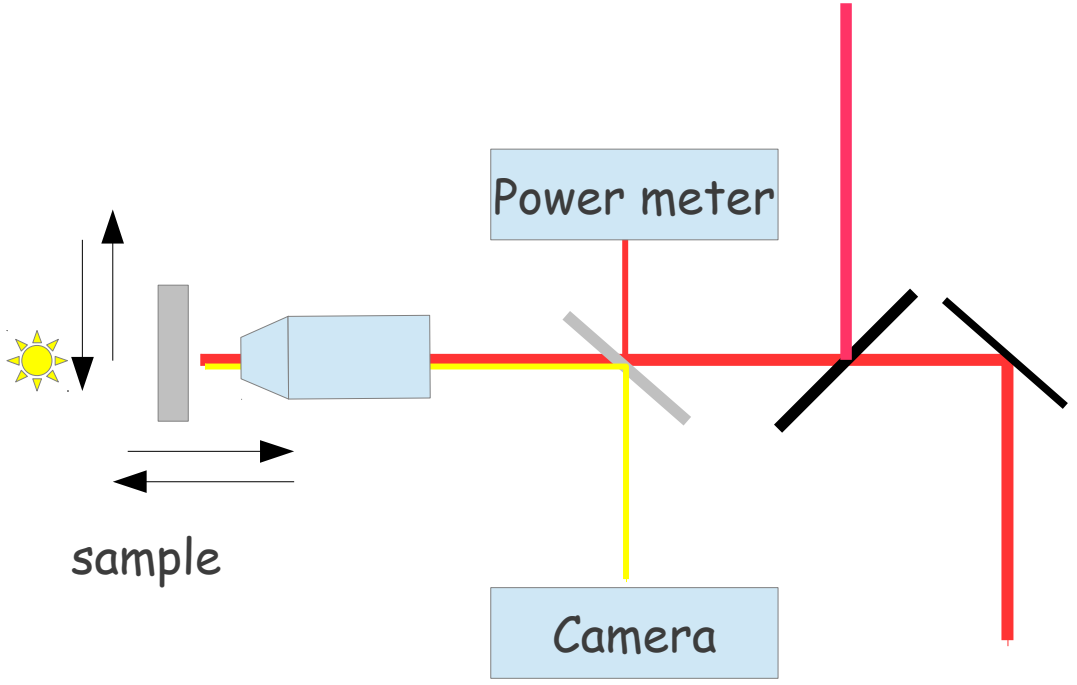


Display of the response to MIPs at grazing incidence

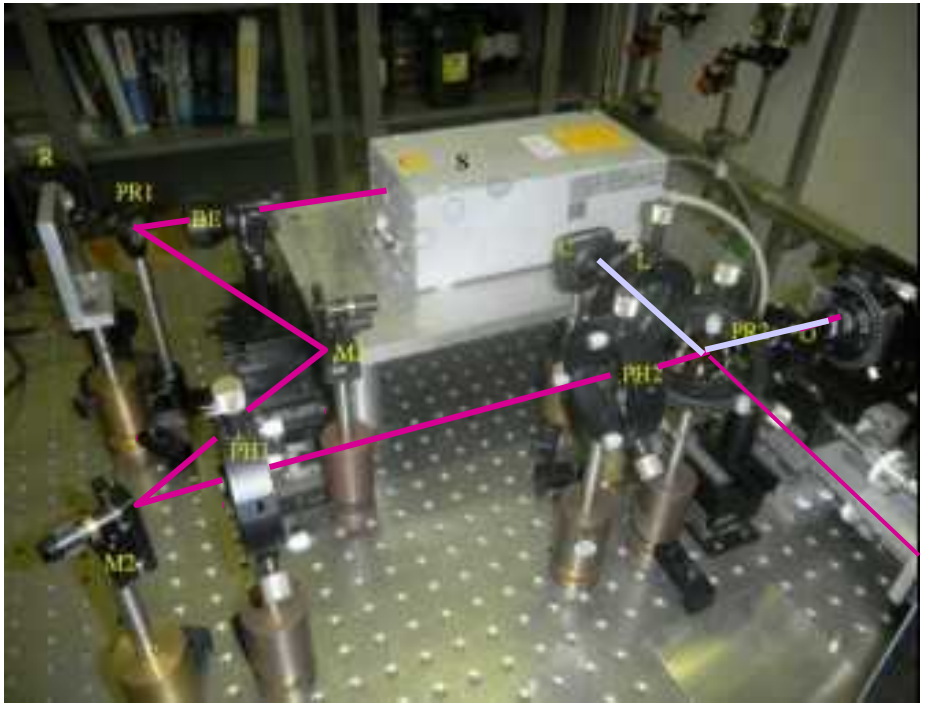
Grafitizzazioni di superficie e 3dim - Firenze

Laboratorio LENS
Dott Marco Bellini

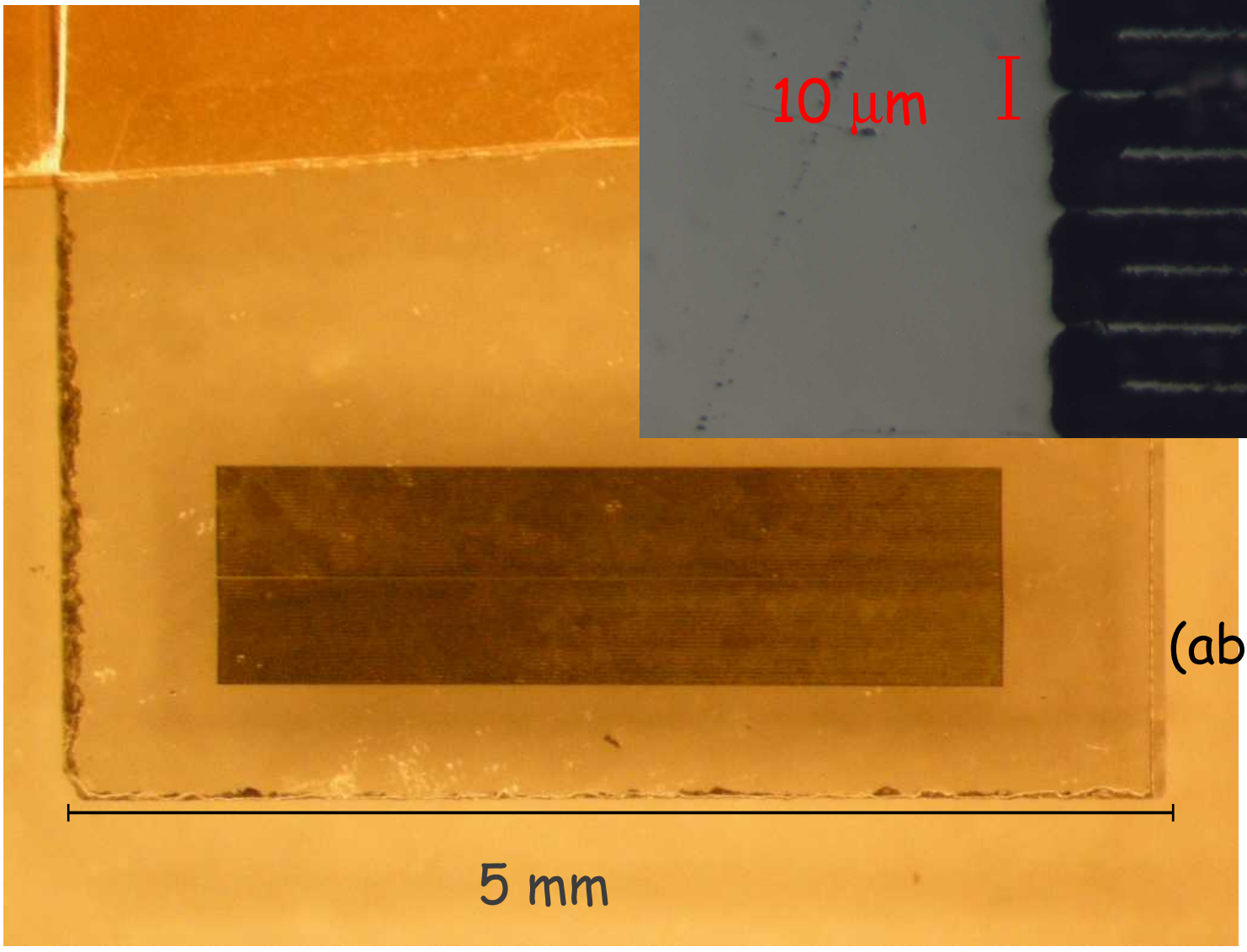
Ti:Sa laser source
800 nm wavelength
30 fs pulse width

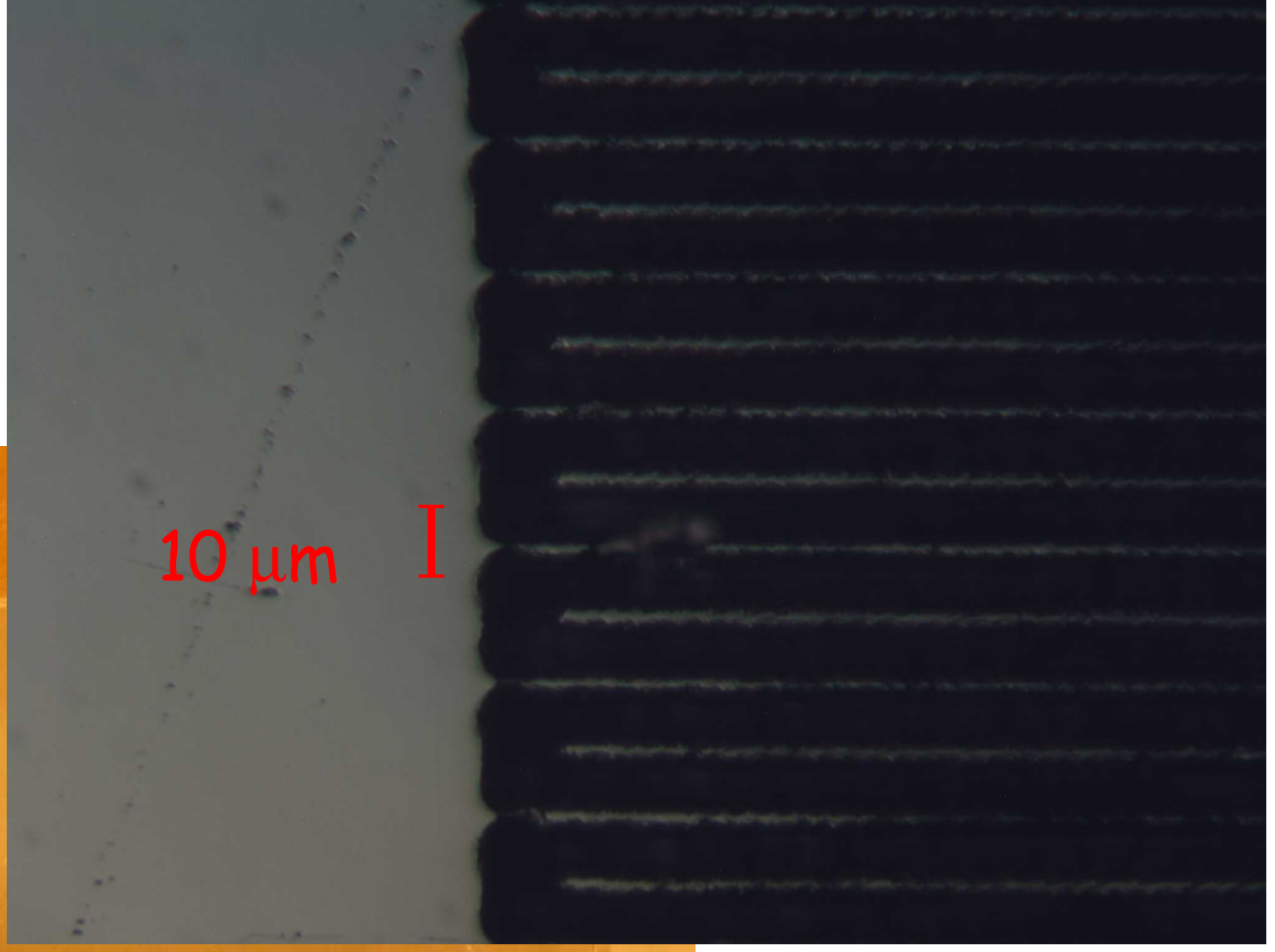


Nd:YAG
Q-switched laser source
1064 nm wavelength
8 ns pulse width



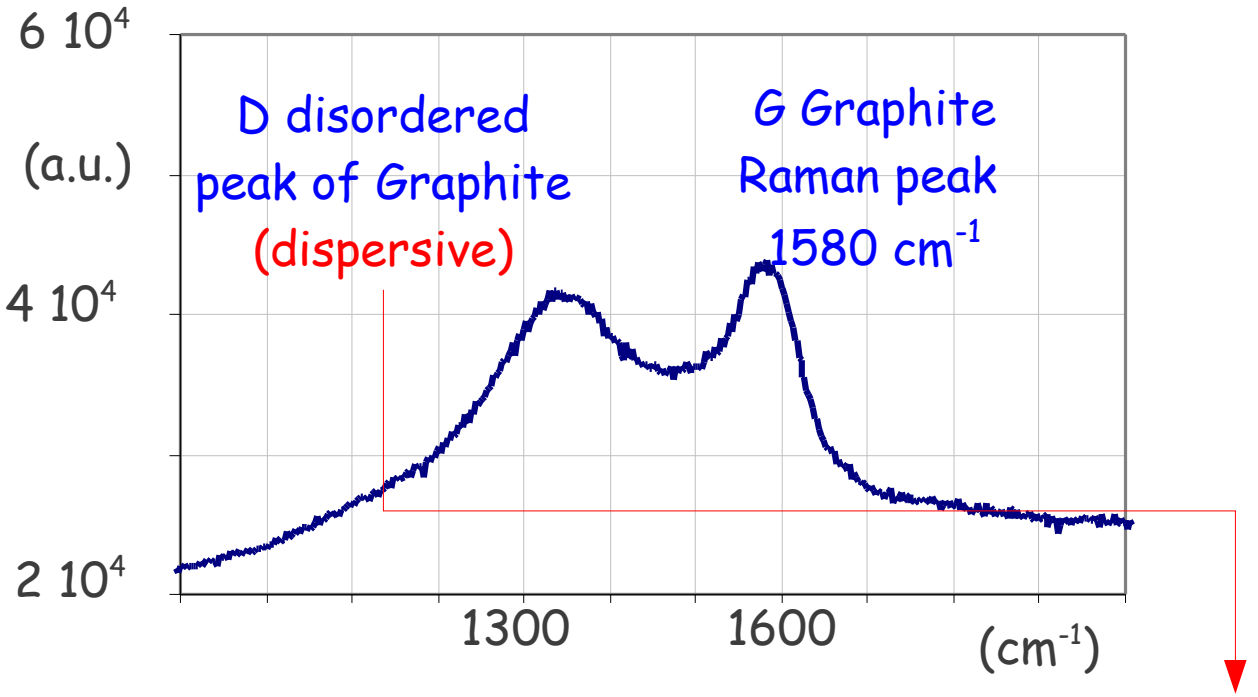
Surface contacts
$\rho \approx 4$ mΩ cm, about
the value of graphite



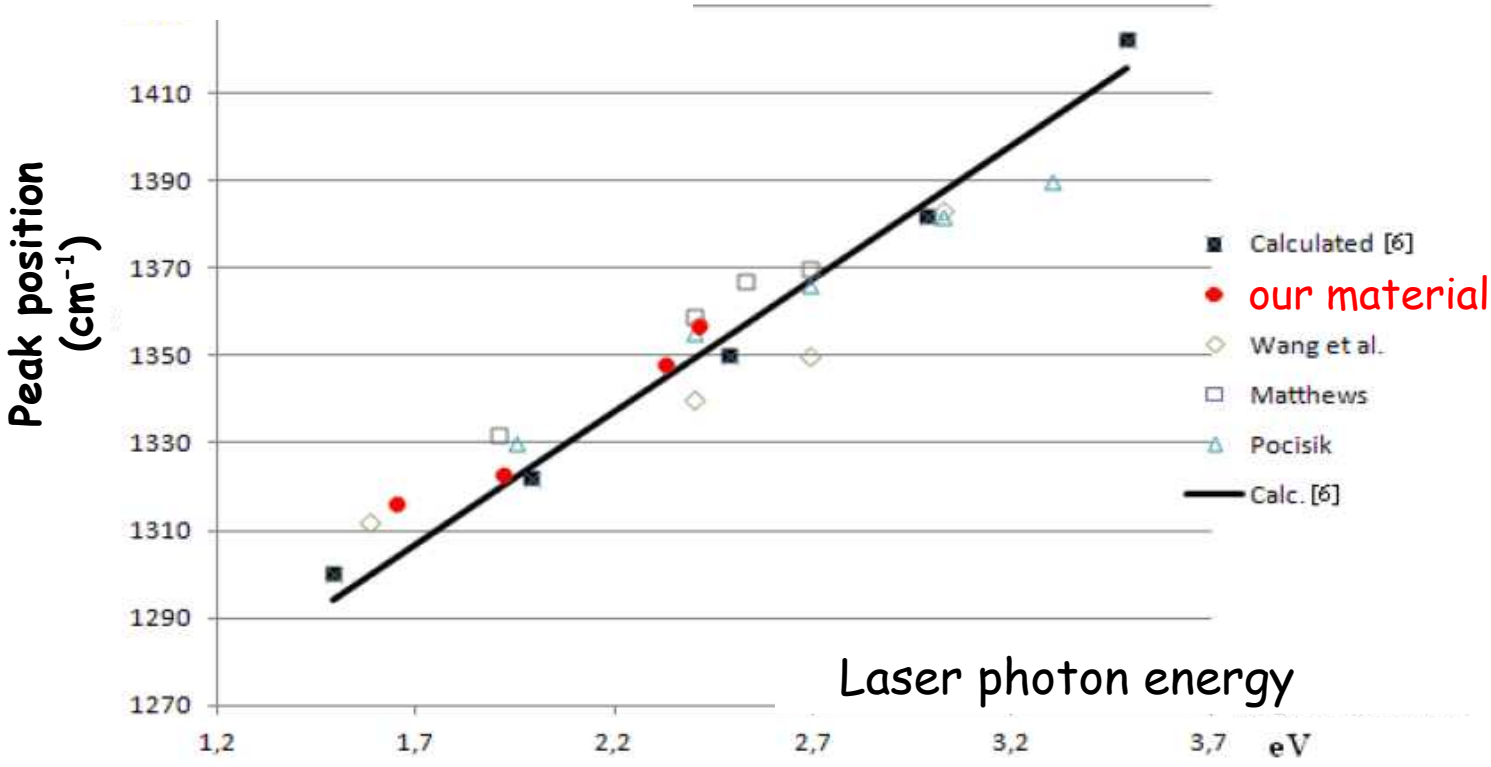


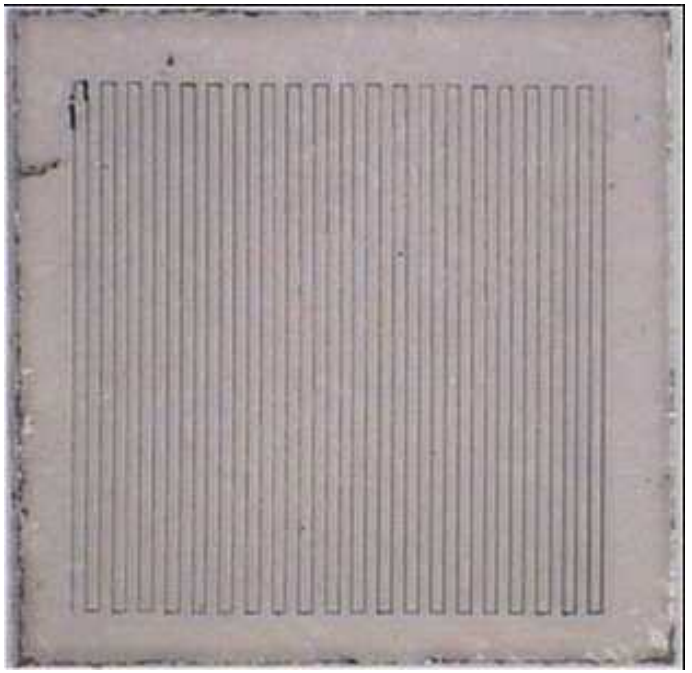
ns laser
(ablation with fs laser)

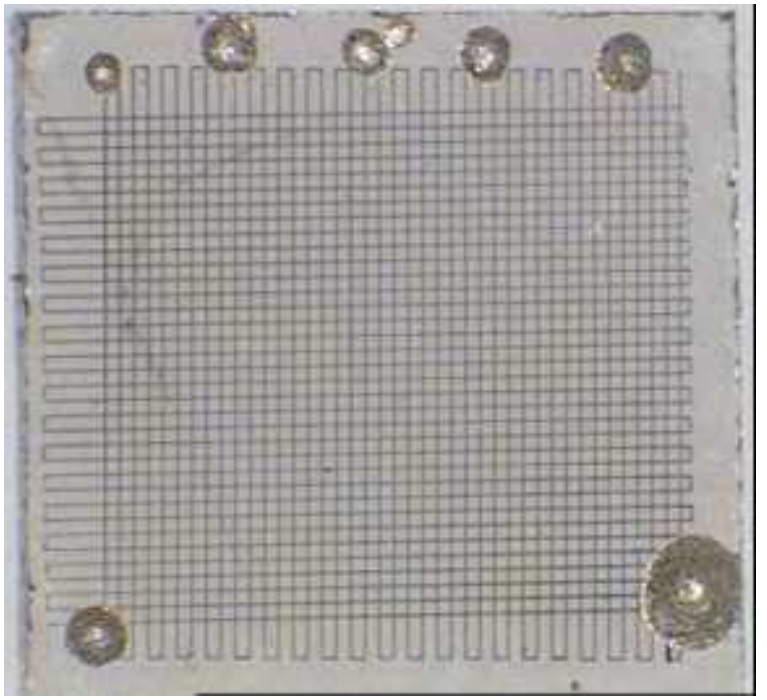
Raman Spectroscopy on surface channels



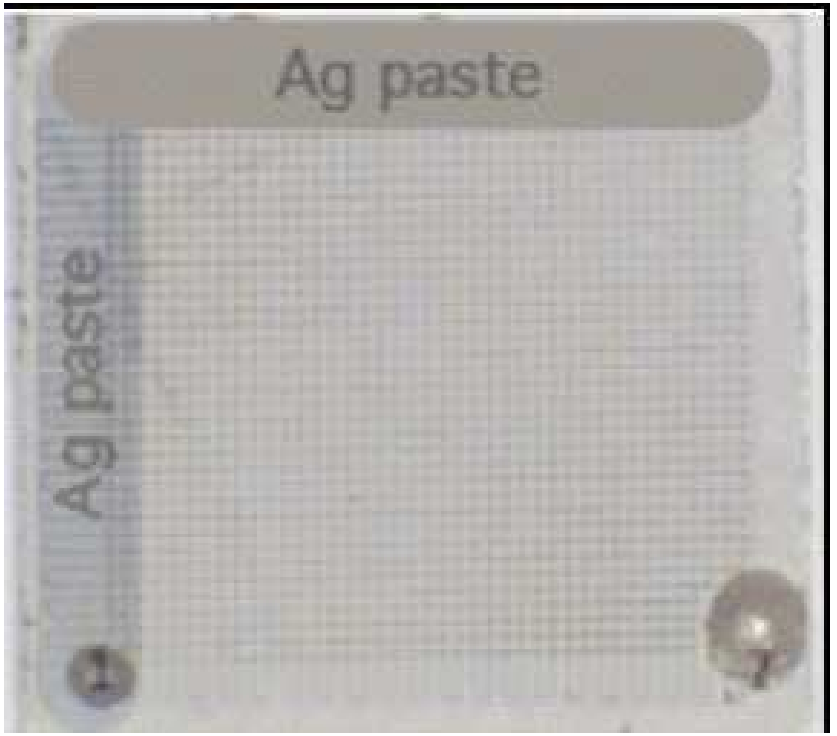
Surface channels are graphitic

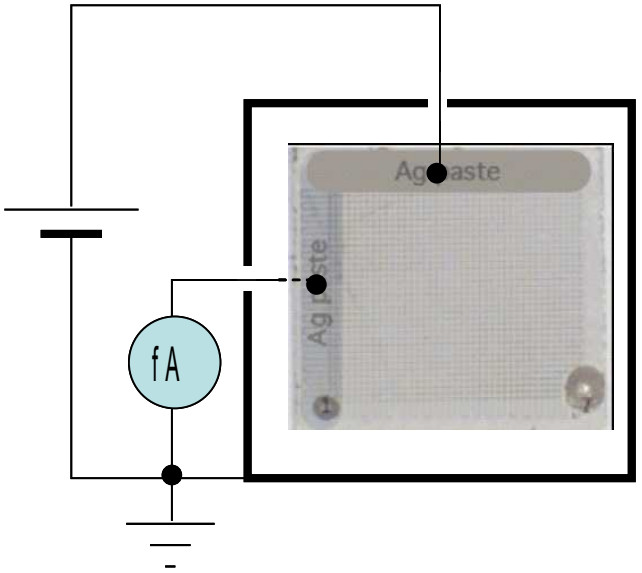


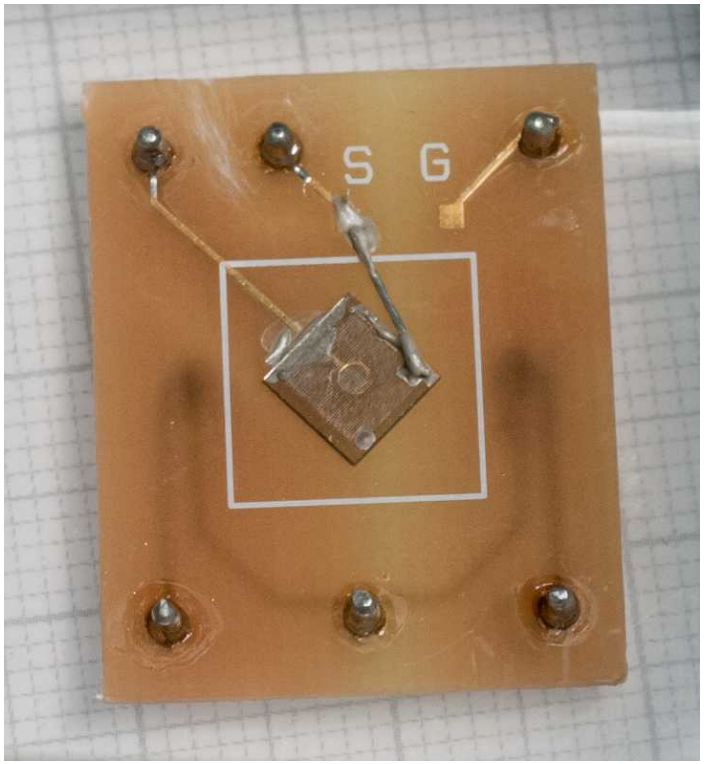




Diamond detector with graphite contacts



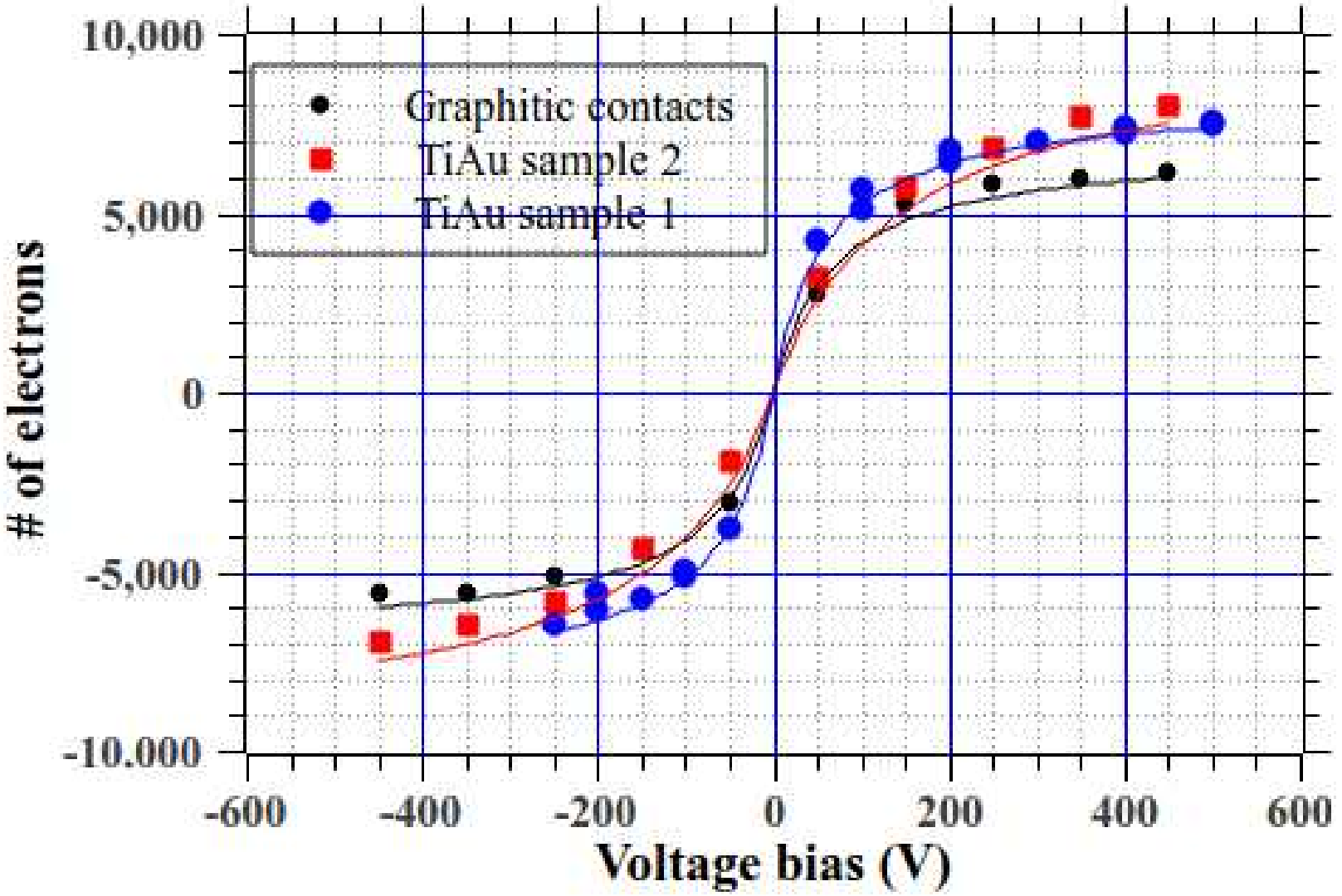




$C = 2.4$ pF

$R \sim 10^{15}$ Ω

Comparison between graphite and standard (Ti-Au) contacts
Three samples of the same quality and geometrical thickness



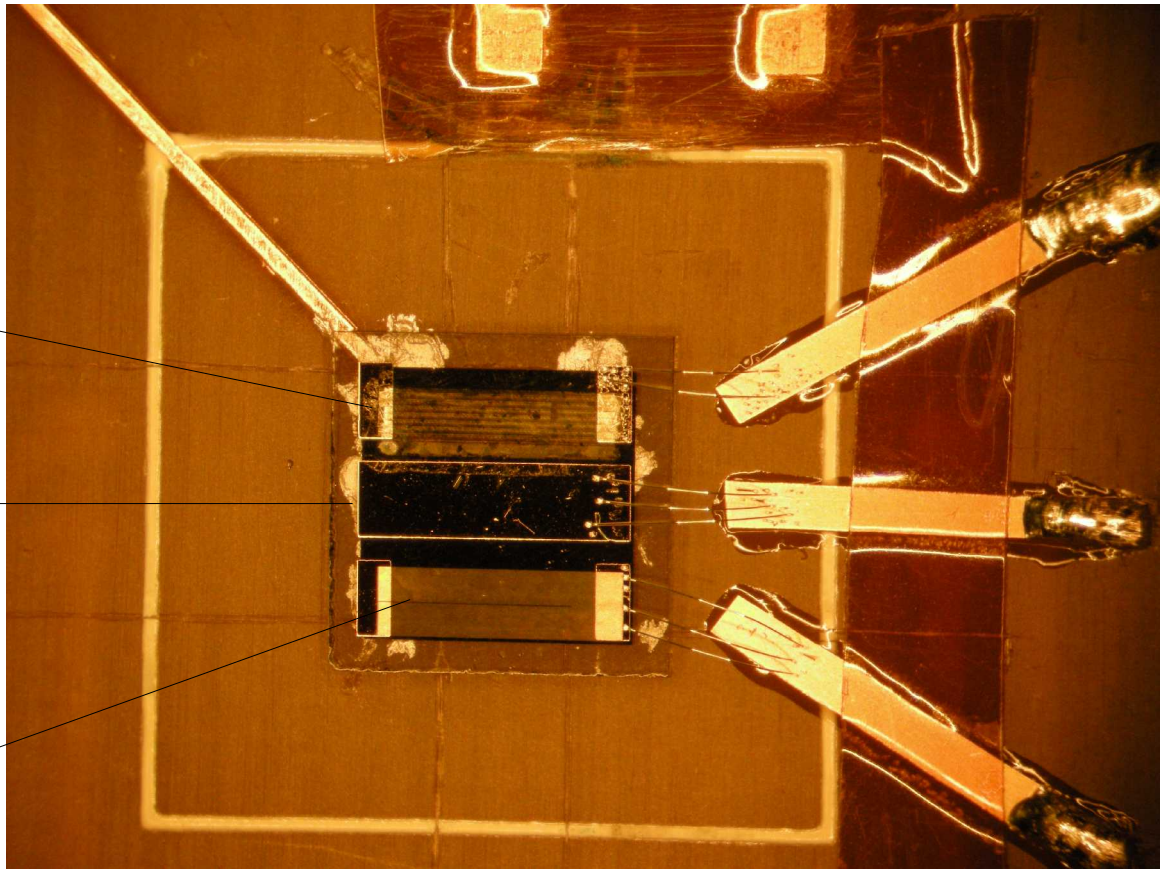
Agreement in the mesaurements according to the lower sensitive volume thickness of the graphite detector

Struttura attualmente sotto test

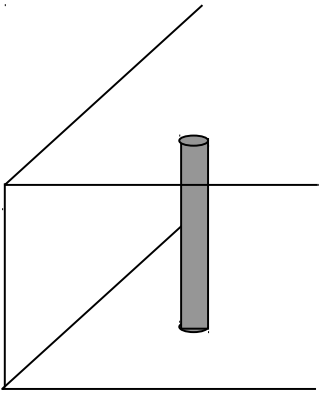
Contatto Grafitico INFN Lecce

Contatto TiAu

Contatto Grafitico INFN Firenze



Grafitizzazioni di volume senza danneggiamenti in regime di femtosecondo



wires

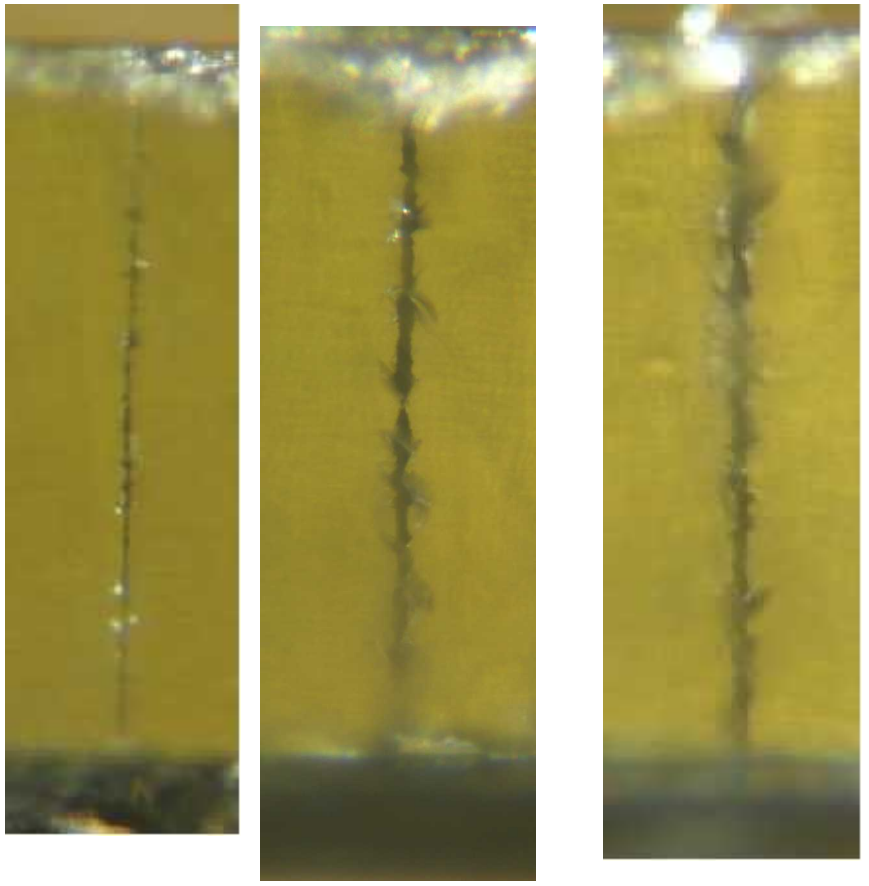
∅ 1.5-5 μm
9 μJ/pulse

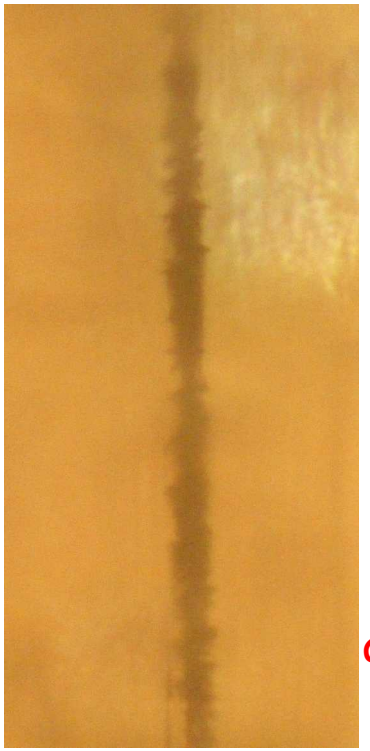
∅ 6.5-8.5 μm
12 μJ/pulse

∅ 9-12 μm
15 μJ/pulse

∅ 8-10 μm
1.5 μJ/pulse

500 μm





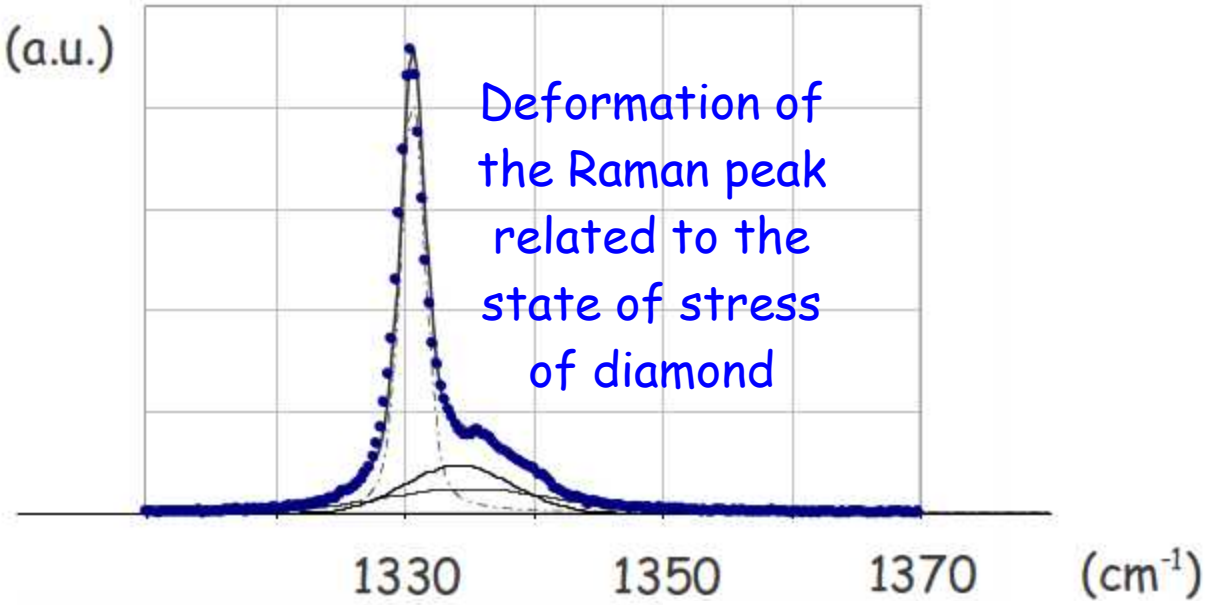
fs columns
ρ =800 mΩ cm

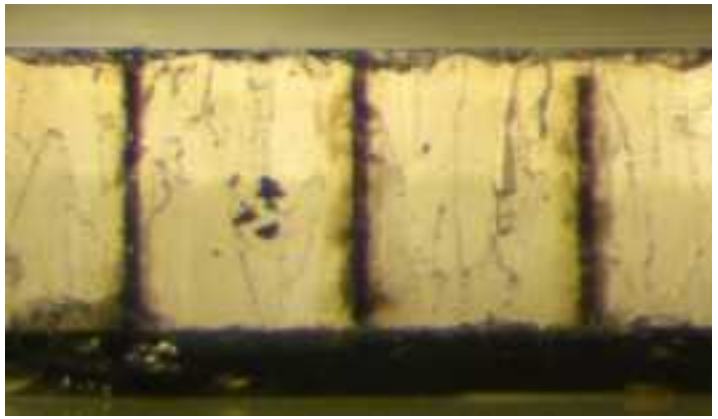
ρ =400 mΩ cm
after annealing

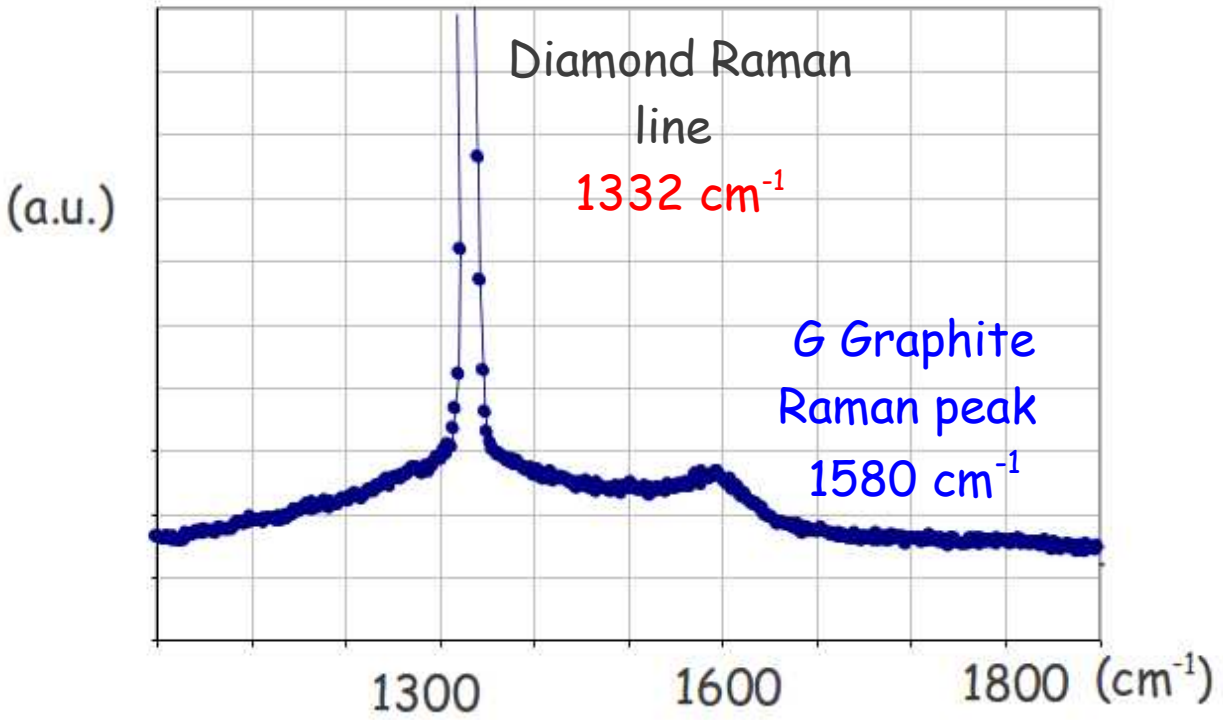
ns columns
ρ =60 mΩ cm

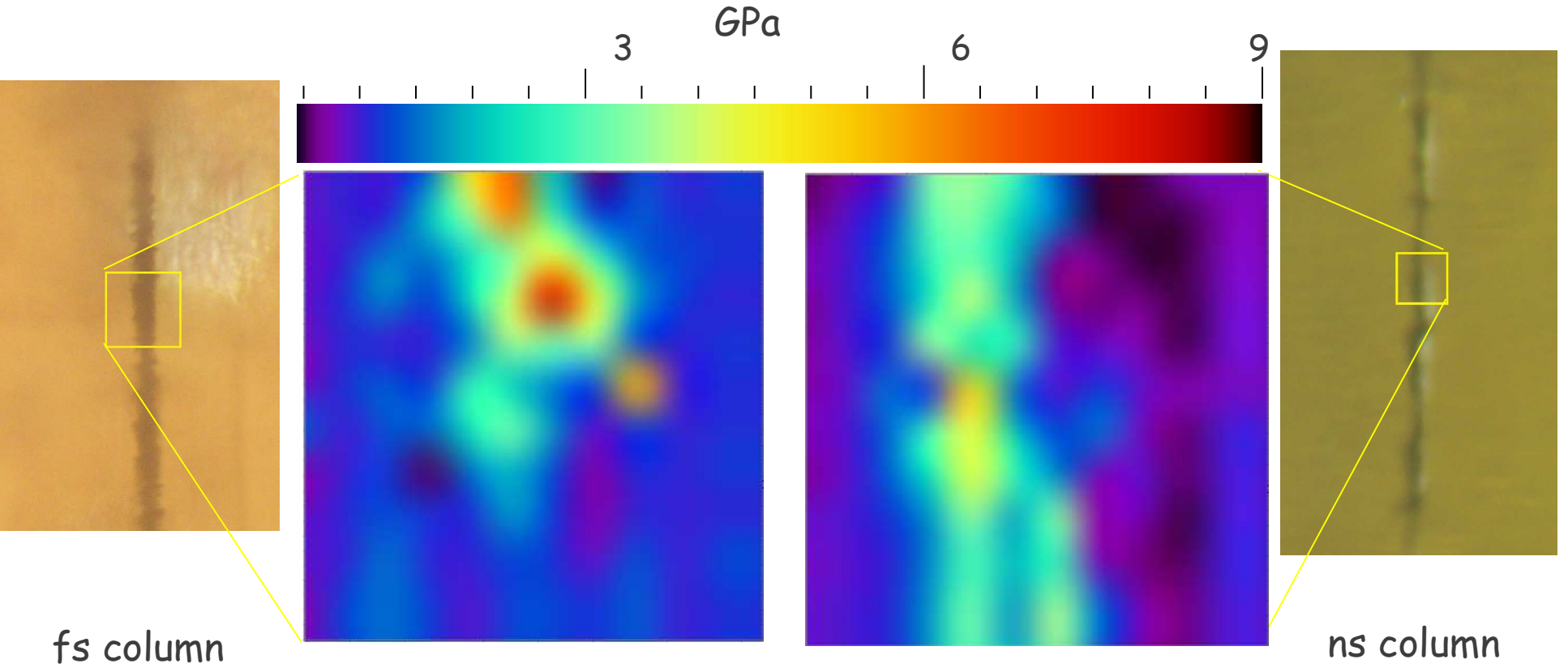
After annealing in Ar at 1050 K
15 <ρ<100 mΩ cm

Raman Spectroscopy of buried structures





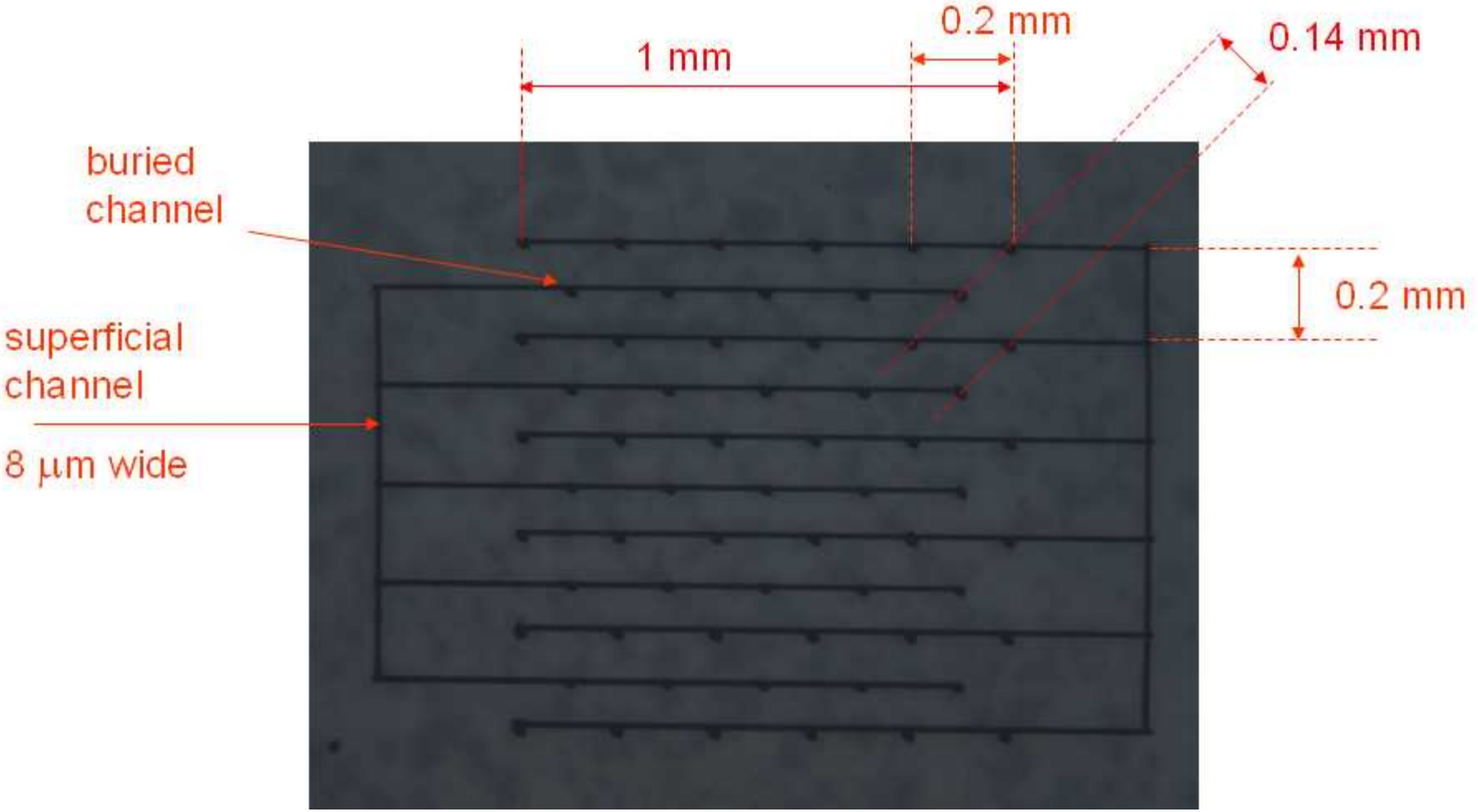




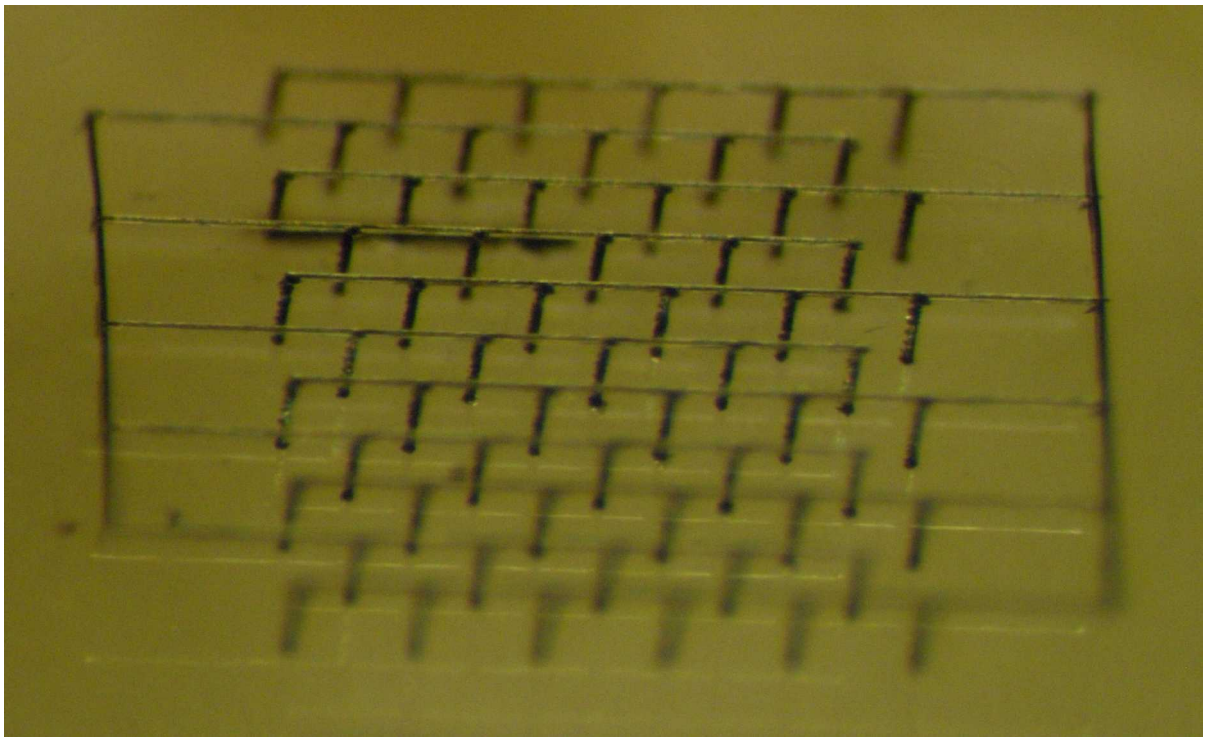
Compressive stress maps

3D detector primo tentativo

A proof-of-concept prototype was fabricated arranging 61 (36+25) staggered wires in a 1x1mm^2, 0.5 mm-thick polycrystalline detector-grade diamond, and contacting them with two inter-digitated graphitic combs.



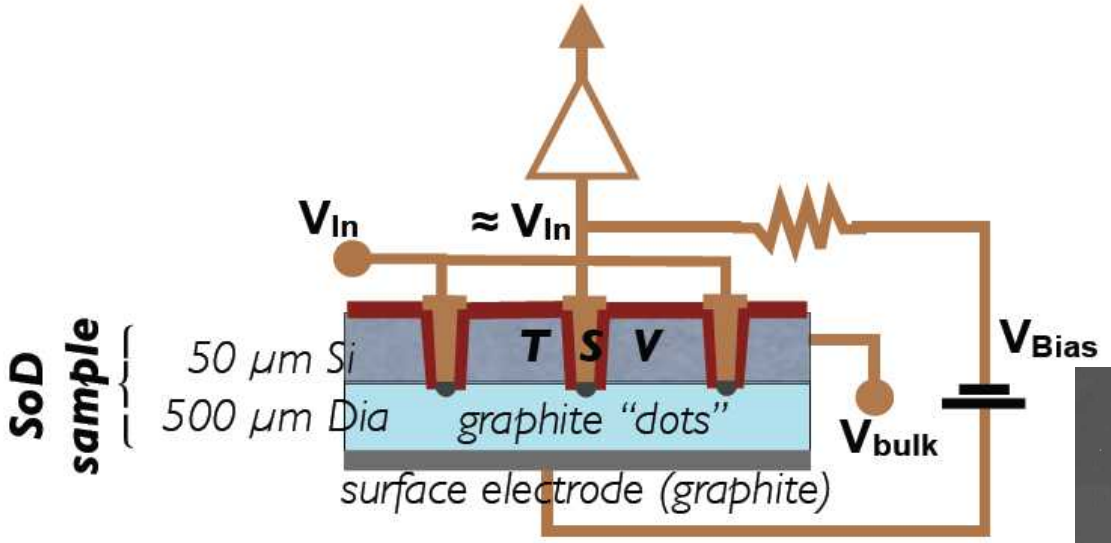
A proof-of-concept prototype was fabricated arranging 61 (36+25) staggered wires in a 1x1mm^2, 0.5 mm-thick polycrystalline detector-grade diamond, and contacting them with two inter-digitated graphitic combs.

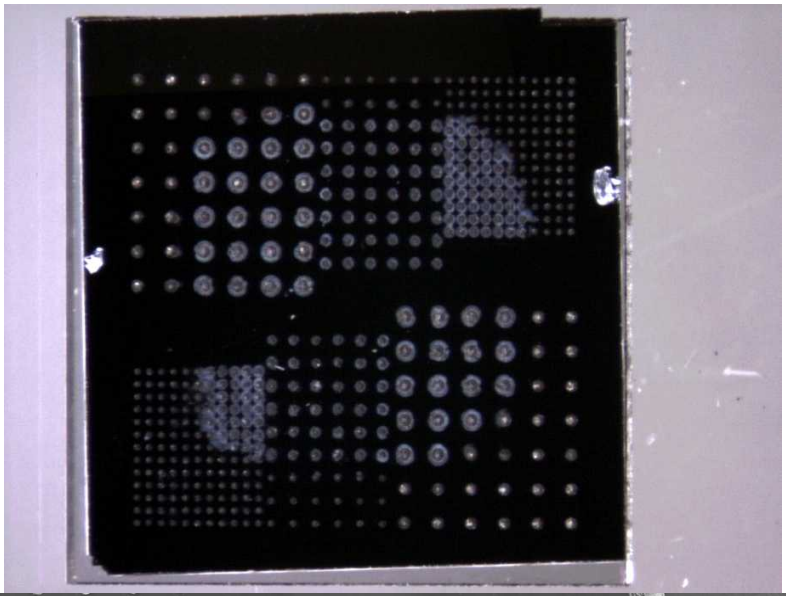


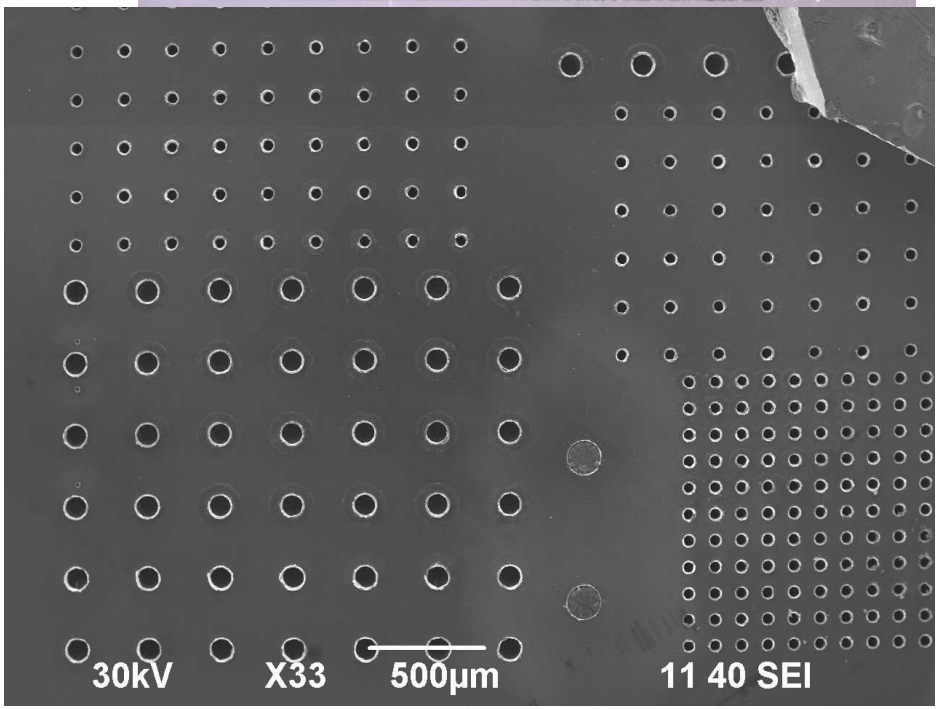
Buried channels are 500 μm long, they seem shorter due to the high refractive index of diamond.

SOD PROTOTIPI DA REALIZZARE NEL 2013

Prototipo 0
In fase di lavorazione

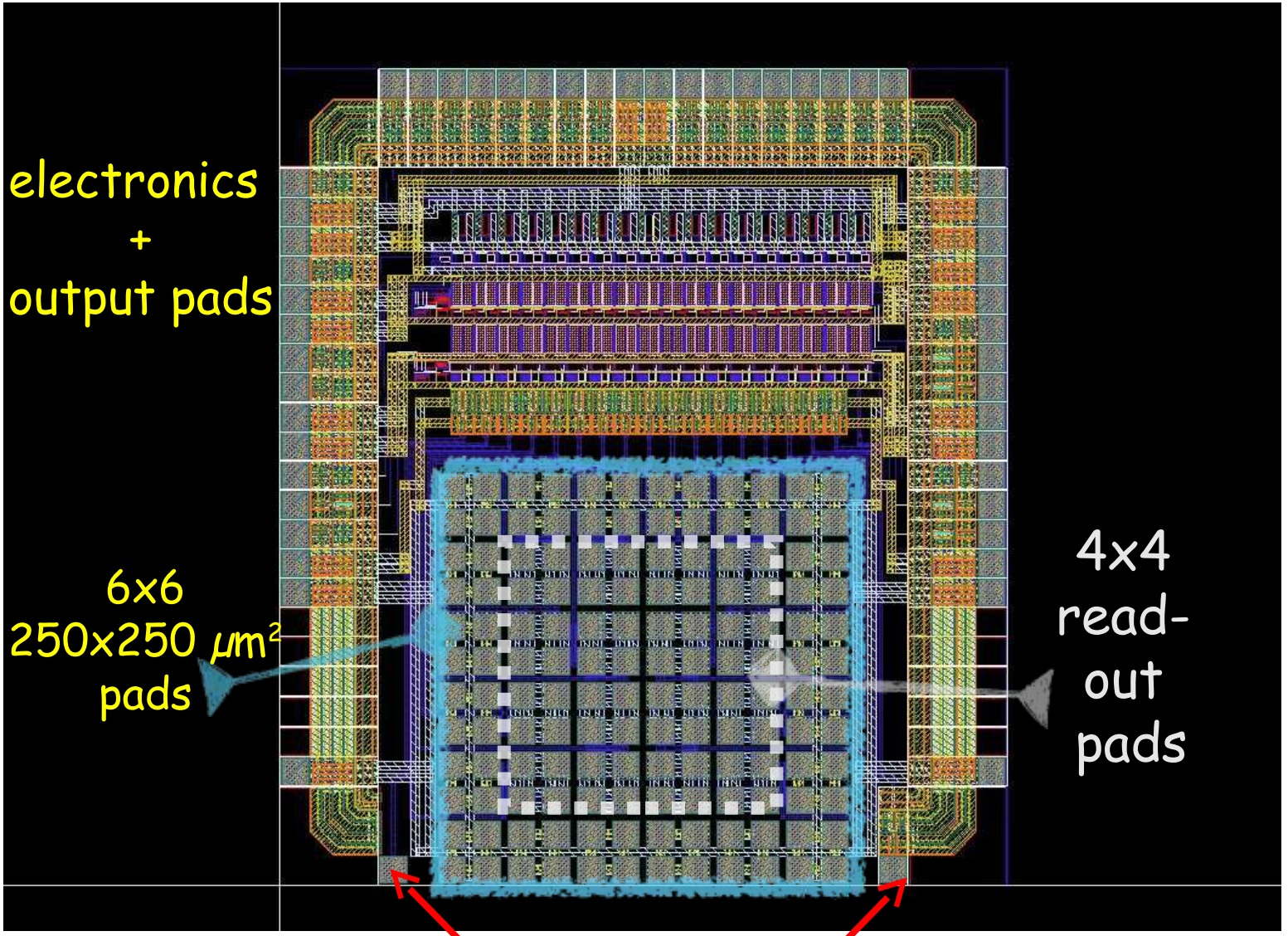






PROTOTIPO 1 CHIPSODIA chip

(G. De Robertis, F. Loddo e A. Ranieri - BA)



≈ 3x3 mm²

CMOS 0.35 μm

τp = 500 ns

ENC 135+30

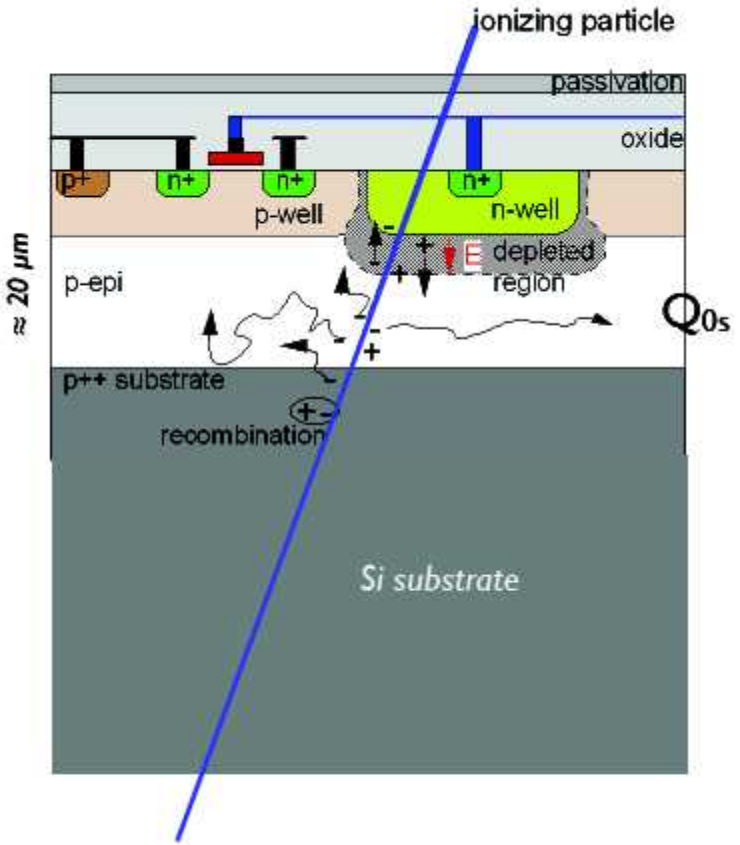
e/pF

2 extra channels

25 chip attualmente sotto test

Maps on diamond: una scorciatoia

I Monolithic Active Pixel Sensors (MAPS) lavorano sulle poche cariche (≈ 1000 el.) integrate nella depletion well del diodo e generate anche al di fuori entro un MFP (< 20 μm).



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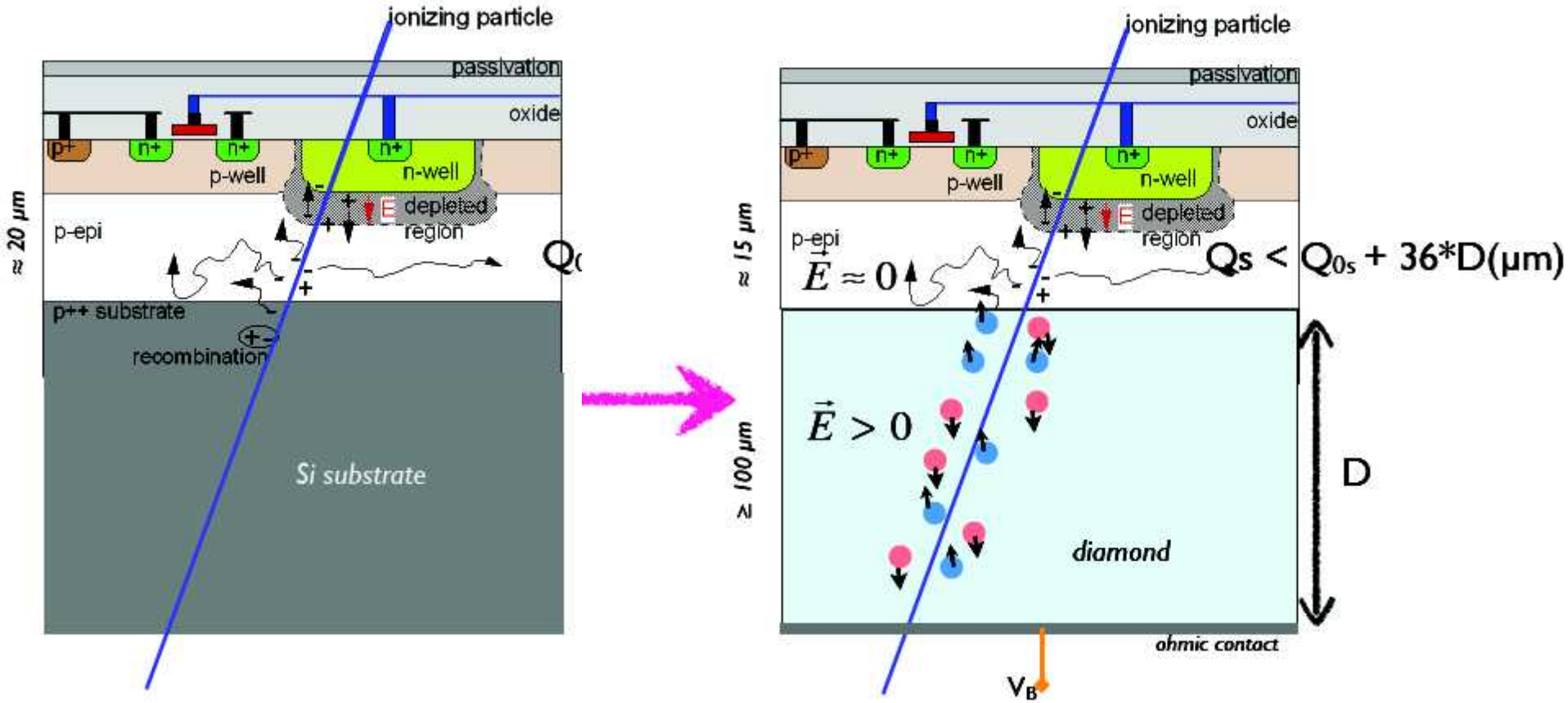
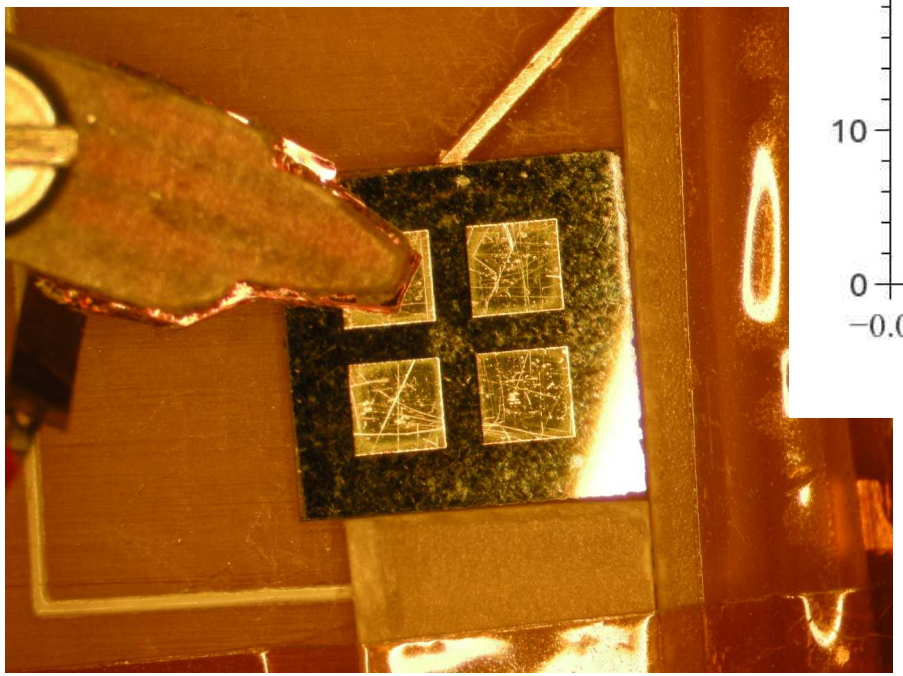
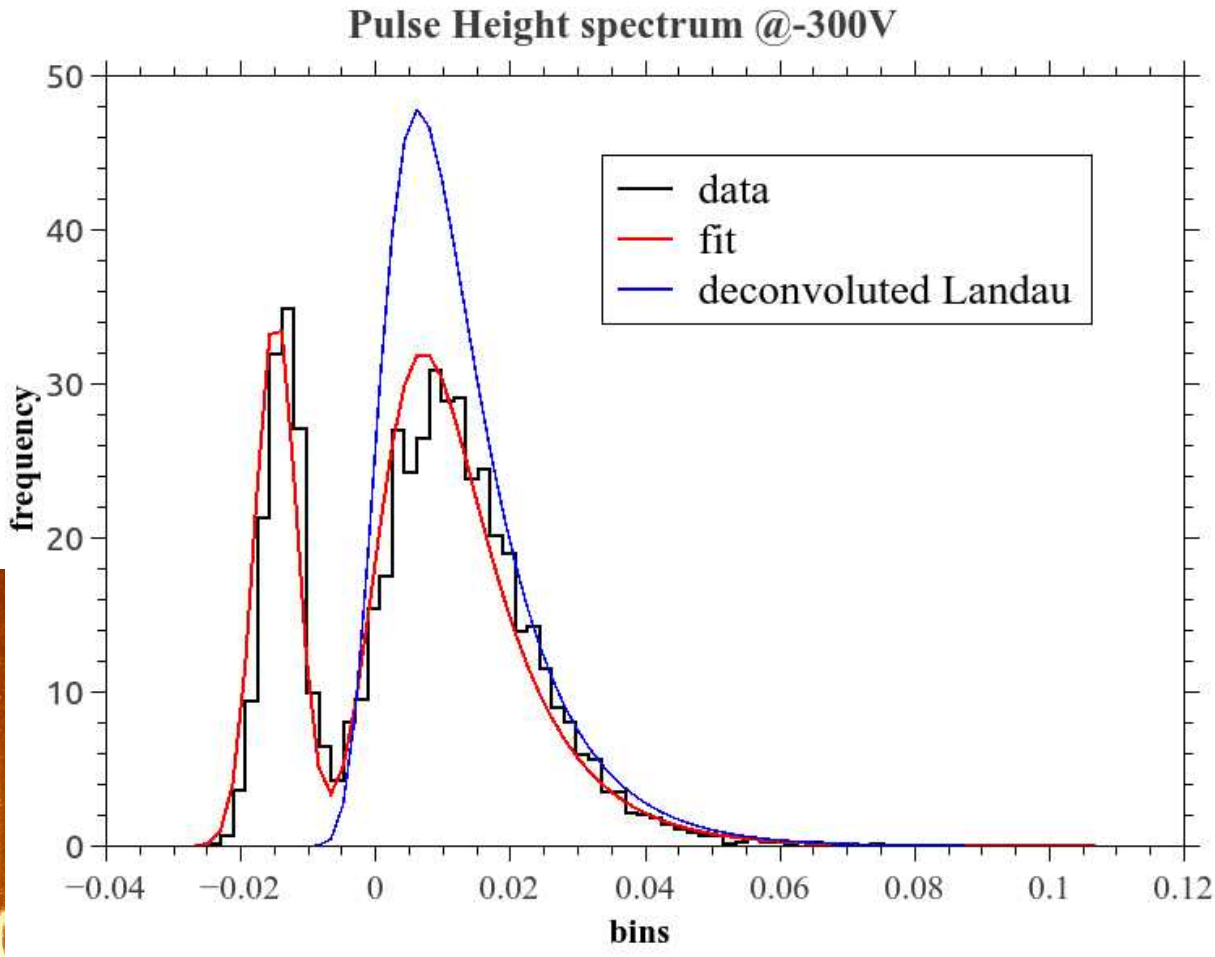
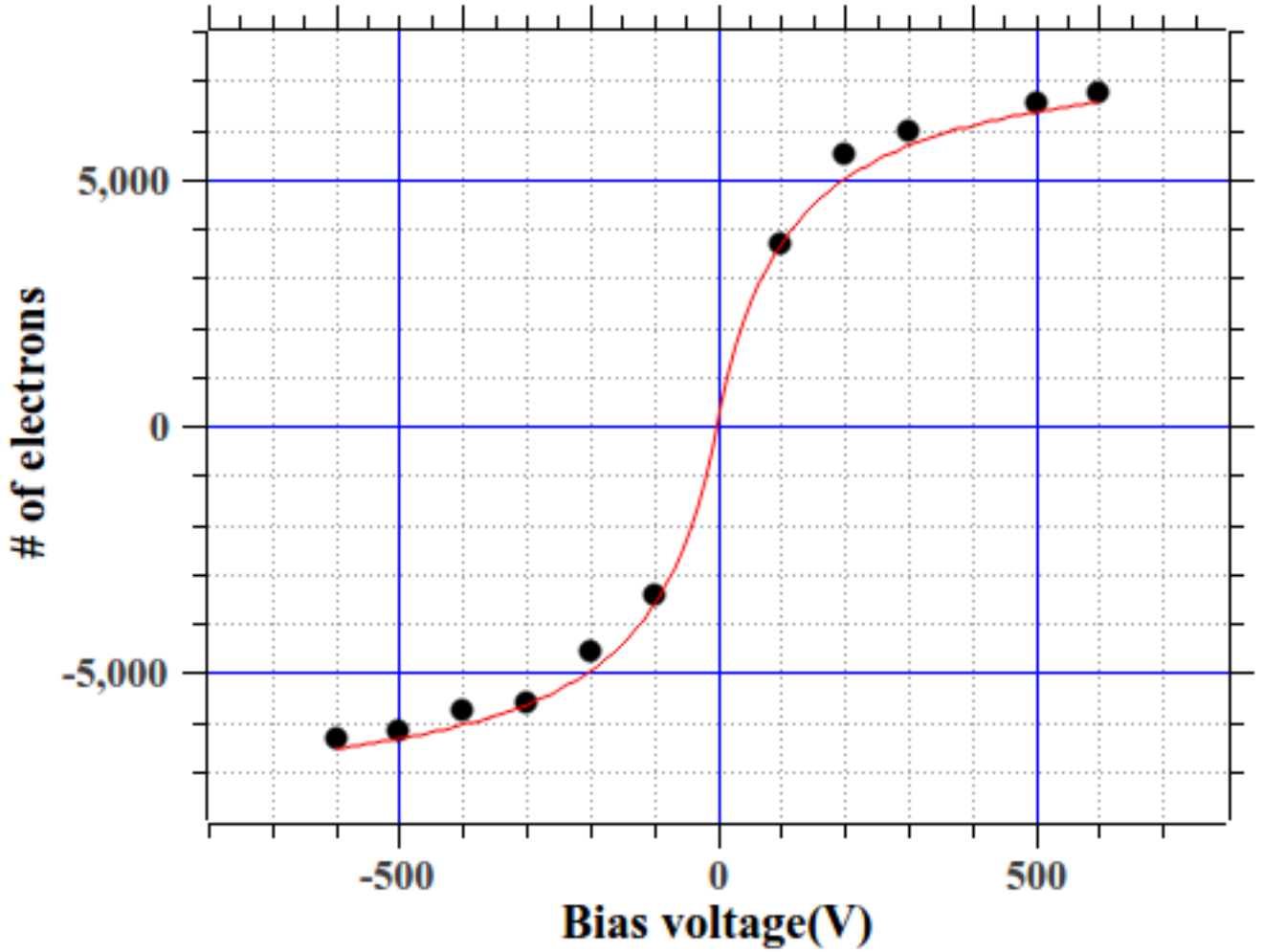


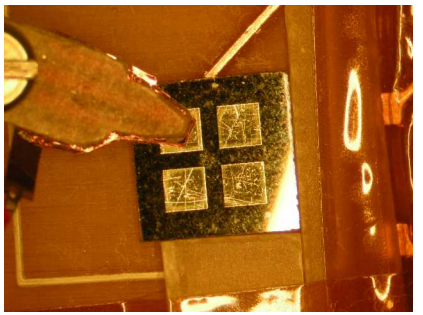
Le cariche vengono raccolte attraverso l'interfaccia si-diamante

SOD28 Cr-Au contacts on diamond,
500 μm thick,
Al contact on Si , 50 μm thick
Antonio de Sio & Emanuele Pace
Department of Physics &
Astronomy, Florence









Charge is collected through the bonding Si-diamond interface