DIAPIX

Responsabile Nazionale: G. Chiodini

Sezioni: CT (NEW), FI, LE, LNS, MIBI, PG, PV, Roma3

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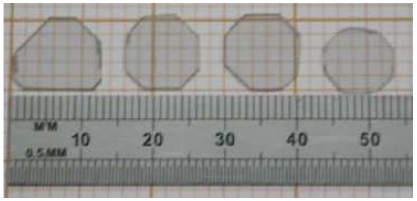
Presentazione Preventivi INFN Lecce
7 Luglio 2011

Outlook

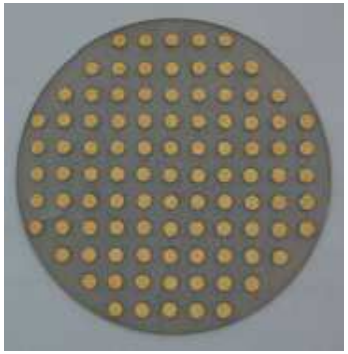
- **Introduction to DIAPIX (DIAmond PIXel)**
- **Attivita' WP1**
- **Attivita' WP4**
- **Attivita' 2012**
- **Partecipanti**
- **Richieste 2012**

DIAmond PIXel: CT-FI-LE-LNS-MIBI-PG-PV-RM3

Nowadays, 6'' wafer polycrystalline Chemical Vapor Deposition (CVD) Diamonds are available on the market featuring a charge collection distance above 250 μm.

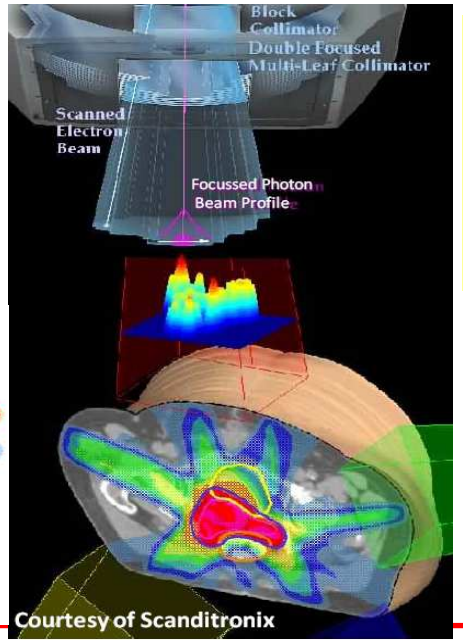


Small size single-crystal diamonds



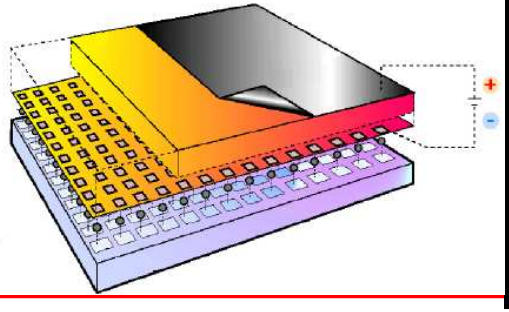
Large size poly-crystal Diamond wafer

This opens up the possibility to manufacture large area detector modules for HEP and medical applications.

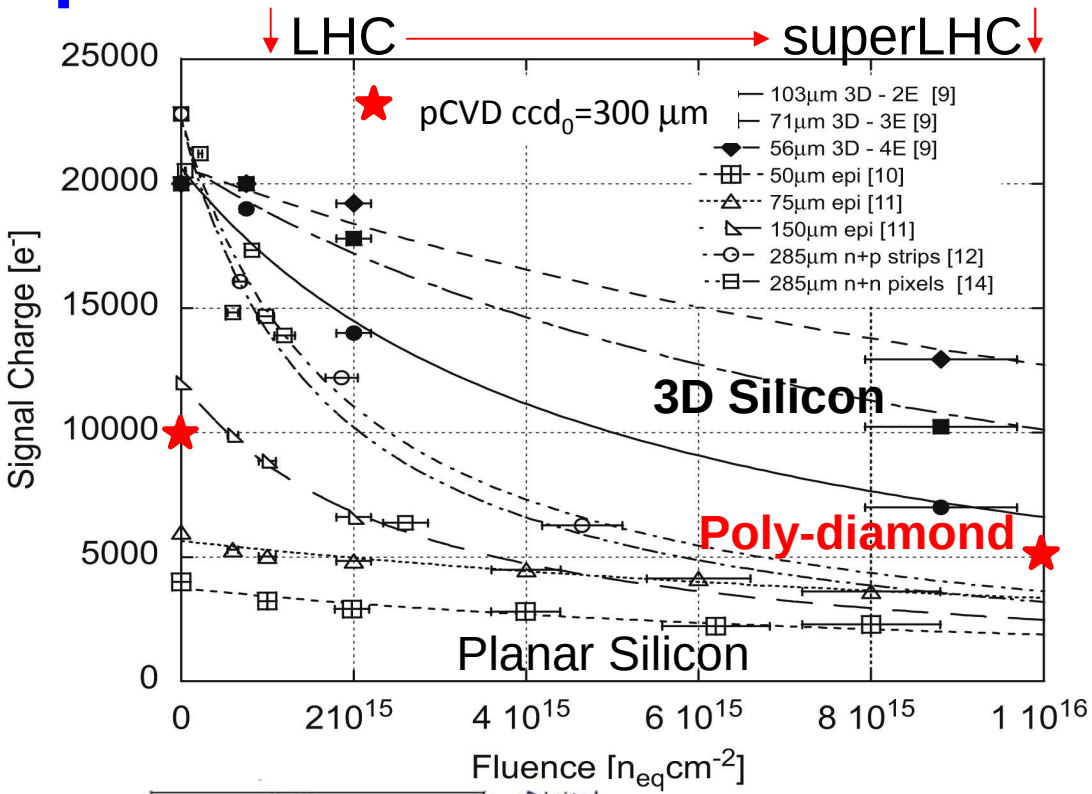


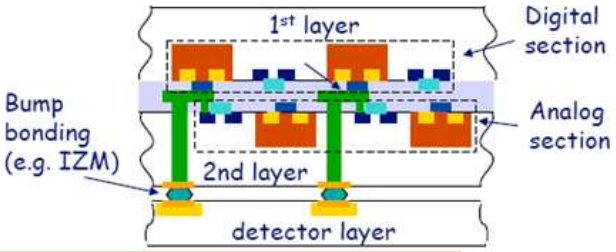
Large area bi-dimensional dosimeter for IMRT radio and hadrons therapy

Ultra-radiation-hard hybrid pixel detector for next generation high luminosity experiment



Ultra-radiation-hard Diamond Pixel





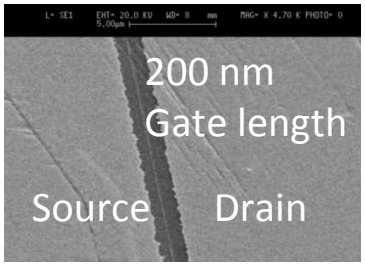
Next generation FE: 3D vertical scale integration electronics for high resistivity sensors

Diamond pros:

- Superior Rad-Hardness
- Superior S/N figure
  - Negligible I_{Leak}
  - Lower C
- Much simpler mechanics:
  - Operable at Room T
  - Excellent thermal conductivity

Diamond cons:

- Smaller signal



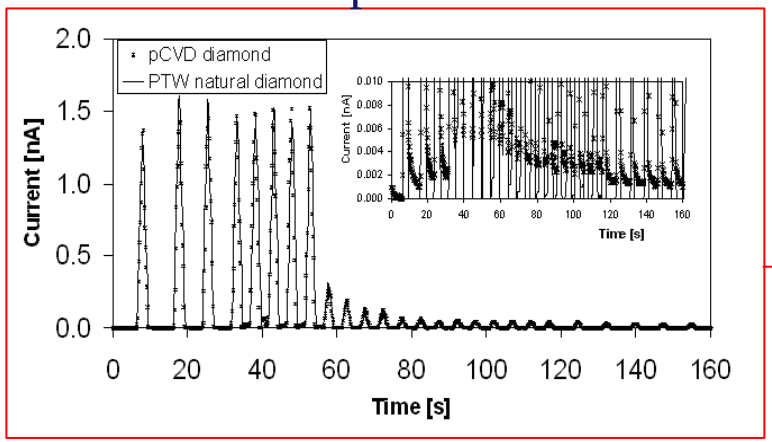
Novel approach: Integrate MESFET diamond as 1-st stage preamplifier

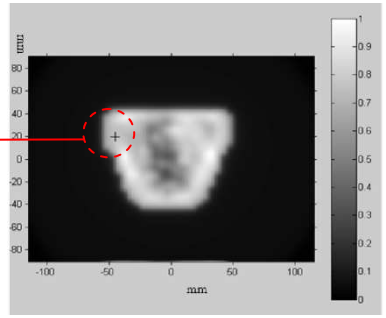
WP1: LE-MIBI-PV (L. Moroni)

WP3: RM3 – PG (G. Conte)

Bi-dimensional diamond dosimeter for IMRT in radio and hadron therapy

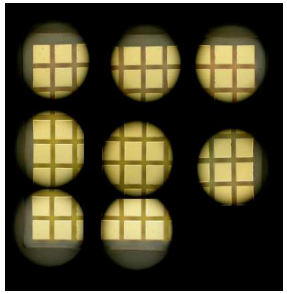
pCVD and PTW diamonds in IMRT field for "step and shoot" mode



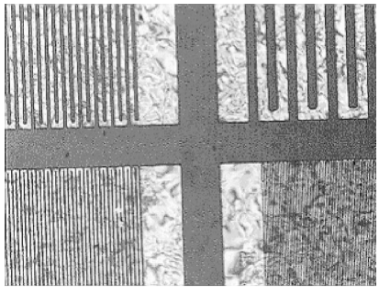


Diamond pros:
- Rad-Hard
- Linear response with dose
- Tissue equivalence (Z=6)

Diamond cons:
- Tail dynamical response



Optimized zero bias contacts for poly:
TiAu metallization:
- **1mm x 1mm pixels**
- **Back contact**



Metal less graphitic contact: Diamond surface graphitization by laser techniques

WP2: FI-LNS (M. Bucciolini)

WP4: LE (M. Martino)

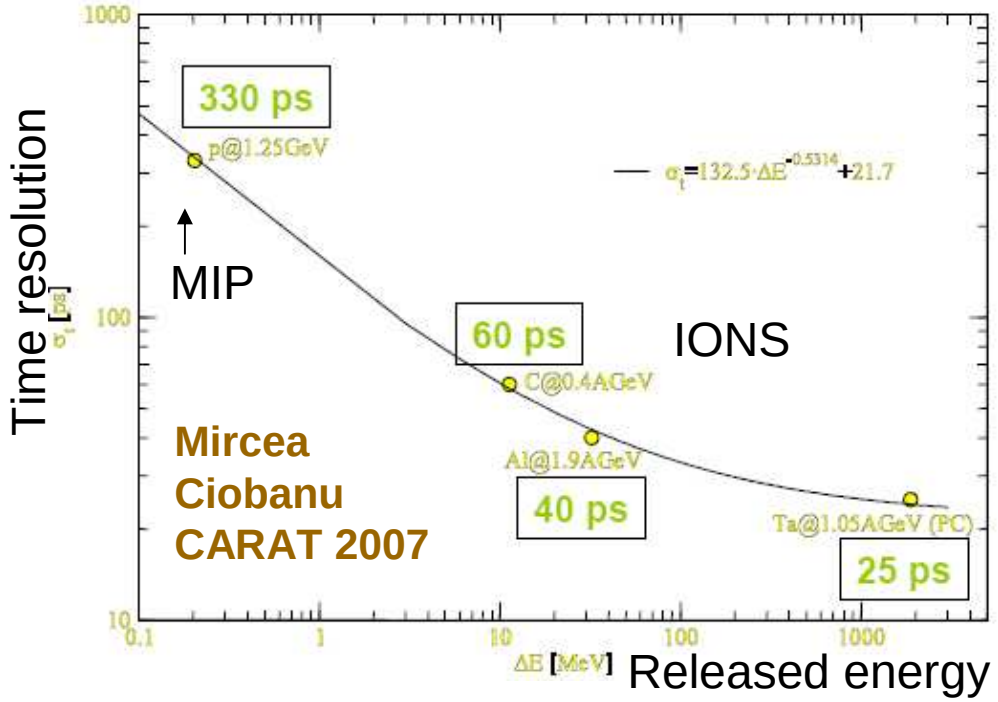
Fast timing with diamond detector for high intensity accelerators (NEW WP)

Time walk: corrected by constant fraction techniques or offline by measured amplitude
Time jitter: reduced by lower noise, faster signal and higher gain

$$\sigma_t^{\min}(t_{\det} = t_{rise\,time}) = \propto \frac{\sqrt{t_{\det}}}{V_0}$$

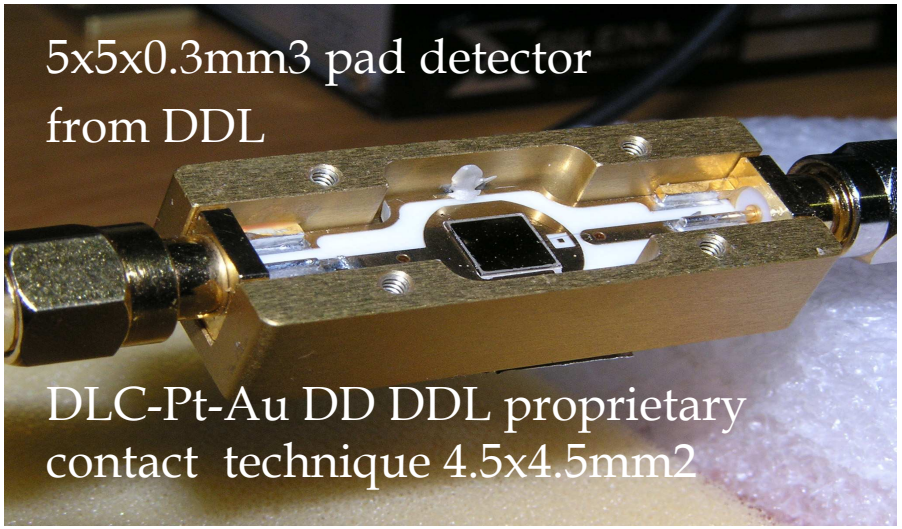
Diamond pros:
- Fast rise time (<< 140 ps)
- Reduced balistic effect
- Low Capacitance

Diamond cons:
- Small signal



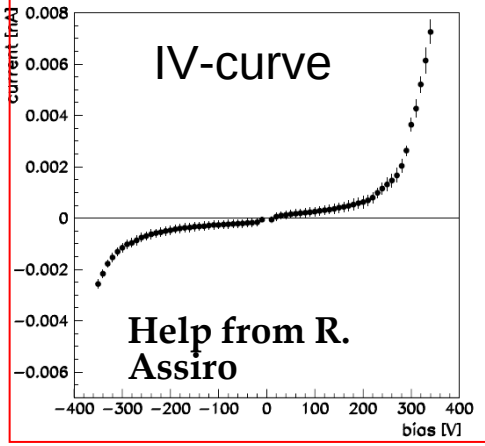
WP5: CT(N. Randazzo)
-FI-LE-LNS-MIBI-ROMA3-PG-PV

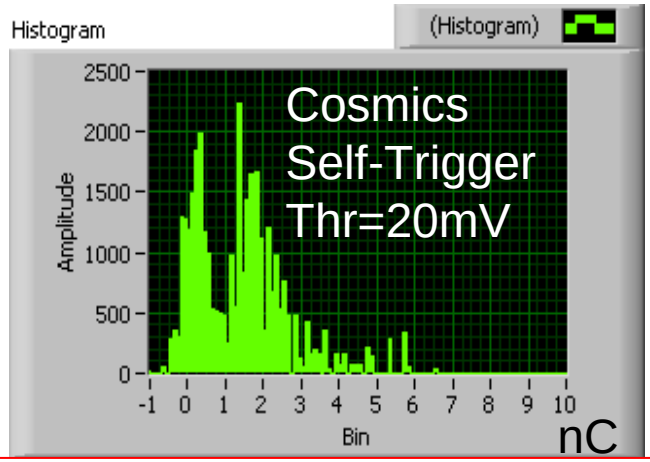
Attivita' WP1 in Lecce

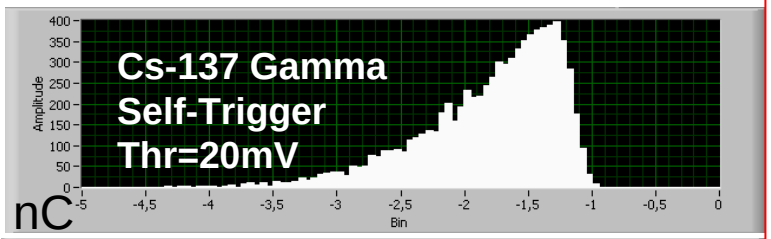


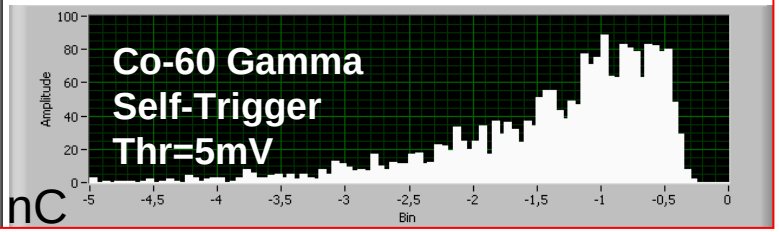
R. Perrino

1 nC ---> 3000 e^- after calibration





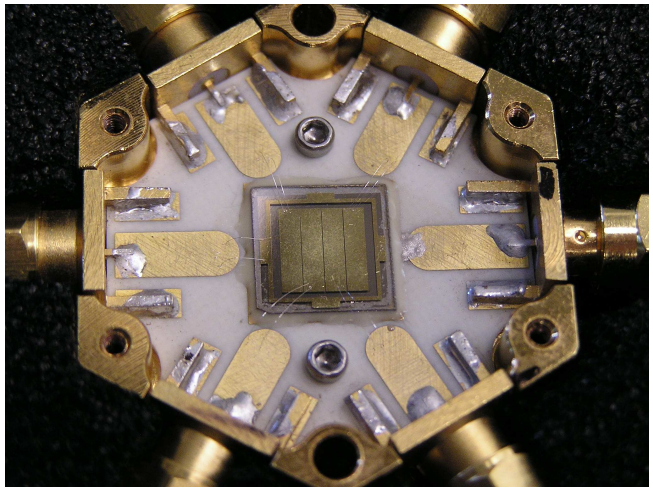


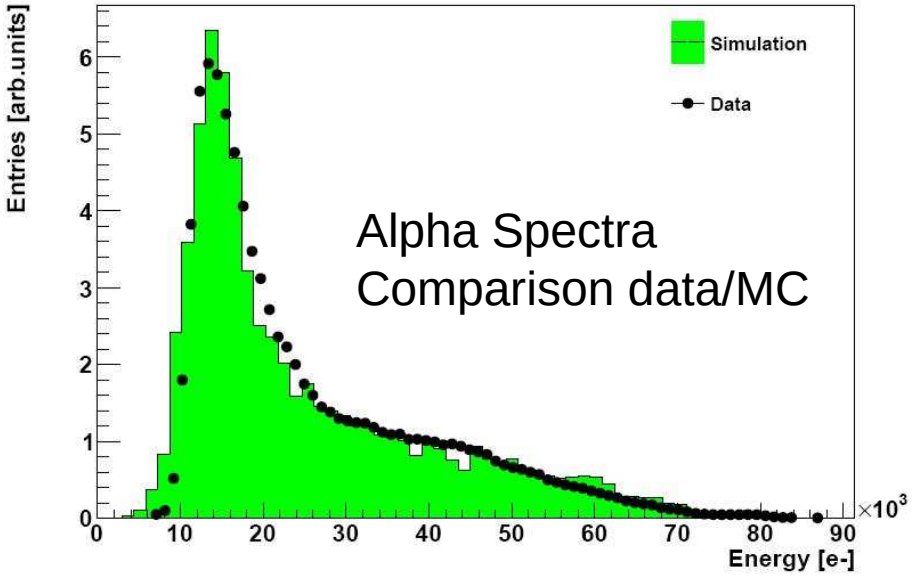


Attivita' WP1 LE-MIBI

P. D'Angelo (MIBI)

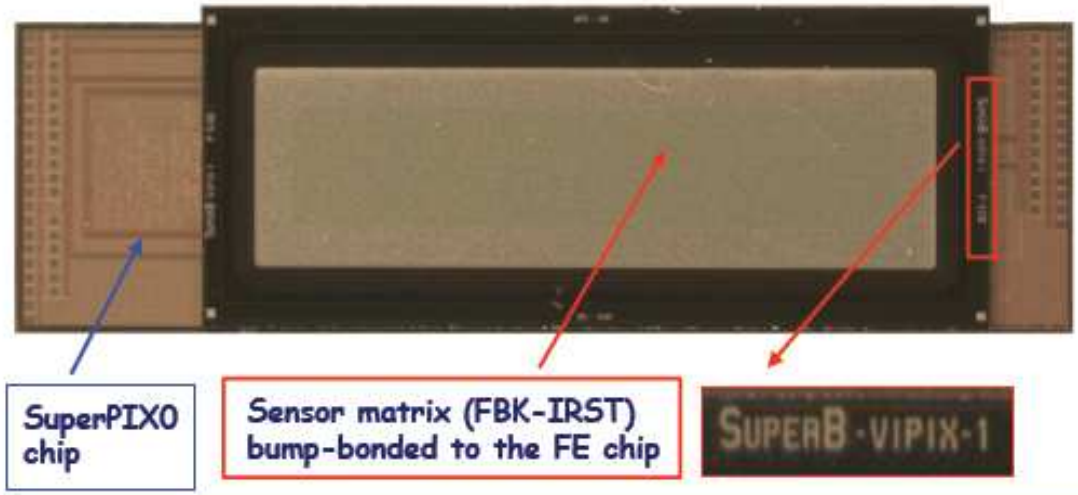
- 2 strip detectors at MI-BI
- Charge sharing studies with alpha in progress
- Simulations:
  - Released energy in diamond from Alpha, Beta, Gamma sources with Geant4 (Chiodini,Spagnolo)
  - Charge transport, induced signal and surface/bulk phenomena modeled with MATHLAB (Chiodini, M . Dinardo University of Boulder)





Attivita' WP1 LE – MIBI -PV

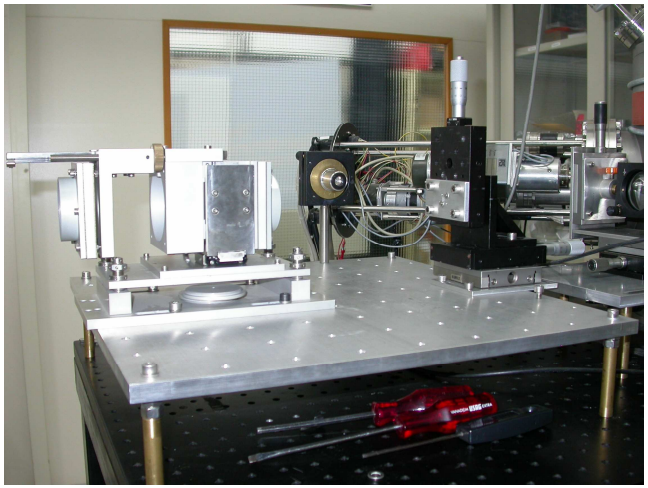
- Sottomissione del chip superPix1 di front-end 3D (matrice 32x128, 50um di pitch) prevista per la fine del 2010 è stata posticipata
- Vogliamo procedere ad integrazione fra SuperPIX0 (130nm ST, matrice 32x128, 50um pitch) e un sensore a pixel al diamante
- Necessario sblocco sj dei referee (12.5 MiBi+7.5 PV = 20 keuro)



- ST-130 nm CMOS technology
- 4k pixels (32x128), 50x50 um^2
- readout architecture: optimized with target hit rate (100 MHz/cm^2) on a full-size chip (~1.3 cm^2)
- VHDL simulation: r.o. efficiency > 98% @ 60 MHz r.o. clock
- Good quality of the interconnections on a 50x50um^2 pitch: 5 defects on 2 chip~6x 10^{-4}

S. Bettarini, "First results on hybrid pixel front-end with sensor", presented at the XV SuperB General Meeting, Caltech (USA), 14-17 Dec. 2010.

Attivita' WP4 in Lecce

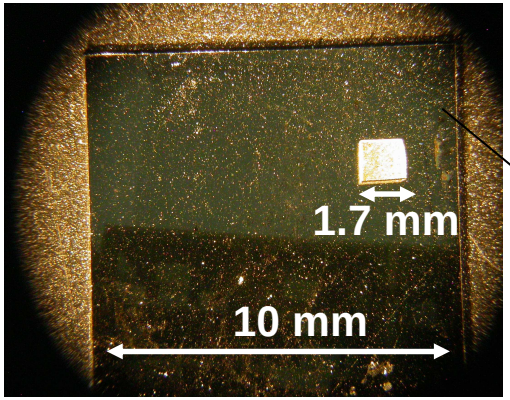


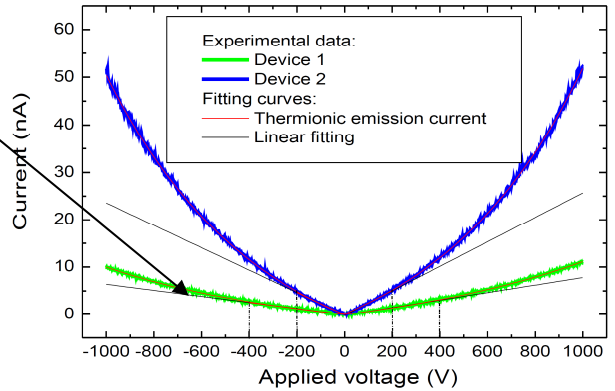
Optical set-up

L^3 laboratory of Prof. M. Martino and his group.
Excimer multigas laser:

- ~800 mJ/pulse @ 248 nm ÷ ~ 500 mJ/pulse @ 193 nm
- 20 ns pulse
- 193 nm absorbed by diamond (ArF mixture)
- 248 nm transparent to diamond(KrF mixture)

Graphitization on thermal grade diamond both side: improved ohmic behavior with silver paint





Graphitization on detector grade diamond with ArF in progress (lenses problems)

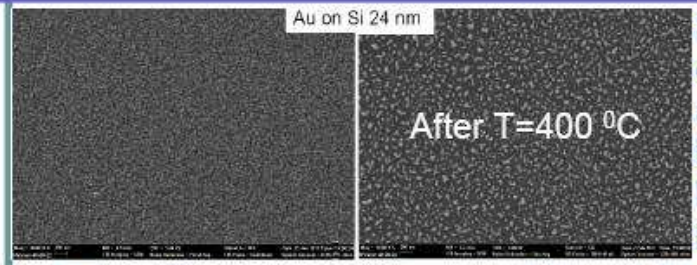
Attivita' WP4 in Lecce

A.P. Caricato

It is a well know phenomena that nanostructured material melting point is well below the bulk melting point

We intend to apply this basic idea to sensor-single chip bonding

Preliminary tests at University of Salento with nanoclusters delivered by Thetis S.P.A.



SEM pictures of Au nanoclusters deposited on Si substrate before and after nanocluster fusion induced by thermal treatment. Test with lower temperatures and back-to-back bonding are under way.

The coatings were realized by Tethis S.P.A. by Pulsed Microplasma Cluster Source (PMCS) coupled to a Supersonic Cluster Beam Deposition (SCBD) system. The PMCS is a patented technology owned by Tethis S.P.A.

The deposition process is at room temperature and is compatible with many kind of substrates, as: silicon, metal oxides, metals, polymers,...

Patterned coatings directly on the substrate by means of hard masks have a typical resolution close to micrometric scale and no post-deposition treatments are needed. Other patterning approaches, as photo-lithography and lift-off techniques, are compatible with the SCBD.

Attivita' 2012

WP1

- Test di irraggiamento ai laboratori nazionali del sud in collaborazione con il gruppo di Mi-Bi e Catania
- Realizzazione e test di rivelatori al diamante con superPIX1 (3D) in collaborazione con Mi-Bi e PV
- Realizzazione sistema di acquisizione dati per rivelatori a pixel ibridi in collaborazione con Mi-Bi
- Test di timing con il diamante

WP4

- Movimentazione 3D sensore da grafitare (finanziati solo due assi nel 2011)
- Realizzazione elettrodi grafitati a geometria a strip e pixel
- Test di saldatura sensore e pixel con materiale nanostrutturato

Partecipanti 2012

WP1

- G. Chiodini - Ricercatore INFN CSN1 30%
- R. Perrino - Ricercatore INFN CSN3 30%
- S. Spagnolo - Ricercatore Università del Salento CSN1 20%
- G. Fiore - Tecnico meccanico INFN 30%
- C. Pinto - Tecnico elettronico Università del Salento 30%
- A. Leone - Tecnico laureato elettronico INFN 30%

WP4

- E. Alemanno - Dottorando Università del Salento CSN5 100%
- A. P. Caricato -Ricercatore Università del Salento CSN5 30%
- M. Martino - Professore associato Università del Salento CSN5 100%
- M. Catalano - Ricercatore CNR-IMM 20%

Totale FTE=3.3 Ric. + 0.9 Tec.

Richieste finanziarie 2012 WP4-LE

Descrizione	**Costo in euro**	**Note**
Completamento movimentazione computerizzata	2000	Slitta M400 50 mm corsa Euro 1940 (x3)
Gas puri per laser	3000	Miscele per laser ad eccimeri (Ne, Ar, F2, Kr, He)
Deposizione e saldatura materiali nanostrutturati	1000	Deposizione materiali nanostrutturati 200 nm film di Cu e Au. Dispositivo meccanico per saldatura
Materiali consumo	4000	Ottiche laser, lenti, maschere Cr, microsaldature in indio, fotolitografia
Obiettivo UV	1500	Sistema ottico per spot micrometrici a 193 nm
Missioni estere	2500	Presentazione a congressi. Contatti con Universita' americana per wafer bonding, contatti con Mosca.
Missioni Interne	1000	Meeting di collaborazione e contatti con industrie
Totale	**15000**	

Richieste finanziarie 2012 WP1-LE

Descrizione	**Costo in euro**	**Note**
Scheda CAPTAN (virtex4) + Scheda ADC+DAC+HV	1000+ 1000=2000	Realizzazione DAQ per pixel ibridi per bench test e test beam
PS LV da banco con GPIB	1000	Alimenatore per DAQ
2 Amplificatori larga banda (> 1.5 GHz) ed alto guadagno (60 dB)	2 x 1500 = 3000	Necessari per misura diretta del segnale indotto sull'elettrodo di lettura e di difficile reperibilità
Realizzazione circuiti stampati	2000	Test sensori, chip di readout e pixel ibridi
Realizzazione sostegni meccanico	2000	Meccanica e termalizzazione per rivelatori per test di irraggiamento e testbeam
Materiali consumo	2000	Connettori, cavi, minuterie …
Missioni estere	1000	Riunione di lavoro di RD42
Missioni Interne	2000	Irraggiamento ai LNS. Test a Mi-Bi. Contatti con collaborazione DIAPIX
Totale	**15000**	

TOTALE LECCE=30 keuro