PADME MEETING
Lecce, April 5th, 2016

Dr. Mary De Feudis

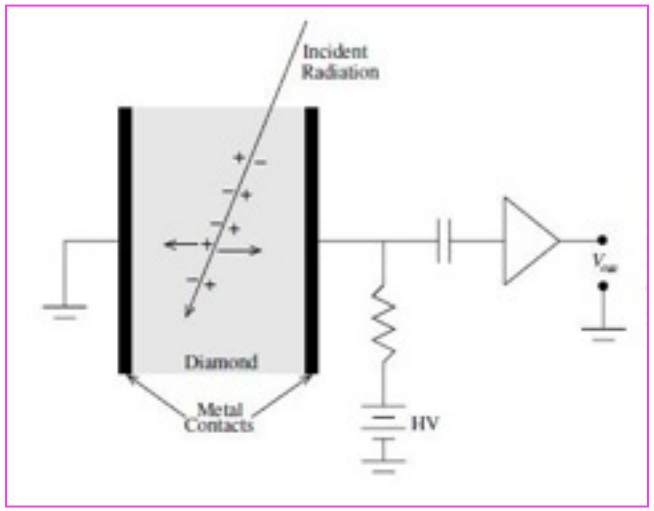
Dep. Mathematics and Physics, University of Salento, Lecce

INFN section of Lecce

DIAMOND DETECTOR

Why Detector of Diamond?

The major problem of solid-state detector is the damage from ionizing radiation.



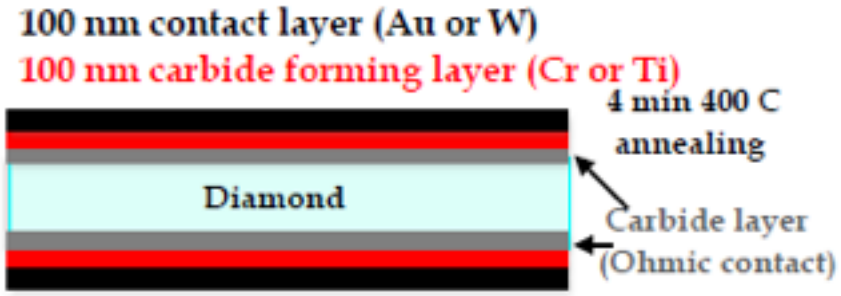
Properties	CVD Diamond	Silicon
Band Gap (eV)	5.5	1.12
Displacement energy (eV/atm)	43	13 - 20
Mass Density (g/cm	3.52	2.33
Dielectric Constant	5.7	11.9
Resistivity (Ω cm)	>10	2.3×10
Thermal Conductivity (W/(cm K))	24	1.5
Breakdown Field (V/cm)	10	3×10
Energy to create e-h pair	13	3.6
Electron Mobility (cm	1800	1350
Hole Mobility (cm	1200	480

Diamond ADVANTAGES:
- ✓ Radiation hardness
- ✓ Low dark leakage
- ✓ High carriers mobility
- ✓ Work at room temperature
- ✓ Tissue-equivalent (Z=6)
- ✓ Biocompatible

Diamond DISADVANTAGES:
- ✓ Low signal
- ✓ Residual polarization

CONTACTING TECHNIQUE

✓ Traditional Contacts



The realization of metal electrodes is not simple!

PROBLEMS:
- Mechanical Adhesion
- Good Charge Injection
- Stability and Reproducibility
- Many steps of manufacturing

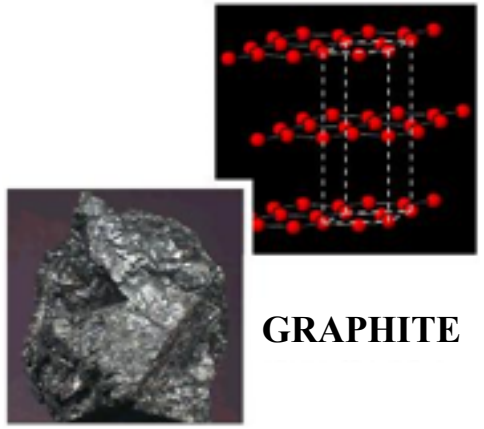
✓ Graphitic Contacts

To resolve the problem of the ohmic good electrode manufacturing it's possible to use the new, reliable and with only one step technique:

GRAPHITIZATION OF DIAMOND BY LASER
- ✓ Radiation-Matter interaction
- ✓ Photothermic process

DIAMOND E

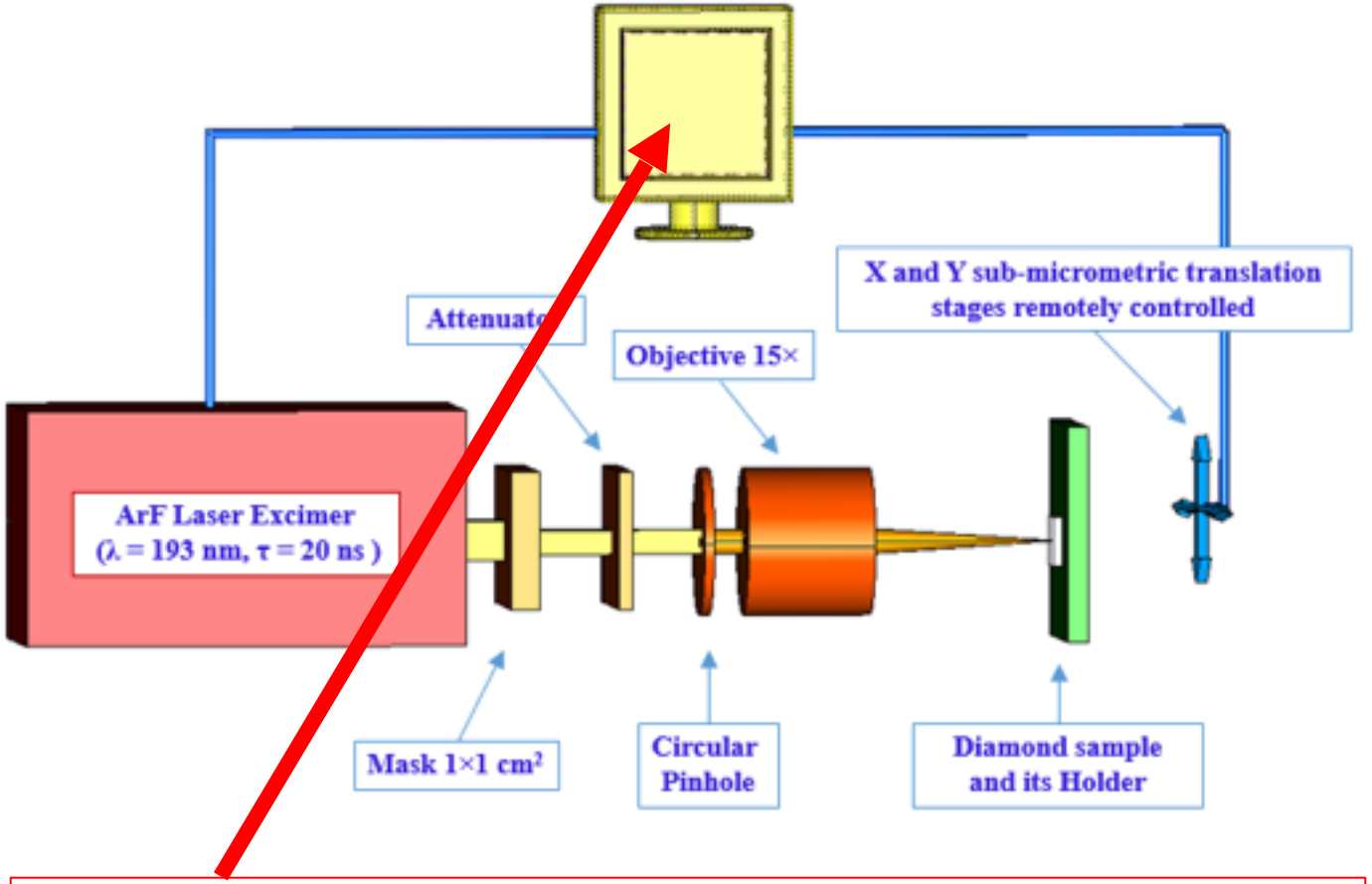
$T > T_g \approx 700°C$



GRAPHITE

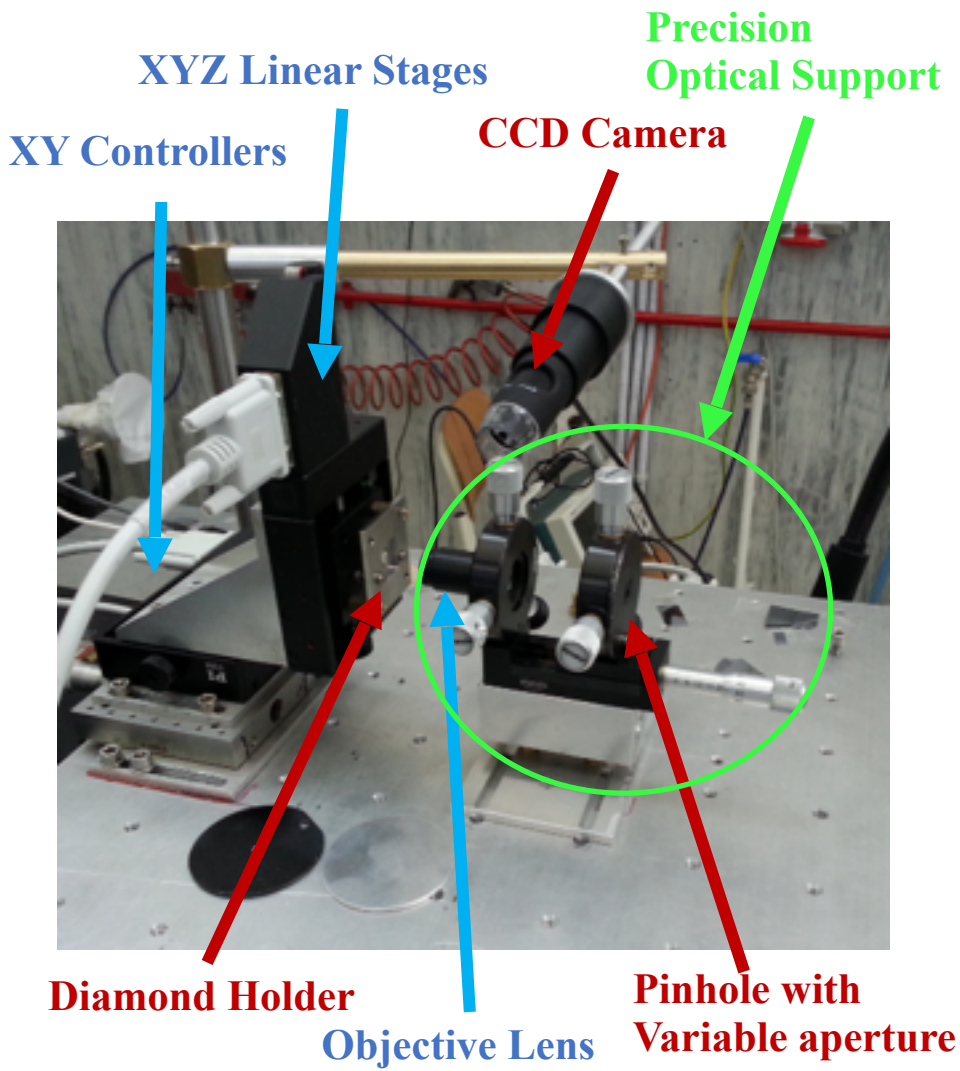
Graphite is the phase thermodynamically stable of Carbon at ordinary conditions.

EXPERIMENTAL SET-UP

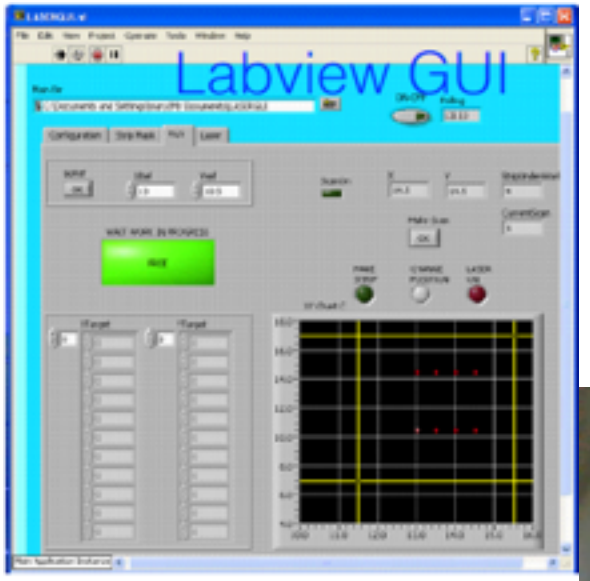


- LabVIEW software used to remotely control at the same time the laser and the X and Y translation stages operations.

New Optomechanical Components:



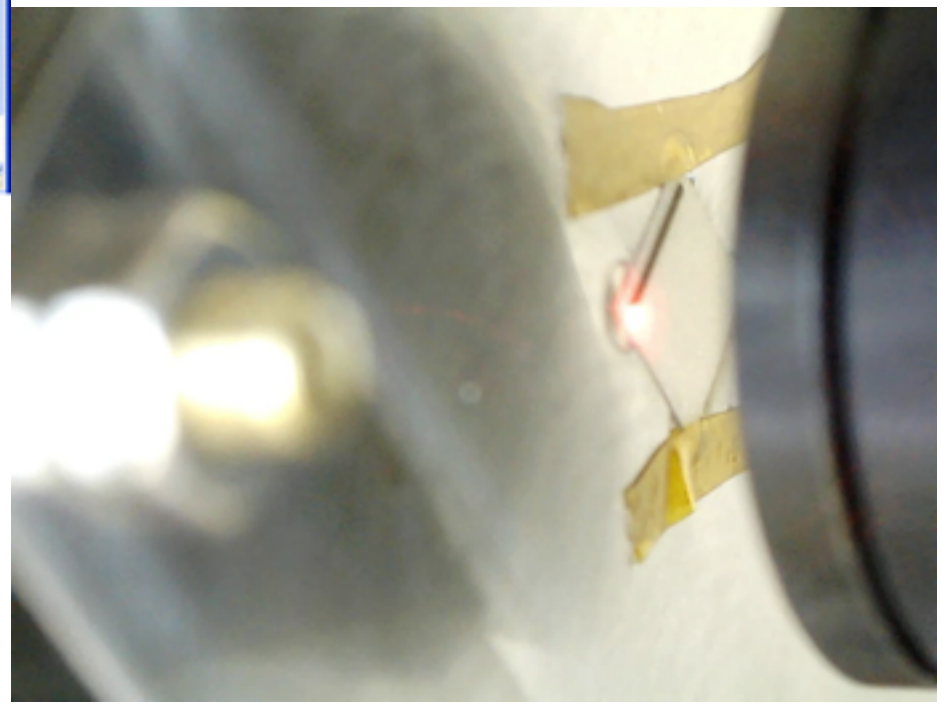
EXPERMENTAL SET-UP AND SOME GRAPHITIC STRUCTURES



THE AUTOMATION GIVES MANY BIG BENEFITS IN TERMS OF:

- ✓ REPRODUCIBILITY
- ✓ TIMING
- ✓ DEGREES OF FREEDOM ON 2D PATTERNS

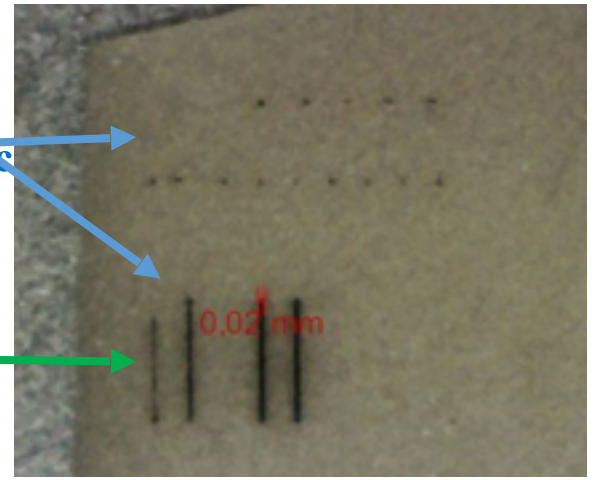
❖ Graphitization process video



First graphitization tests with new set-up

❑ Several geometric forms

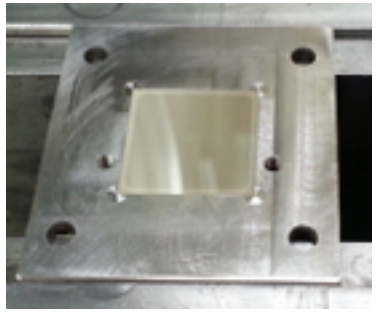
❑ Miniaturization process



GRAPHITIZED DIAMOND SAMPLES

UNIRRADIATED SAMPLES

- A Diamond and its Holder

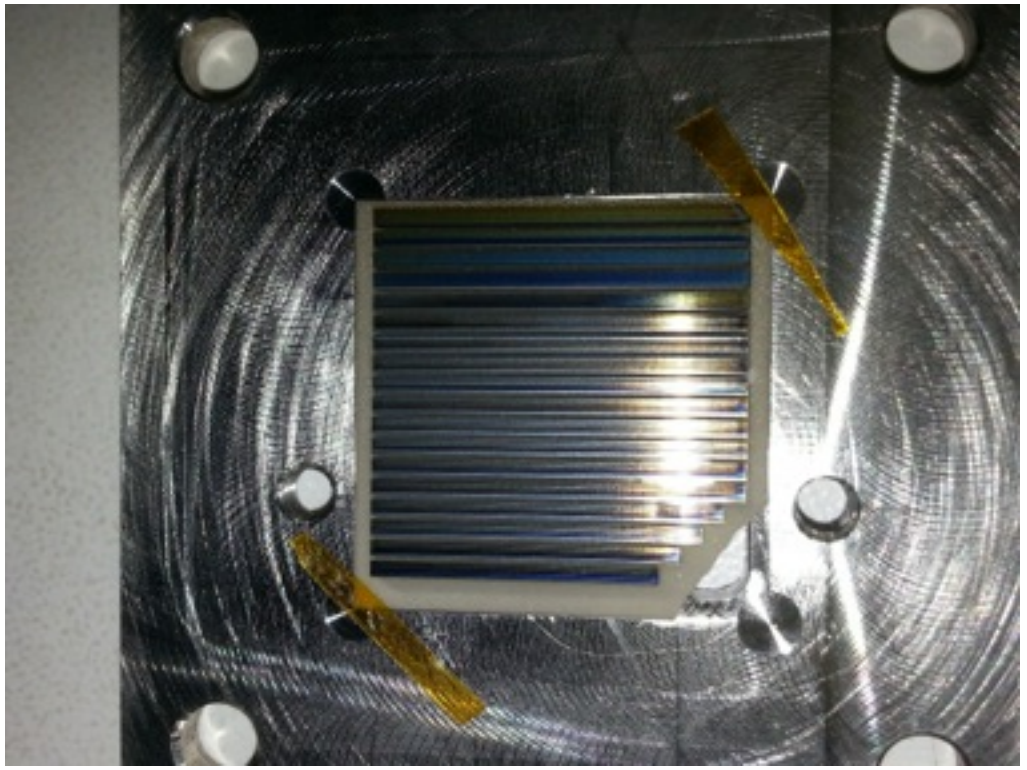


- CVD Polycrystalline Diamonds
  20 x 20 x 0.05 mm^3

GRAFITIZATION ON THE WHOLE SURFACE

- 4 Graphitic Electrodes (3 x 0.8 mm^2)
- gap 0.2 mm
- Energy 100 mJ, Laser Scans 4

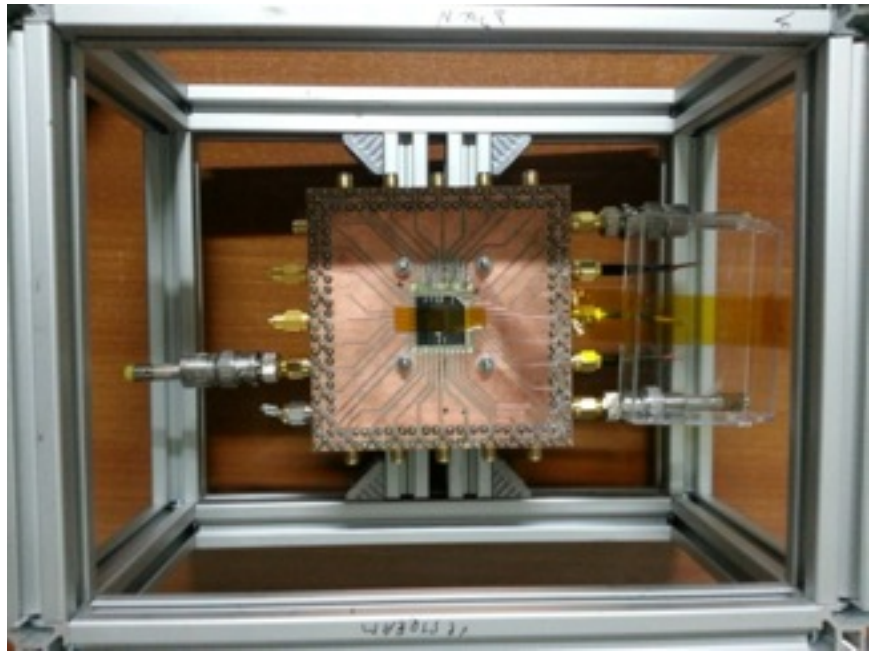
FULL CARBON ACTIVE TARGET PROTOTYPE FOR PADME EXPERIMENT



FULL CARBON ACTIVE TARGET PROTOTYPE FOR PADME EXPERIMENT

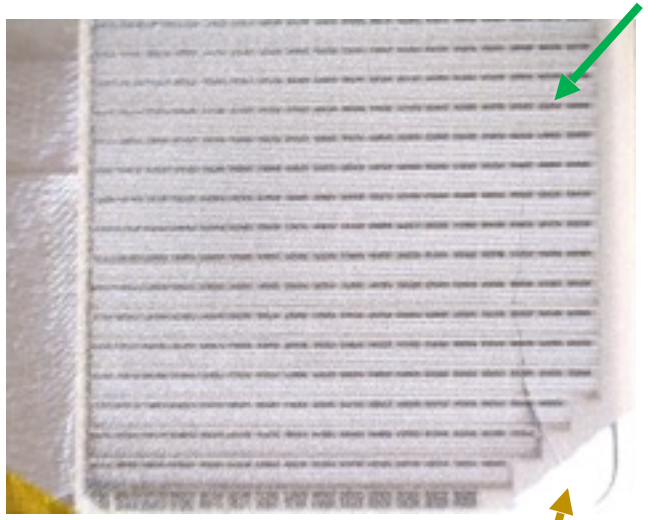
The PADME (Positron Annihilation into Dark Matter Experiment) proposal at Laboratori Nazionali di Frascati of INFN aims to search for the "Dark Photon" using positron on target collision at the DAFNE Beam Test Facility.

BTF Nov 2015



GRAFITIZATION ON BOTH THE SURFACES

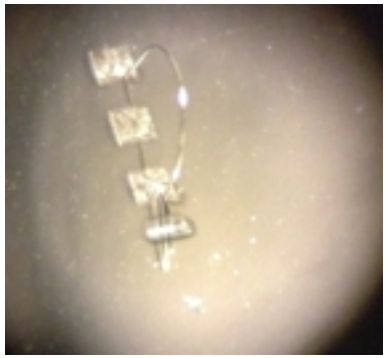
- The strips sets of the 2 surfaces are mutually orthogonal



DETAILS:

- X-Y graphitic strips
  Dimensions: 18 x 0.8 mm²
- 1 mm pitch X-Y strips
- PC Board made at home
- Technique to contacting:
  - Silver conductive Glue
  - Wire-bonding

WIRE-BONDING TESTS:



Good adhesion on Graphitic pads (CNR – Nanotec, Lecce)

TESTBEAM RESULTS AND WORKING IN PROGRESS

- Tests by 500 MeV ELECTRON and POSITRON beams
- bunch of 8000-12000 e- / e+ 10 ns long 50 Hz rate

RESULTS:

1. Preliminary results give a Spatial Resolution of 0.5 mm less than that required by experiment (1 mm)
2. Sensor manipulated without breaking it (graphitization, cleaning, assembly, transport, tests)
3. Good Capacity to sustain High Voltage (150 V for 2 weeks)
4. All the connected strips worked properly
5. Online Beam Monitoring by active target

WORKING IN PROGRESS:

- Sensor Characterizations In progress (Nano-Indentation, Raman, SEM, V-I, etc.)
- New Sensor: Working with Safely in Lab!
- New tests for Connection on PC Board

Thanks for your kind attention!

It is Very important to Minimize contact with diamond samples due to their fragility