*QUANTUM EFFICIENCY MEASUREMENTS OF Mg FILMS PRODUCED BY PULSED LASER ABLATION DEPOSITION FOR HIGH BRIGHTNESS ELECTRON SOURCES**

***G.Gatti*, L.Cultrera, F.Tazzioli, C.Vicario**
INFN-LNF

A.Fiori
University of Rome "Tor Vergata", Chemical Science Department

A. Perrone,C. Ristoscu
University of Lecce, Physics Department and INFN

Work partially supported by the EU Commission in the sixth framework programme, contract no. 011935 **EUROFEL*

NOWADAYS SITUATION IN PHOTOCATHODES

QE vs. ***ROBUSTNESS***

LOOKING FOR COMPROMISES
e.g. DIAMOND
SEC . EMISSION

METALS ARE RUGGED AND OFFER FASTEST RESPONSE (BLOW OUT?)

BEST QE PERFORMANCE IN METAL PC REACHED BY Mg (UP TO 10^{-3} λ=266nm)

PROBLEMS

Mg ADHERENCE ON SUBSTRATE (Cu) IN RF-GUN ENVIRONMENT,DARK CURRENT (HIGH FIELD)

OUR GOALS ON Mg FILMS

SYNTHETIZE A Mg PC TO WORK IN A RF-GUN

FEATURES

- QE >10^{-4}
- SURFACE QUALITY (EMISSION DISTRIBUTION)
- LASER RADIATION RESISTANT
- HIGH FIELD RESISTANT (LOW DARK CURRENT)
- RUGGEDNESS (SUBSTRATE ADHERENCE)

ACTIVITIES

WORKING ON VARIOUS LINES

SPUTTERING

MEASUREMENTS TO EVALUATE THIS WELL KNOWN TECHNIQUE & MAKE IMPROVEMENTS (VACUUM ARC DEPOSITION)

-RESISTANT FILMS (POLLUTION & LASER)
-BEST QE RESULTS UP TO NOW (BNL)
-POOR ADHERENCE

PLAD

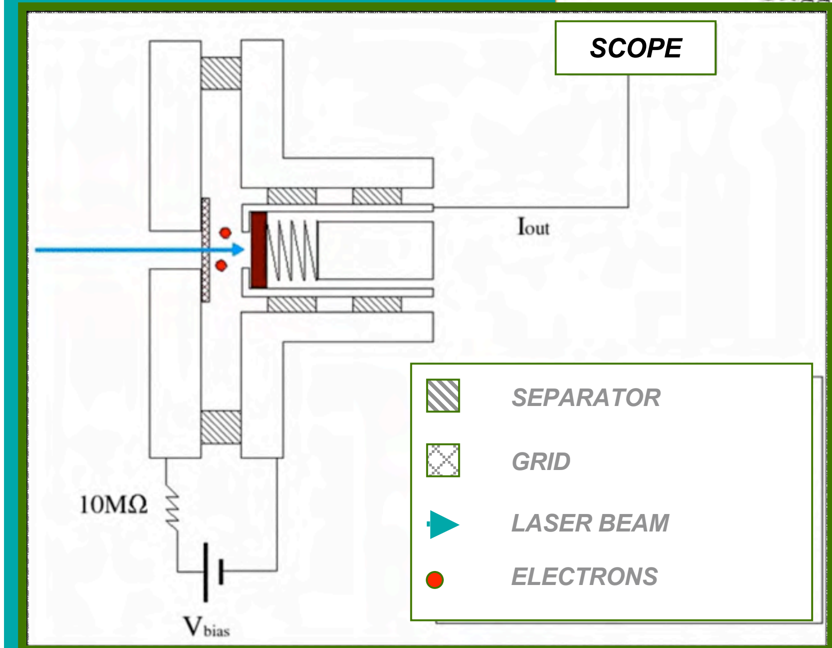
STUDYING & DEVELOPING NEW PC AND PROTECTIVE LAYERS BASED ON THIS PROMISING TECHNIQUE

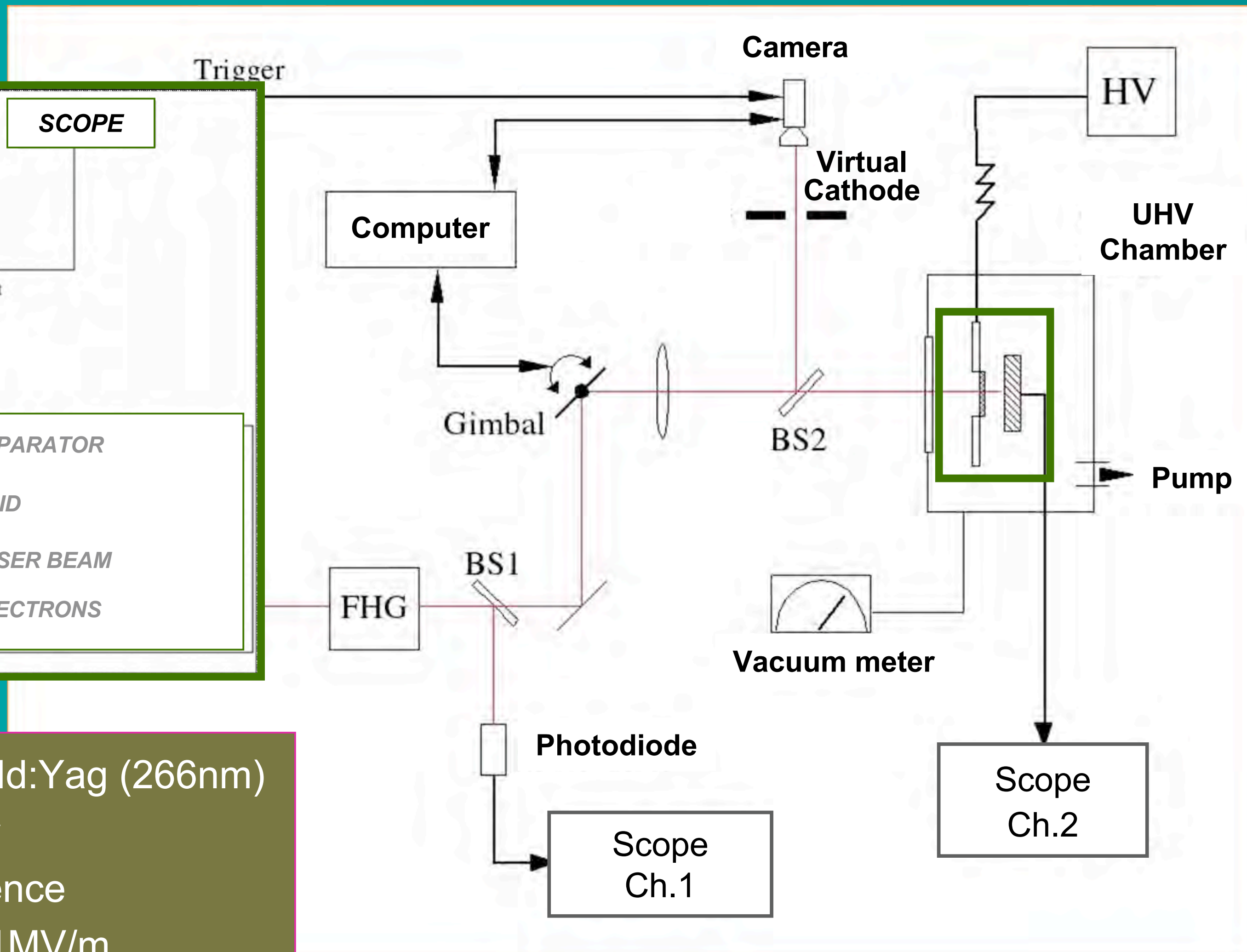
- GOOD FILM QUALITY
- GOOD ADHERENCE
- MULTI LAYERS

- DIFFICULT TO REACH BIG THICKNESS
- PRESENCE OF DROPLETS
- THICKNESS CONTROL

QE MEASUREMENT SET-UP

CATHODE HOLDER





Quadrupled Nd:Yag (266nm)

P < 10^{-8} mbar

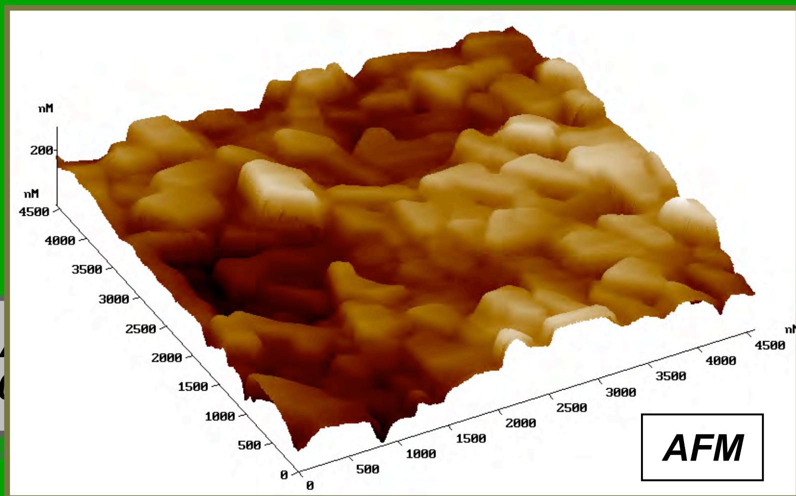
Normal Incidence

E_{extrac} Up To 1MV/m

SPUTTERING RESULTS

10μm Sputtered Mg Film On Cu Substrate *(Koral Labs)*

Structural Measurement / QE Measurement

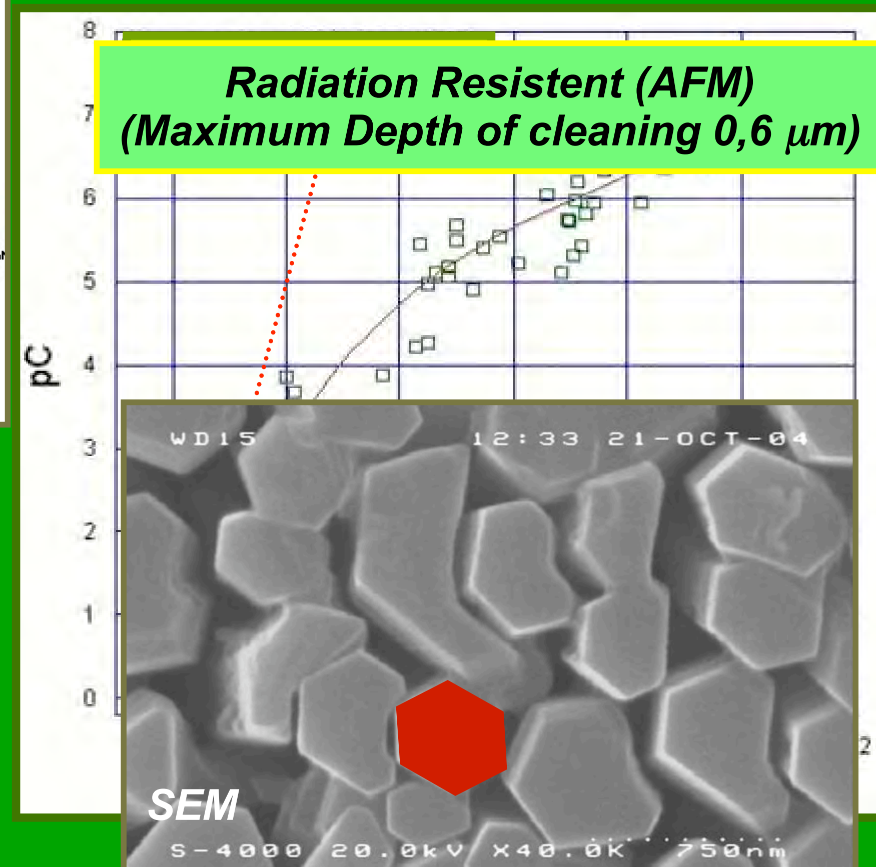


LA…
150…

FINAL QE >1X10^{-4}

Well Defined Crystal Structure (Hexagon shape)

-Su…
-Ext…
-Easy QE recovery (Thick Film)

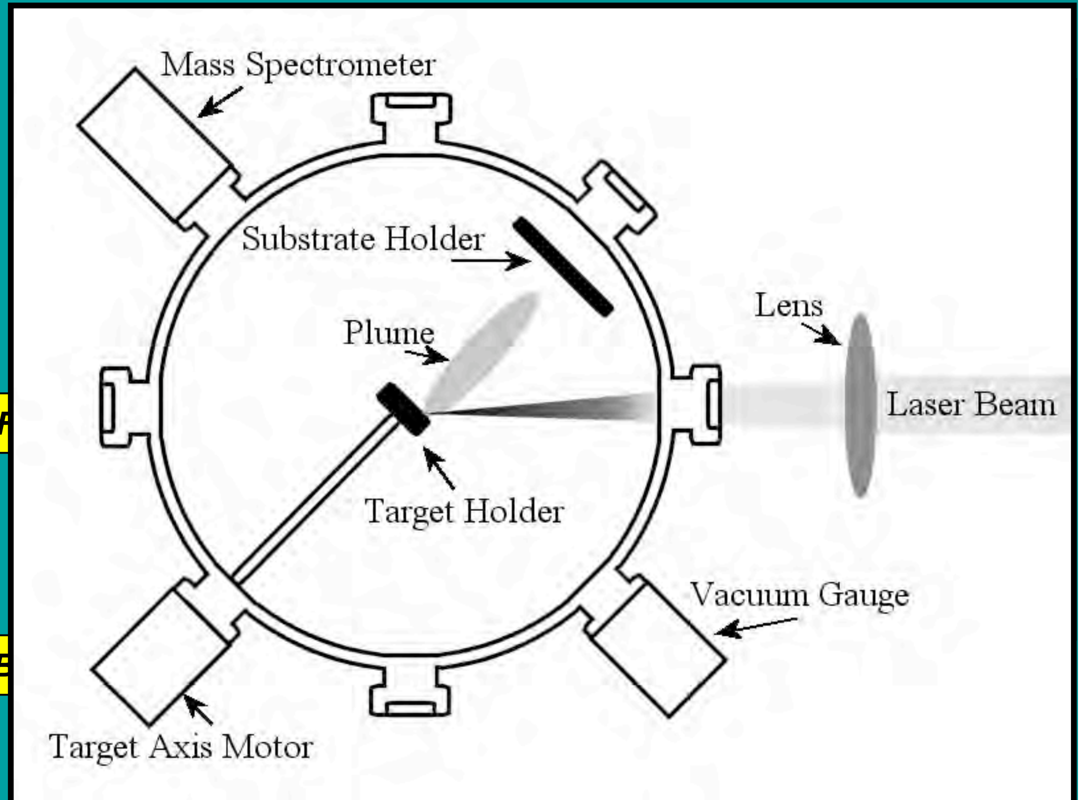


Radiation Resistent (AFM) (Maximum Depth of cleaning 0,6 μm)

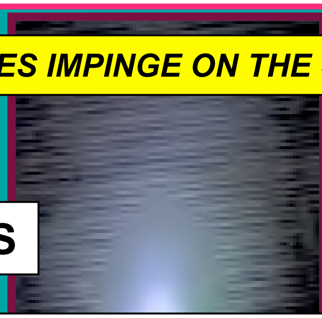
INFN Istituto Nazionale di Fisica Nucleare Laboratori Nazionali di Frascati

DEPOSITION SET-UP

- Xe Cl Laser (308 nm)
- τ_{pulse} 30 ns
- Incidence angle 45°
- UHV Chamber (better than 10^{-7}mbar)
- Online Mass Spectrometer
- Target Rotation Frequency 1Hz
- Up to 20J/cm^2 (0,6 GW/cm^2) fluence
- Typical Target-Substrate Distance 5cm
- Typical Spot Size 1mm^2



3. HIGH ENERGY PARTICLES IMPINGE ON THE SUB



ADVANTAGES

- *HIGH FILM PURITY*
- *POSSIBILITY OF THICKNESS CONTROL (# PULSES)*
- *THIN PROTECTIVE FILMS POSSIBLE (TENS nm)*
- *MULTI LAYER DEPOSITION*
- *UNIFORM SURFACE*
- *GOOD ADHERENCE TO SUBSTRATE*

DRAWBACKS

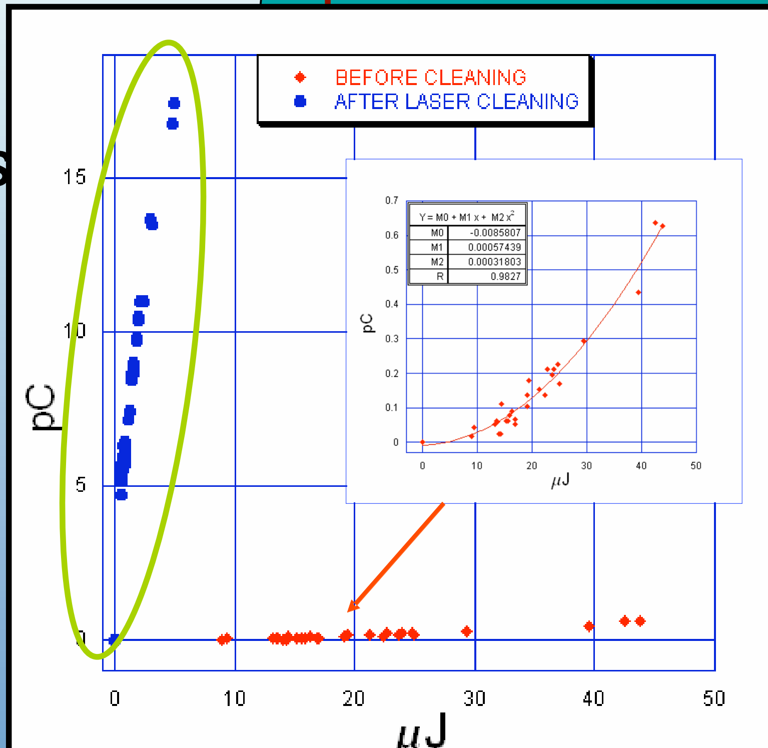
- *PRESENCE OF DROPLETS*
- *DIFFICULT LARGE THICKNESS*

IMPROVEMENTS

PLAD QE Measurements

STARTING WITH POOR QE QUADRATIC RESPONSE (C)
CLEANING OF 1mm^2 AREA WITH 5000 4GW/cm^2 PULSES

ATE
YER



	µm
	0 nm
	0 mm^2
	$^{-8}$ mbar
	J/cm^2
	X10^4
	X10^3
	5cm

INVESTIGATE PLAD QE & LAYER PROTECTION

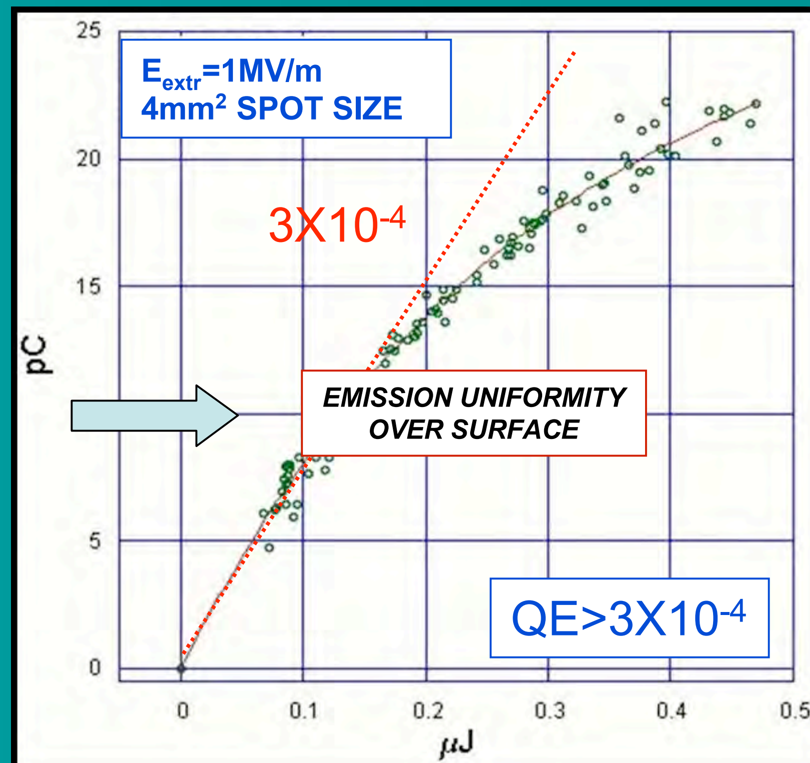
ATE
MENT

	m
	mbar
LASER SPOT SIZE	0,9 mm^2
R FLUENCE	10 J/cm^2
# SHOTS FOR Mg	5X10^4
TARGET DISTANCE	3,5cm

S

SAMPLE 2

SAME QE AS SPUTTERING



SEM :AMORPHOUS STRUCTURE OF FILM WITH DROPLETS
EDX :RESIDUAL C ON THE CLEANED AREA

Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

PLAD RESULTS

SAMPLE 2

Mg FILM ON Si (100) SUBSTRATE DEPOSITED WITH He CONFINMENT

Mg THICKNESS	2,5 μm
He PRESSURE	$5X10^{-2}$ mbar
LASER SPOT SIZE	0,9 mm^2
LASER FLUENCE	10 J/cm^2
# SHOTS FOR Mg	$5X10^4$
TARGET DISTANCE	3,5cm

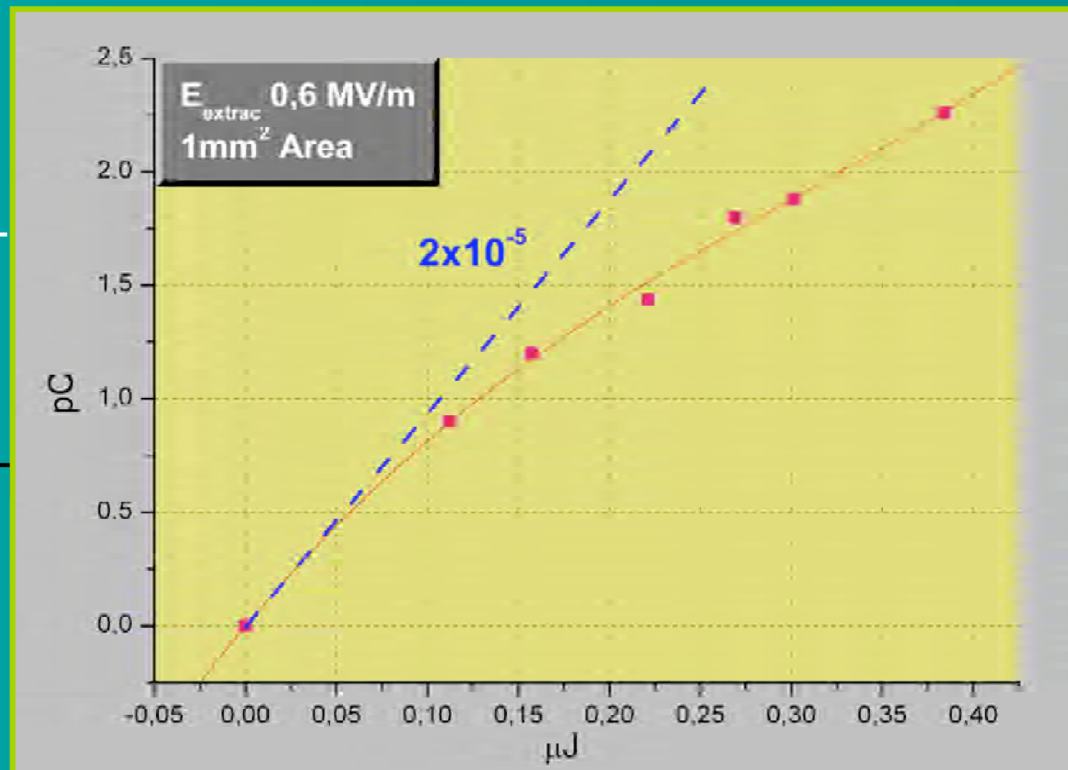
STEP 1: CLEANING FIRST AREA
[1mm^2 WITH 1200 SHOTS AT 1,25GW/cm^2]

STEP 2: QE MEASURING ON FIRST AREA

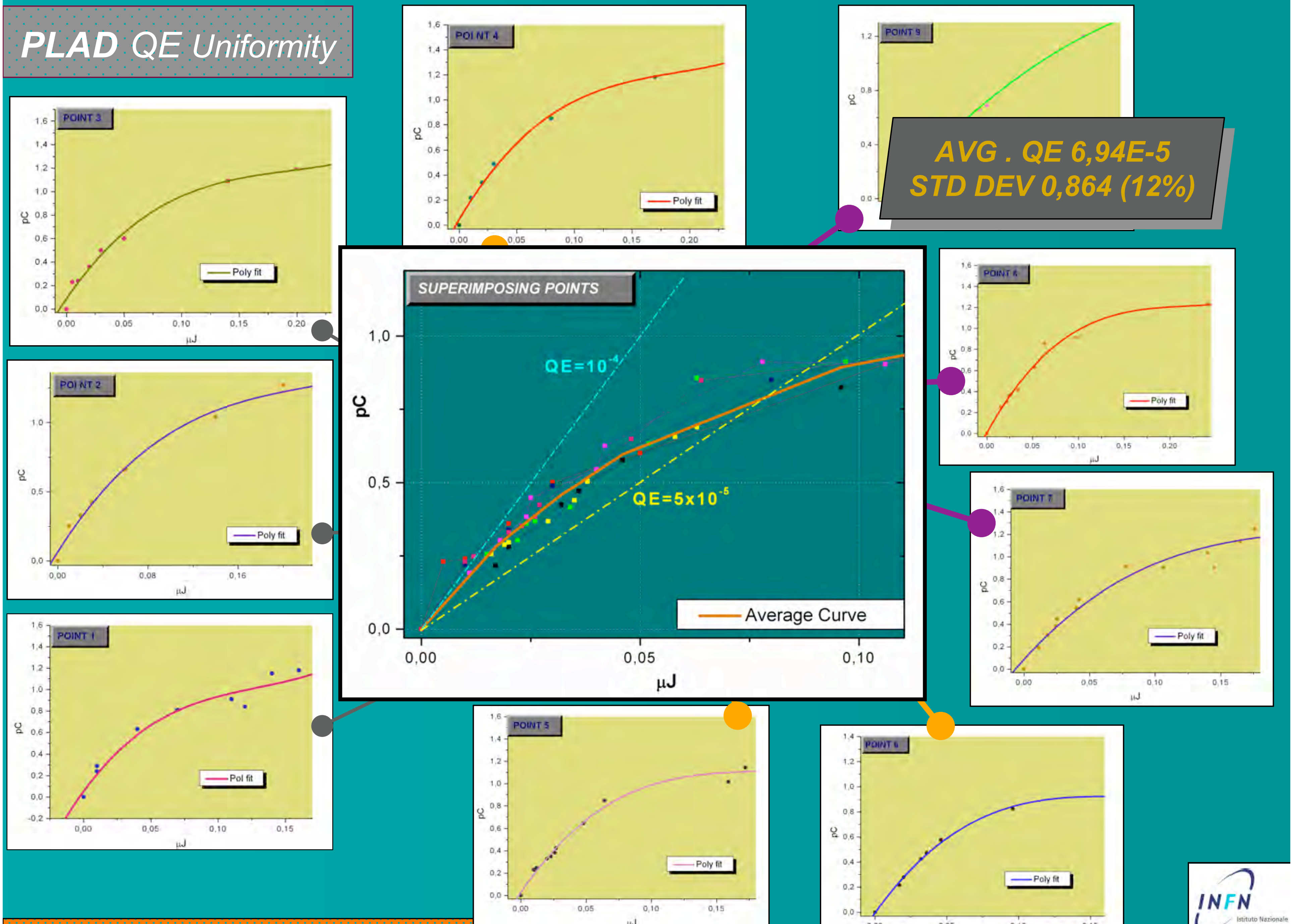
STEP 3: STRONG CLEANING
[0,5 mm^2 WITH 100 SHOTS AT

-Final QE $2x10^{-5}$
-Poor as expected

STEP 4: MEASURING QE DIST
[9 SUB-AREAS OF 0,04 mm^2]



PLAD QE Uniformity

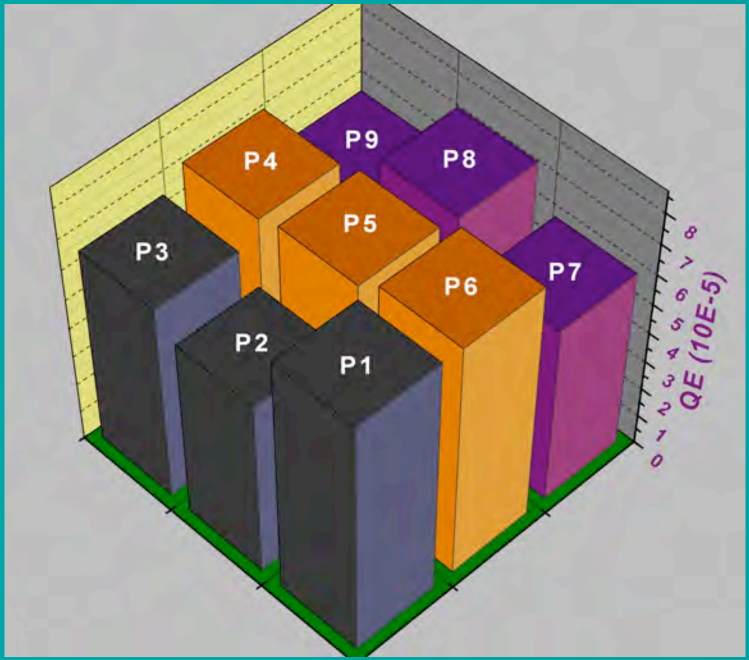


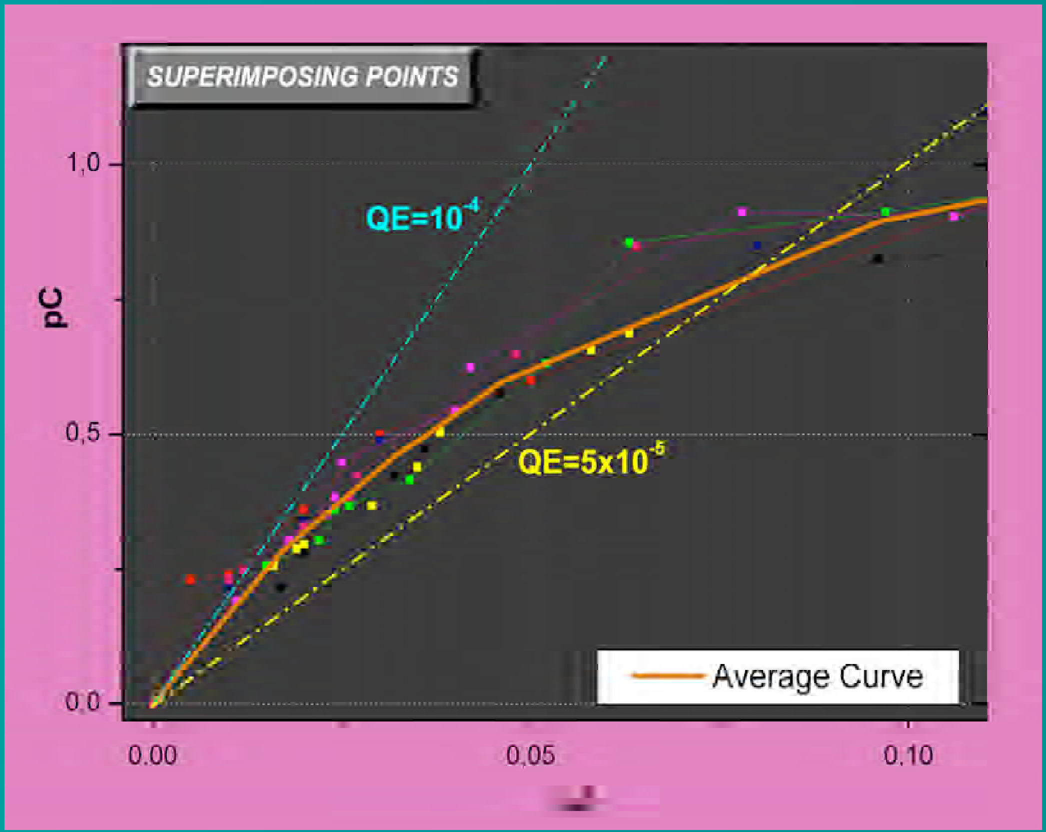
INFN Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

PLAD QE Uniformity

2nd AREA

MIN QE $5,76X10^{-5}$
MAX QE $8,02X10^{-5}$

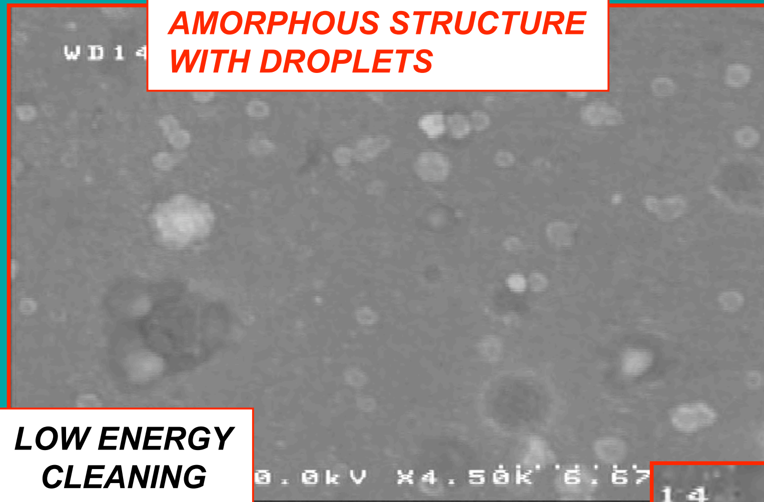




AVG . QE 6,94E-5
STD DEV 0,864 (12%)

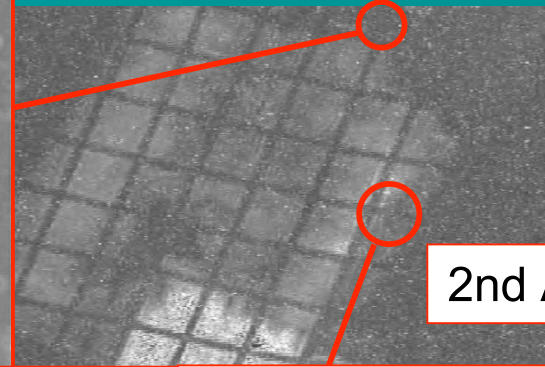
PLAD SEM

AMORPHOUS STRUCTURE WITH DROPLETS



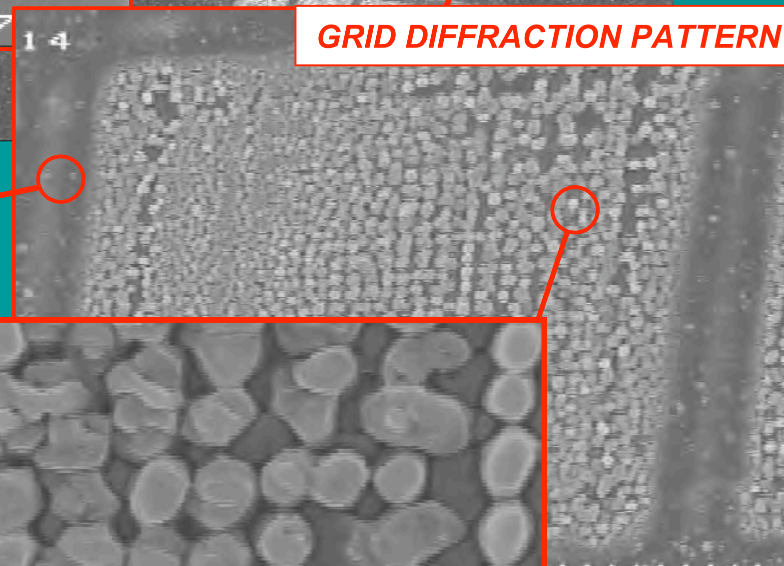
LOW ENERGY CLEANING

1st AREA



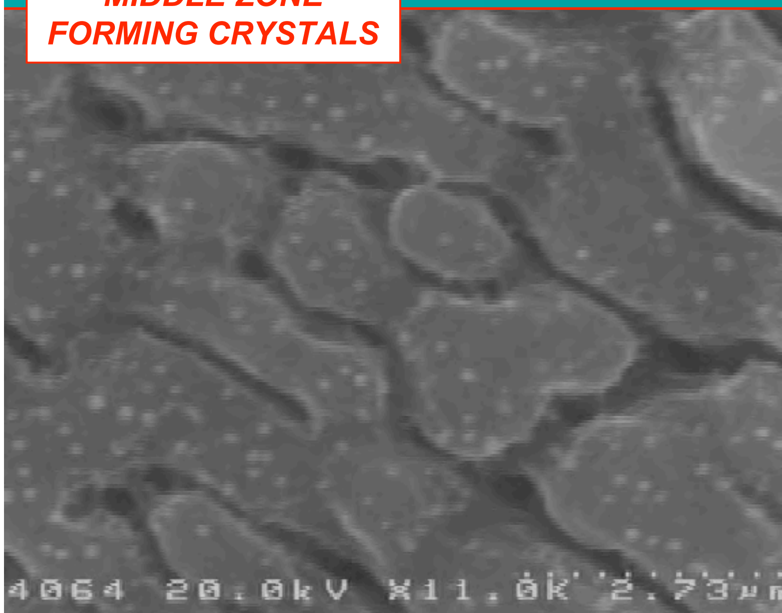
2nd AREA

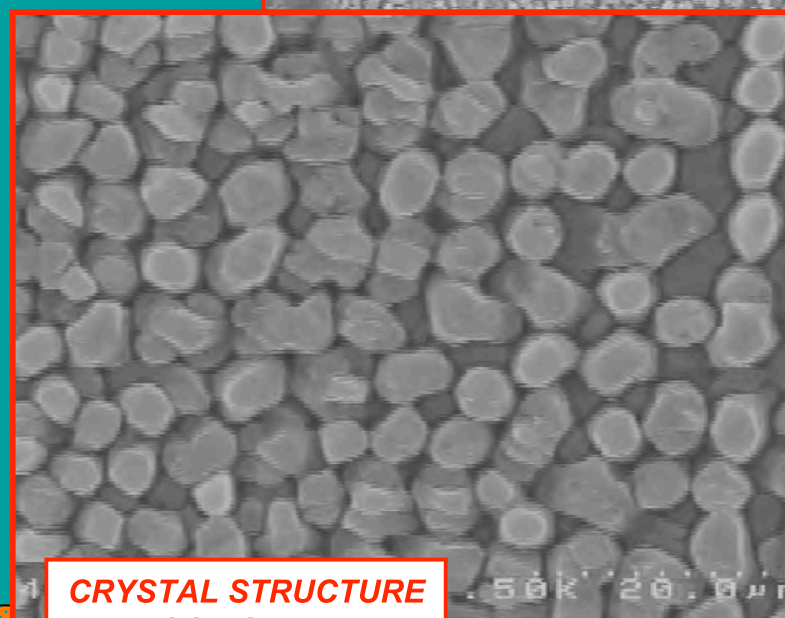
GRID DIFFRACTION PATTERN



HIGH ENERGY CLEANING

MIDDLE ZONE FORMING CRYSTALS





CRYSTAL STRUCTURE HEXAGON SHAPE

INFN Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

CONCLUSIONS

-PROTECTIVE LAYER WORKS BUT NOT NECESSARY WITH THICK FILMS

-THICK FILMS ARE FEASIBLE. IMPROVEMENT IN COURSE

-PROVEN QE = $3X10^{-4}$ IS SUFFICIENT BUT CAN BE IMPROVED

FUTURE PLANS

- IMPROVEMENT OF PLAD Mg
- DEPOSITION ON RF-GUN FLANGE
- ARC DEPOSITION
- INTEREST IN OTHER MATERIALS