

# ***STUDY OF SURFACE CHARACTERISTICS DETERMINING THE ELECTRON CLOUD GROWTH***

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The results presented have been obtained thanks to the collaboration of :

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## ***TOPICS:***

\* ***Pure metals      Technical materials    : The influence of the surface***

\* ***Changing the S.E.Y. :***

*Surface composition*

*Surface roughness*

*Irradiation by energetic particles*

\* ***Conclusions***

# ***THE SECONDARY ELECTRON EMISSION***

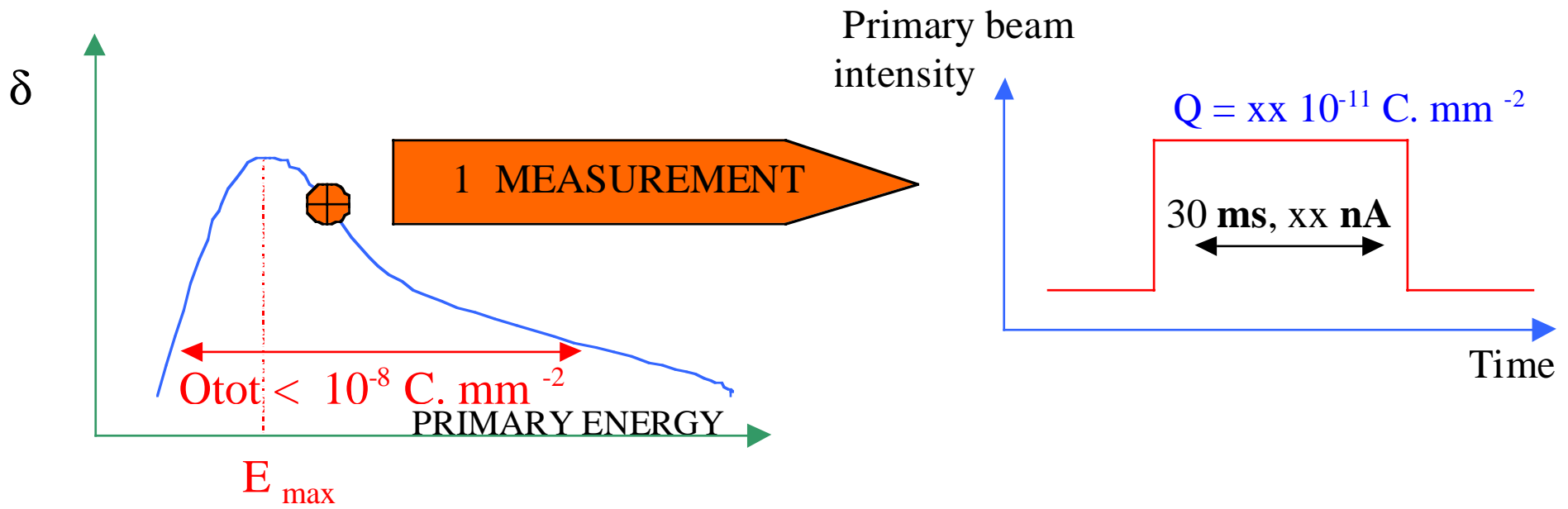
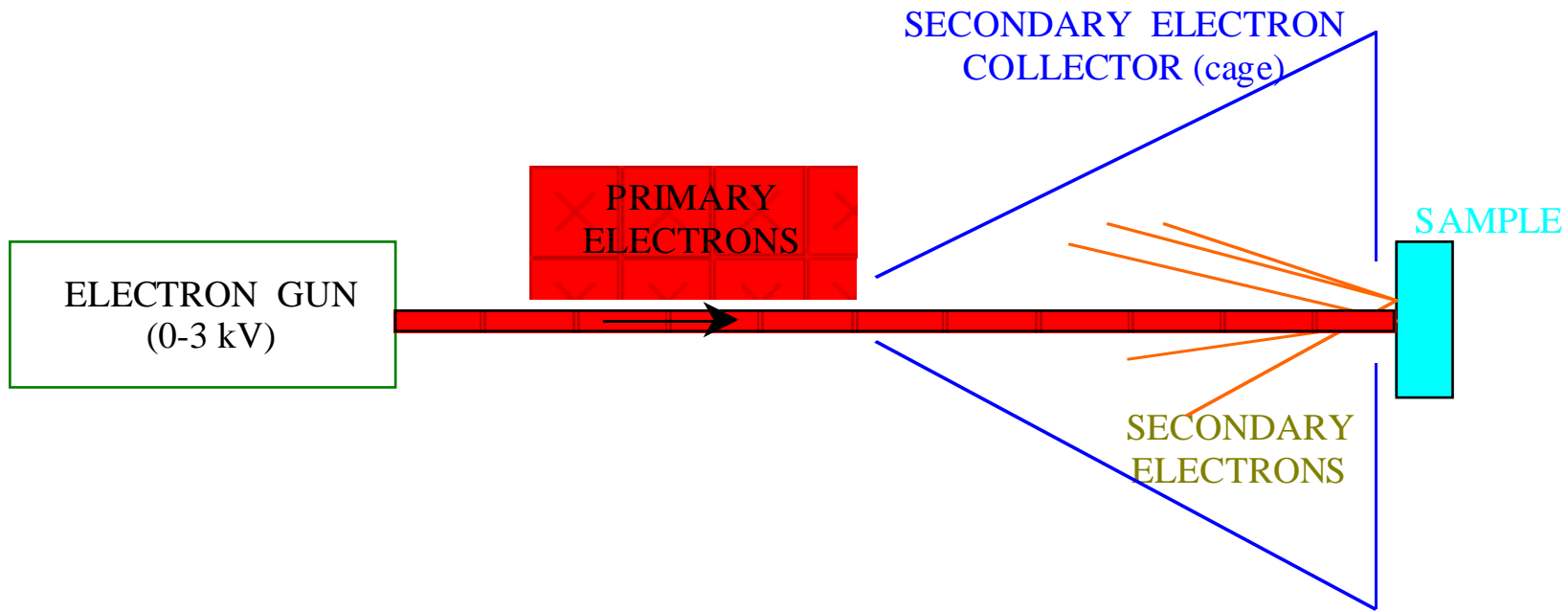
*OLD SUBJECT : AUSTIN –STARK (1902)*

*MOST OF PURE METALS MEASURED BEFORE LAST WAR*

*WHY MEASUREMENTS IN 2000??*

*HOW TO MEASURE IT???*

*IMPORTANCE OF LOW PRIMARY CURRENT*



# ***PURE METALS AND TECHNICAL MATERIALS***

*COMPARISON BETWEEN PURE METALS AND TECHNICAL MATERIALS*

*ORIGIN OF THE DISCREPANCY => OXIDES + CONTAMINANTS*

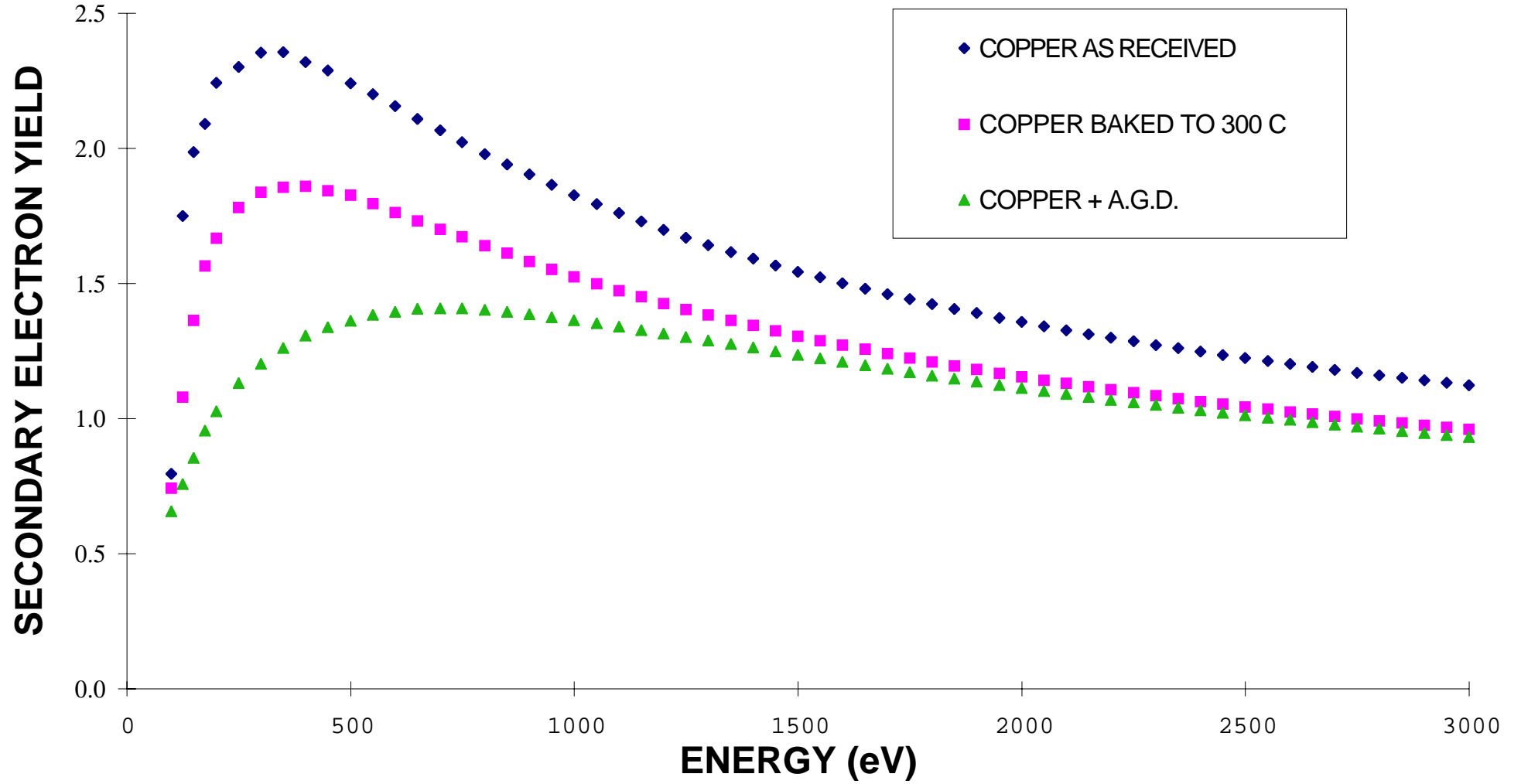
*INFLUENCE OF OXIDE*

*INFLUENCE OF WATER*

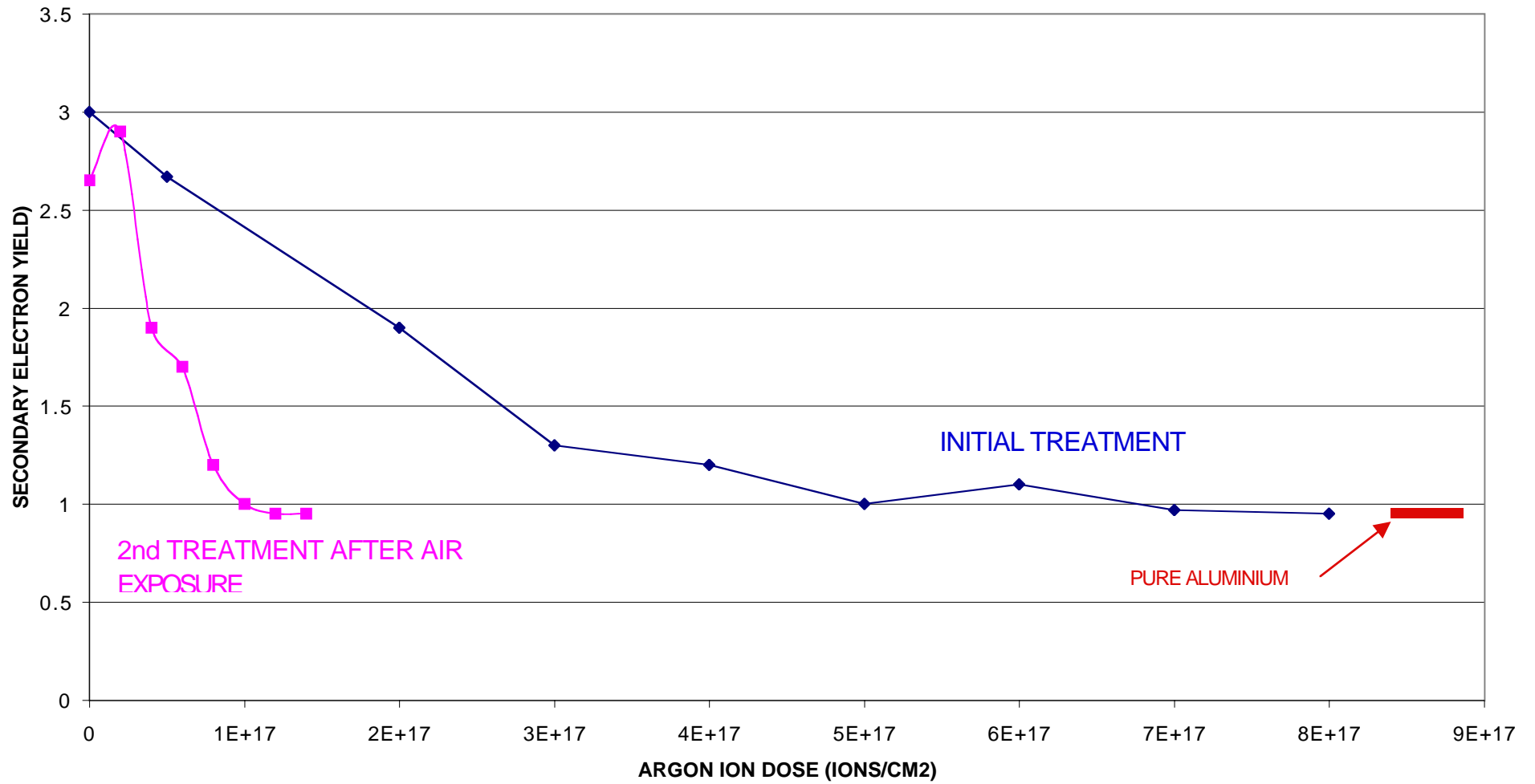
*SECONDARY ELECTRON YIELD      COMMON TECHNICAL MATERIALS*

*SECONDARY ELECTRON YIELD OF INSULATORS => INFLUENCE OF THE PURITY*

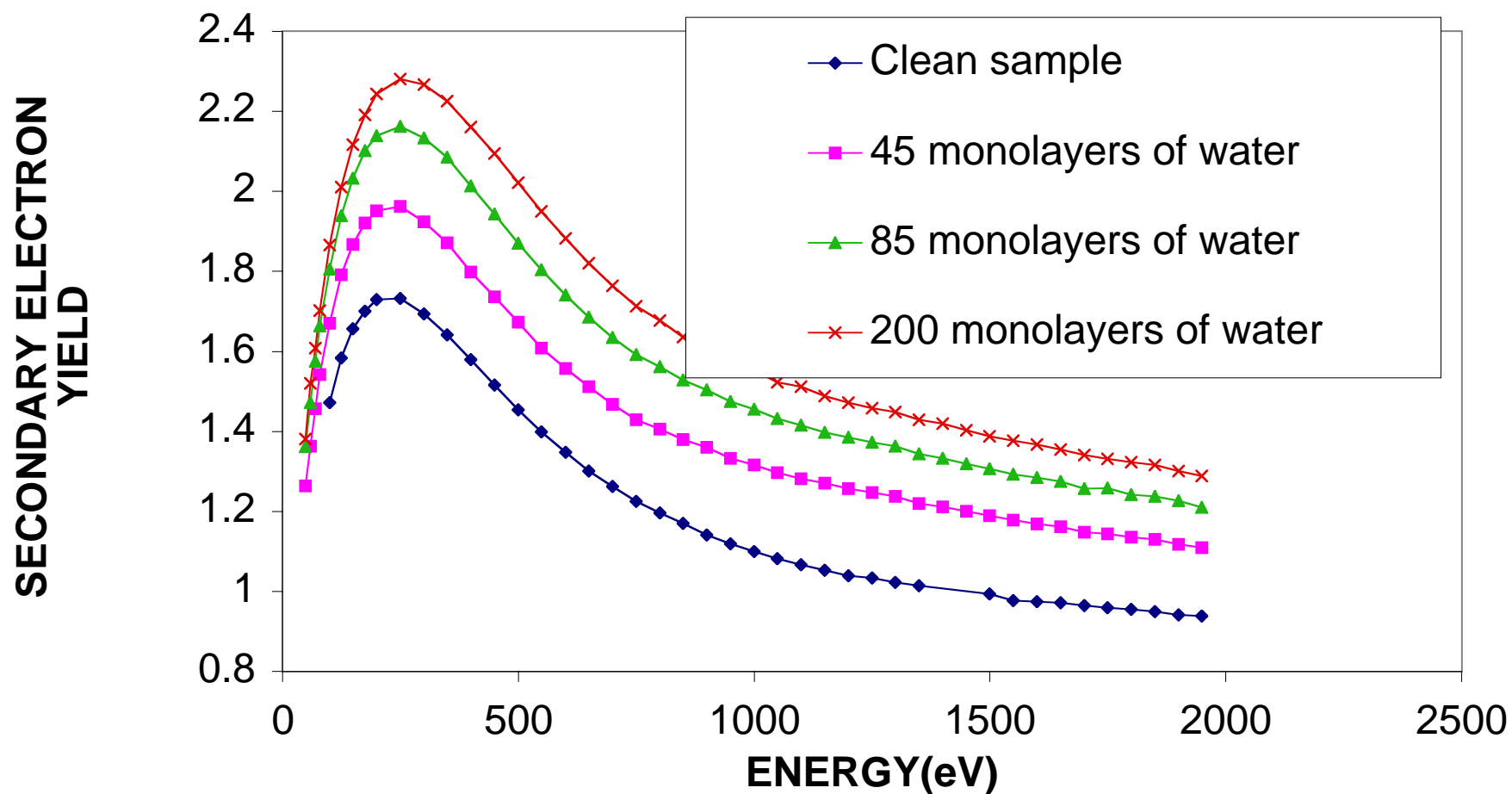
SECONDARY ELECTRON YIELD



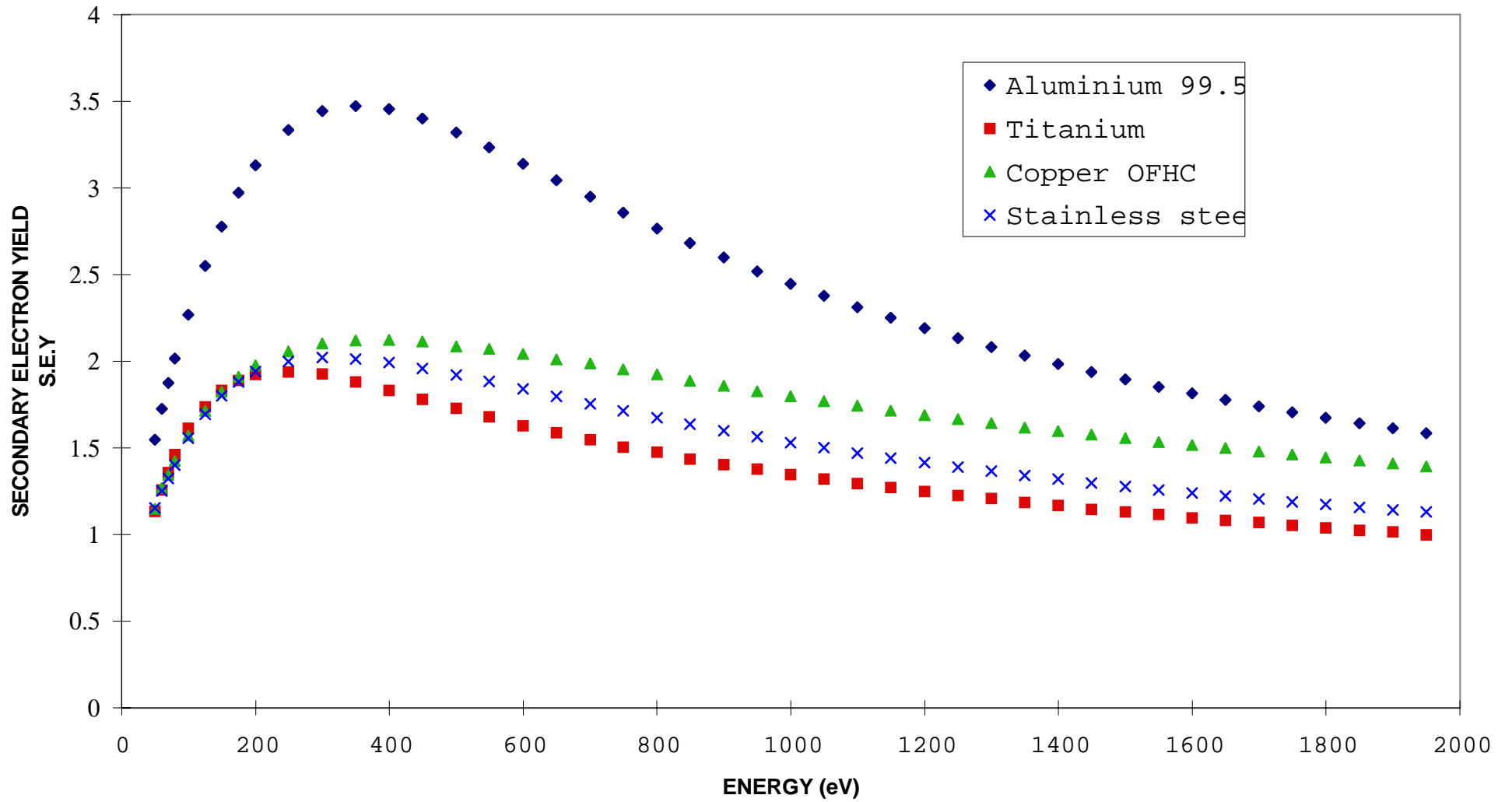
# SECONDARY ELECTRON YIELD VERSUS ARGON ION DOSE ALUMINIUM SAMPLE



# SECONDARY ELECTRON YIELD OF CONDENSED WATER

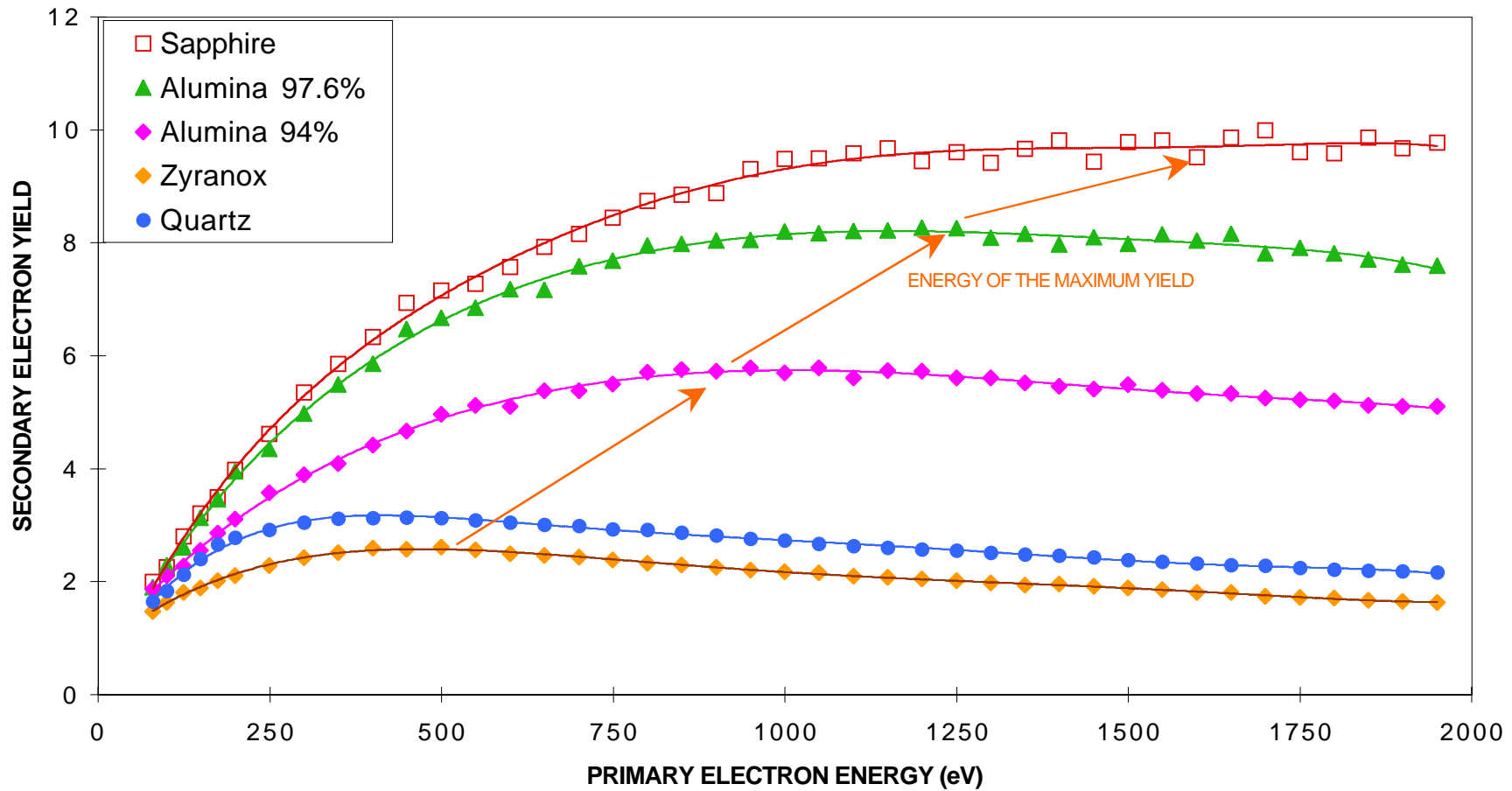


SECONDARY ELECTRON YIELD  
As received





# SECONDARY ELECTRON YIELD OF INSULATORS AFTER A 250 °C BAKE OUT



# REMEDIES

*THREE TYPES :*

***\*CHANGE THE SURFACE CHEMISTRY***

*ADD LAYERS (TiN, getters,...)*

*REPLACE NATIVE SURFACE:*

*REACTIVE SPUTTERING (N<sub>2</sub> G.D., AO<sub>2</sub> G.D.)*

*VERY SENSITIVE TO AIR EXPOSURE*

*NEED REBAKING TO BE AT THEIR BEST*

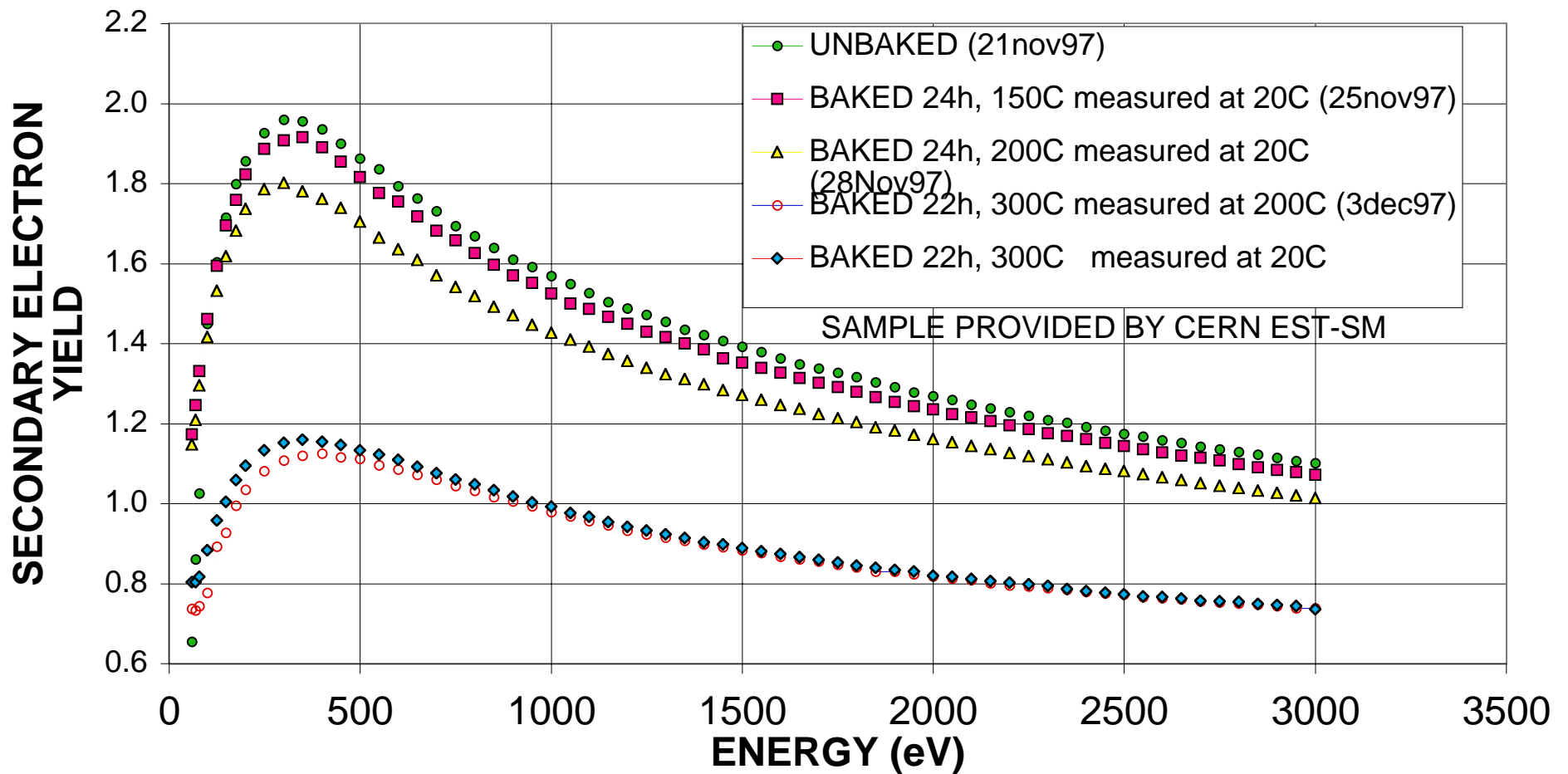
***\*CHANGE THE SURFACE TOPOGRAPHY:***

*BLACK LAYERS: AQUADAG , GOLD BLACK , SOOT*

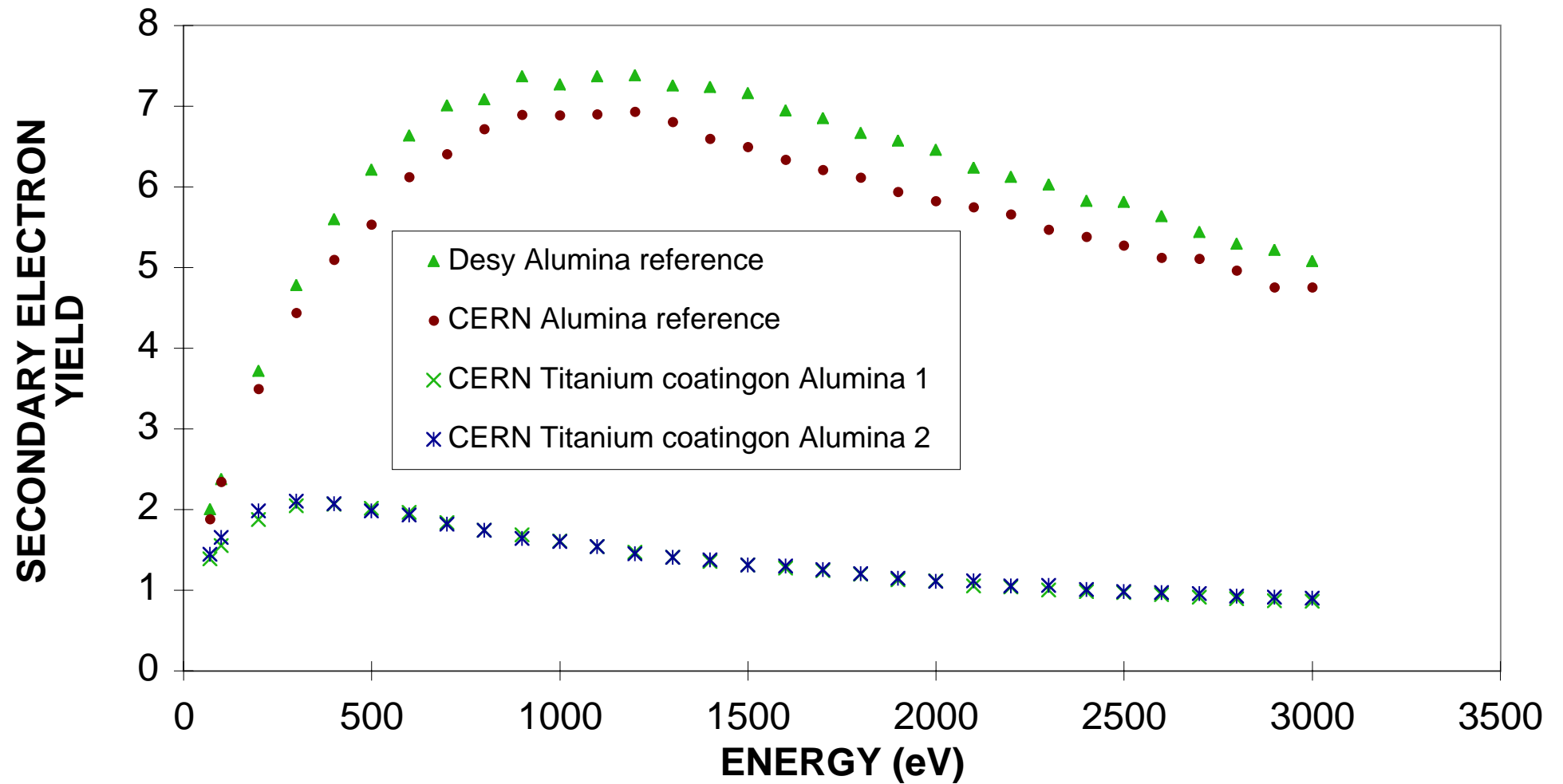
*OXIDE GROW e.g. COPPER OXIDE*

*MORE ELABORATED THINGS....LESS SENSITIVE TO AIR EXPOSURE*

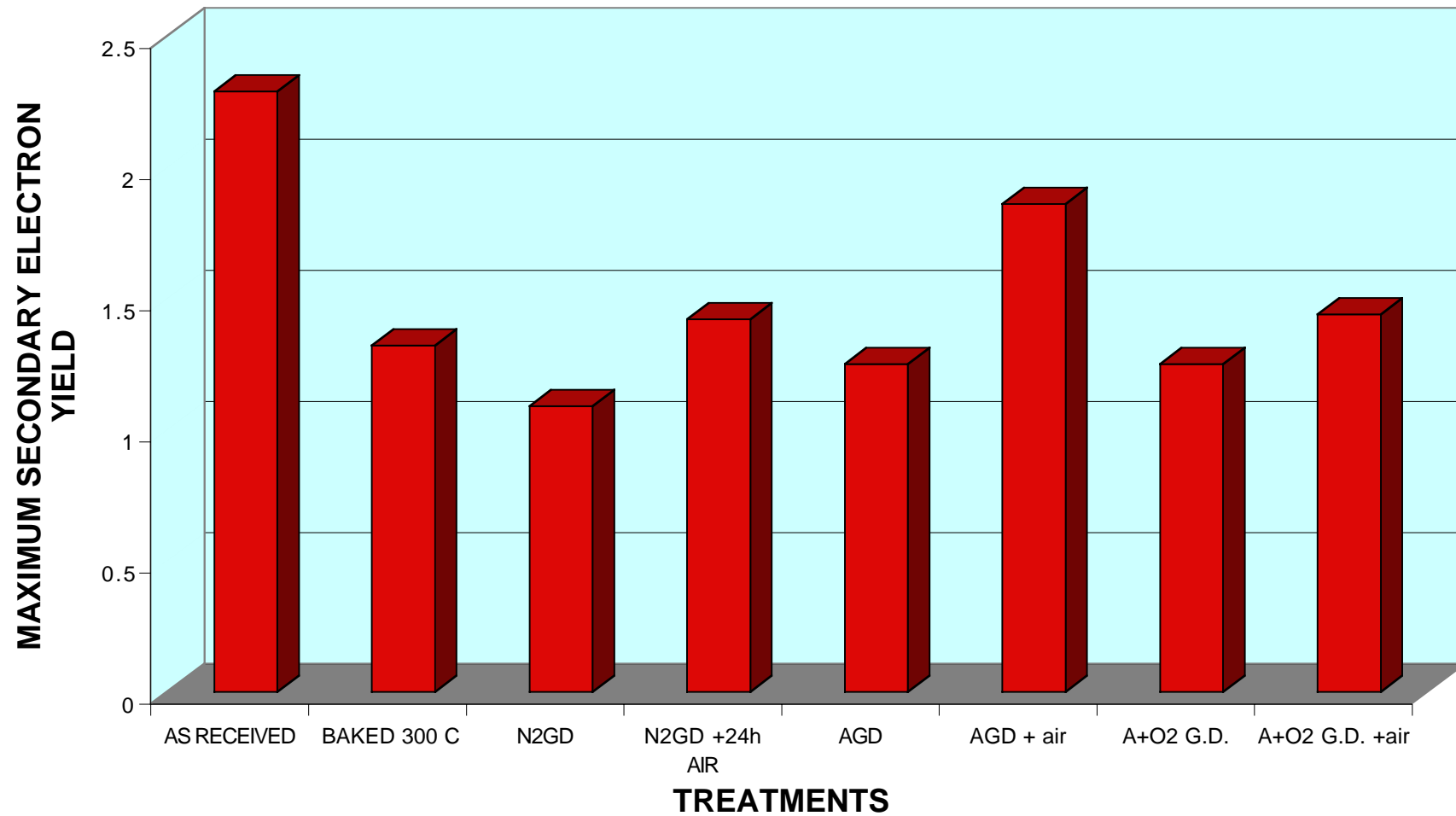
# SECONDARY ELECTRON YIELD OF A GETTER LAYER



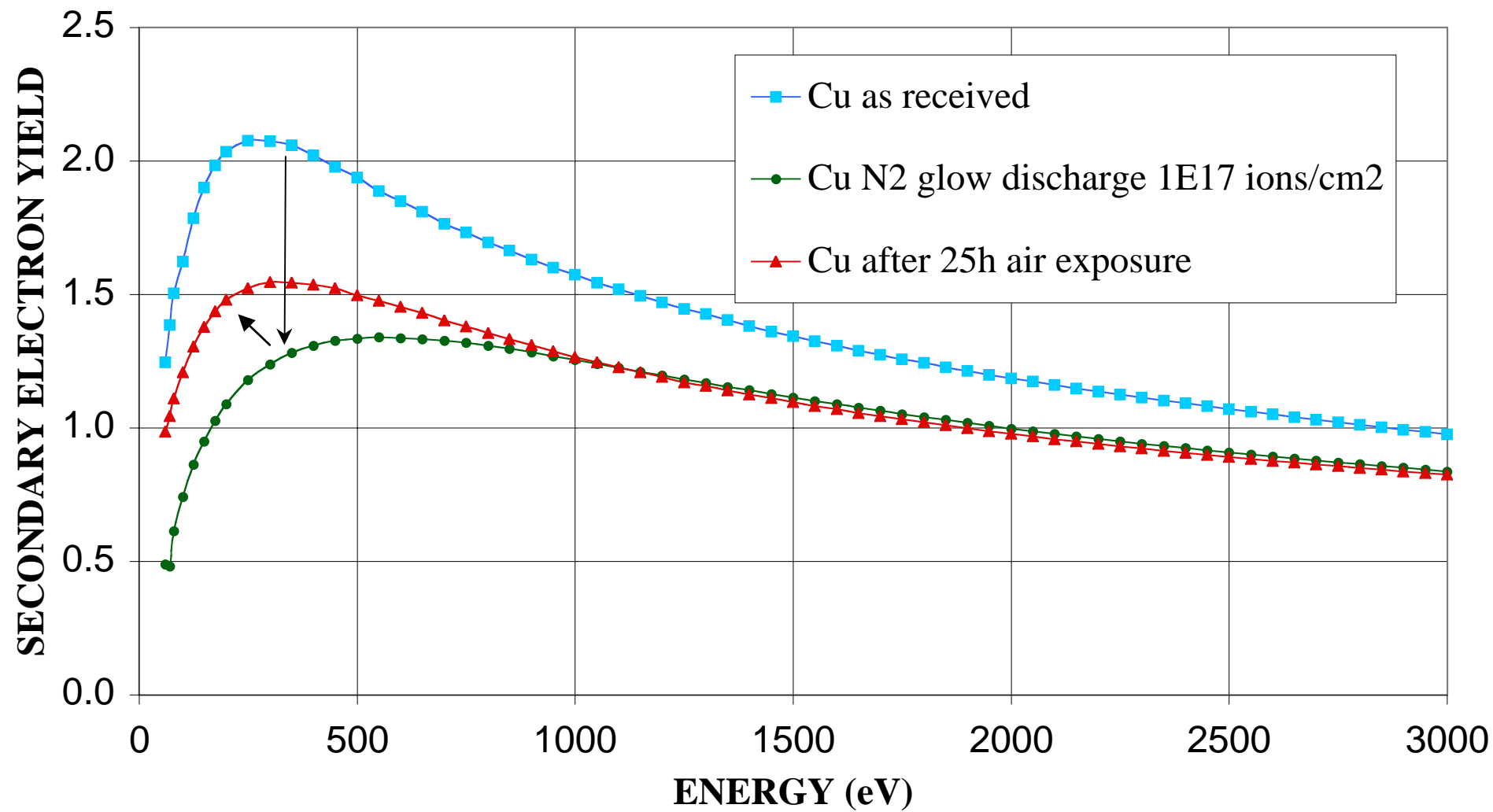
## SECONDARY ELECTRON YIELD OF VARIOUS INSULATING MATERIALS AS RECEIVED

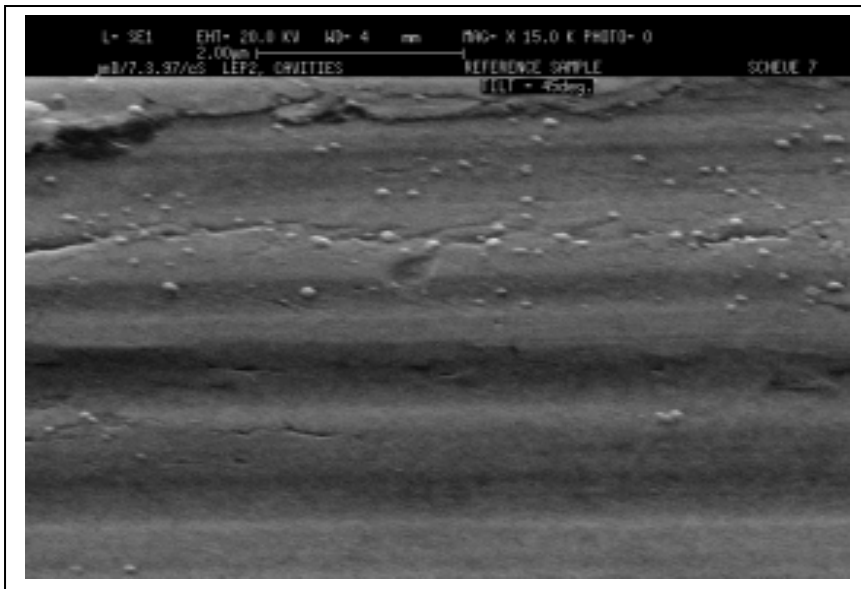


## VARIATION OF THE SECONDARY ELECTRON YIELD OF NIOBIUM WITH THE SURFACE TREATMENTS

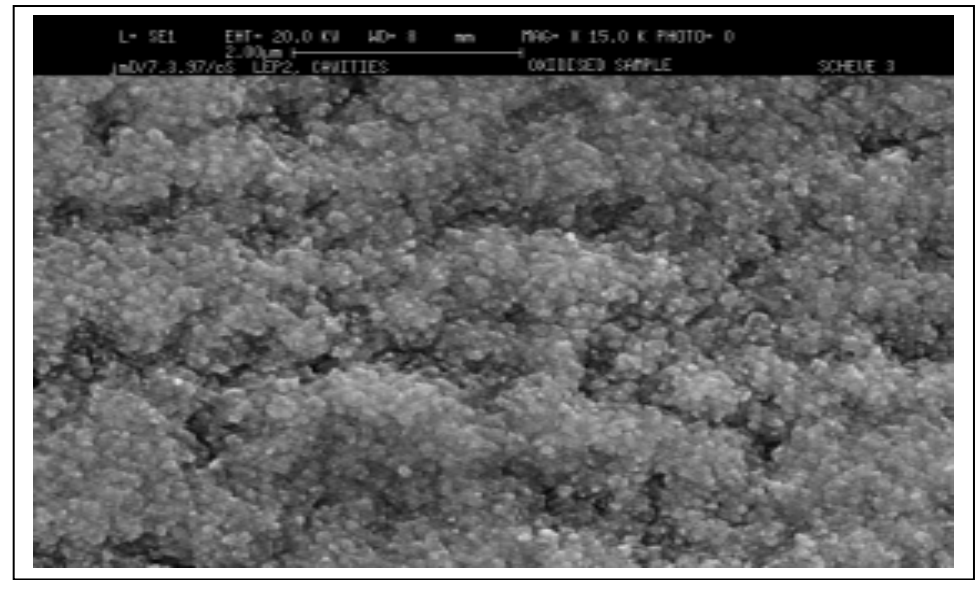


EFFECT OF A NITROGEN GLOW DISCHARGE ON COPPER

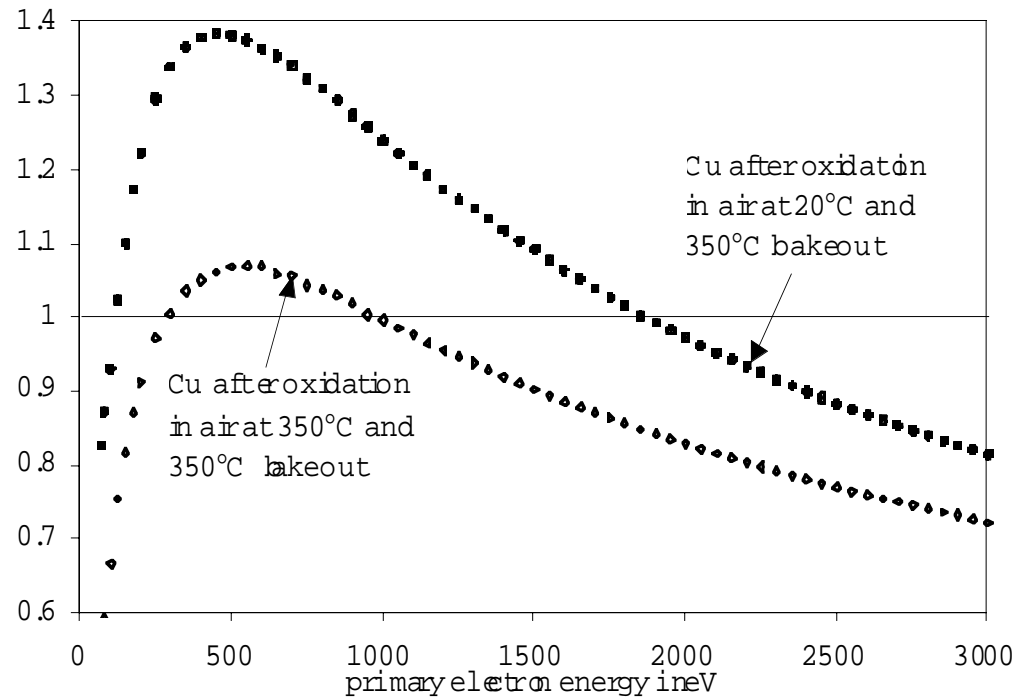




Copper as received, Mag = 15 000



Copper after 5 min air exposure at 350°C and 350°C bakeout under vacuum Mag = 15 000



# REMEDIES

## **\*THE DOSE EFFECT**

*IN SITU TREATMENT: CONDITIONNING,  
FOR ALL MATERIALS*

***VERY EFFICIENT***

*.....PROVIDED OPERATION IS POSSIBLE WITH A SIGNIFICANT  
BOMBARDMENT OF THE SURFACES*

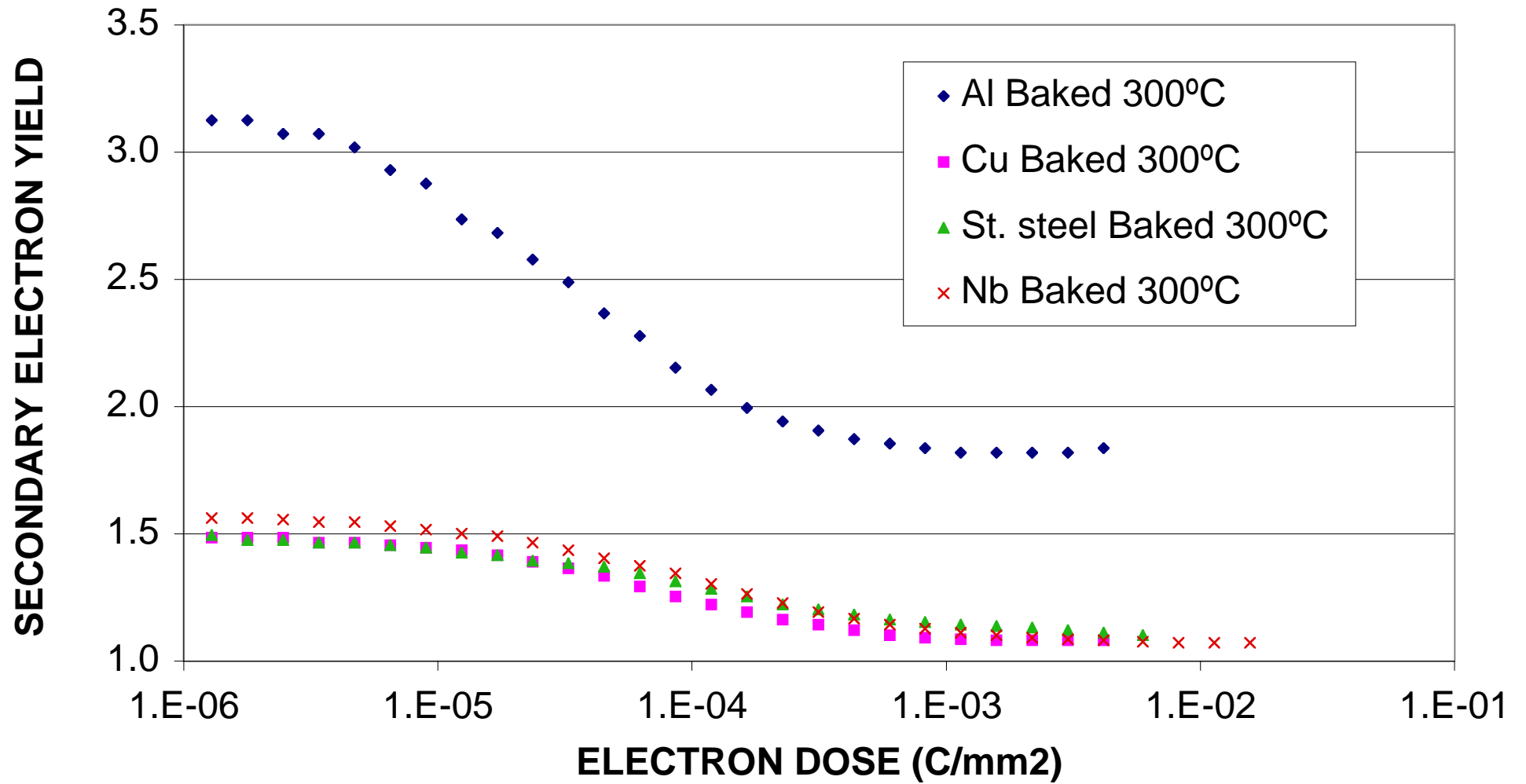
***BUT RECONDITIONNING NEEDED AFTER AIR EXPOSURE***

*\*TESTED IN EPA (500 MeV accumulator  $E_c = 194$  eV)*

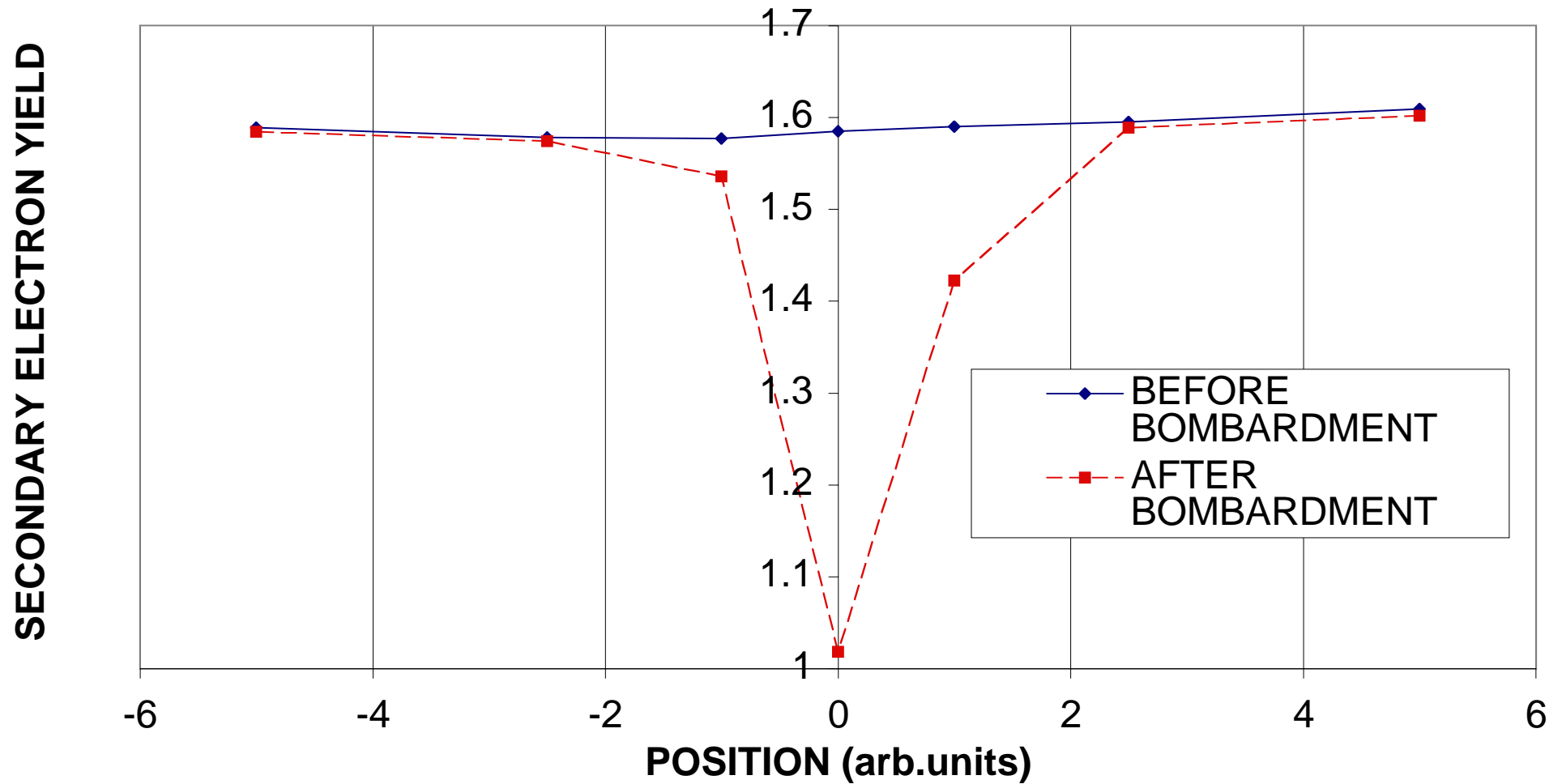
*\*STILL NOT FULLY UNDERSTOOD : ELECTRON STIMULATED  
CARBON LAYER FORMATION??*



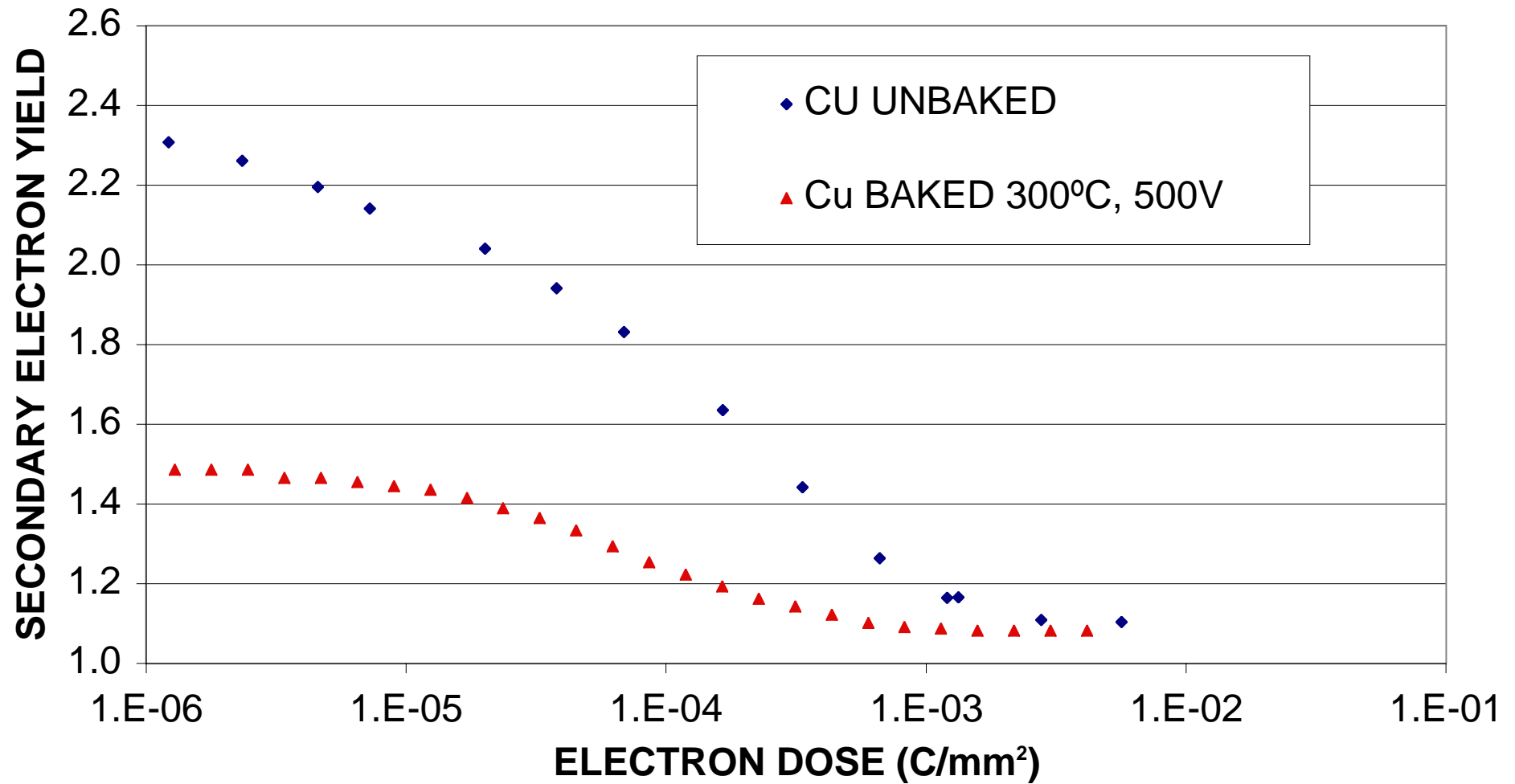
VARIATION OF THE SECONDARY ELECTRON YIELD WITH THE PRIMARY ELECTRON DOSE



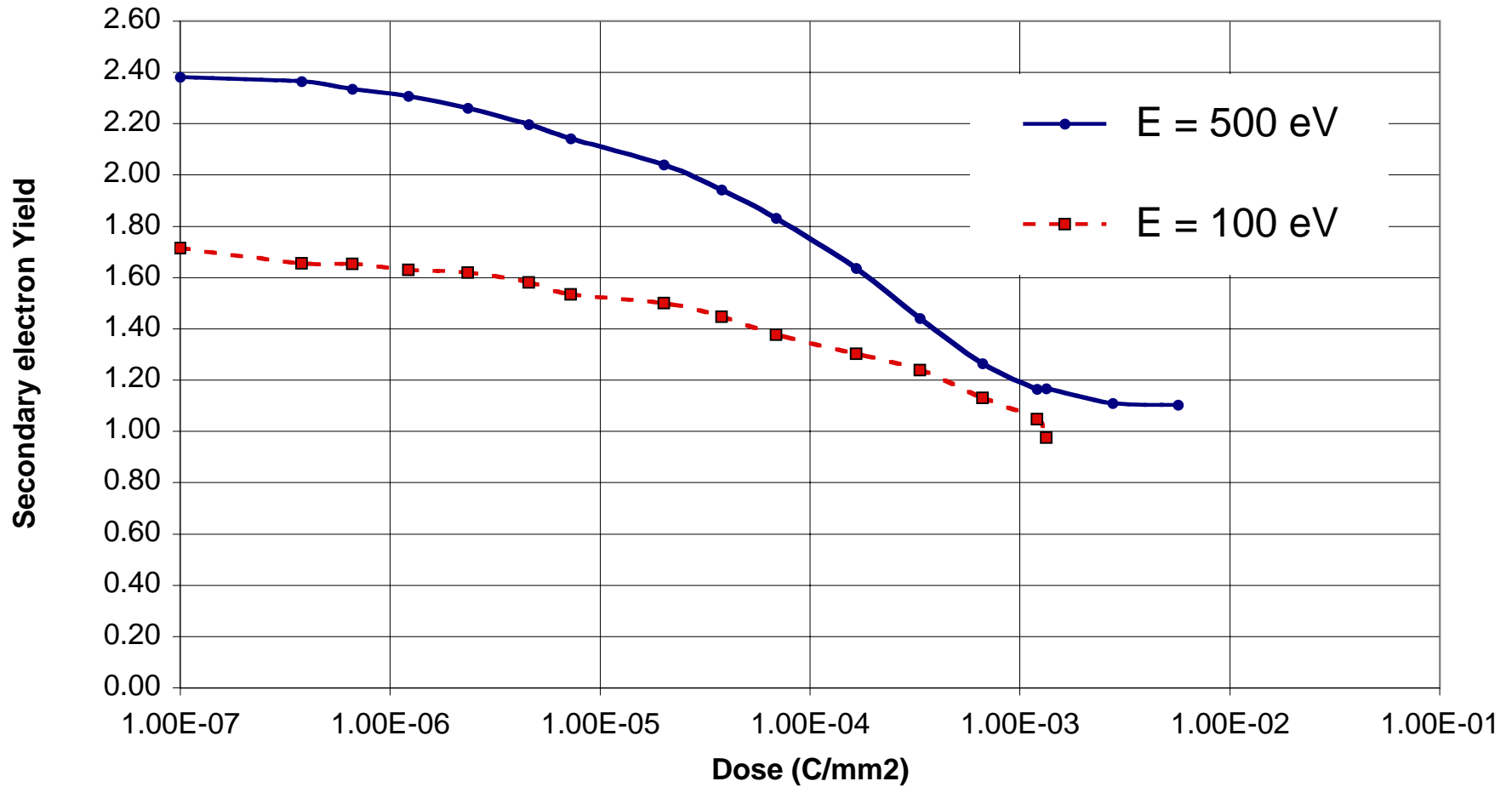
## VARIATION OF THE SECONDARY ELECTRON YIELD AS A FUNCTION OF THE POSITION, BEFORE AND AFTER DOSING



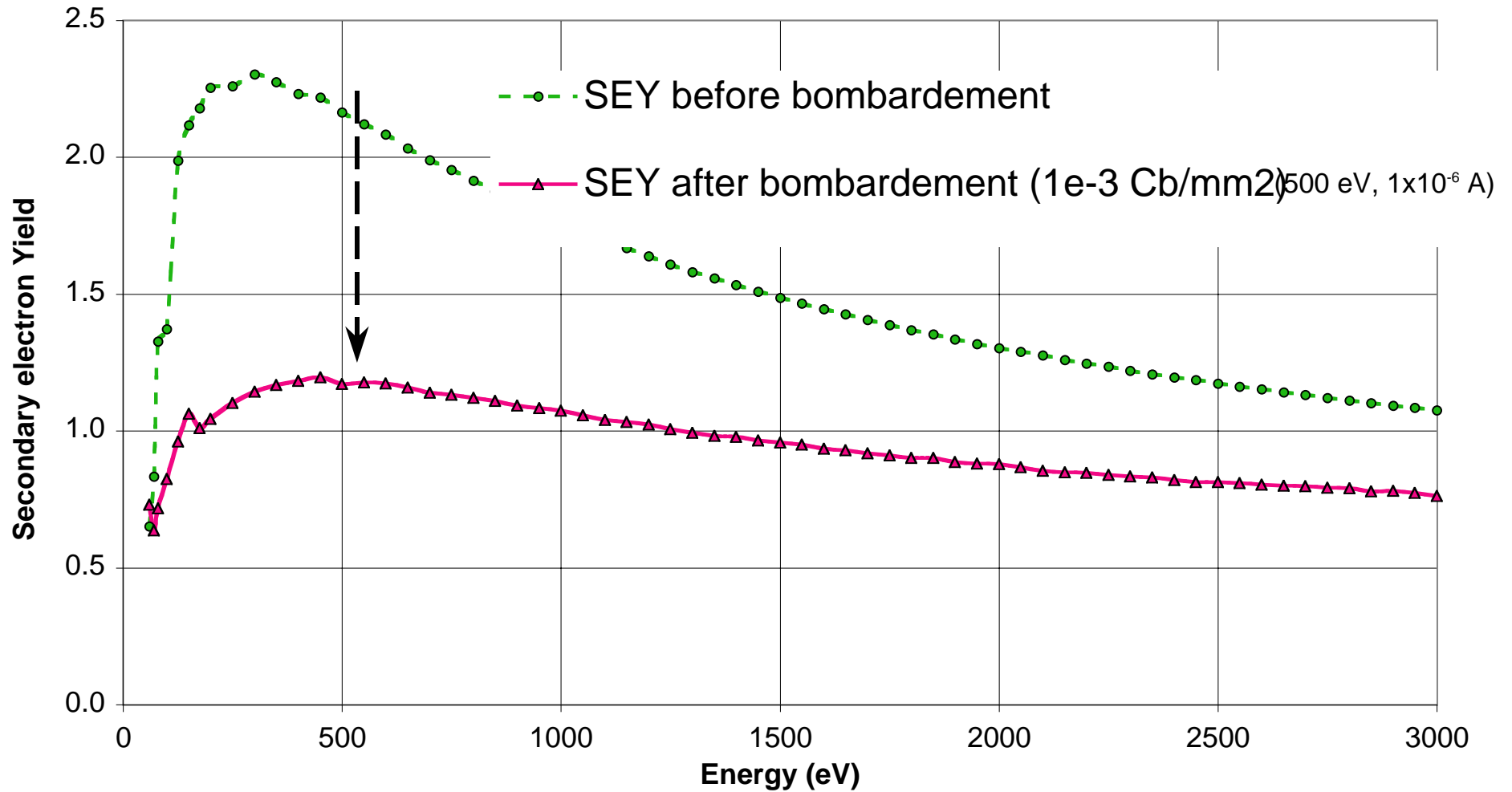
## VARIATION OF THE SECONDARY ELECTRON YIELD WITH THE PRIMARY ELECTRON DOSE



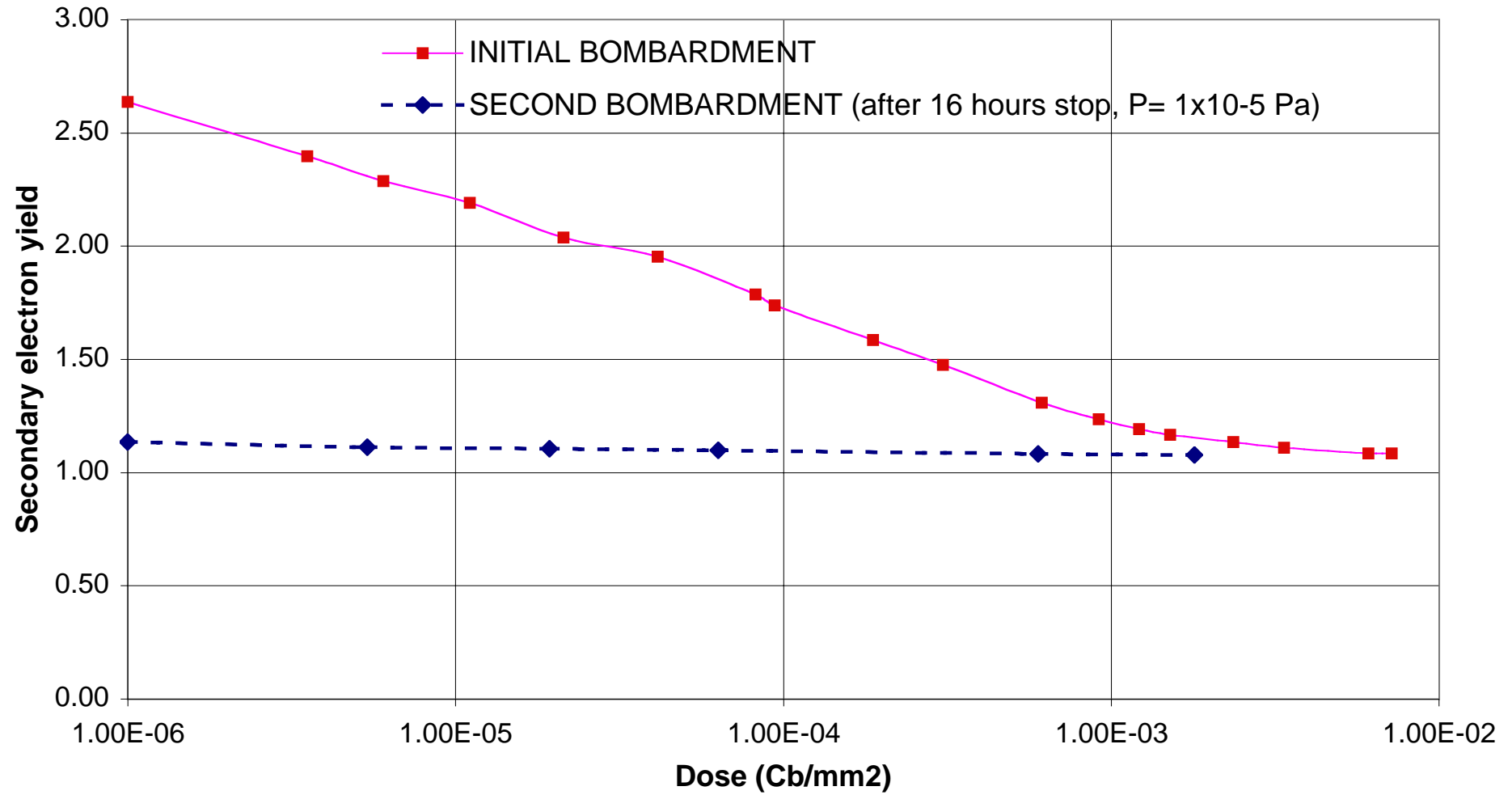
### INFLUENCE OF THE ELECTRON ENERGY ON THE COPPER SECONDARY ELECTRON YIELD VARIATION



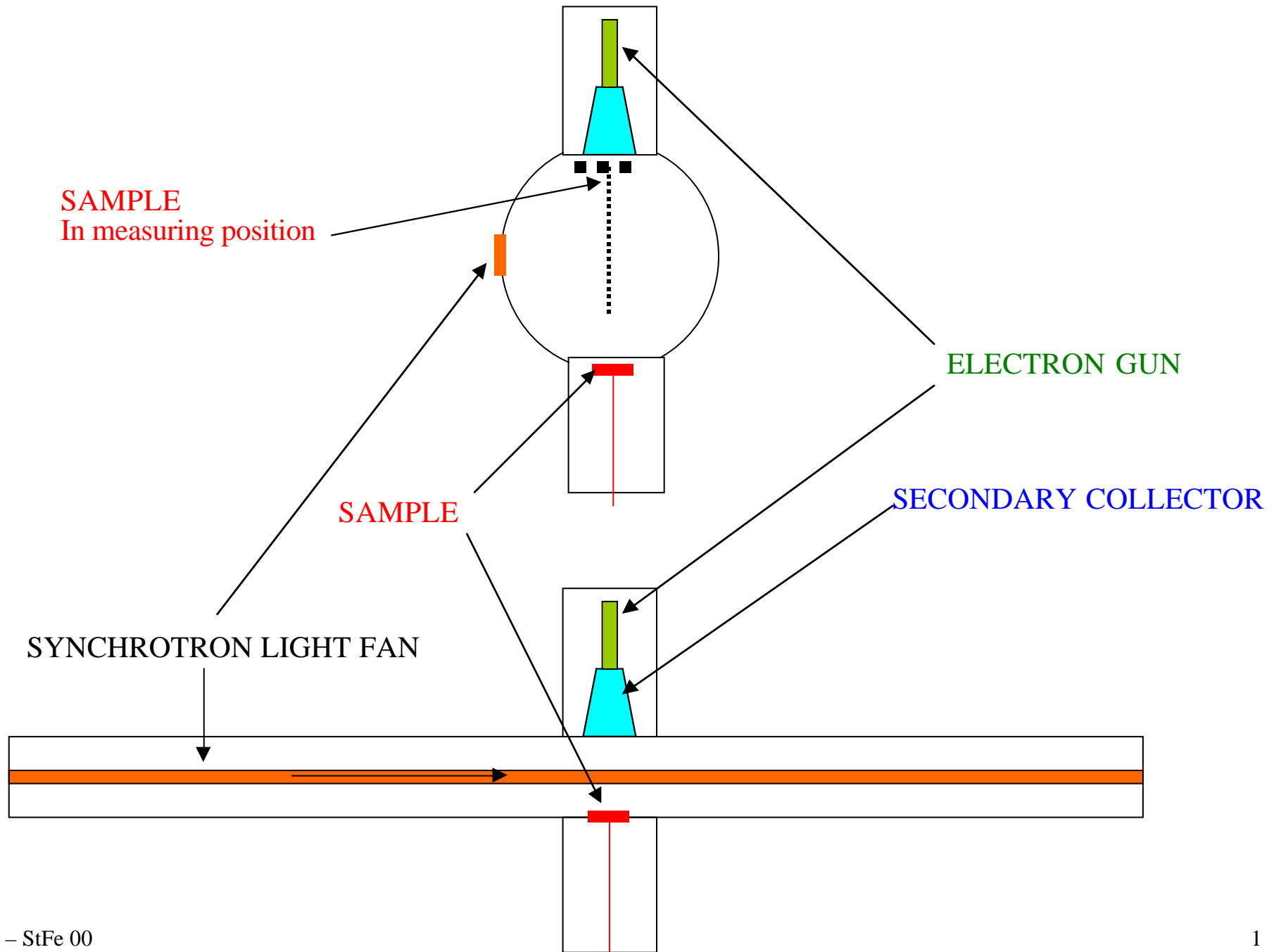
SEY variation with the beam energy at 2 different electron doses  
Material: Colaminated copper on stainless steel



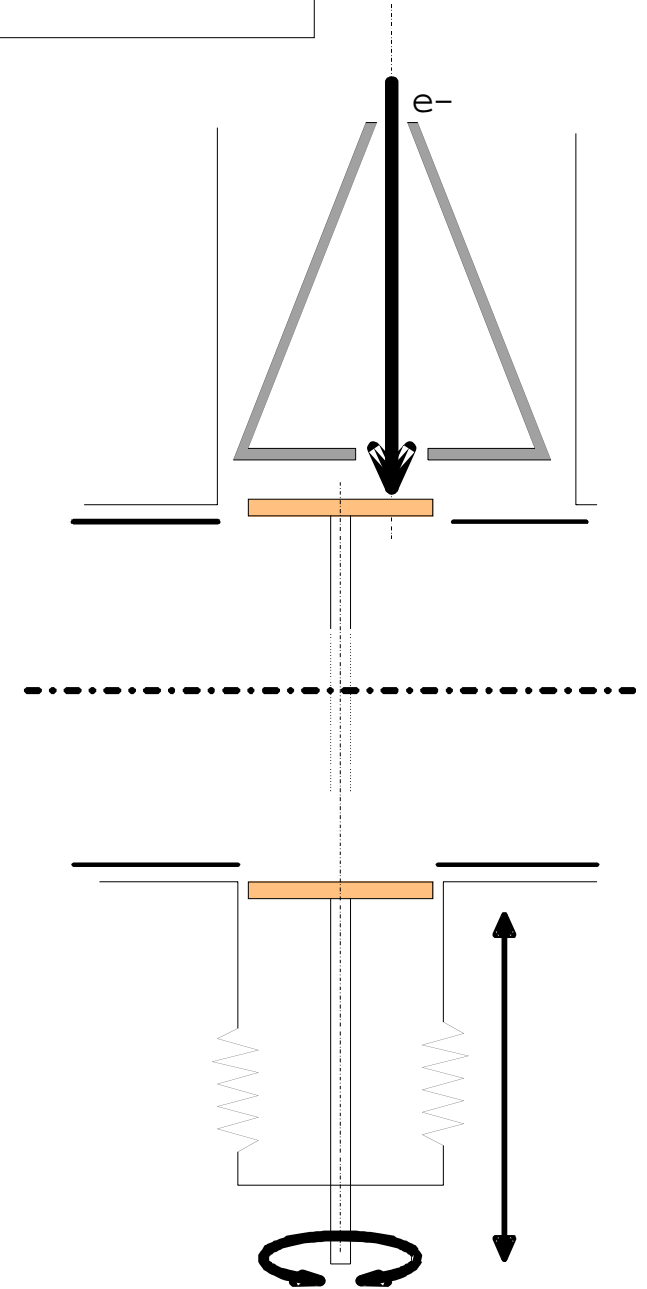
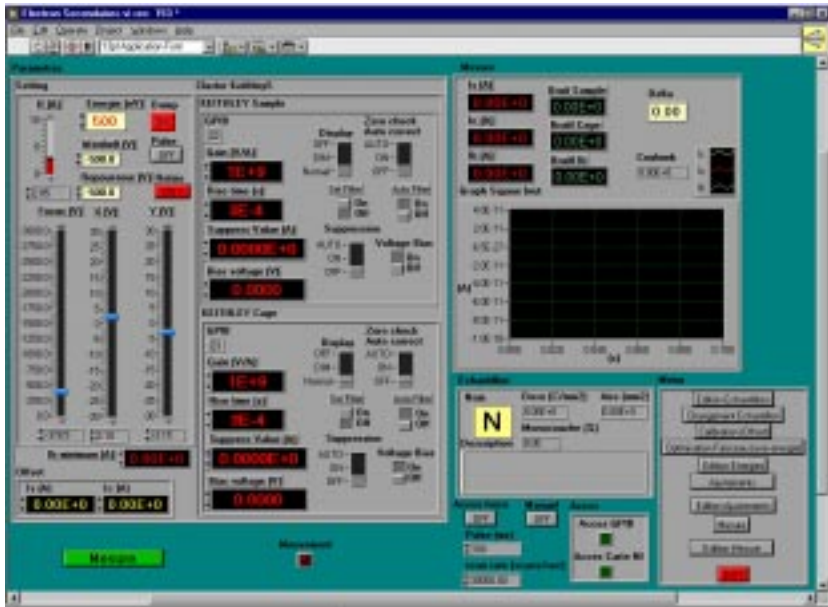
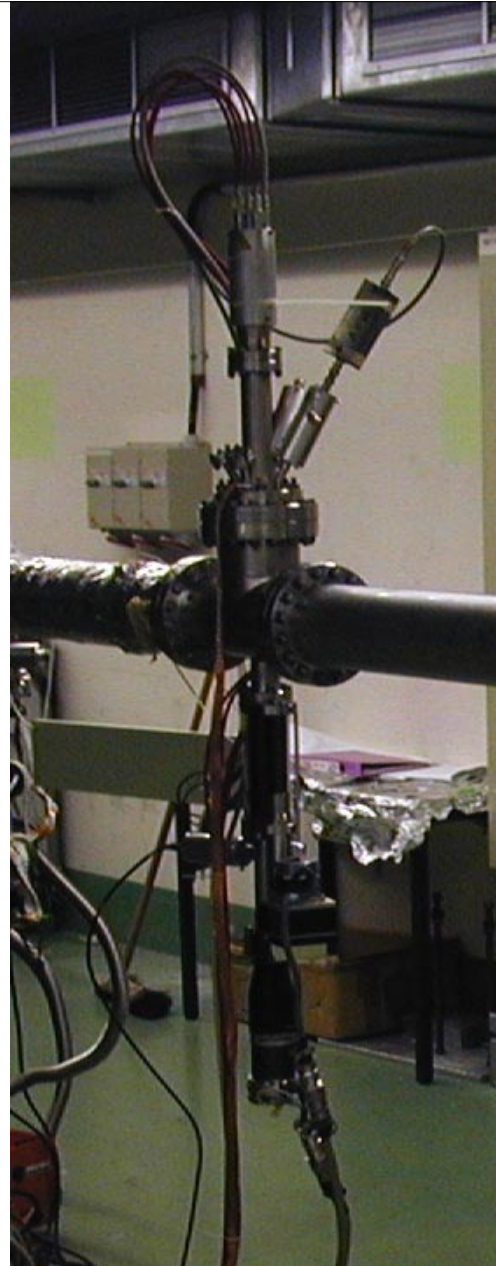
Variation of the secondary electron yield with the electron dose for 2 consecutives bombardment (1e-6 A, 500eV).



# THE EPA EXPERIMENT

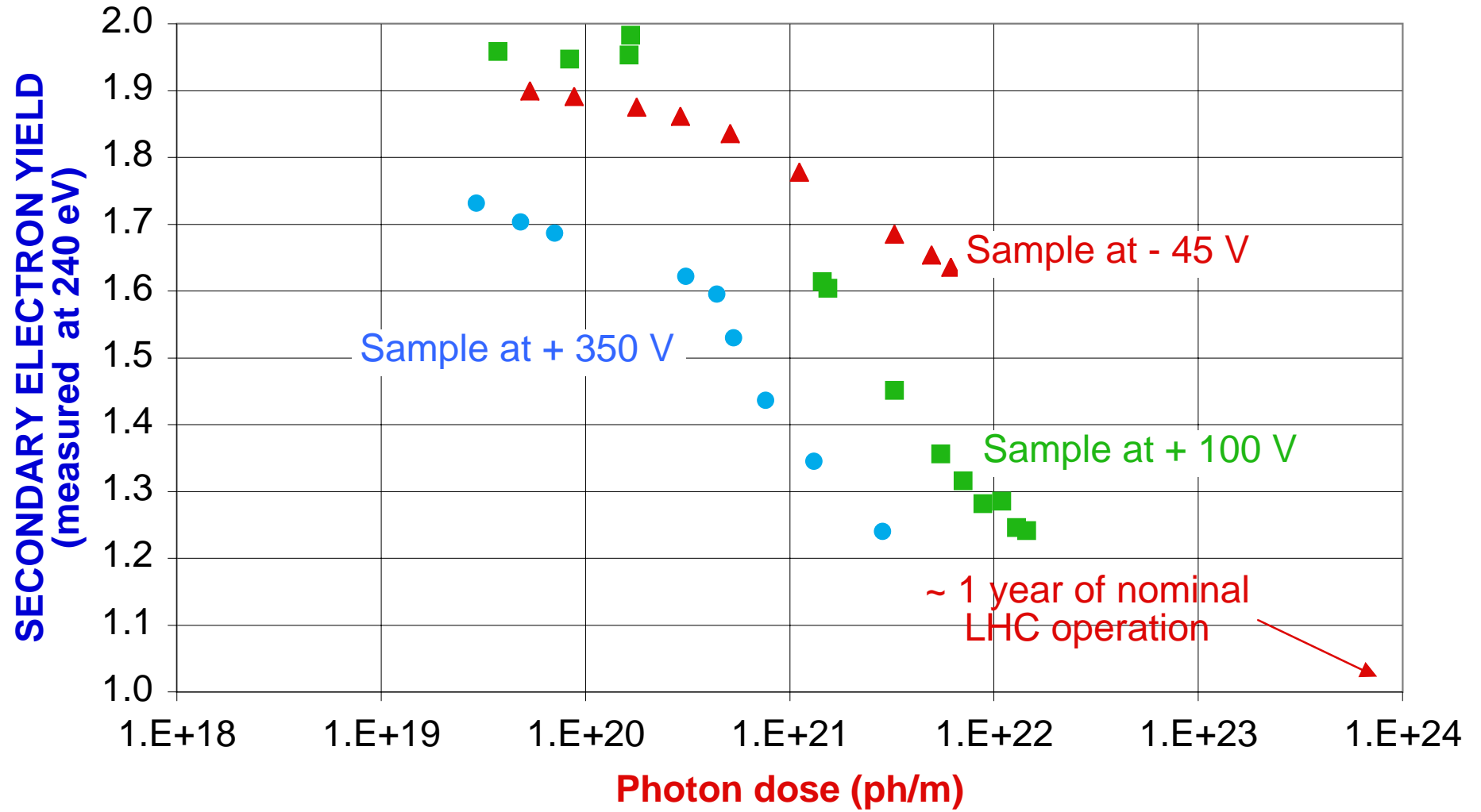


# THE SECONDARY ELECTRON TEST SYSTEM IN EPA

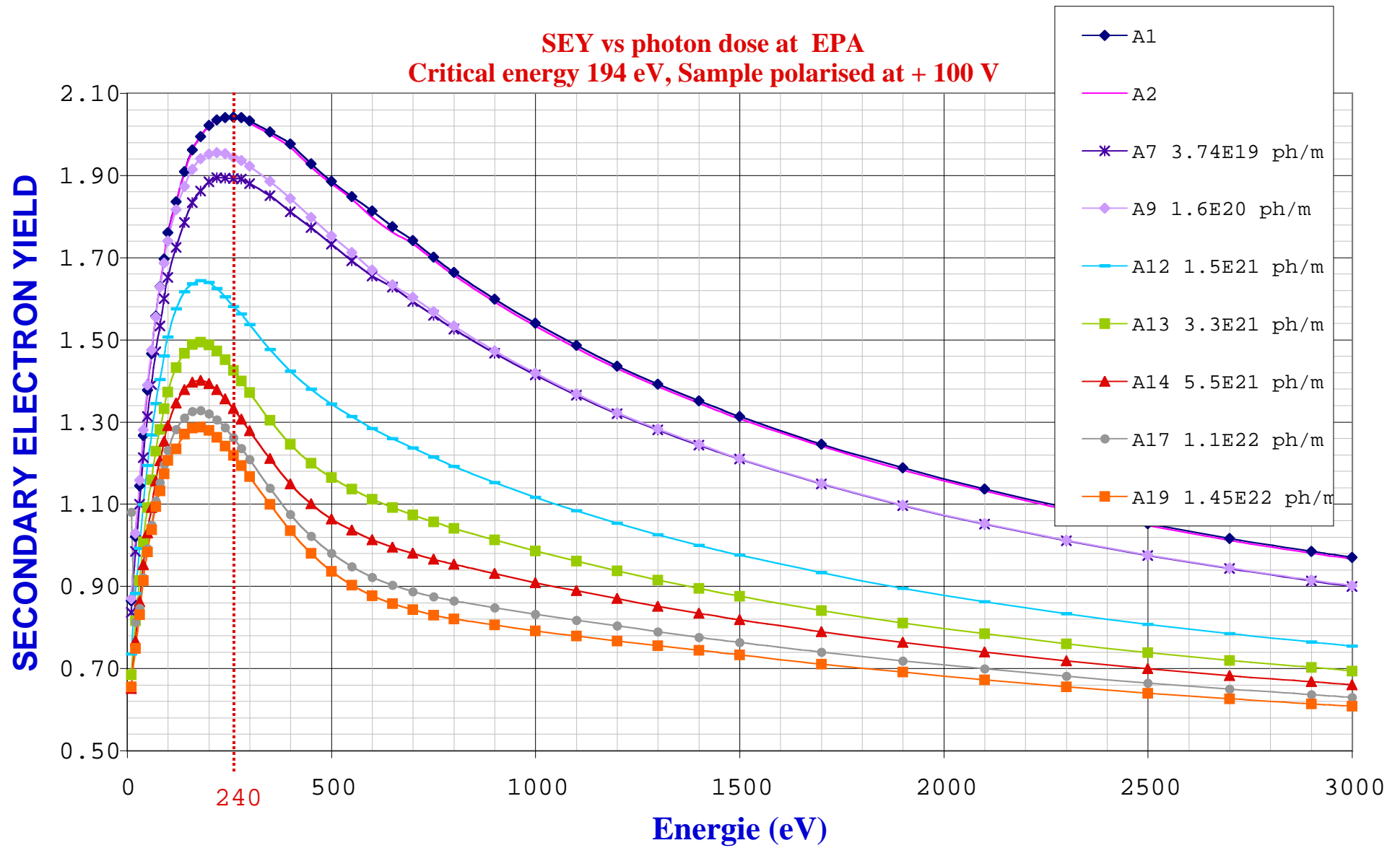




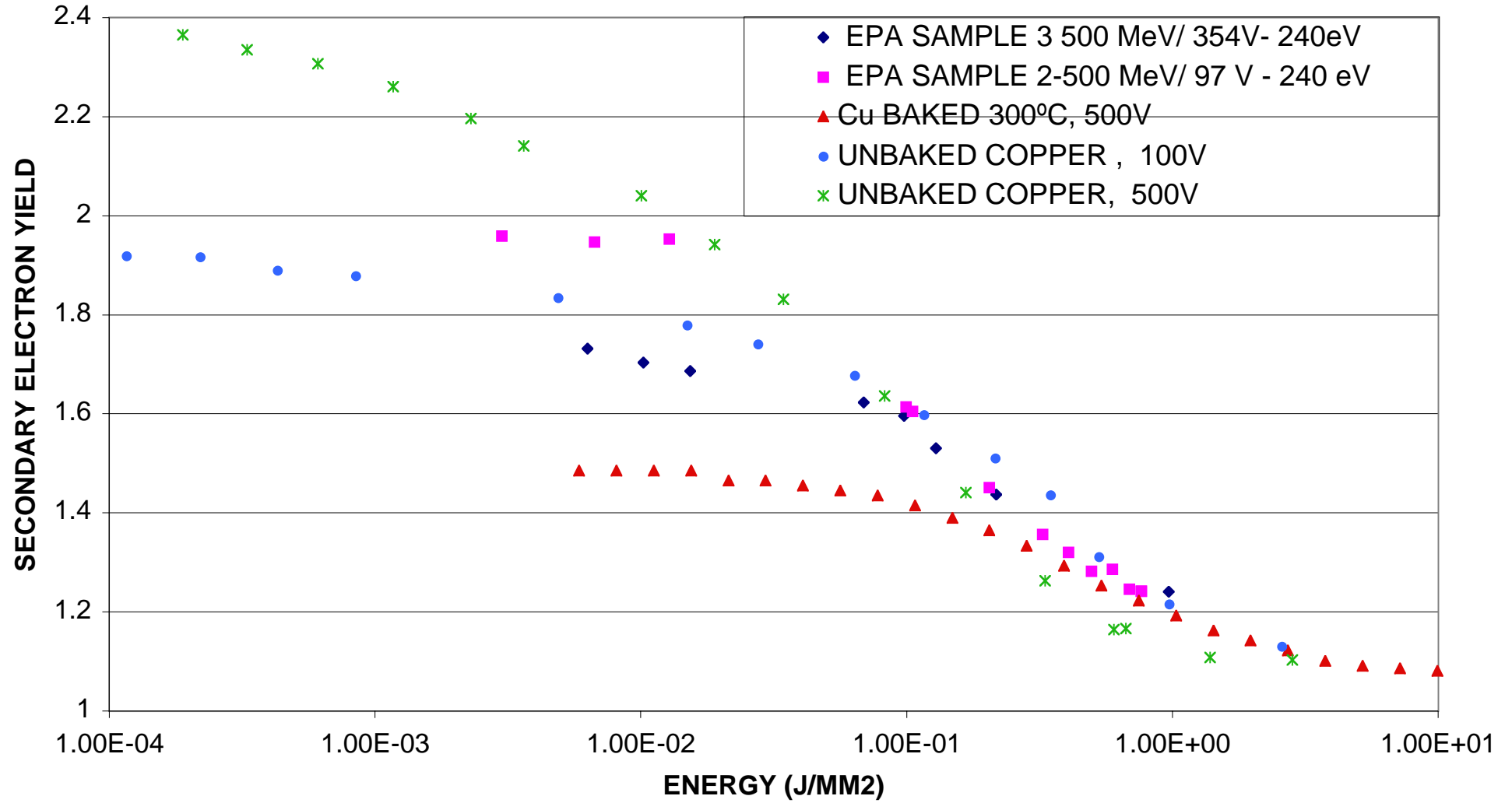
**SEY vs photon dose at EPA**  
**Critical energy 194 eV**



**SEY vs photon dose at EPA**  
**Critical energy 194 eV, Sample polarised at + 100 V**



## SECONDARY ELECTRON YIELD VERSUS DEPOSITED ENERGY



## CONCLUSIONS

*S.E.E IS STRONGLY SURFACE DEPENDENT:*

*MORE INFLUENCED BY THE SURFACE PREPARATION THAN BY THE  
BASE MATERIAL ITSELF*

*WONDER LAYERS NEED TO BE PRODUCED IN-SITU OR BAKED  
OUT TO BE FULLY EFFICIENT*

*NATURE IS KIND AND GAVE US "THE DOSE EFFECT" :*

*PROVIDING LOW S.E.Y FOR ALL MATERIALS*

*( MAX~ 1 -> 1.2 )*

*PATIENCE IS NEVERTHELESS MANDATORY*