

# ***THE SECONDARY ELECTRON YIELD OF TECHNICAL MATERIAL AND ITS VARIATION WITH SURFACE TREATMENTS***

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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**

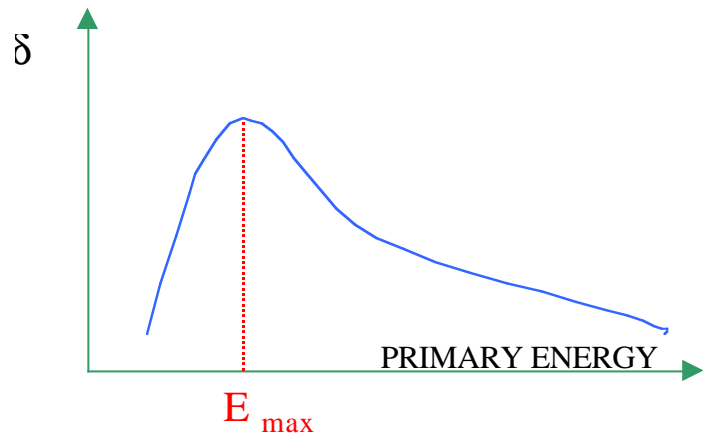
*OLD SUBJECT : AUSTIN –STARK (1902)*

*MOST OF PURE METALS MEASURED BEFORE LAST WAR*

*WHY MEASUREMENTS IN 2000??*

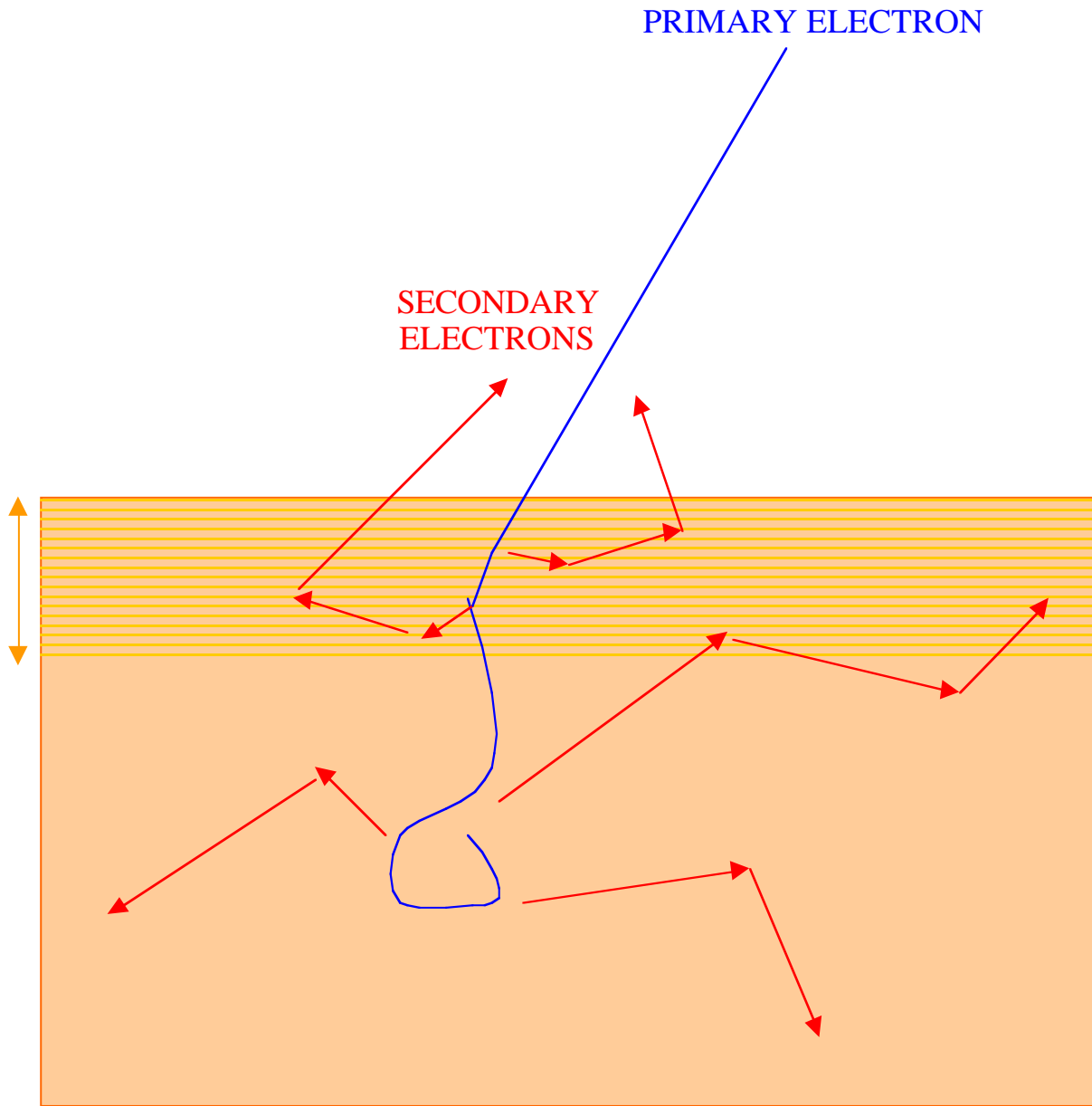
*HOW TO MEASURE IT???*

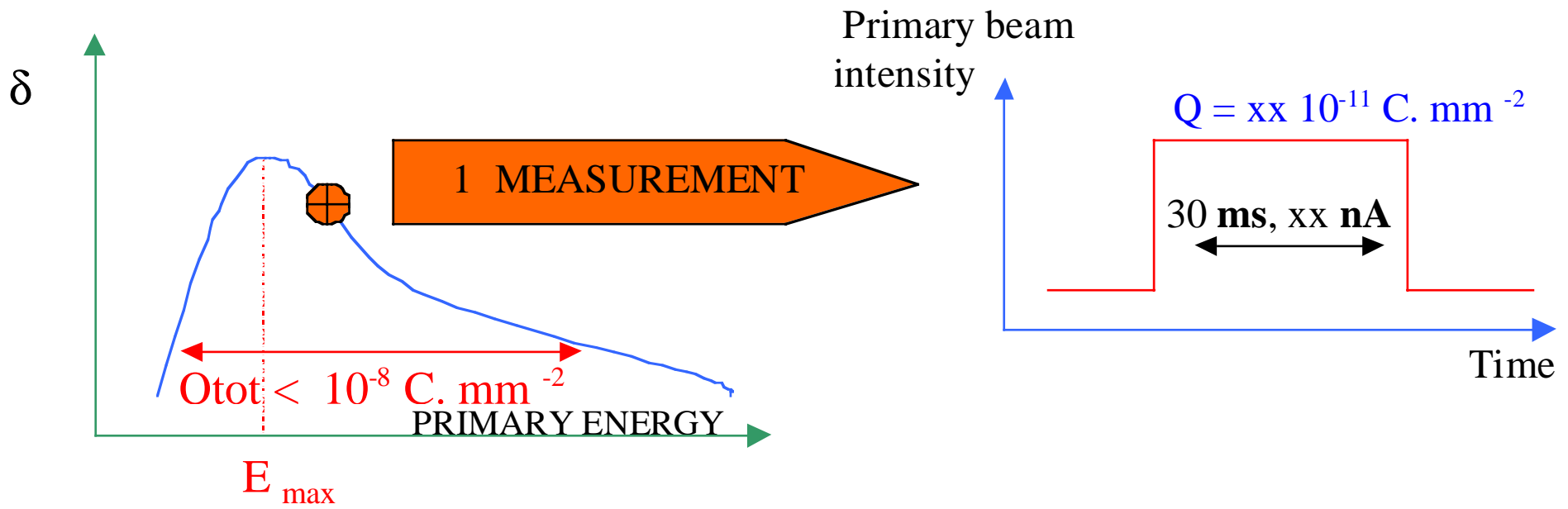
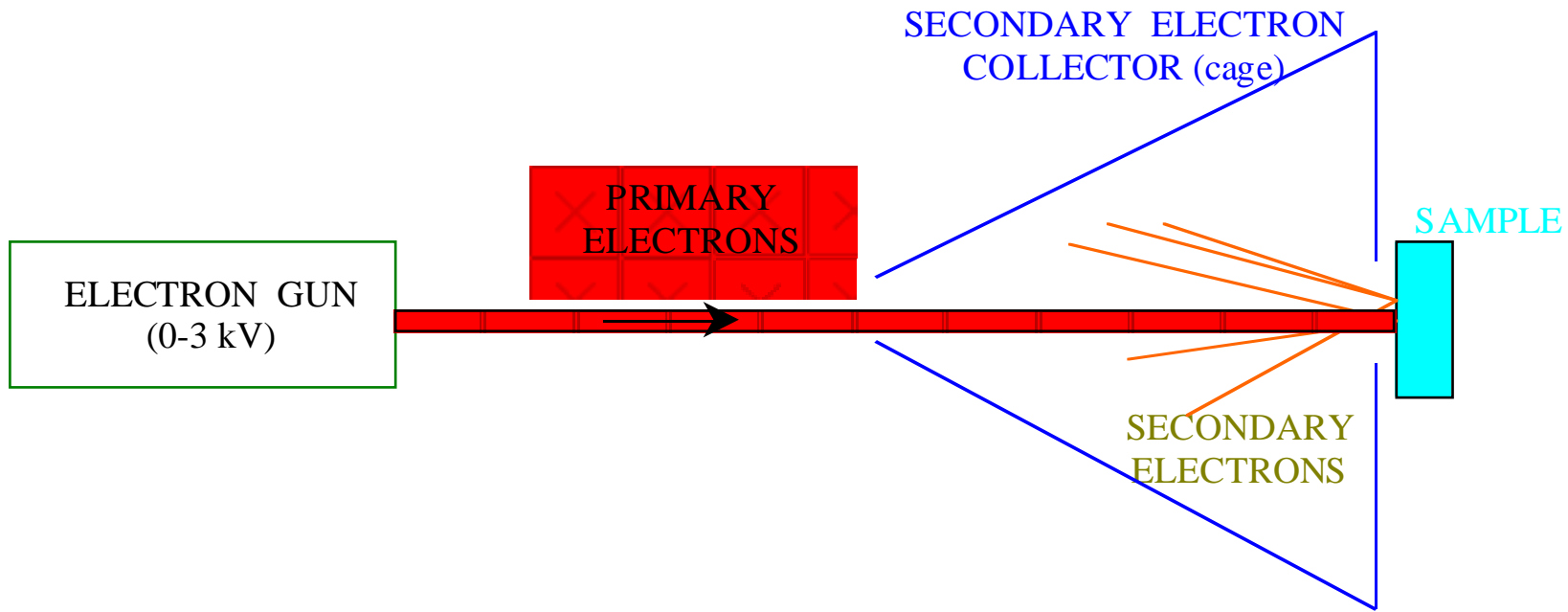
*IMPORTANCE OF LOW PRIMARY CURRENT*



SECONDARY ESCAPE DEPTH

Metals  $\diamond$  insulators





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

*COMPARISON BETWEEN PURE METALS AND TECHNICAL MATERIALS*

*ORIGIN OF THE DISCREPANCY => OXIDES + CONTAMINANTS*

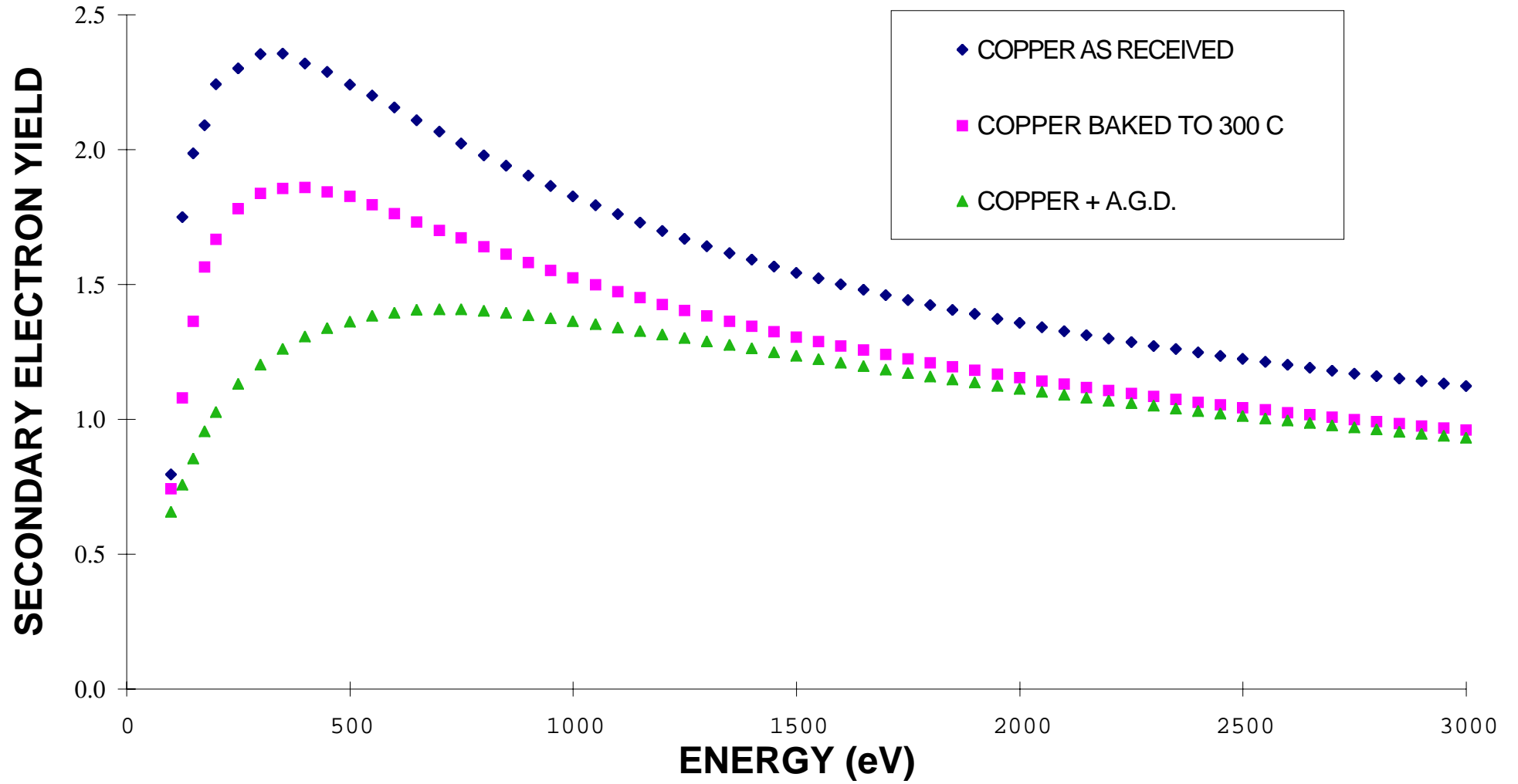
*INFLUENCE OF OXIDE*

*INFLUENCE OF WATER*

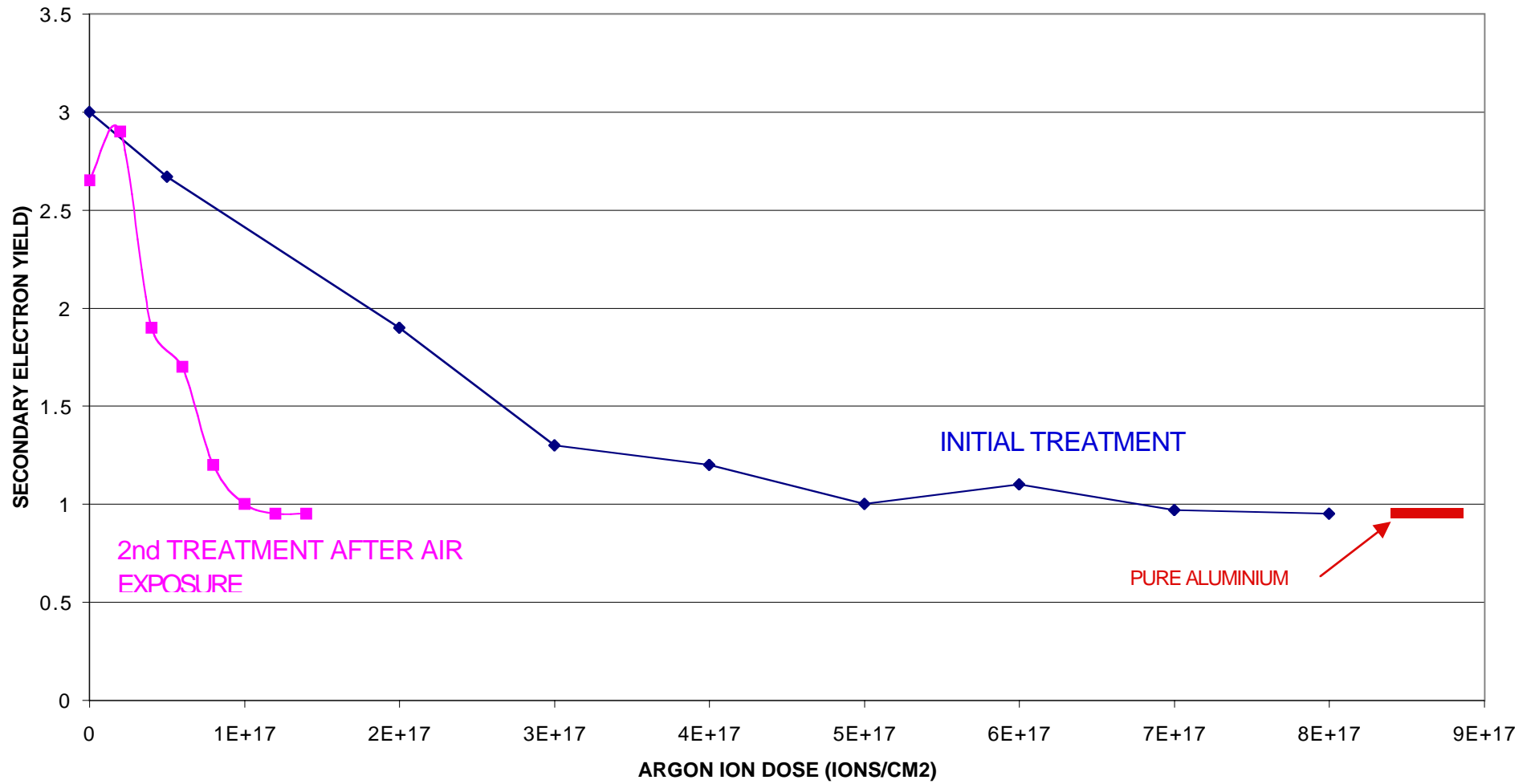
*SECONDARY ELECTRON YIELD      COMMON TECHNICAL MATERIALS*

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

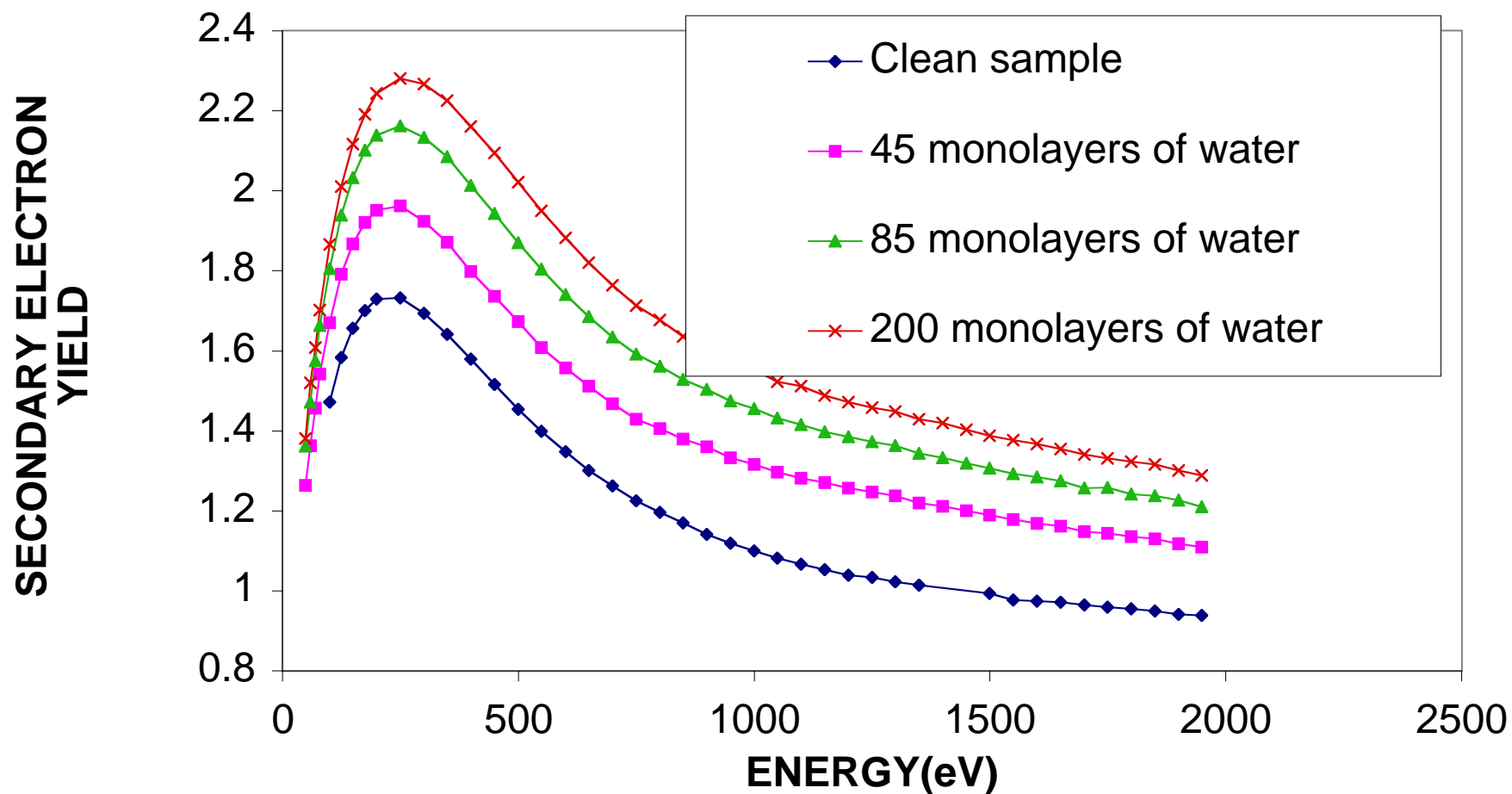
SECONDARY ELECTRON YIELD



# SECONDARY ELECTRON YIELD VERSUS ARGON ION DOSE ALUMINIUM SAMPLE

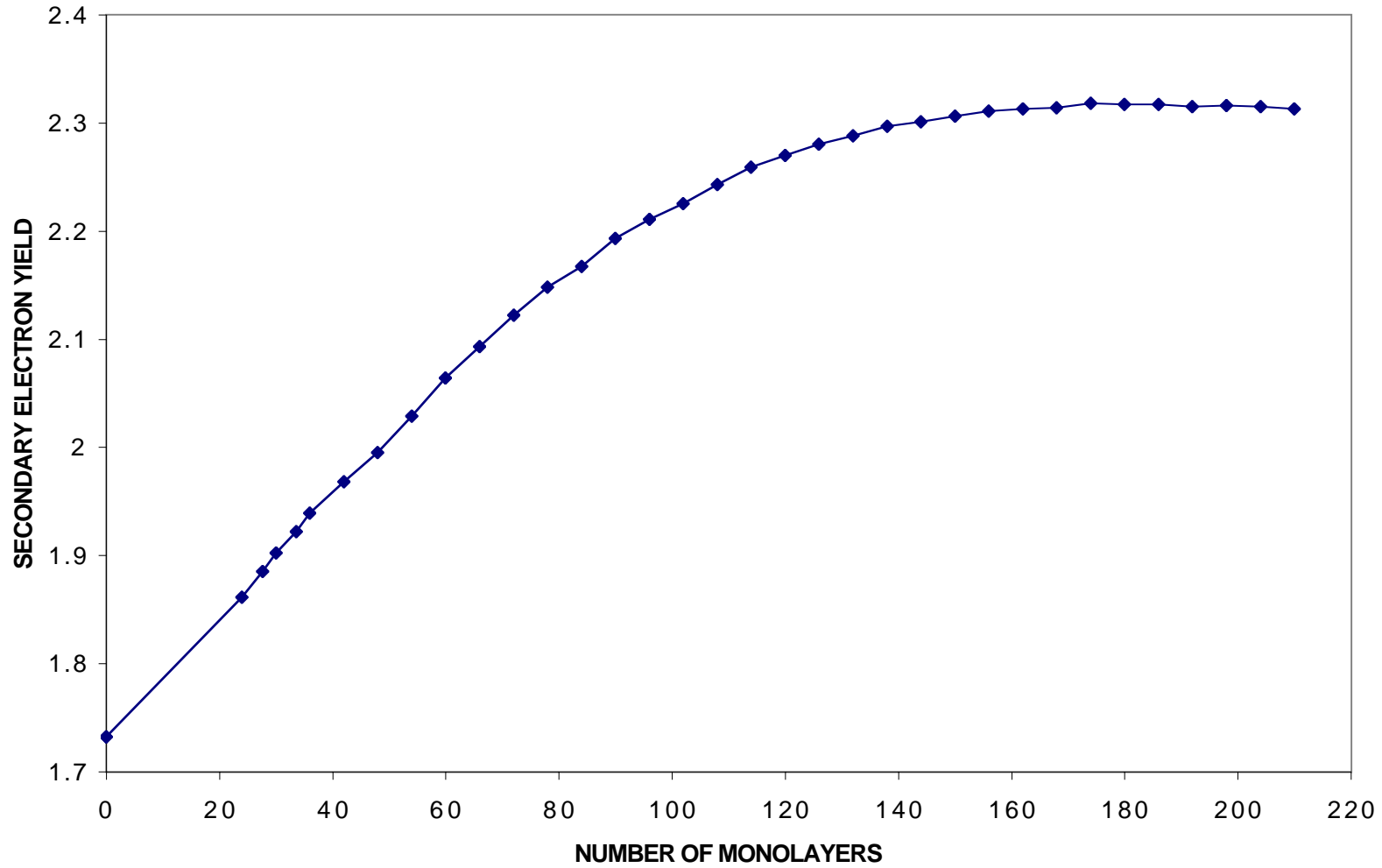


# SECONDARY ELECTRON YIELD OF CONDENSED WATER



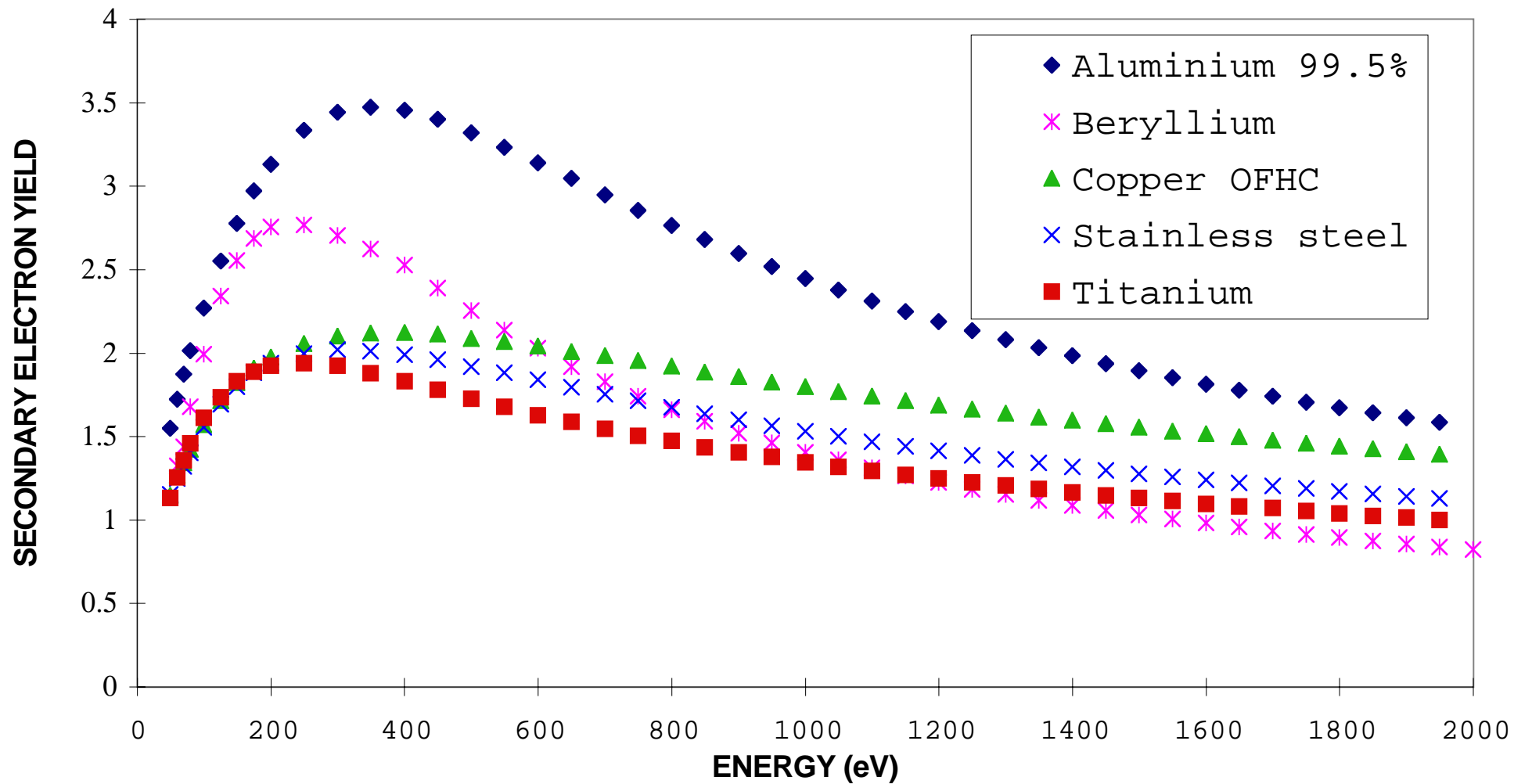


VARIATION OF THE S.E.Y. WITH THE CONDENSED WATER THICKNESS

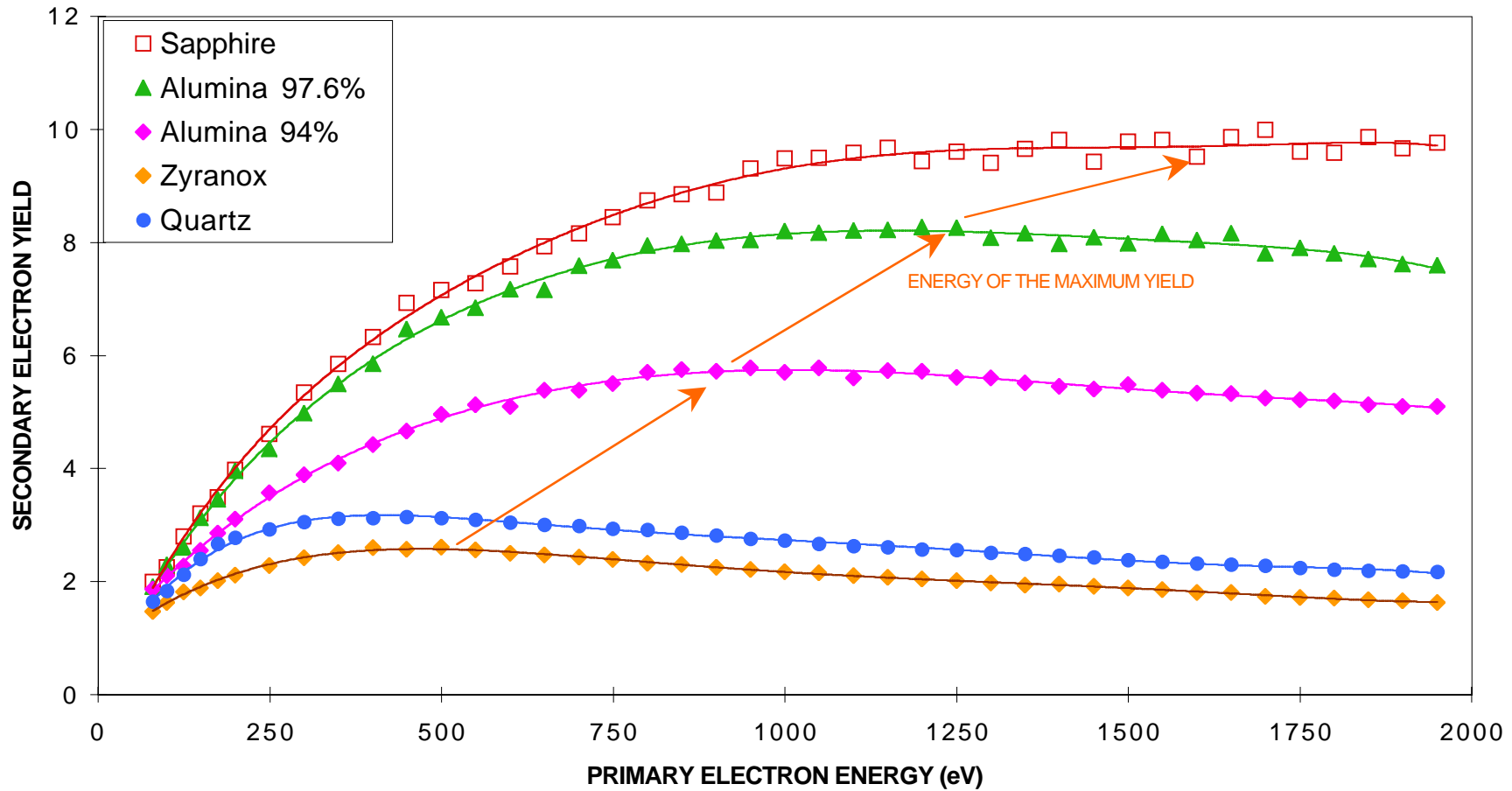


# SECONDARY ELECTRON YIELD

## 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

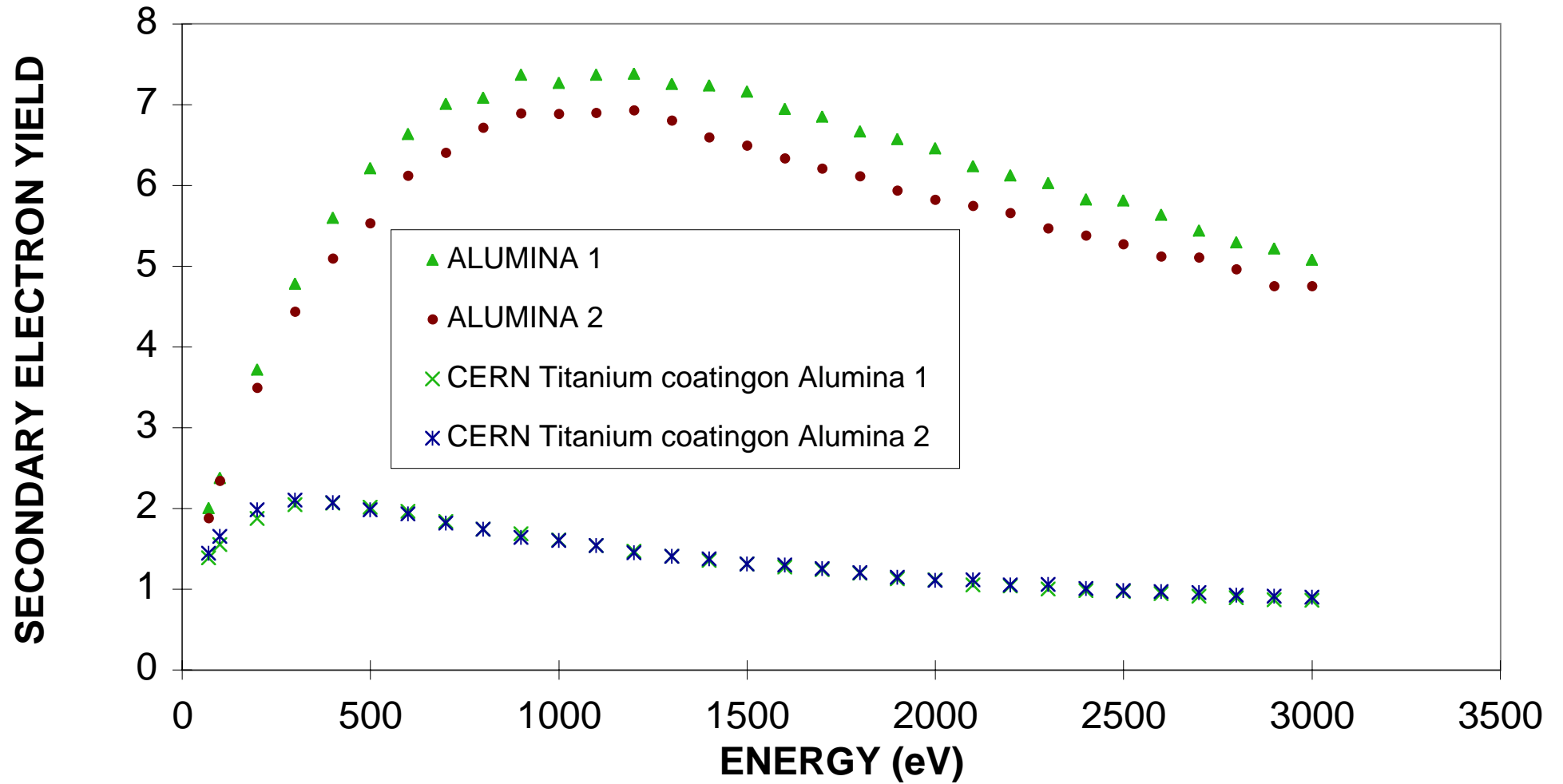
**\*CHANGE THE SURFACE TOPOGRAPHY:**

BLACK LAYERS: AQUADAG , GOLD BLACK , SOOT

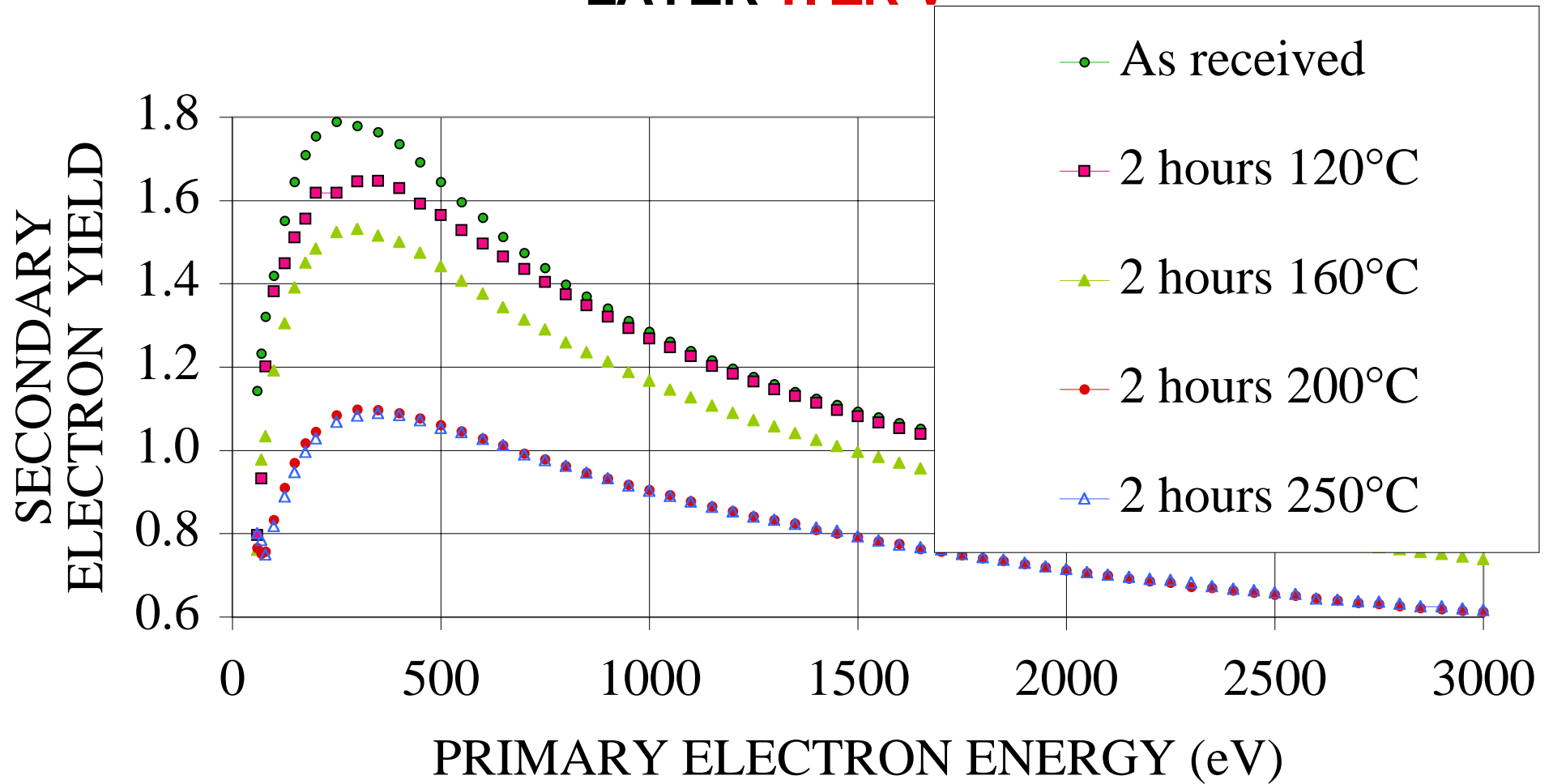
OXIDE GROW e.g. COPPER OXIDE

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

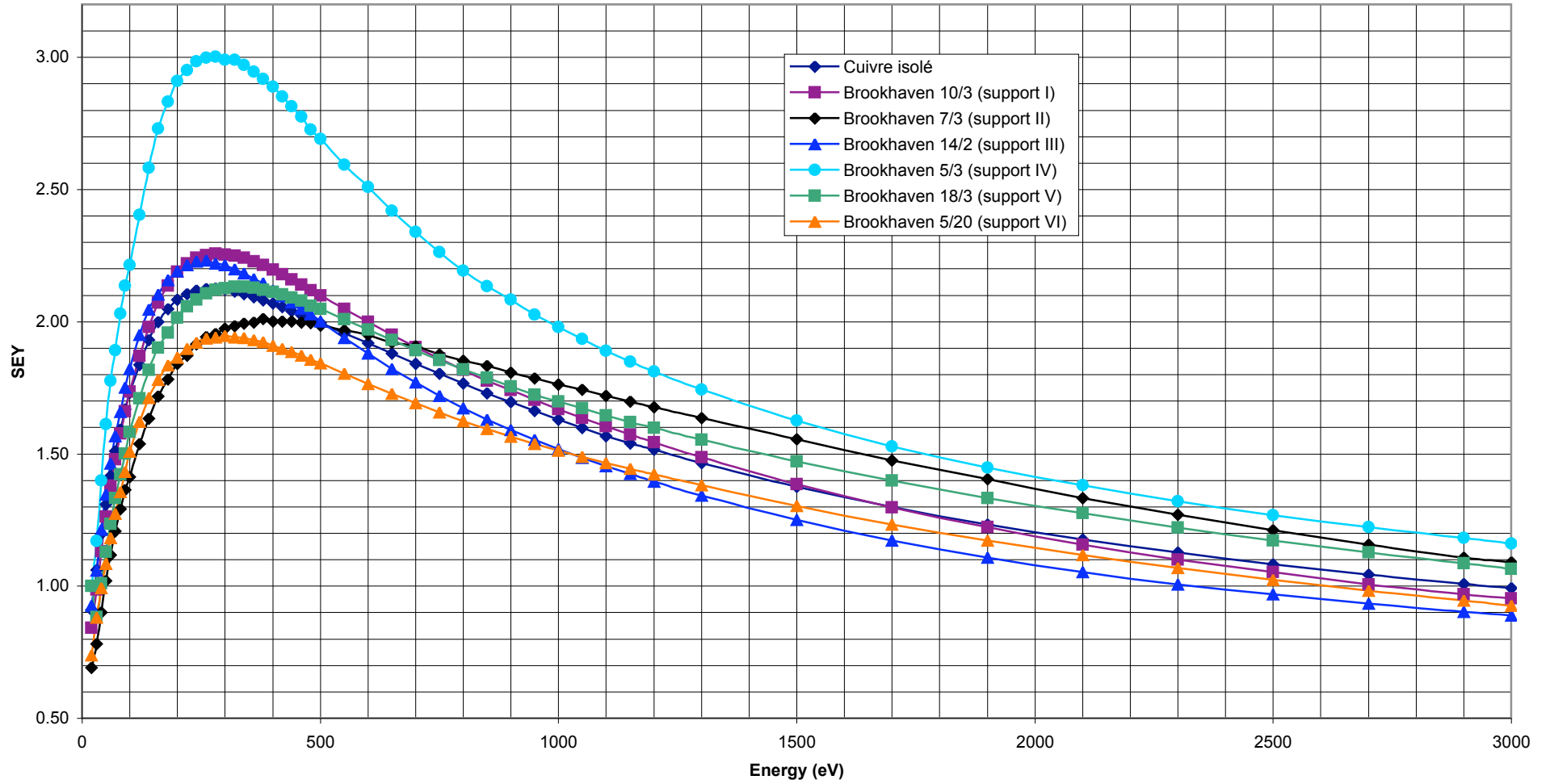
## INFLUENCE OF COATINGS



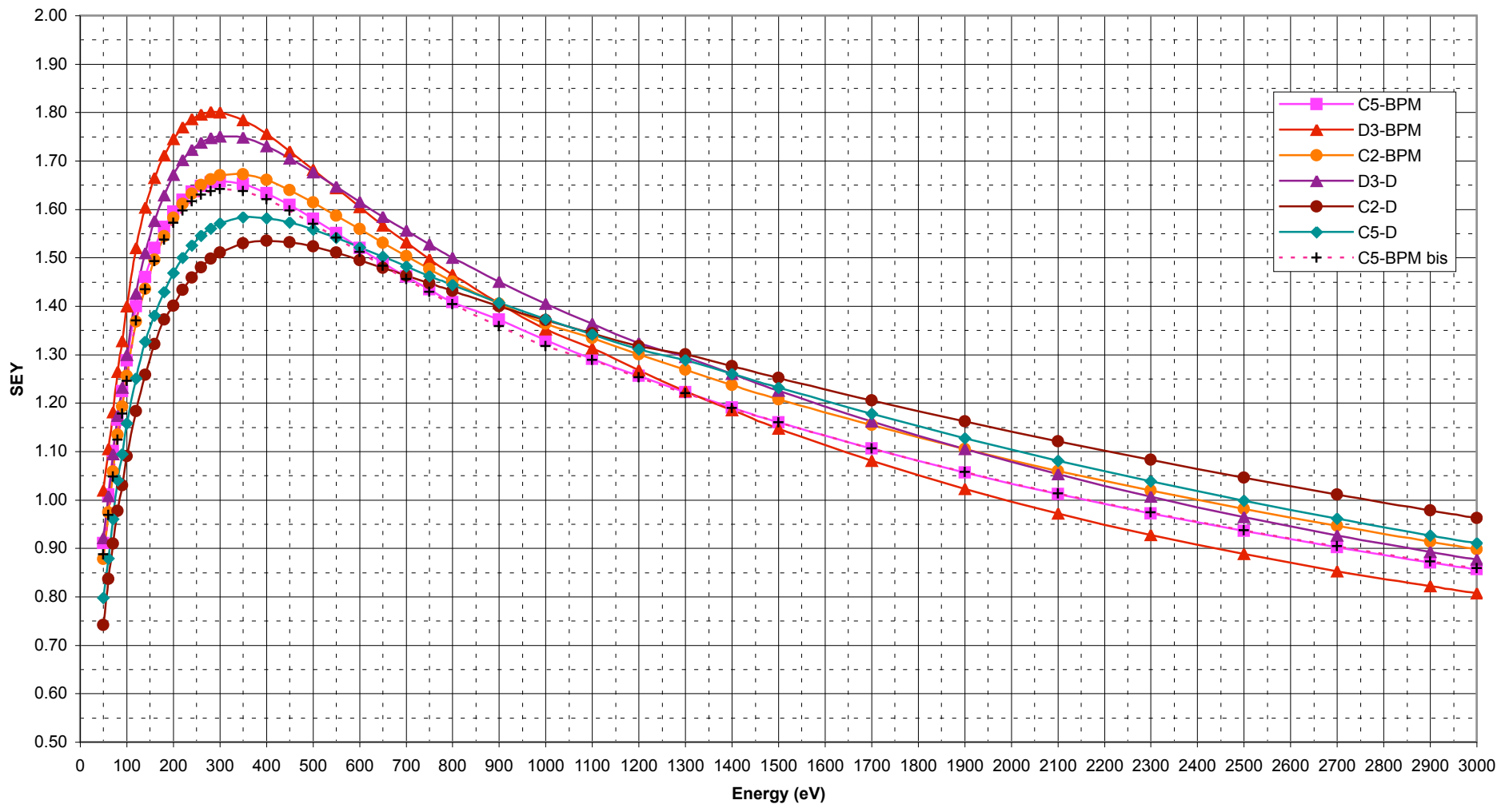
# SECONDARY ELECTRON YIELD OF A GETTER LAYER **TI ZR V**



**SEY of Brookhaven TiN samples**  
**As received state**  
CERN LHC/VAC B. HENRIST 12th january 2000

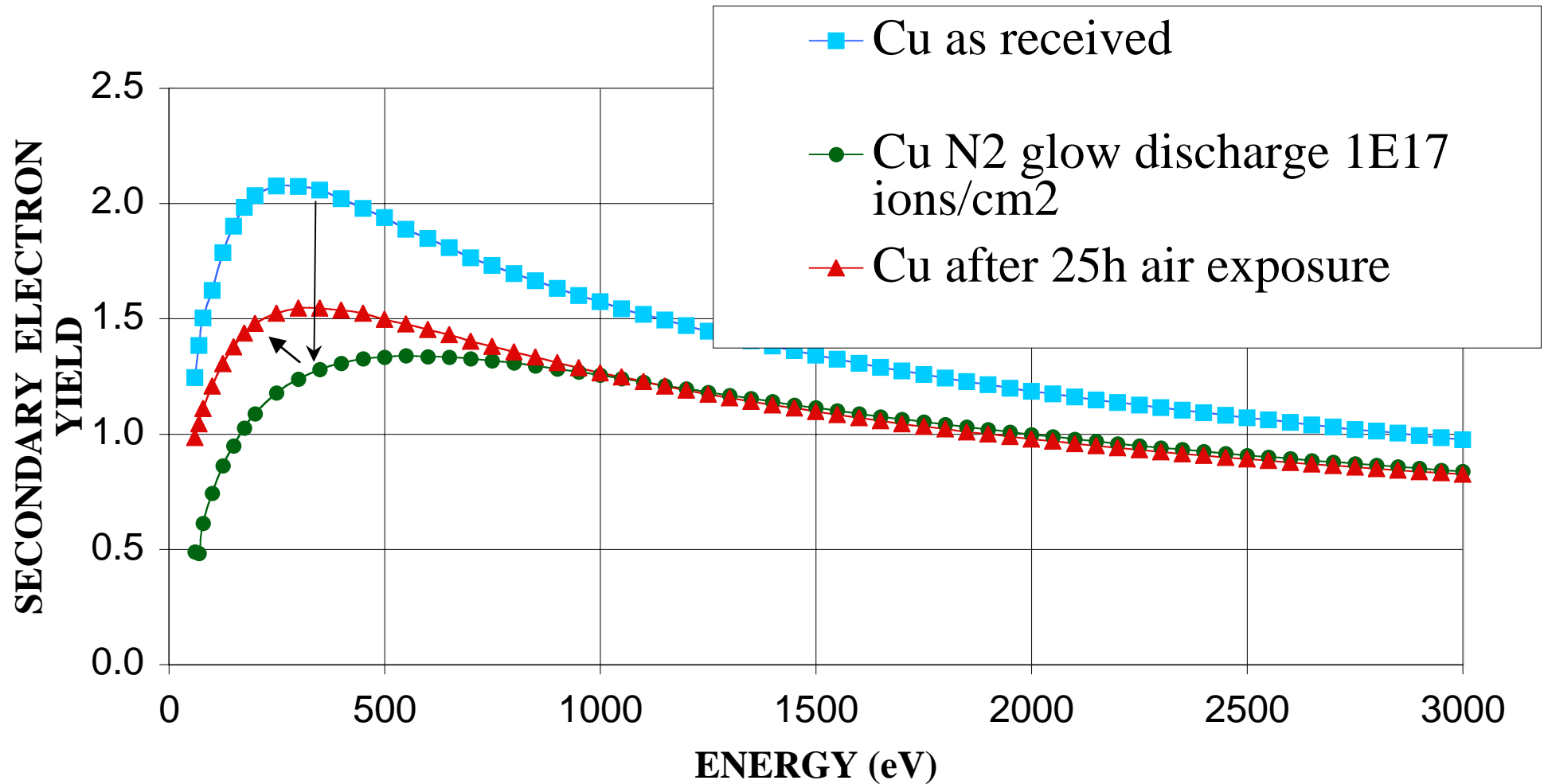


TiN  
As received SEY measurement  
CERN AT-VAC B. HENRIST 23/5/2003

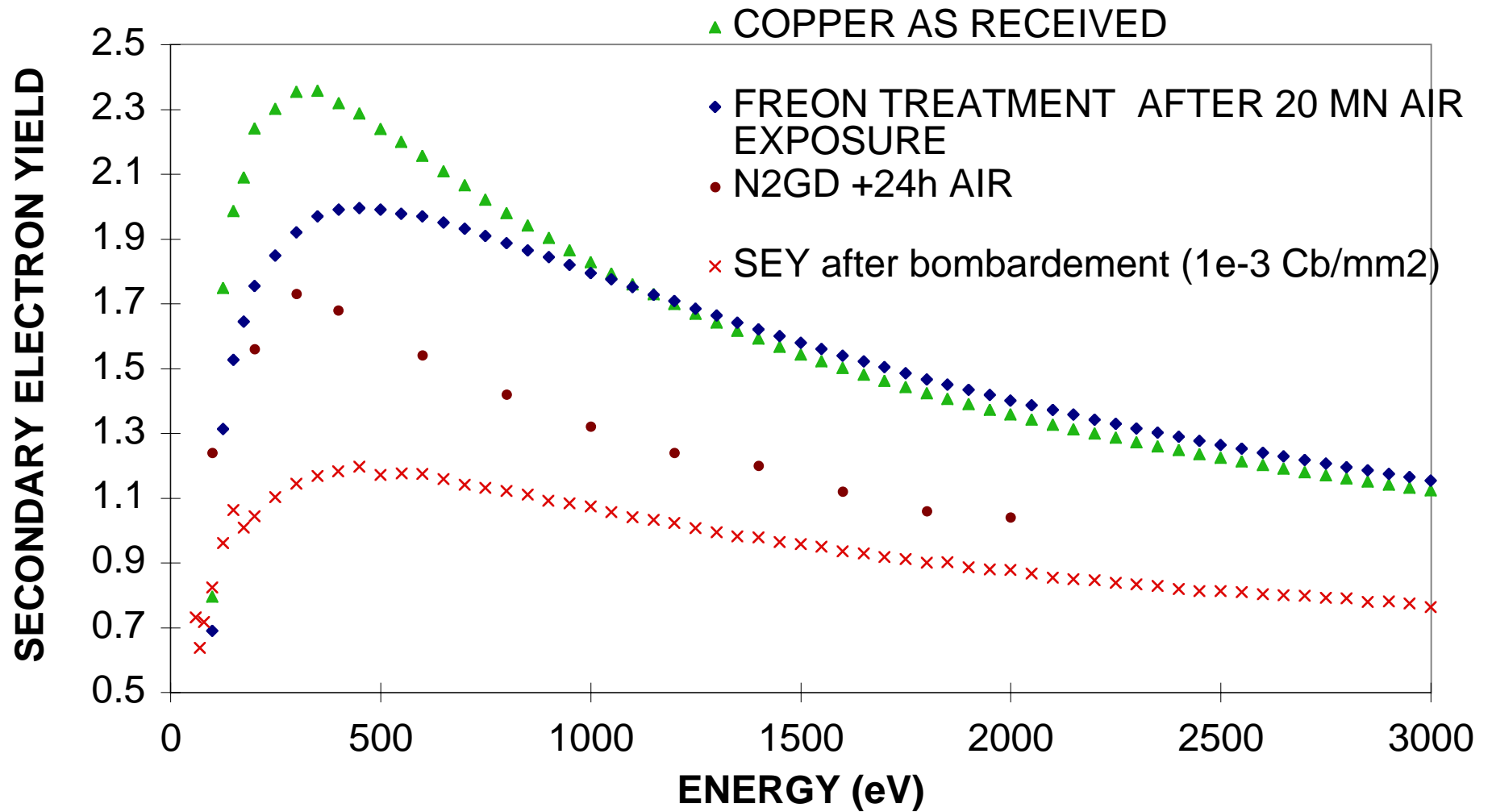




# EFFECT OF A NITROGEN GLOW DISCHARGE ON COPPER



# TREATED COPPER AFTER AIR EXPOSURE



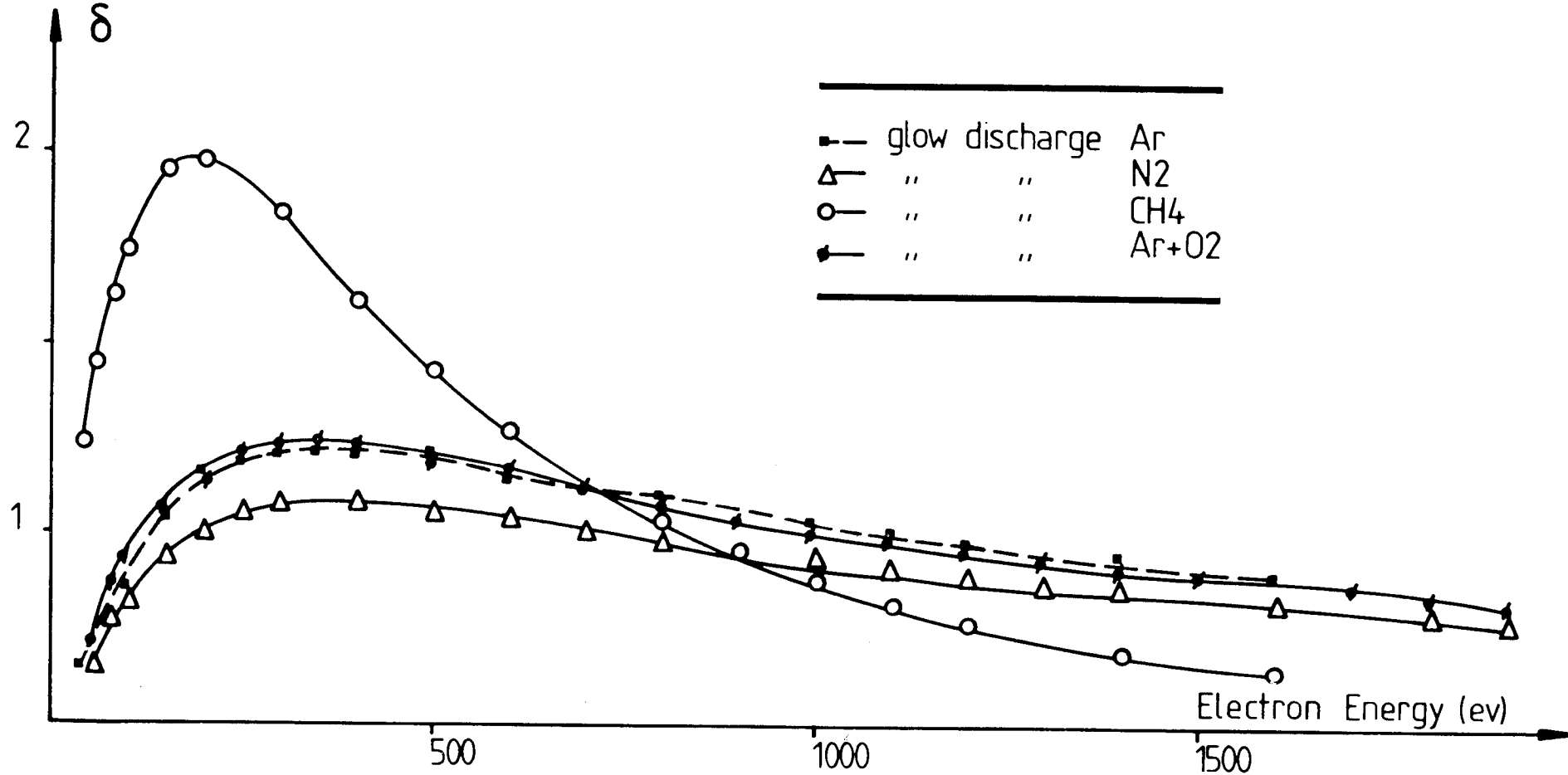
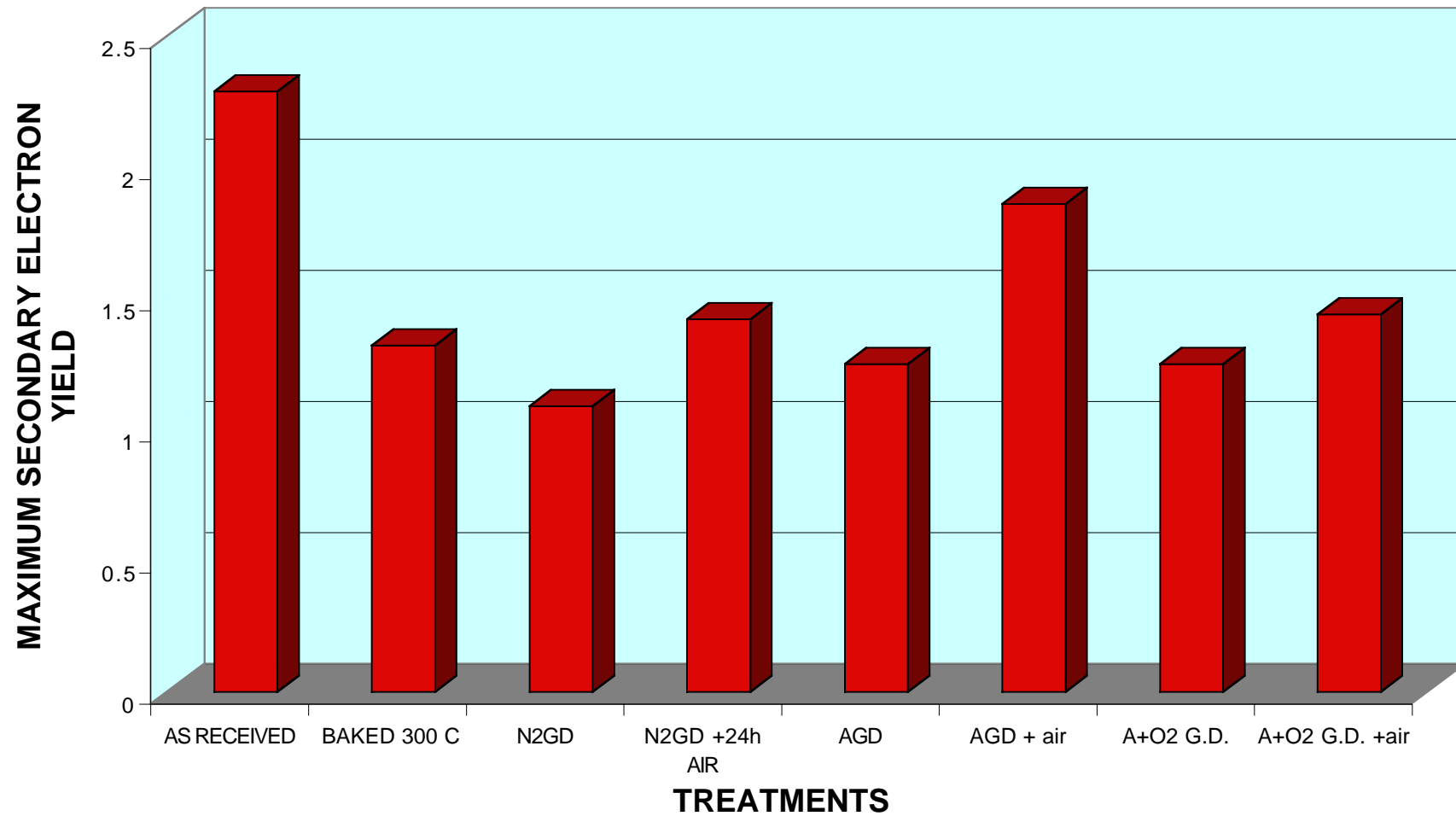
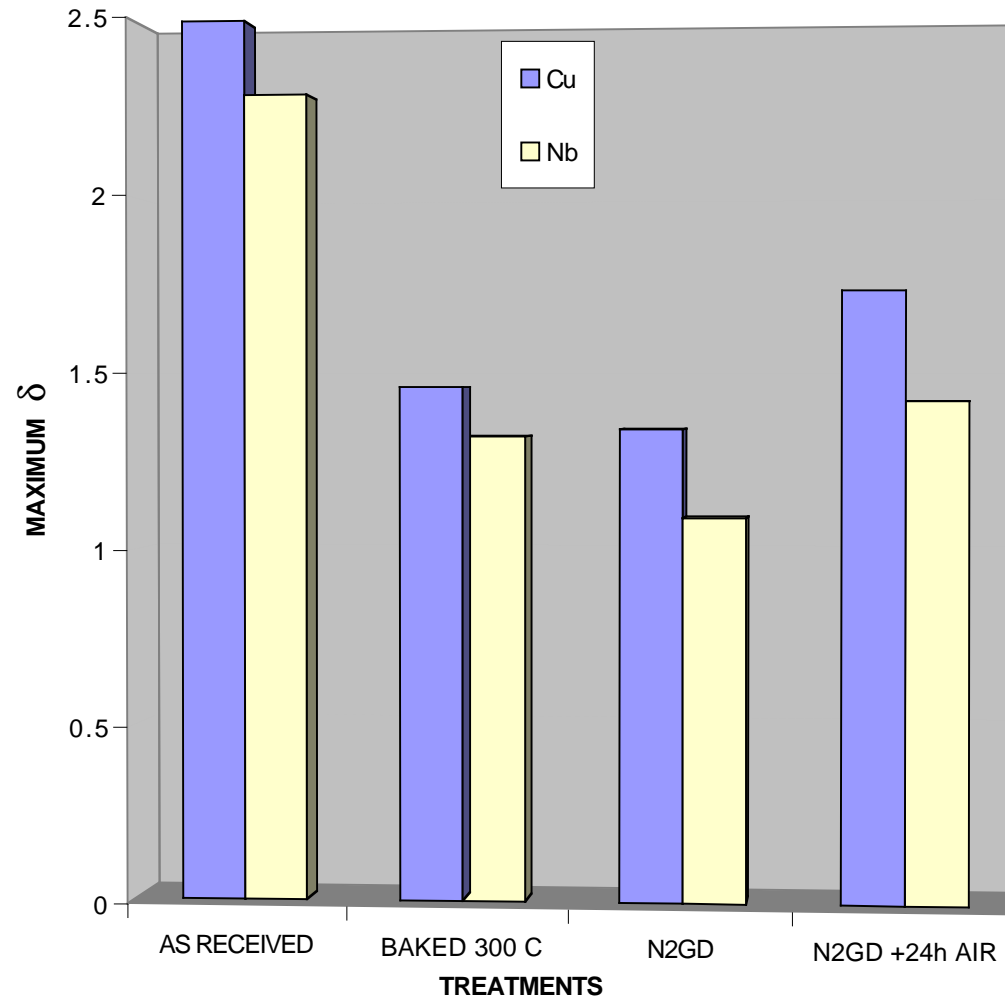


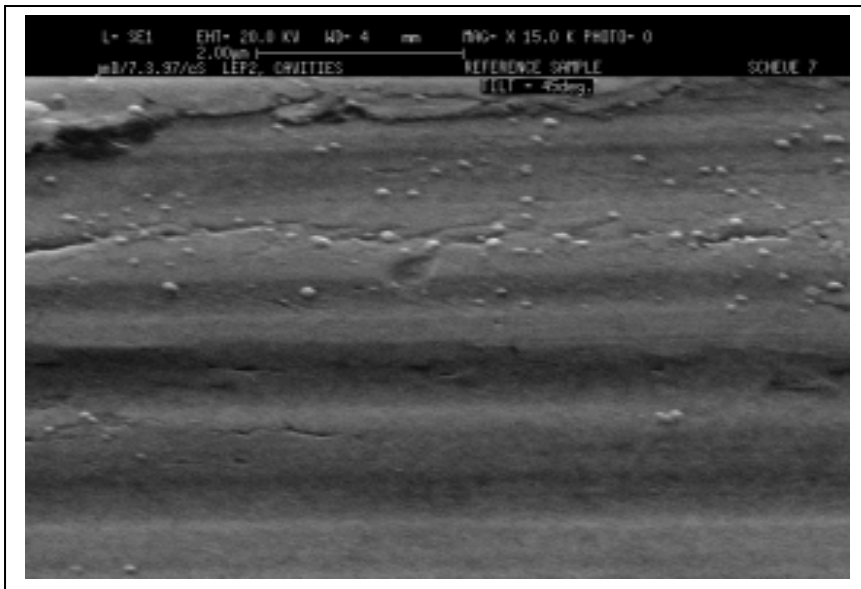
Fig. 5.  $\delta(E)$  curves after various glow discharge treatments.

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

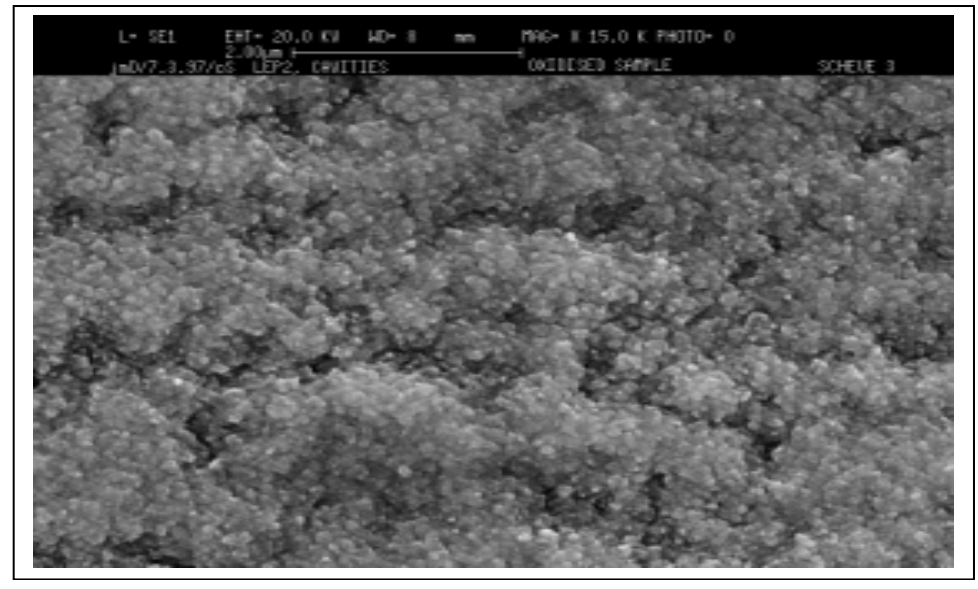


## VARIATION OF THE SECONDARY ELECTRON YIELD OF NIOBIUM AND COPPER AFTER VARIOUS TREATMENTS

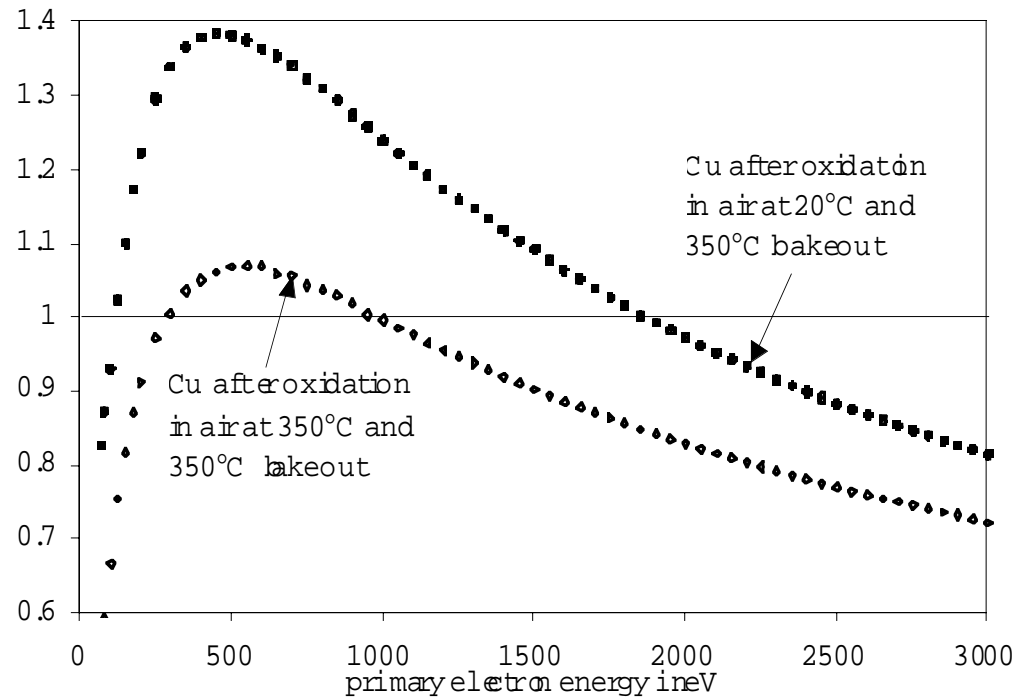


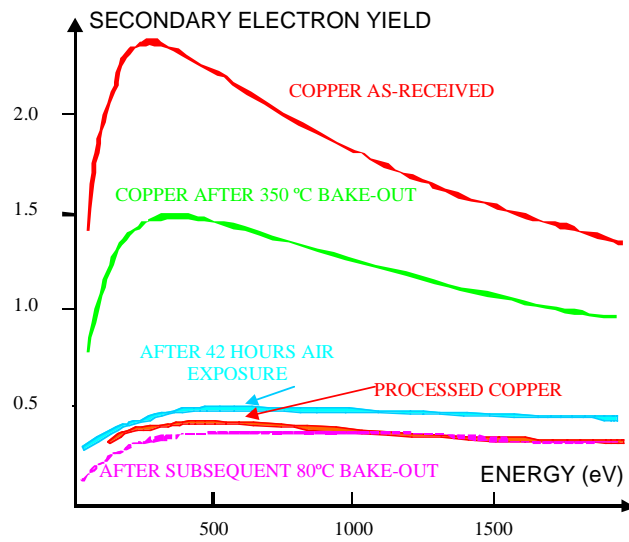
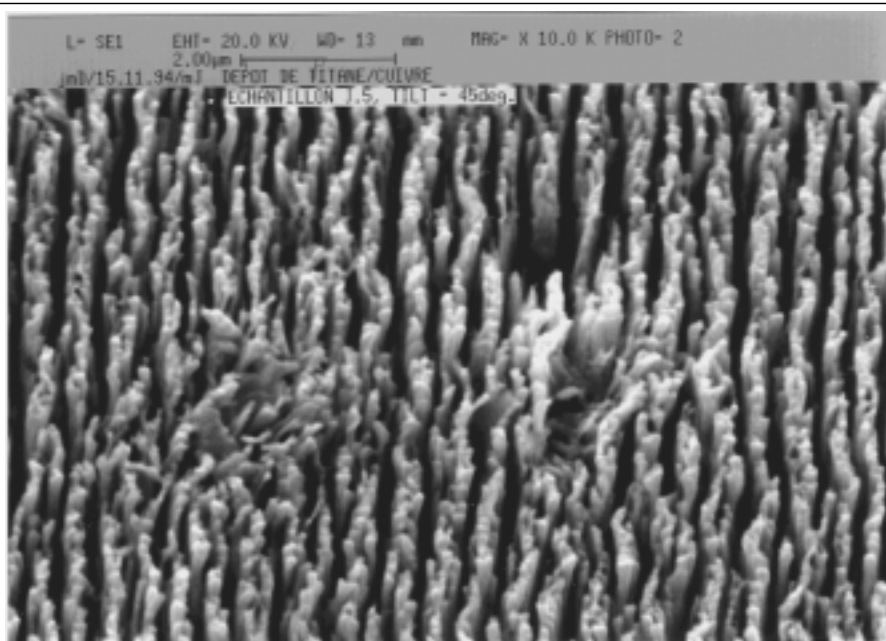


Copper as received, Mag = 15 000



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





PROCESSED COPPER SURFACE

# REMEDIES

## \* **THE DOSE EFFECT**

*IN SITU TREATMENT: CONDITIONNING,  
FOR ALL MATERIALS*

### **VERY EFFICIENT**

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

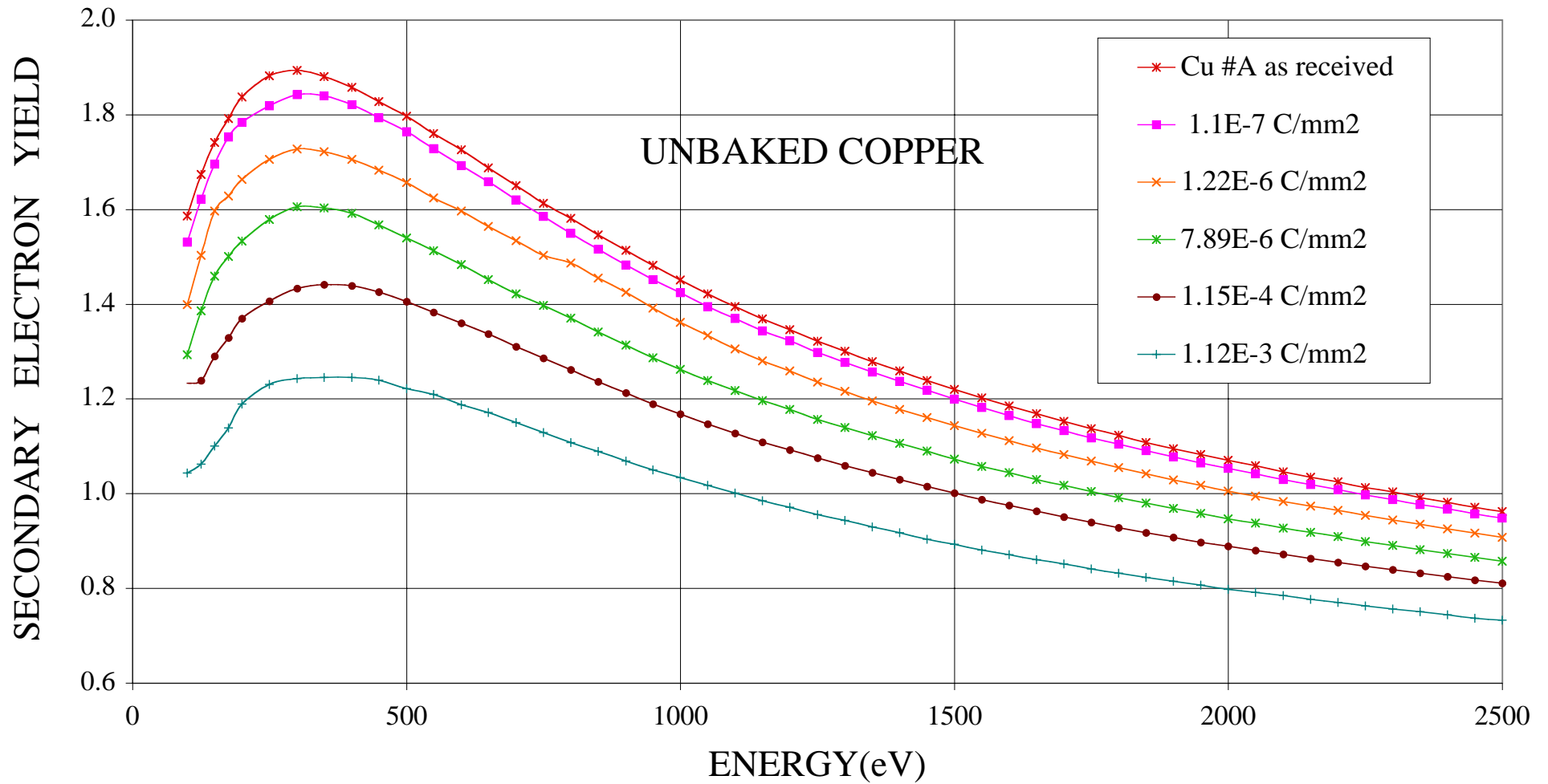
**BUT** *RECONDITIONNING NEEDED AFTER AIR EXPOSURE*

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

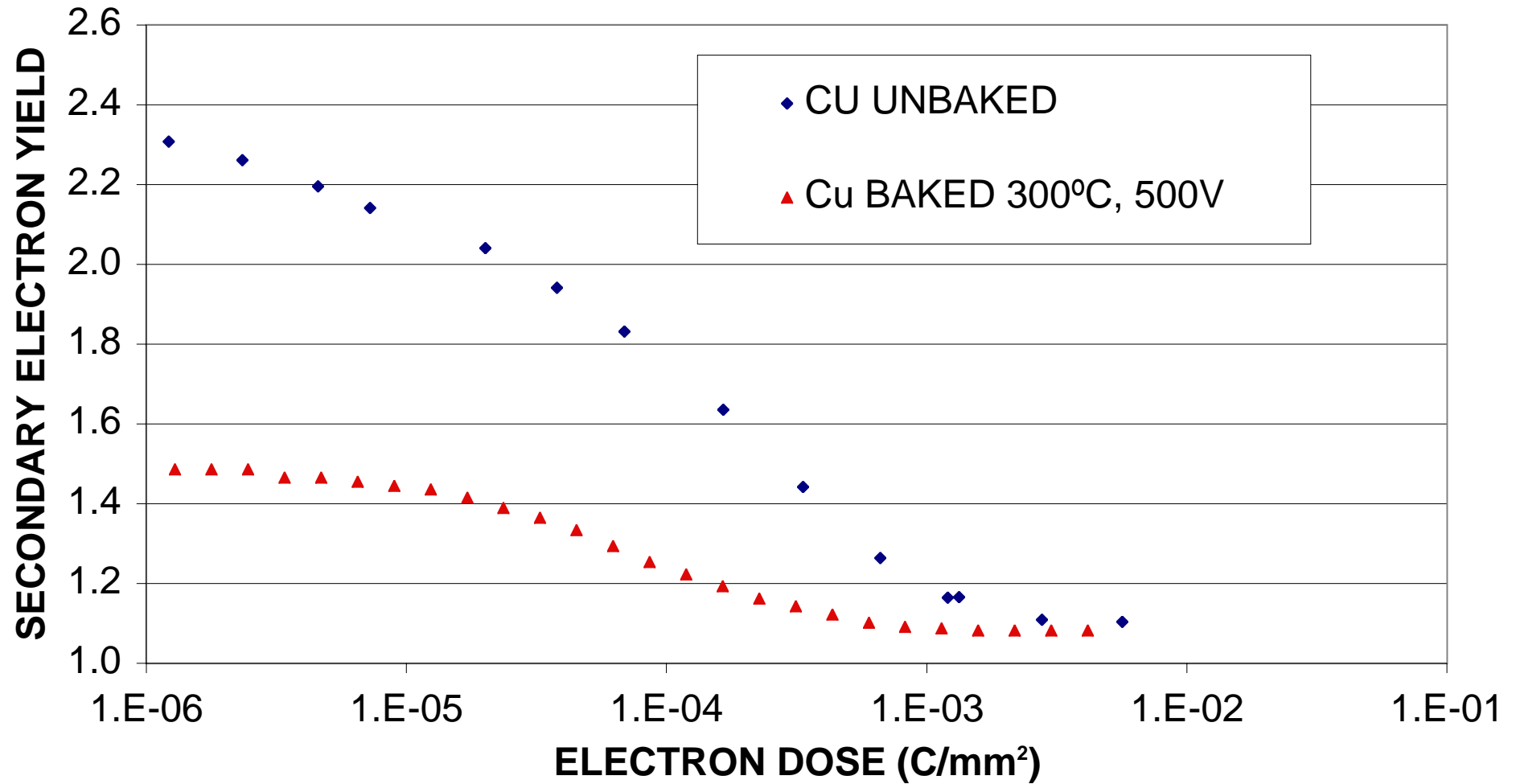
*\*STILL NOT FULLY UNDERSTOOD : ELECTRON STIMULATED  
CARBON LAYER FORMATION??*



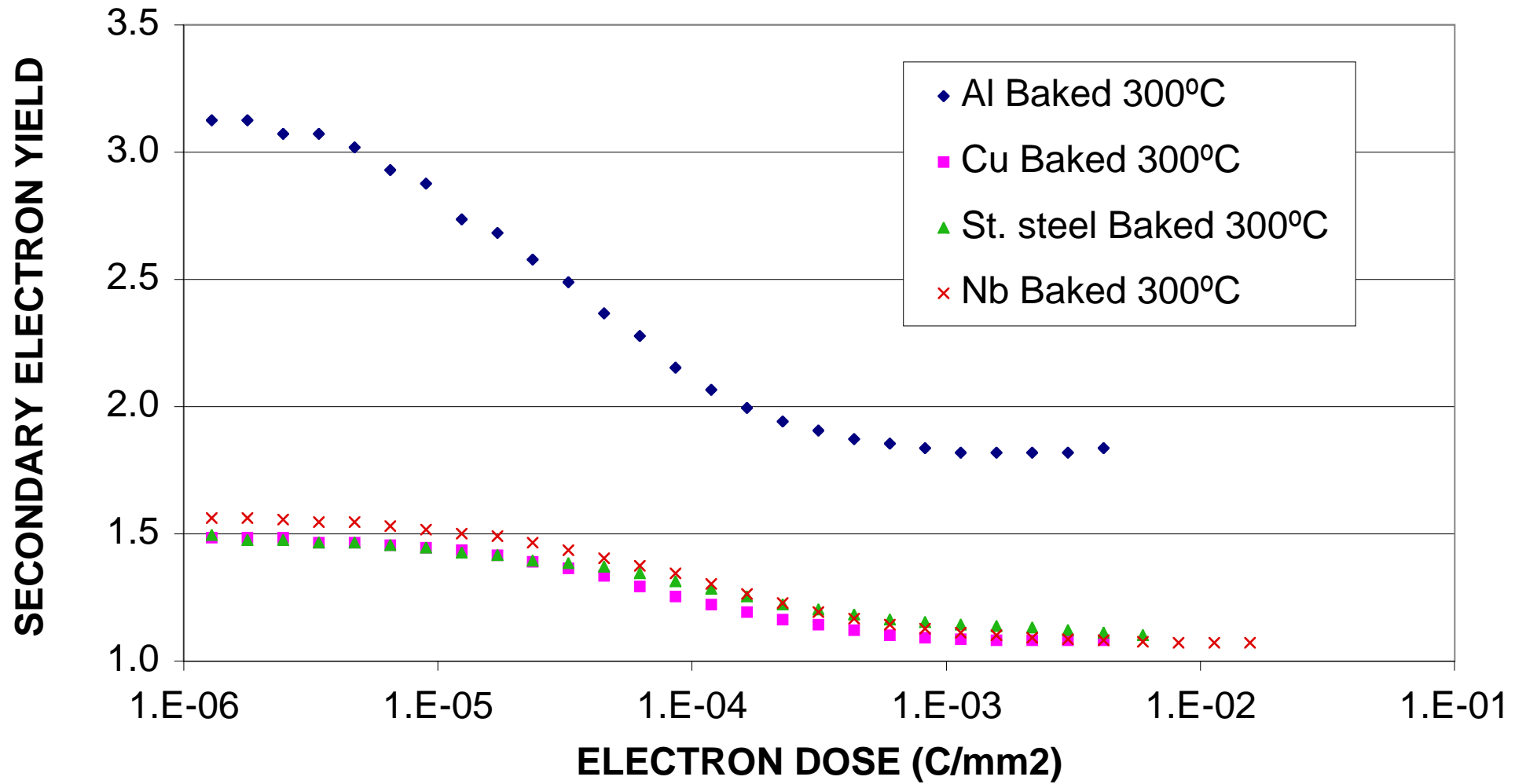
# VARIATION OF THE SECONDARY ELECTRON YIELD CURVES WITH THE DOSE



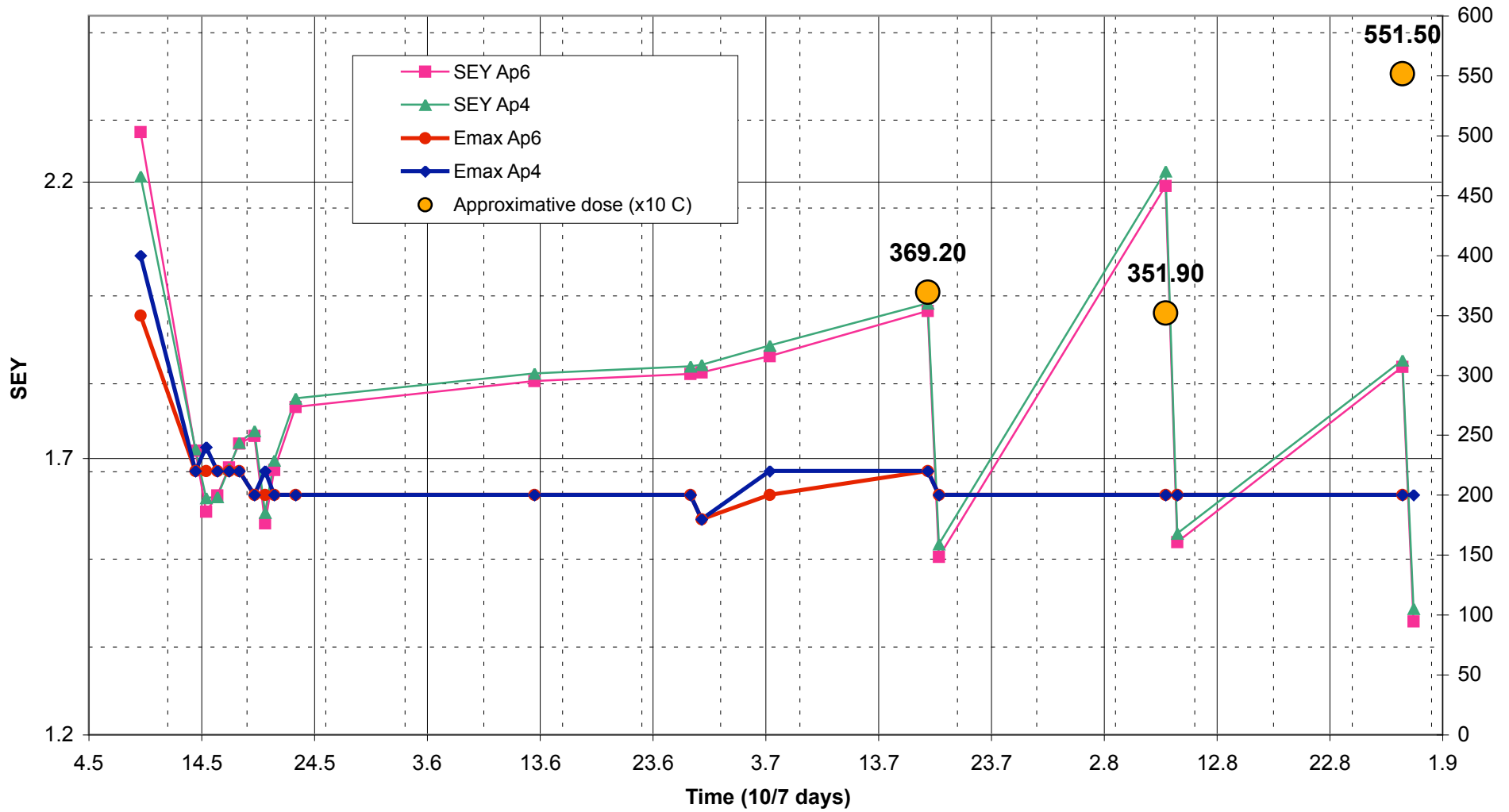
## VARIATION OF THE SECONDARY ELECTRON YIELD WITH THE PRIMARY ELECTRON DOSE



VARIATION OF THE SECONDARY ELECTRON YIELD WITH THE PRIMARY ELECTRON DOSE



**SPS run 2002 in situ SEY measurements on copper**  
 CERN LHC/VAC B. HENRIST 9/3/2002



## 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***