

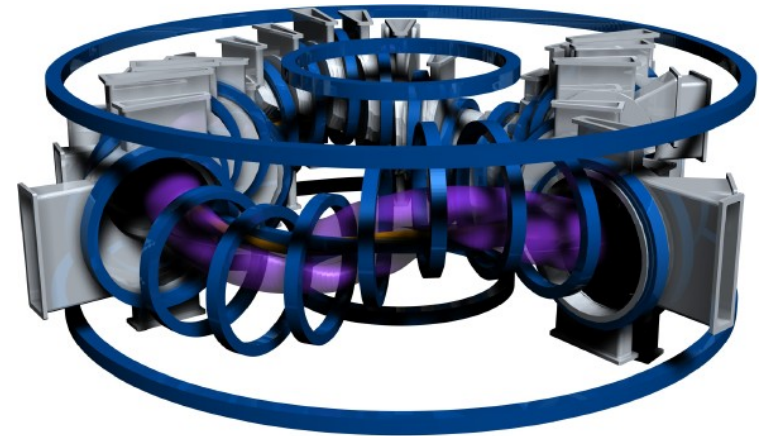
Electrical characteristics of lithium surfaces exposed to a plasma

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Lithium coating of TJ-II (Helic type stellerator)

- The coating technique is based on vacuum vaporisation of solid lithium (4 gr each conditioning cycle) from effusive sources at temperatures of 500-600°C
- The presence of an underlying boron coating deposited previous to the lithiation, crucially affected the lifetime of the Li layer.



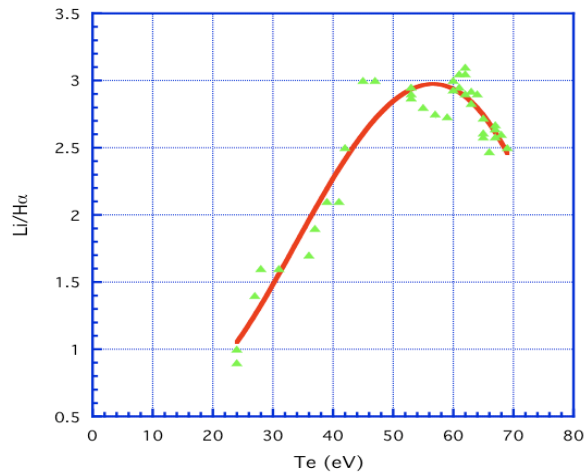
Effect of lithium in the TJ-II operation

- Substantial improvement of the main plasma parameters, particle and energy confinement
- Control of the density ramp in NBI plasmas (not achieved with boronized walls).
- Extension of the TJ-II operational window.
- Achievement of H-mode

Experiments in TJ-II

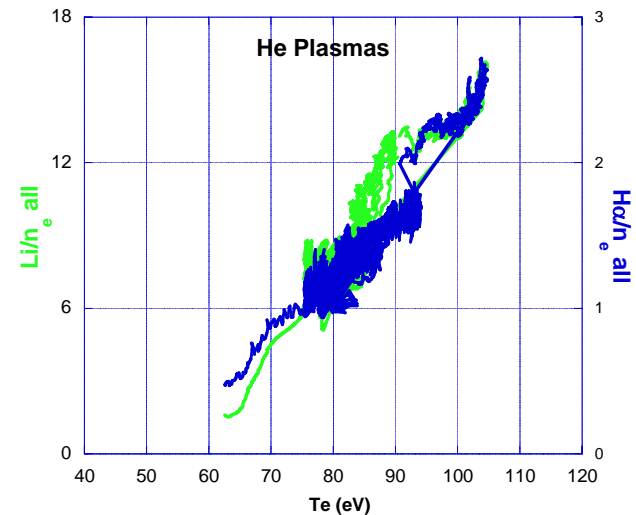
The sputtering and desorption characteristics of H and He plasmas on a Li surface

Hydrogen plasma



Sputtering yield < TRIM calculation
Eth > TRIM calculation

Helium plasmas



Eth Sputtering Li ~ Eth H desorption
Same energy dependence

Both species, Li and H could obey to the same release mechanism

Experiments in laboratory are necessary:

- Check of the Li sputtering in presence of H
- Study of factors that affects the process: role of B

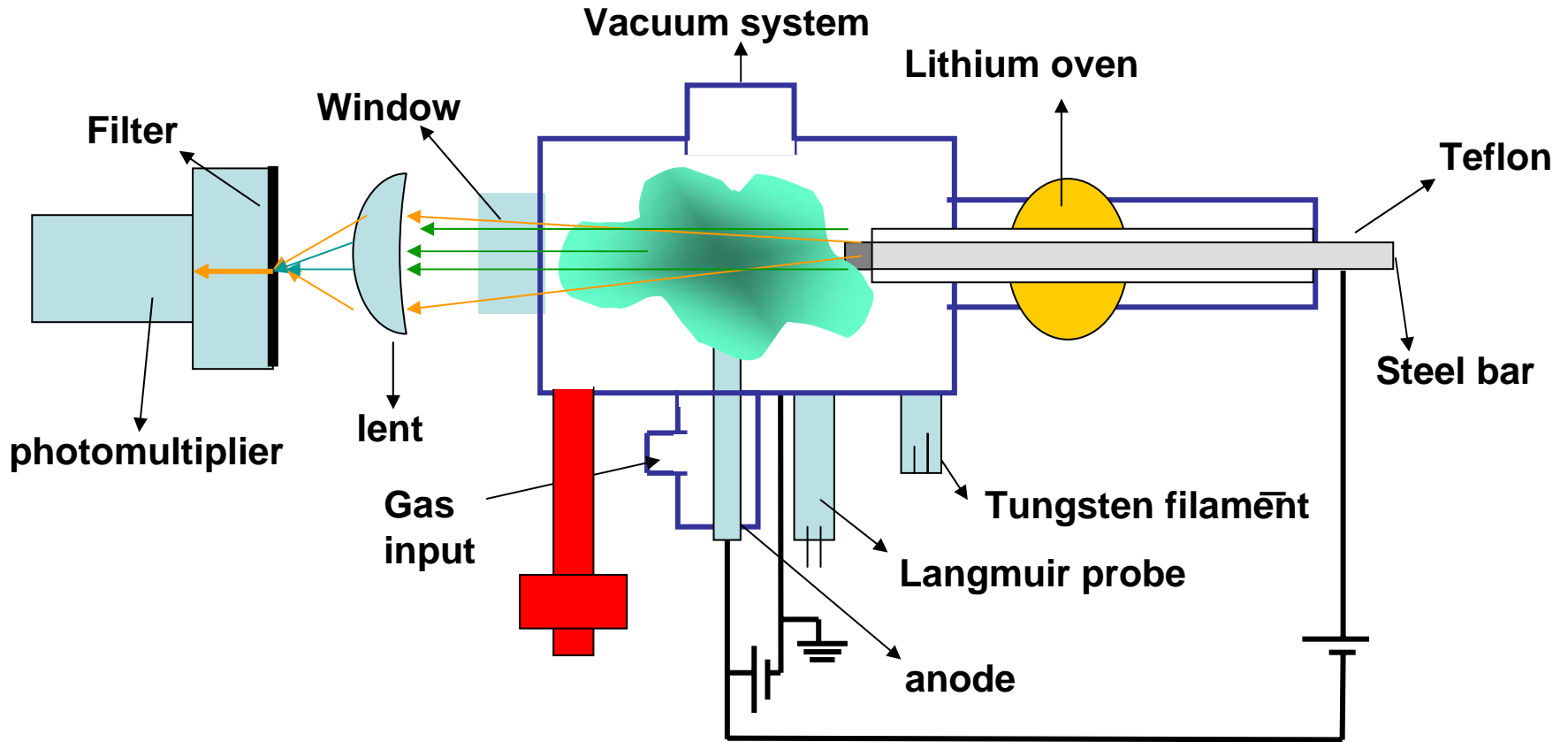
And

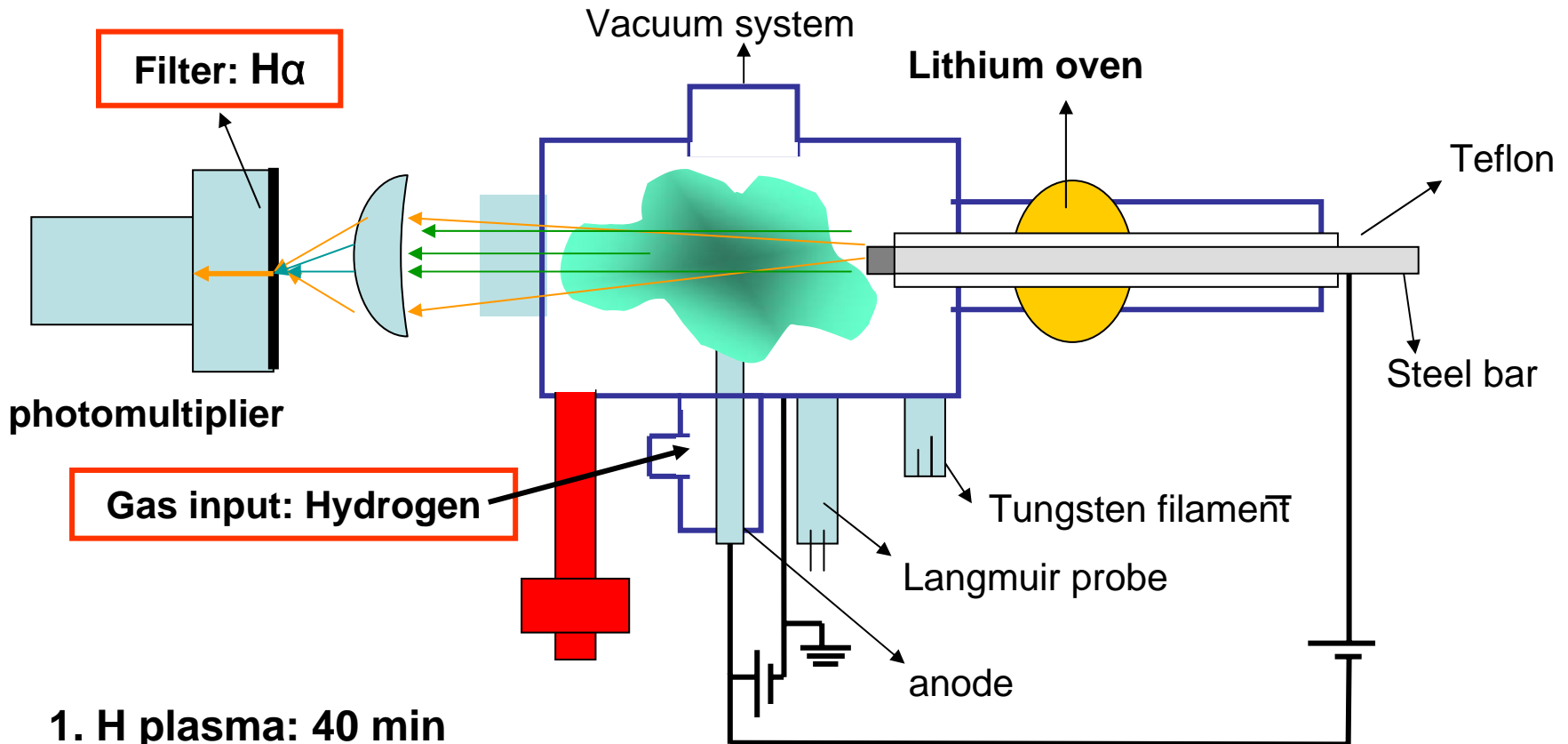
To find new positive effects of lithium surfaces other than low recycling

↙
Tritium control in fusion reactors calls for a high recycling scenario

In order to figure out the influence of the surface condition in the sputtering, three surface coatings had been studied in the laboratory experiments:

- Li coating
- Li and H coating
- Li and B coating





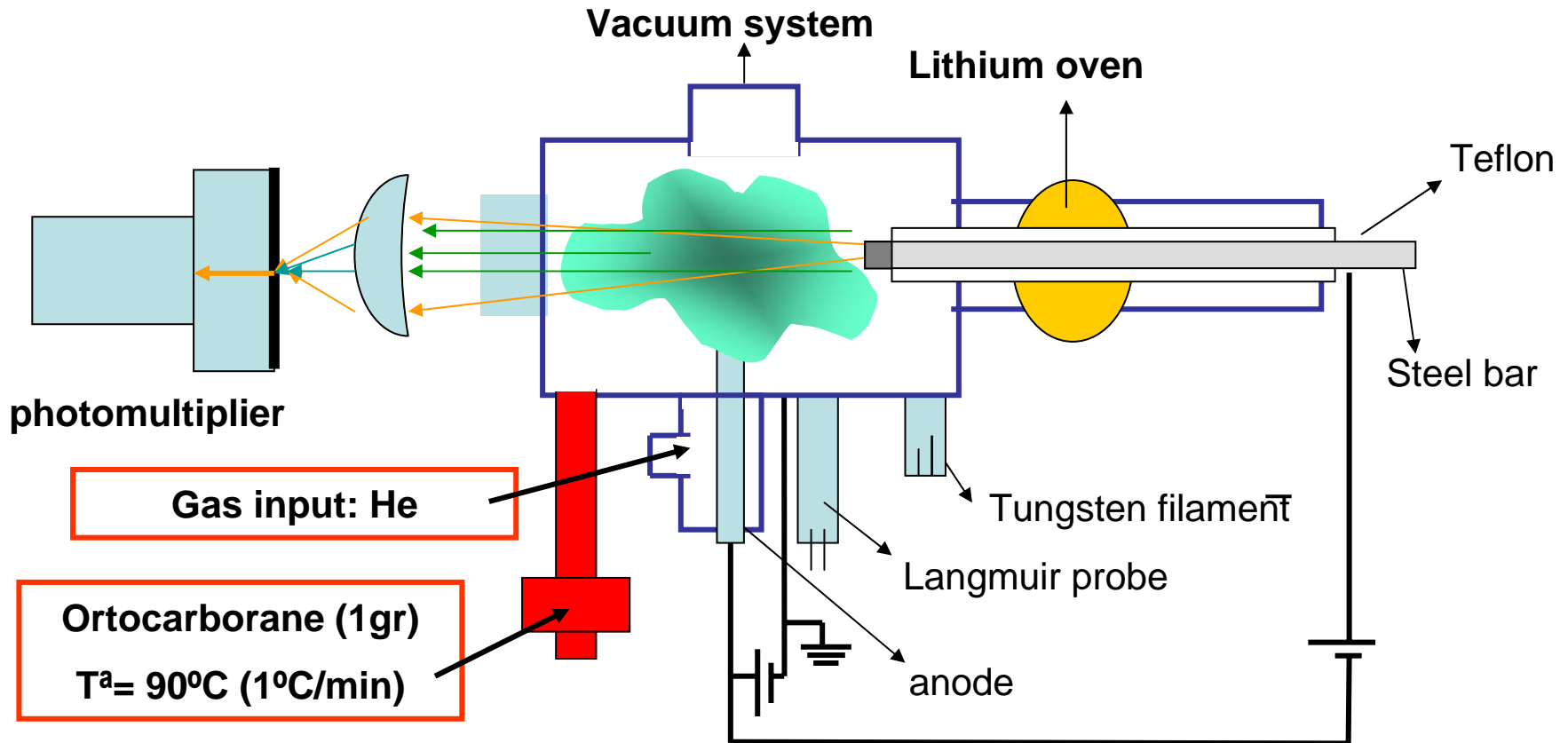
1. H plasma: 40 min

2. Cleaning of the chamber: → Monitoring of H α signal

-He plasma

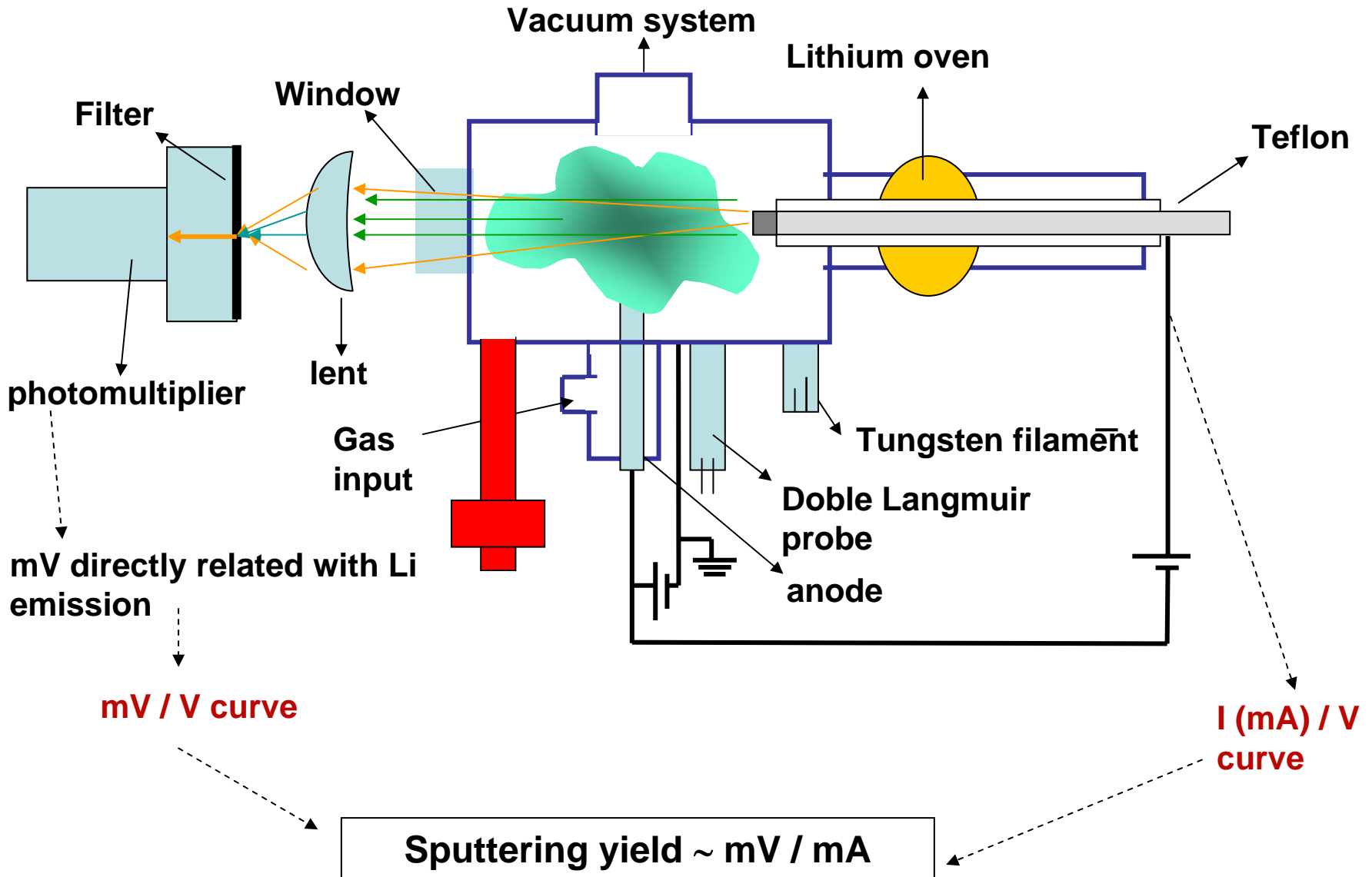
-High potentials in the bar

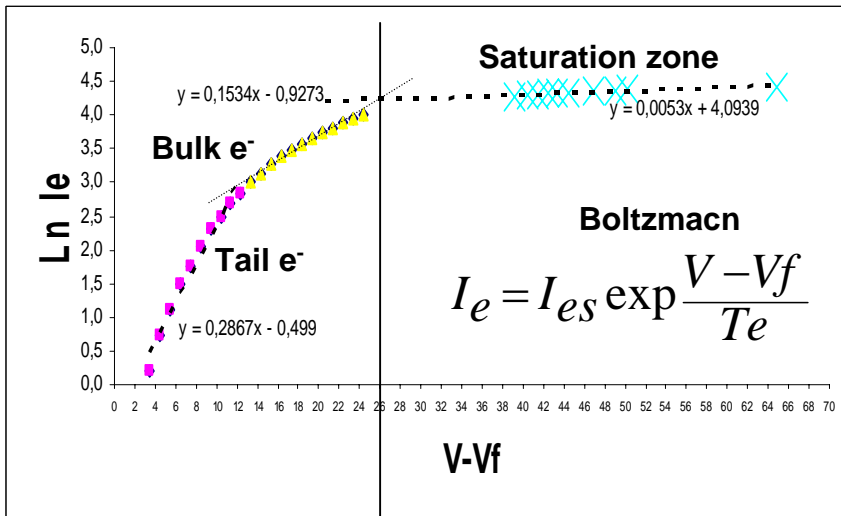
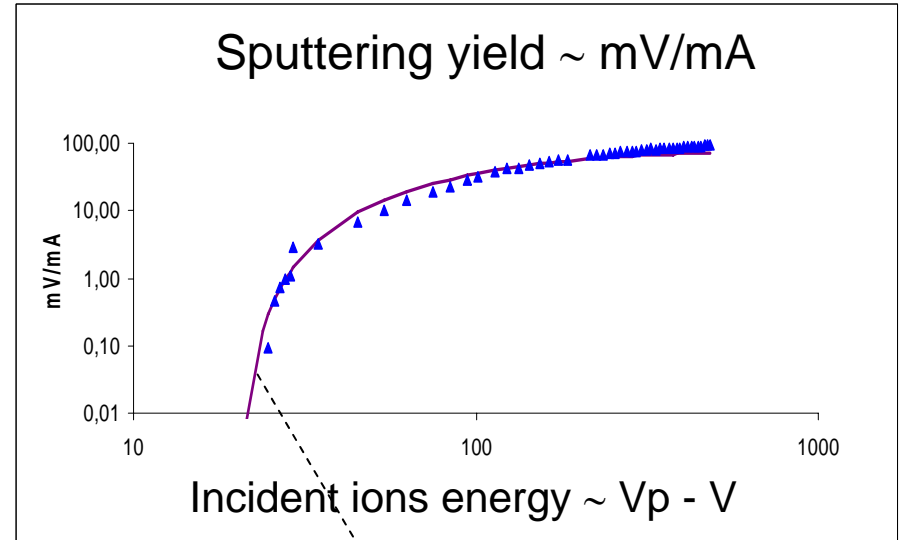
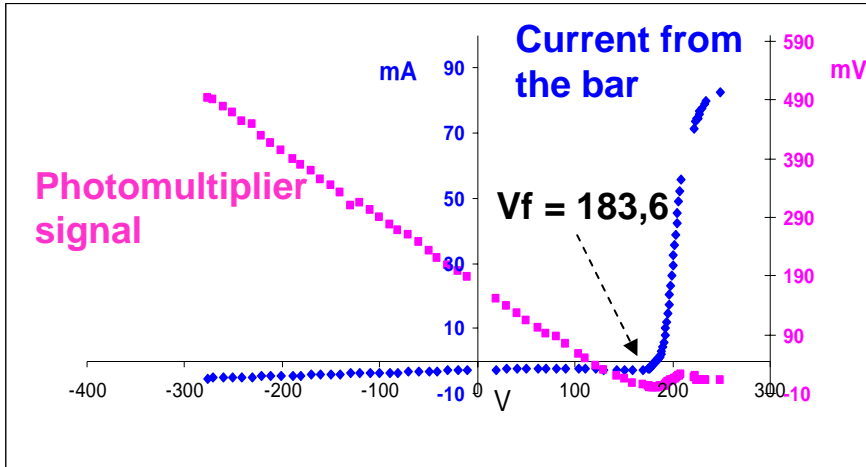
Li + B COATING



Orto-carborane sublimation → Monitoring of the pressure

Break of the molecule: He plasma





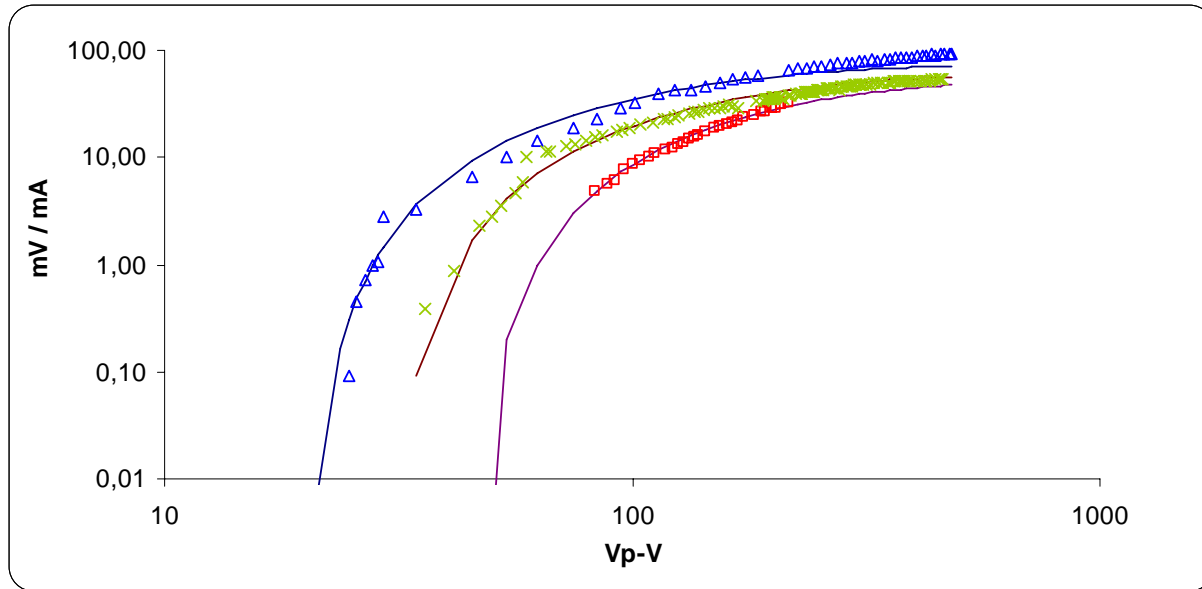
$$V_p - V_f = 26 \Rightarrow V_p = 26 + 183,6 = 209,6 \text{ V}$$

$$Y = Q S n(E) \left(1 - \frac{E_{th}}{E}\right)^2 \left(1 - \left(\frac{E_{th}}{E}\right)^{2/3}\right)$$

$Q = 230$

$E_{th} = 20 \text{ eV}$

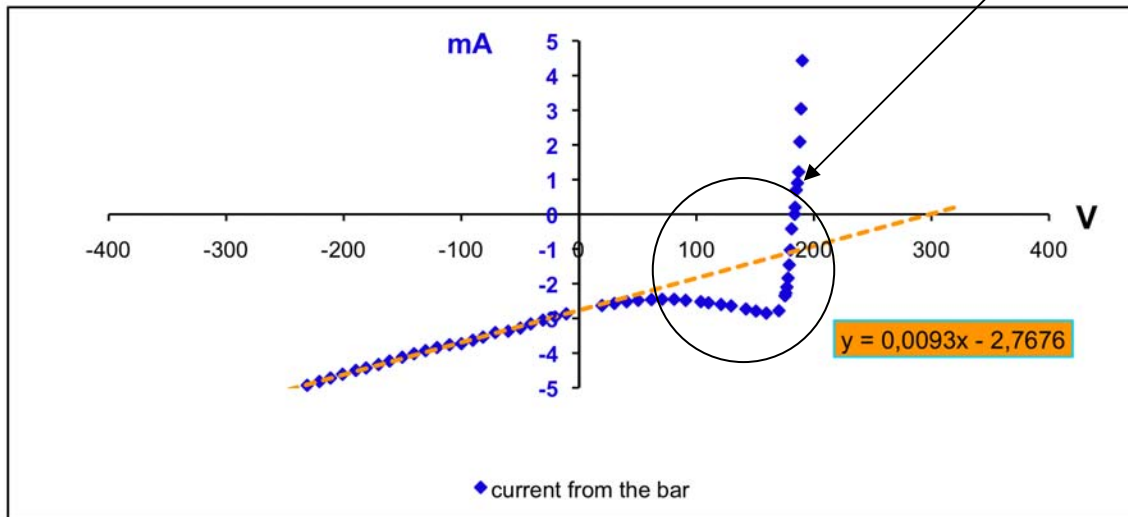
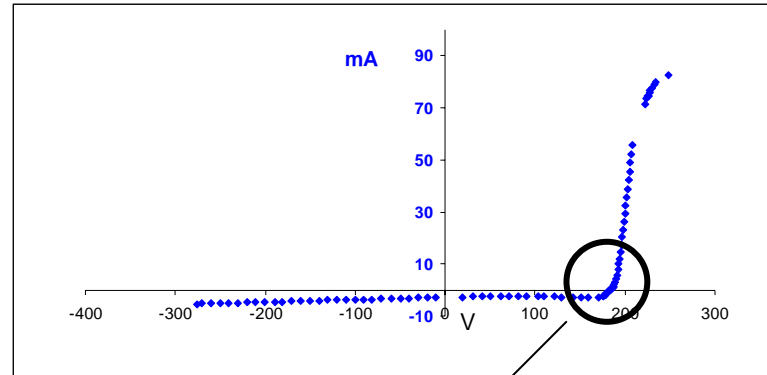
(E_{th} predicted = 9,6 eV)

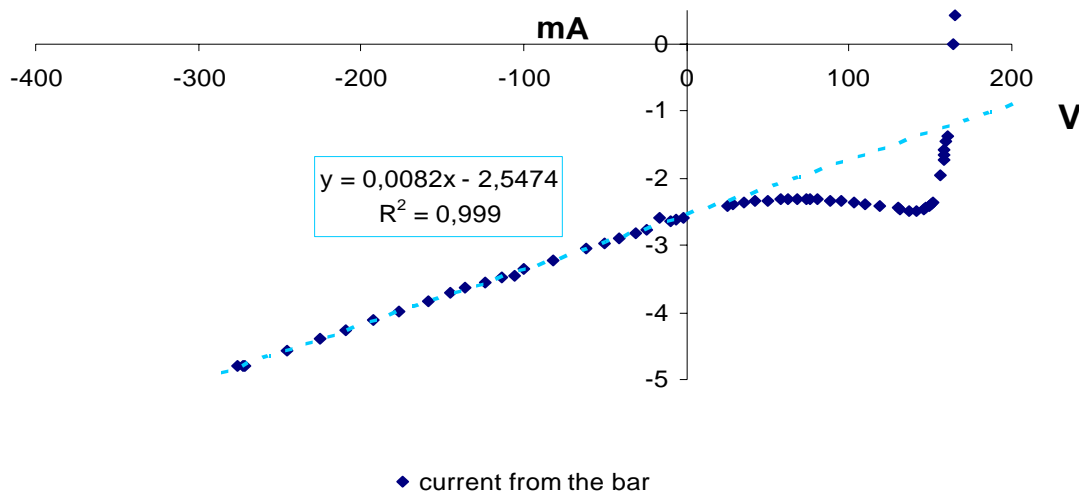


Coating	Li	Li + H	Li + B
Eth (eV)	20	30	45
Sputtering yield (max)	92	56	46

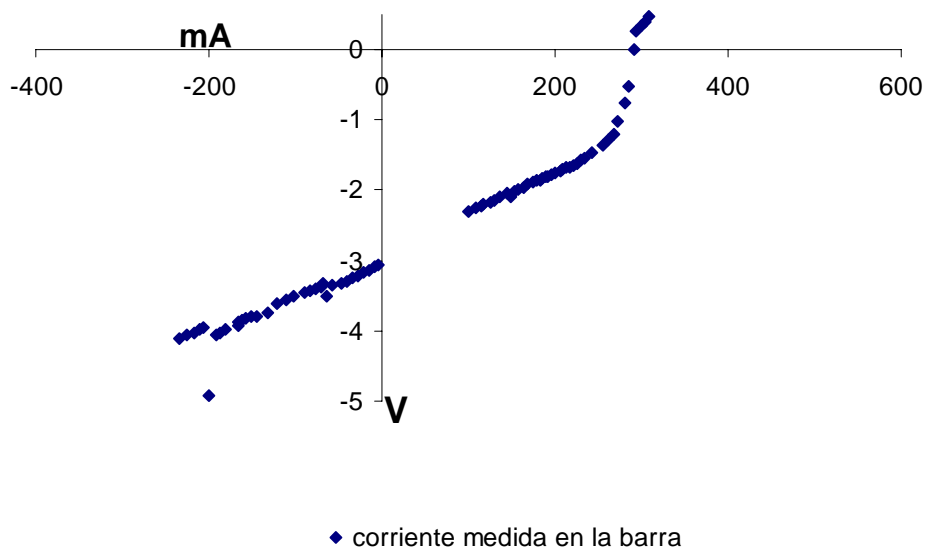
Fit
(Bohdansky)

$$Y = QSn(E) \left(1 - \frac{E_{th}}{E} \right)^2 \left(1 - \left(\frac{E_{th}}{E} \right)^{2/3} \right)$$





Li + H COATING



Li + B COATING

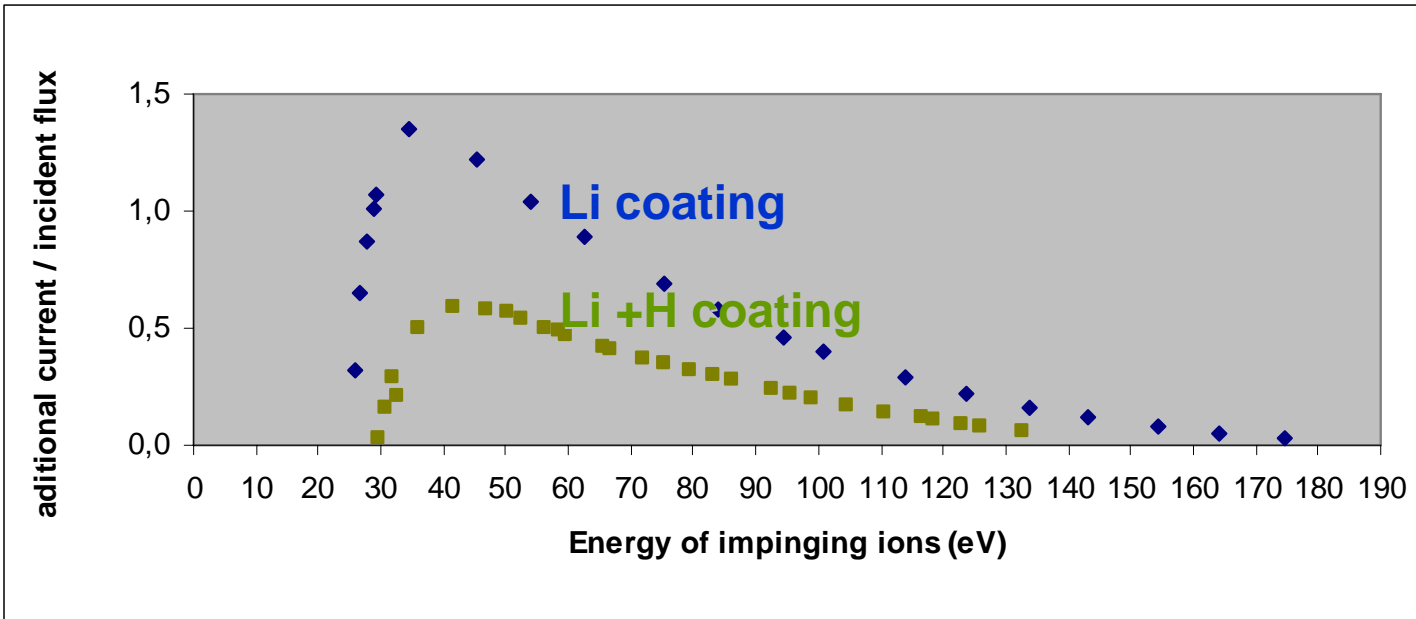
Secondary electron emission ? Additional ion current?

This phenomenon appears to be related to the sputtering:

- starts at energies near of E_{th}
- the values are higher for conditions with higher sputtering yield

No conventional secondary emission of electrons:

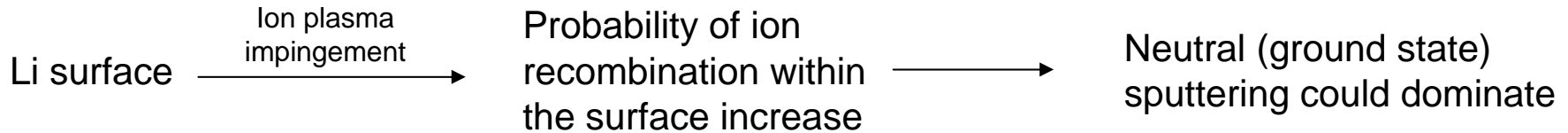
- Li electron secondary emission coefficient= 0,5 (upper limit for ion induced electron emission)
- Here maximum $\sim 1,5$
- Conventional secondary electron emission peaks at higher energies



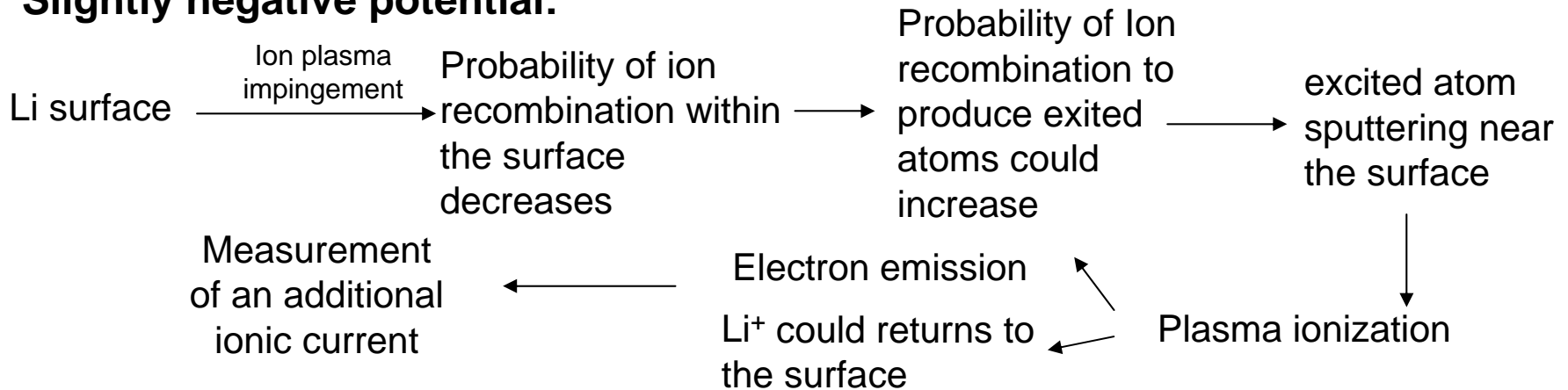
Non biased surface → $2/3 \text{ Li}^+ + 1/3 \text{ Li}$

biased surface → Yield ?

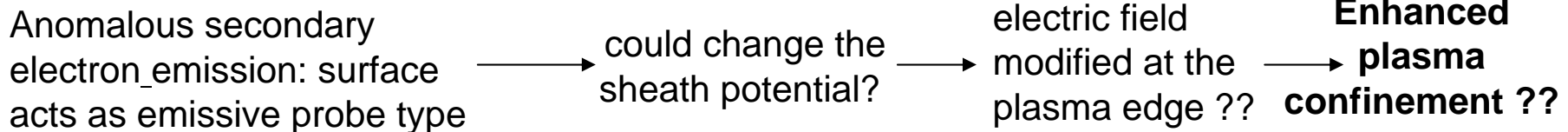
Highly negative potential:



Slightly negative potential:



Implications in the plasma??



- Anomalous negative current is detected at slightly negative bias on lithium and lithium-hydrogen surface
- Not detected under boronized-Li conditions
- Energy dependence showing threshold and yield characteristics of sputtering
- Could be associated to plasma ionization of sputtered (excited) neutrals