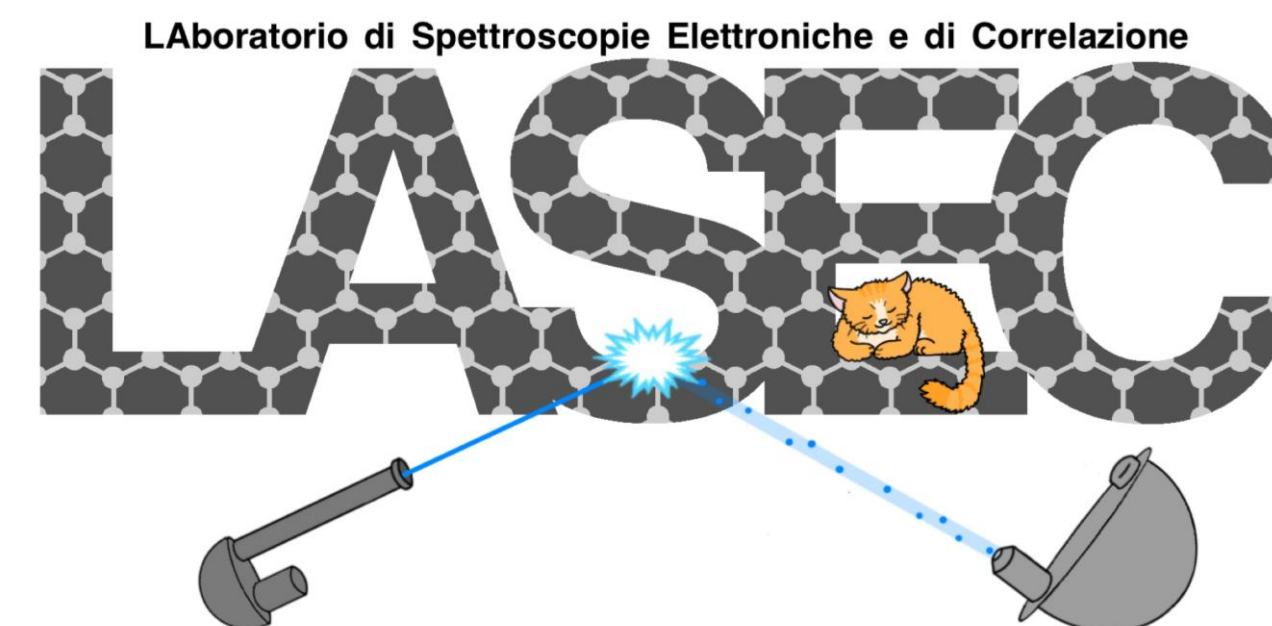


RD_Ptolemy update activity: Transmission through Graphene H-source commissioning NPG hydrogenation

Alice Apponi, Alessandro Ruocco, Daniele Paoloni,
Narcis Silviu Blaj, Orlando Castellano

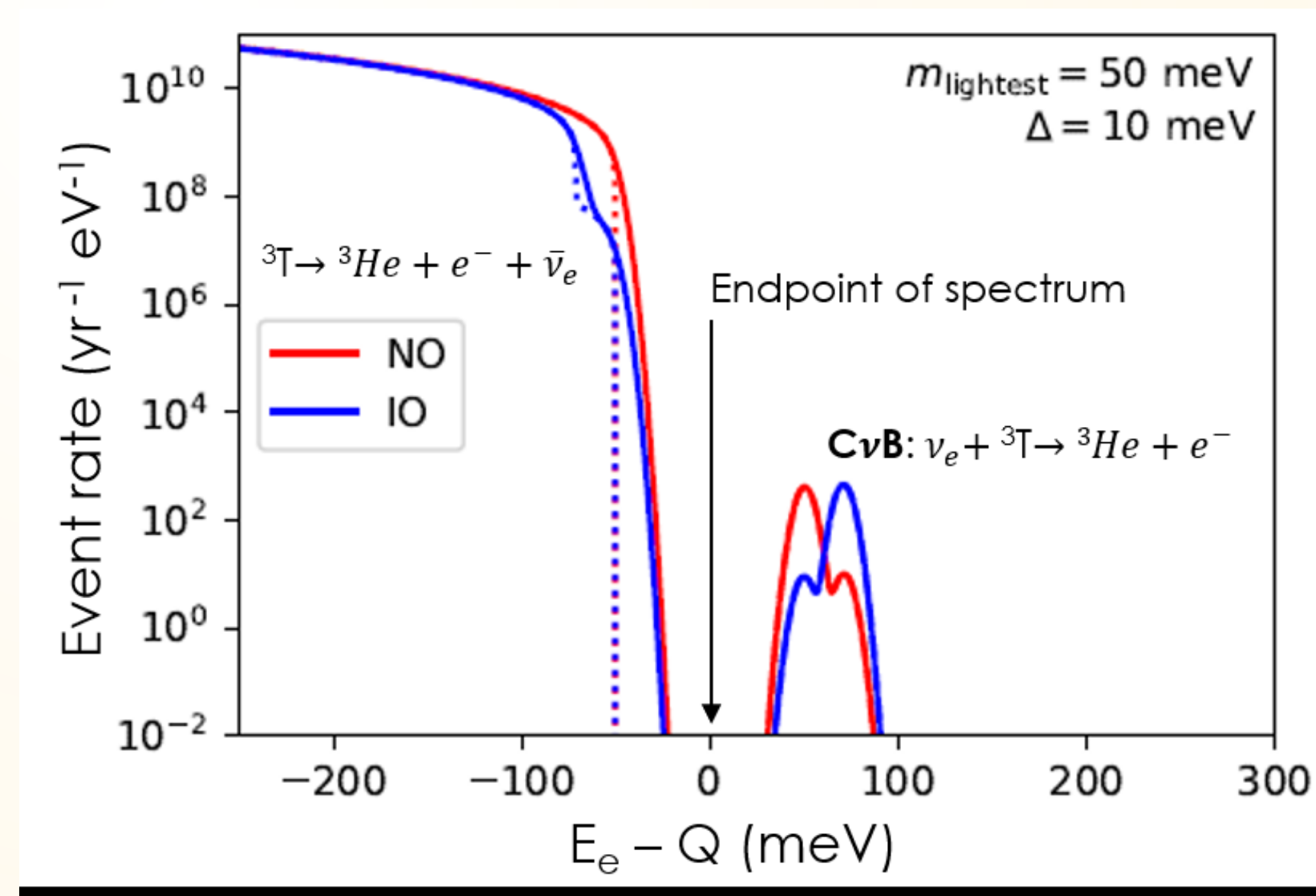
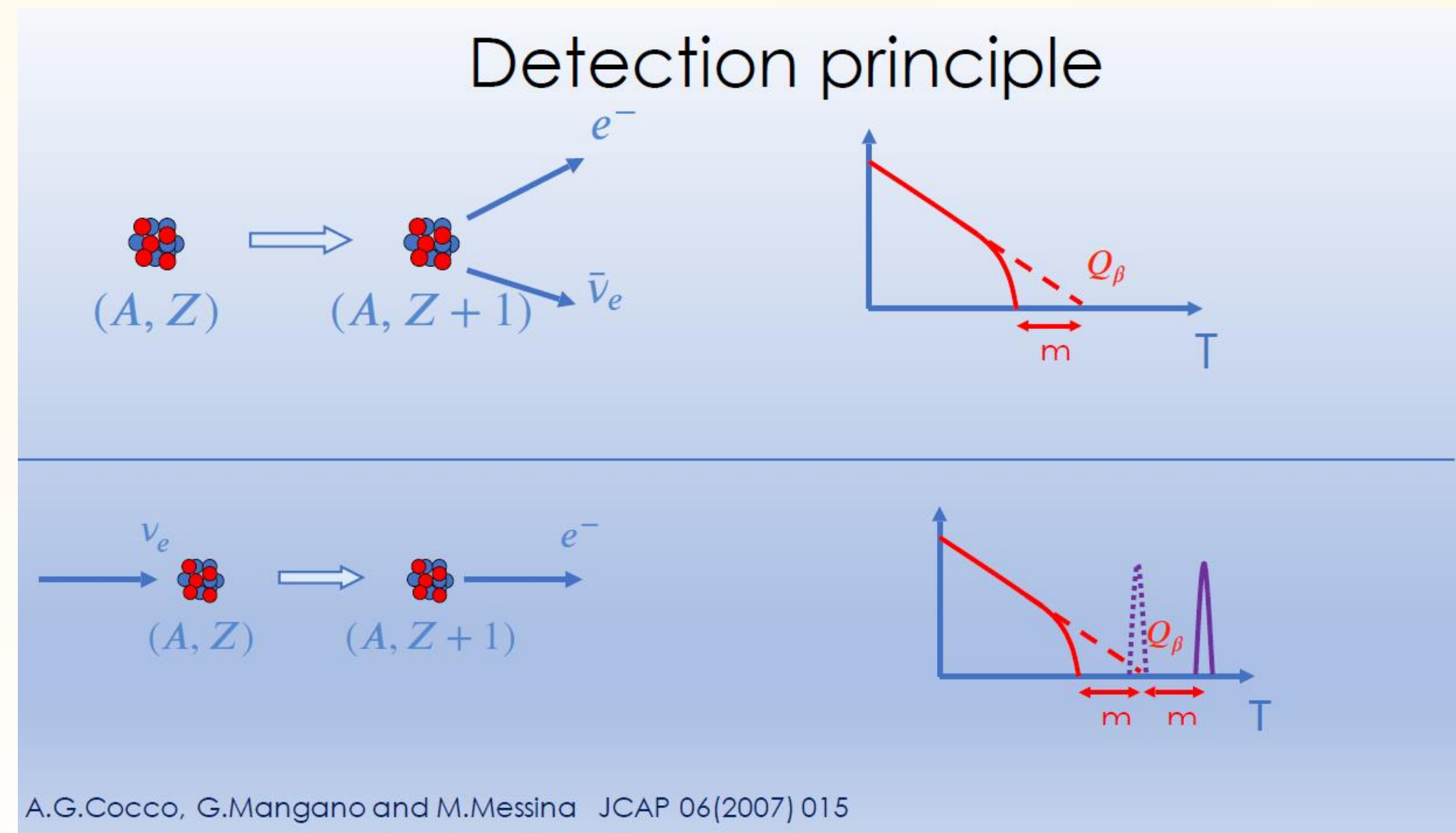
Consiglio di sezione INFN Roma Tre 5.07.2023



The Ptolemy project

A three-four year project to advance on key technologies to elaborate a **Conceptual Design** of a detector for **Cosmic neutrino background** based on a tritium target

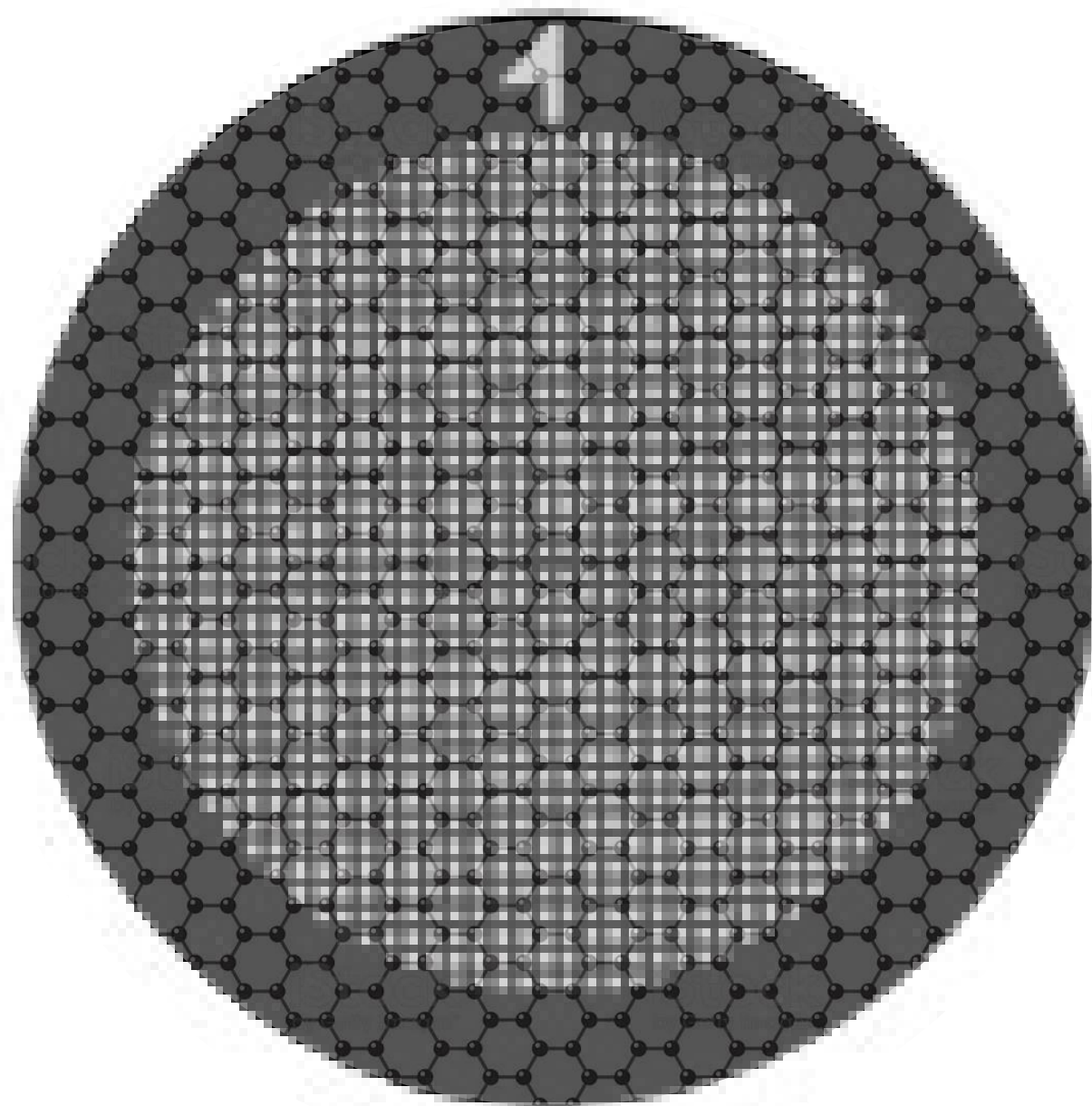
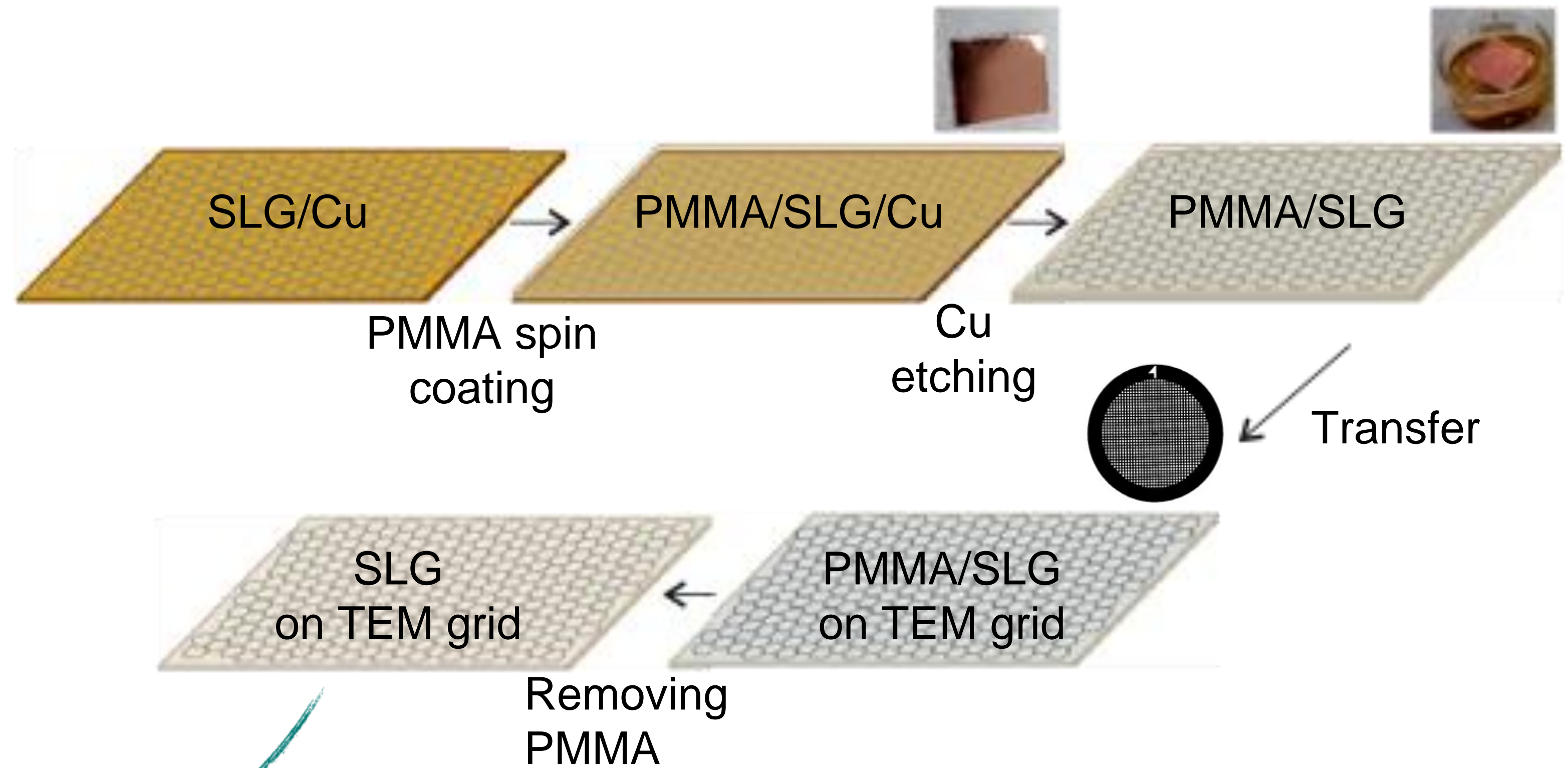
Develop detectors for **light (MeV) dark matter** searches and for new concept to analyse the beta-spectrum endpoint (measurements of the **neutrino mass**)



Sample preparation: graphene growth and transfer on TEM grid

Mono-/tri- layer graphene on nickel TEM grid:

- ❖ G2000HAN - Ted Pella Inc.
- ❖ 2000 mesh per inch \rightarrow $12.5 \mu\text{m}$ pitch
- ❖ Hole width $6.5 \mu\text{m}$
- ❖ Nominal geometrical transmission 41%



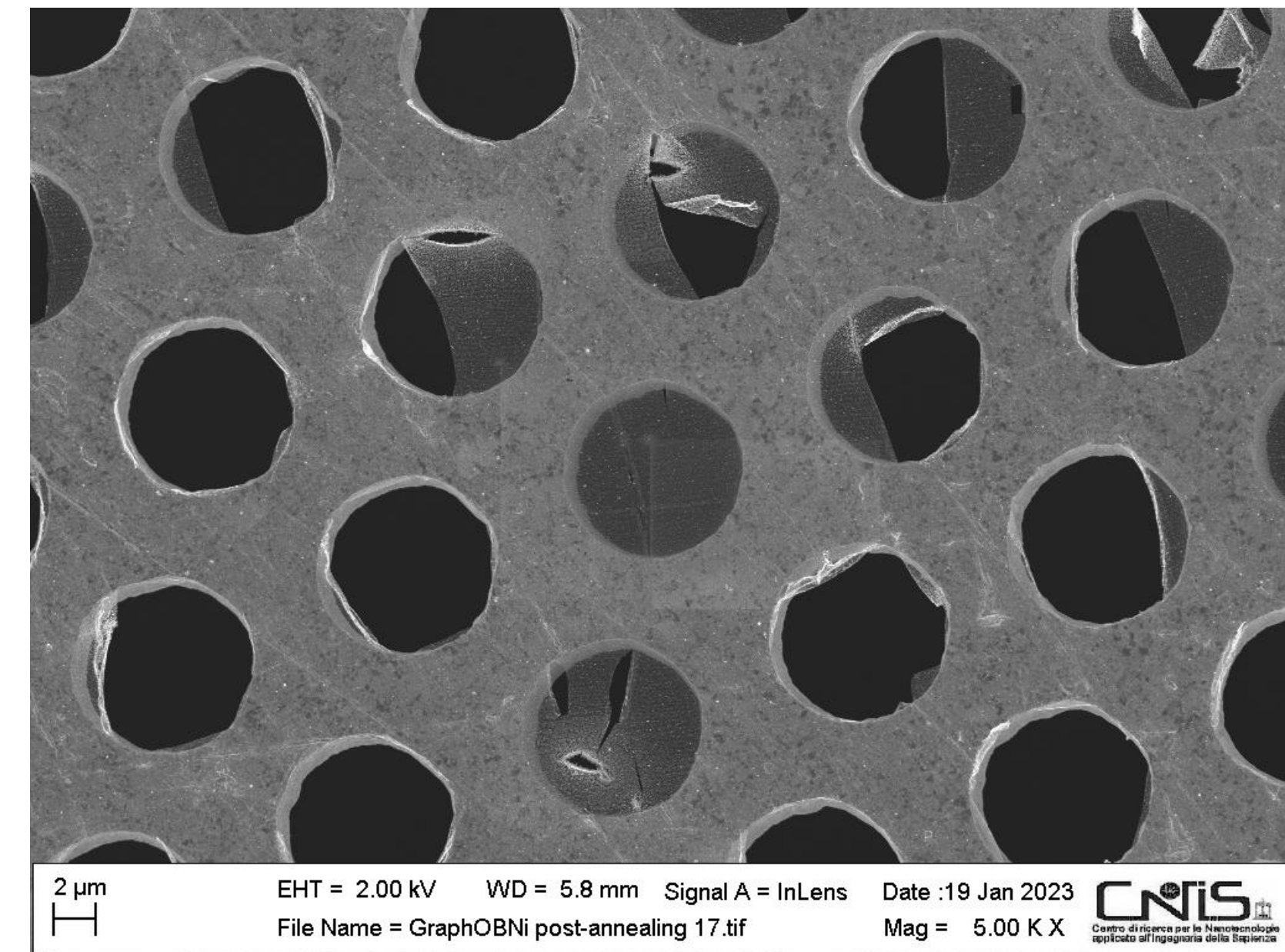
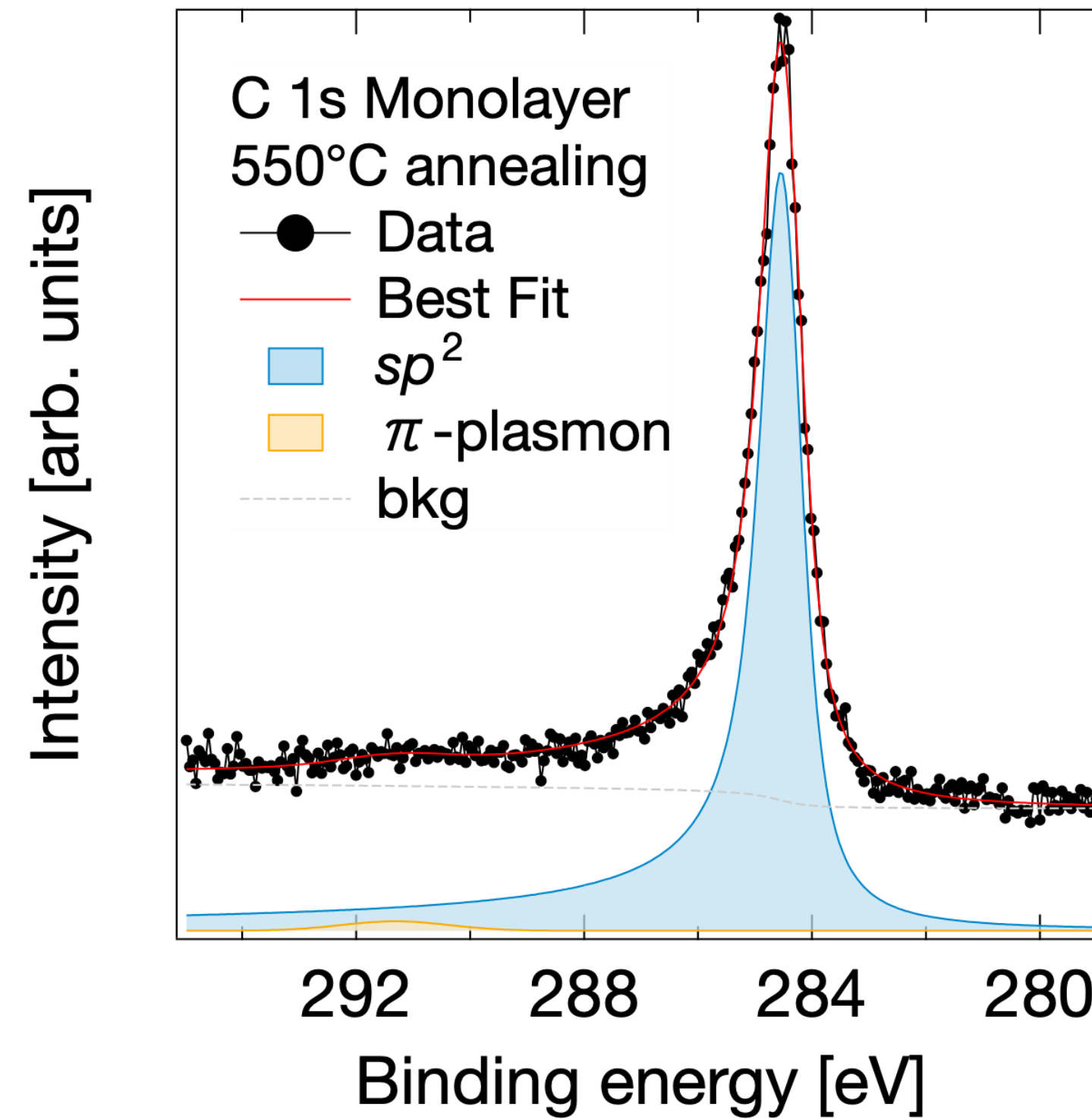
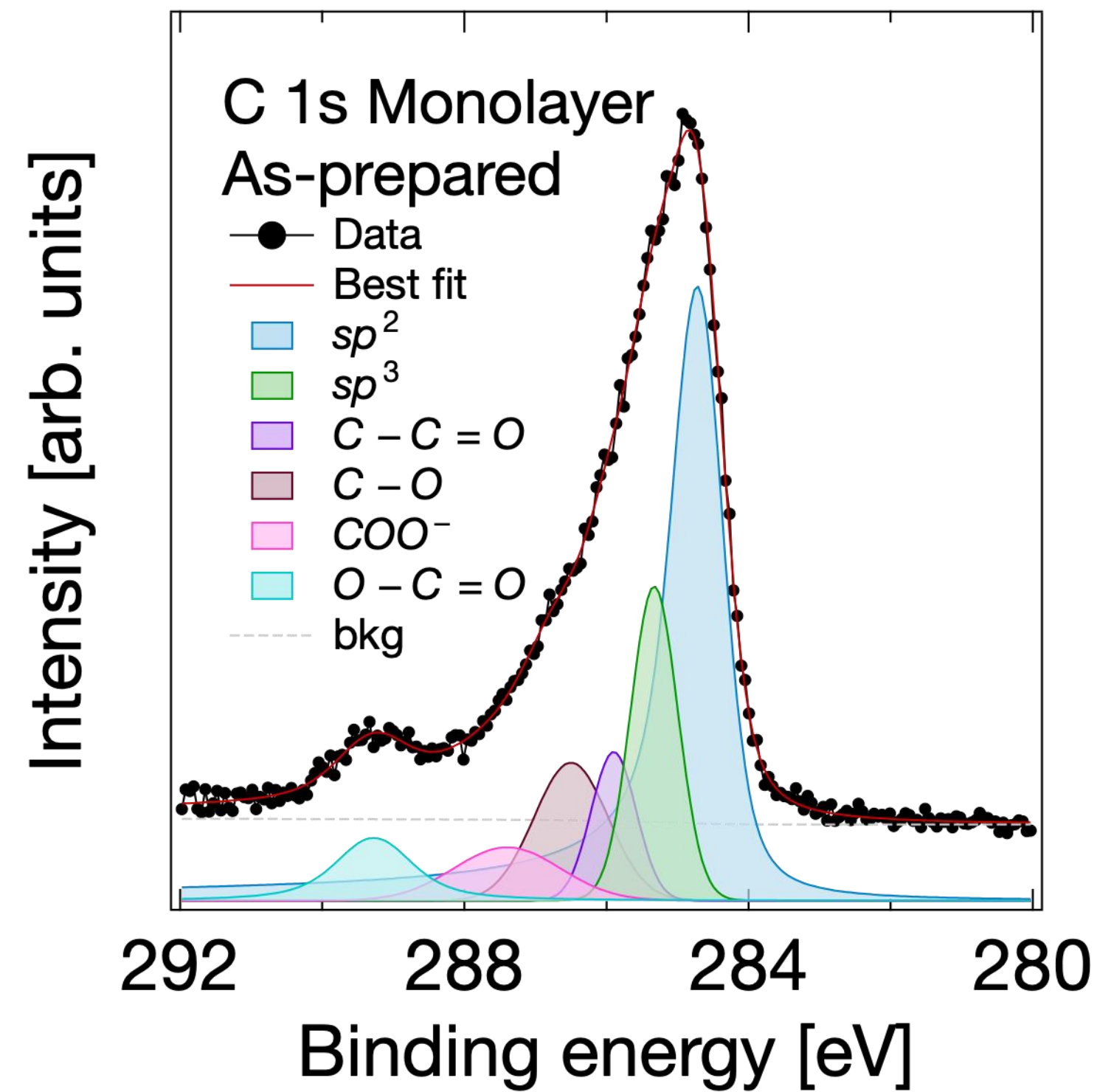
PMMA = Poly-methyl-methacrylate $(\text{C}_5\text{O}_2\text{H}_8)_n$

High temperature annealing cleans...but damages

Full covered, few spots no graphene **but** PMMA contamination



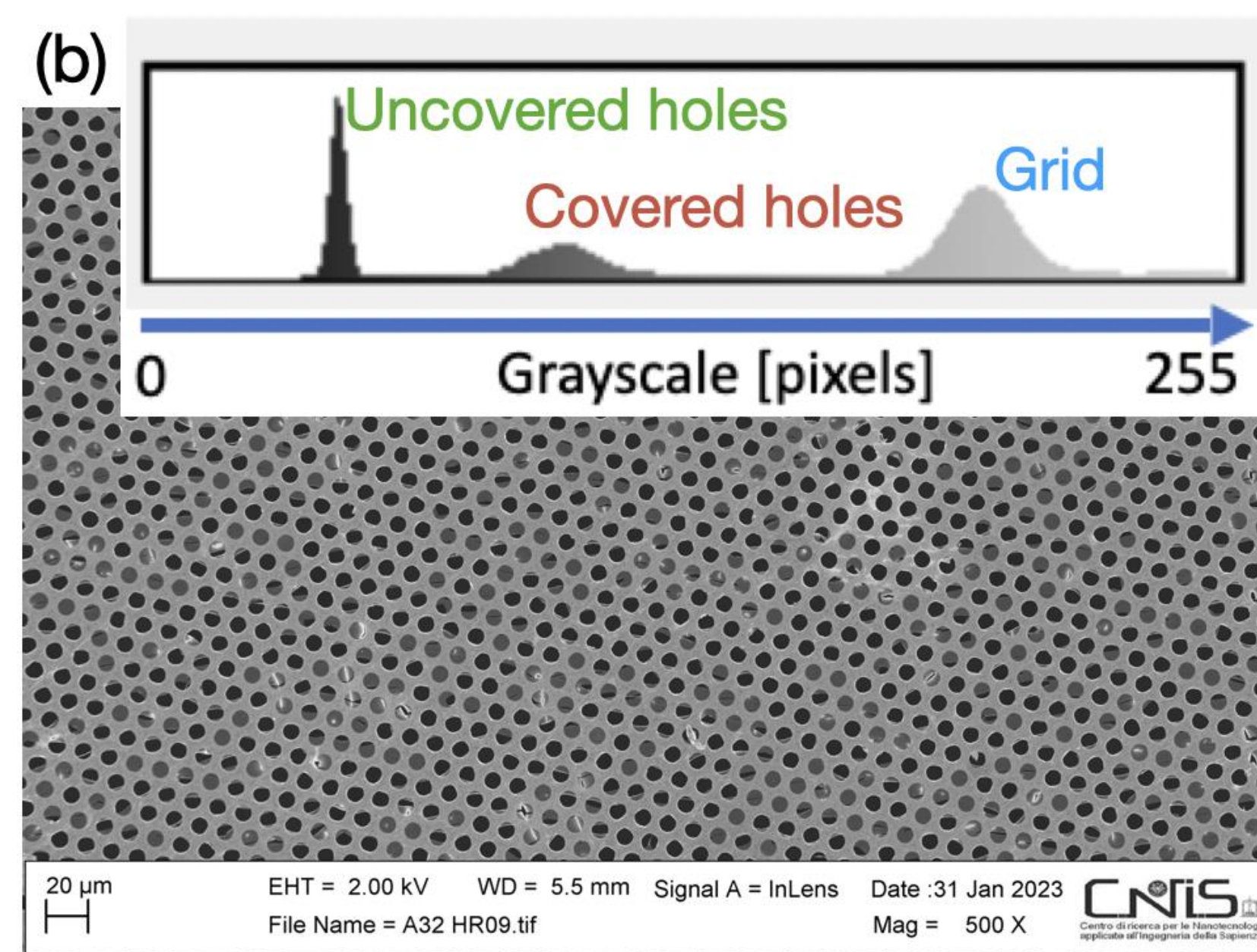
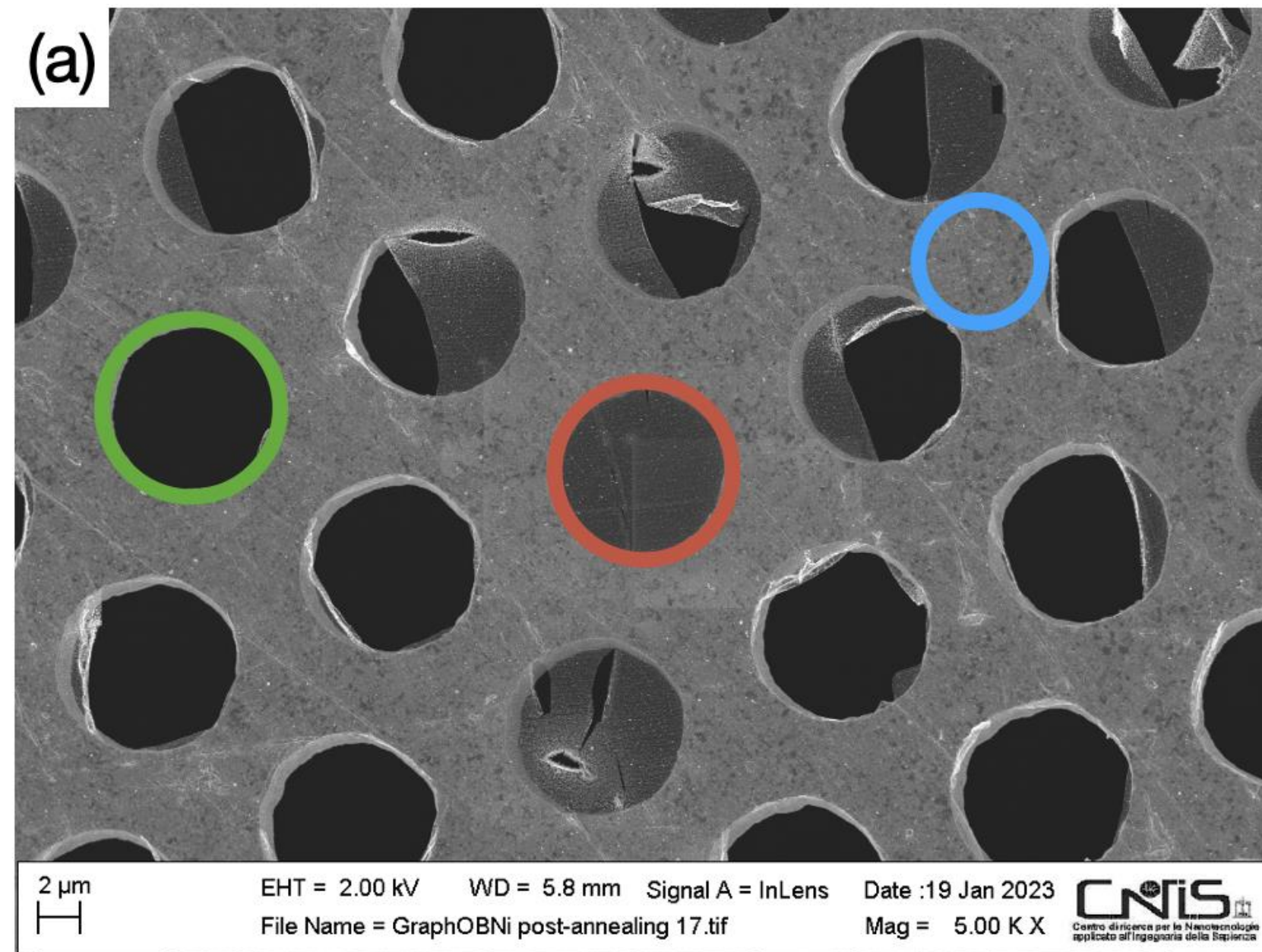
550° C annealing removes PMMA **but** damages graphene



Damages probably caused by **strain** due to different **thermal expansion coefficients** of Ni and Graphene

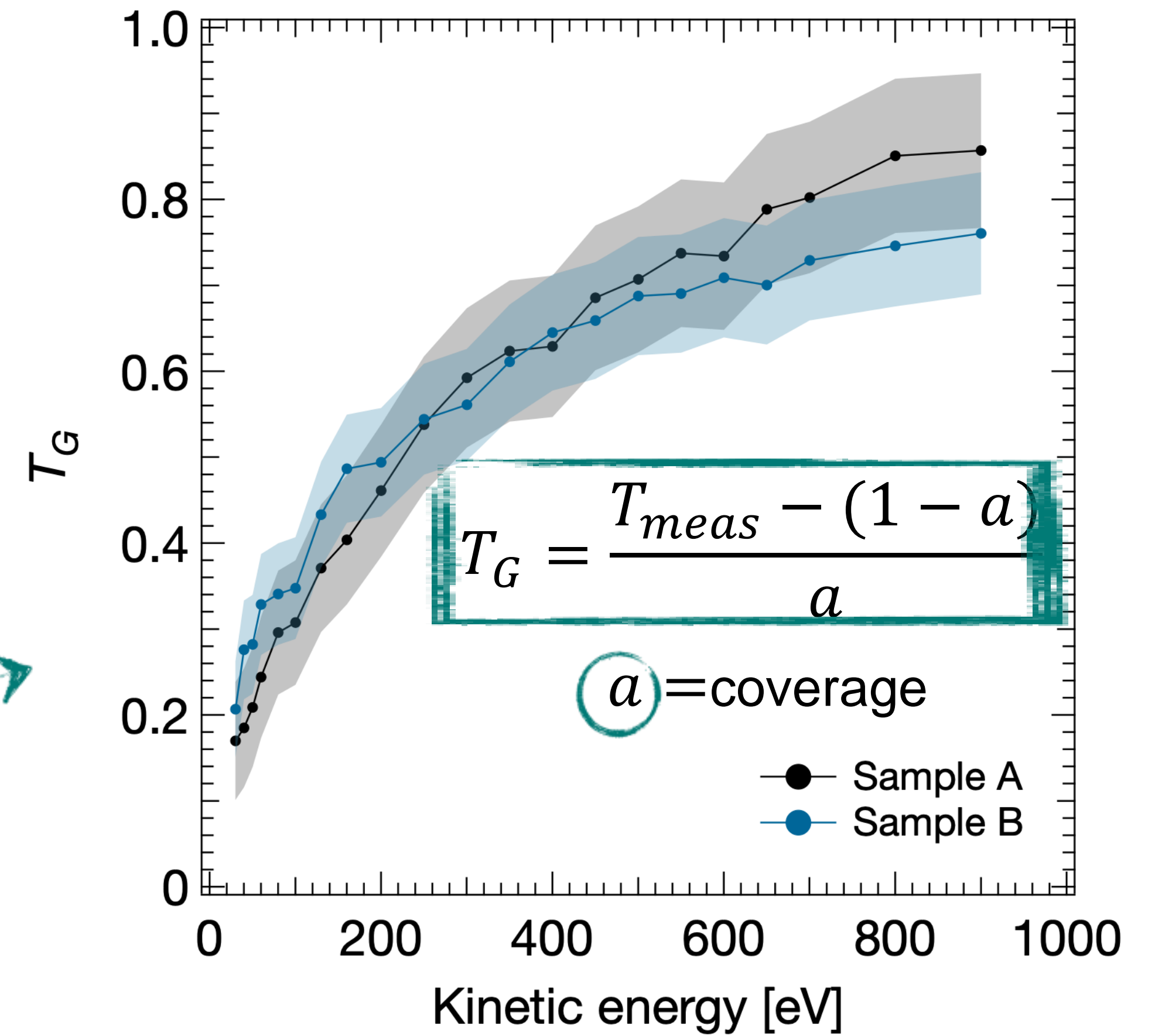
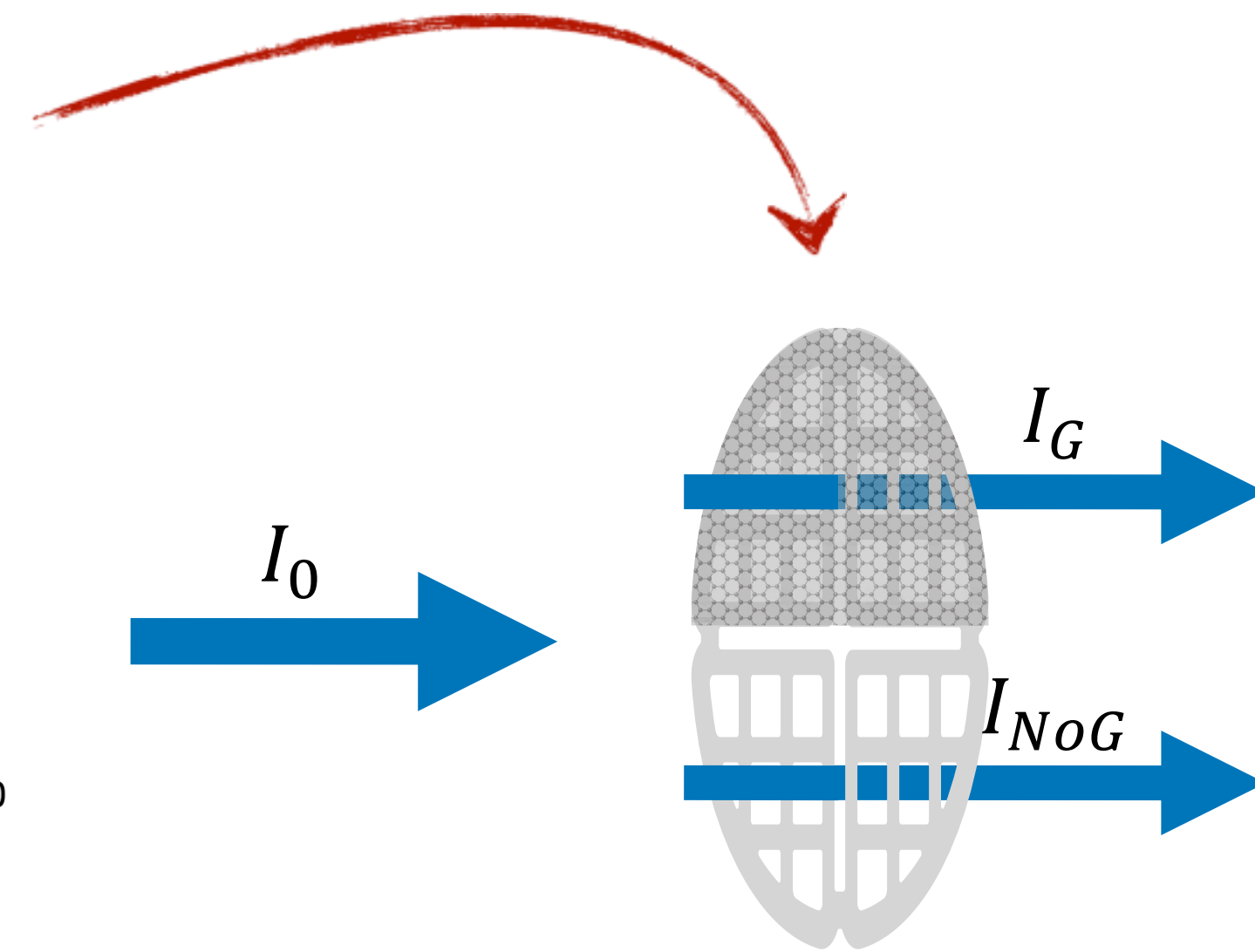
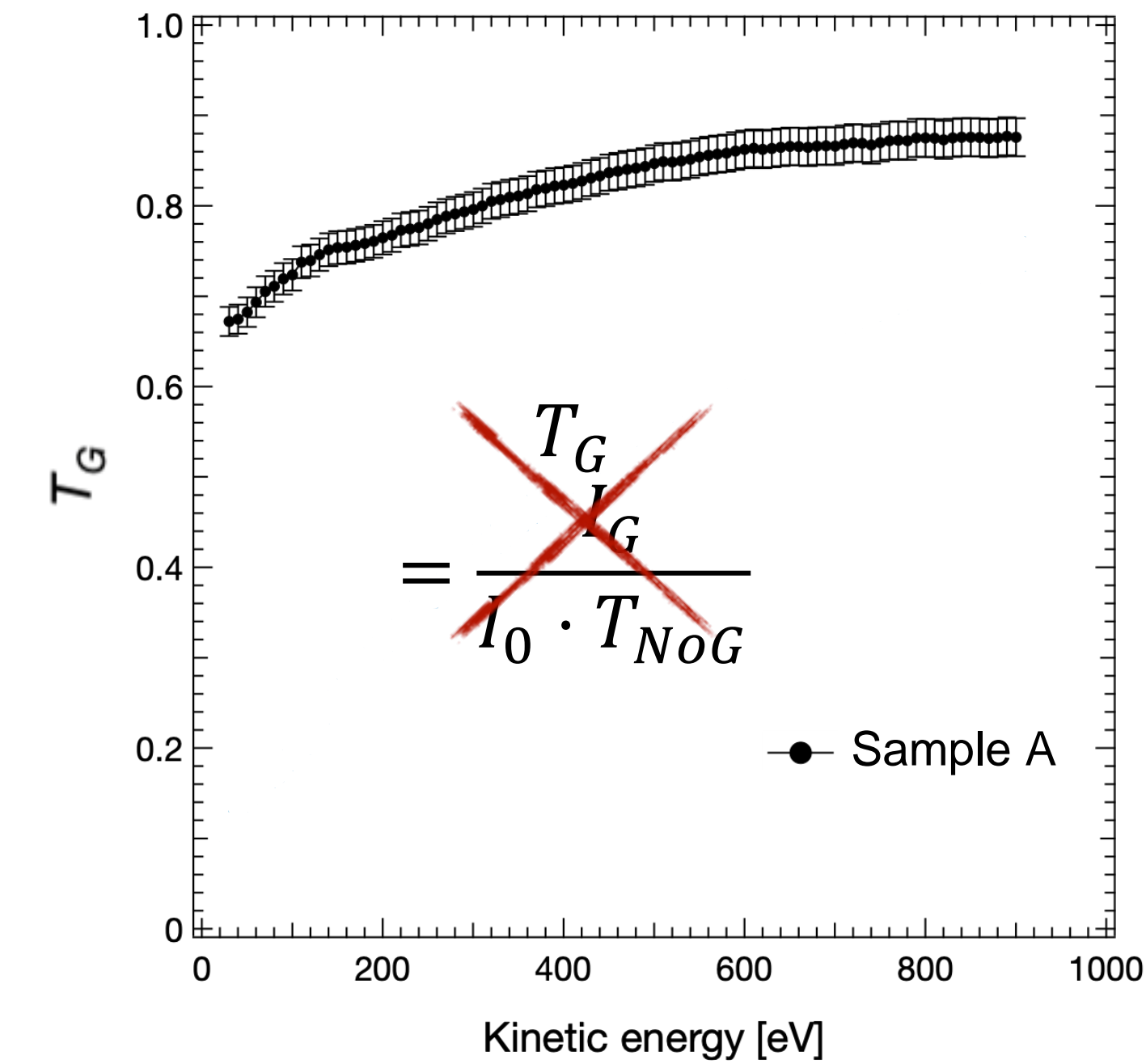


Greyscale histogram for the evaluation of holes coverage



- ❖ Software generates histogram based on pixels grey level
- ❖ Area of the covered holes, uncovered holes and grid regions
- ❖ Evaluate graphene coverage and geometrical transmission

The coverage correction mostly affects low energy region



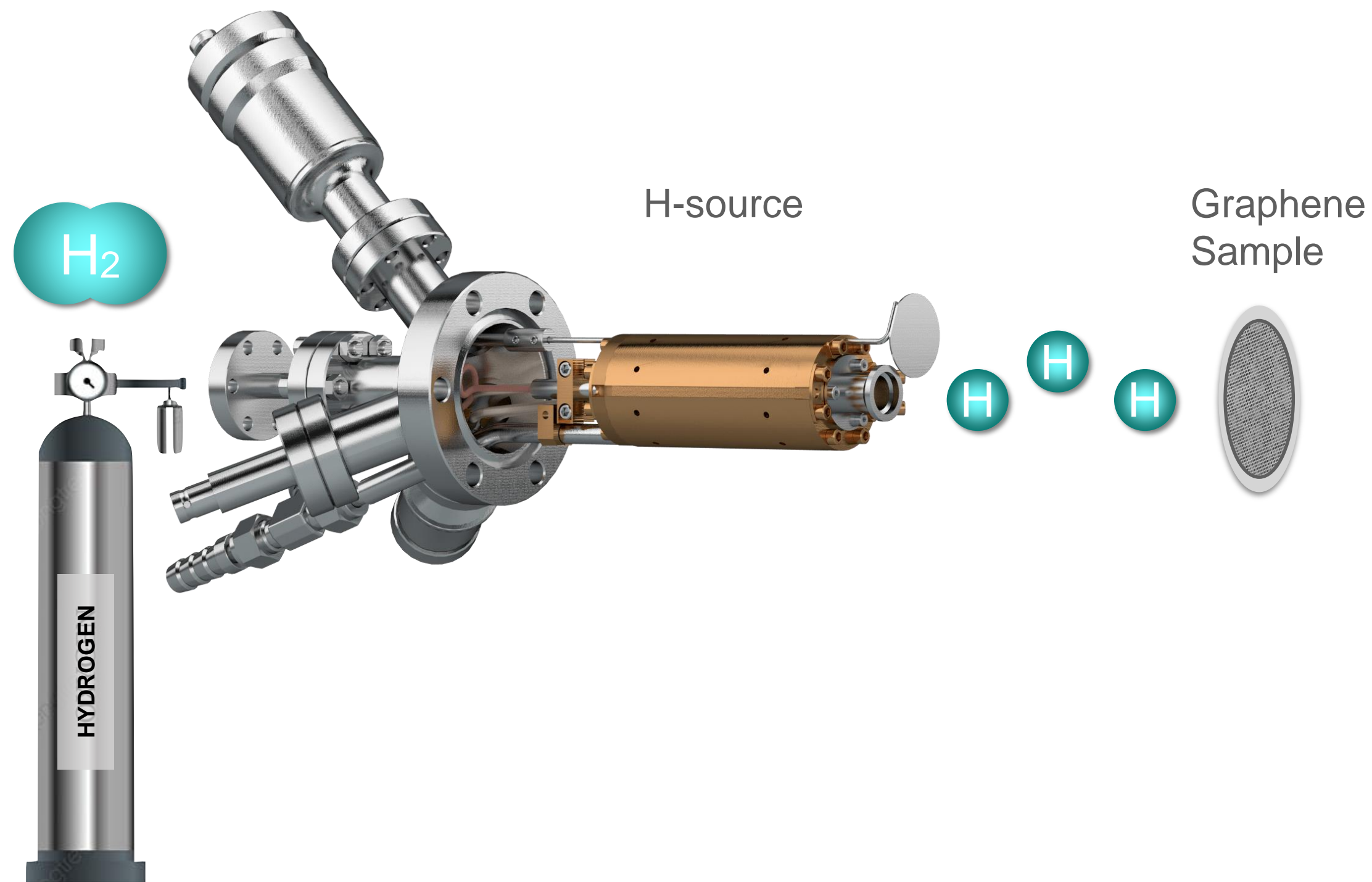
Grid geometrical transmission
(Nominal value 41%)

- ♣ Sample A (37 ± 1)%
- ♣ Sample B (44 ± 1)%

Graphene coverage

- ♣ Sample A (38 ± 1)%
- ♣ Sample B (42 ± 1)%

Hydrogenation of C-nanostructures: recipe ingredients



Atomic hydrogen source (**H-source**):

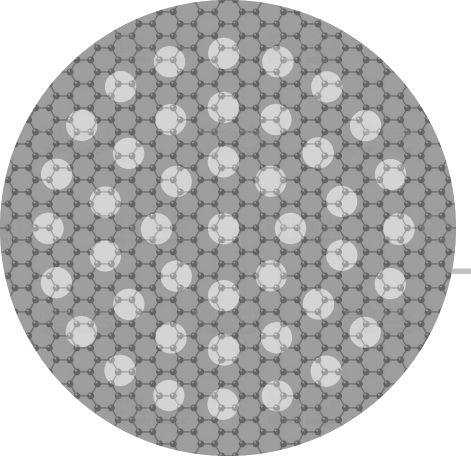
- ❖ FOCUS EFM-H
- ❖ Hot **tungsten** capillary
- ❖ H_2 **thermal cracking** into H

H-source operating conditions:

- ❖ H_2 pressure $1.8 - 3.6 \cdot 10^{-6}$ mbar
- ❖ Power 8 - 40 W
- ❖ H dose $10 \text{ kL} = 3.6 \cdot 10^{-6}$ mbar · hour

—————> Which is the “right” recipe?

Increase of sp^3 : XPS footprint of hydrogenation

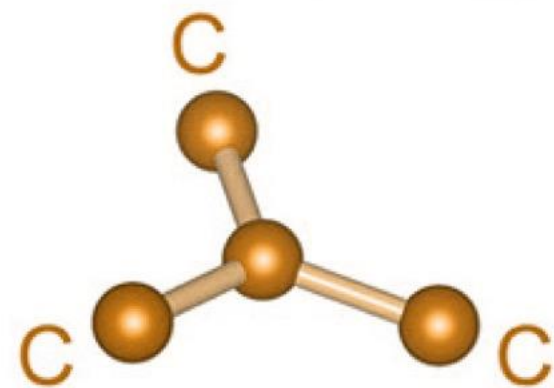
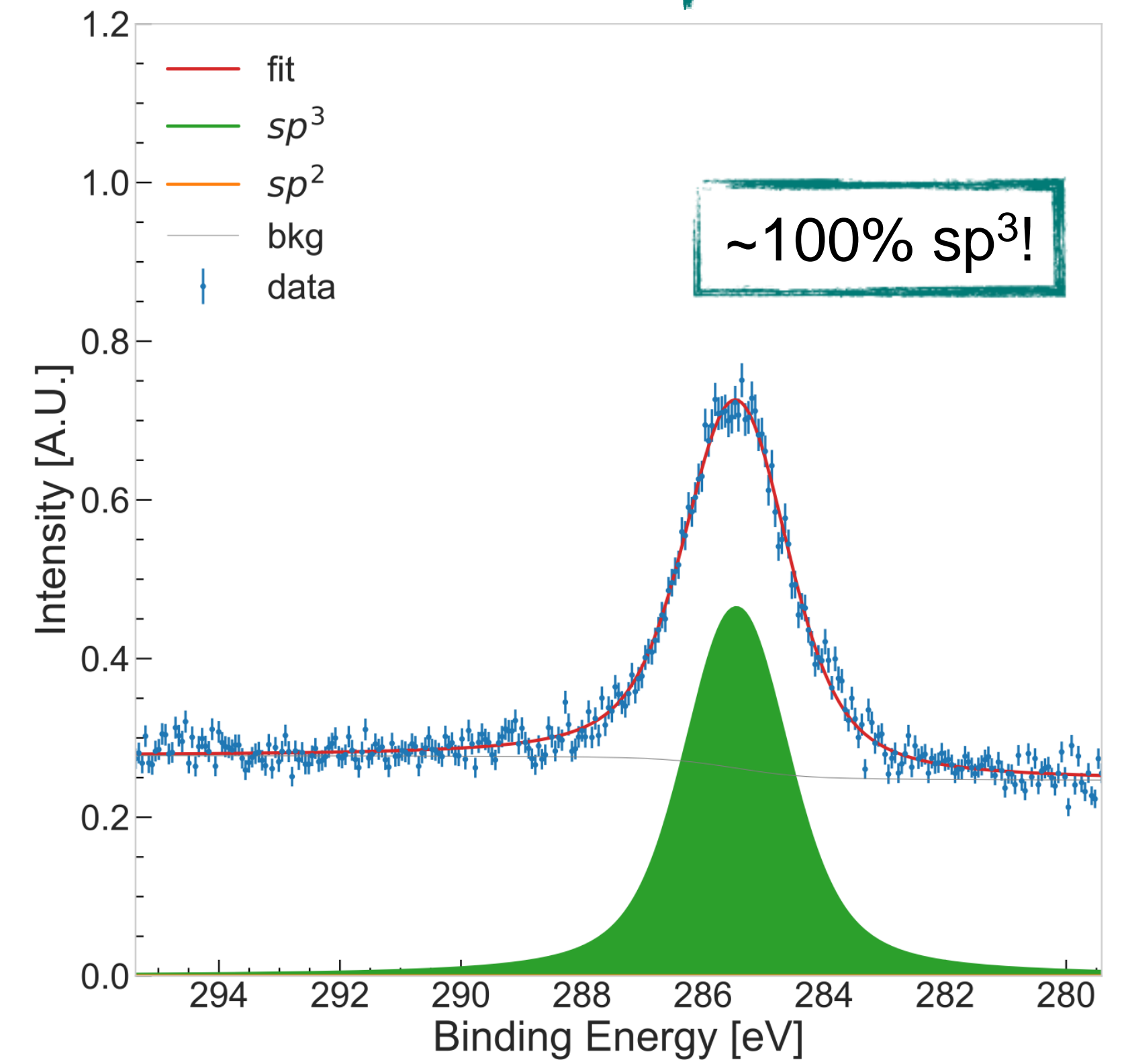
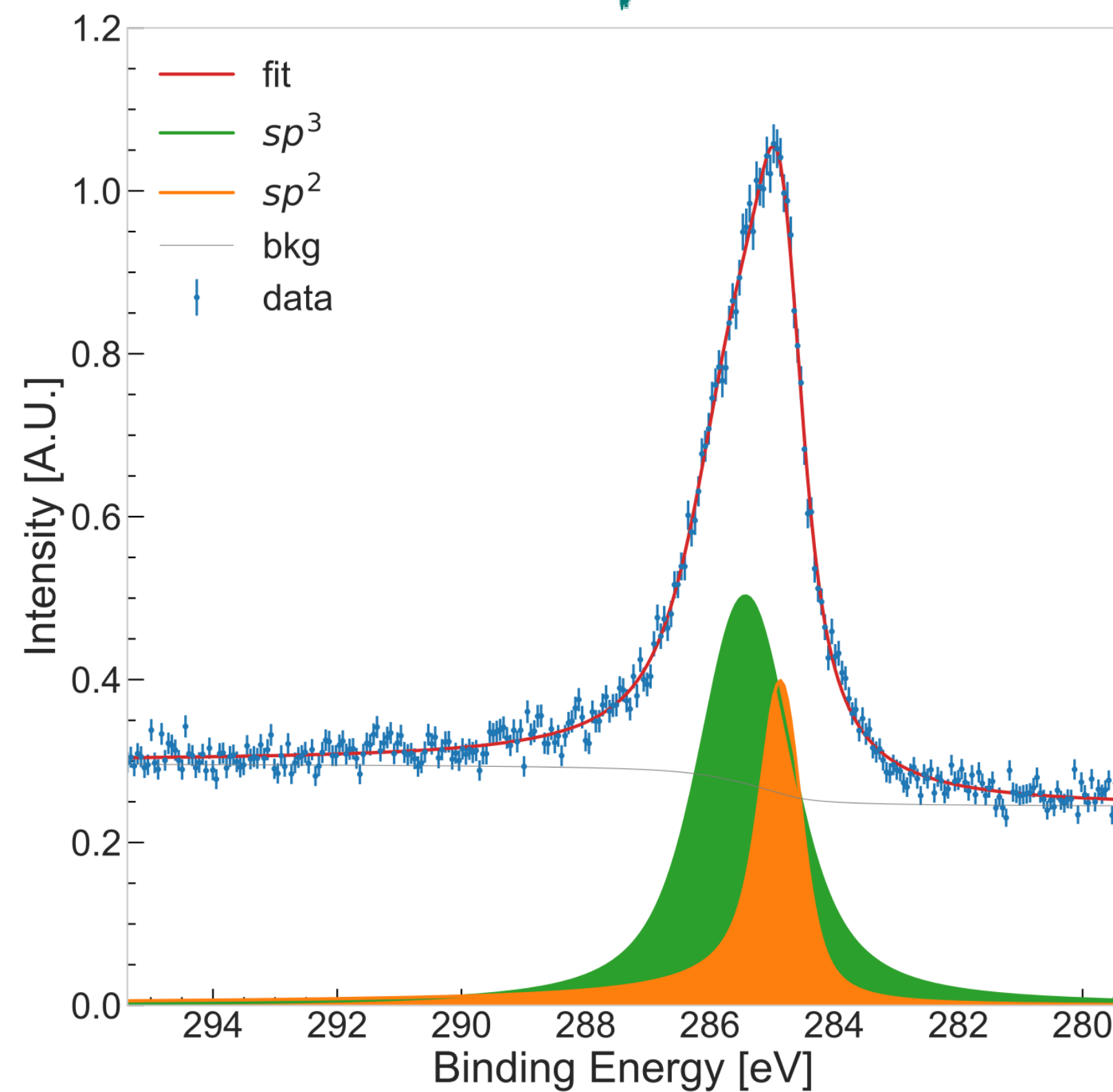
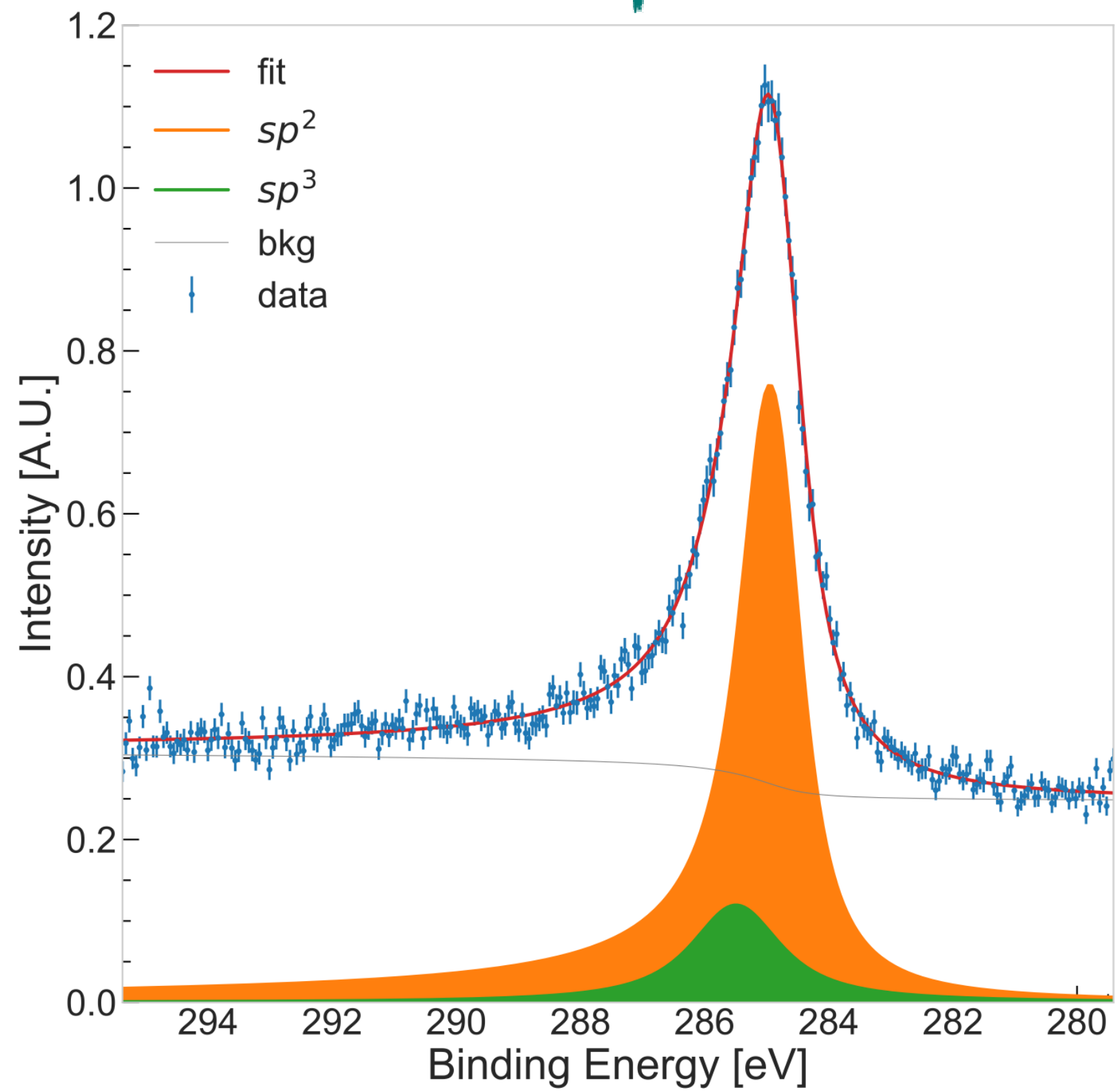


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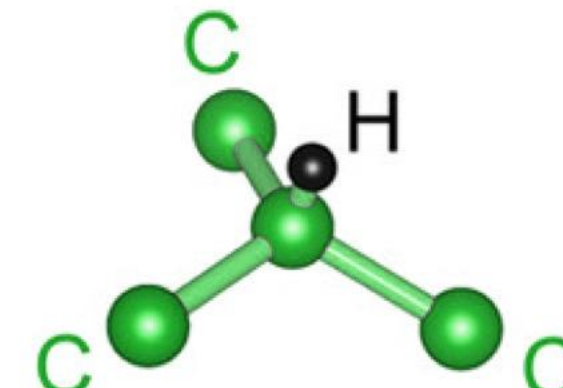
140

260

Dose [kL]



Carbon hybridization
changing from sp^2 to sp^3



Orlando Castellano's
master thesis

Increase of sp^3 and quenching of π -plasmon

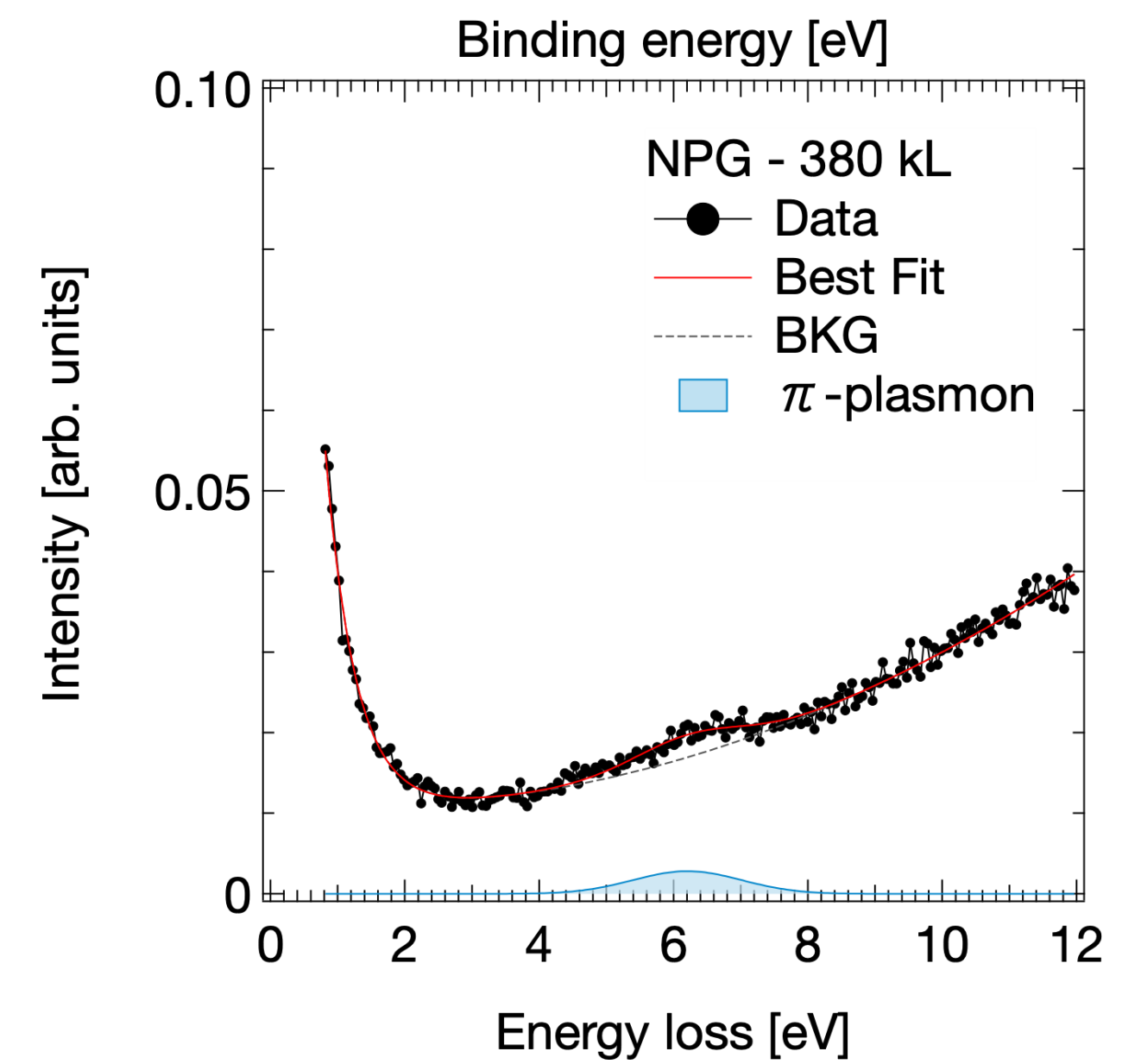
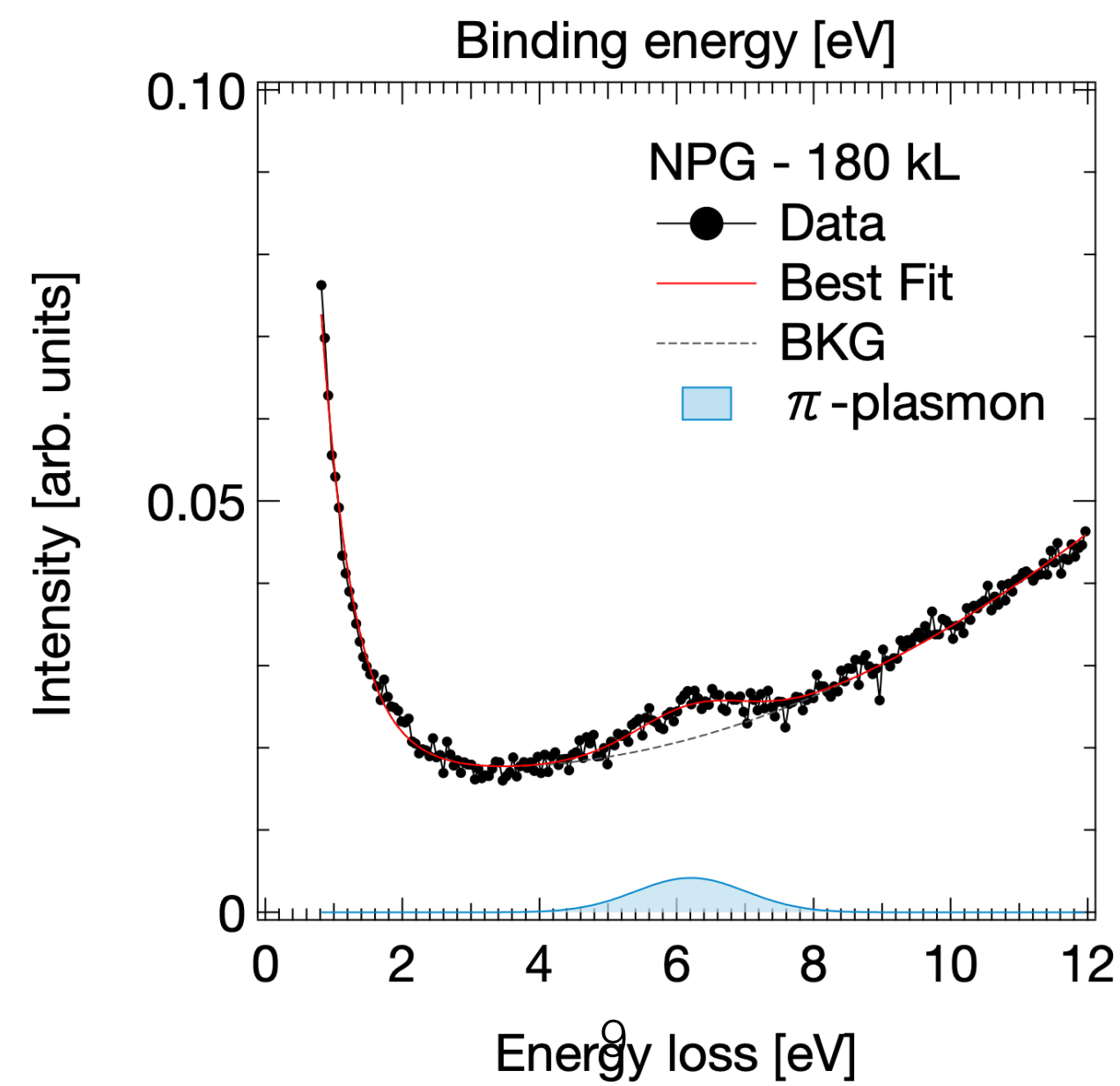
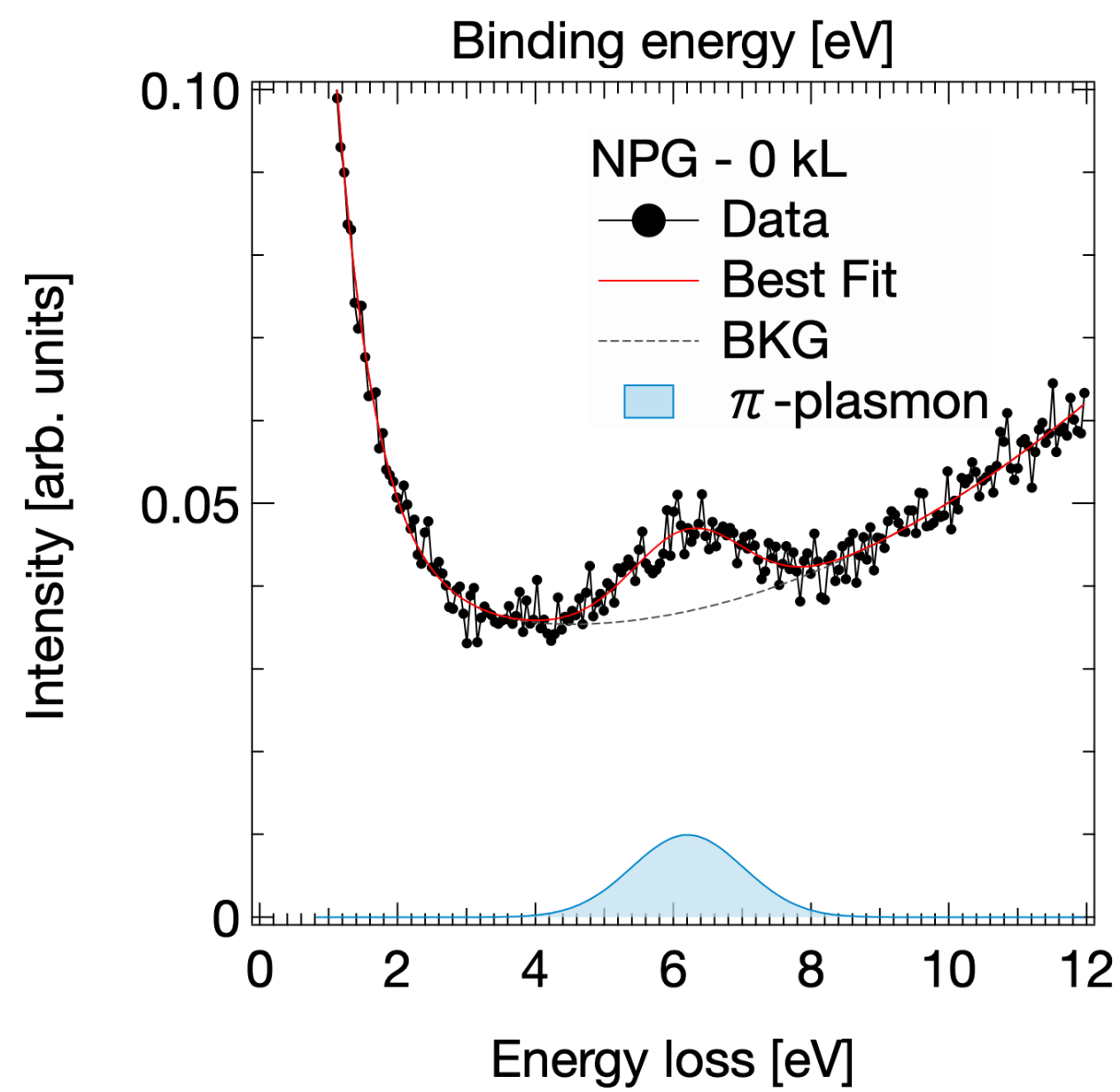
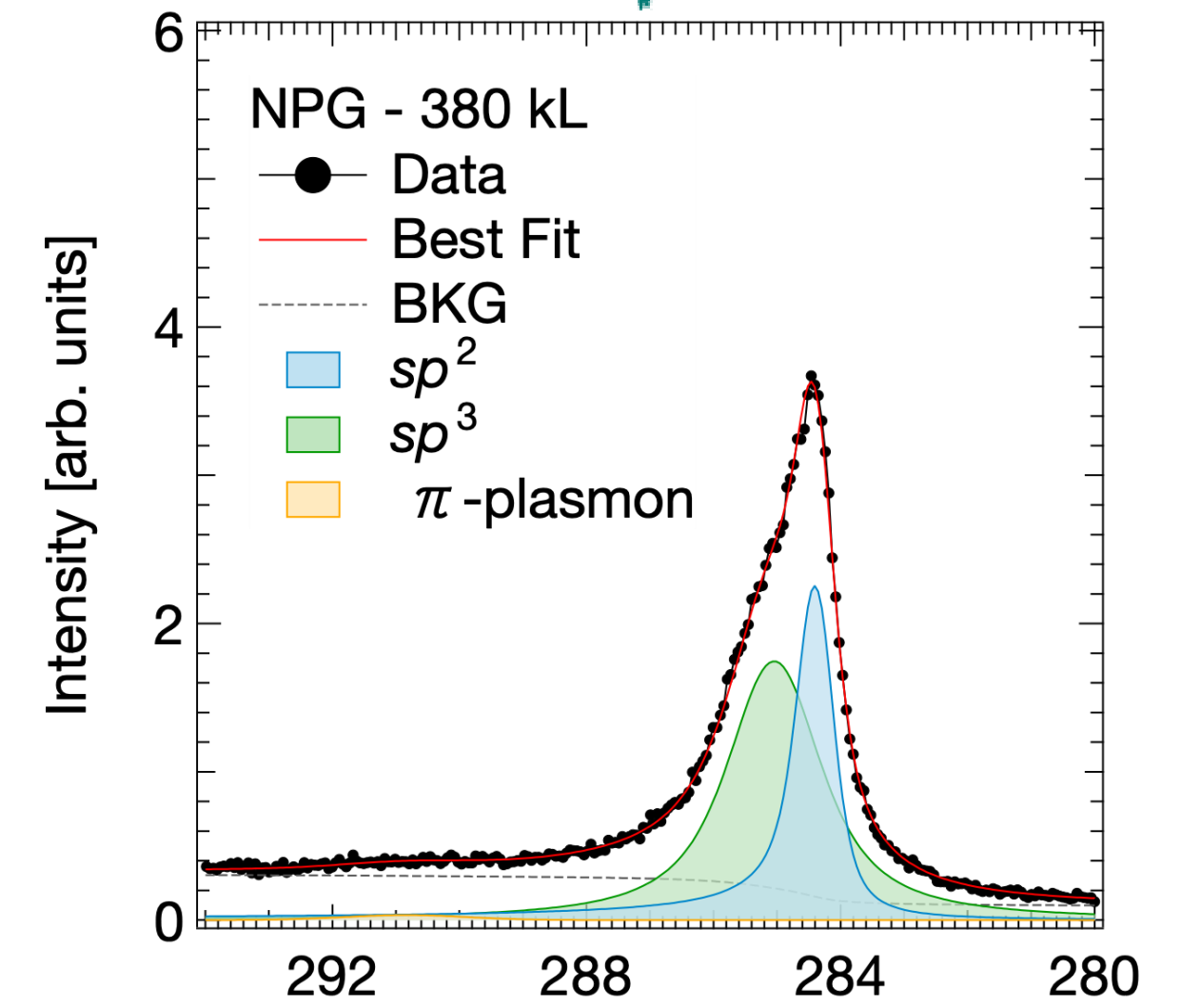
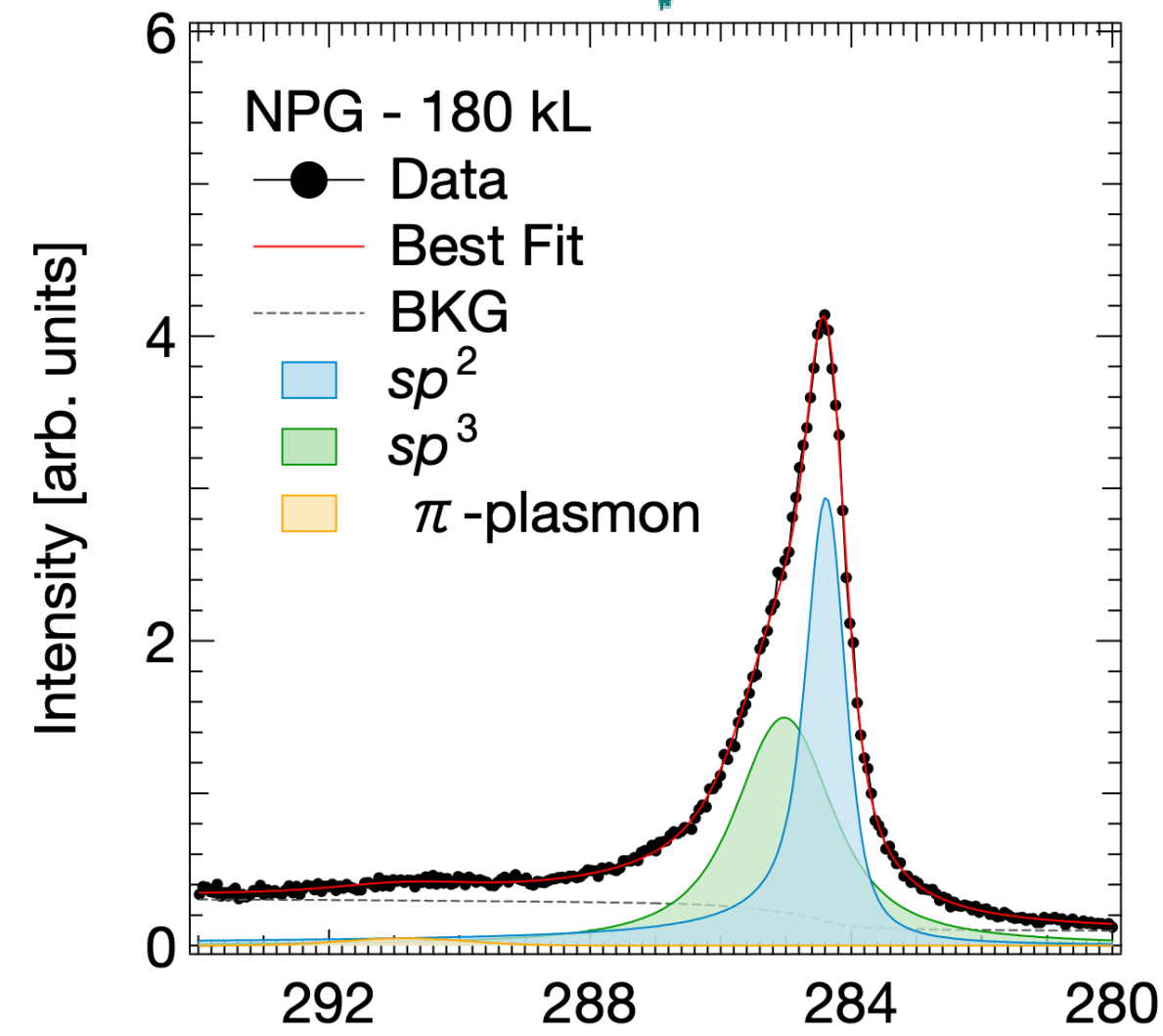
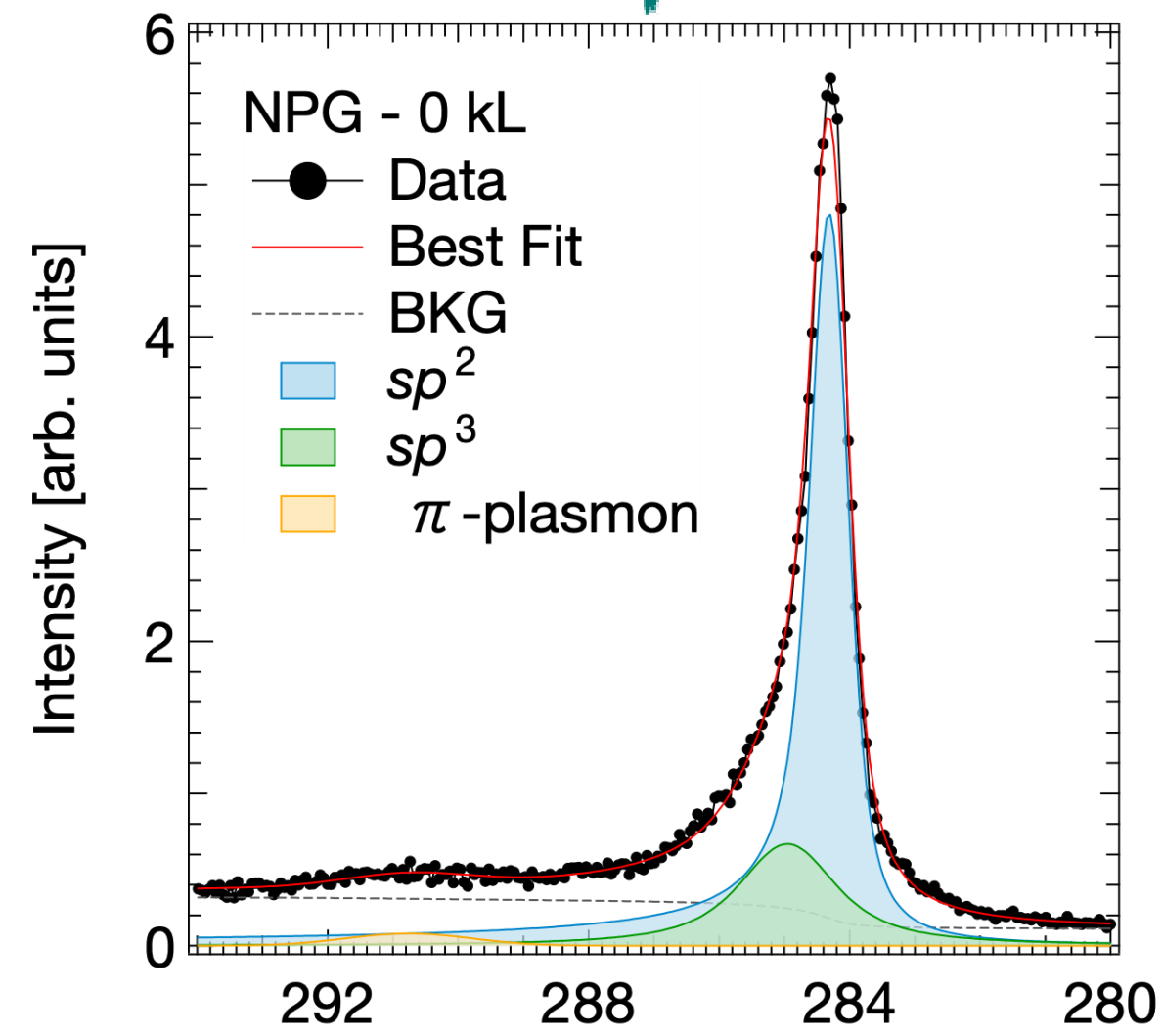


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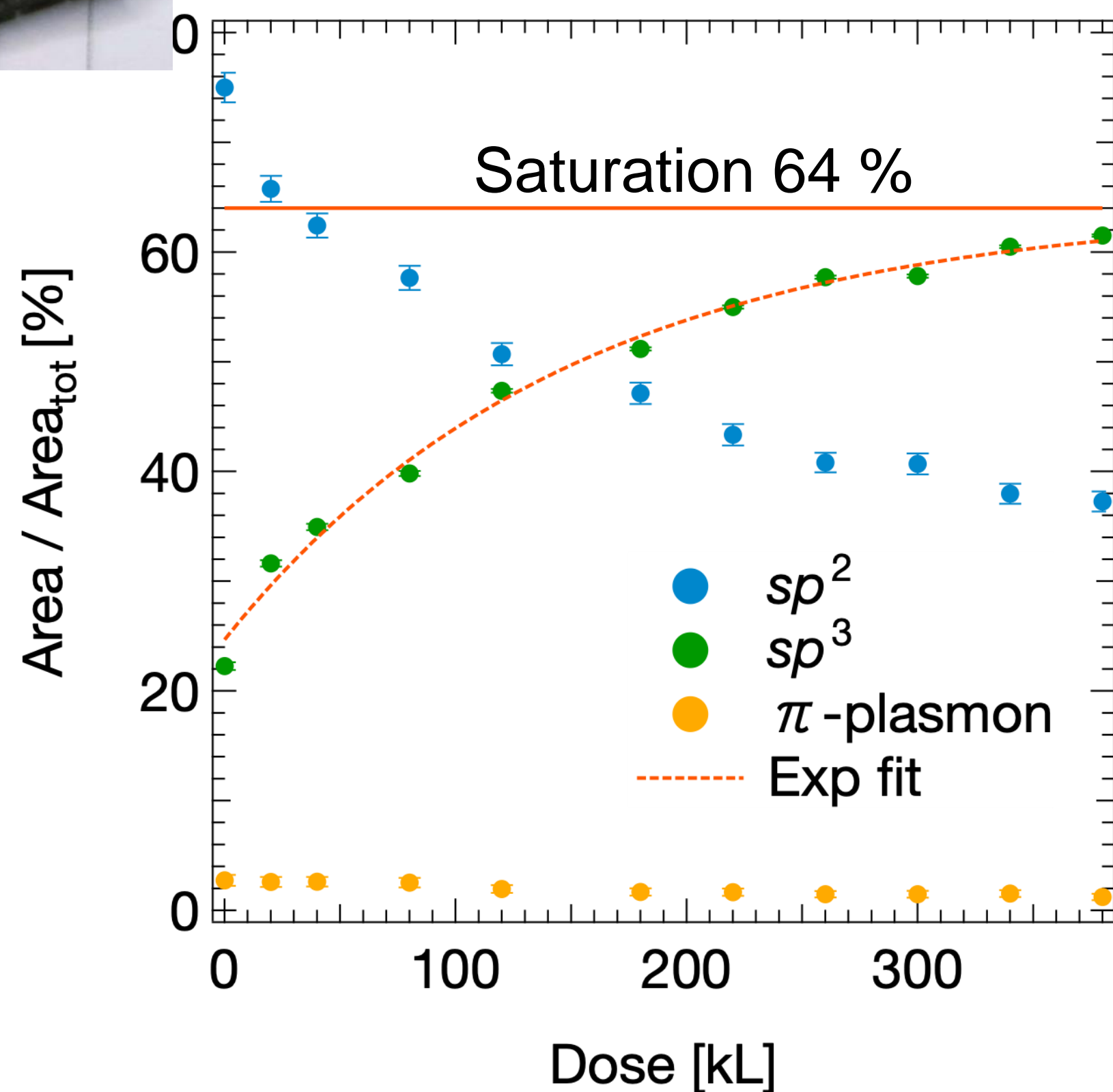
180

380

Dose [kL]

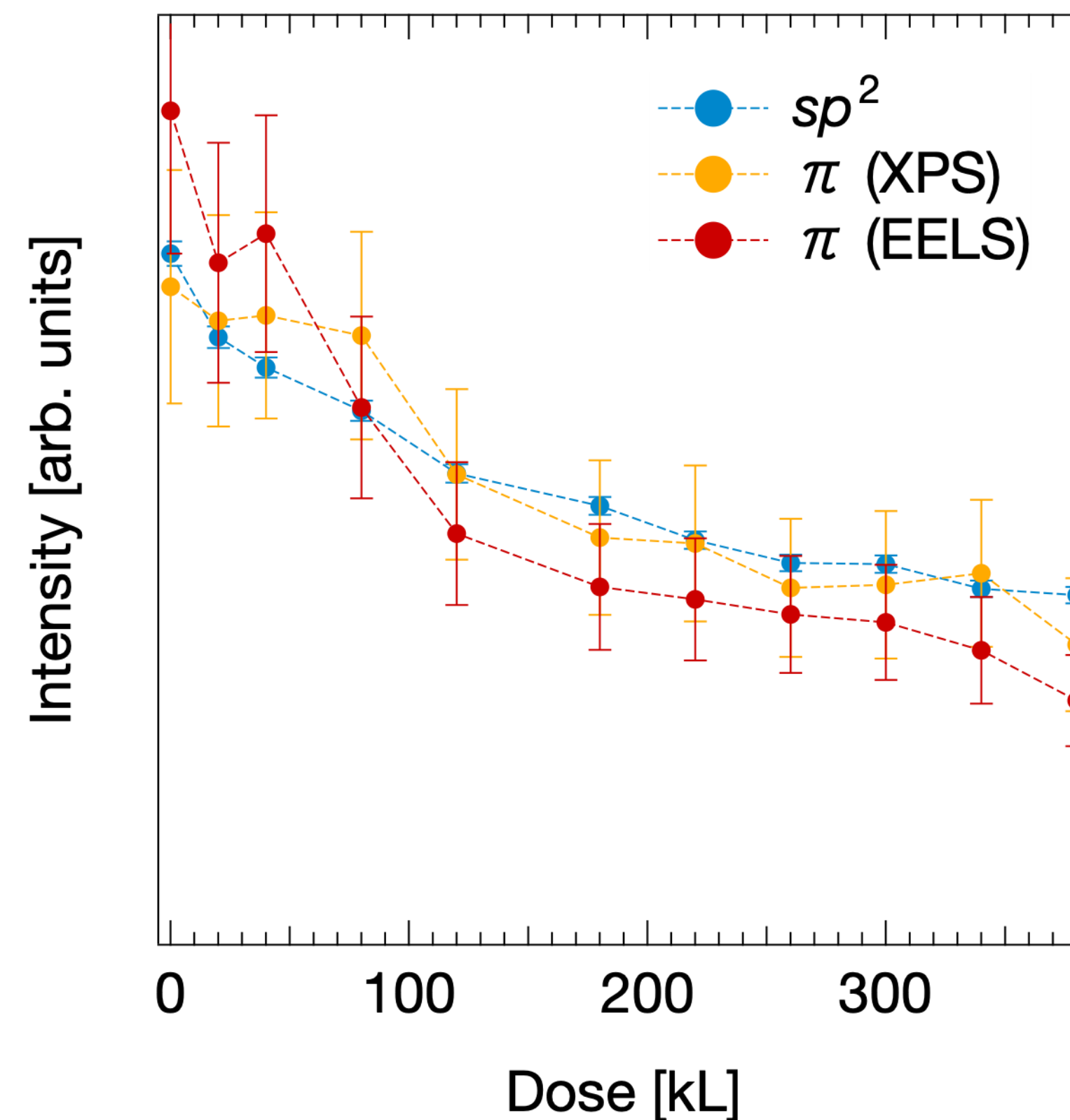


We reached the 64% saturation



XPS result:

- ❖ Decrease of sp^2 and π -plasmon
- ❖ Exponential increase of sp^3
- ❖ 64% saturation seems to be ~reached



XPS-EELS comparison:

- ❖ Behaviour seems compatible
- ❖ π -plasmon not completely quenched
- ❖ sp^2 still there

Impegni per il 2024

	RD_Ptolemy	SEGNAR (A. Fabbri)	Upmost (F. Pilo Pisa)
Ruocco Alessandro	0.4	0	0.1
Apponi Alice (dottoranda)	0.8	0	0.2
Paoloni Daniele (assegnista)	0.5	0.3	0.2
	1.7	0.3	0.5
