Photons Interaction with technical surfaces

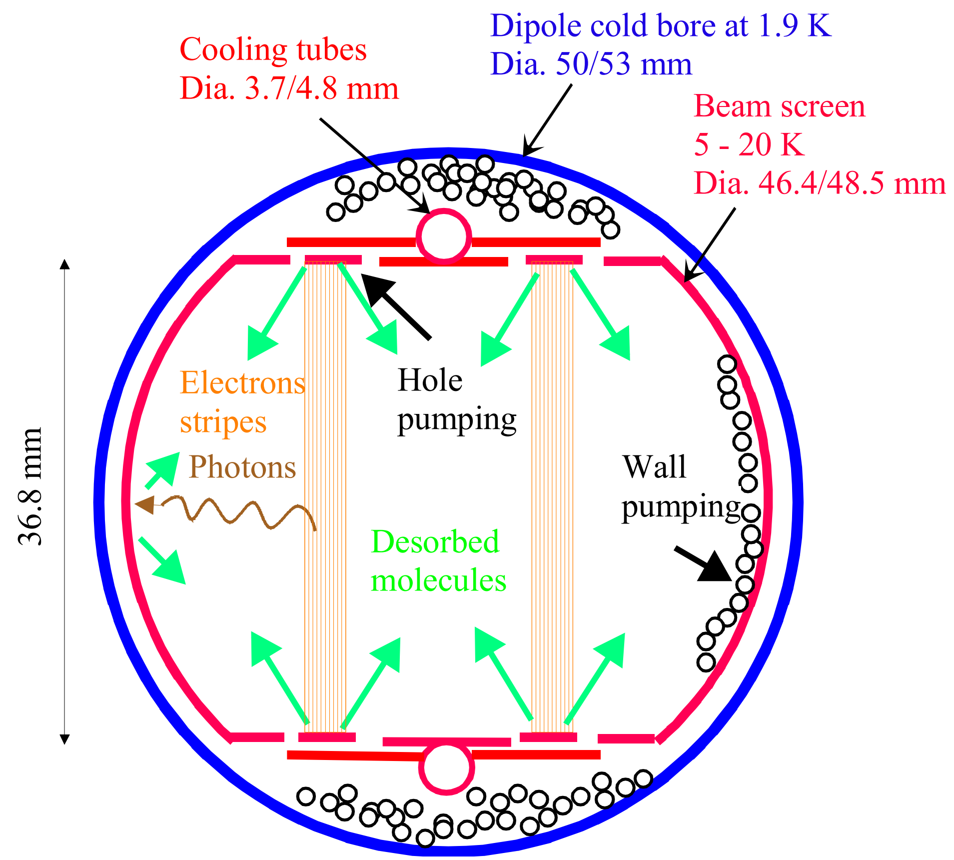
Marco Angelucci[1]

Luisa Spallino[1], Andrea Liedl[1], Rosanna Larciprete[1,2] and Roberto Cimino[1]

[1] LNF-INFN, Frascati, Italy [2] CNR-ISC, Roma, Italy

Introduction

- Residual Gas
- Photons
- Electrons
- Ions



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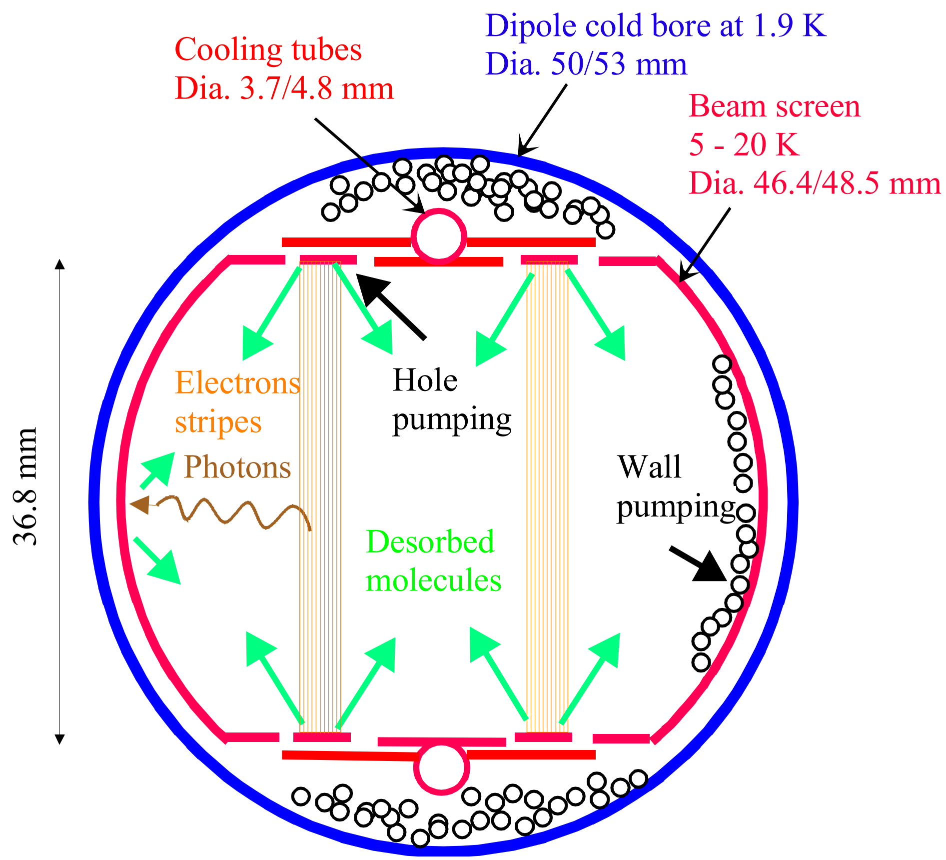
- Gas Desorption
- Secondary Electron Emission
- Surface Modification (Chemistry)
- Electron Cloud
- Heat Load



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- Beam Instabilities
- Power Consumption (cryogenic)
- Engineering

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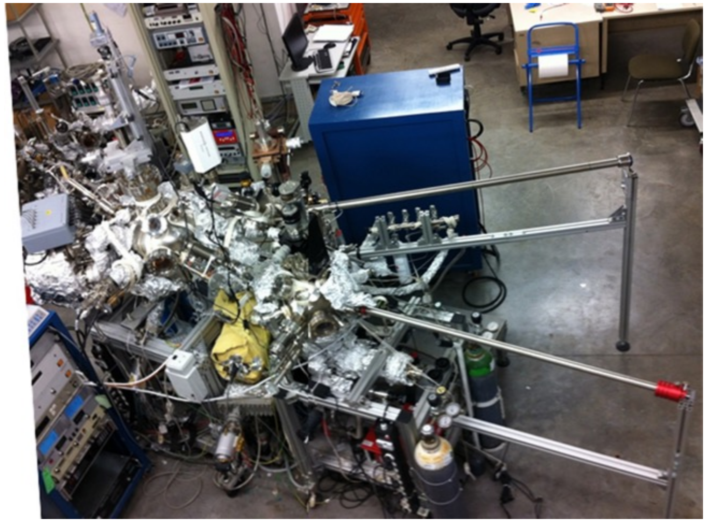
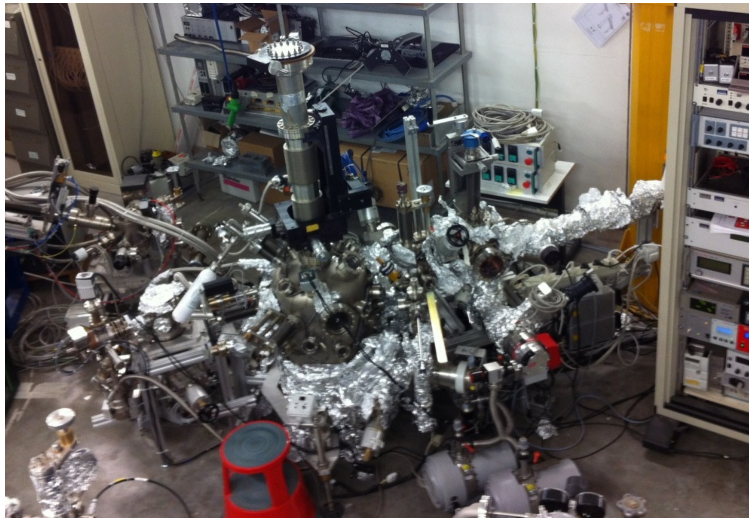
How To study (LNF Laboratory)

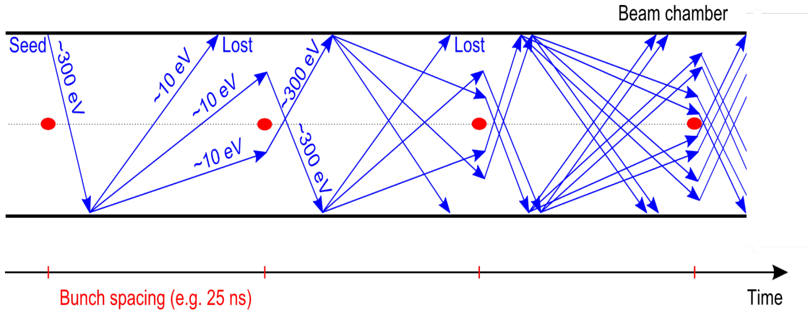


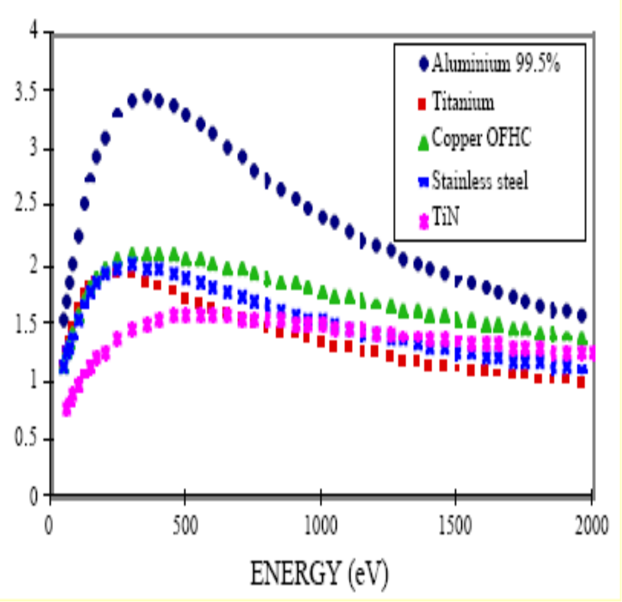
1) Ultra High Vacuum systems with fast-entry lock
2) Samples preparation chamber
3) Cryogenic Manipulator (15-300 K)
4) Gas Line
5) Electron Gun / Faraday Cup
6) Quadrupole Mass Spectrometer
7) X-ray / UV sources

1) Non baked samples
2) Surface treatments (Sputtering, Heating, Coating …)
3) Low temperature studies
4) Gas dosing on cold surfaces
5) Secondary Electron Yield
6) Gas Desorption (ESD, PSD, TPD) **(L. Spallino's talk)**
7) Surface characterizations



Electron Interactions…





N. Hilleret *et al.*, LHC Project Report 433 2000, EPAC 00

…Induce

Heat load

Secondary electrons and related instabilities (e-cloud)

Electron induced desorption

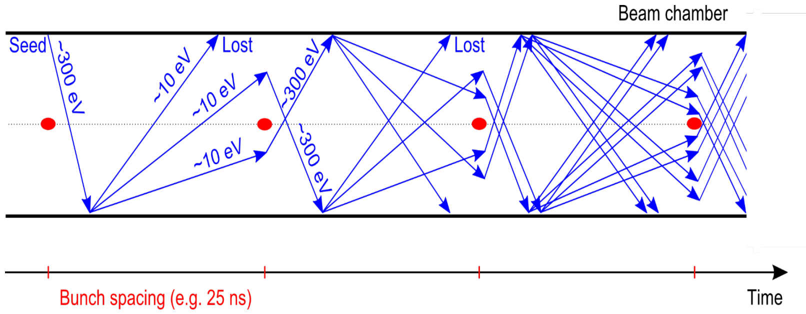
Studies

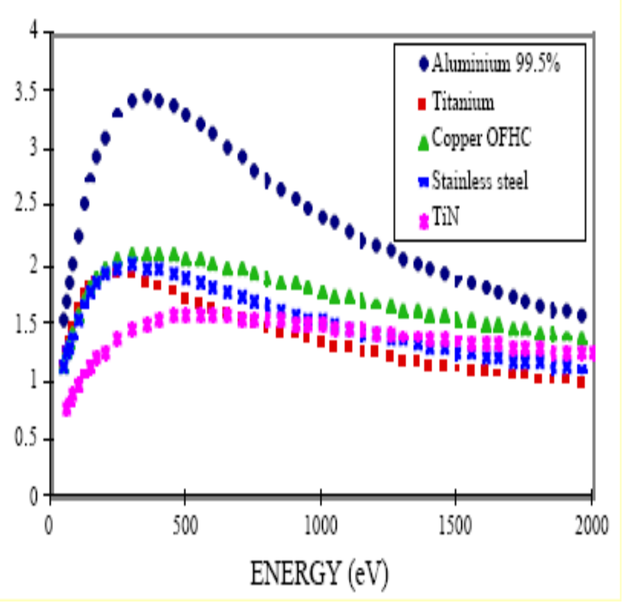
Secondary Electron Yield

Surface chemistry

Electron induced desorption

Electron Interactions…





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Surface chemistry

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Electron Interactions

Electron Scrubbing (with e⁻gun)

Surface Modification

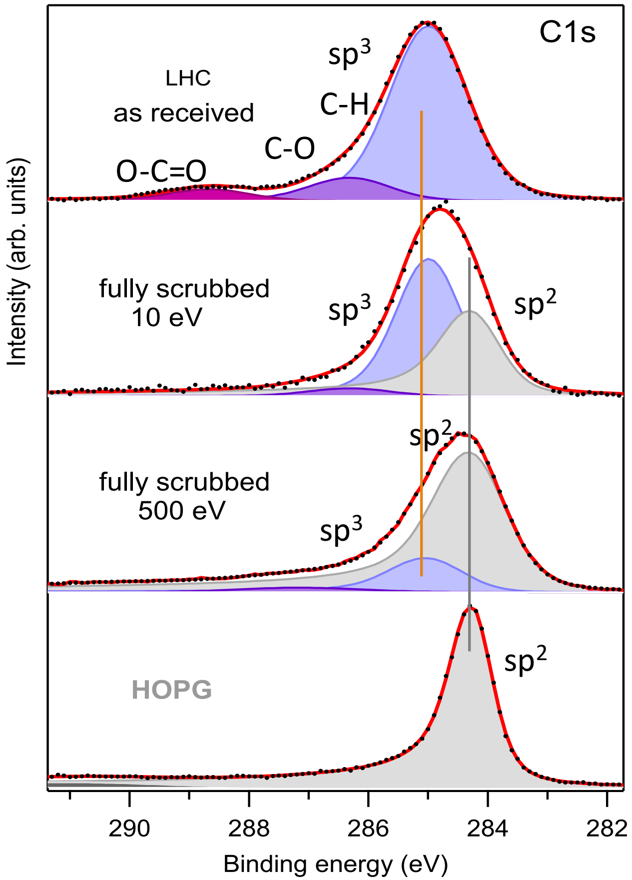
SEY

Chemistry (XPS)

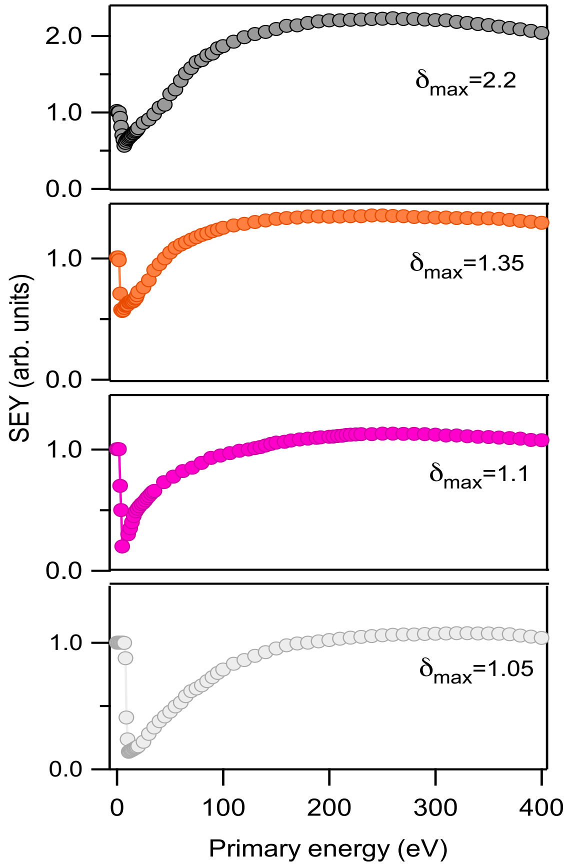
Variation
From δ=2.2
To δ=1.05

Formation of Carbon sp^2
(Graphite like)
from sp^3 (impurities)

XPS

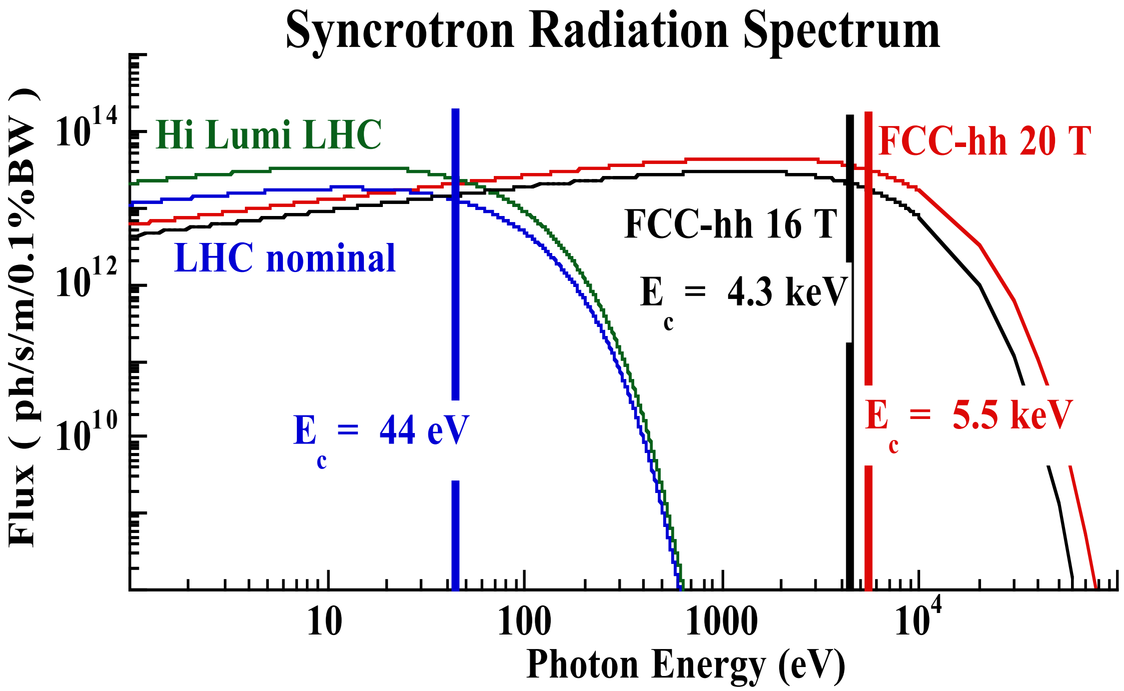


SEY



R. Cimino et al. PRL **109 064801 (2012)**

Photon Interactions…



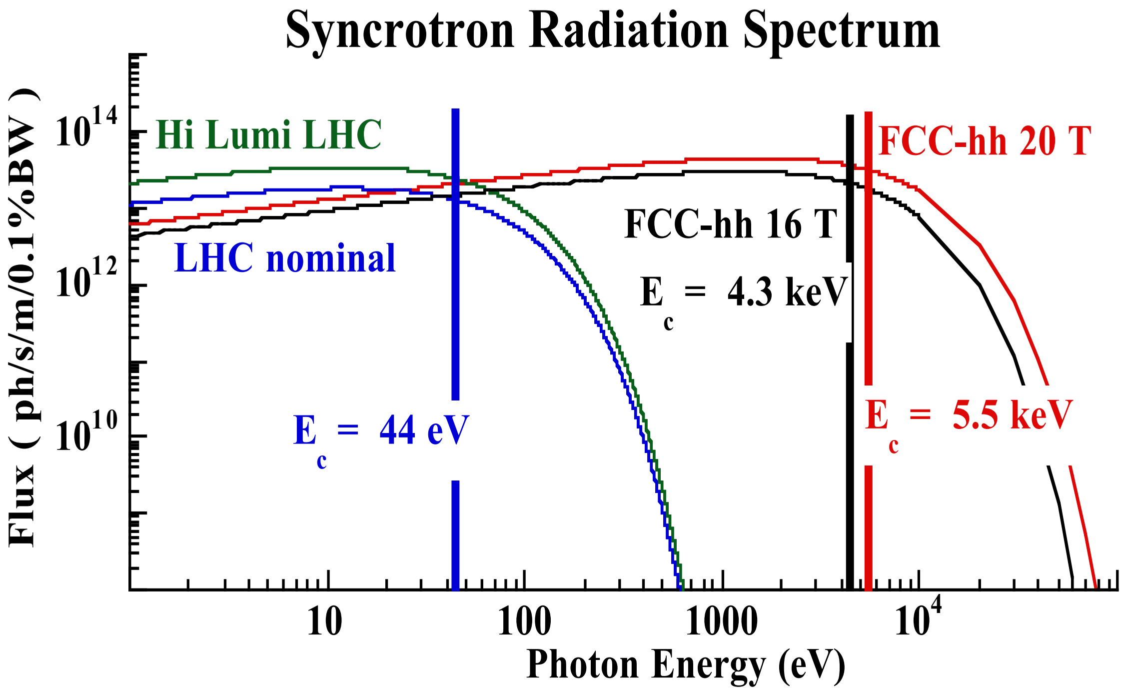
…Induce

Heat load
Photo electrons and related instabilities
Photo induced desorption

Studies

Reflectivity (where photons interact with BS)
Photo Yield (Number of photo-el produced)
Photo induced desorption

Photon Interactions…



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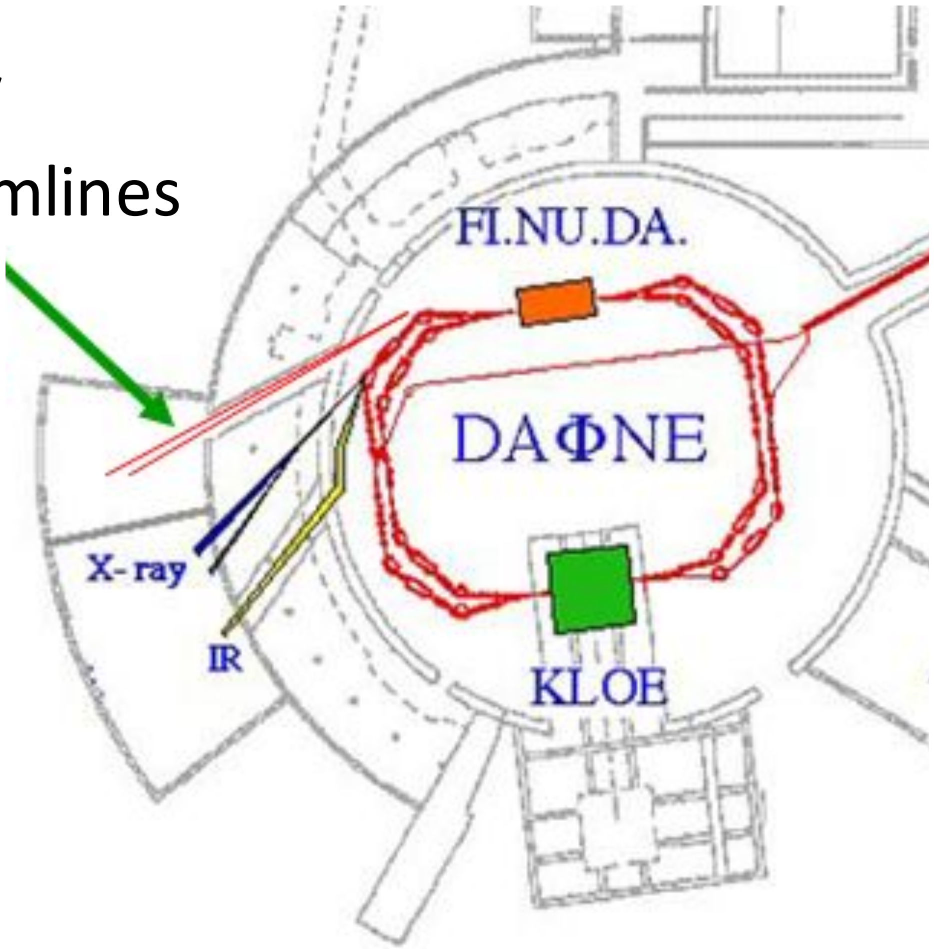
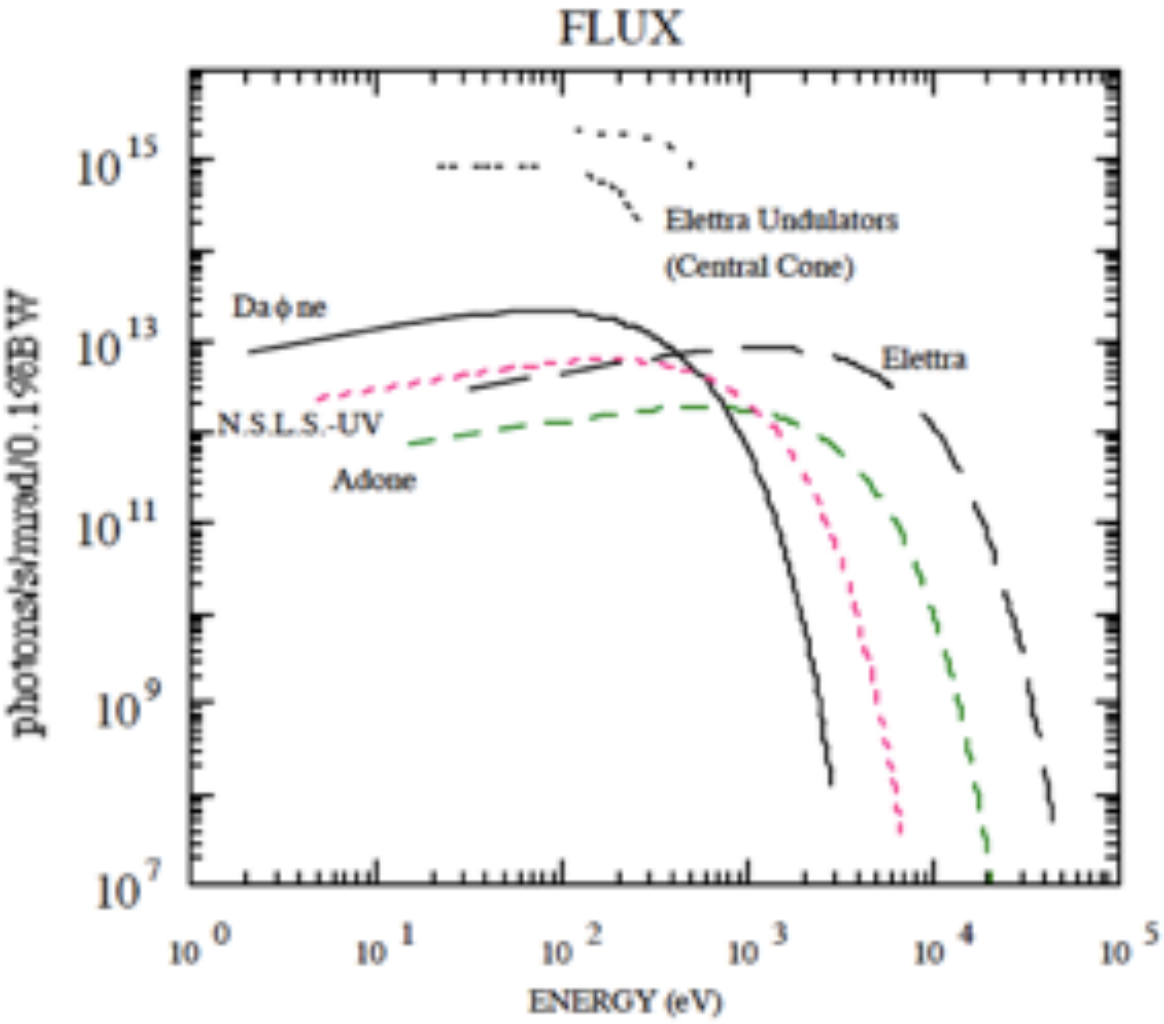
DAΦNE

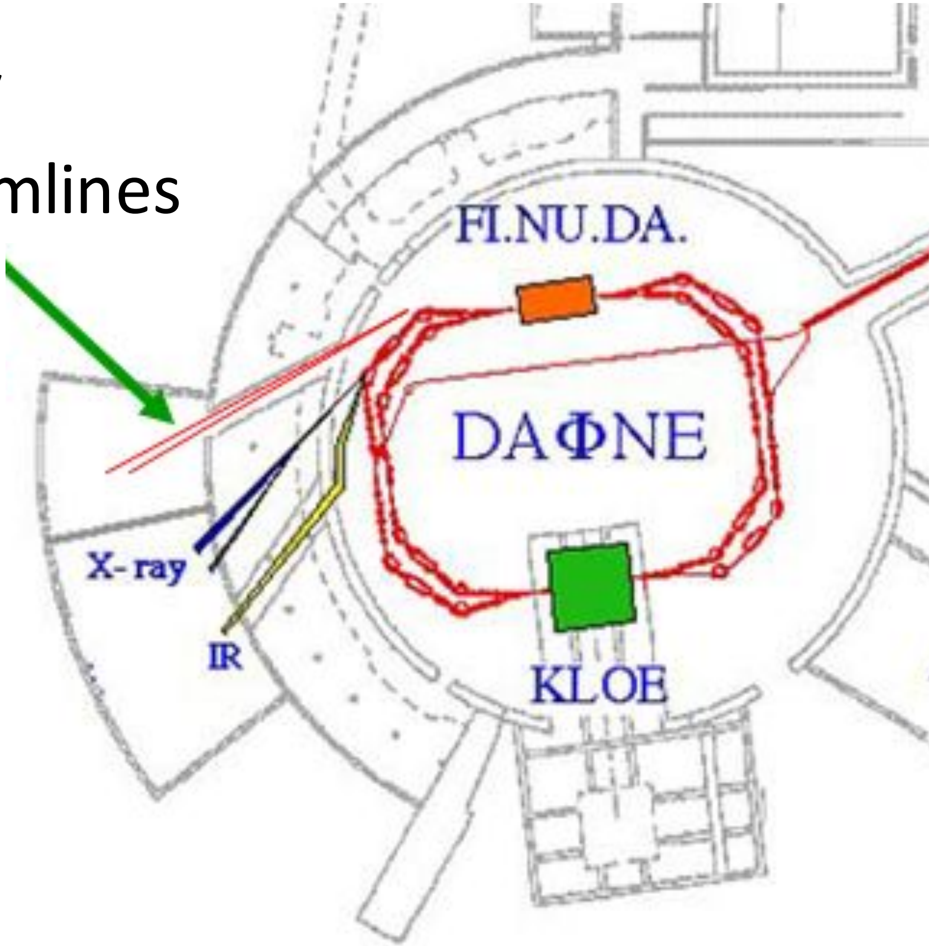
XUV
Beamlines





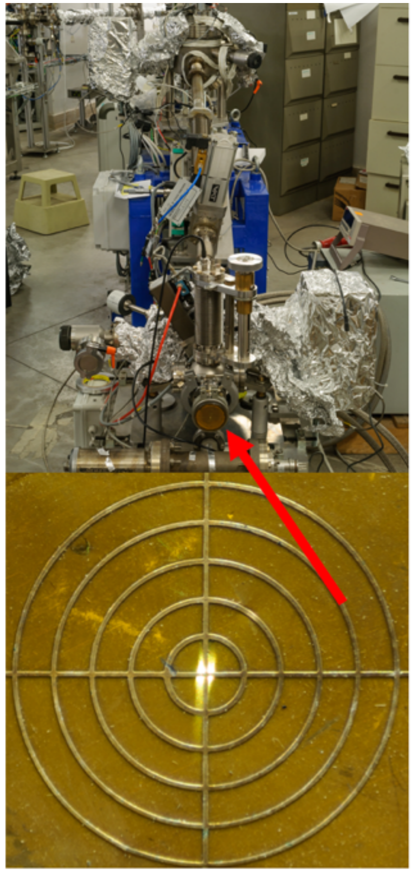
DAΦNE

XUV
Beamlines

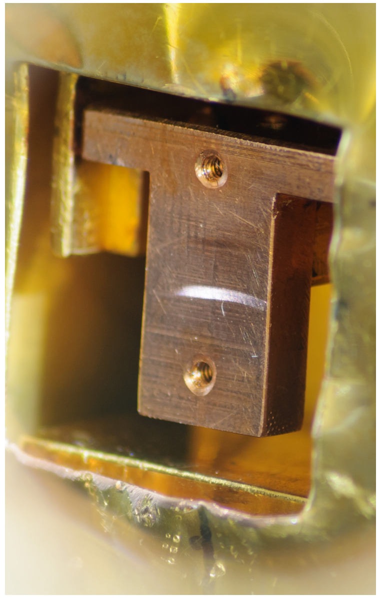


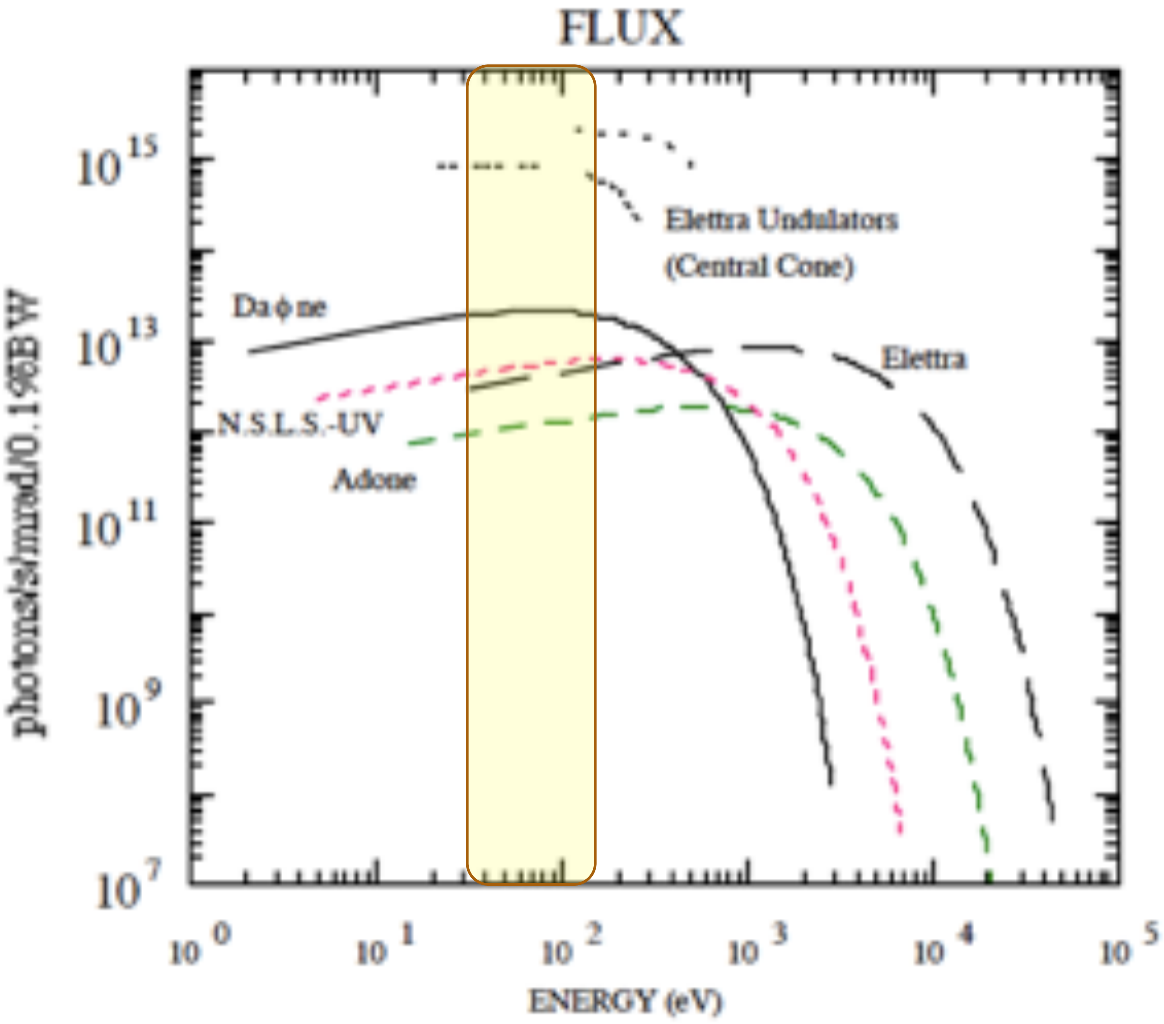
DAΦNE XUV Beamlines

Low Energy (30-150 eV)



White light
~ 1 μA
on sample
(to be optimized)

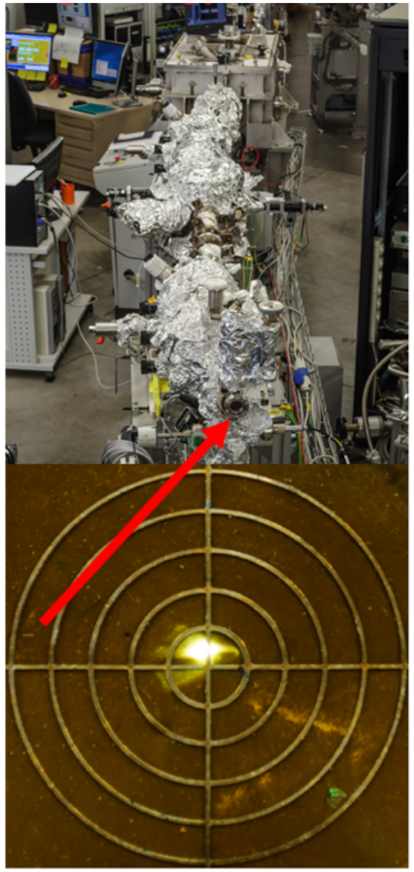


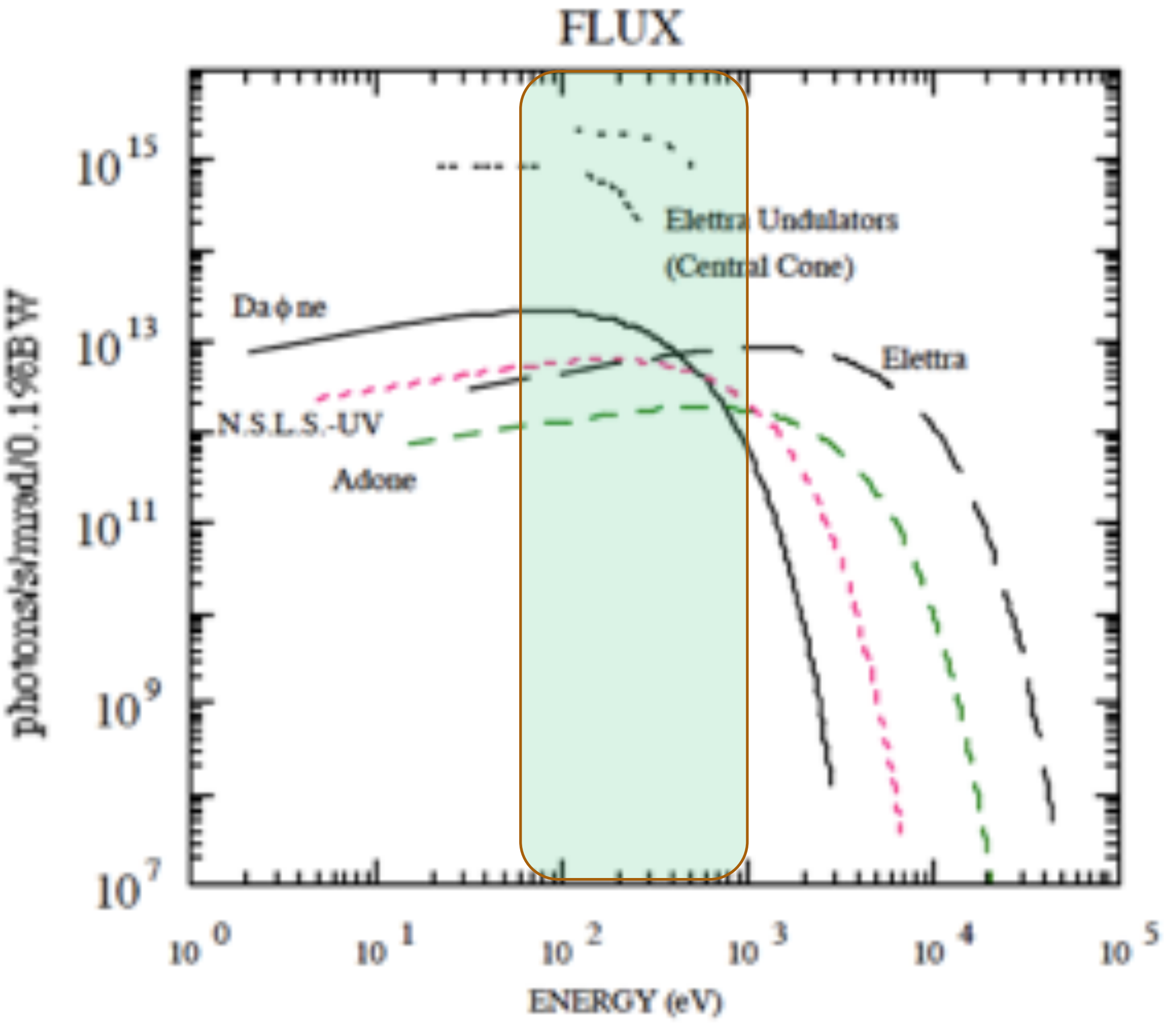


DAΦNE XUV Beamlines

High Energy (60-1000 eV)

White light
>50 μA
on sample





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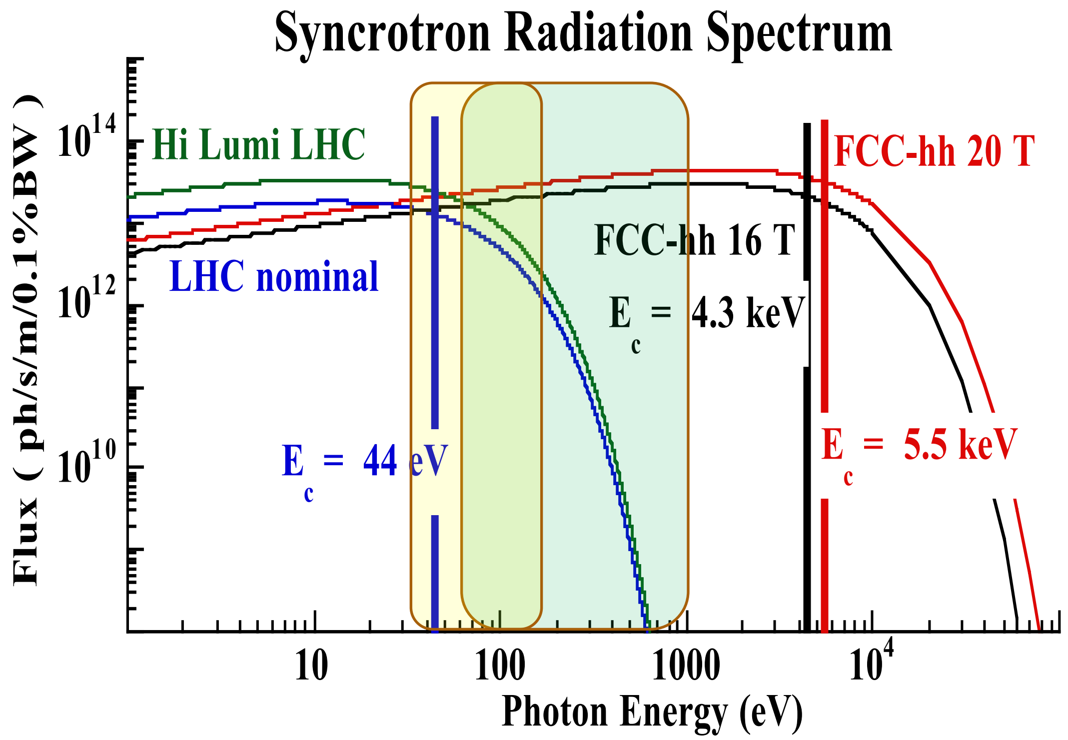
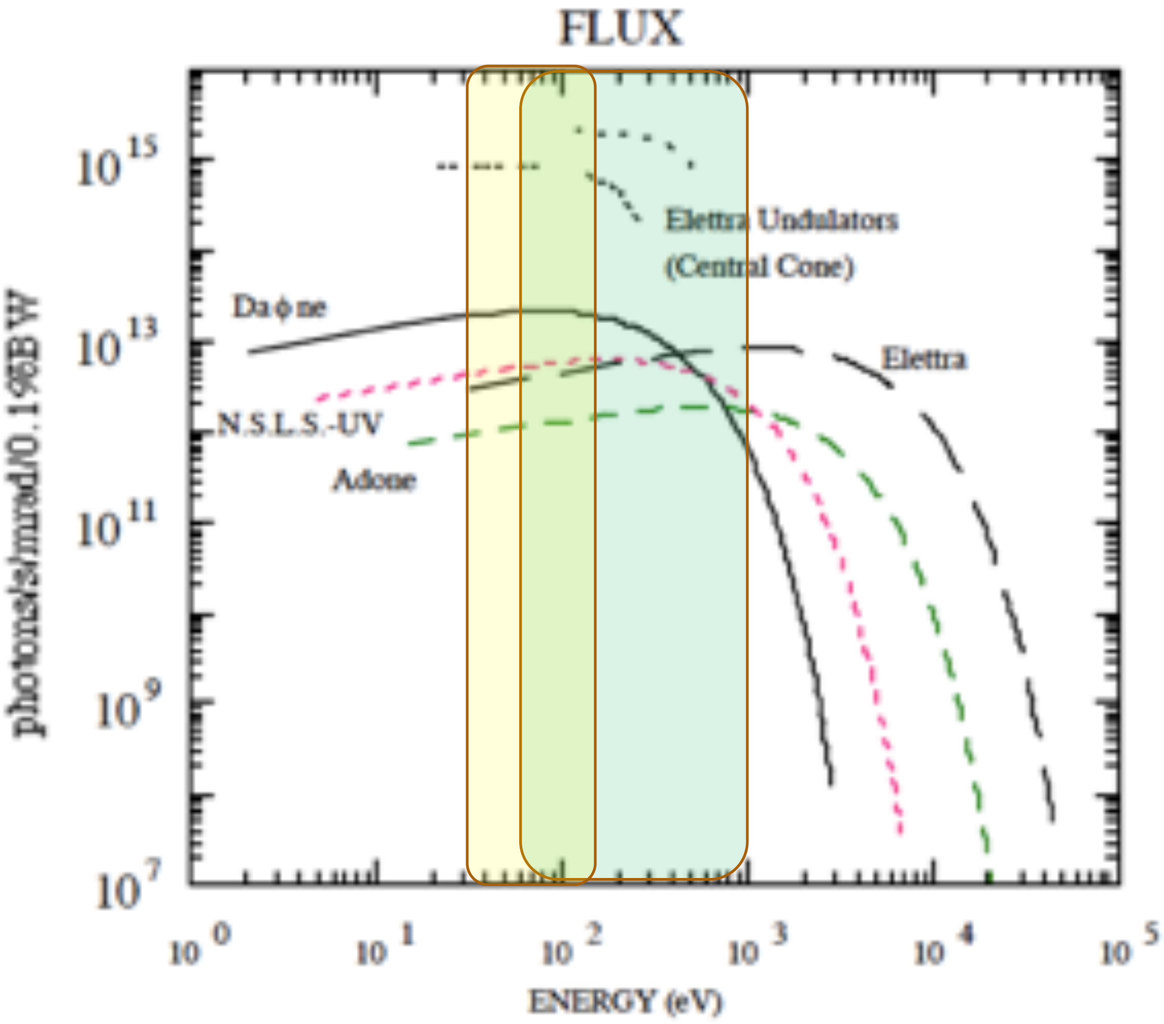




Photon Interaction

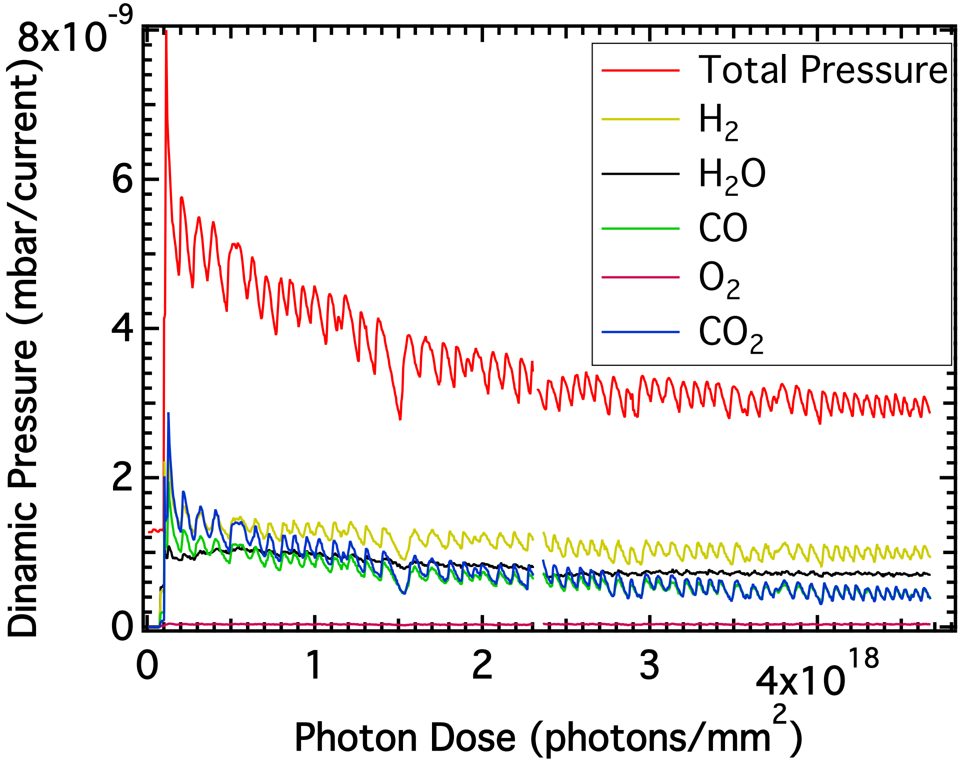
Photon Stimulated Desorption

Pressure Evolution

Surface Chemistry Changes

Photon / Electron Scrubbing comparison

Preliminary results on PSD from small samples @ DAΦNE



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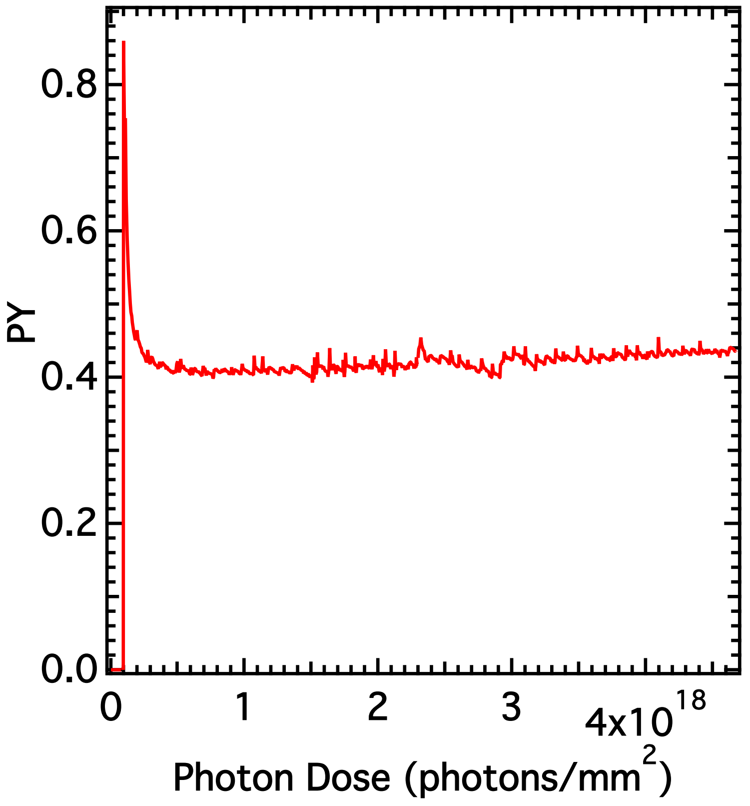


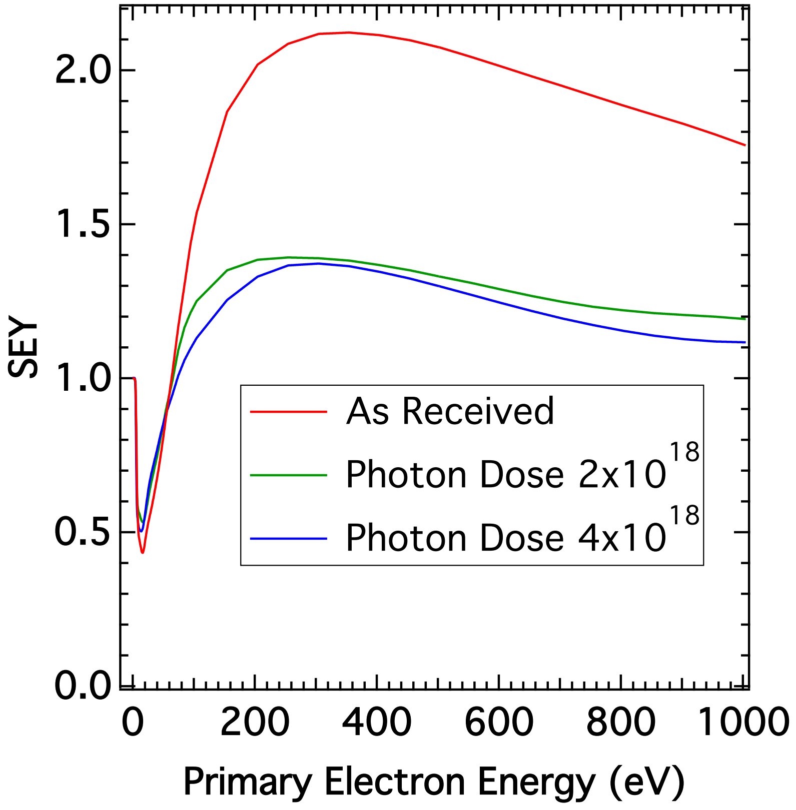
Photon Scrubbing

Surface Modifications

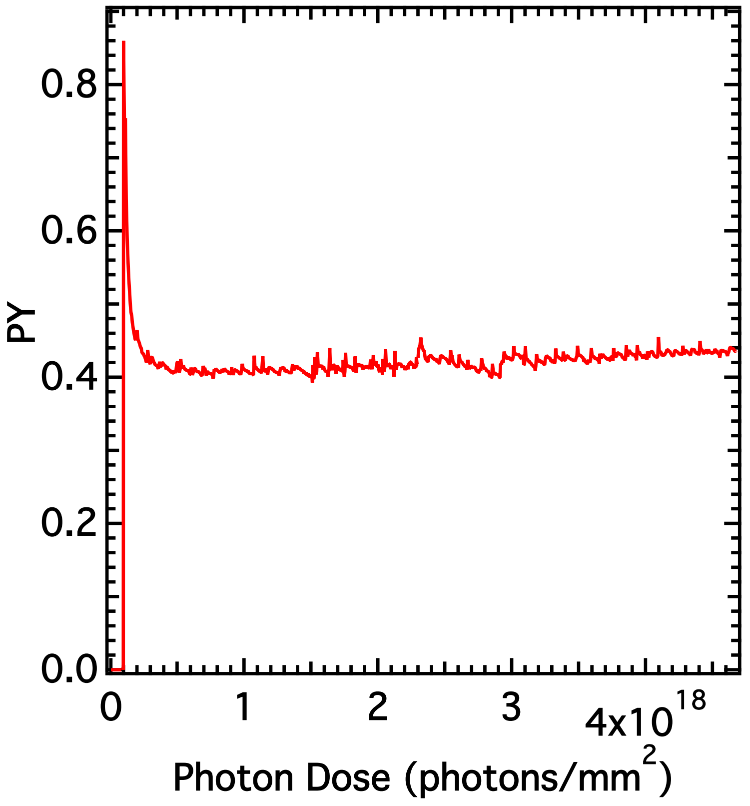
Photo Yield

SEY

Strong variation of surface conditions at "low dose"



Photon Interaction



Photon Scrubbing

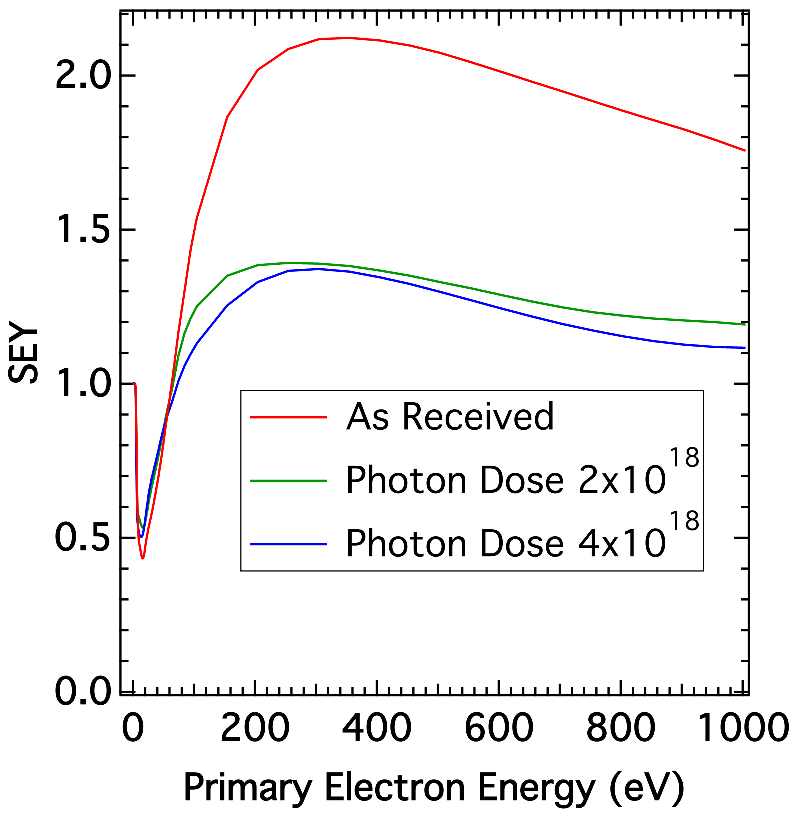
Surface Modifications

Photo Yield

SEY

Strong variation of surface conditions at “low dose”

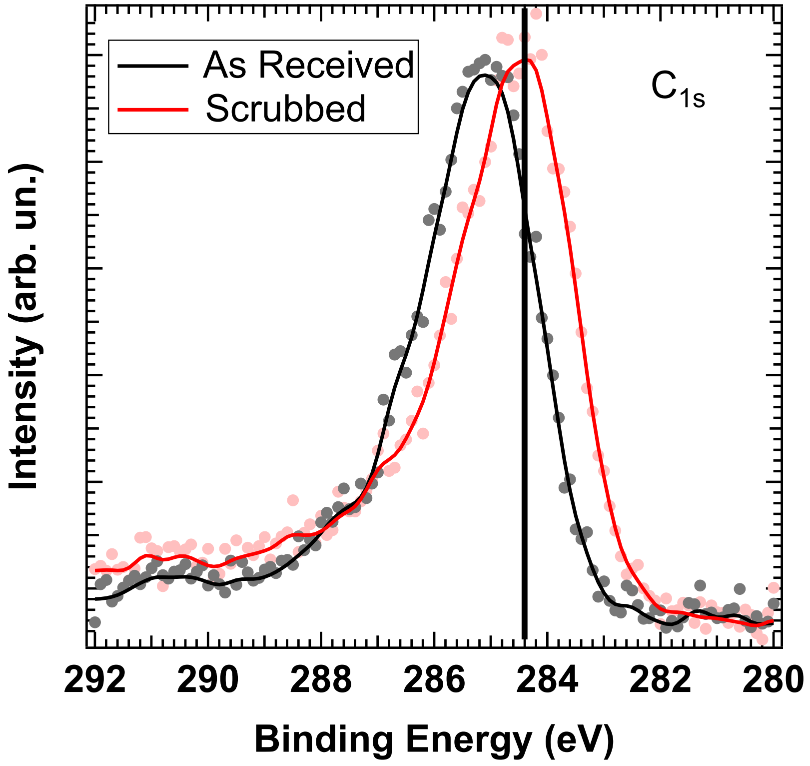
Slow variations at “high doses”



Finale State SEY=1.3

Photon Interaction

XPS

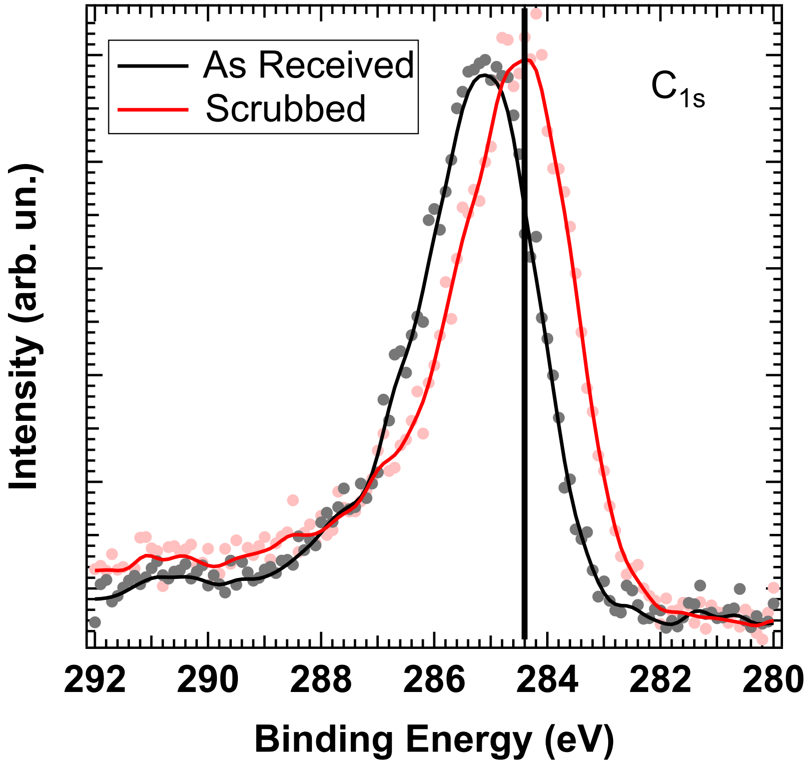


Surface Modifications

Modification of Carbon C-1s
From sp^3 to sp^2

Photon Interaction

XPS



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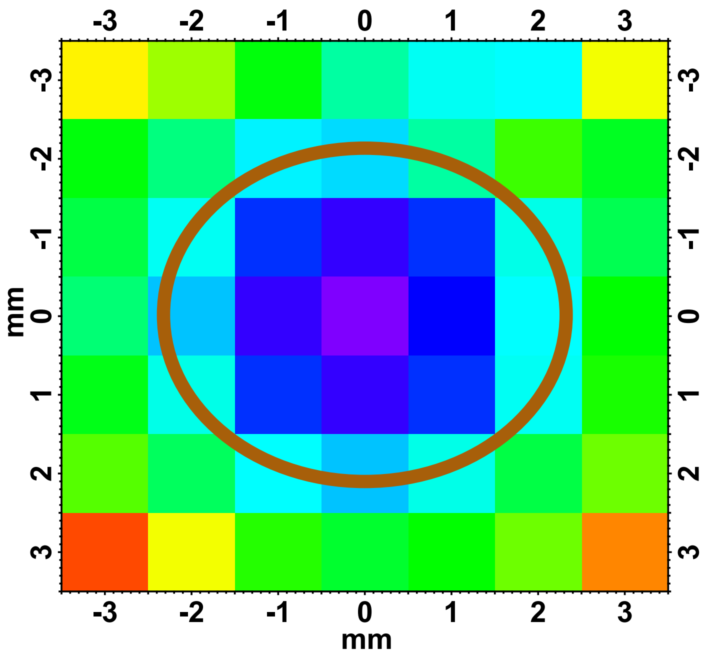
XPS Map

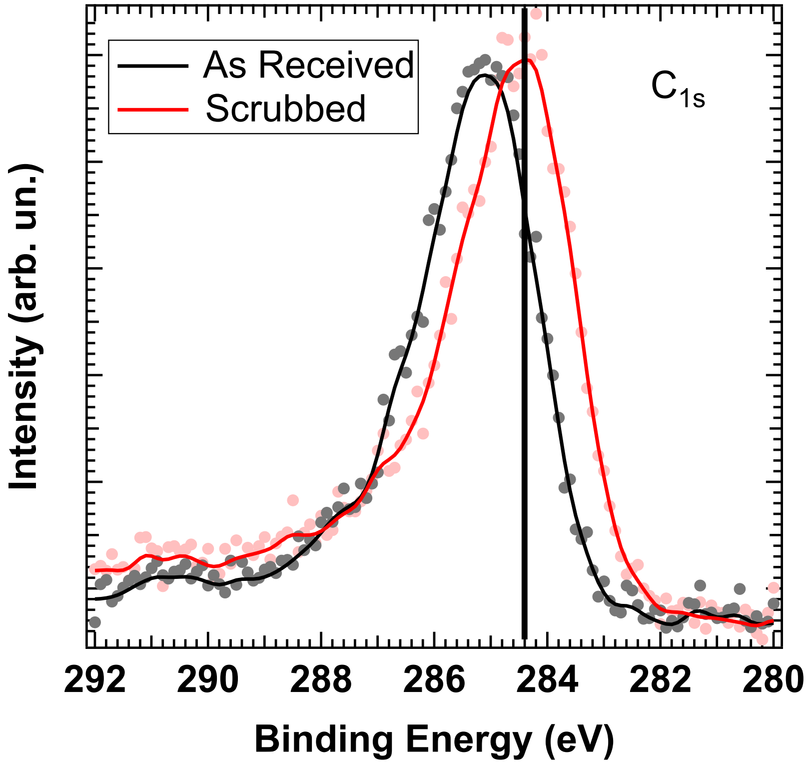


Scrubbing Area

Spot Dimension

Photon Interaction

XPS



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Modification of Carbon C-1s
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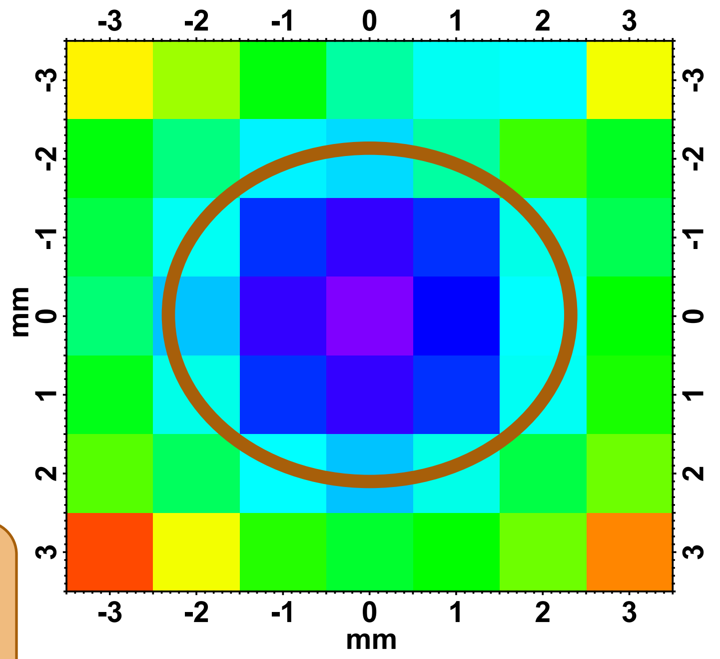
Same chemical process of Electron Scrubbing

XPS Map



Scrubbing Area

Spot Dimension

Photon Interaction

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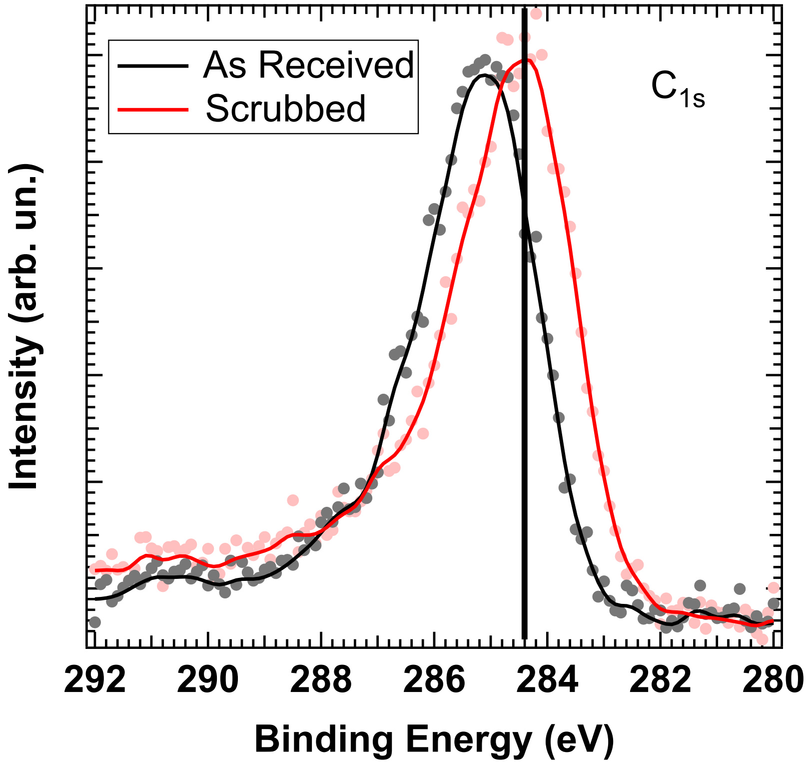

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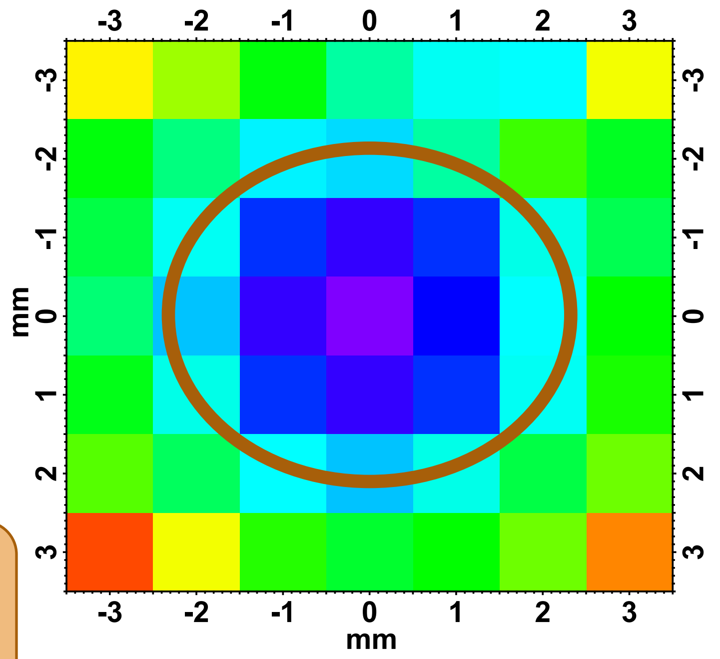
Final State?

XPS Map



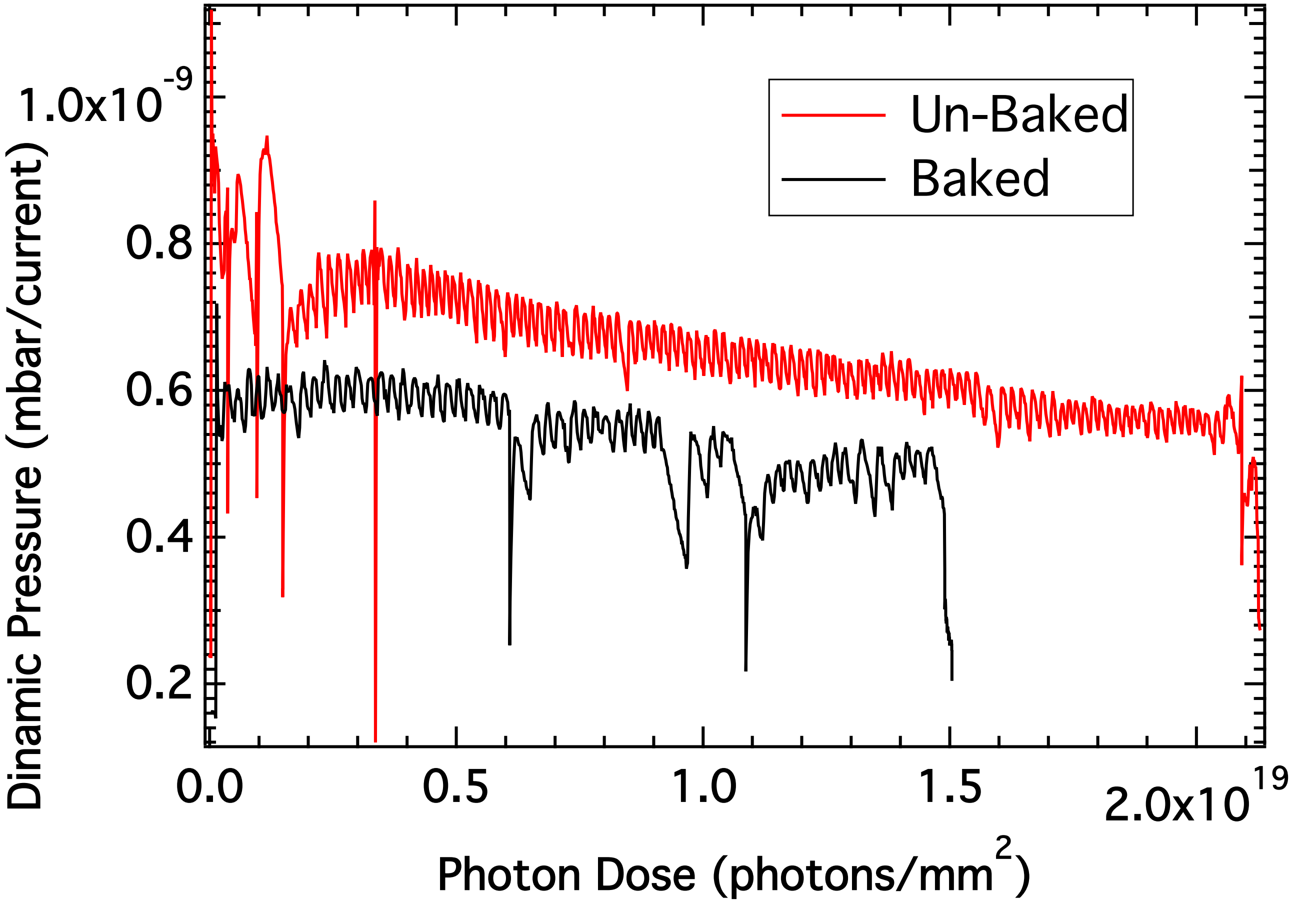
Scrubbing Area

Spot Dimension

Photon Interaction

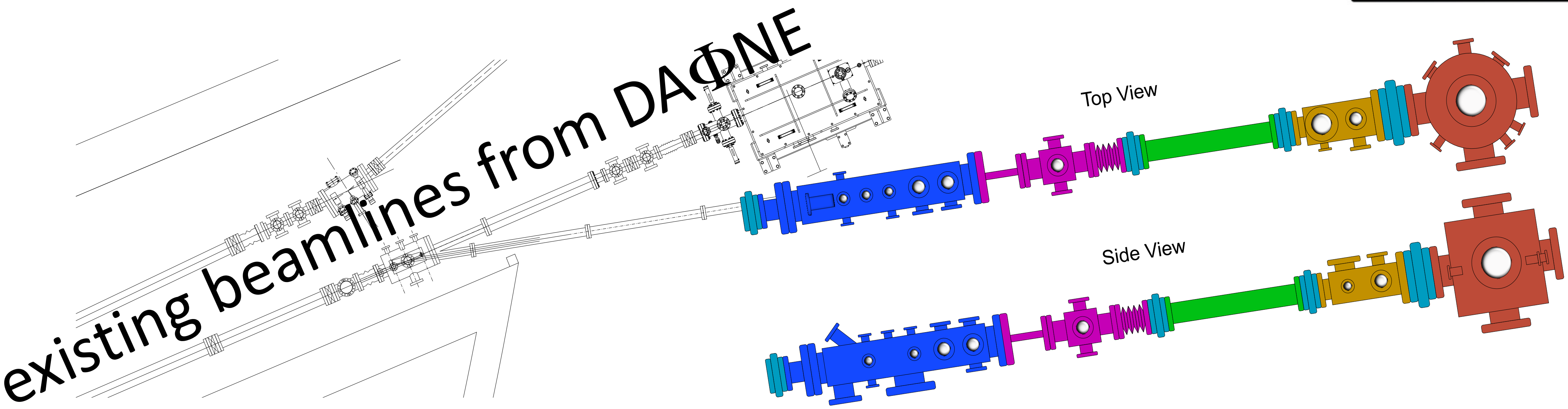
Different Desorption rate versus photon dose due to the surface contaminant and pre-conditioning

"In situ" sample controlled preparation



Temperature conditioning (baking) before Photon Stimulated Desorption

New Beamline



The goal (within a collaborative effort with CERN*) is to have a "White light" irradiation test facility to study desorption properties on long and real beam-pipes and to correlate such results with the one obtained on small samples

*KE3724/TE/HL-LHC-Addendum No.4 to Agreement TKN3083

Conclusions

Characterization of the sample studying different properties:

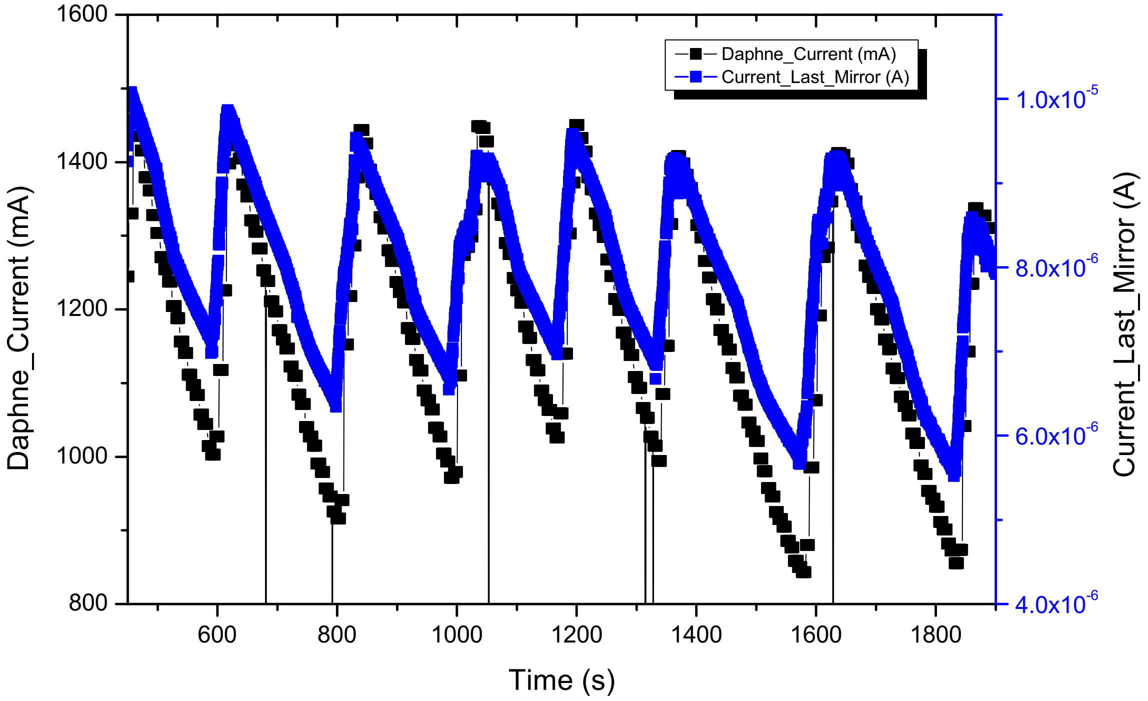
- Photon and Electron Stimulated Desorption
- Photon Yield
- Secondary Electron Yield
- X-Ray Photoemission

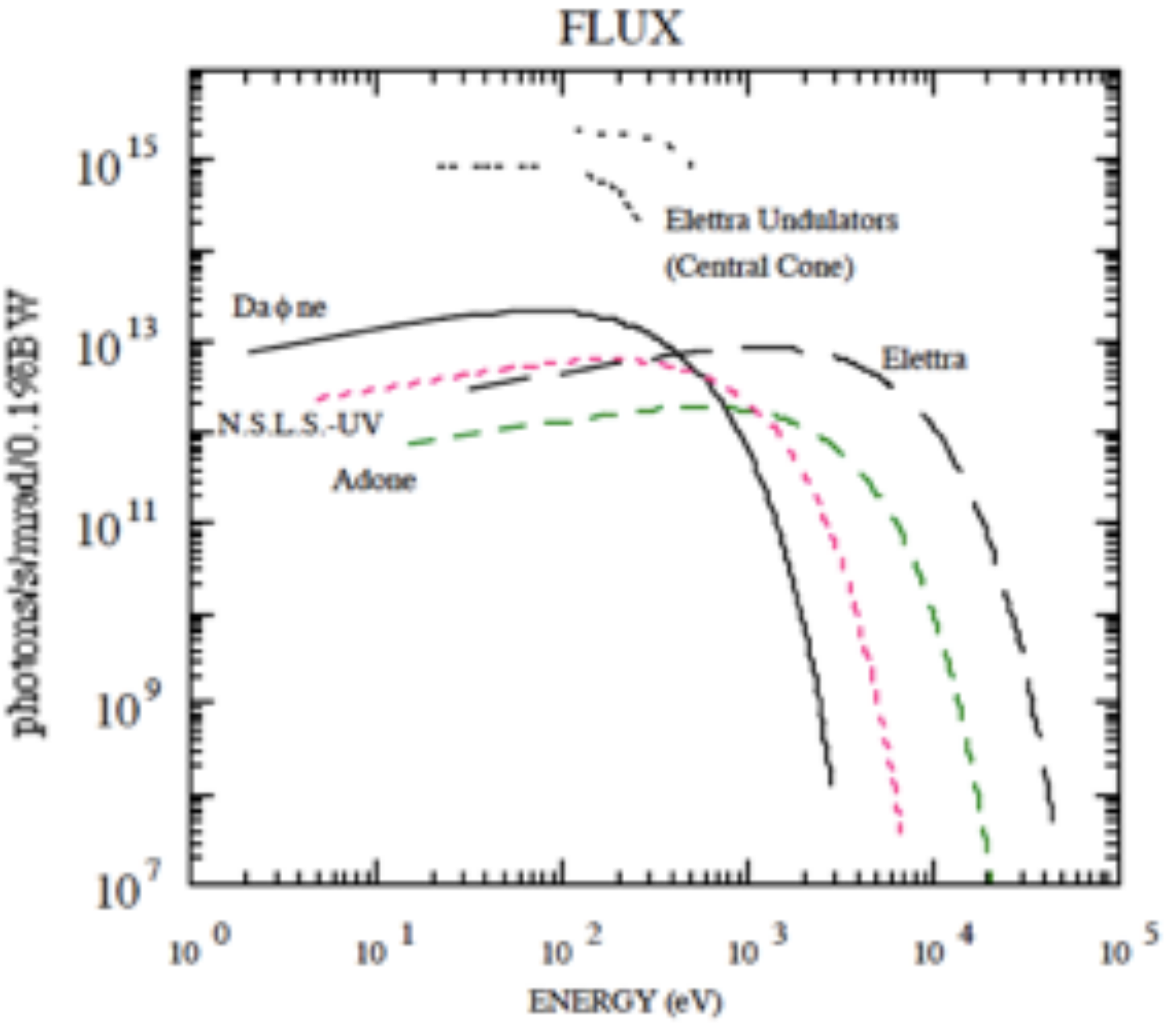
Conclusions

- Study samples as close as possible to the real system
- Study the difference between electron and photon scrubbing

Thank You for Your Attention

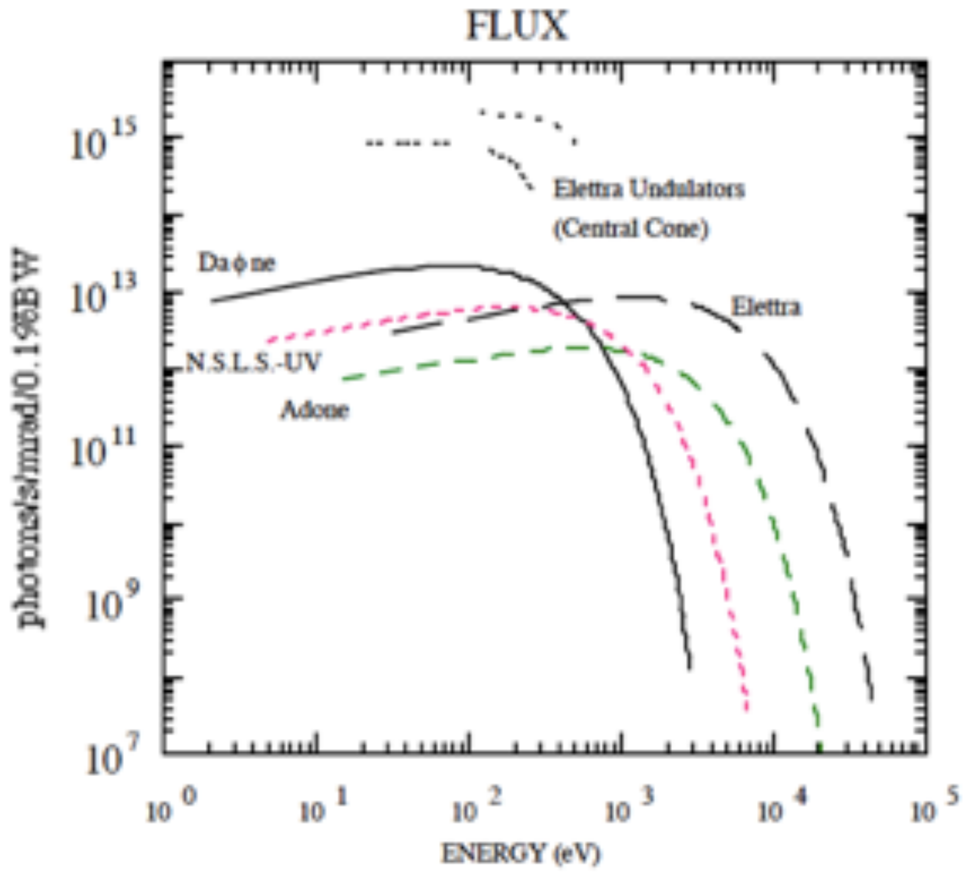
DAΦNE

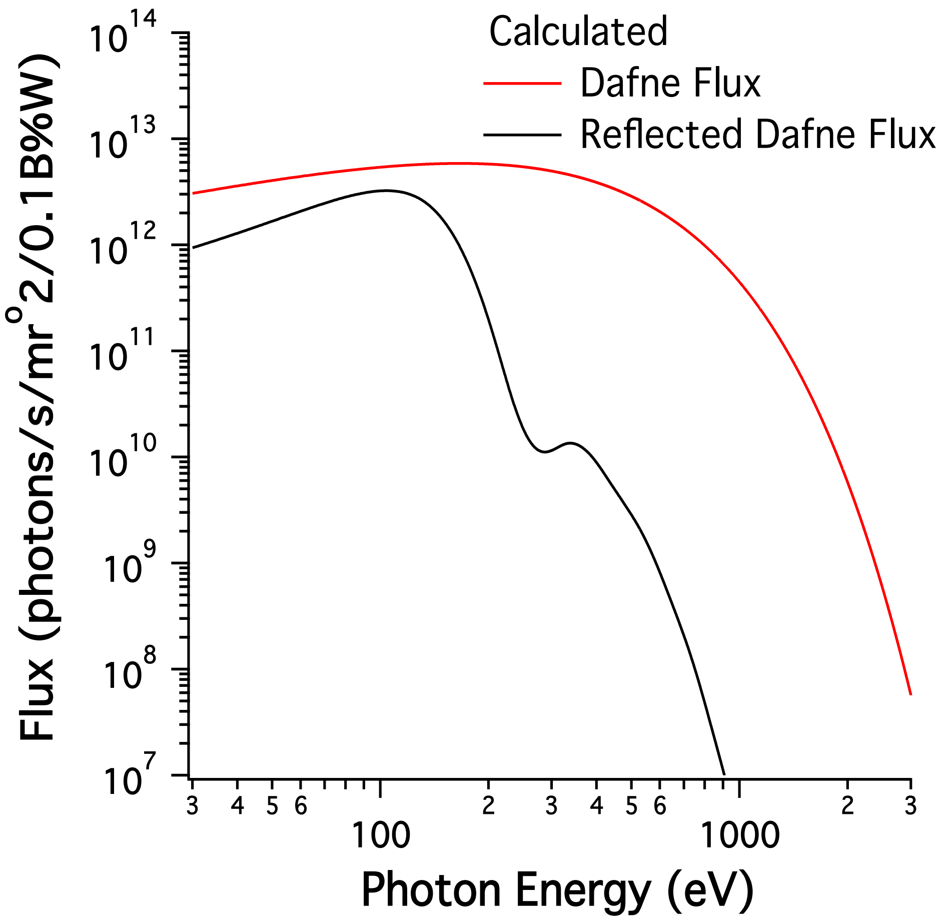




High e⁻ Current

DAΦNE

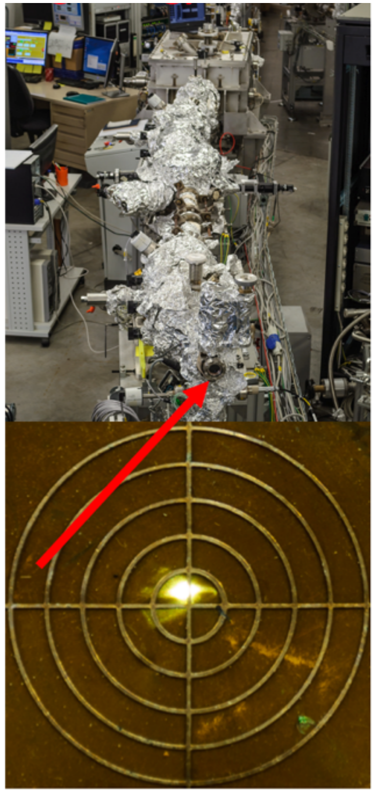

FLUX
Elettra Undulators
(Central Cone)
Da ϕ ne
Elettra
N.S.L.S.-UV
Adone
photons/s/mrad/0.1%BW
ENERGY (eV)


Calculated
Dafne Flux
Reflected Dafne Flux
Flux (photons/s/mr°2/0.1B%W)
Photon Energy (eV)

XUV Beamlines @ LNF

White light
>50 μA
on sample

High Energy
(60-1000 eV)



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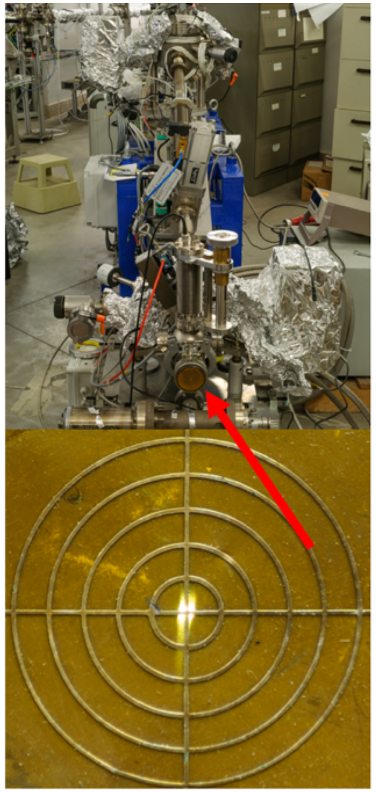

White light
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