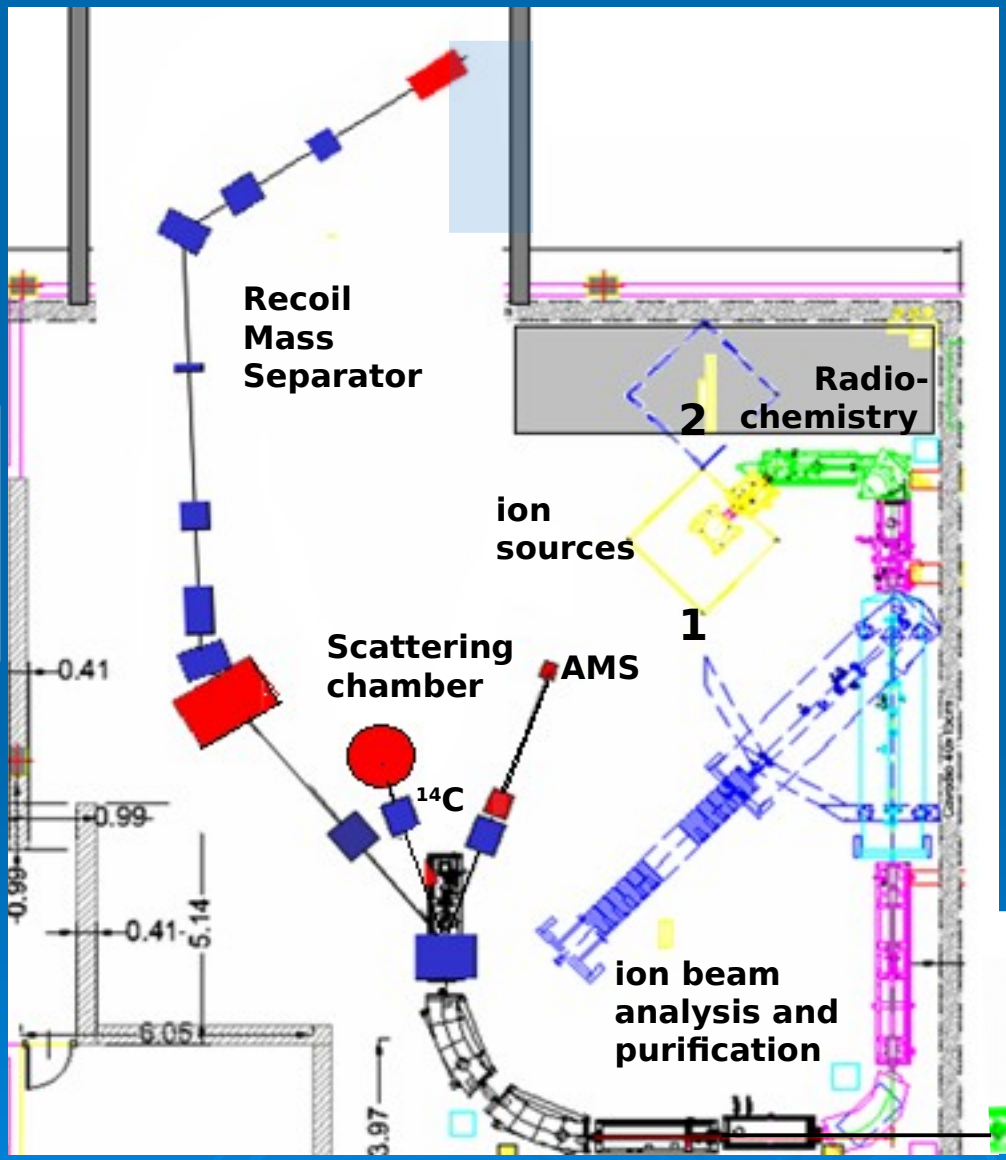
Nuclear physics applications with ion beams

L. Gialanella University of Campania Vanvitelli and INFN Napoli

CIRCE
Tandem Accelerator Lab
(UCV/INNOVA)
3MV Pelletron



http://www.circe.unicampania.it/

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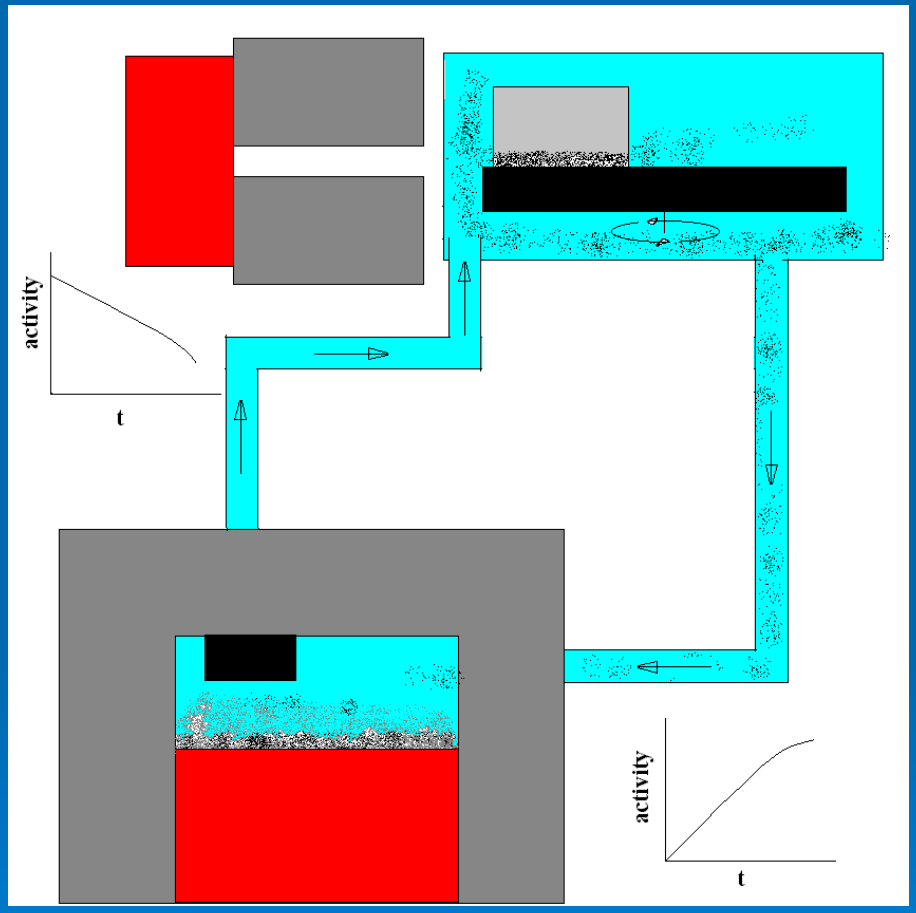
Radiochemistry Laboratory

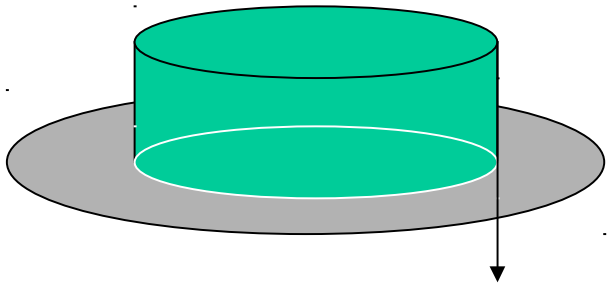
Radioactive ion beam injector

Wear measurement using radiotracers

Residual activity



Removed activity

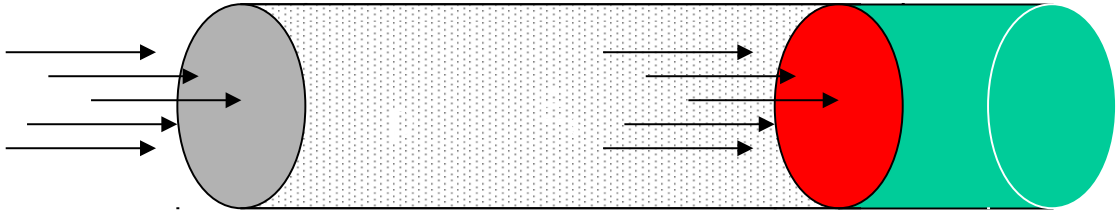


Implantation profile: dN/dz

Wear speed: dz/dt

Activity variation:

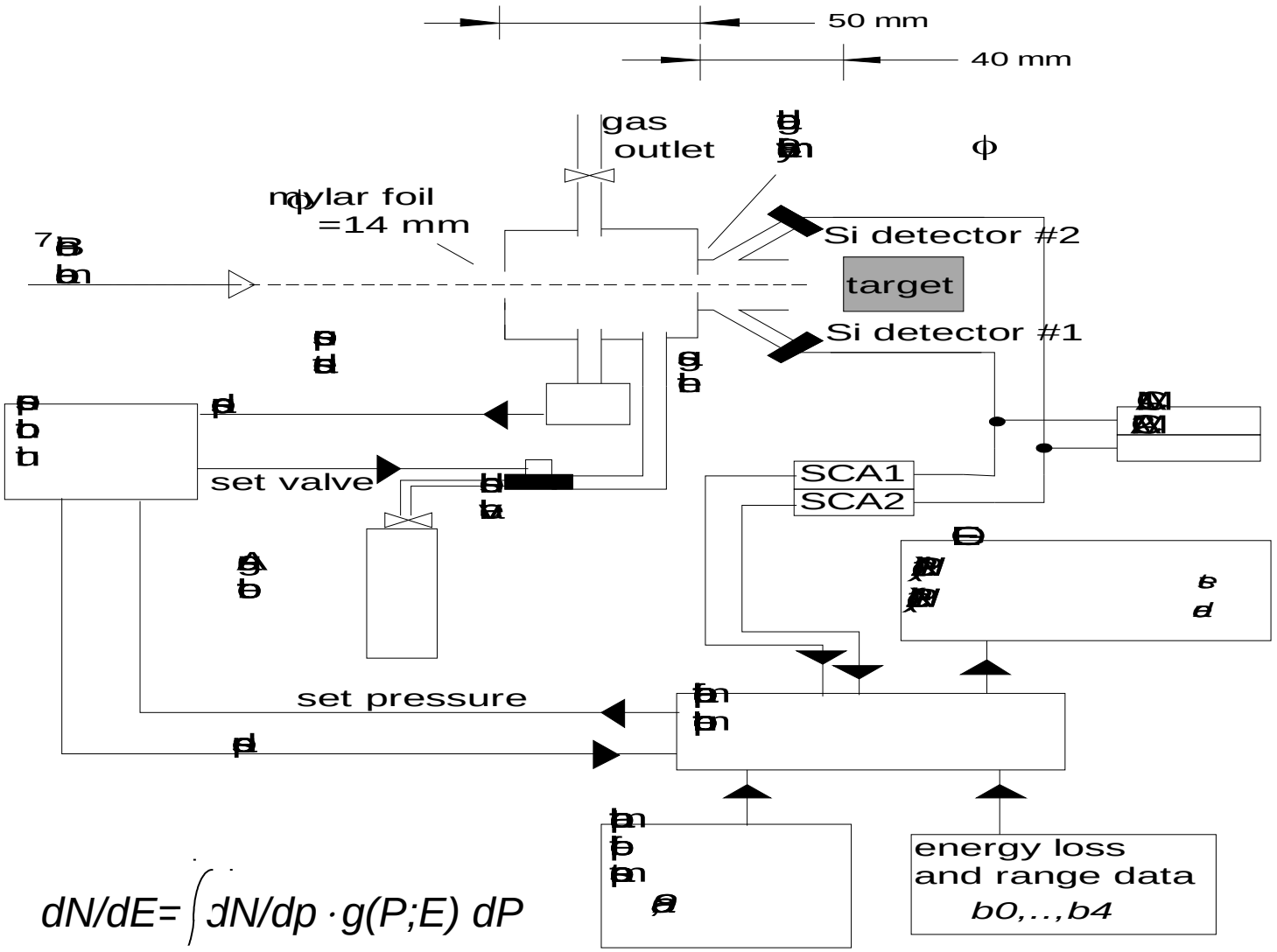
$dA/dt = \varepsilon \cdot dN/dz \cdot dz/dt$



$$dN/dz = \int dN/dE \cdot f(z;E)\, dE$$

$\cdot f(z;E)$ *ion range distribution at incident energy E*

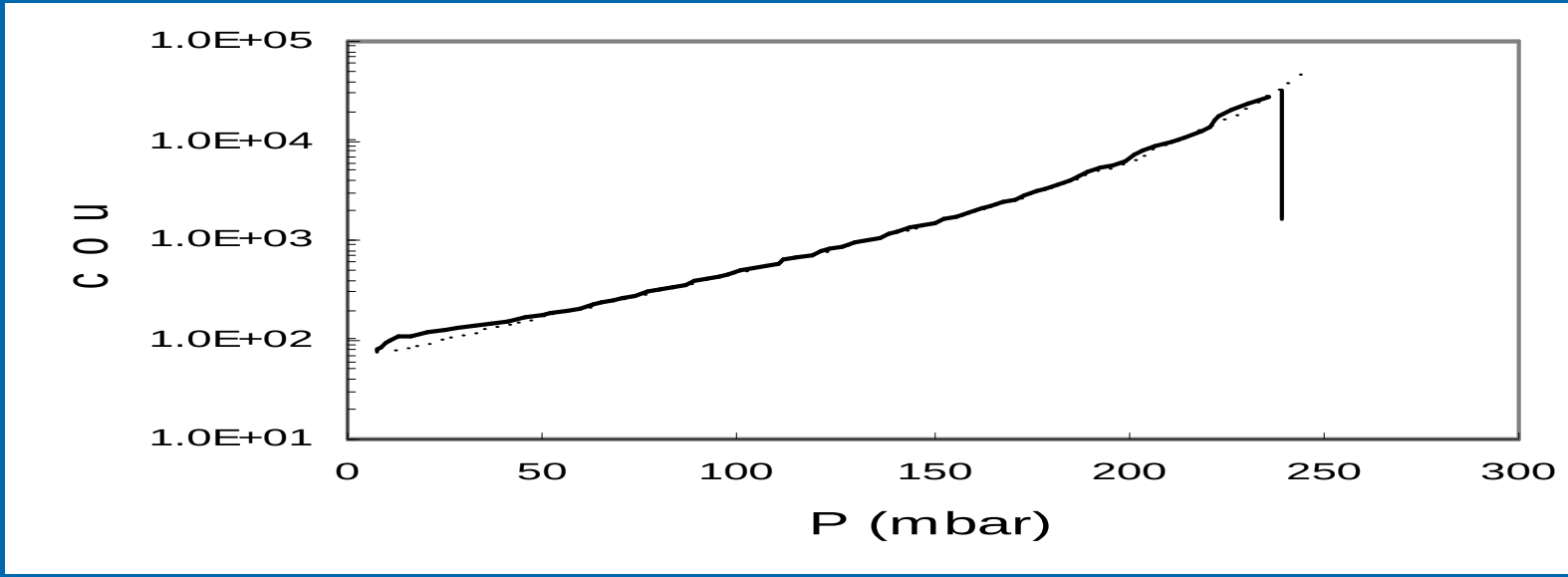
Depth profile control : gas degrader

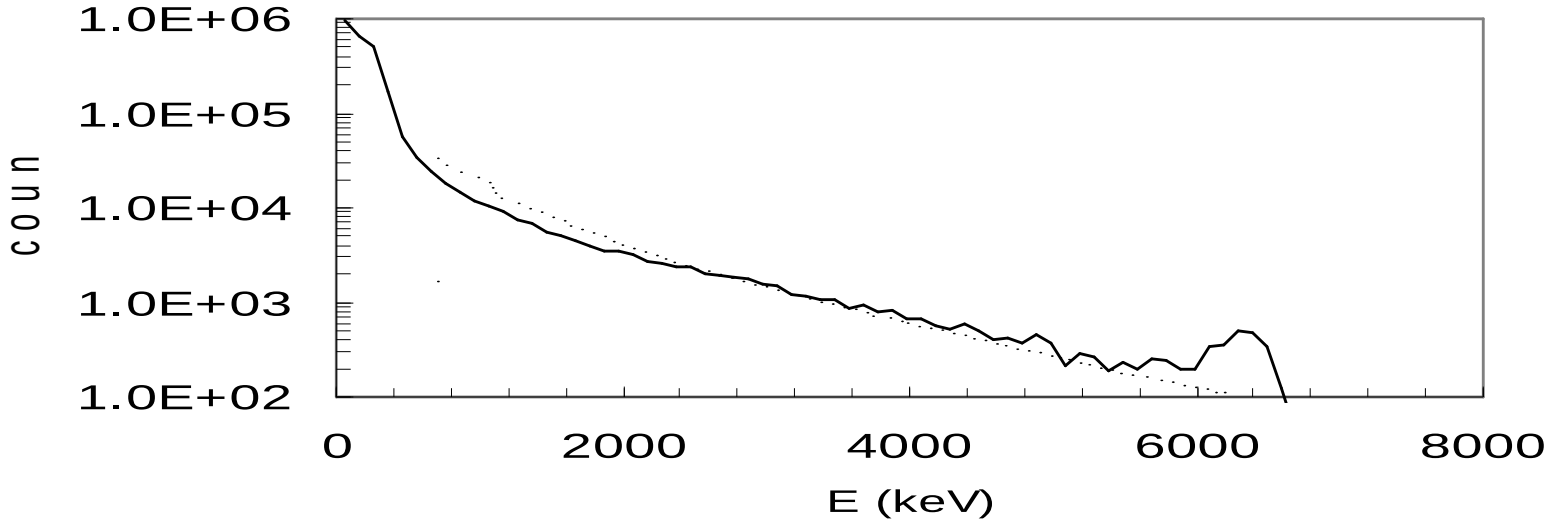


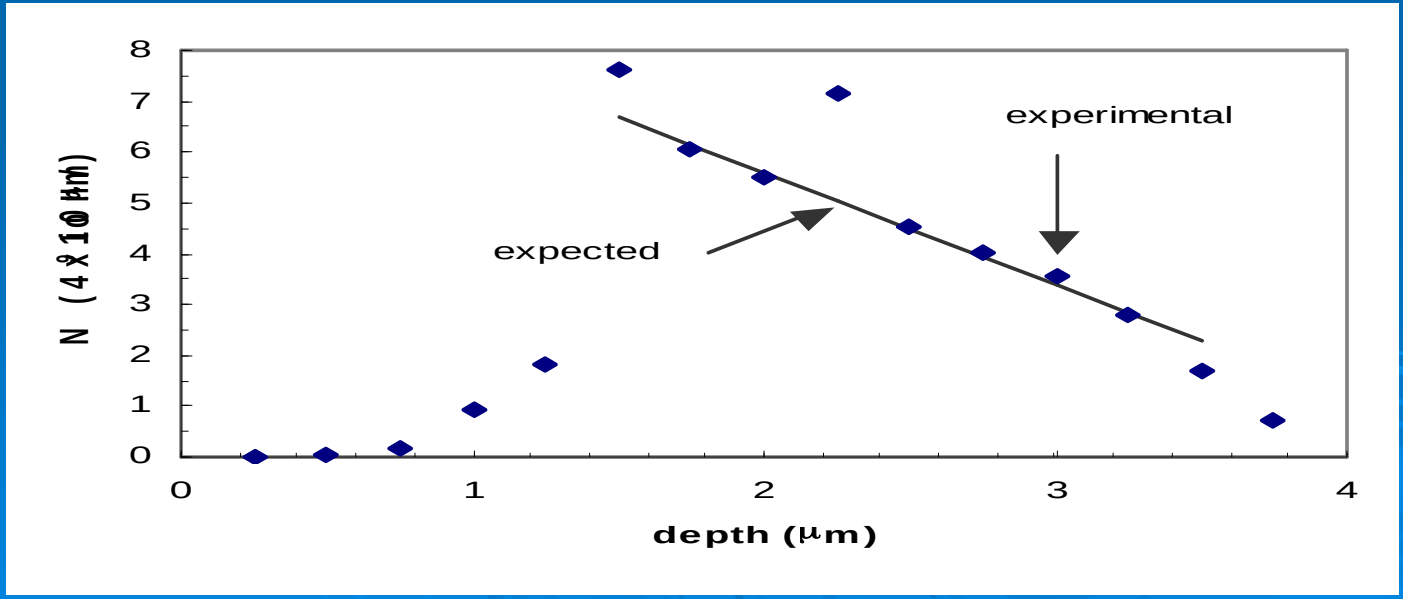
$$dN/dE = \int dN/dp \cdot g(P;E)\, dP$$

g(P;E) ion energy distribution at pressure P and incident energy E_0

g(P;E) ion energy distribution at pressure P and incident energy E_0


1.0E+05
1.0E+04
1.0E+03
1.0E+02
1.0E+01
coun
0
50
100
150
200
250
300
P (mbar)


1.0E+06
1.0E+05
1.0E+04
1.0E+03
1.0E+02
coun
0
2000
4000
6000
8000
E (keV)


8
7
6
5
4
3
2
1
0
0
1
2
3
4
experimental
expected
depth (μm)

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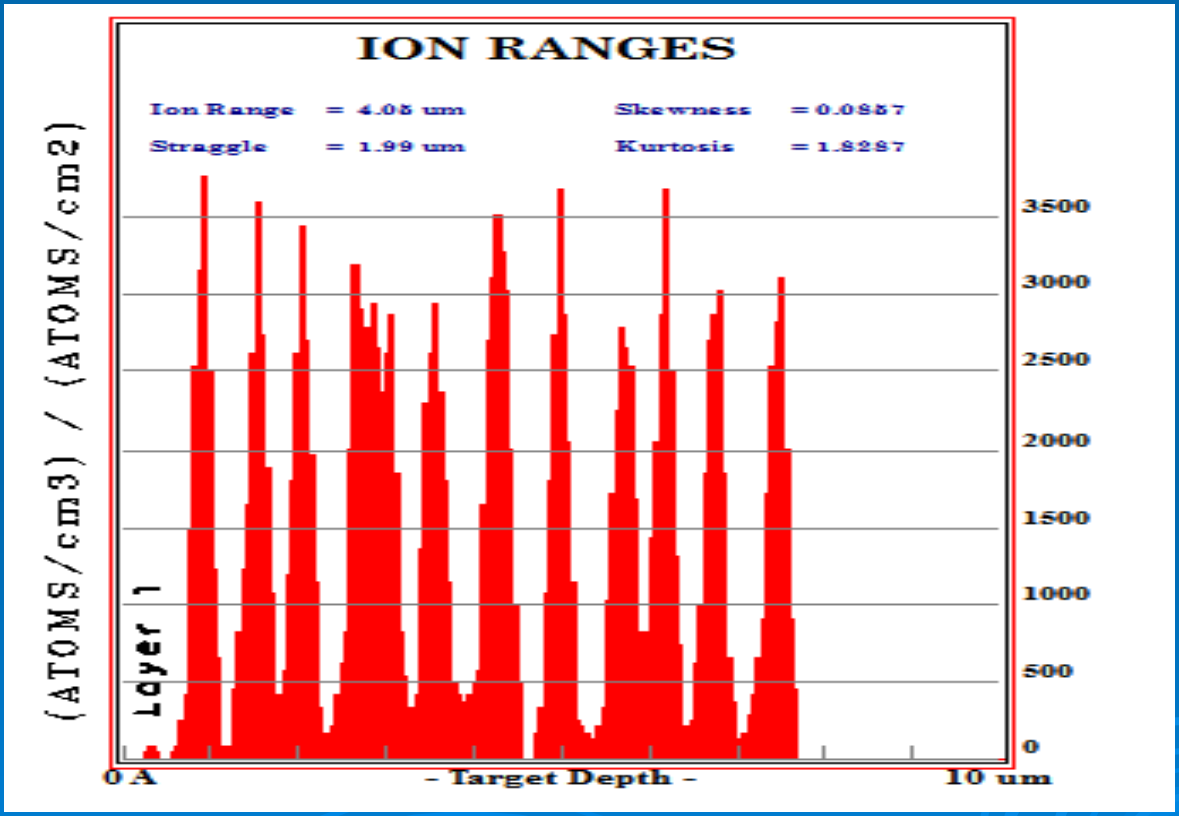
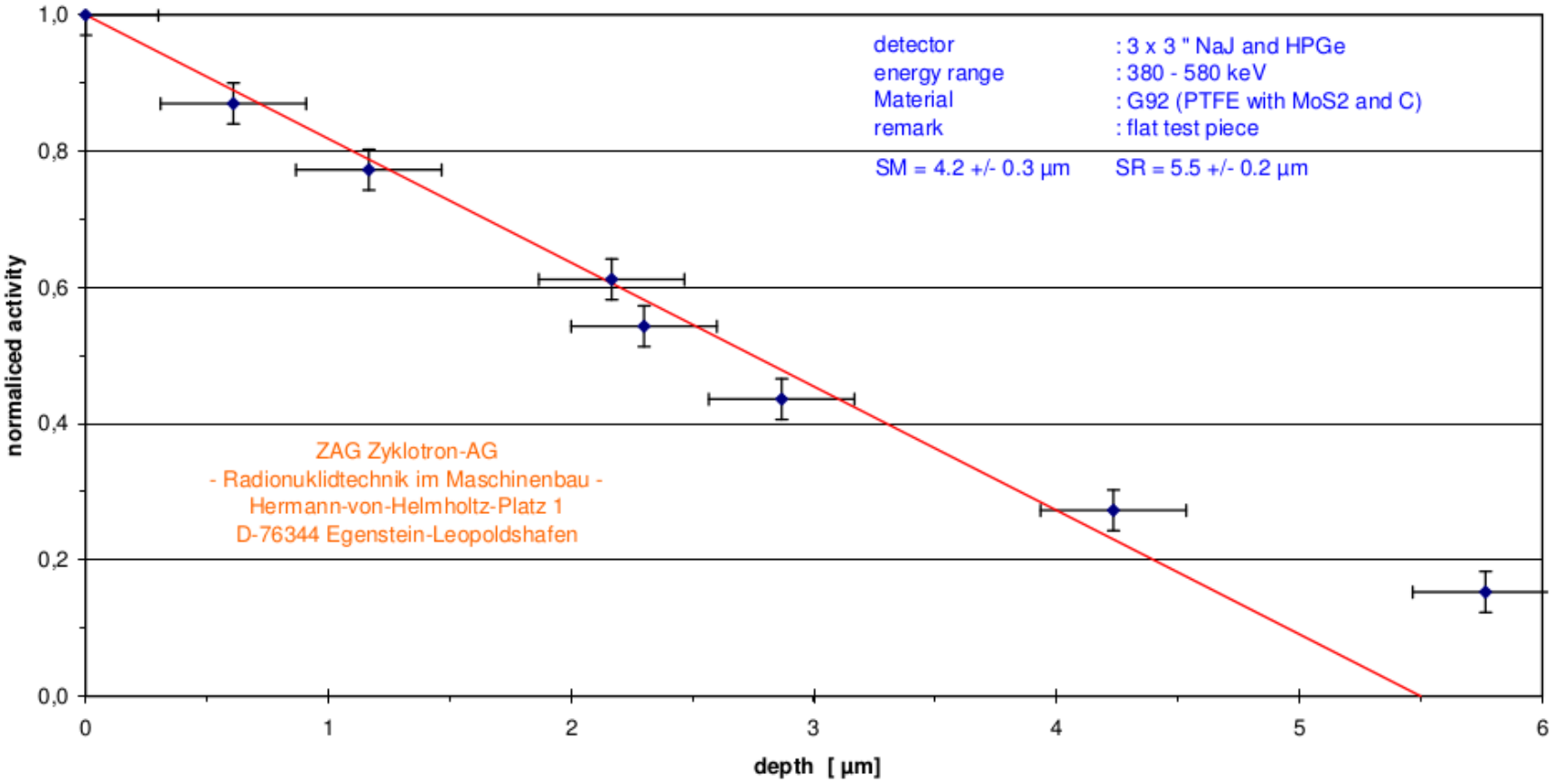
Depth profile control : foil degraders+beam energy change



Depth profile

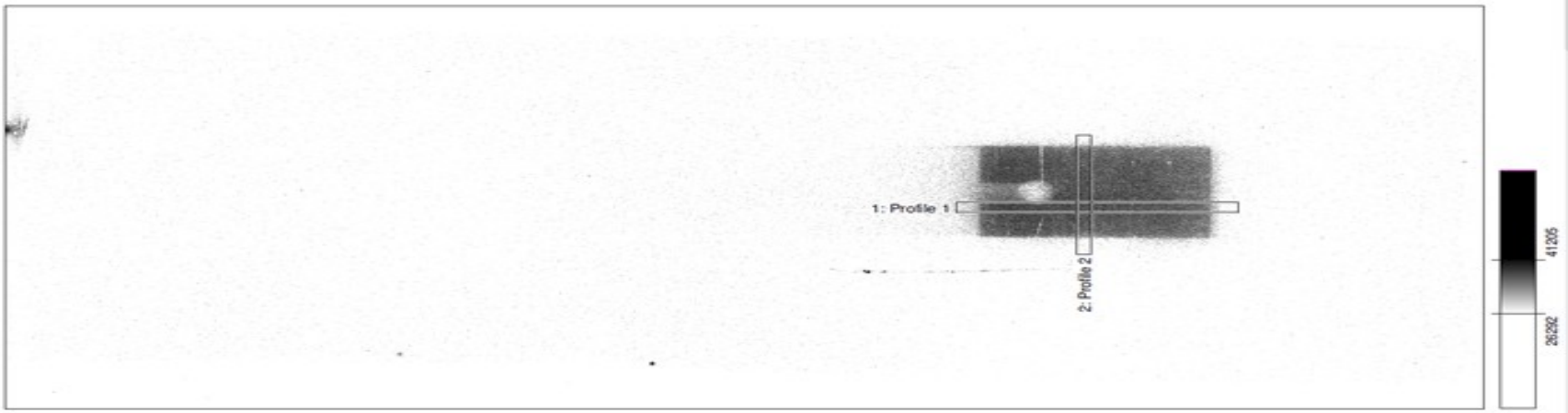


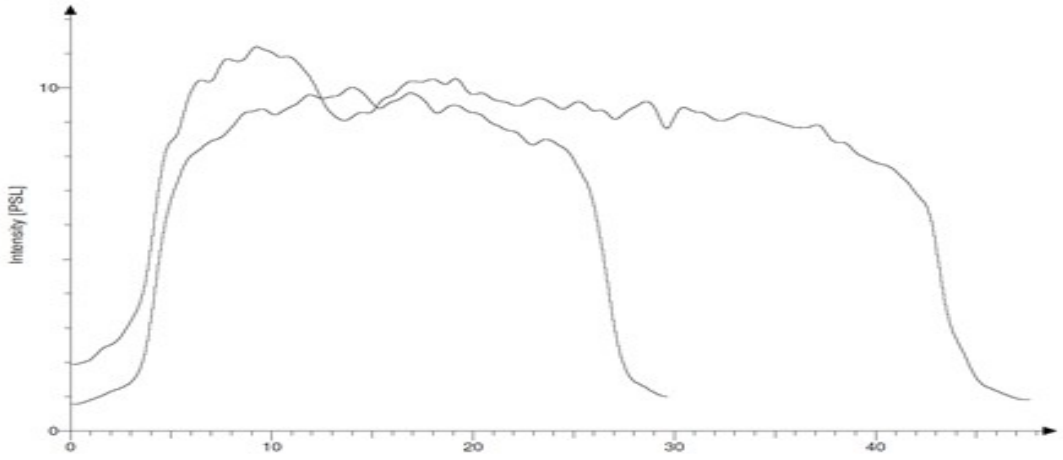
Courtesy ZAG

Imaging plate type: 20*40
Scanner: Fuji BAS 2500
Sensitivity: 10000
Latitude: 5

Comment: 112104

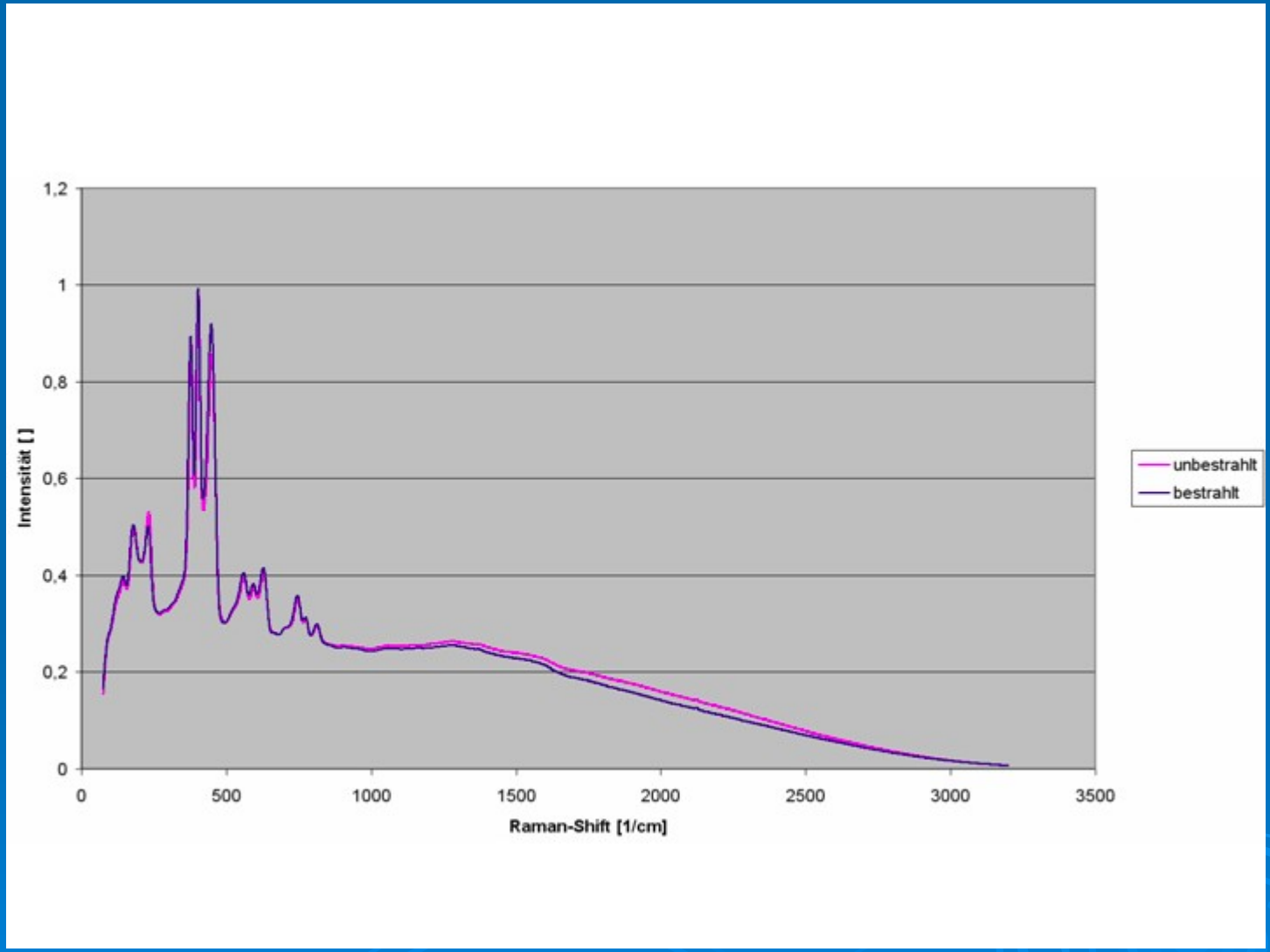
Digital resolution: 65536, 16 bit per pixel
Image size: 2000*5000, 100.00mm*250.00mm
Pixel size: 50µm*50µm





Courtesy ZAG

Raman spectroscopy on PTFE



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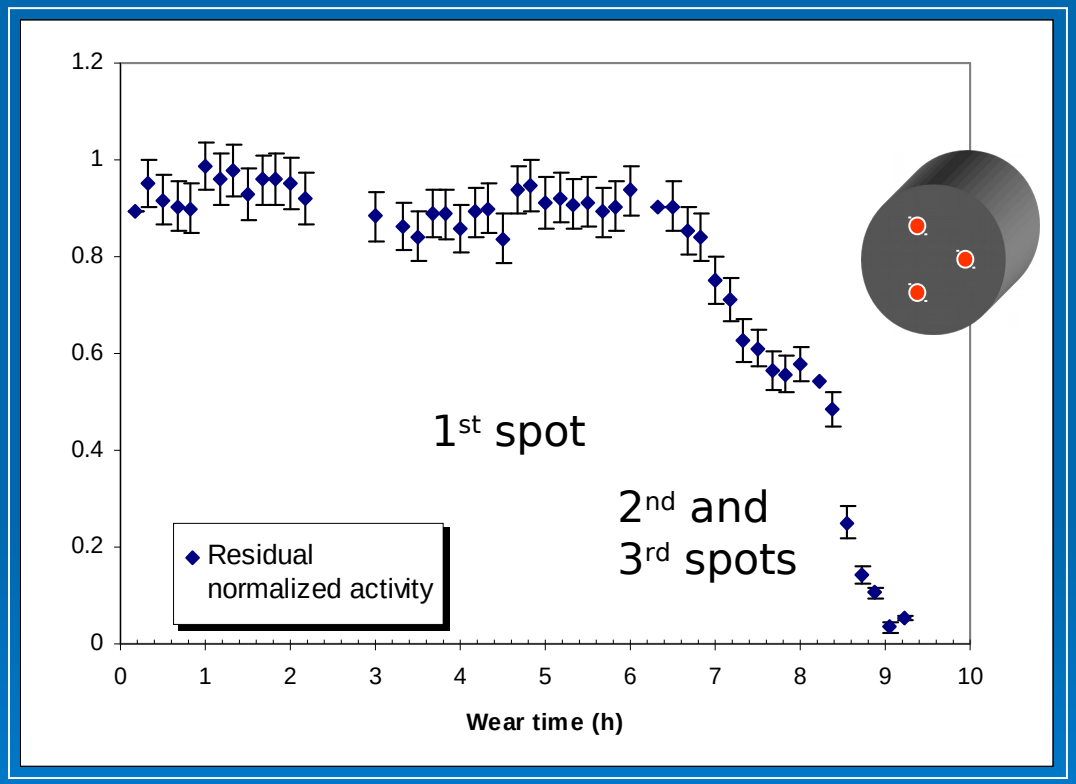
Characterization of hardening processes



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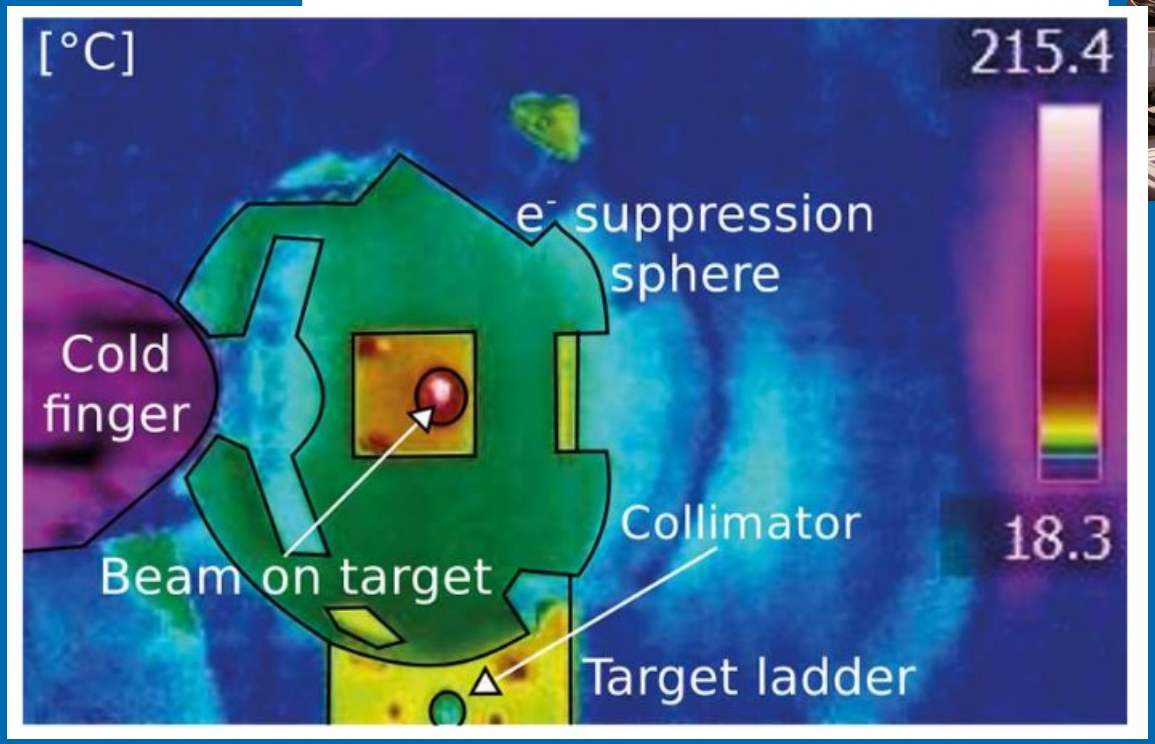
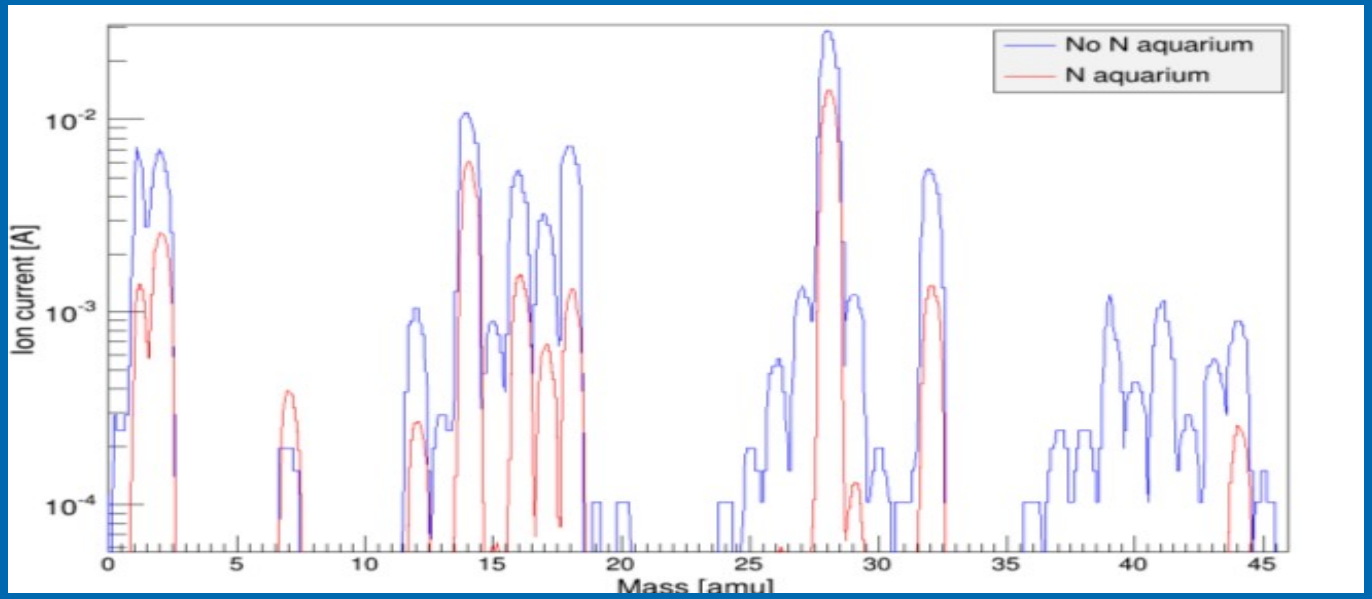
Target material investigation

- 2 stage (Gas-Si) detector array GASTLY
  - Si strip detector array
  - cooled solid target
  - IBA
  - rest gas mass spectrometry
  - thermografy



Hydrogen content as a function of target temperature and rest gas composition



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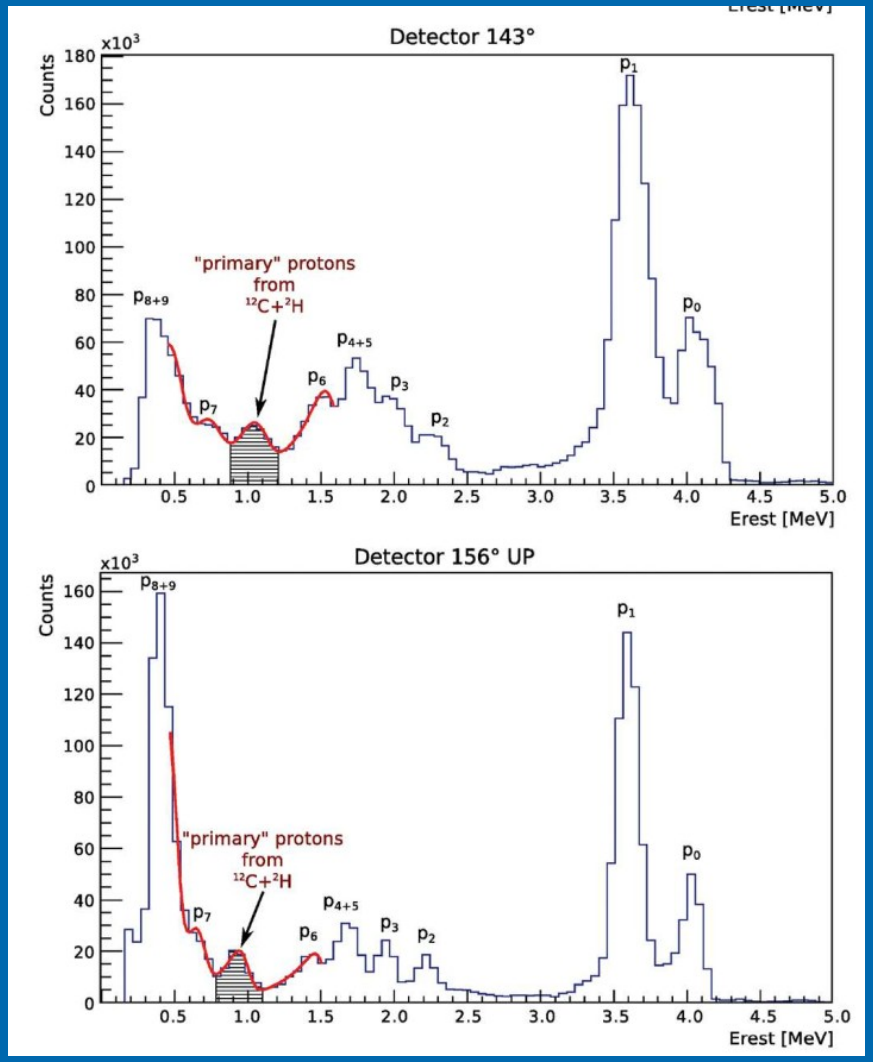
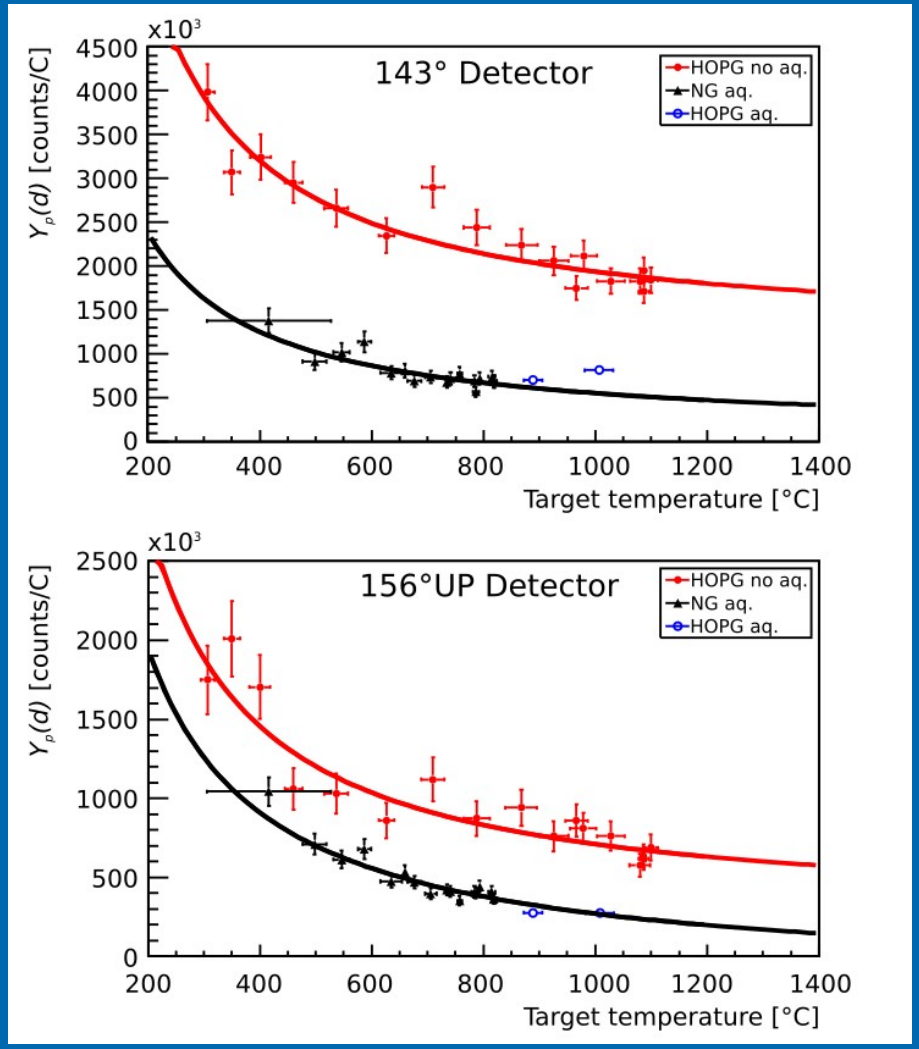
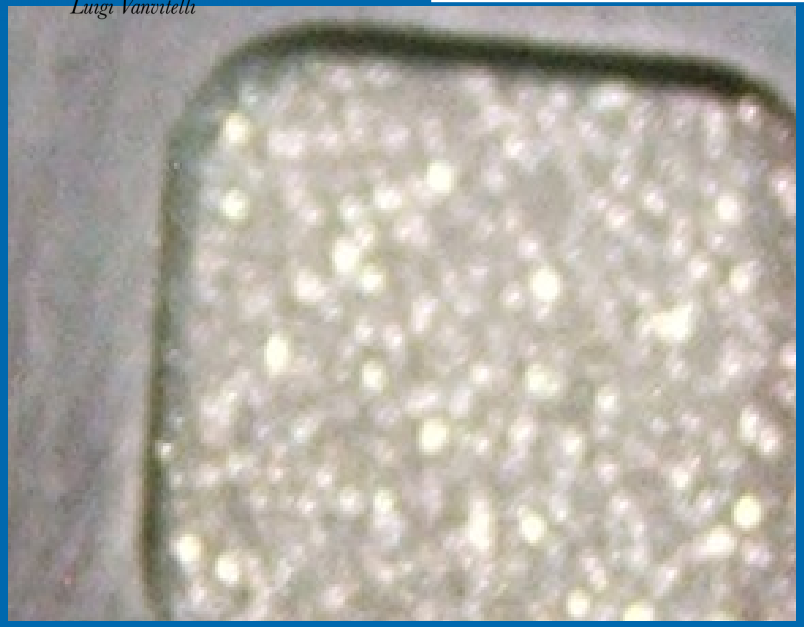


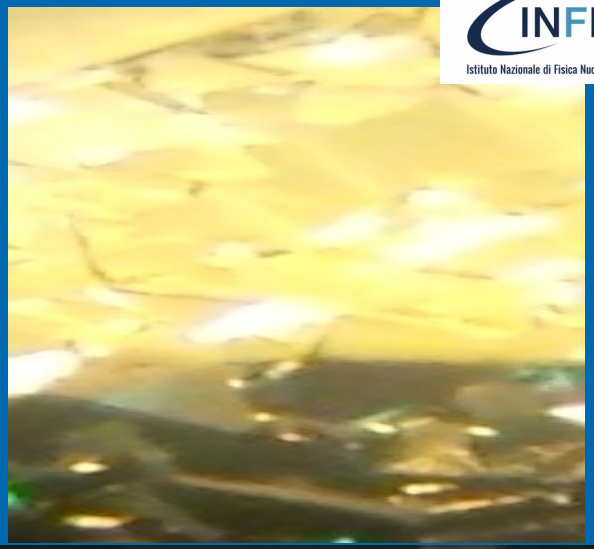


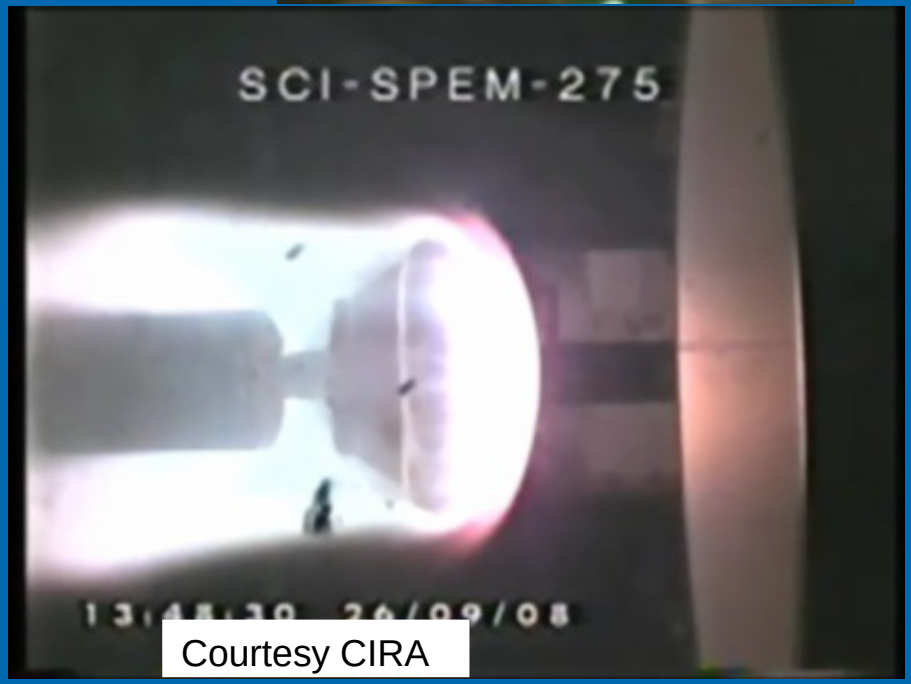
Reduction of deuterium content in carbon targets for $^{12}C + ^{12}C$ reaction studies of astrophysical interest

Eur. Phys. J. A (2018) **54**: 132
DOI 10.1140/epja/i2018-12564-8

Midas touch: from diamond to graphite







Courtesy CIRA

Outlook

- radioactive ion implantation, possibly assisted by IBA, is an attractive alternative to activation (sensitivity, accuracy, radioprotection, radiation damage)

- possible new developments: new nuclides, sensors

- higher energy, deepest implantation, that is necessary in some applications

- possible reuse of by-products of production targets or beam dumps (e.g. see Erawast-PSI)

R. Buompane, A. Di Leva, A. D'Onofrio, L. Gialanella,
F. Marzaioli, M. Romoli, F. Terrasi

+

12C+12C
M. Aliotta, C. Bruno, T. Davinson, G. Imbriani, L. Morales

7Be+p
Zs. Fulop, G. Gyurky, E. Somorjai

Aerospace diagnostics
A. Del Vecchio, M. De Cesare, F. De Filippis

Wear measurements
J. Daul, H. Schweickert