

EXPANDING EXPERIMENTAL CAPABILITIES FOR SOLID-STATE PHYSICS AT ISOLDE

The upgraded ASPIC and ASCII setup

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University of Göttingen

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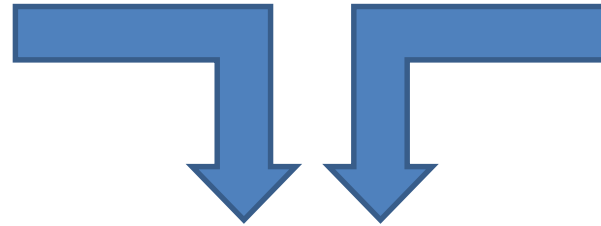
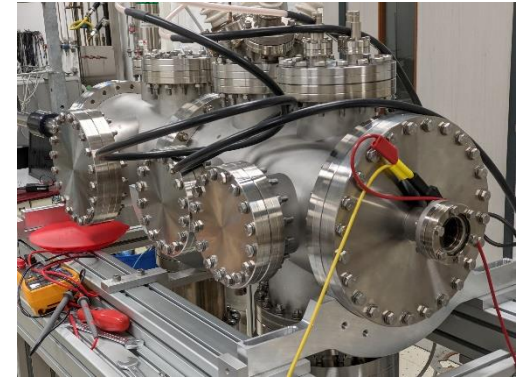
ASPIC

Surface/interface
Modification & characterization



ASCII

Ultra-low energy implantation
Control of probe isotopes



PAC

(atomically) local information

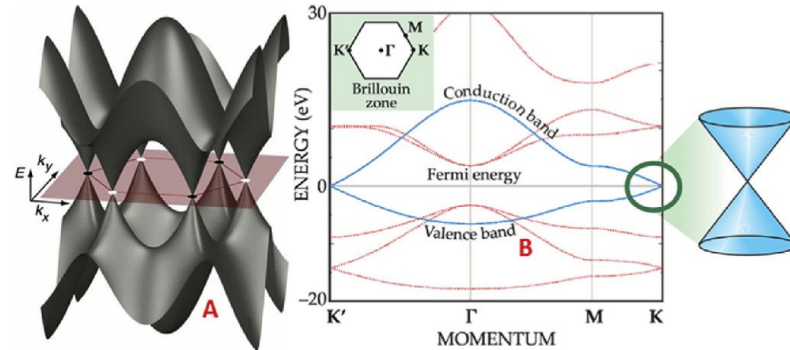
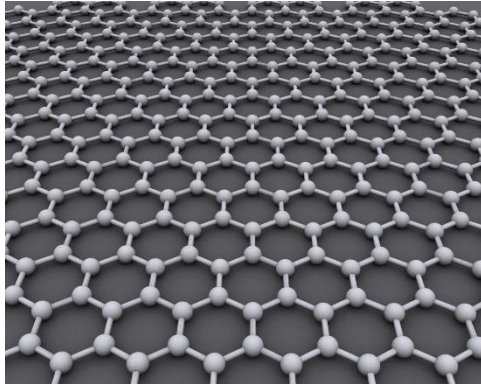


research into

2D materials

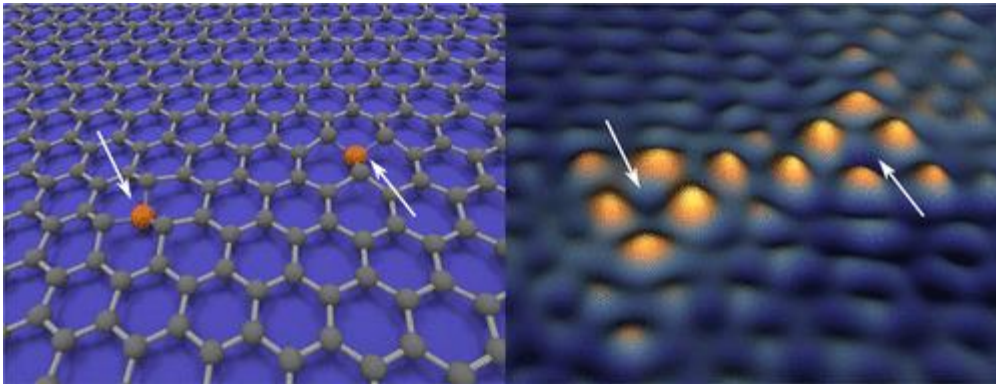
2D materials

- Exceptional electrical/optical/mechanical... properties
- Graphene
 - Potential for spintronics
 - Modification in different ways

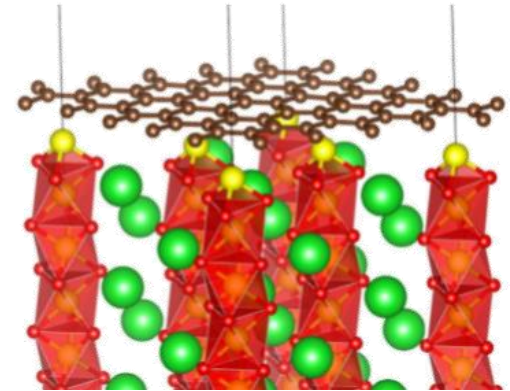


Graphene – Modification

- Modify electronic / magnetic properties by adding elements
 - Substitutional Mn (by ULE implantation)
 - Multiferroic substrate (e.g. BaMnO₃)



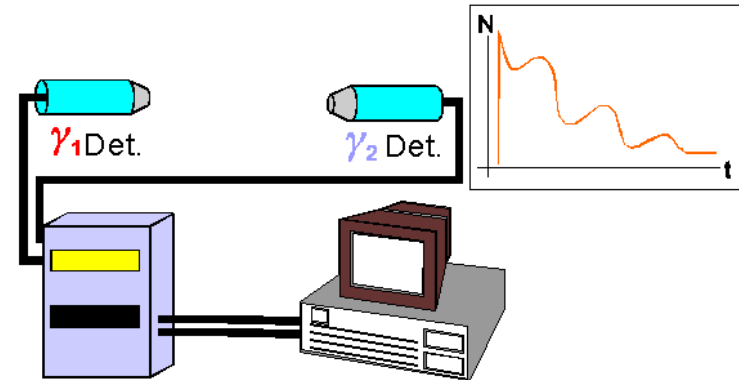
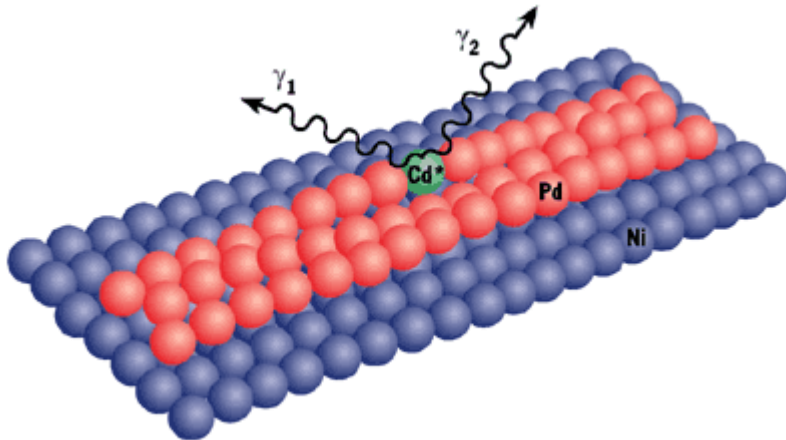
P.-C. Lin et al., ACS Nano 2021, 15, 3, 5449-5458



Z. Zanolli, Sci Rep. 2016 Aug 23;6:31346

Perturbed Angular Correlations (PAC) spectroscopy

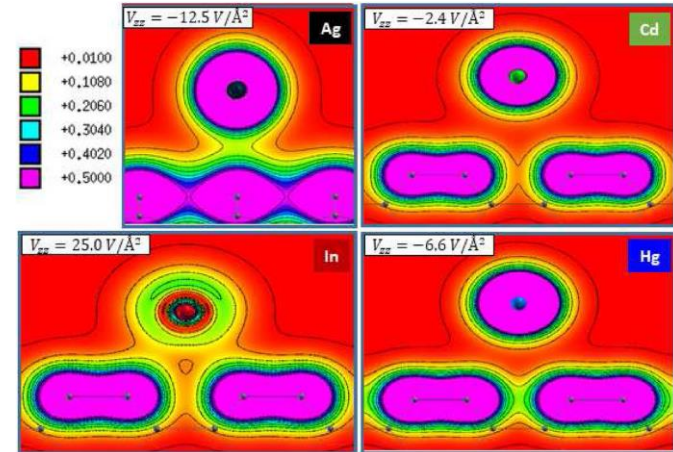
- Nuclear technique based on 2-gamma decay of certain isotopes
 - ^{111}In , $^{111\text{m}}\text{Cd}$, $^{204\text{m}}\text{Pb}$...
- Info on local (atomic) magnetic and electric field



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PAC applied to 2D materials

- PAC very promising for 2D materials (e.g. graphene)
 - Sub-Å local information on structure



A.S. Fenta *et al.* *Applied Physics A* (2021) 127:573

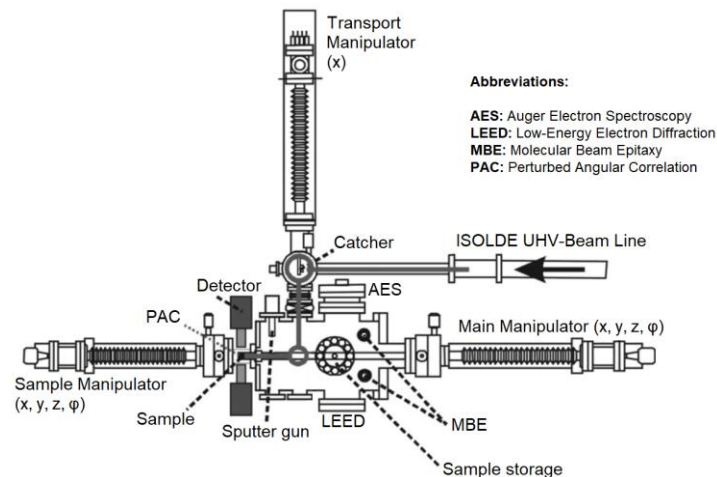
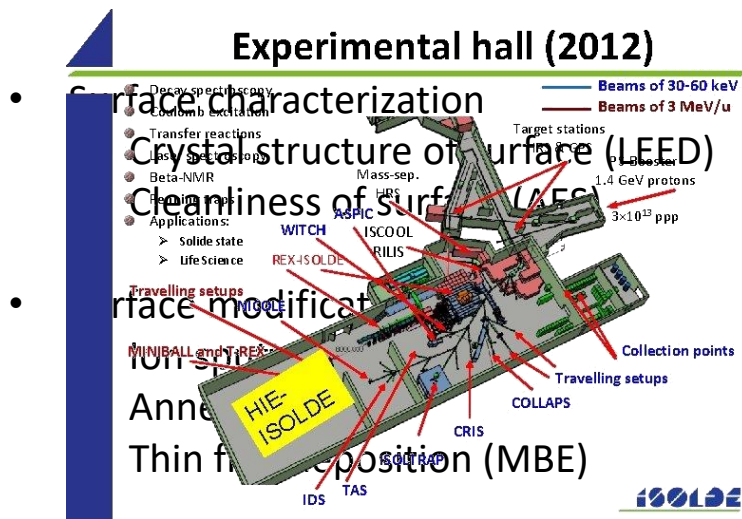
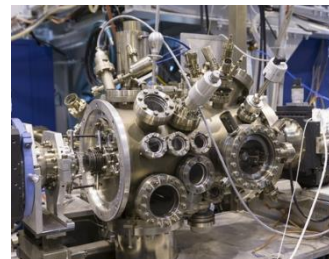
PAC applied to 2D materials

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 - Sub-Å local information on structure

- Requirements:
 - Clean surfaces and interfaces → **ASPIC**
 - Control over probe location (nm scale!) → **ASCII**

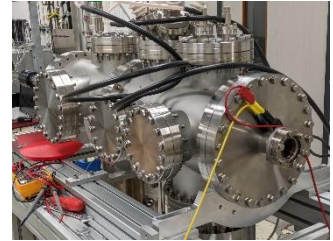
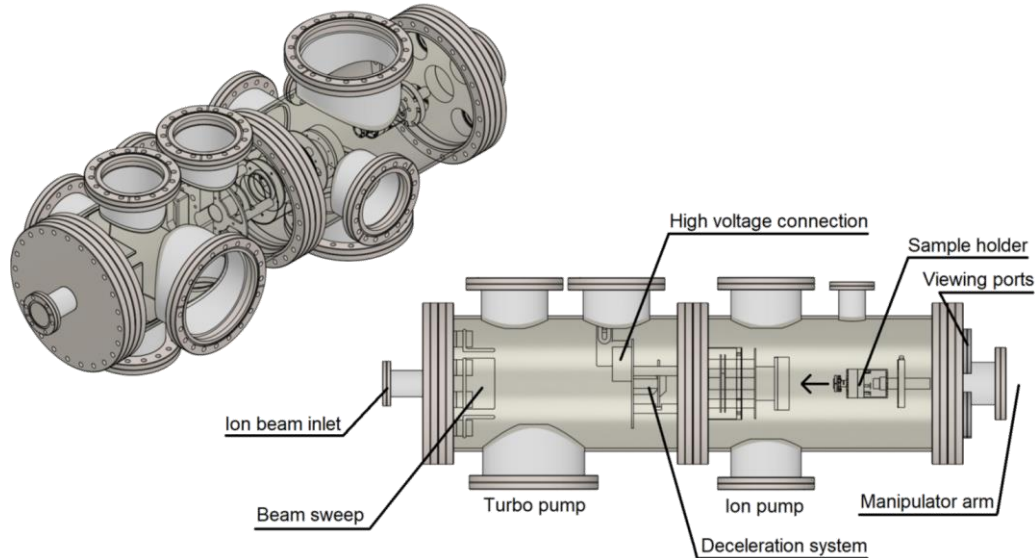
ASPIC

- Apparatus for Surface Physics and Interfaces at CERN
- Designed and operated in ISOLDE in 1980 and 90's
- Last installed at VITO beamline



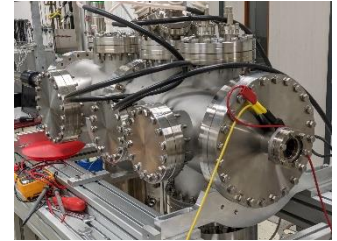
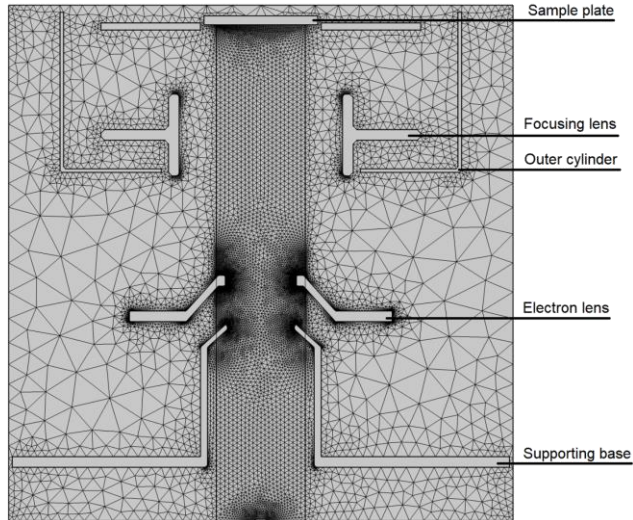
ASCII

- **ASPIC's Ion Implantation chamber**
- **Decelerates ions from 60 keV to ≤ 20 eV**



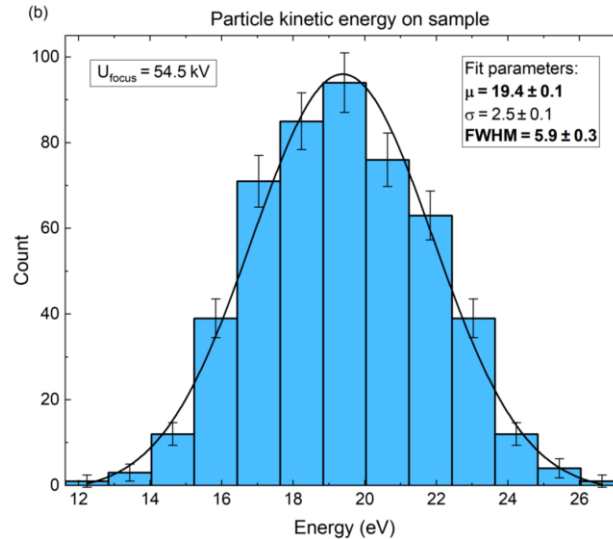
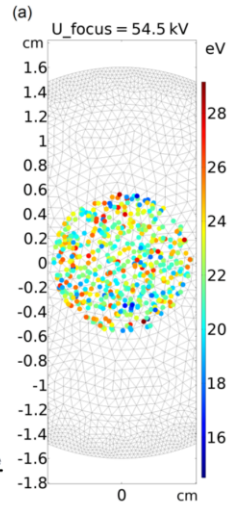
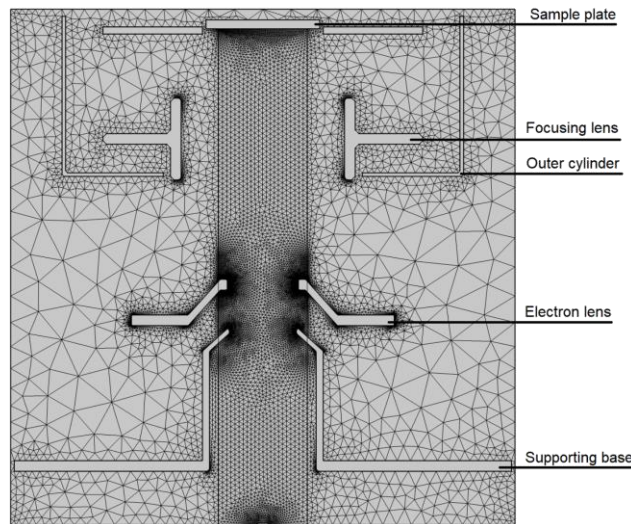
ASCII

- Electrostatic deceleration stage



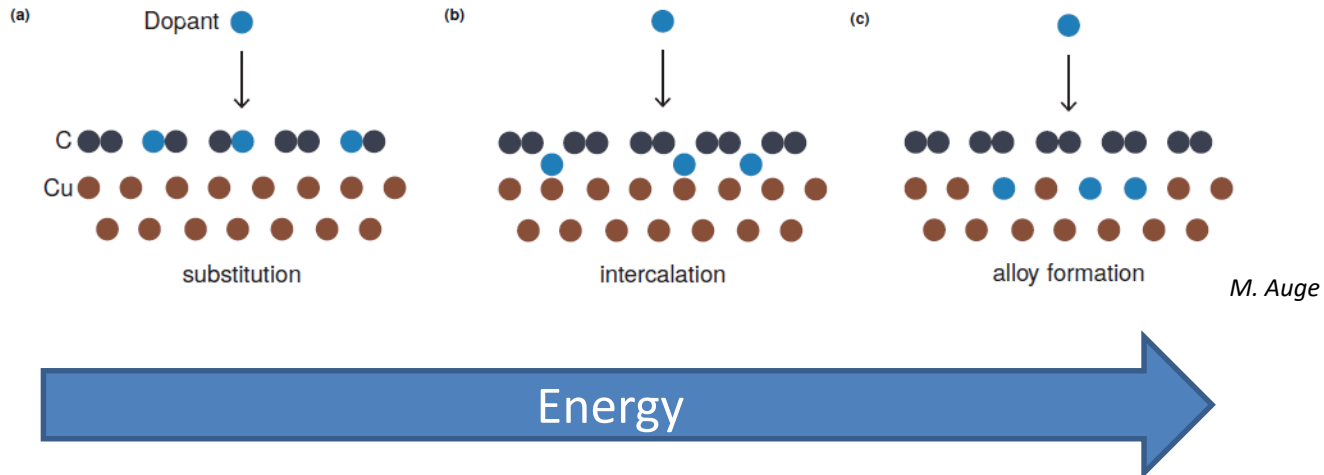
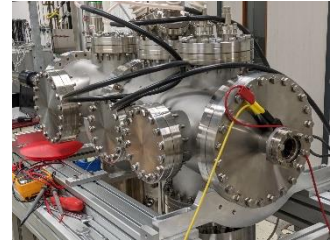
ASCII

- Electrostatic deceleration stage
- Probe location control by changing energy



ASCII

- Electrostatic deceleration stage
- Probe location control by changing energy



ASPIC and ASCII: status

- ASPIC: mostly ready, quality-of-life improvements, new mounting system
- ASCII: proof-of-principle tests soon (Jan/Feb 2022)
- Vacuum connection between chambers: spring/summer 2022

ASPIC and ASCII: installation in ISOLDE?

- Not clear yet
- ASCII compact enough for GLM
- To be decided by ISCC
 - Possibly travelling setup?



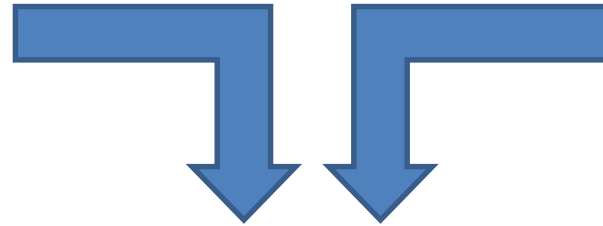
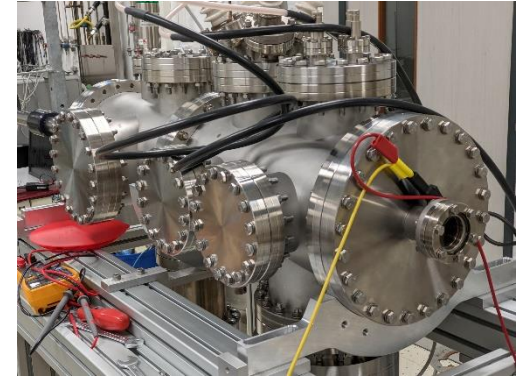
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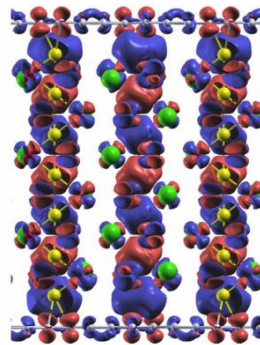
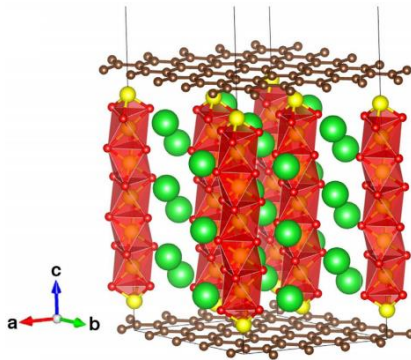


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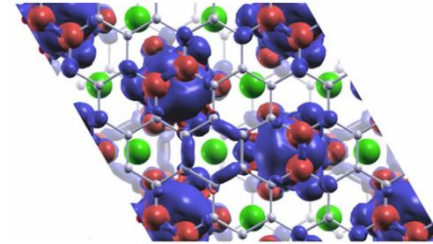
2D materials

Graphene – Multiferroics substrates

- Interface substrate / graphene
 - BaMnO_3 , BiFeO_3 , etc.



M[μB]
2.73
-2.38
2.46
-2.42
2.46
-2.38
2.73



Z. Zanolli, Sci Rep. 2016 Aug 23;6:31346