IFAST kick-off meeting 04/05/2021

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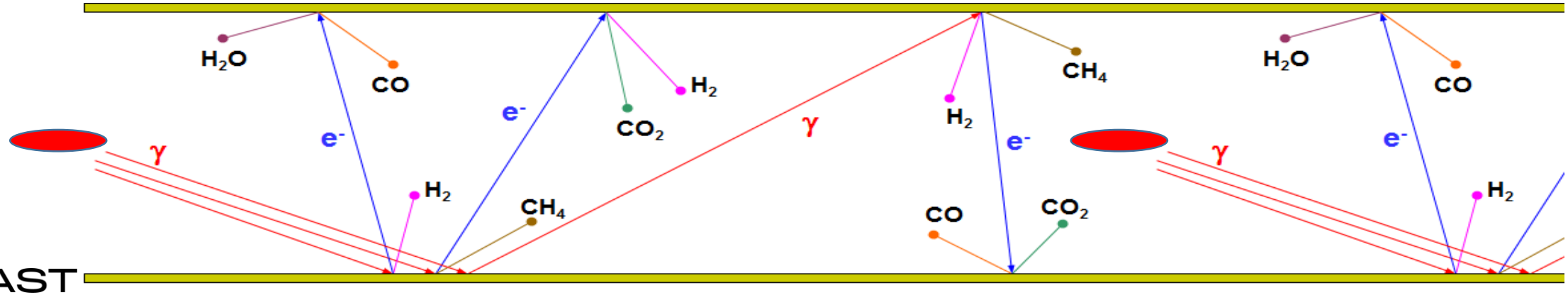
Vacuum in particle accelerators

All particle accelerators need vacuum. The main reason is beam-gas interaction leading to a beam quality degradation:

- Increases beam size (emittance)
- Reduces beam lifetime
- Increases radiation hazard
- Encourages recombination

- **Photon stimulated desorption (PSD)** is one of the most important sources of gas ***in the presence of synchrotron radiation (SR)*** *or any photons with E > 5-10 eV*.
- PSD can be considered as a two-step process:
- first, photons with energy >5-10 eV cause the photoelectron emission,
- then the photoelectron stimulate gas desorption.



What nonevaporable getter coating coating does?

1) **Reduces gas desorption:**

   A pure metal (Ti, Zr, V, Hf, etc.) film 0.5-3-μm thick without contaminants.

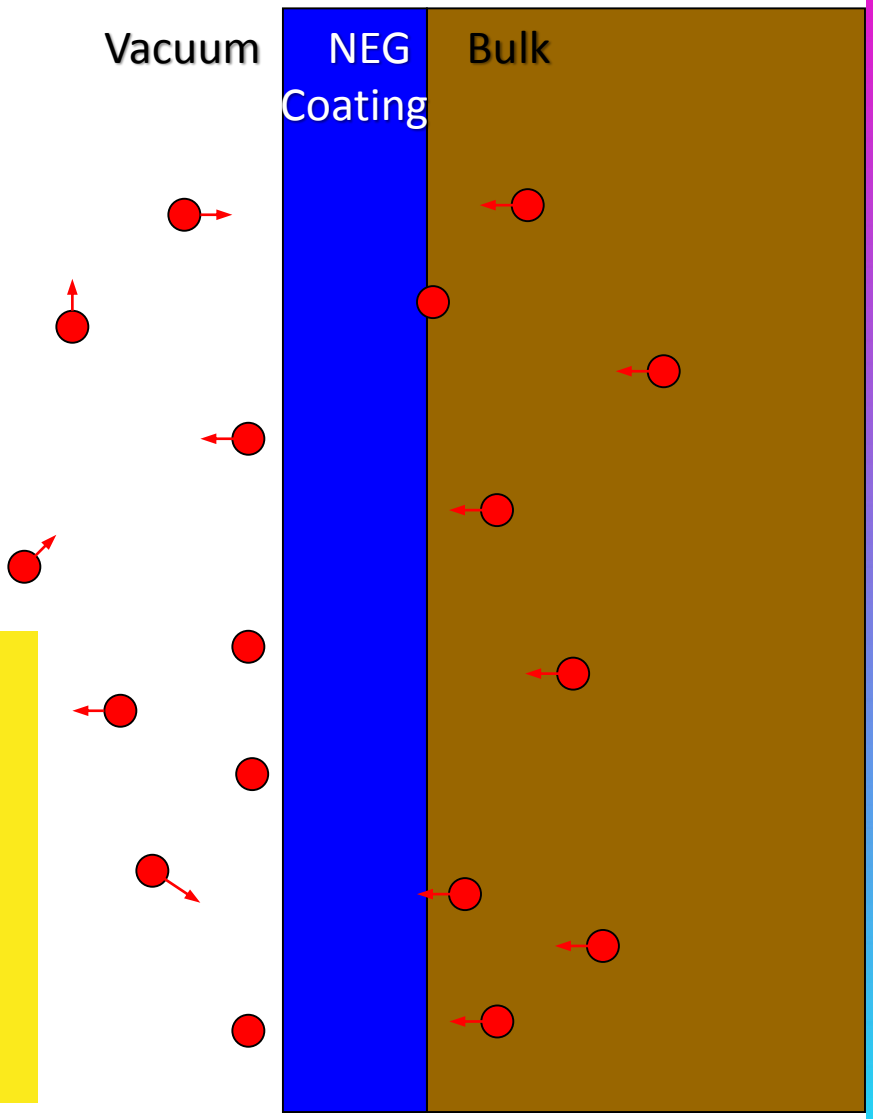
   A barrier for molecules from the bulk of vacuum chamber.

2) **Increases distributed pumping speed, *S*:**

   A sorbing surface on whole vacuum chamber surface

   $S = \alpha \cdot A \cdot v/4$;

where α – sticking probability, A – surface area, v – mean molecular velocity



Main benefits of NEG coating:

- Can be activated at low temperature of 150-160 °C
- Meeting challenging vacuum specification at UHV or XHV
- Lower cost of vacuum system
  - ✓ Less number of pumps, thus less controllers and cables
  - ✓ Smaller size of the pumps, thus lower cost per unit
- The only solution for narrow vacuum chambers

What is really need for vacuum system design

- There are not enough PSD data for various NEG coatings.
  - A future machine vacuum deign can't be done properly without these data.
- What information have to be obtained:
  - PSD yields and sticking probabilities for H_2, CH_4, CO, CO_2 (*for modelling future machines*)
    - for various types of NEG coatings (composition and structure),
    - as a function of photon dose,
    - as a function of activation temperature and duration,
    - as a function of film thickness,
    - for shapes similar vacuum chamber of future machines,
    - *etc*.
  - Practical knowledge on what happens in case of various operation issues:
    - SR induced activation, recovery rate after a vacuum accident,
    - SR induced pumping,
    - a leak during NEG activation,
    - SR beam alignment fluctuation,
    - non-uniform temperature during activation: overheated NEG, underheated NEG,
    - not uniformly coated and partially coated chambers (a chamber with an antechamber),
    - effect of storage in vacuum, in nitrogen, in argon, in air, ...,
    - NEG lifetime,
    - *other questions from machine operation experience*.

Task 10.5 objectives

- Building facilities for photon stimulated desorption (PSD) yield measurement on beamlines.
- Obtaining and analysing the photon stimulated gas desorption (PSD) experimental data from Non-Evaporable Getter (NEG) coated prototypes under conditions similar to future light sources.

	Milestone/Deliverable name	Delivery date (in months)	Content
Milestone	First NEG coated sample are installed on SR beamline at DLS and Soleil	12	Report
Deliverable	First PSD data from NEG coating	36	Report

Task 10.5 partners (vacuum experts from 4 HEI)

Partner	Main capability relevant to the project	Future machine
UKRI/STFC/ASTeC	• NEG deposition and characterisation • Pumping property and ESD evaluation • Gas dynamics modelling, data analysis, large vacuum system deign	UK-XFEL
Diamond LS	• PSD facility at a SR beamline on Diamond • Pumping property and ESD evaluation • Large vacuum system deign and operation	Diamond-2
Soleil	• PSD facility at a SR beamline on Soleil • Pumping property and ESD evaluation • Large vacuum system deign and operation	Soleil-2
DESY	• NEG deposition and characterisation • Pumping property and ESD evaluation • Large vacuum system deign and operation	PETRA-IV

Task 10.5 ongoing activities

Task 10.5 has already started:

- Two preparatory meeting took place
  - on 2nd Mar 2021
  - on 7th April 2021

- Deposition and testing facilities are operational at UKRI and DESY
- SR beamlines have been design and are being built at DLS and Soleil

- Task 10.5 kick-off meeting is scheduled on 12th May 2021

iFAST

Thanks for your attention

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