The displacement cascade

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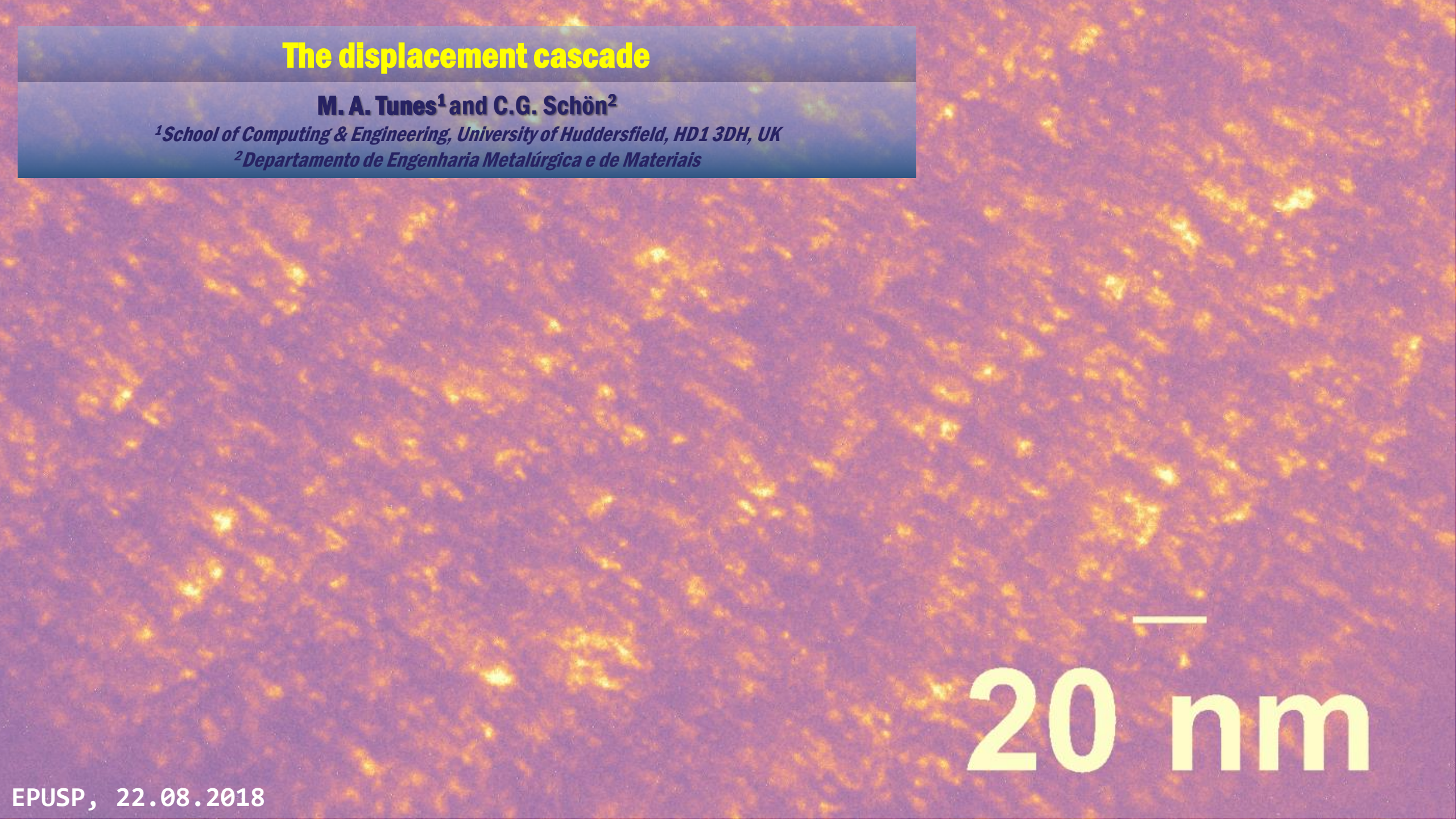
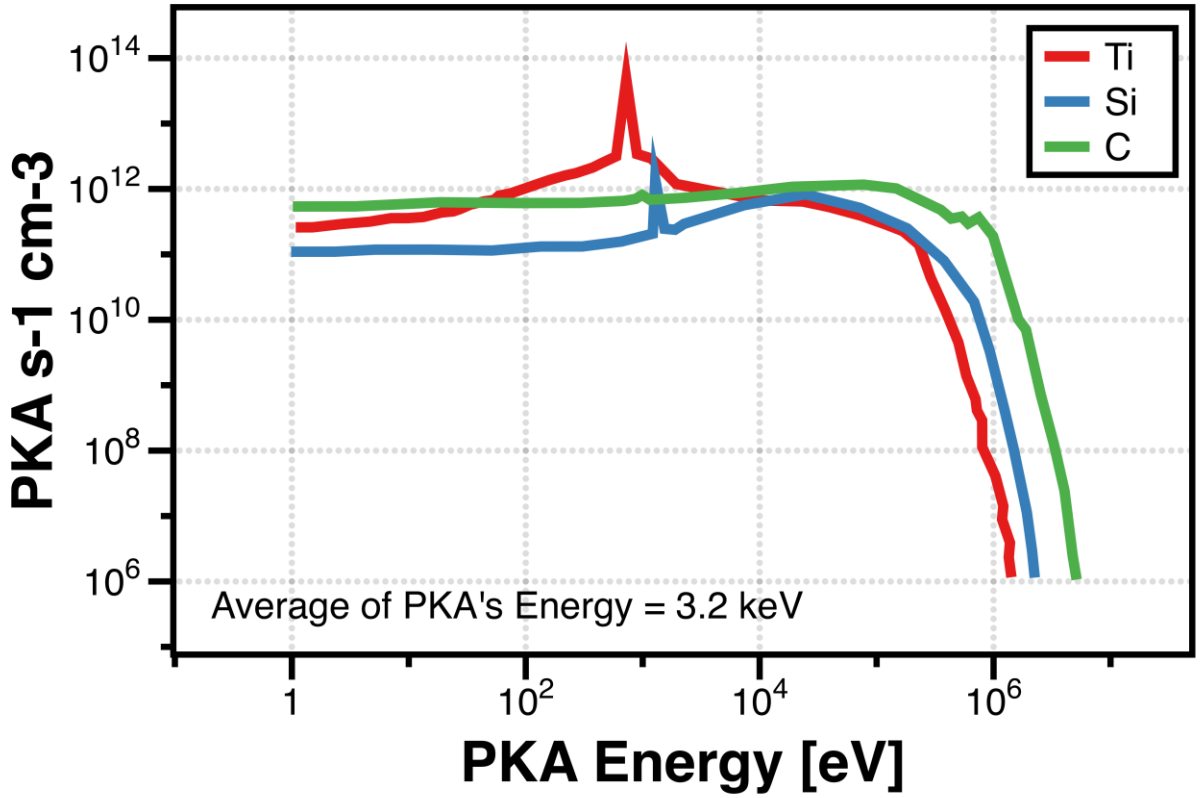


The radiation damage due to the cascade

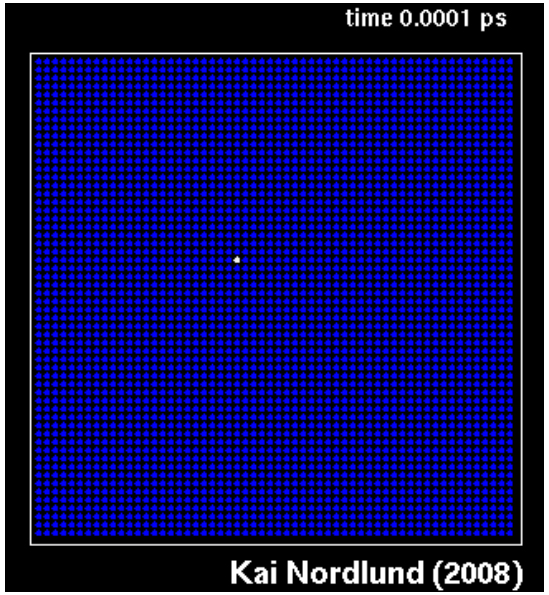
PKAs distribution from the
High-Flux Isotope Reactor
(ORNL-USA)



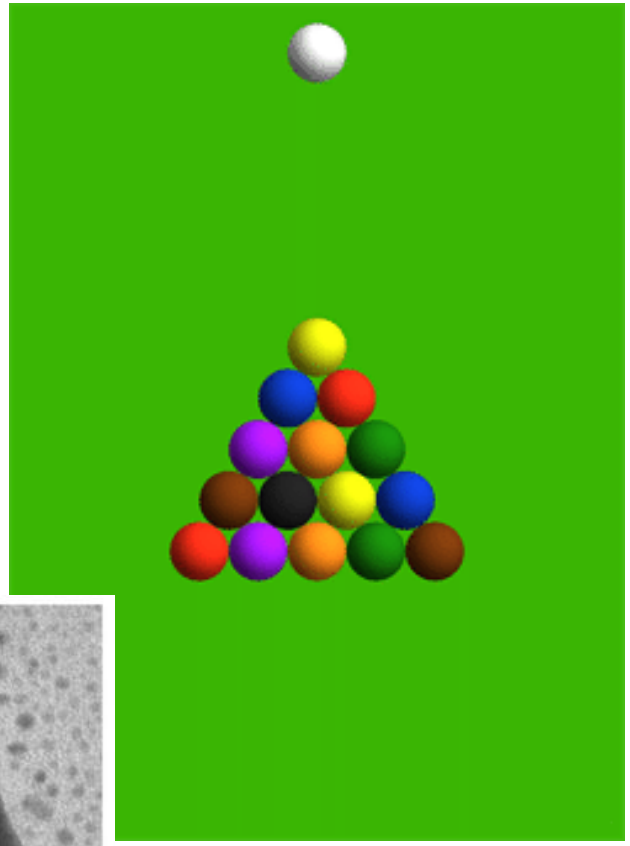
- Fast neutrons E = 1 to 20 MeV.
- Generate PKAs with energies around few keV.
  - In fusion reactors E_{pka} > 100 keV.
- PKAs have energy to promote more displacements.
- How many displacements?

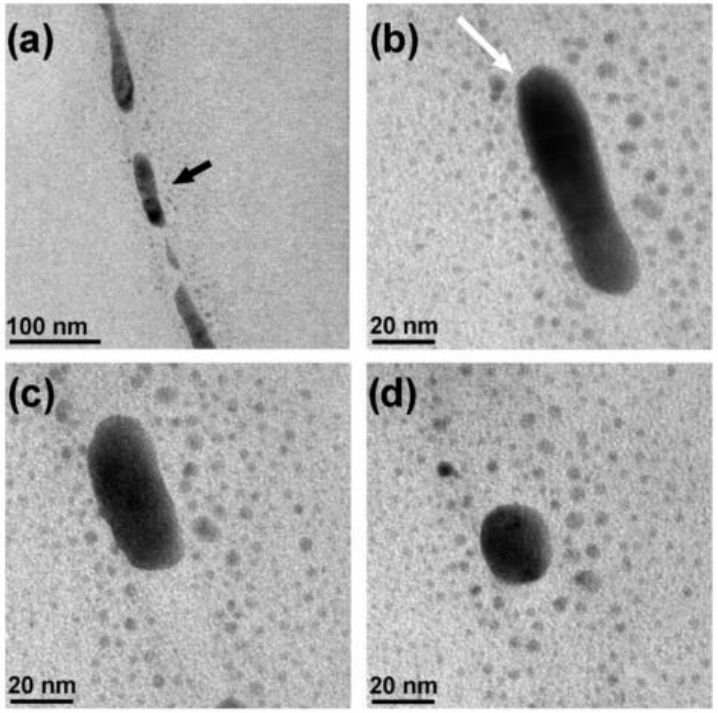
$$\bar{\nu}(T) = \frac{T}{2E_D}$$

Kinchin-Pease 1955 in UK
Norgett-Robinson-Torrens 1970s USA

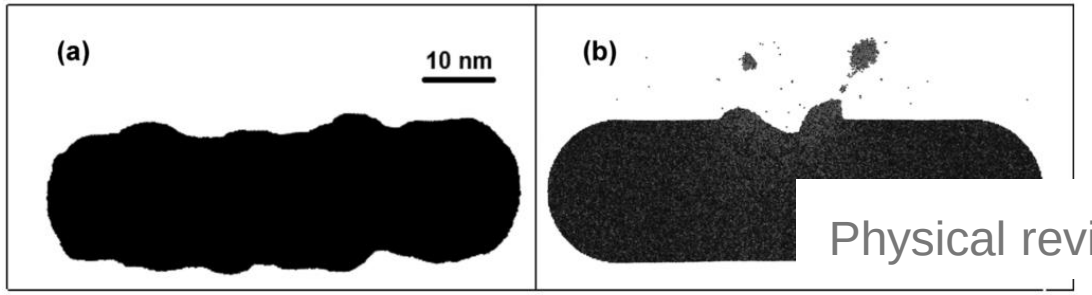


Cascade morphology

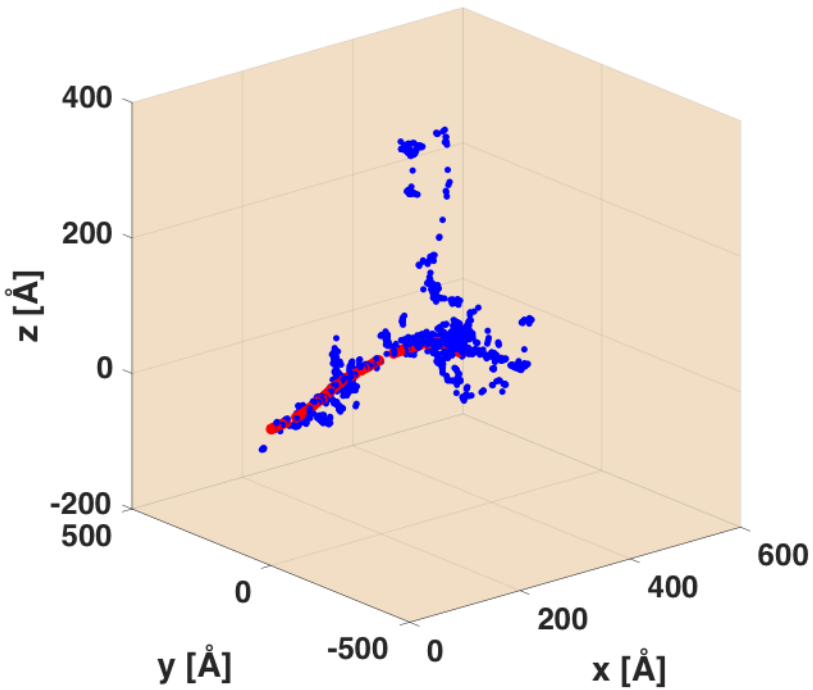


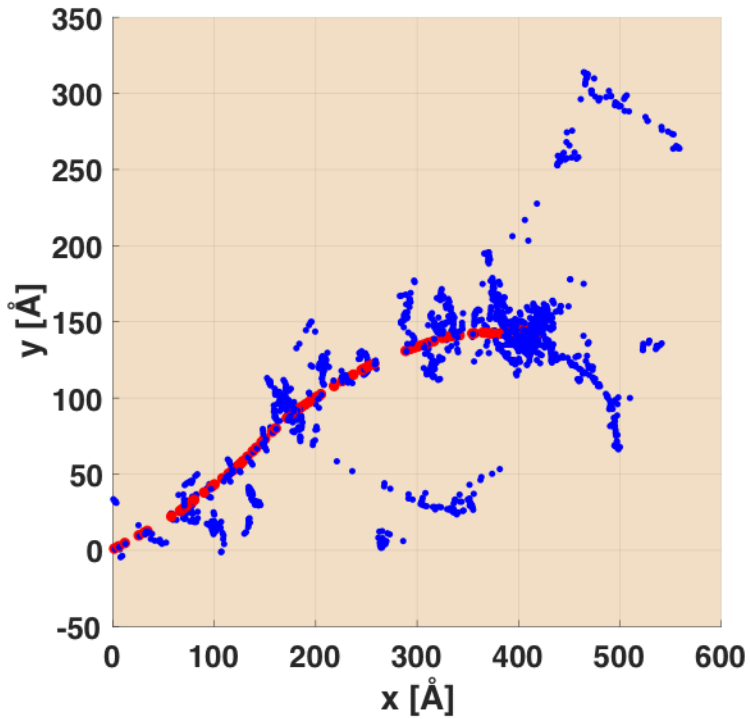


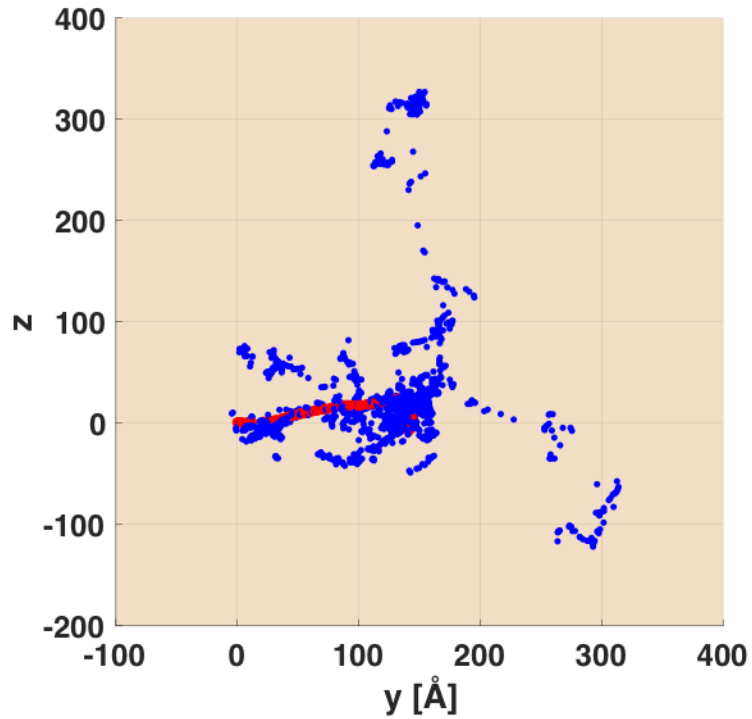
- The displacement cascade is:
  - NRT and KP models describes radiation damage as the average number of displacements-per-atom or dpa.
  - A very small area of the material where a **large amount of energy** is deposited in a few picoseconds.
- Spatially homogenous radiation damage theory may not be adequate!
- **Thermal spike model** had to be introduced.
  - High energetic particles spikes the material.
  - Raises temperature above the melting point within the cascade spatial limits.
  - It can create nano/mesoscopic defects bigger than the cascade.



Physical review letters 111 (6), 065504



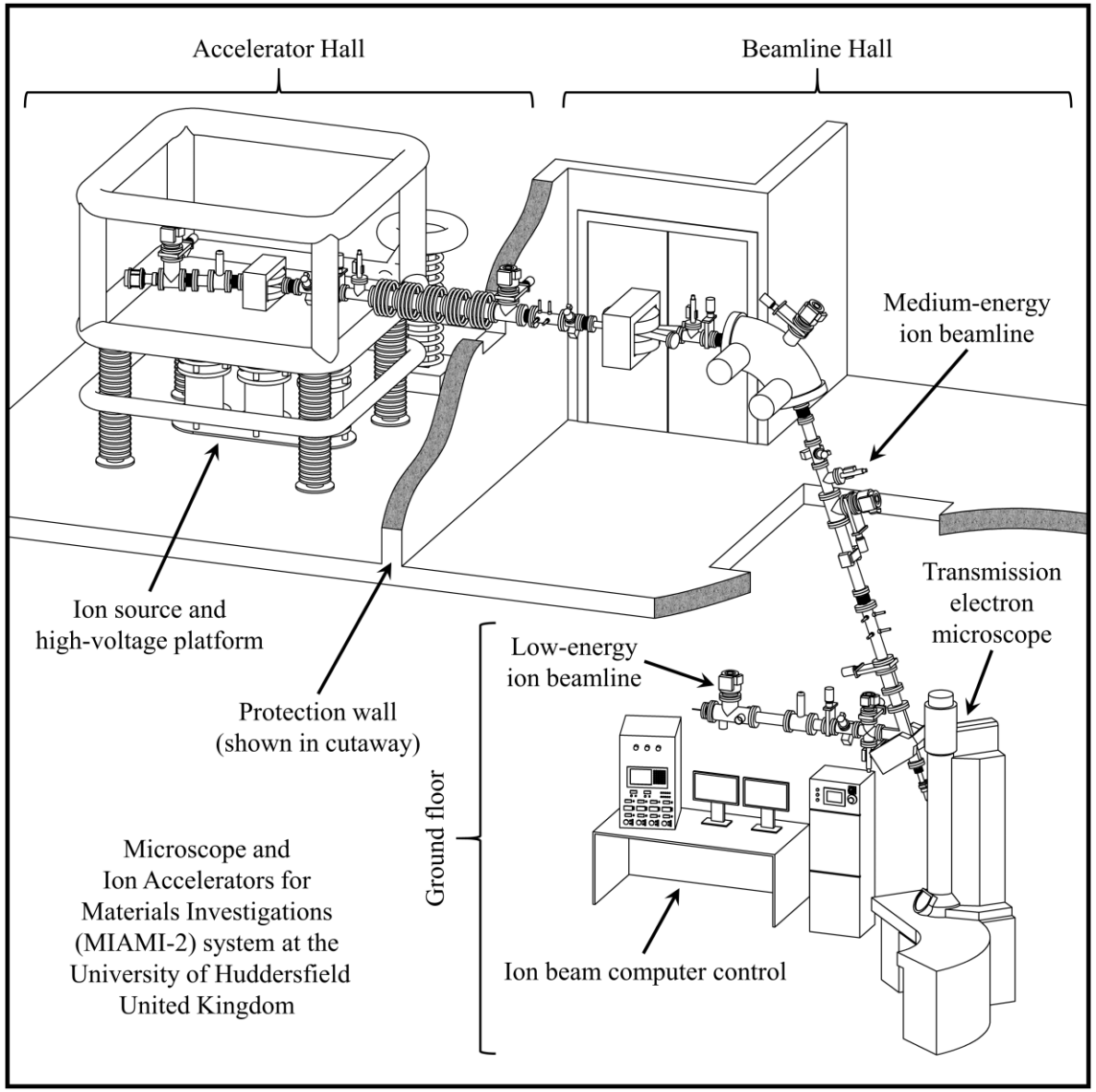


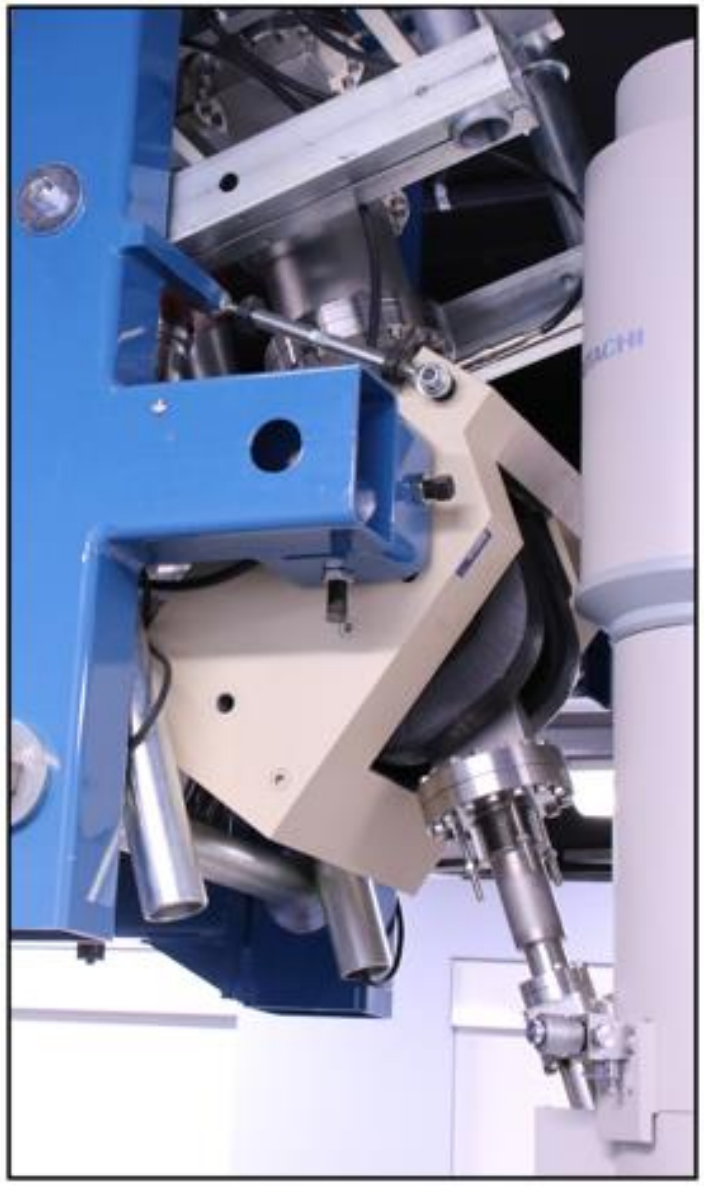


Recoils PKAs

Is it possible to “see” the cascade in the electron microscope?

Ion irradiation with *in situ* TEM





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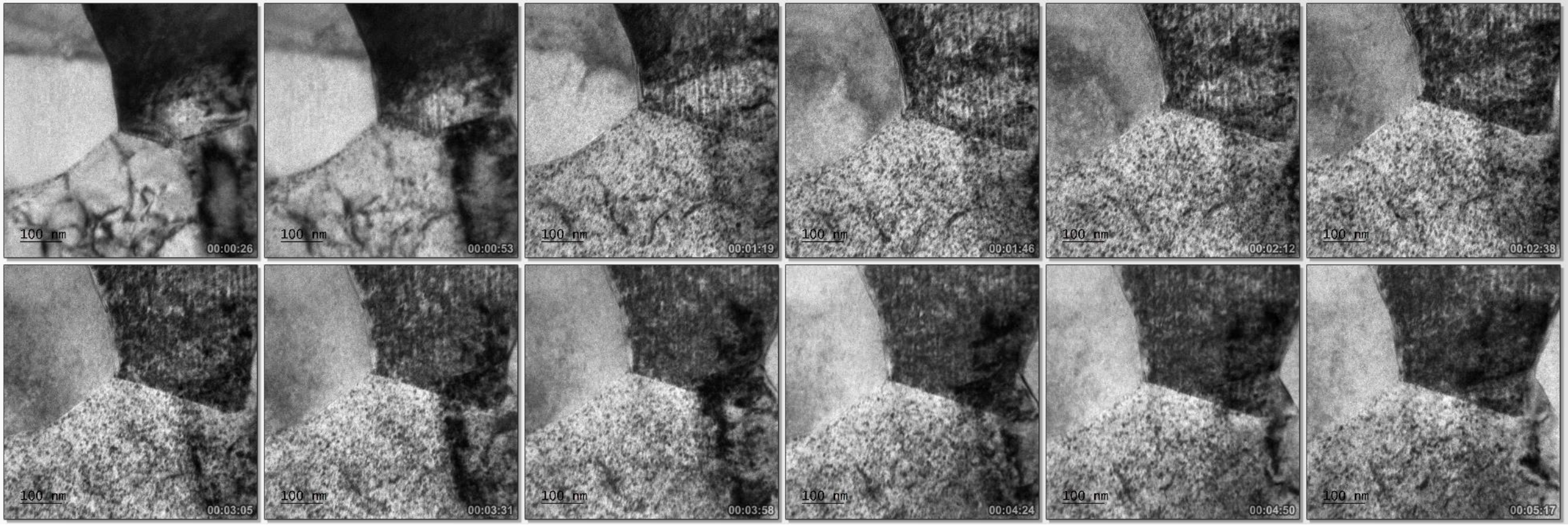
MPC-HC



Thanks for your attention

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