Tokamaks and Ion Beams: Revolutionizing materials analysis inside magnetic fusion devices

**Challenge: Monitor operational wall conditions**

The plasma-facing materials in Alcator C-Mod are routinely coated with boron for plasma performance; oxygen content must be minimized to for high vacuum purity. Yet, no assessment technique previously existed!

**Challenge: Localize, quantify fusion fuel retention**

Fusion fuel (deuterium and tritium) is retained in plasma-facing materials, causing issues in plasma control ( uncontrollable fueling), operation (insufficient tritium), and safety (radioactivity tritium buildup in walls). Achieving understanding, solution is critical; yet, no previous diagnostic technique!

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**Experimental validation of particle detection**

*Laboratory gamma spectrum*

**Spectra taken in laboratory with multiple detectors on controlled samples allow identification and quantification of isotopes**

*Neutron detector pulse shapes*

**Distinguish neutrons and gammas by the shape of pulse tail**

*Evolution of deuterium on surface*

**Integrate difference between spectra in ²H(d,n)³He energy range**

*Scale a reference spectrum to each day’s spectrum*