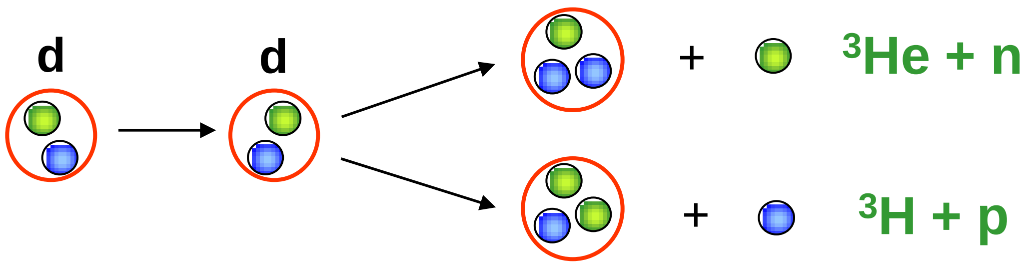
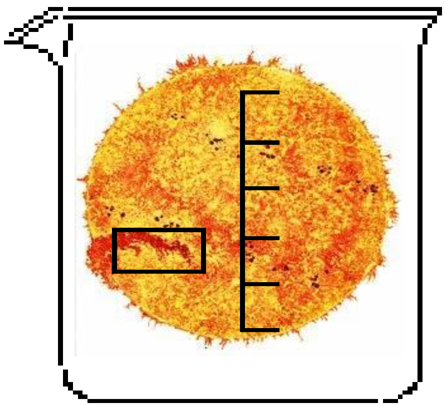
New Evidence of the Cold Nuclear Fusion – Accelerator Experiments at Very Low Energies

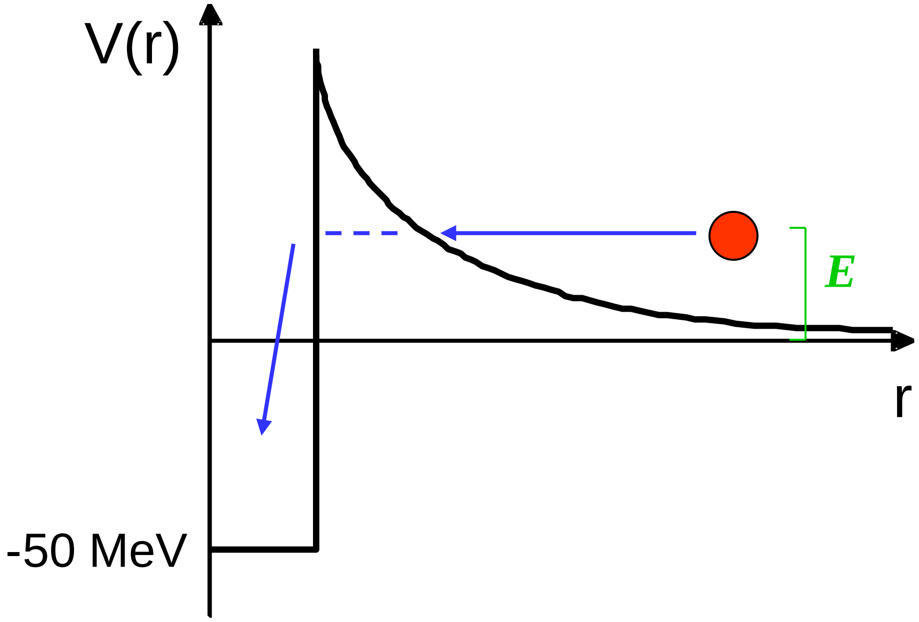




New advancements on the Fleischmann-Pons Effect: paving the way for a potential new clean renewable energy source? , European Parliament - Brussels, June 3, 2013

Konrad Czerski

Tunnel Effect



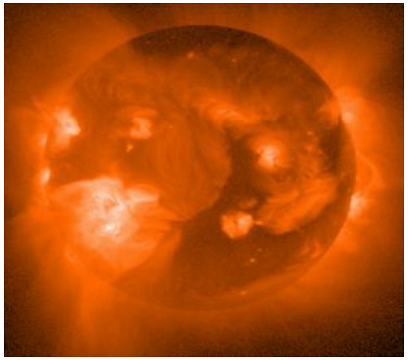
$$V(r) = \frac{Z_1 Z_2 e^2}{r}$$

penetration factor
through the Coulomb barrier

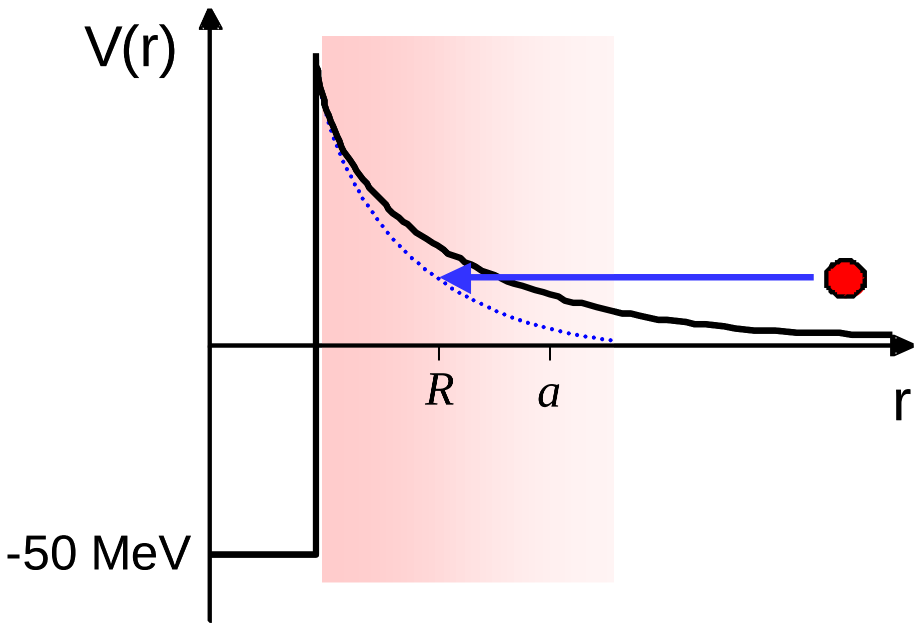
$$P(E) = \sqrt{\frac{E_G}{E}}\, \exp\left(-\sqrt{\frac{E_G}{E}} \right)$$

... depends on the plasma temperature

T (Sun) = 15 million deg



Electron Screening in Nuclear Reactions



$$V(r) = \frac{Z_1 Z_2 e^2}{r} \exp(-r/a)$$

$$\approx \frac{Z_1 Z_2 e^2}{r} - U_e$$

$$U_e = \frac{Z_1 Z_2 e^2}{a}$$

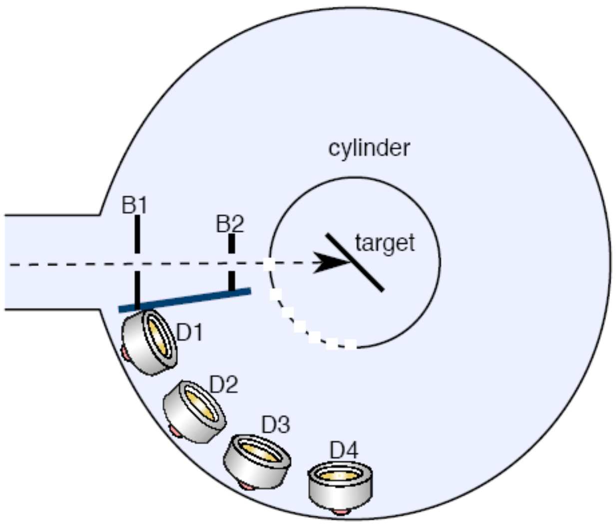
screening energy

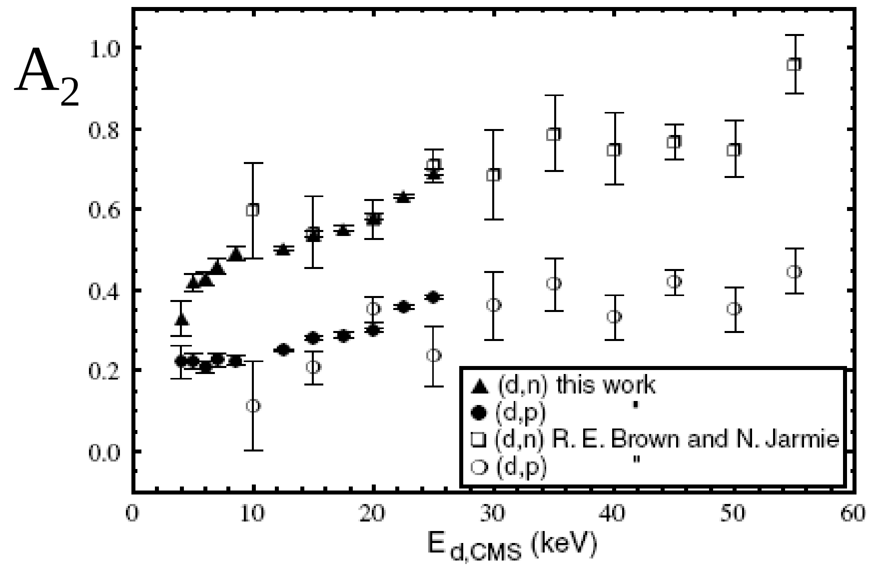
$$P(E) = \sqrt{\frac{E_G}{E}} \exp\left(-\sqrt{\frac{E_G}{E}}\right)$$

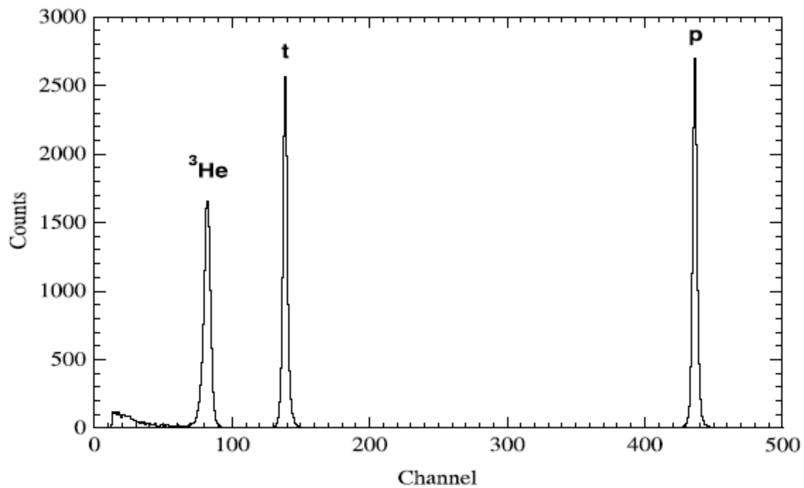
s-wave penetration factor

$$P(E) \longrightarrow P(E+U_e)$$

Experimental Results (HV)



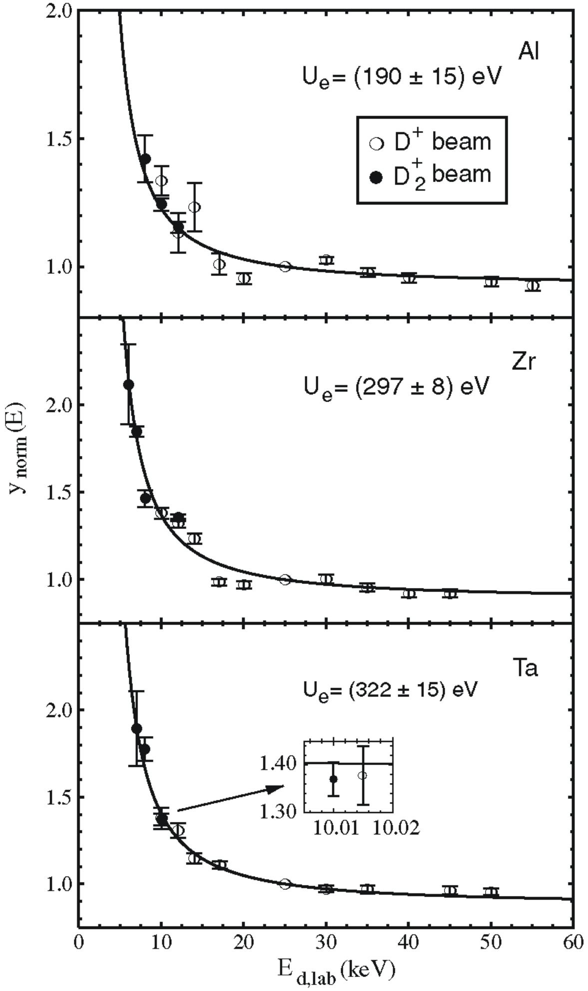




angular distribution

$$\frac{d\sigma}{d\Omega} = \sigma_{tot}\left(1 + A_2 P_2(\cos\varphi)\right)$$

Experimental Results (HV) II



$$d + d \longrightarrow {}^3He + n$$

$$d + d \longrightarrow {}^3H + p$$

metal target

NIC 1998, p. 152
Europhys. Lett. 54 (2001) 449

Similar results:

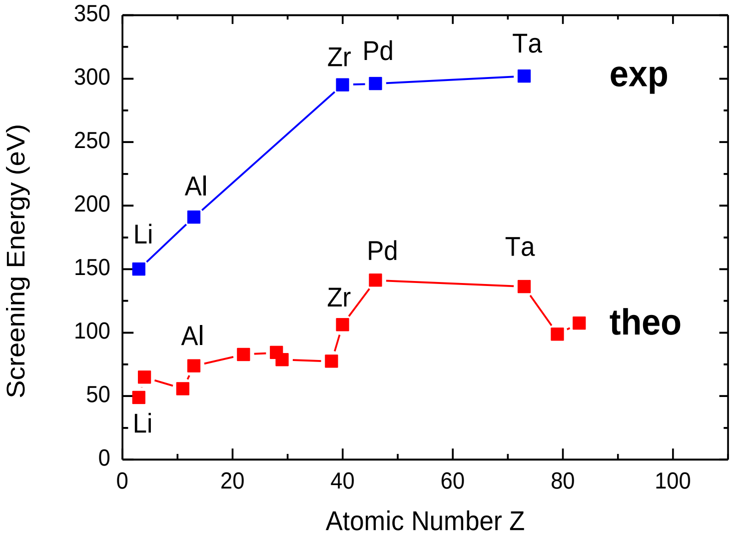
J. Kasagi et al., J.Phys.Soc.Jap. 71 (2002) 2281
F. Raiola et al., Eur.Phys.J. A13 (2002) 337
F. Raiola et al., Eur.Phys.J. A19 (2004) 283

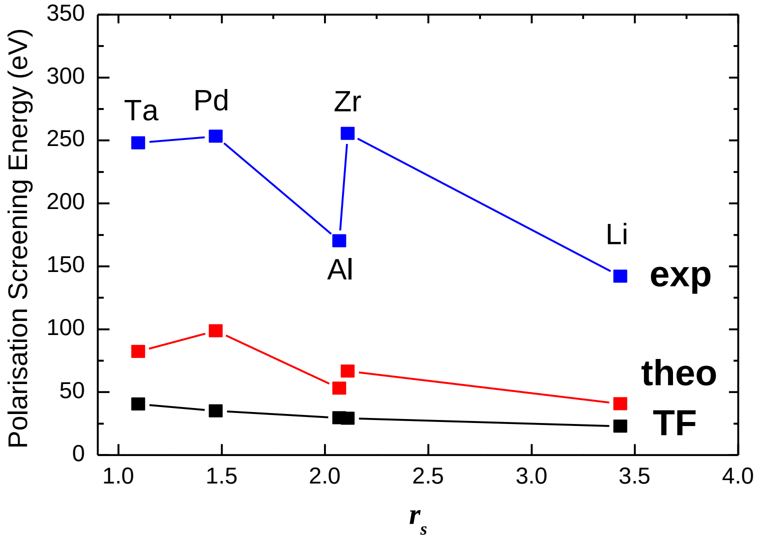
gas target

U_e = 25±5 eV

U.Greife et al., Z.Phys. A351 (1995) 107

Experimental (HV) and Theoretical Results





dielectric function theory:

free and bound electron polarization

cohesion screening

electron-gas parameter r_s

$$r_s = \left(\frac{3}{4\pi\, n}\right)^{1/3} \frac{1}{a_0}$$

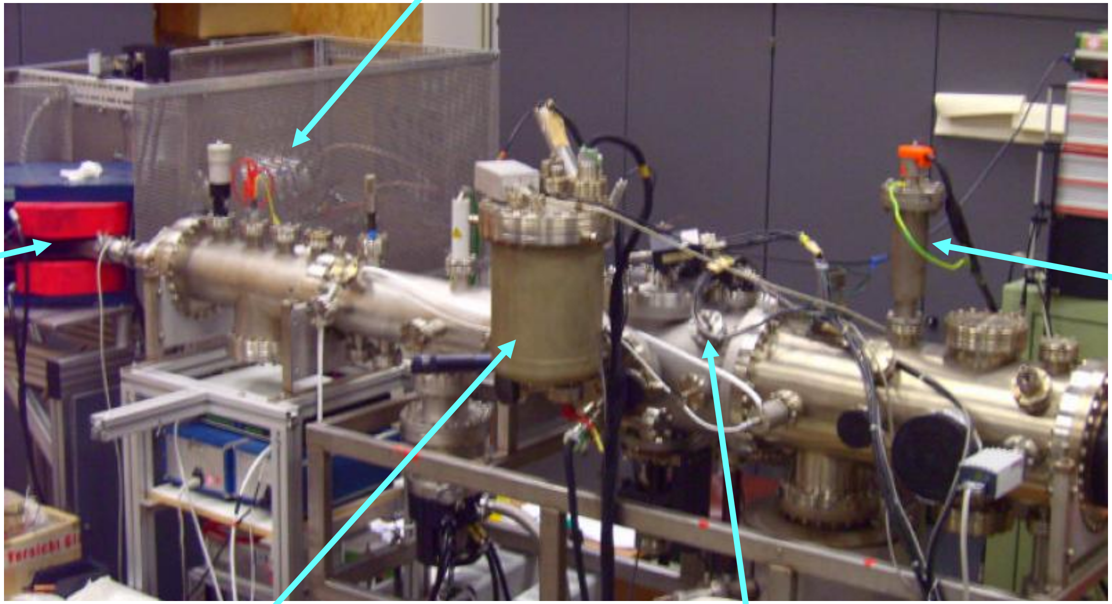
K.Czerski et al., Europhys. Lett. 2004

UHV Experimental Setup

I: 10-30 μA
V: 30 kV
ΔV: ~ 1 V

ECR ion source

analyzing magnet



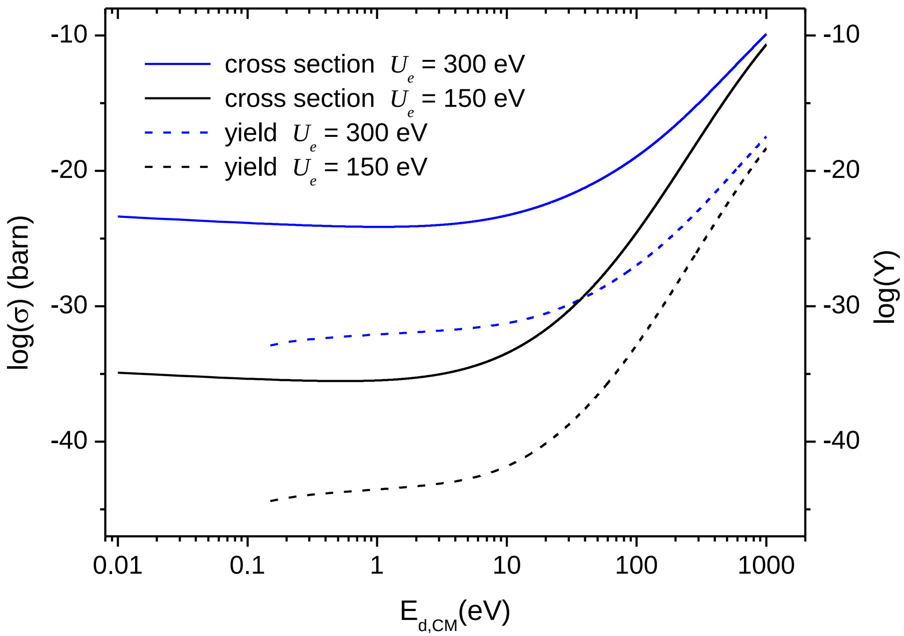
mass spectrometer

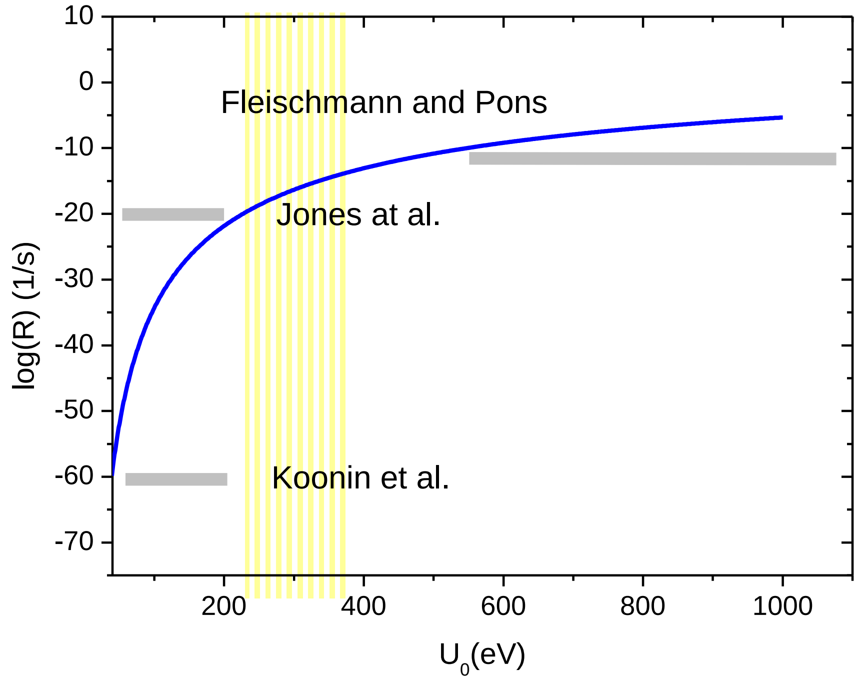
electron detector

target chamber

p: 10^{-11} – 10^{-10} mbar

Results: Extrapolated Cross Section & Yield (PdD)





$$R_{scr}(E) = N\sigma_{scr}(E)v_{rel} = N\sigma_{scr}(E)\sqrt{\frac{4E}{M}} \cong \frac{2NS_0}{\sqrt{MU_0}}\exp\left(-\sqrt{\frac{E_G}{U_0}}\right)$$

Cold Fusion – Doubts

$^2H + ^2H \rightarrow$

- $^3H + p$ $E_p \sim 3.6$ MeV $E_t \sim 1.2$ MeV
- $^3He + n$ $E_n \sim 2.4$ MeV $E_\tau \sim 0.8$ MeV
- $^4He + \gamma$ $E_\gamma \sim 24$ MeV

• tunnel effect

cross section at least by 10^{40} too small

• branching ratios

$^3He/^3H \approx 10^5$, $^3He/^4He \approx 10^{-5}$

• the lowest projectile energy (accelerator exp.)

$E_d = 4$ keV

Two Processes at Room Temperature

1. Low deuteron loading, off the 0^+ resonance

electron screening locally enhanced by impurities and crystal defects

low level neutron and proton production due to stripping reactions,
bursts, no heat production, weak material dependence

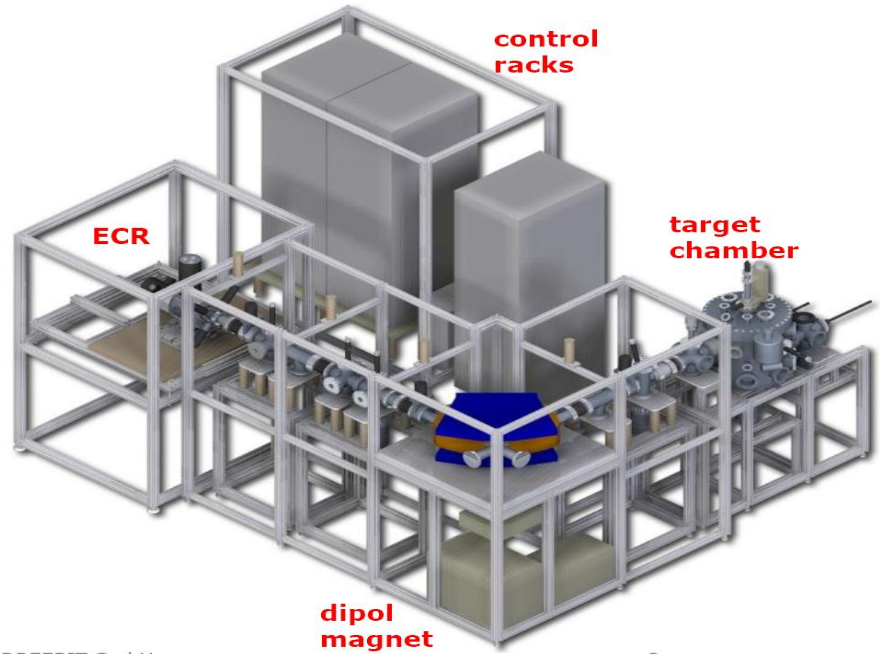
2. High deuteron loading, on the 0^+ resonance

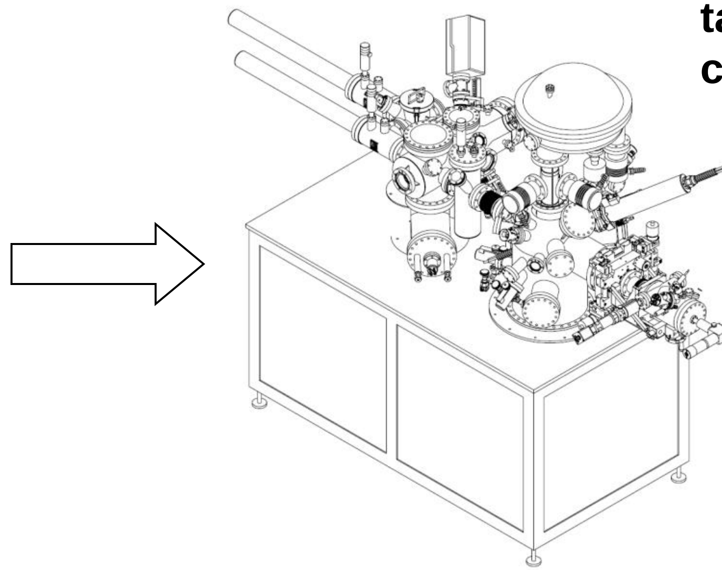
balance between the resonance and electron screening

high intensity ^4He and d production, heat production
hot spots, strong material dependence

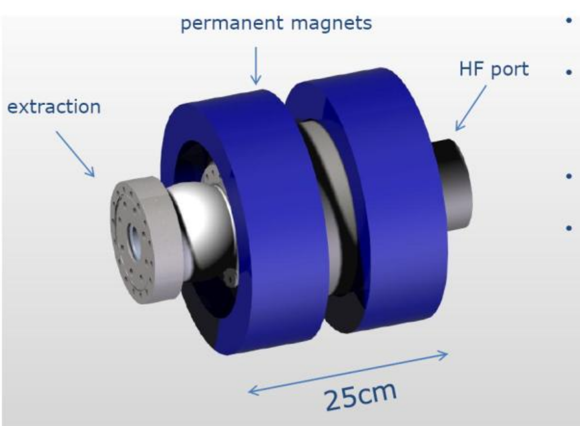
Laboratory of Nuclear and Medical Physics

accelerator with ultra high vacuum

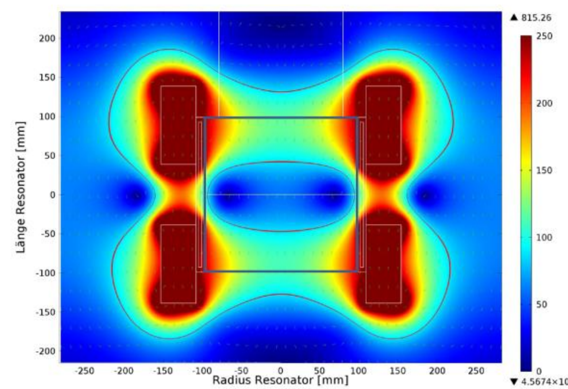




target
chamber



- 2.45GHz ECR ion source
- designed to provide a beam of lowly charged ions
- beam current: up to mA
- beam energy: up to 30keV per charge state



People

Electron Screening

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