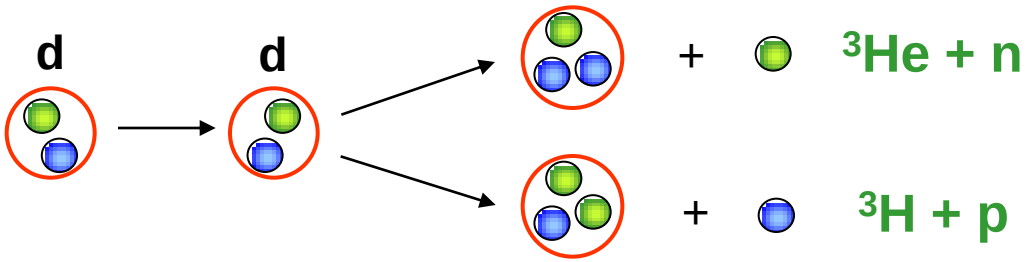
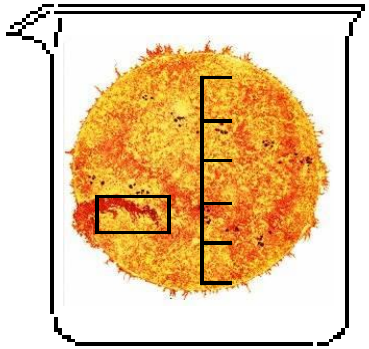
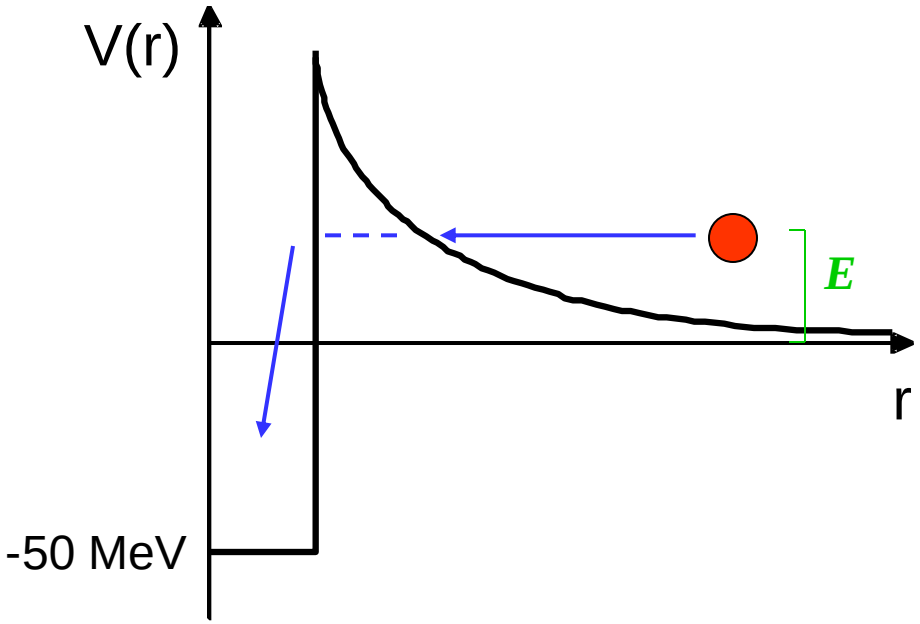
Effects of a Threshold Resonance in the DD Reactions Studied in Metallic Environments





Tunnel Effect



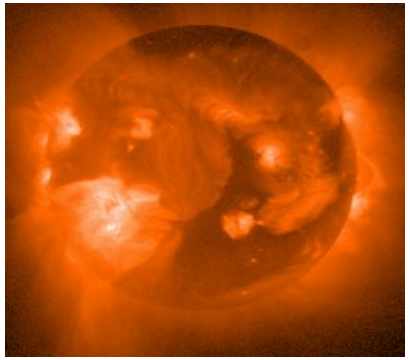
$$V(r) = \frac{Z_1 Z_2 e^2}{r}$$

penetration factor
through the Coulomb barrier

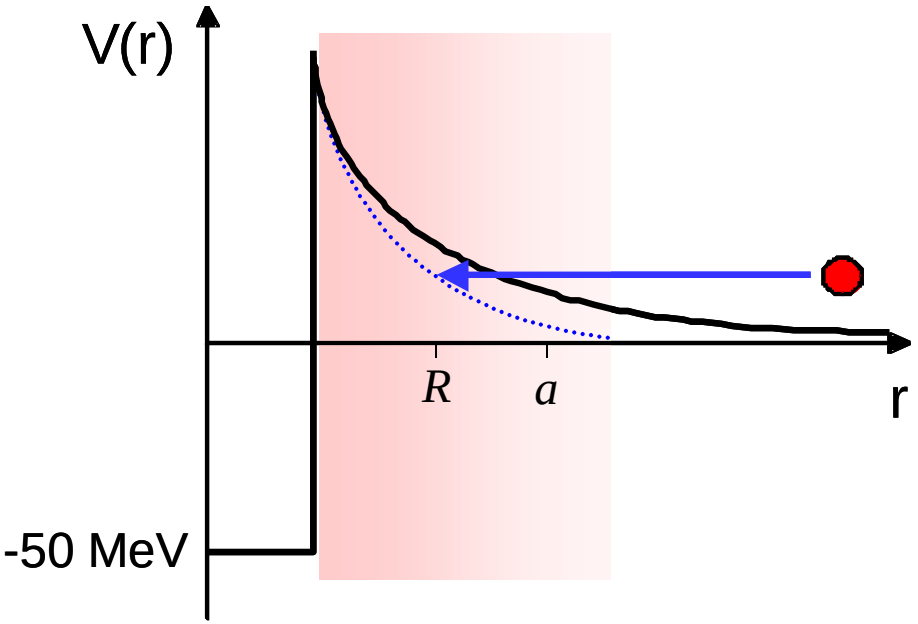
$$P(E) = \sqrt{\frac{E_G}{E}} \exp\left(-\sqrt{\frac{E_G}{E}}\right)$$

... depends on the plasma temperature

T (Sun) = 15 million deg



Electron Screening in Nuclear Reactions



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

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

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

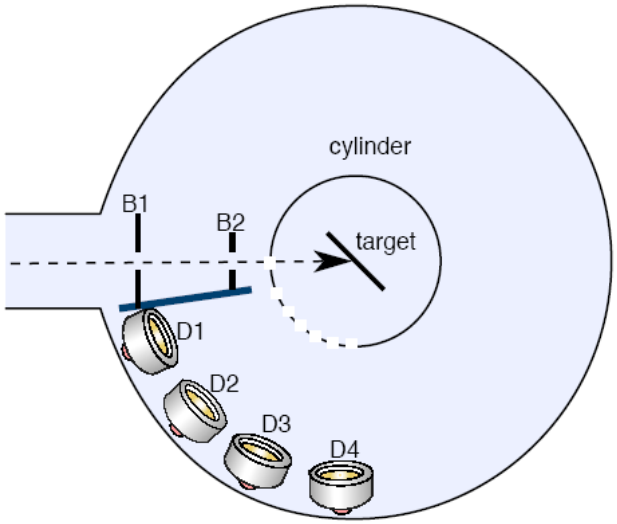
screening energy

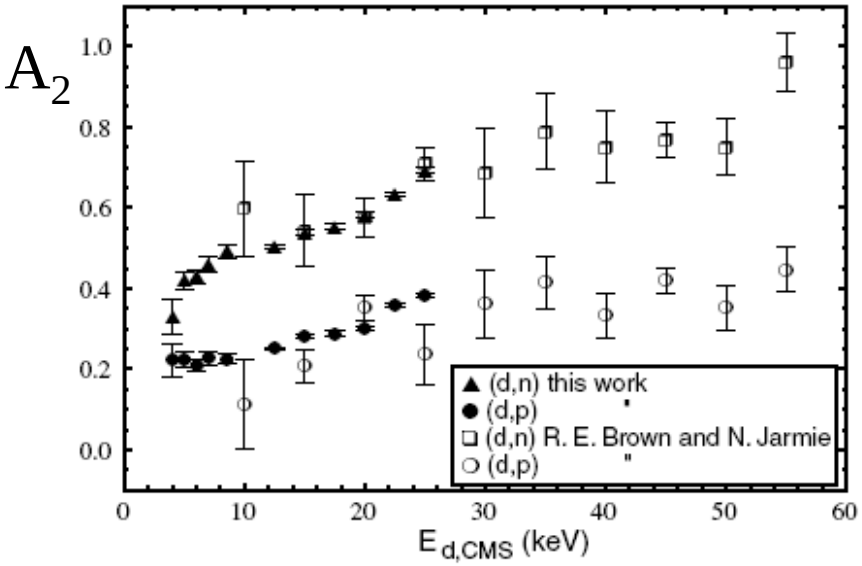
$$P(E) = \sqrt{\frac{E_G}{E}} \exp\left(-\sqrt{\frac{E_G}{E}}\right)$$

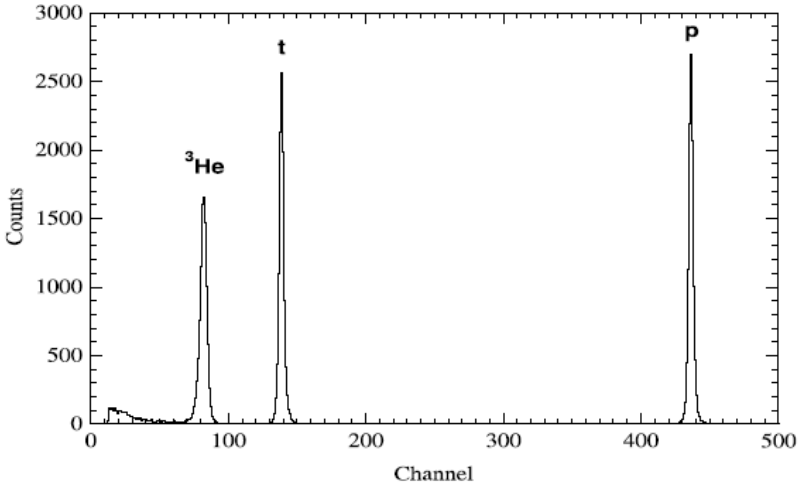
s-wave penetration factor

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

Experimental Results (HV)





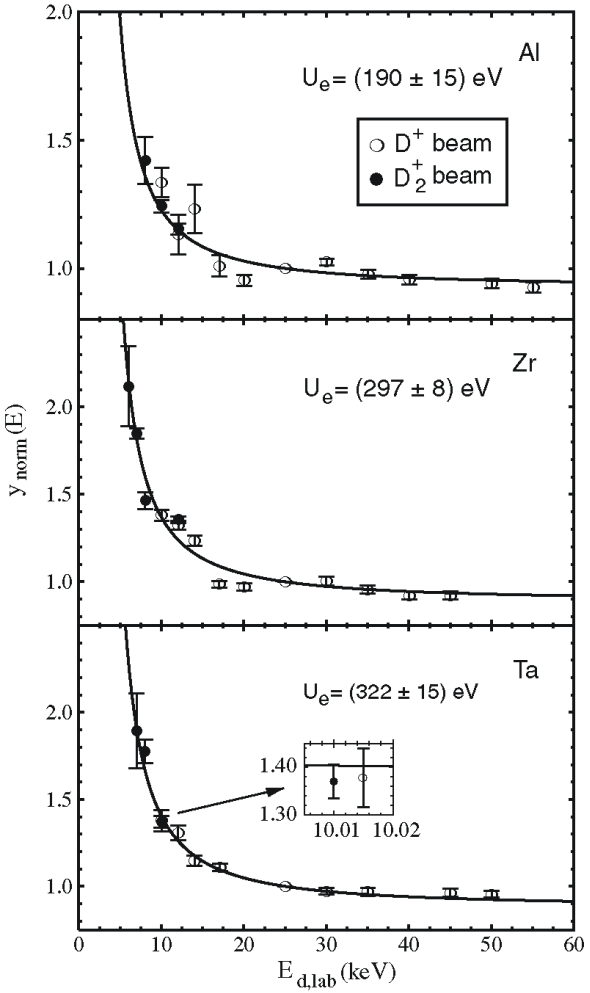


angular distribution

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

EPL 2001

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

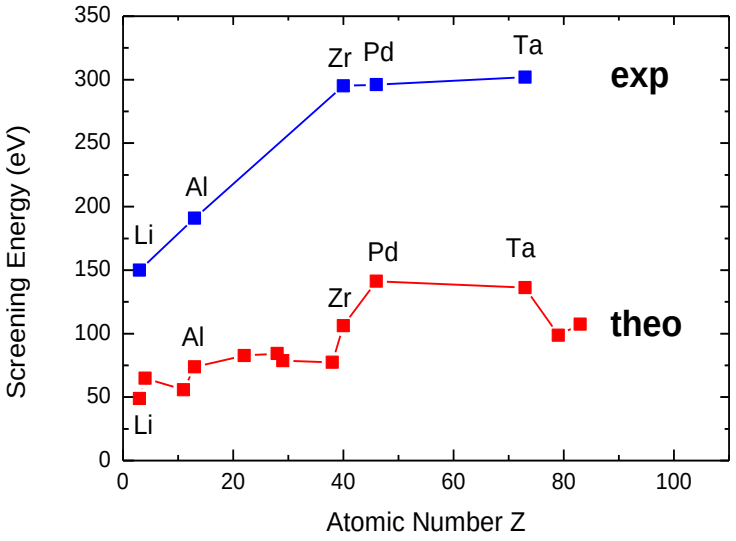
Similar results:
J. Kasagi et al., J.Phys.Soc.Jap. 71 (2002) 2281
F. Raiola et al., Eur.Phys.J. A13 (2002) 337
F. Raiola et al., Eur.Phys.J. A19 (2004) 283

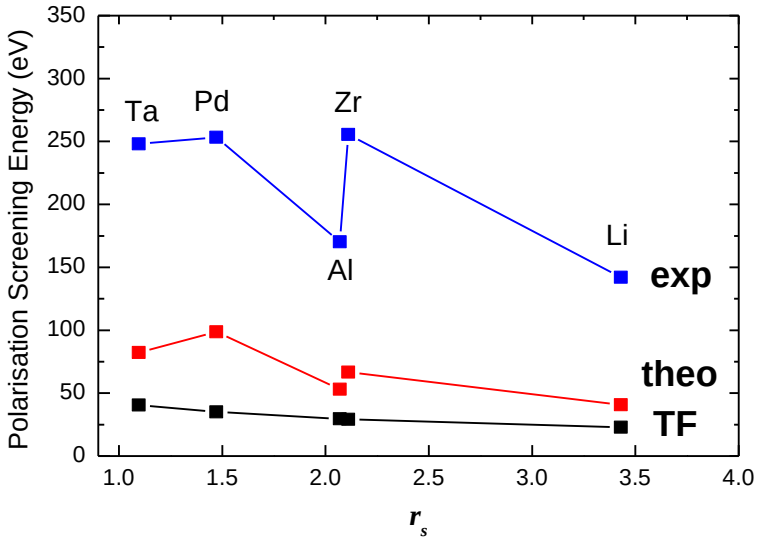
gas target

$U_e = 25 \pm 5$ 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

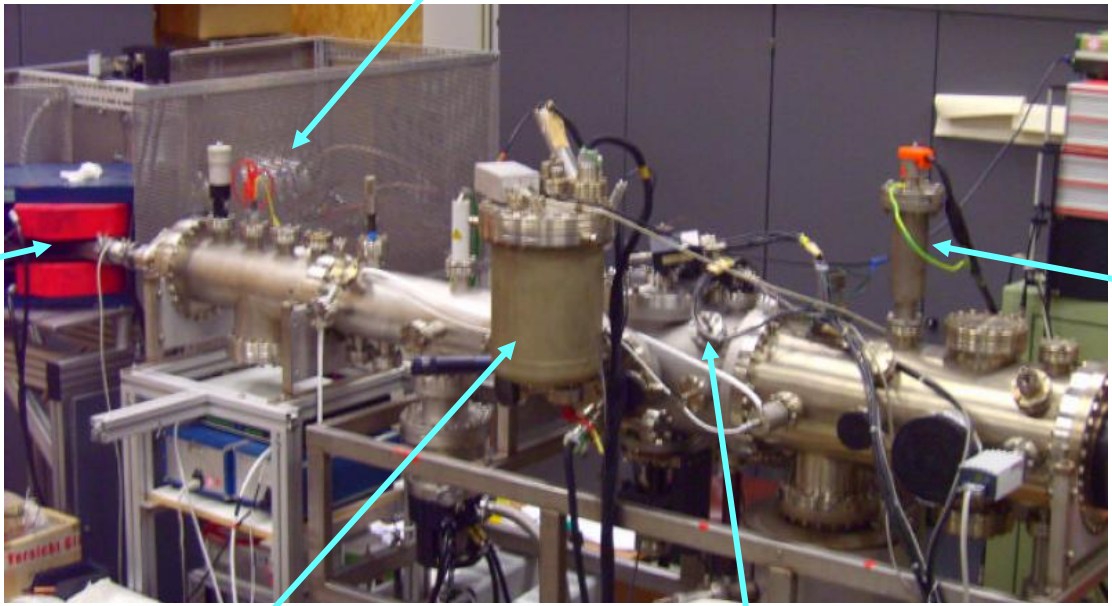
$$r_s = \left(\frac{3}{4\pi\, n}\right)^{1/3} \frac{1}{a_0}$$

Europhys. Lett. 2004, Phys. Rev. C 2008

UHV Experimental Setup

ECR ion source

I: 10-30 µA
V: 30 kV
ΔV: ~ 1 V



analyzing magnet

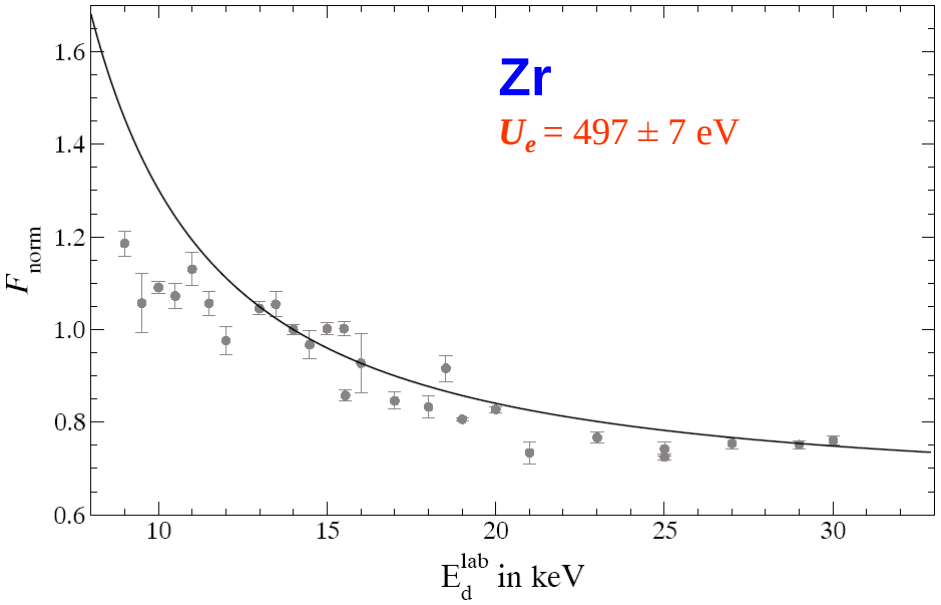
mass spectrometer

electron detector

target chamber

p: 10^{-11} – 10^{-10} mbar

UHV Results

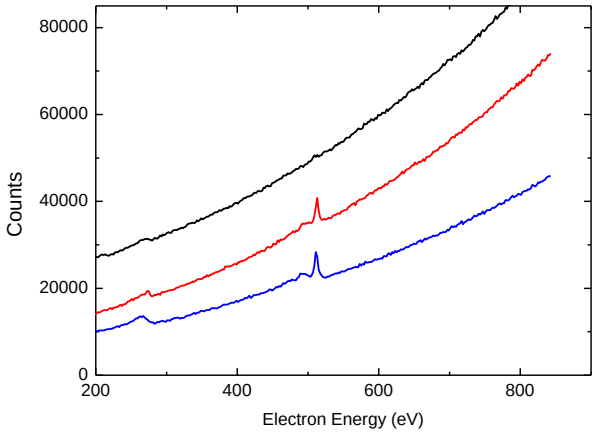


with LN_2 cooling
p_{H_2O} ~ 5x10^{-12} mbar

U_e (HV) ~ 300 eV

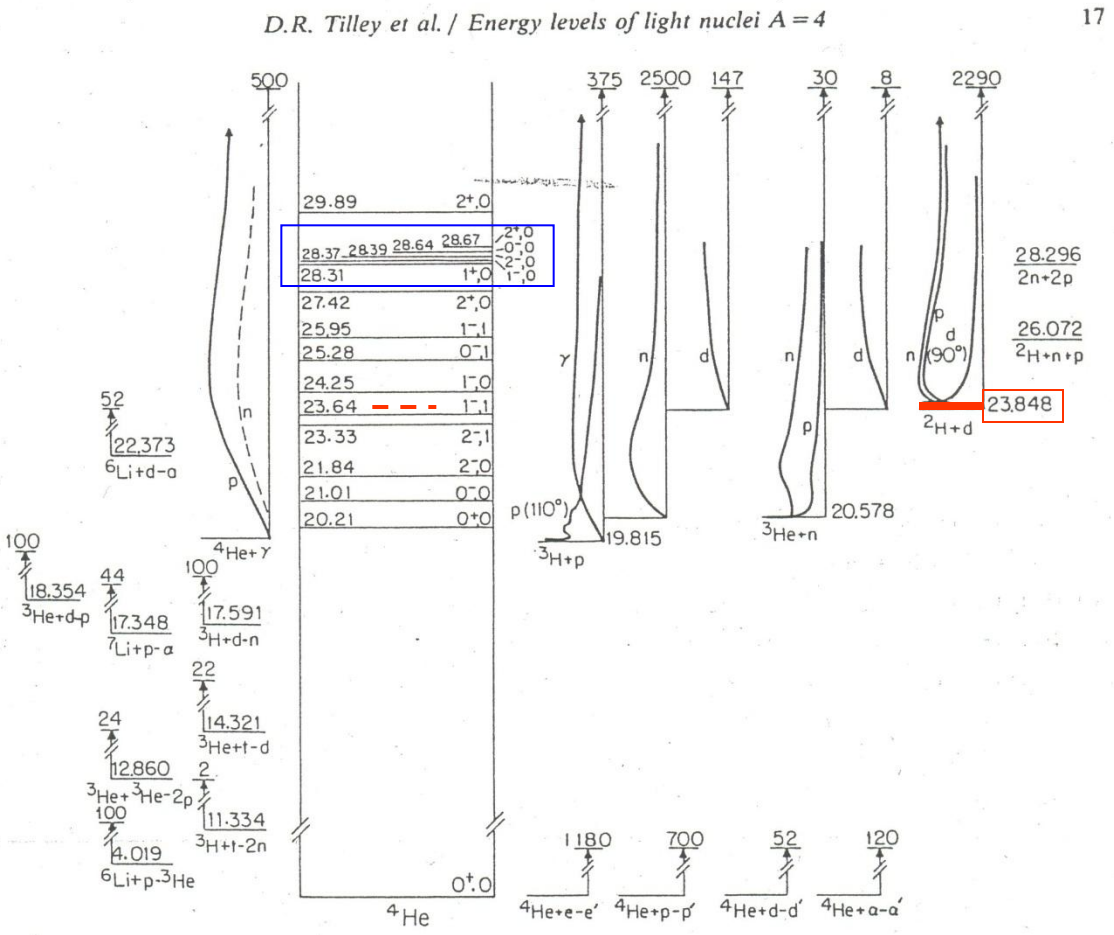
U_e (theo) ~ 97 eV

Auger electron spectroscopy



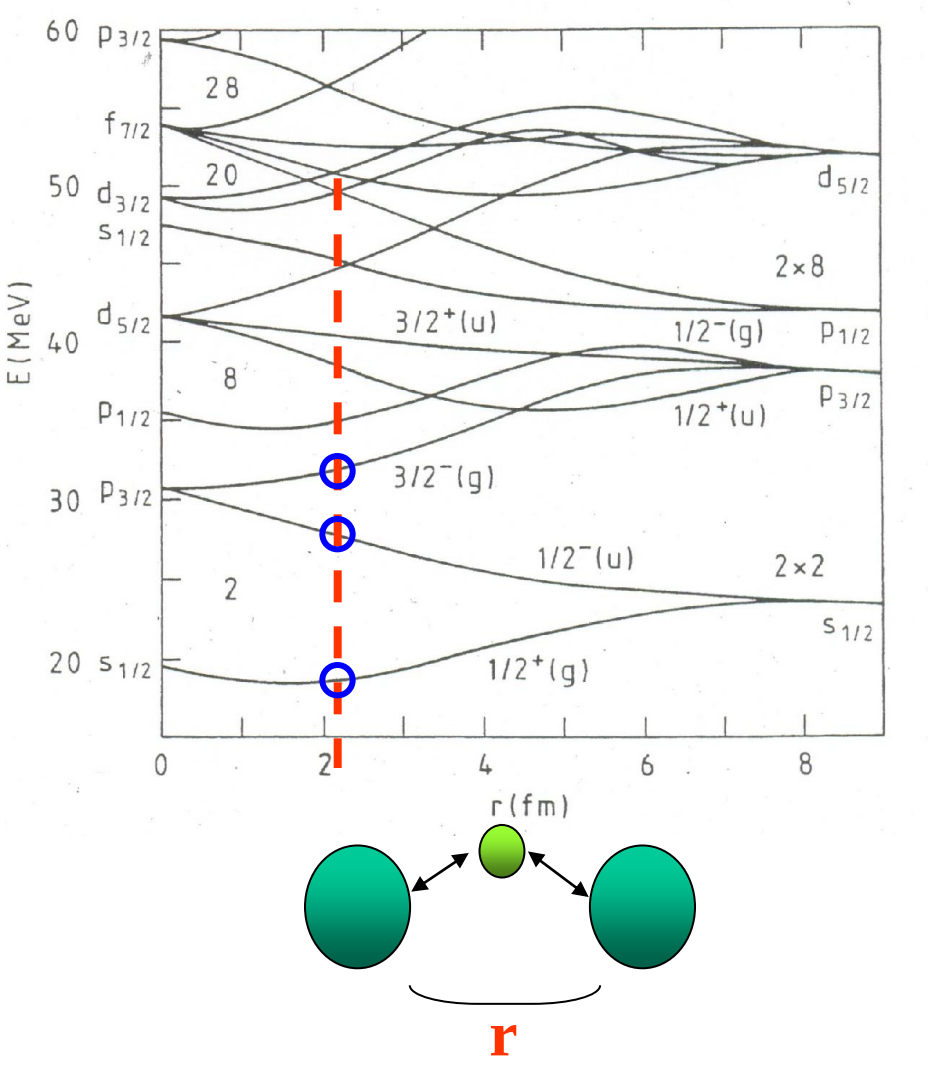
EPJ A, 2011

Compund Nucleus ^{4}He

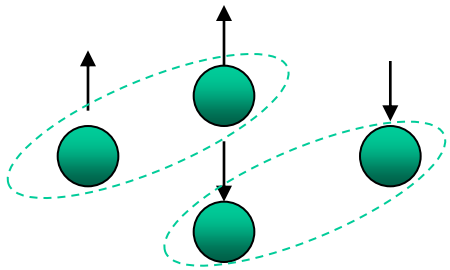


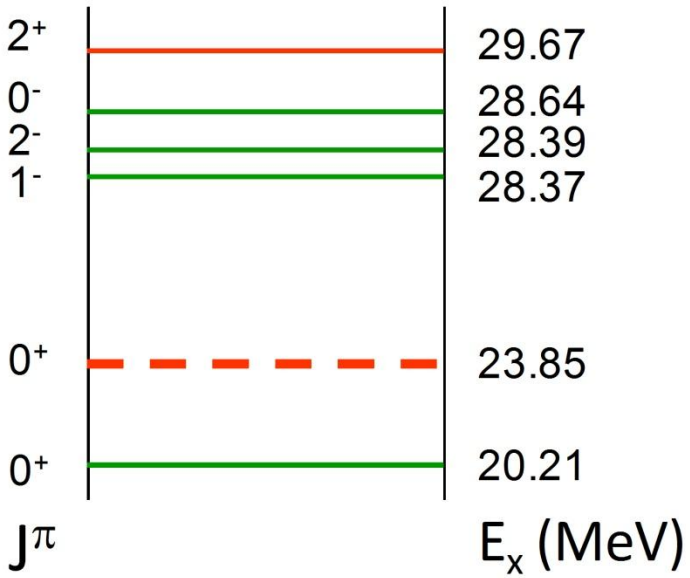
Nuclear Molecule States

Correlation diagram for the valence particle in the nuclear two-center system

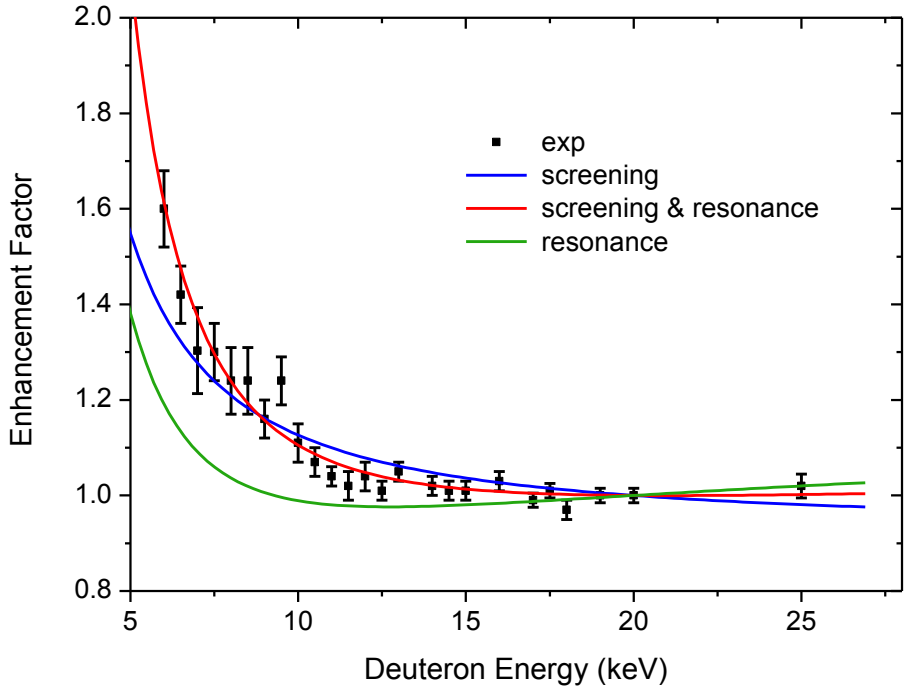


d + d structure





UHV Electron Screening – Resonance Contribution



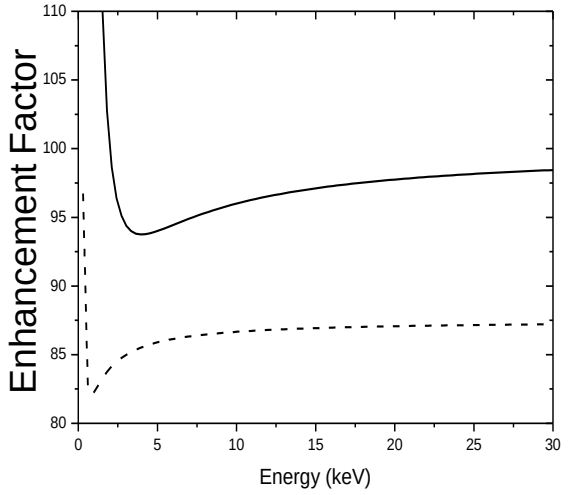
Zr

U_e = 130 eV

Γ_p=20 meV

interference effect

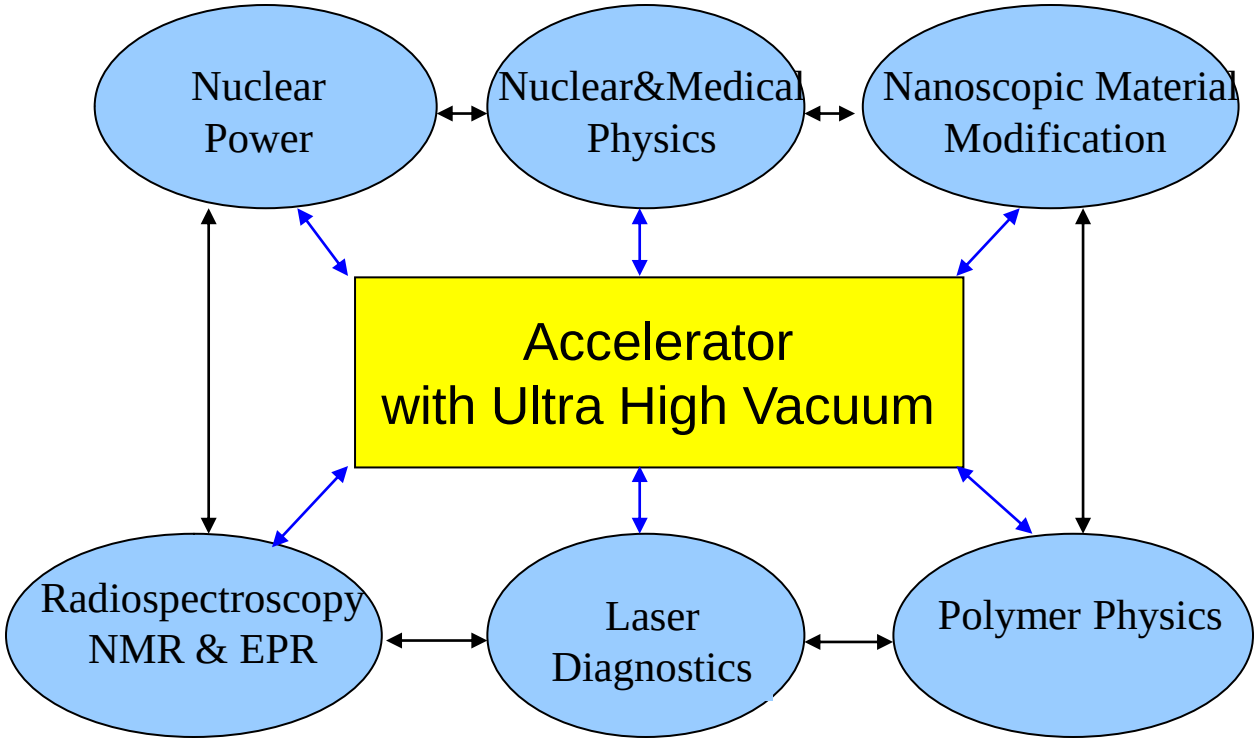
$$\sigma = \left|\sqrt{\sigma_F} + \sqrt{\sigma_R}\right|^2 = \sigma_F + \sigma_R + 2\sigma_F\sigma_R\cos\varphi$$



16 matrix elements $T_{\beta\alpha} = <^{2S\alpha+1}L_{\alpha J}|J^{\pi}|^{2S\beta+1}L_{\beta J}>$

eLBRUS: scheme

Unique combination of research methods of nuclear physics with methods of solid-state physics and laser optics for study of the condensed hard, soft and biological matter



e
Laboratoria
Badawczo-
Rozwojowe
Uniwersytetu
Szczecinskiego

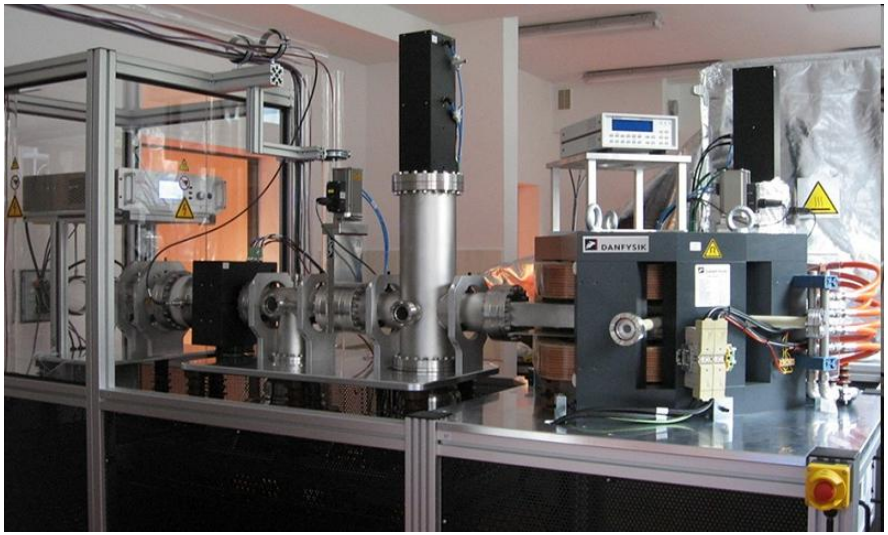
eLBRUS: realization

Laboratory of Nuclear and Medical Physics

accelerator with ultra high vacuum

prototype ECR ion source
low emittance , high current,
light ions – a few mA

Dreebit, Dresden, Germany



Equipment:

Electron Auger Spectroscopy

XPS, UPS

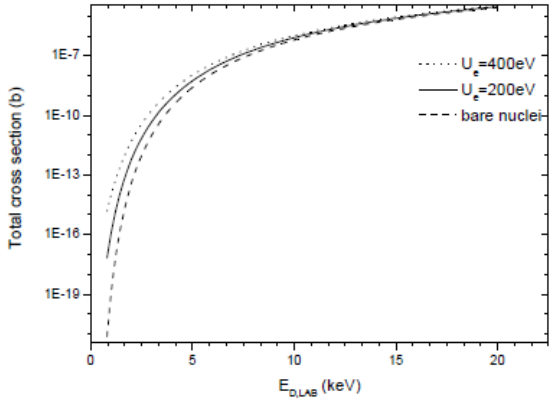
scanning pulsed Argon gun – ToF spectr.

mass spectroscopy

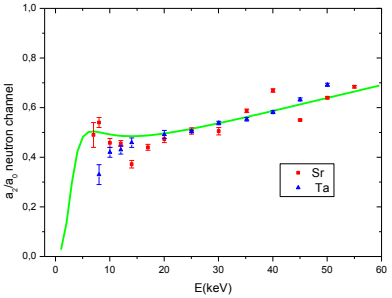
$p = 10^{-11}$ mbar

PREVAC, Poland

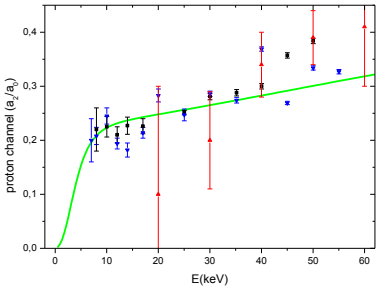
Cross Sections @ 1 keV

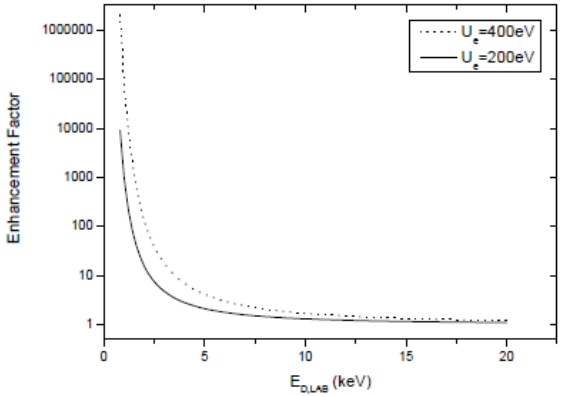


neutron channel

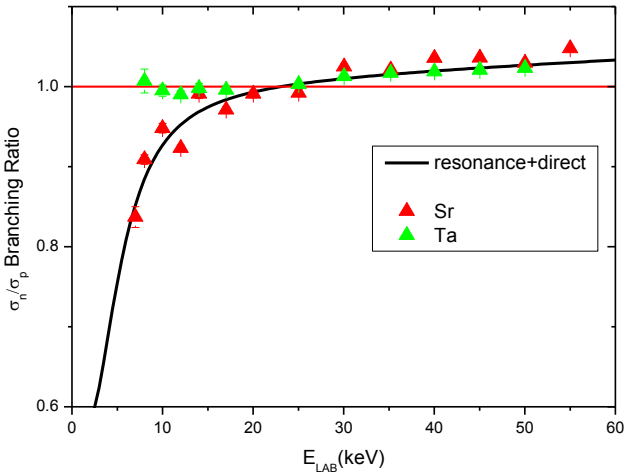


proton channel





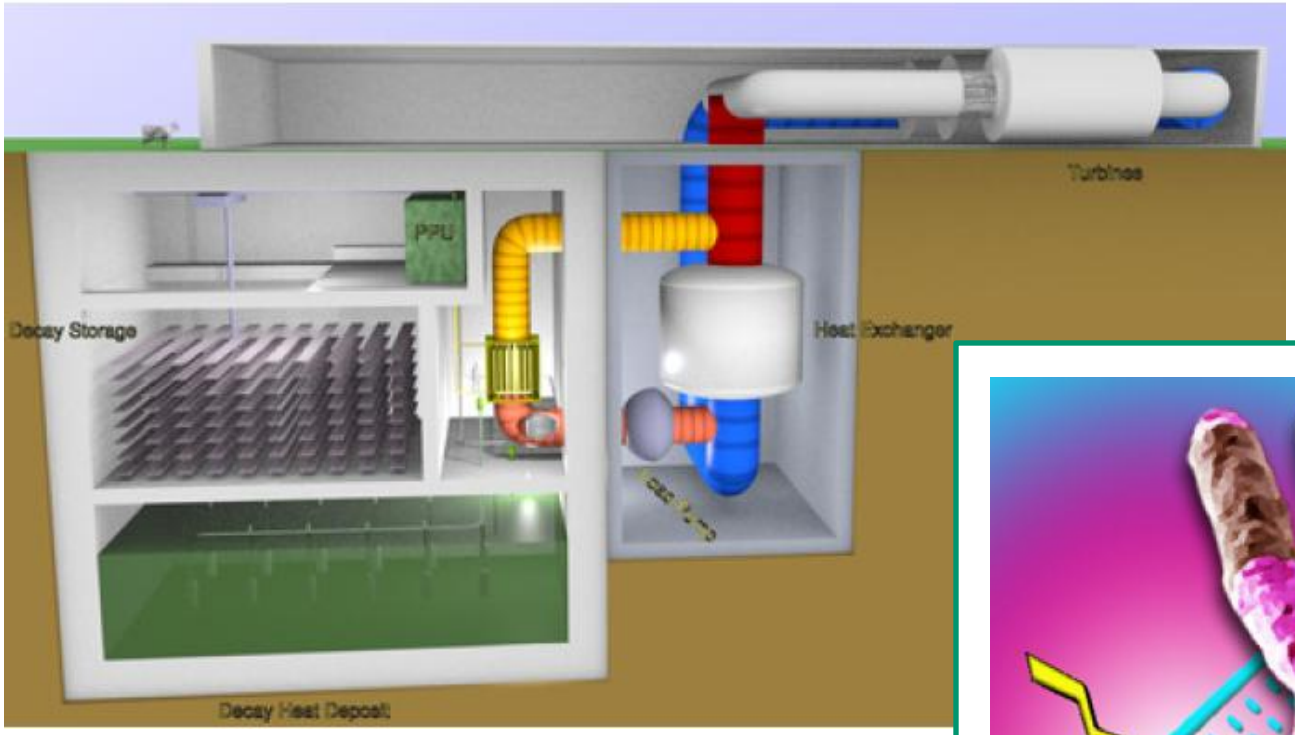
branching ratio

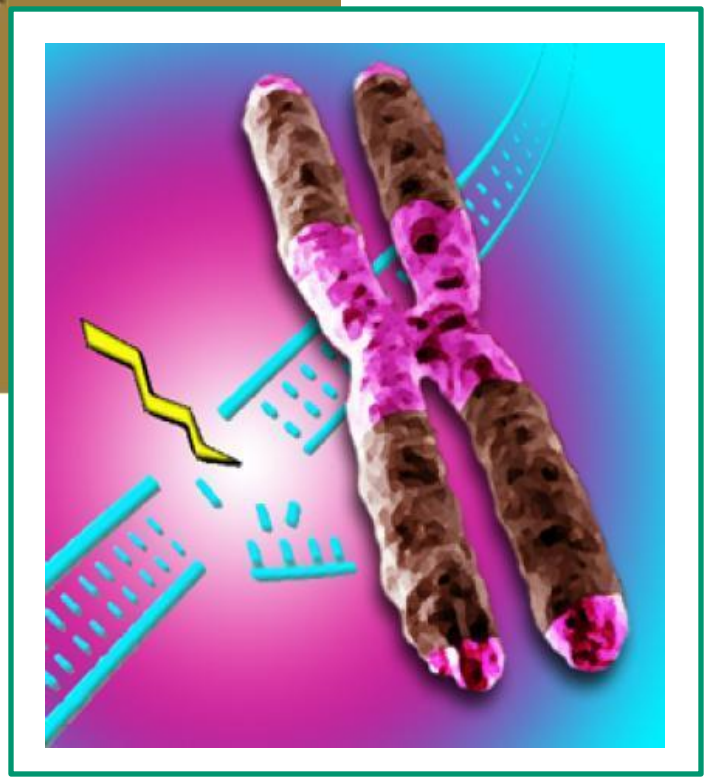


16 transition matrix elements

APP B 2014

eLBRUS : Dual Fluid Reactor





& chromosome aberrations

People

Electron Screening

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K. Czerski
A. Huke
P. Heide
D. Weißbach

U Szczecin
K. Czerski
N. Targosz
A. Kilic
M. Kaczmarski
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W. Pereira

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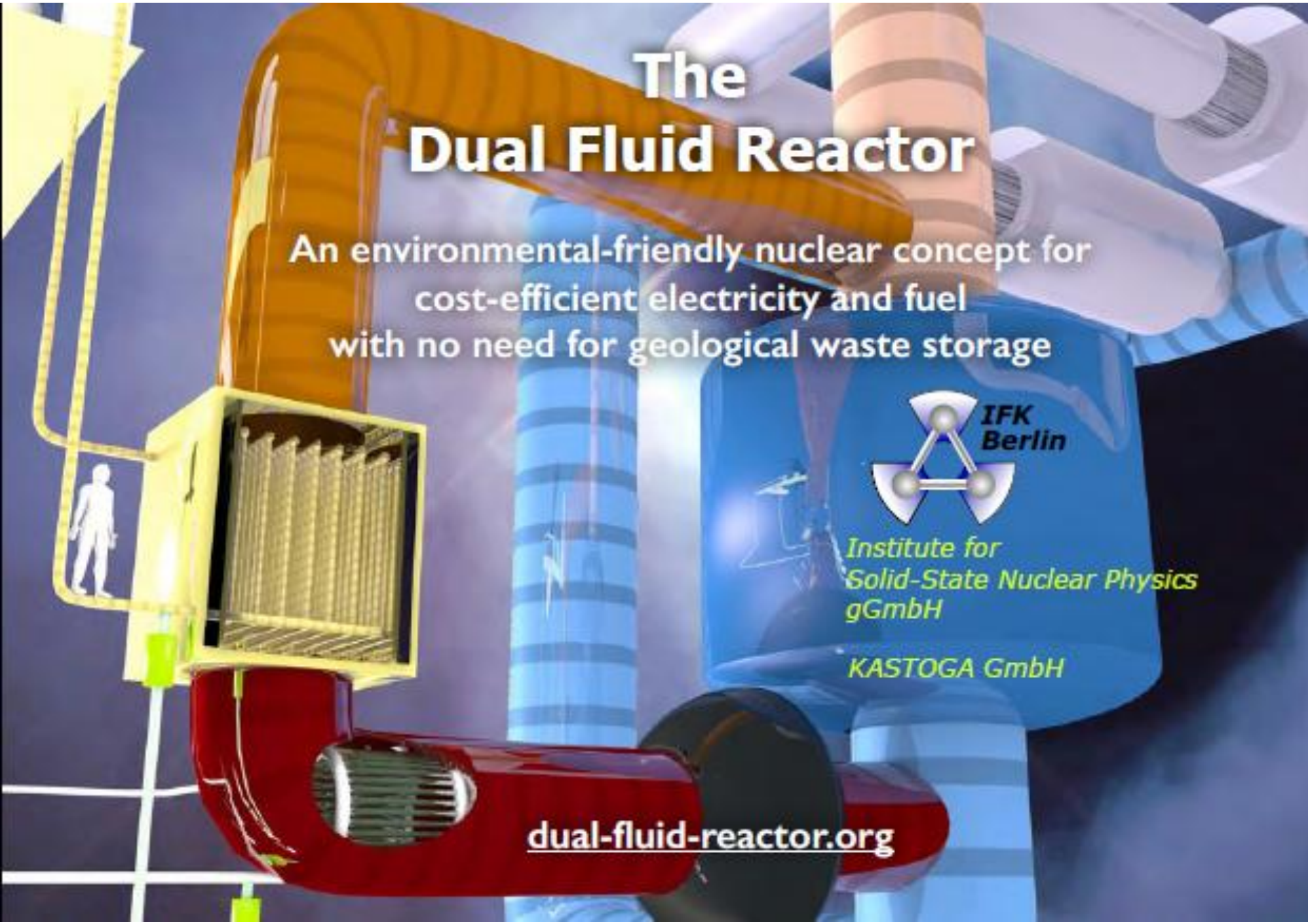
G. Ruprecht
L. Martin

HU Berlin
H. Winter
D. Blauth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