Nuclear orientation in transfer reactions

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Overview

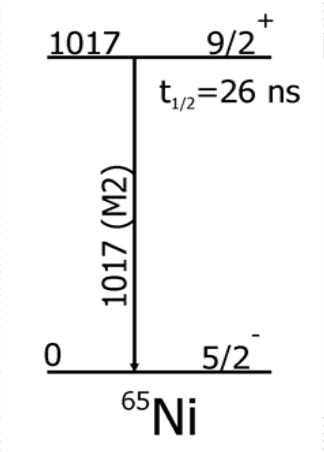
nuclear moments measurement ⟷ spin-oriented nuclear ensemble

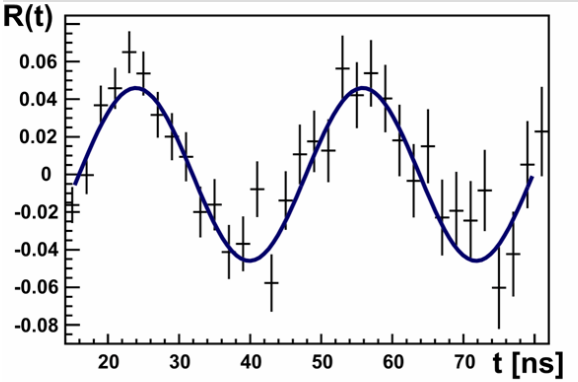
Spin orientation in single-particle transfer reactions:

- ^{65m}Ni - direct kinematics (d,p)
- ^{66m}Cu – direct kinematics (d,p)
- ^{64m}Cu – inverse kinematics (d,p)

^{64}Ni (d,p) ^{65m}Ni

- enriched ^{64}Ni target
- pulsed 1nA D beam, 3MeV/u
- ferromagnetic host





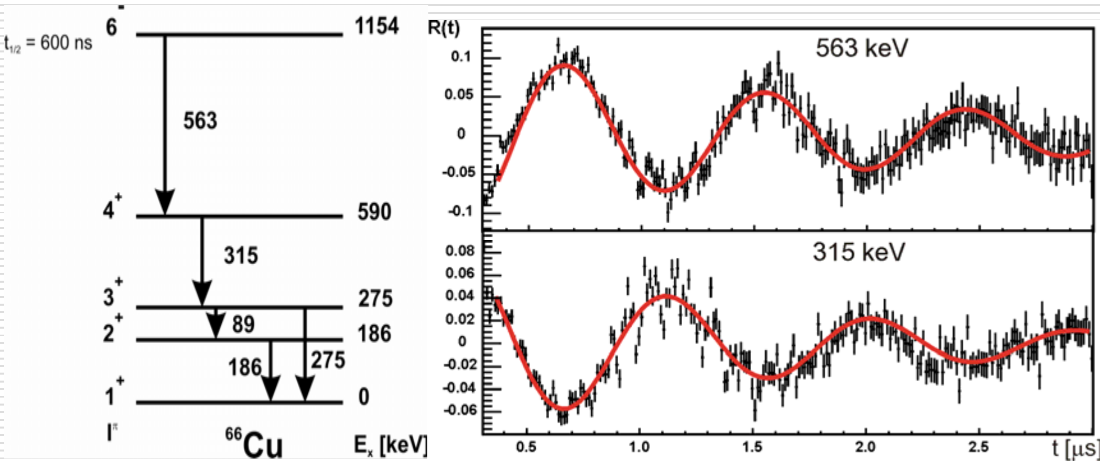
$t_{1/2}$ = 26ns

σ/I = 1.11

(B_2 = 0.14)

^{65}Cu (d,p) ^{66m}Cu

- ^{65}Cu target, natural isotope abundance
- pulsed D beam, 2.7 MeV/u



$t_{1/2}$ = 600ns

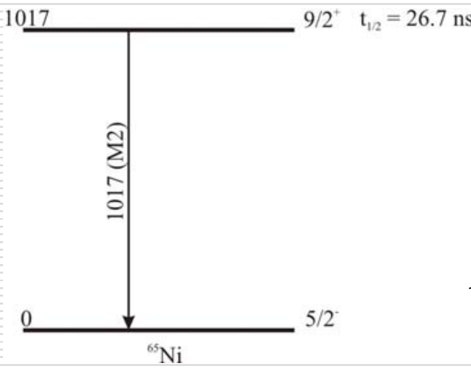
σ/I = 0.55

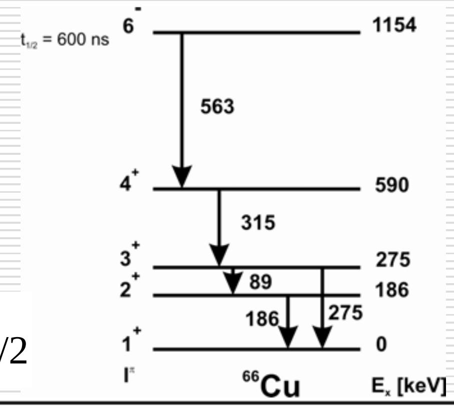
(B_2 = 0.45)

^{65}Ni vs. ^{66}Cu orientation?

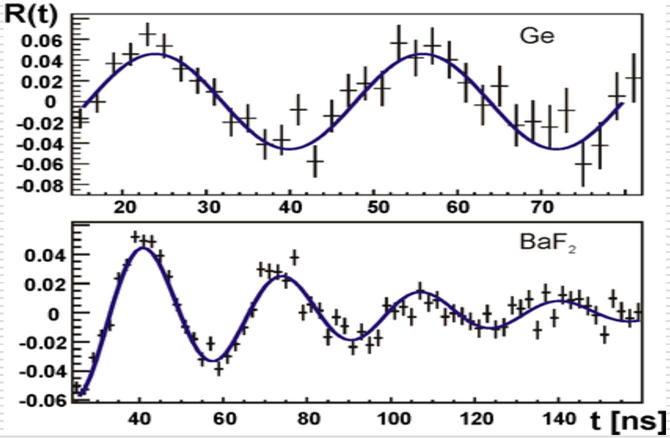
^{64}Ni(d,p)^{65m}Ni @ 3 MeV/u

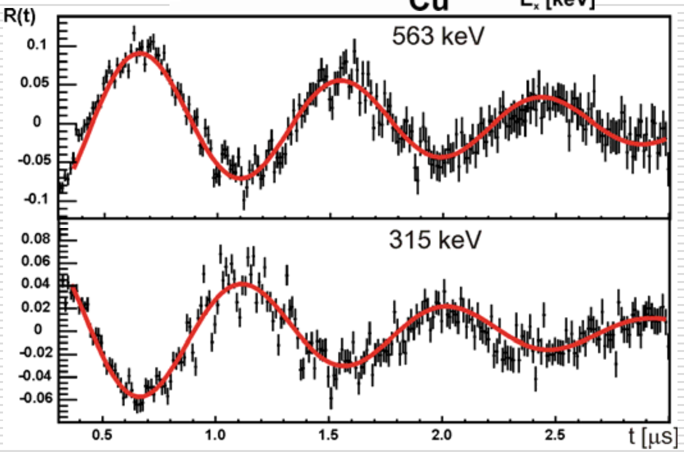
^{65}Cu(d,p)^{66m}Cu @ 2.7 MeV/u





$\nu g_{9/2} \leftarrow\rightarrow \pi p_{3/2} \otimes \nu g_{9/2}$





$\sigma/I = 1.11$

$(B_2 = 0.14)$

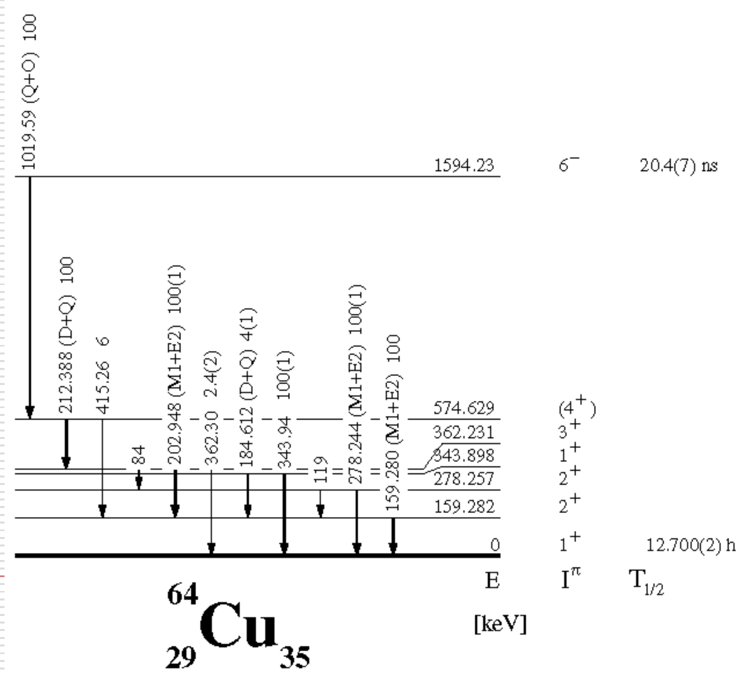
$\sigma/I = 0.55$

$(B_2 = 0.45)$

^{63}Cu (d,p) ^{64m}Cu

- (d,p) reaction in inverse kinematics
- 2mg/cm² CD_2 target
- ^{63}Cu beam,220 MeV (3.5 MeV/u)
- ferromagnetic backing
- permanet magnet as external field

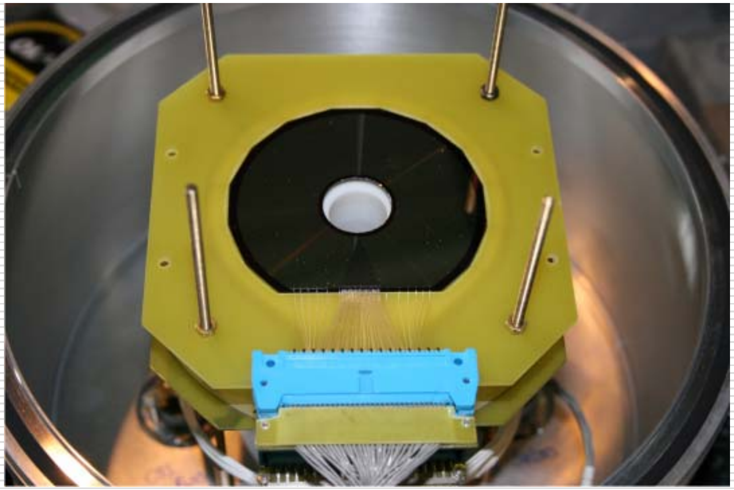
$t_{1/2}$ = 20ns

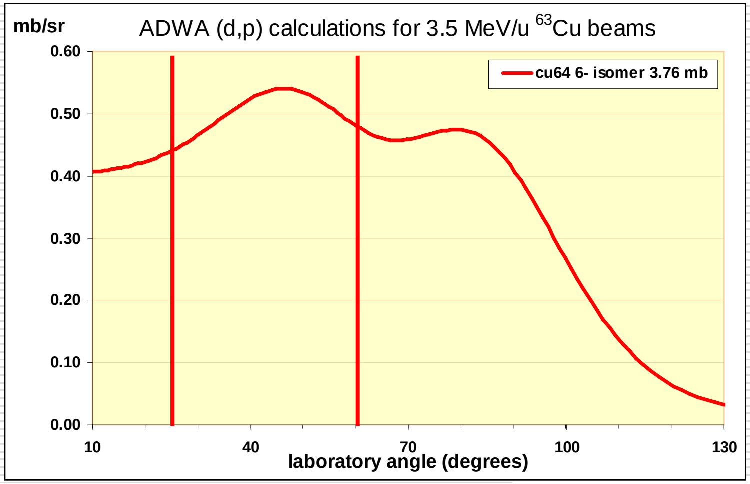


^{64}Cu – Particle identification

- ΔE det → annular Si (8 strips) from TIARA
- E det → CsI scintillator (16 sectors)

Angular coverage → 25° - 60°



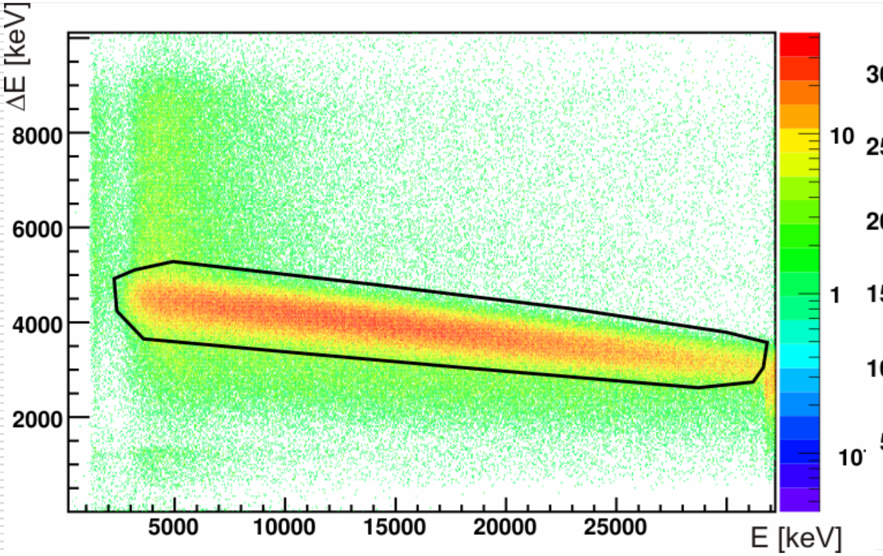


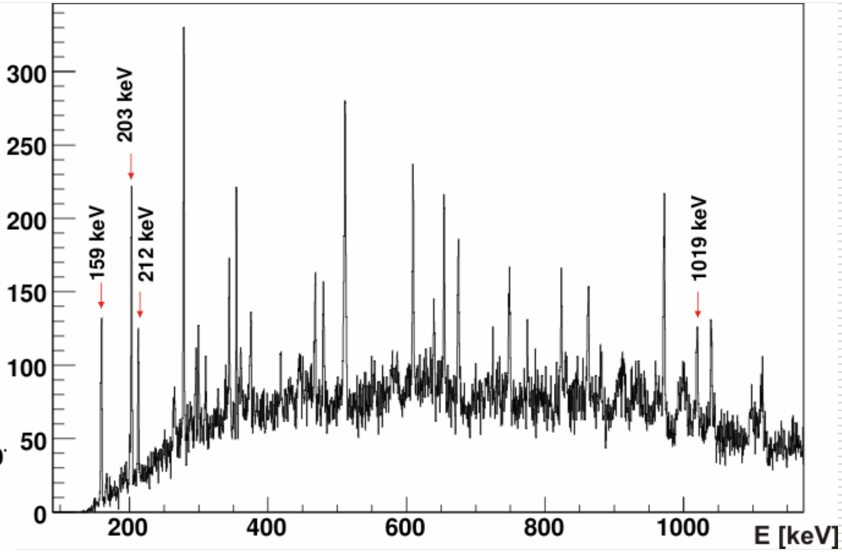
W.N. Catford

^{64}Cu - Spectroscopy

clean particle identification

all transition observed

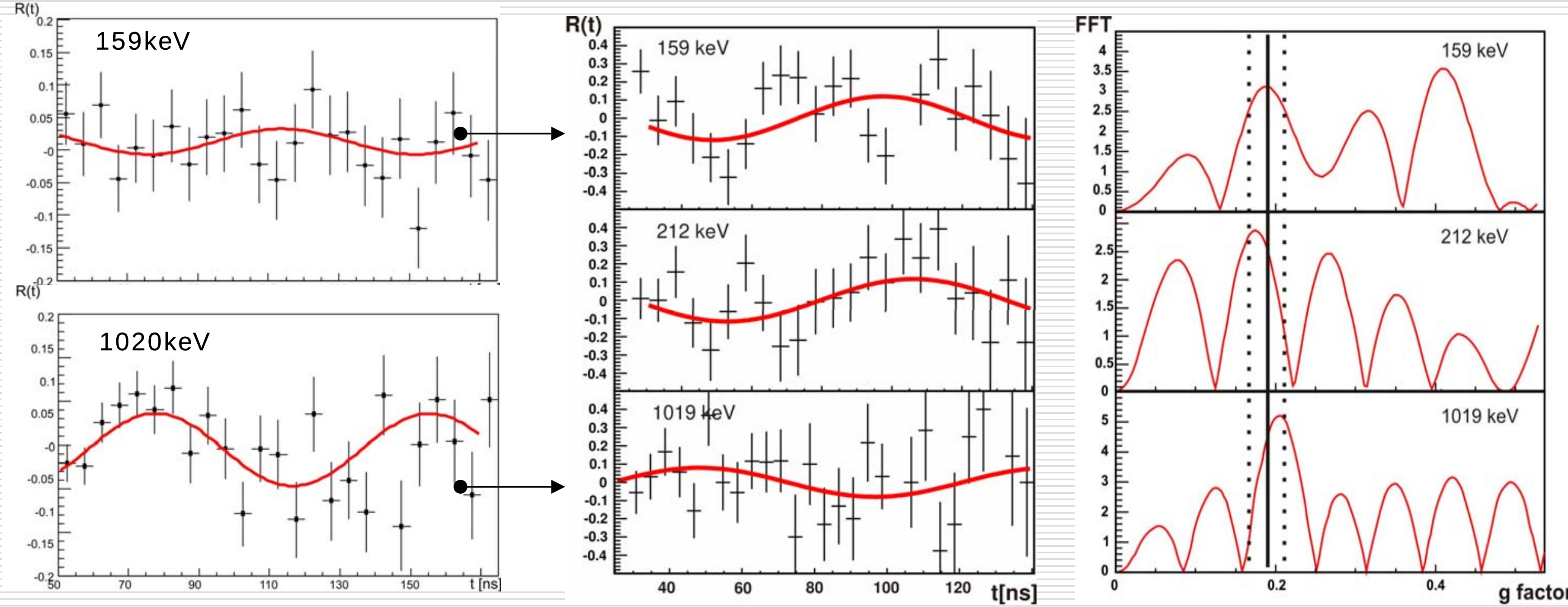




^{64}Cu - Results

γ vs beam pulsing $\rightarrow \sigma/I = 0.93$ ($B_2 = 0.19$)

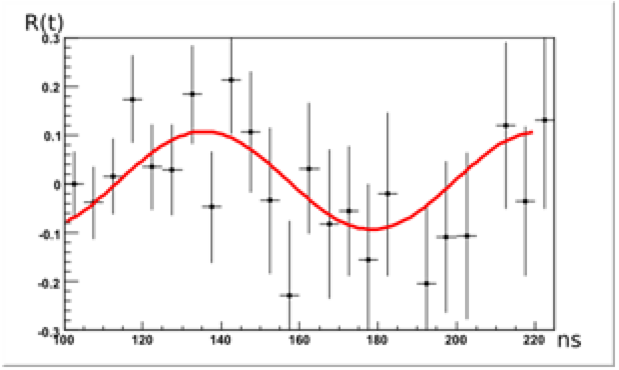
p-γ correlation $\rightarrow \sigma/I = 0.66$ ($B_2 = 0.34$)



^{64}Cu - Statistics

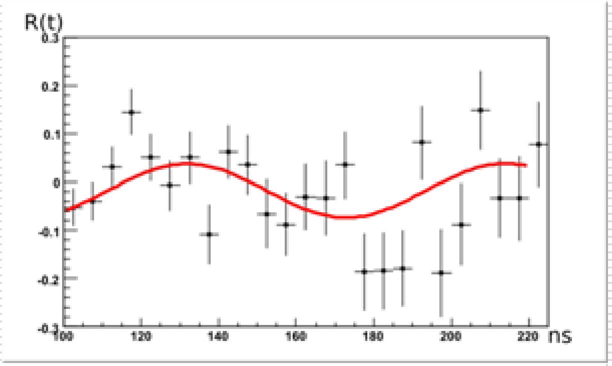
1020keV

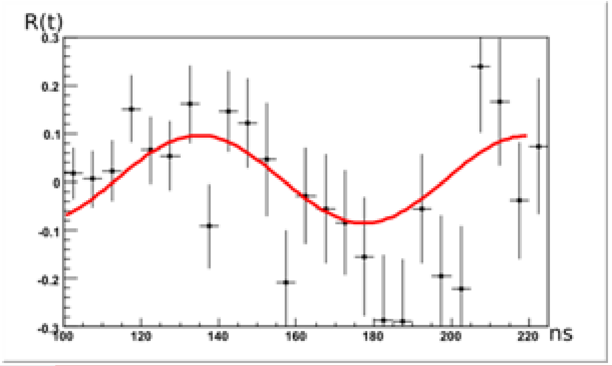
total ions on target



$3*10^{13}$

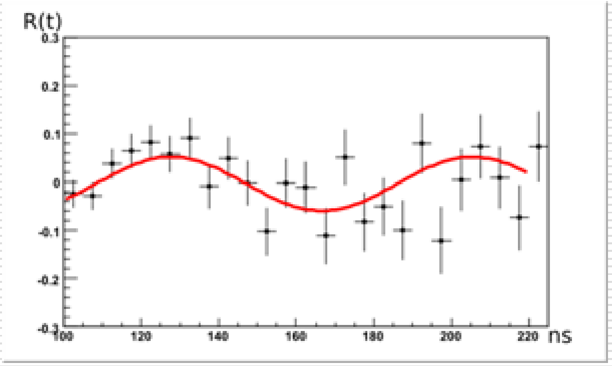
$1.5*10^{15}$





$6*10^{13}$

$3*10^{15}$

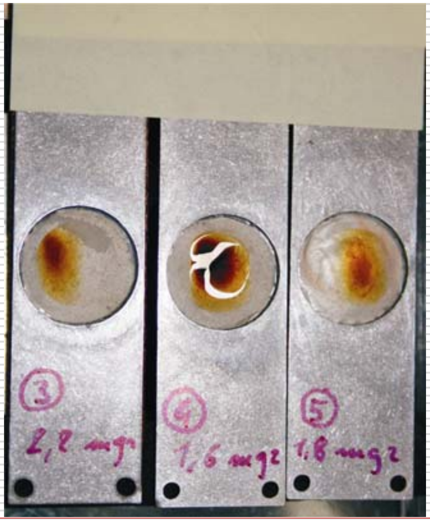


CD_2 target dose

- After ~100 MGy the target is destroyed

100 MGy ~20h 0.3enA (10^8pps) of $(17^+)^{63}$Cu at 220MeV

- Not a heat effect



Conclusions

- single nucleon transfer reaction can be used for nuclear moment measurements in inverse kinematics
- p-γ correlation could provide higher orientation and might be used in continuous beam conditions
- further studies and developments are necessary for better understanding and control of the technique

Collaboration

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and the N4, N-SI-4 and N-SI-14 collaborations:

S. Ashley[4], G. Audi[1], G. Belier[5], S. Brown[4], W.Catford[4], J.M. Daugas[5], F. Dayras[1], F. De Oliveira Santos[6], S. Franchoo[7], W. Gelletly[4], K. Gladnishki[2], F. Ibrahim[7], G. Jones[4], F. Le Blanc[7], M. Lebois[7], M. Lewitowicz[6], G. Lo Bianco[3], R. Lozeva[8], S. Lukyanov[9], I. Matea[10], V. Meot[5], E. Minaya[1], P. Morel[5], S. Nardelli[3], G. Neyens[8], Yu.E. Penionzhkevich[9], S. Pietri[4], P.H. Regan[4], O. Roig[5], A. Saltarelli[3], O. Sorlin[7], M. Stanoiu[7], M. Tarisien[5], C. Thibault[1], N. Vermeulen[8], D. Verney[7], P. Vingerhoets[8], D. Yordanov[8]

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