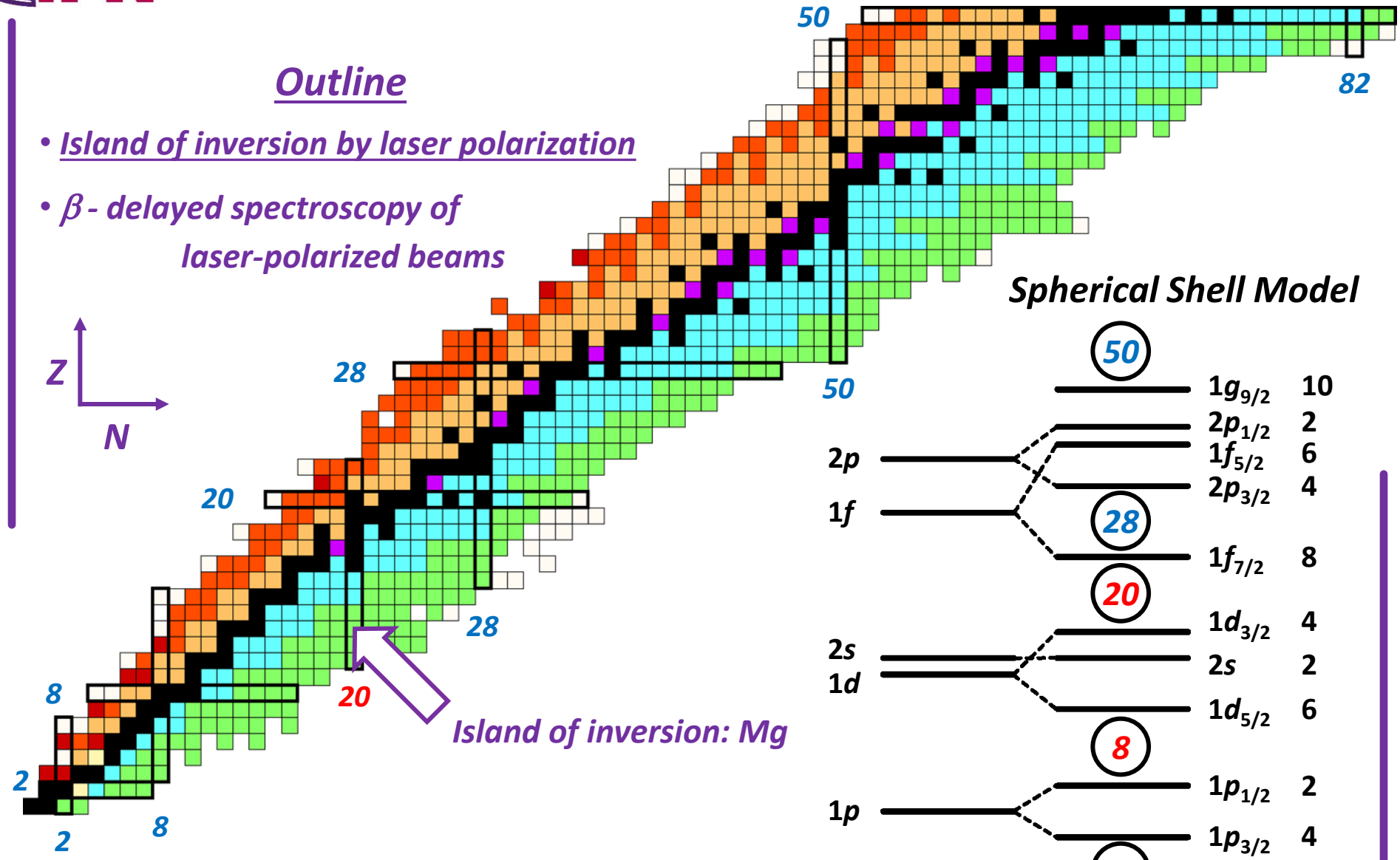
Project for Laser-Induced Nuclear Orientation at ALTO

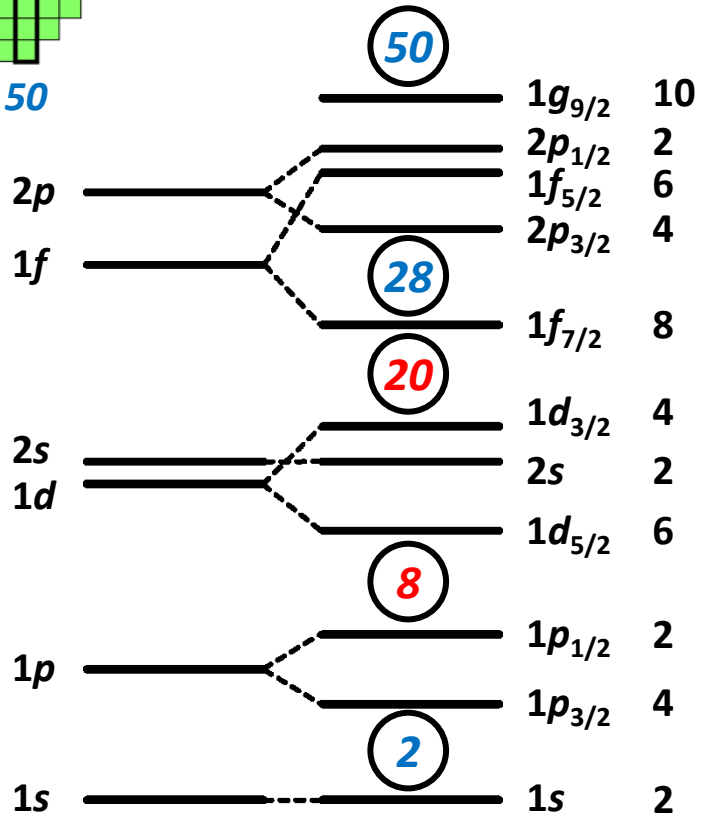
D. T. Yordanov for the LINO project

Outline

- Island of inversion by laser polarization
- β - delayed spectroscopy of laser-polarized beams



Spherical Shell Model



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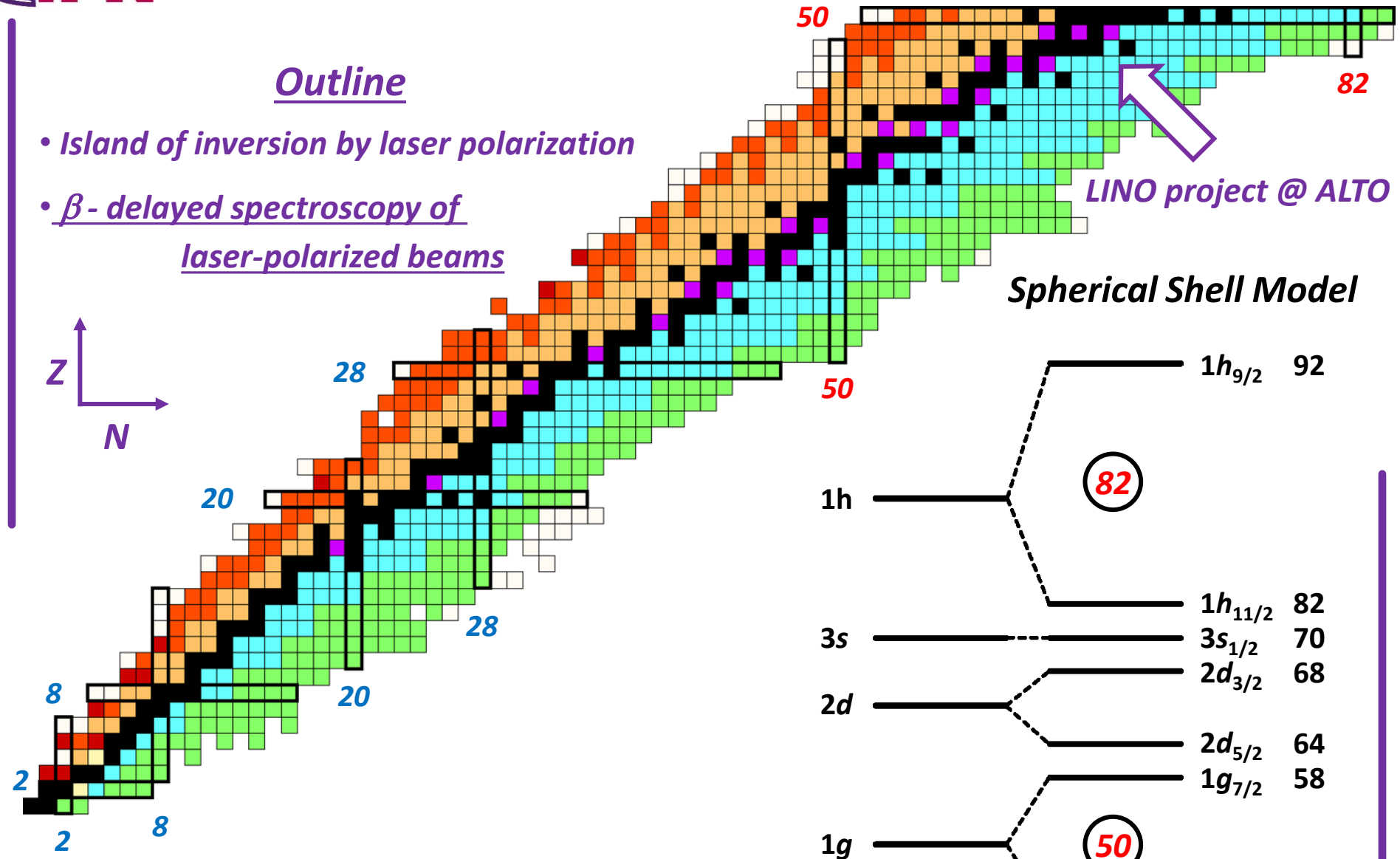

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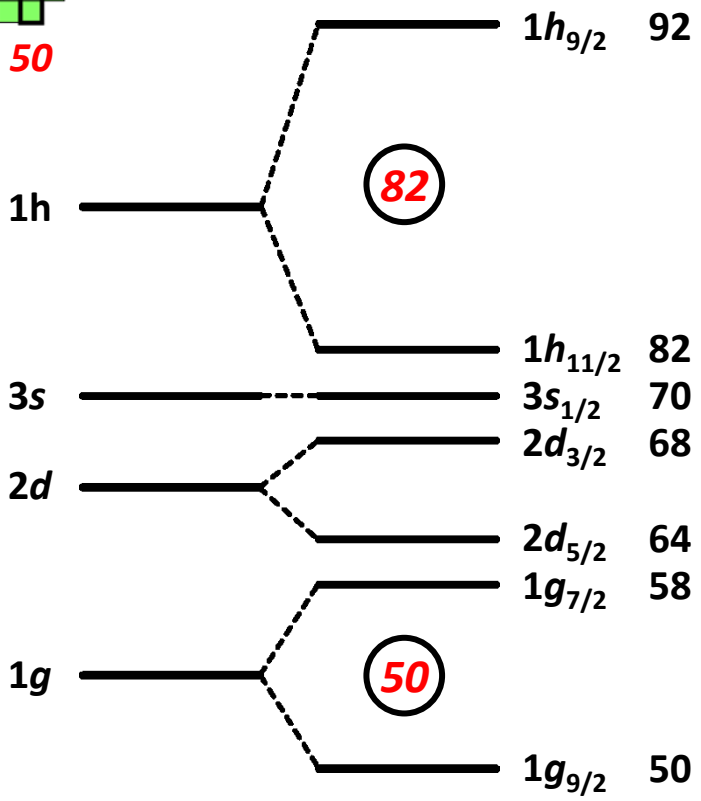
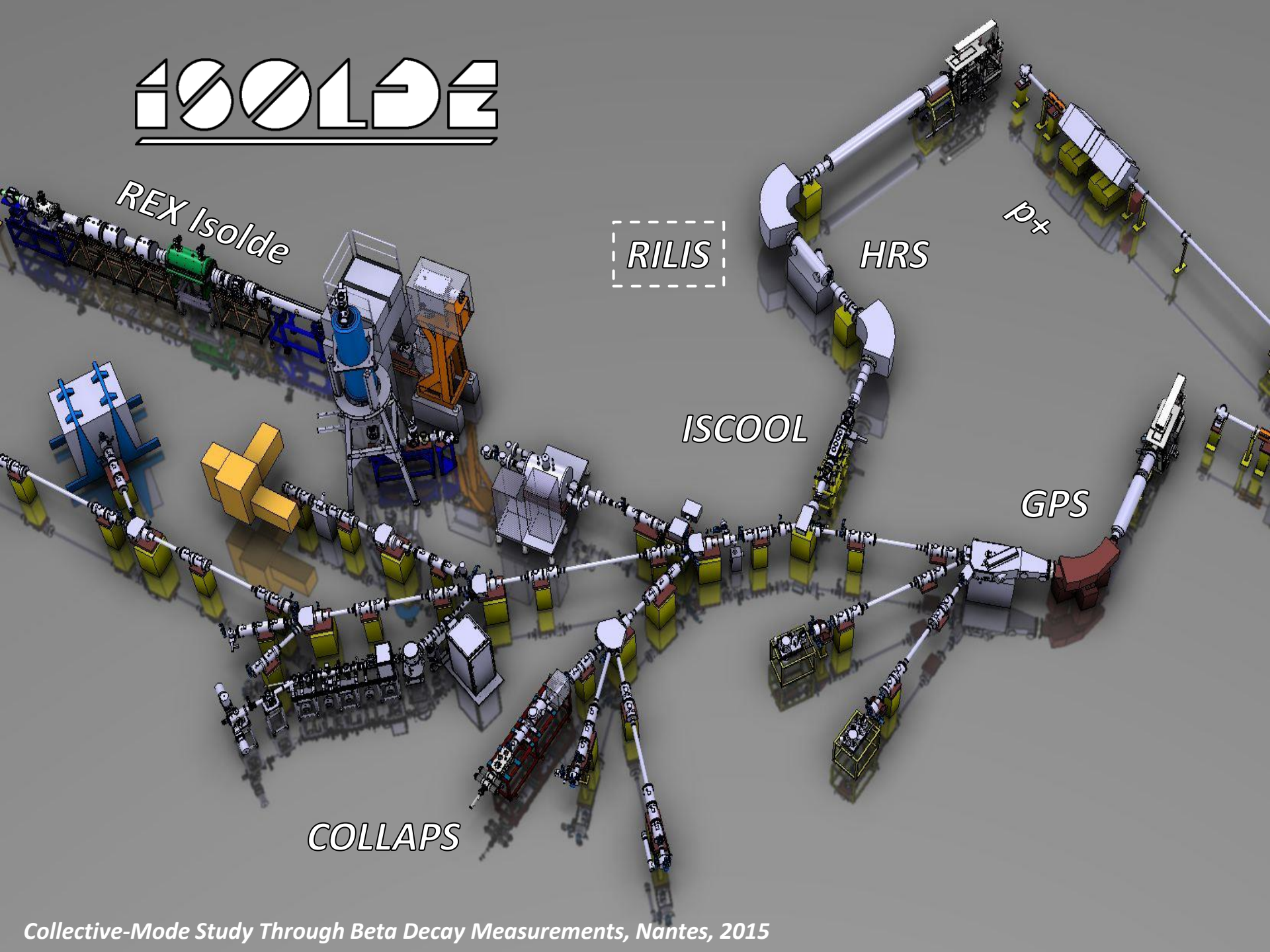
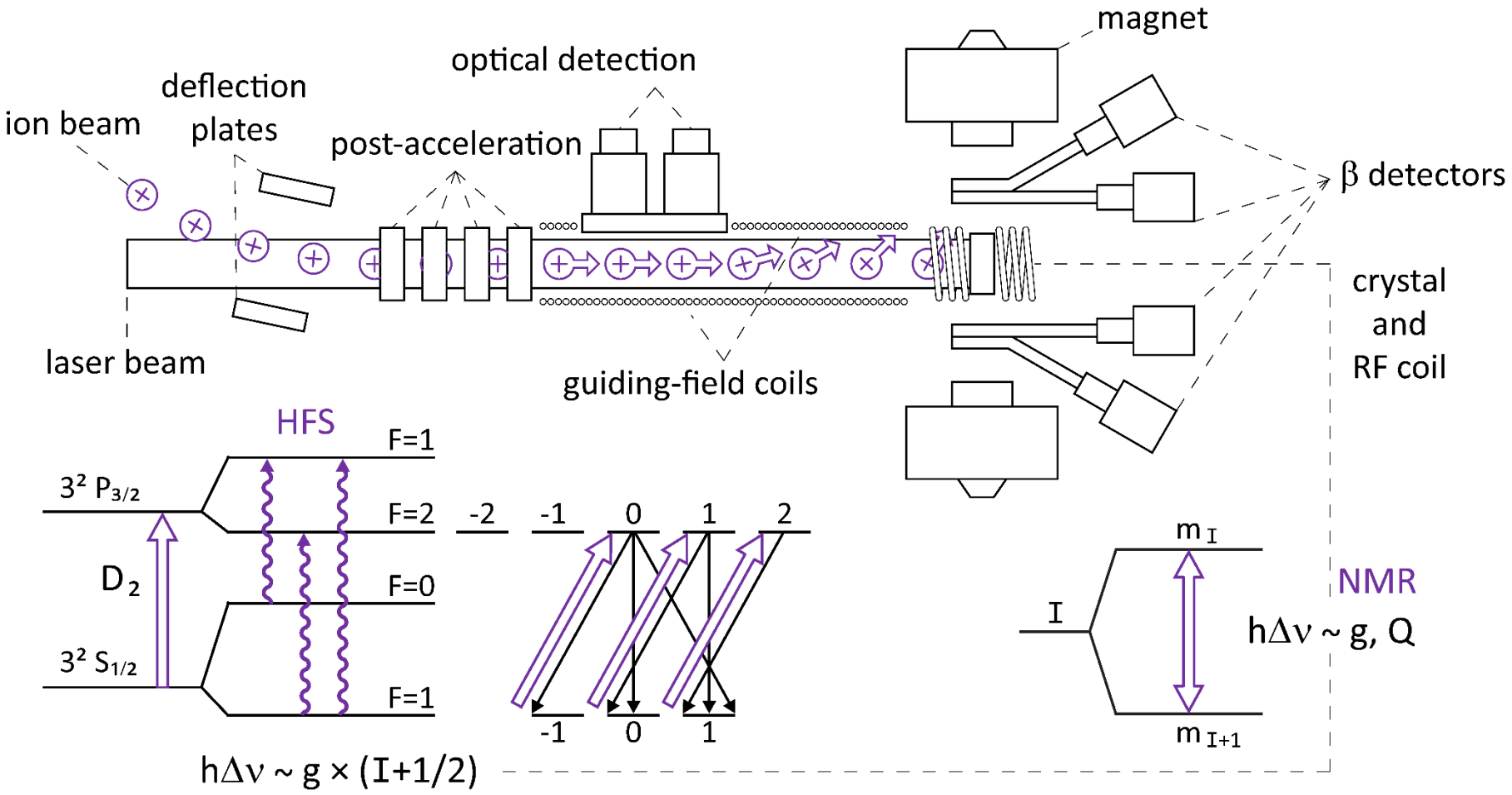



ISOLDE
REX Isolde
RILIS
HRS
ISCOOL
GPS
COLLAPS

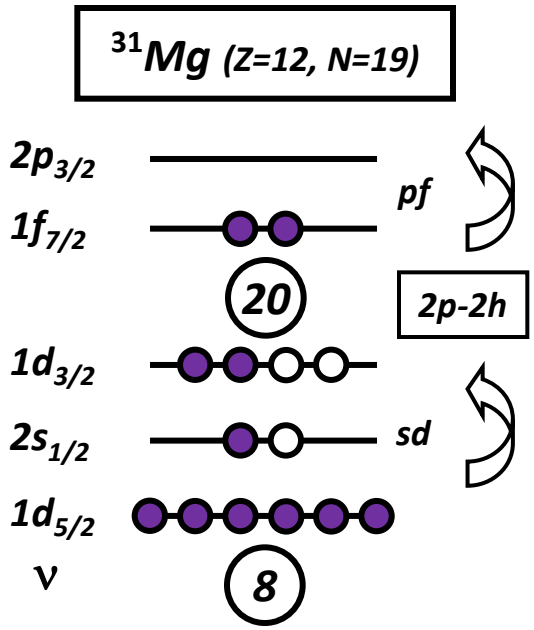
Laser Spectroscopy in the Island of Inversion

The β - NMR method

nuclear moments; spin; charge radius



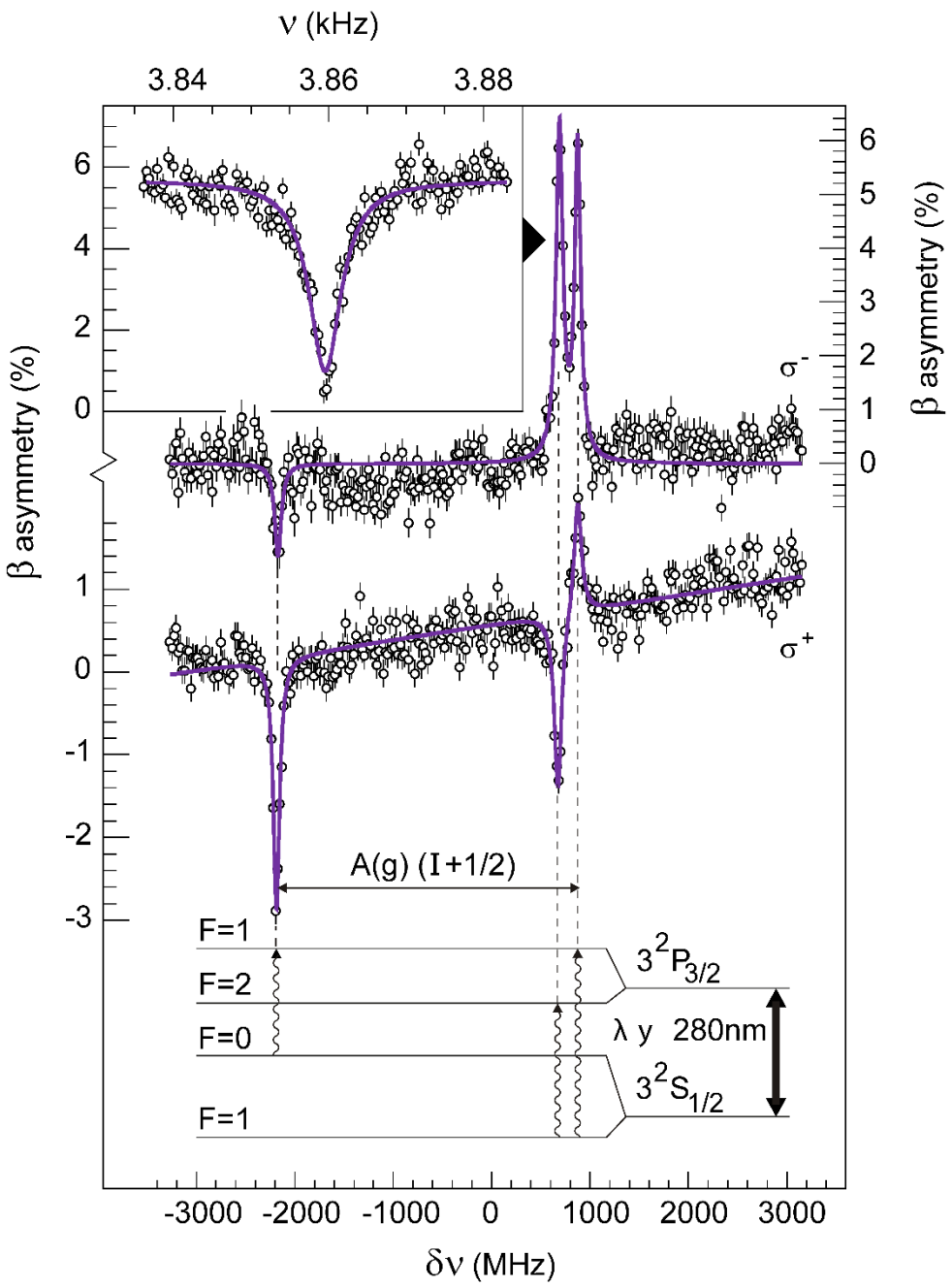
Spin and magnetic moment of ^{31}Mg



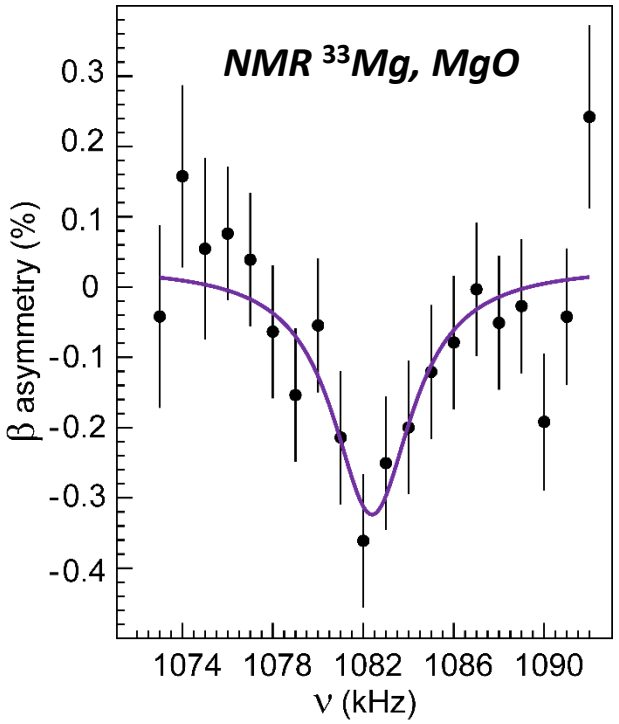
$\mu_{Schmidt} = -1.9\mu_N$

Ground-state properties of ^{31}Mg	
$\mu = -0.88355(15)\mu_N$	$I = 1/2$

Phys. Rev. Lett. 94, 022501 (2005)

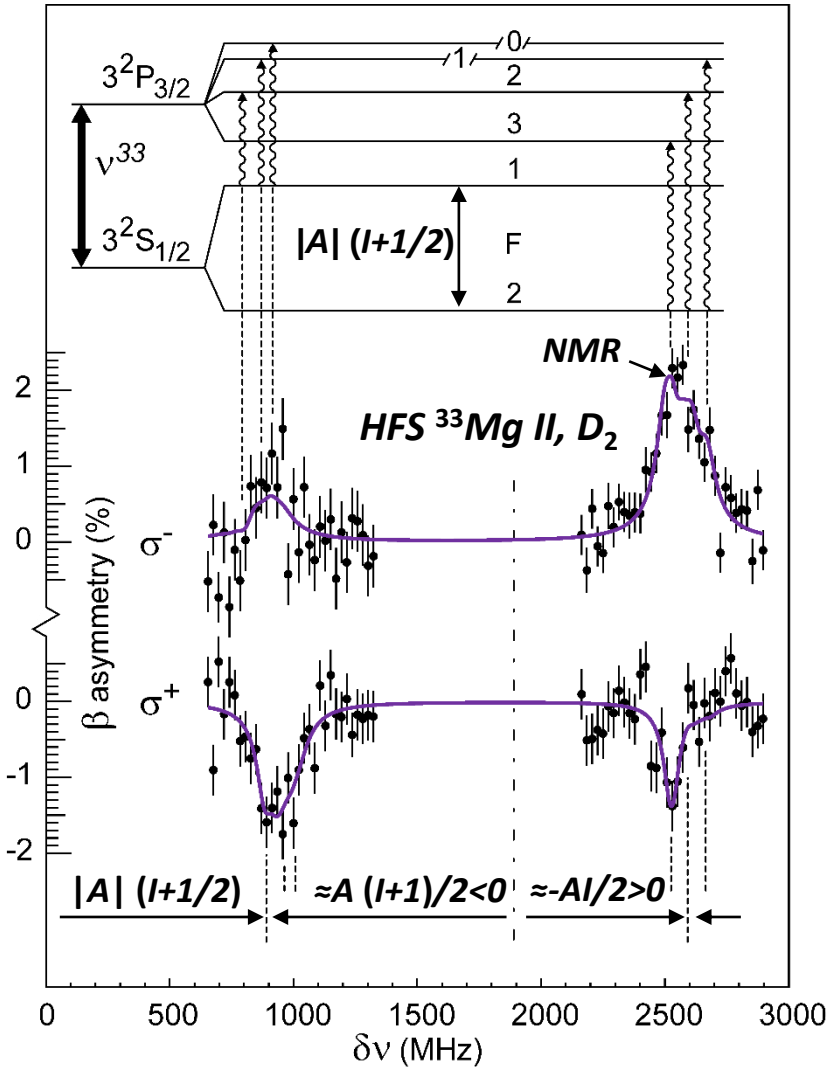


Spin and magnetic moment of ^{33}Mg

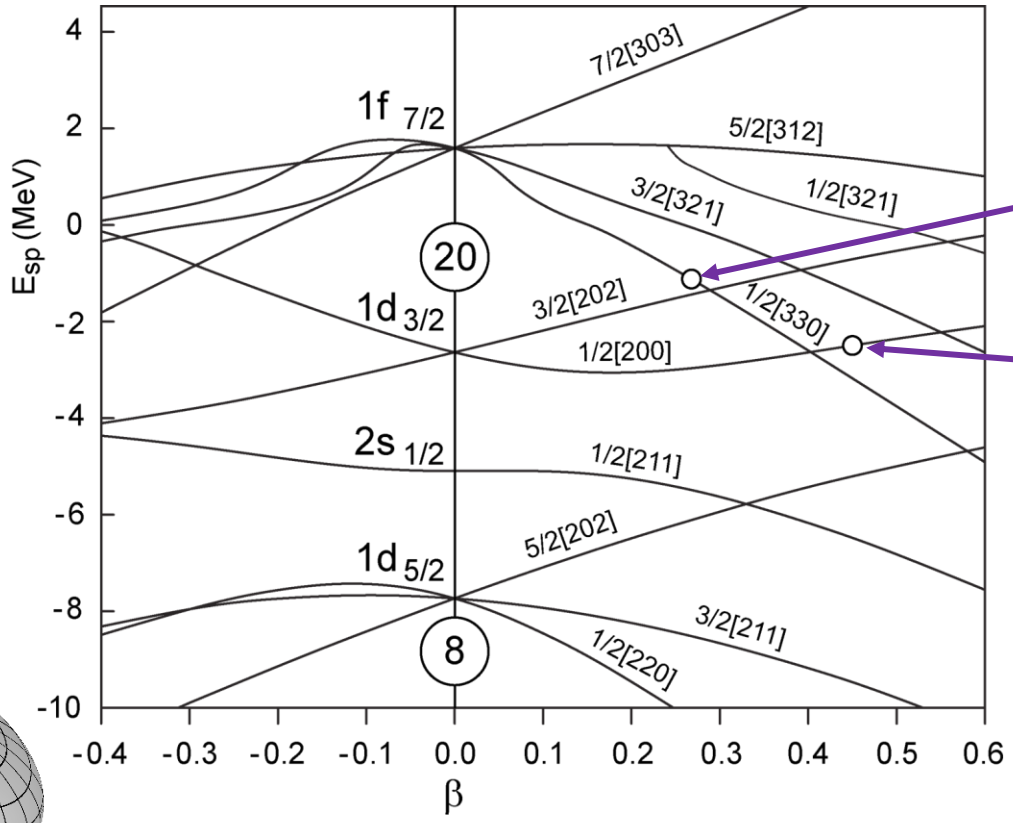


Ground-state properties of ^{33}Mg	
$\mu = -0.7456(5)\mu_N$	$I = 3/2$

Phys. Rev. Lett. 99, 212501 (2007)



Deformed shell model for ^{31}Mg and ^{33}Mg



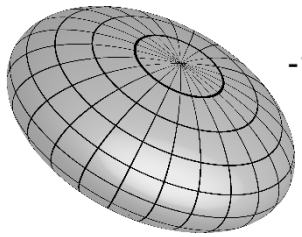
^{33}Mg, $I^{\pi} = 3/2^{(-)}$

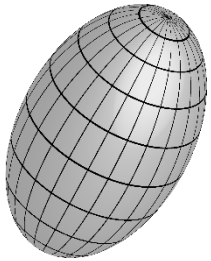
1/2[330]: μ = -0.76 μ_N

^{31}Mg, $I^{\pi} = 1/2^{+}$

1/2[200]: μ = -0.86 μ_N

^{31}Mg	μ = -0.88355(15) μ_N
^{33}Mg	μ = -0.7456(5) μ_N

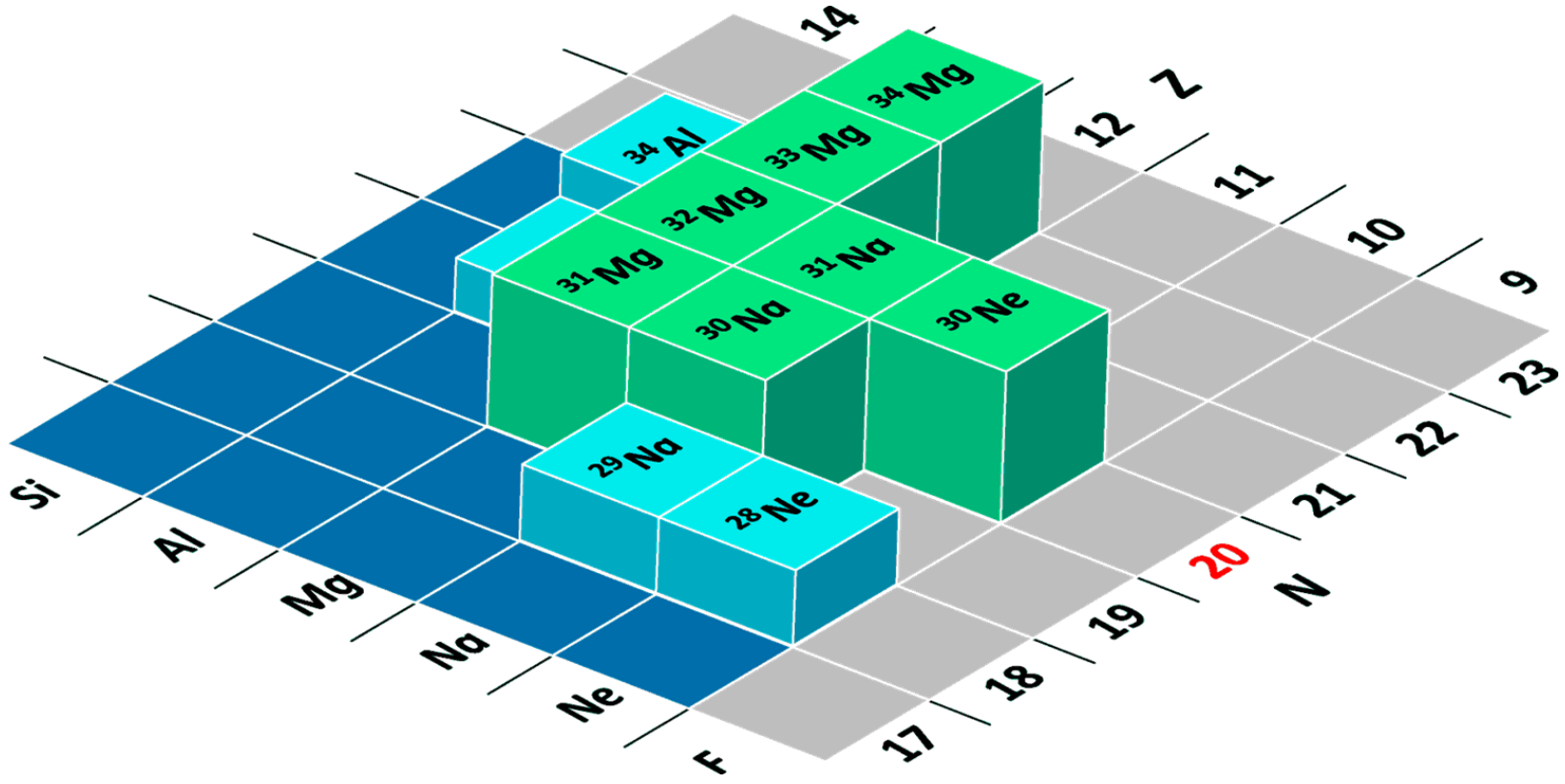




Calculation by I. Hamamoto

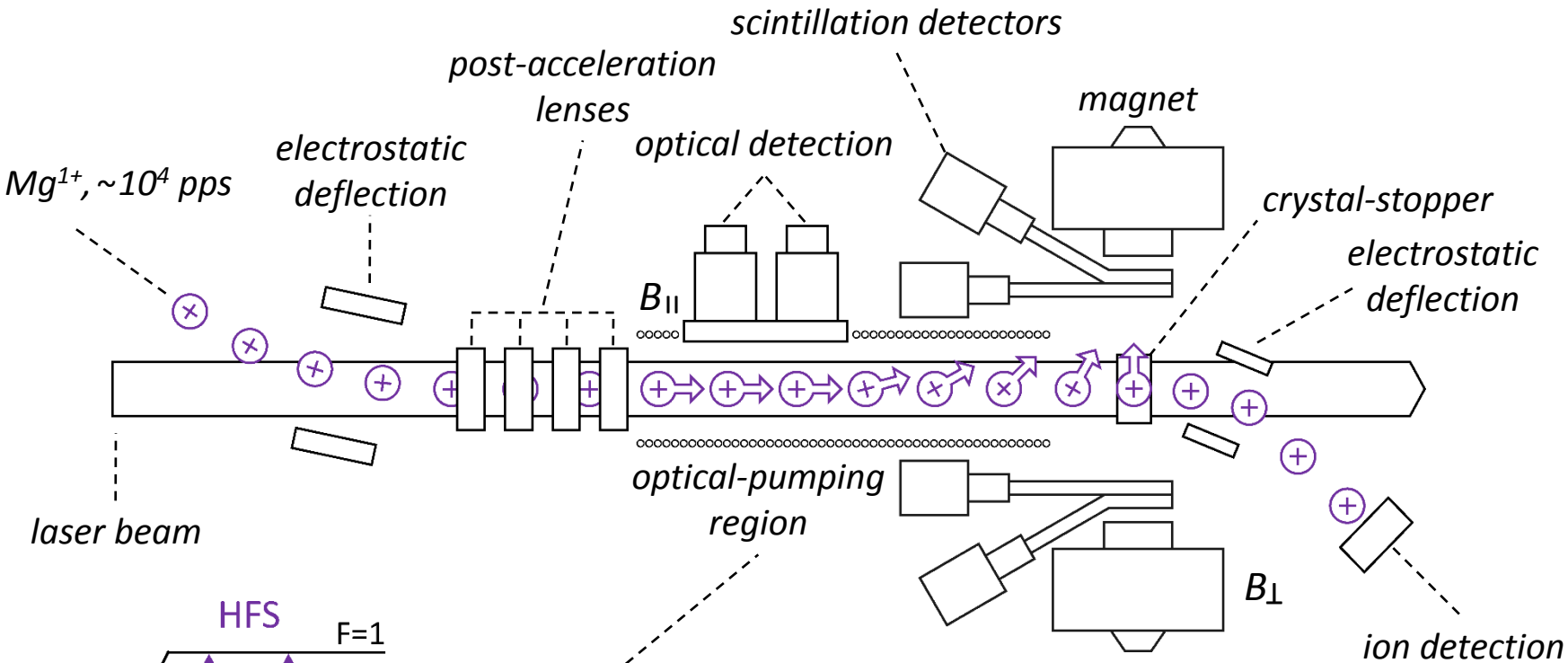
PRL 104, 129201 (2010)

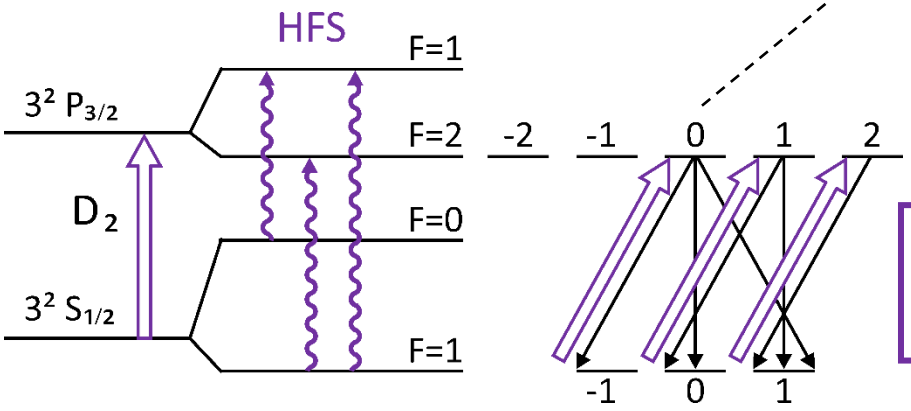
ISLAND OF INVERSION = ISLAND OF DEFORMATION ?



The "island of inversion" in terms of the SPHERICAL shell model

New experimental technique: fluorescence + β detection after nuclear orientation



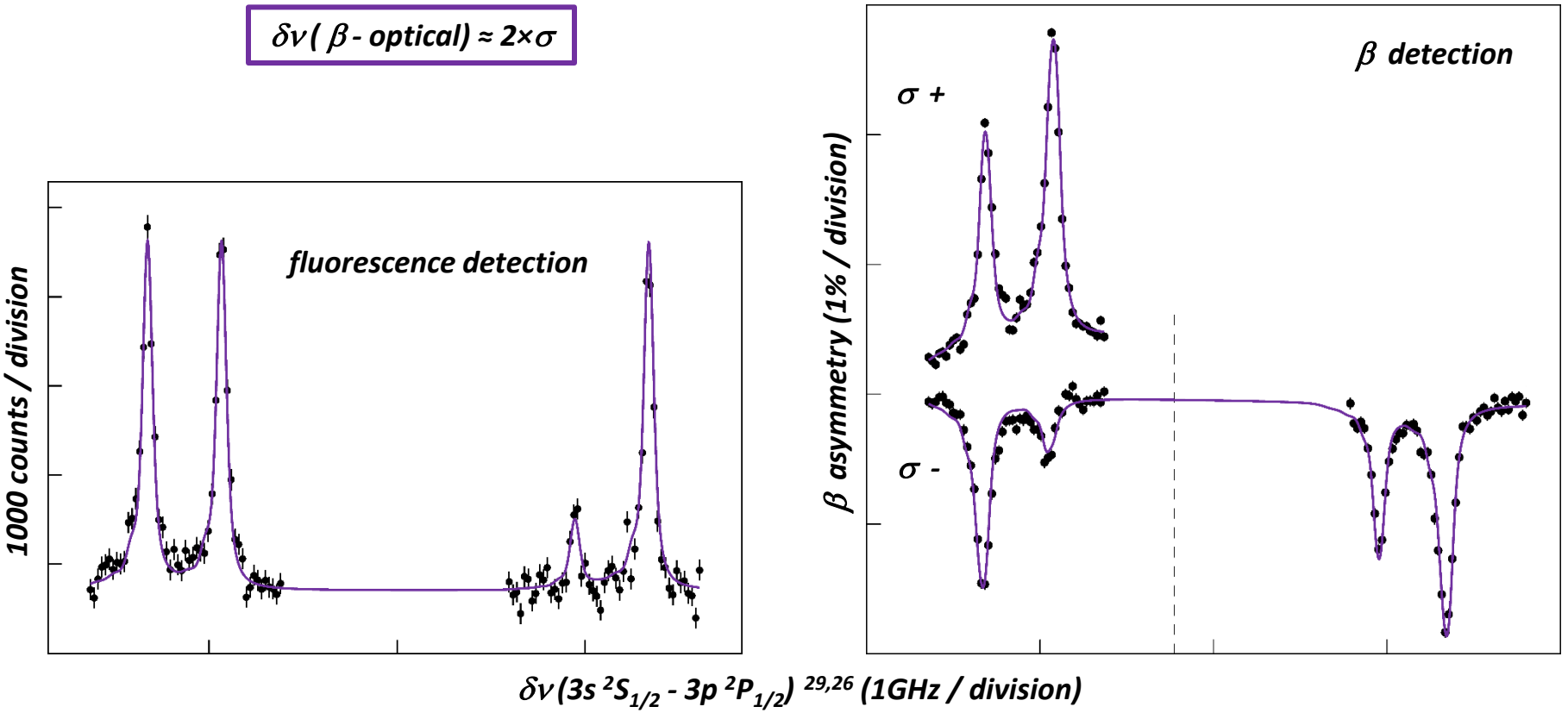


the atomic isotope shift

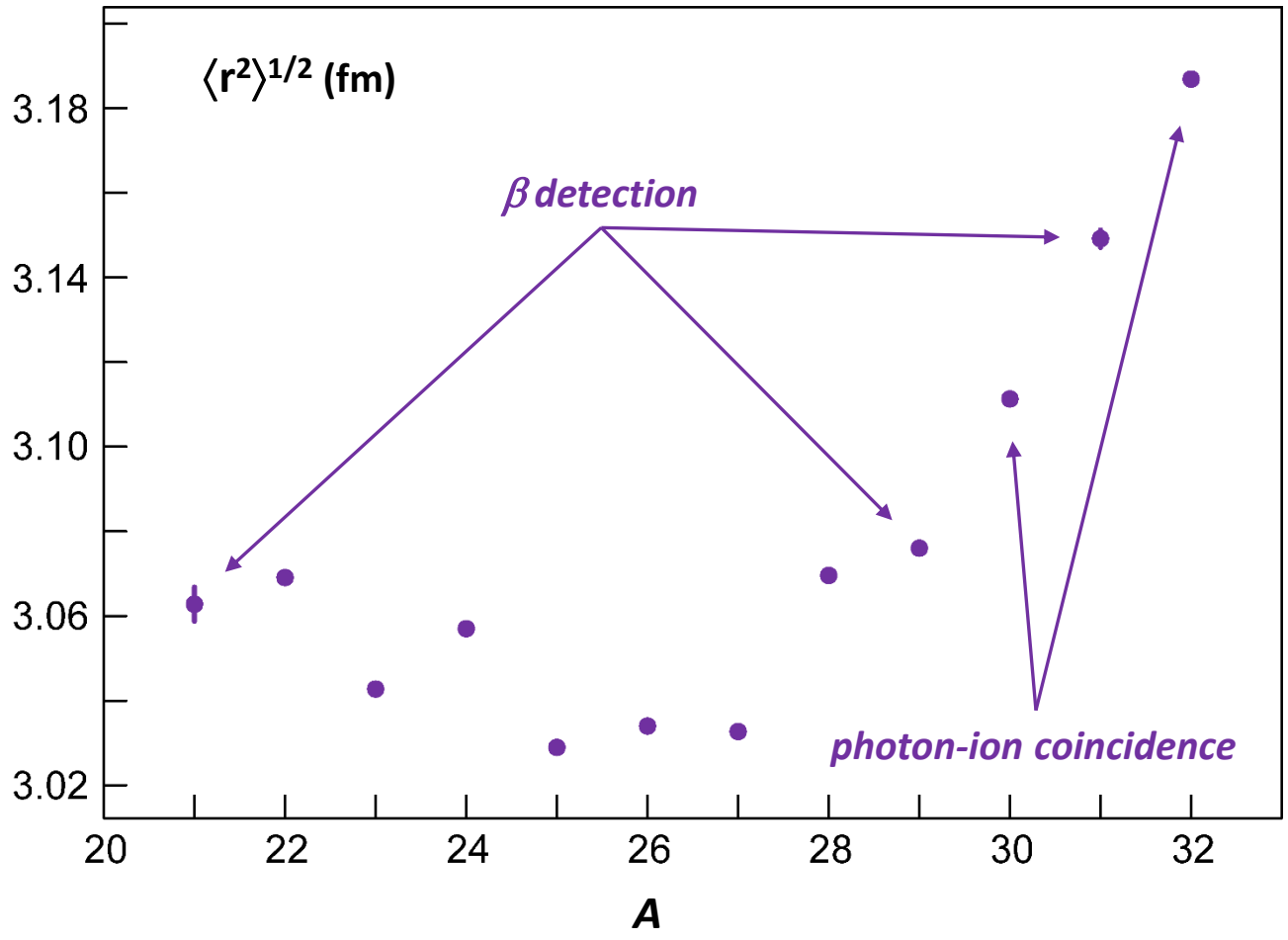
$$\delta\nu_i^{AA'} = K_i \frac{m_A - m_{A'}}{m_A\, m_{A'}} + F_i\, \delta \left\langle r^2 \right\rangle^{AA'}$$

Proof of principle: fluorescence vs. β detection on ^{29}Mg

$\delta\nu$ (β - optical) ≈ 2×σ

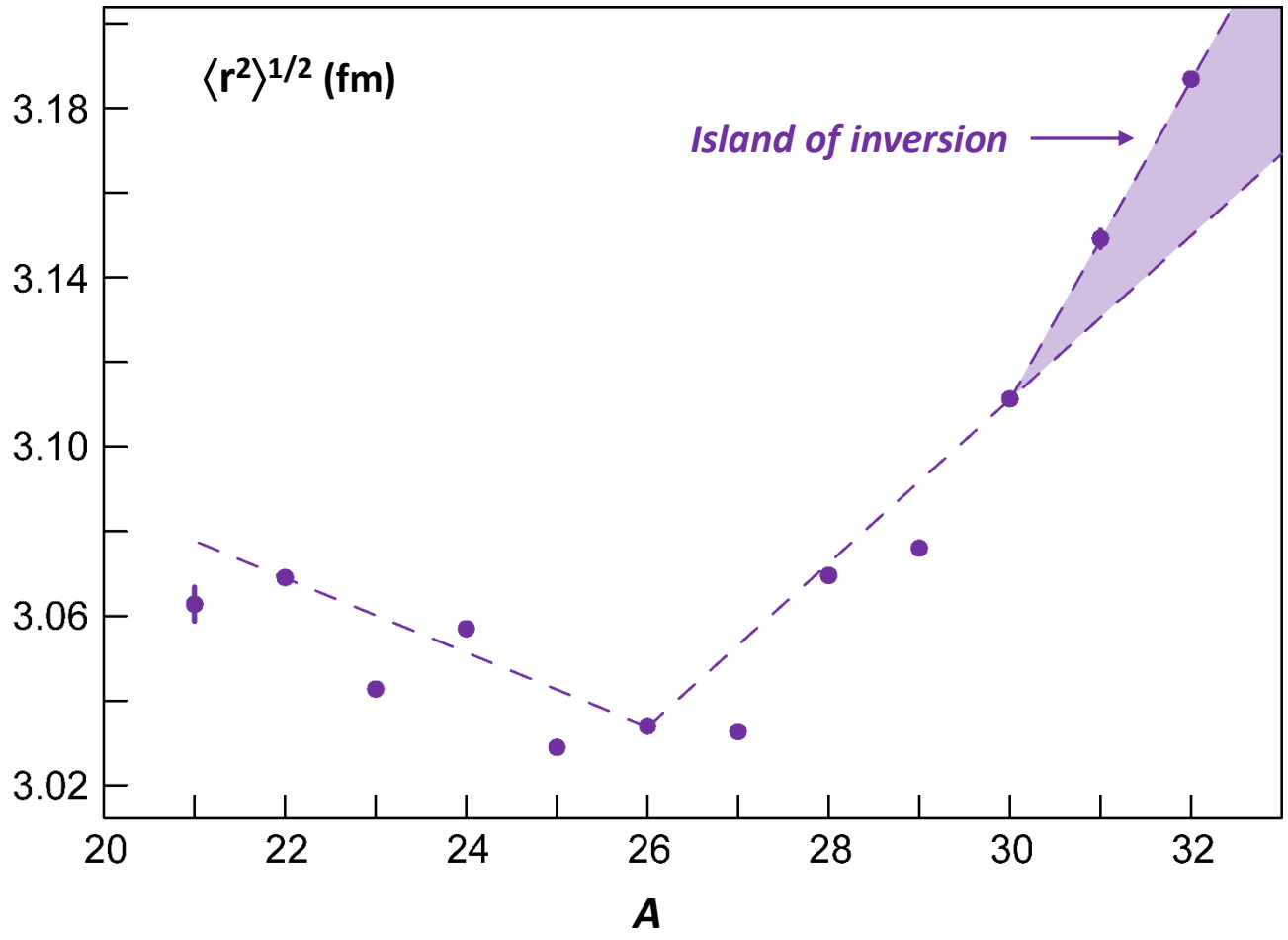


Rms charge radii in the sd shell



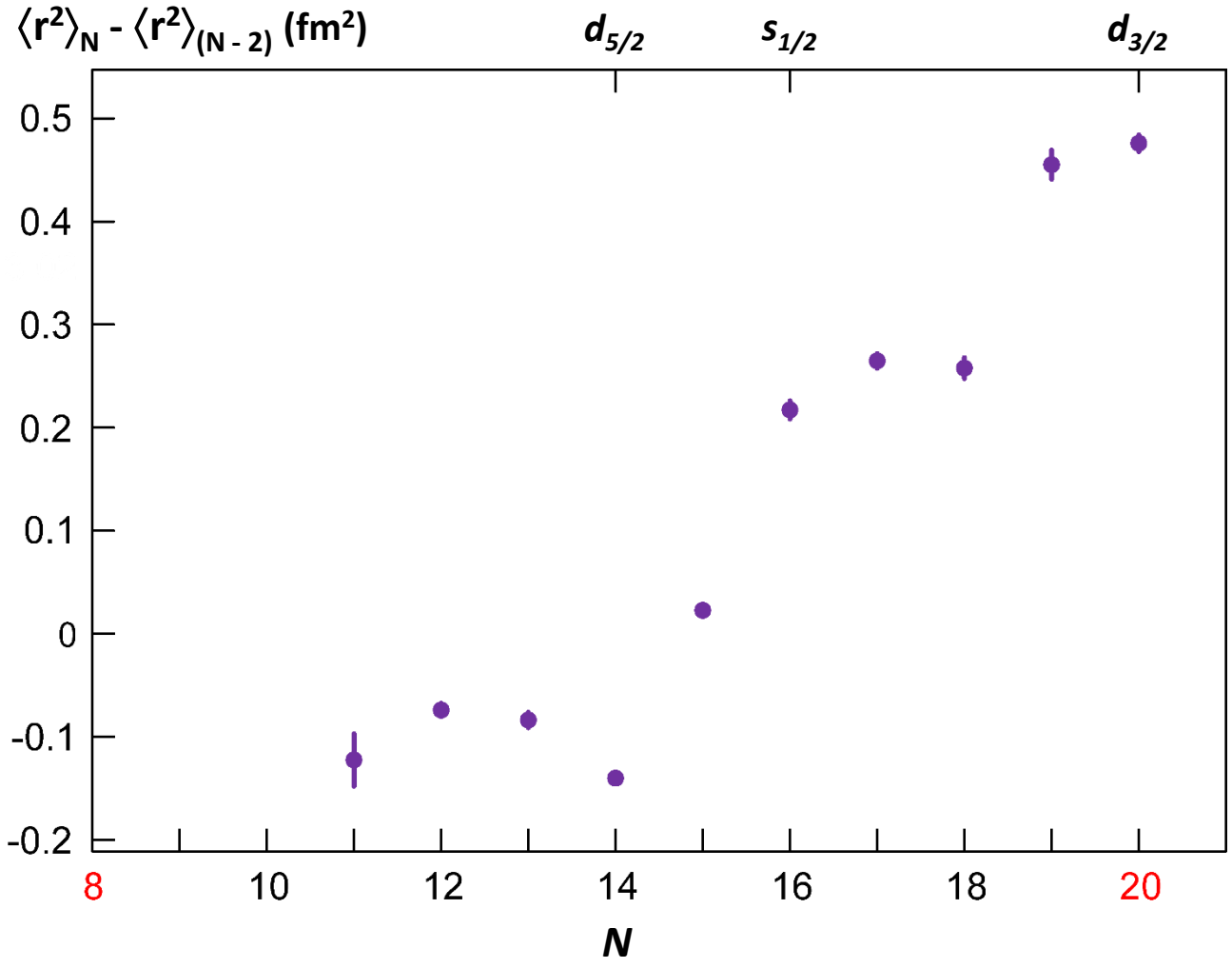
PRL 108, 042504 (2012)

Rms charge radii in the sd shell



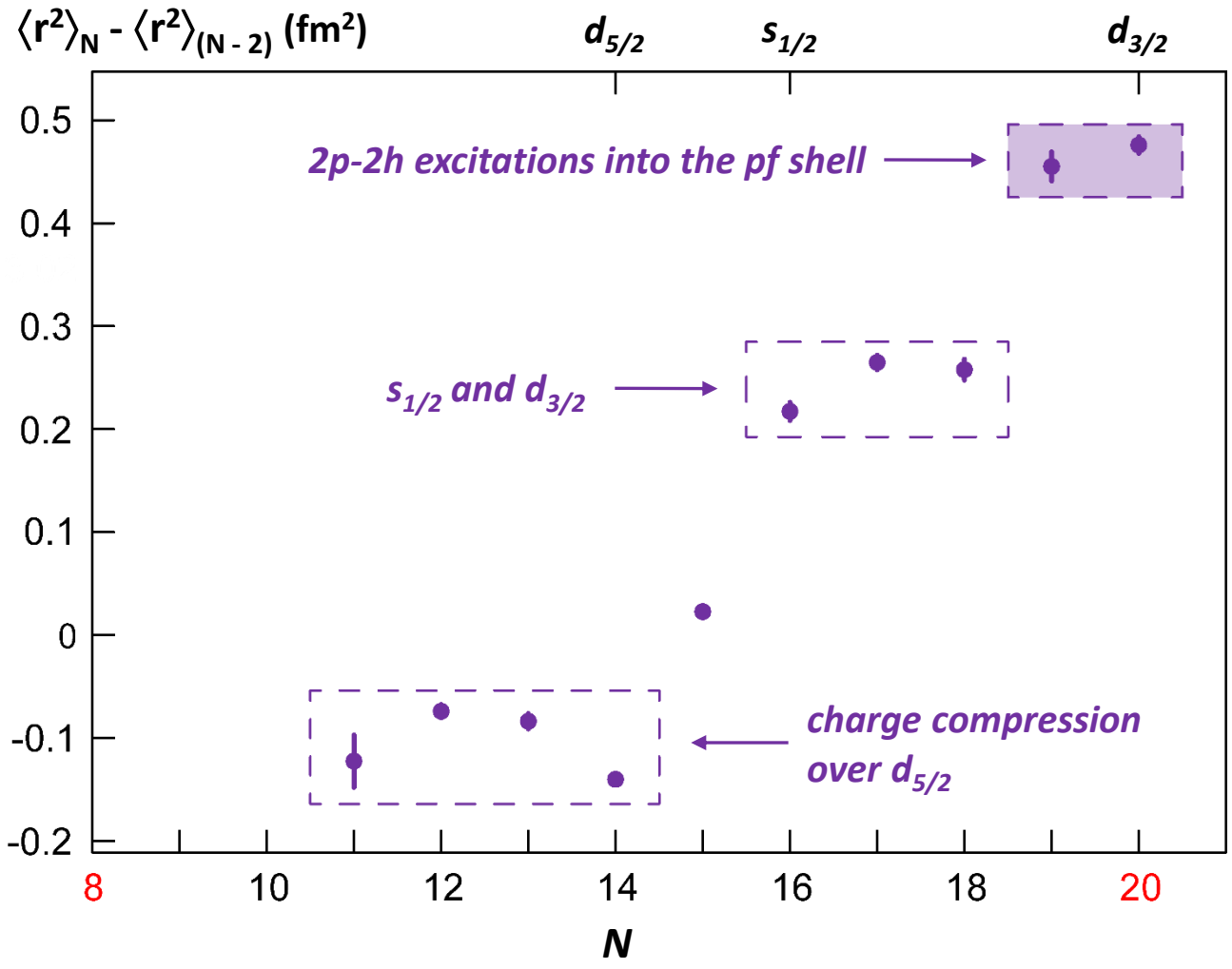
D. T. Yordanov et al., submitted

Differential ms radii in the sd shell



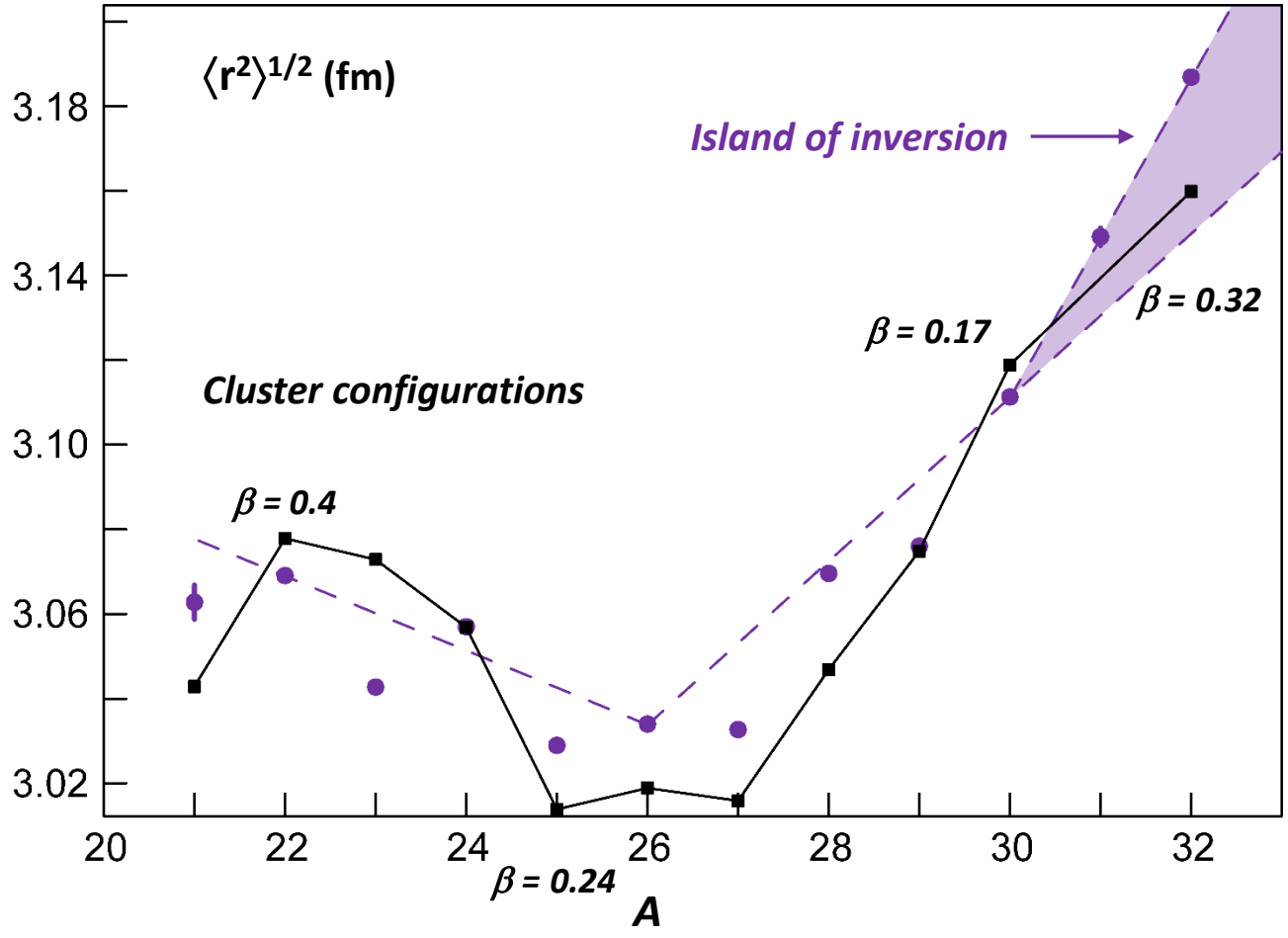
PRL 108, 042504 (2012)

Differential ms radii in the sd shell



PRL 108, 042504 (2012)

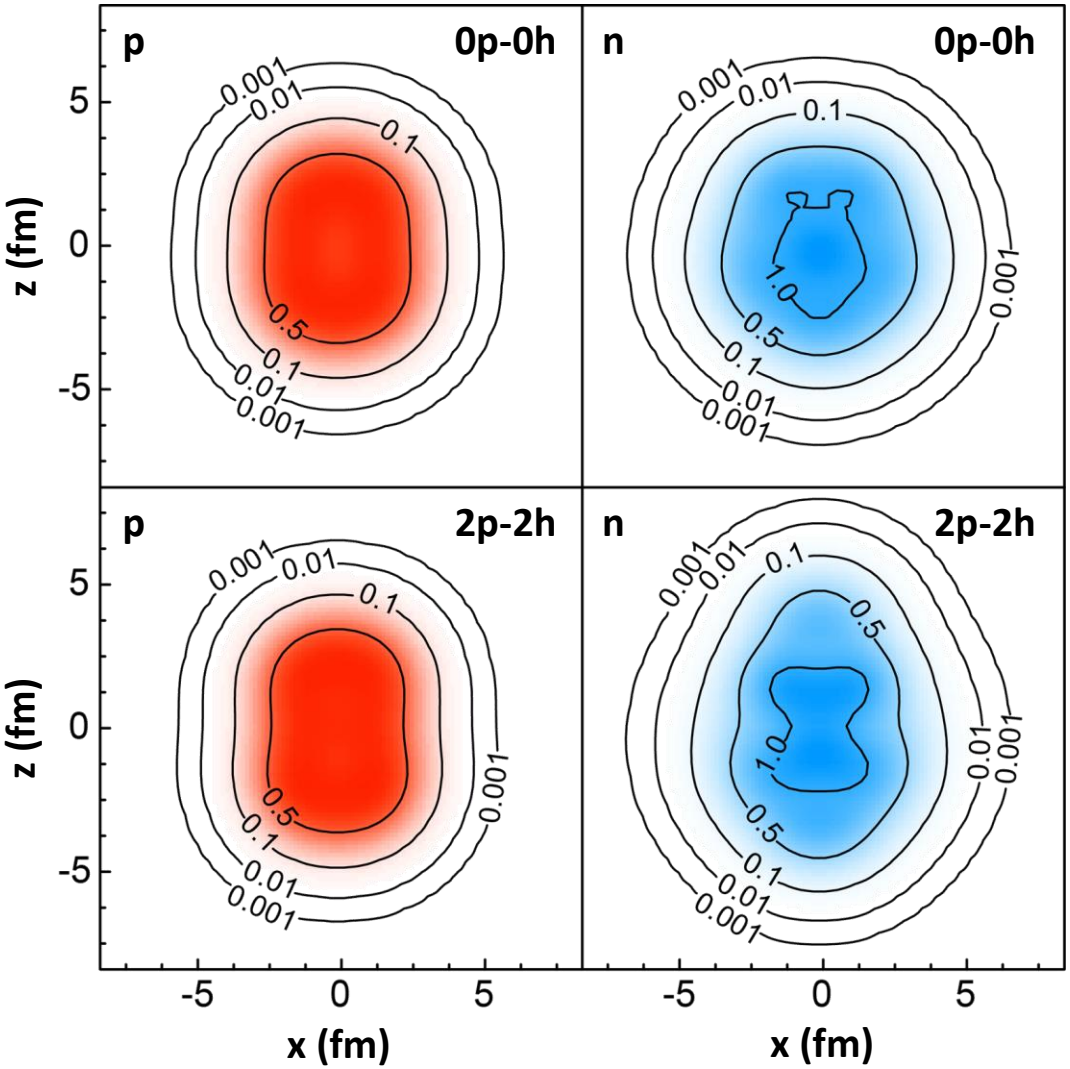
Experiment vs. Fermionic Molecular Dynamics



FMD by T. Neff

PRL 108, 042504 (2012)

Cuts through the proton and neutron densities in ^{32}Mg

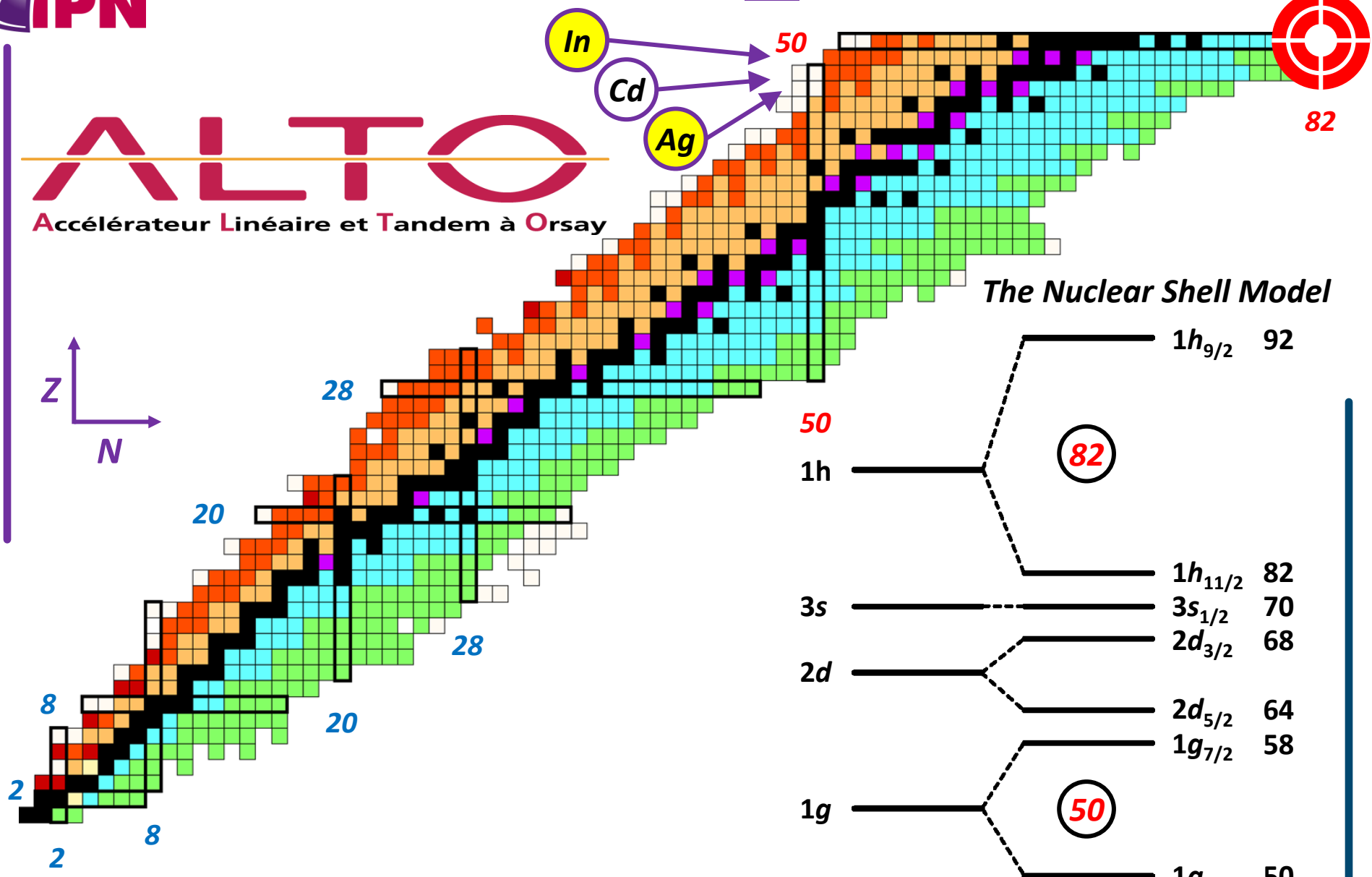


FMD by T. Neff

PRL 108, 042504 (2012)

IPN

ALTO
Accélérateur Linéaire et Tandem à Orsay

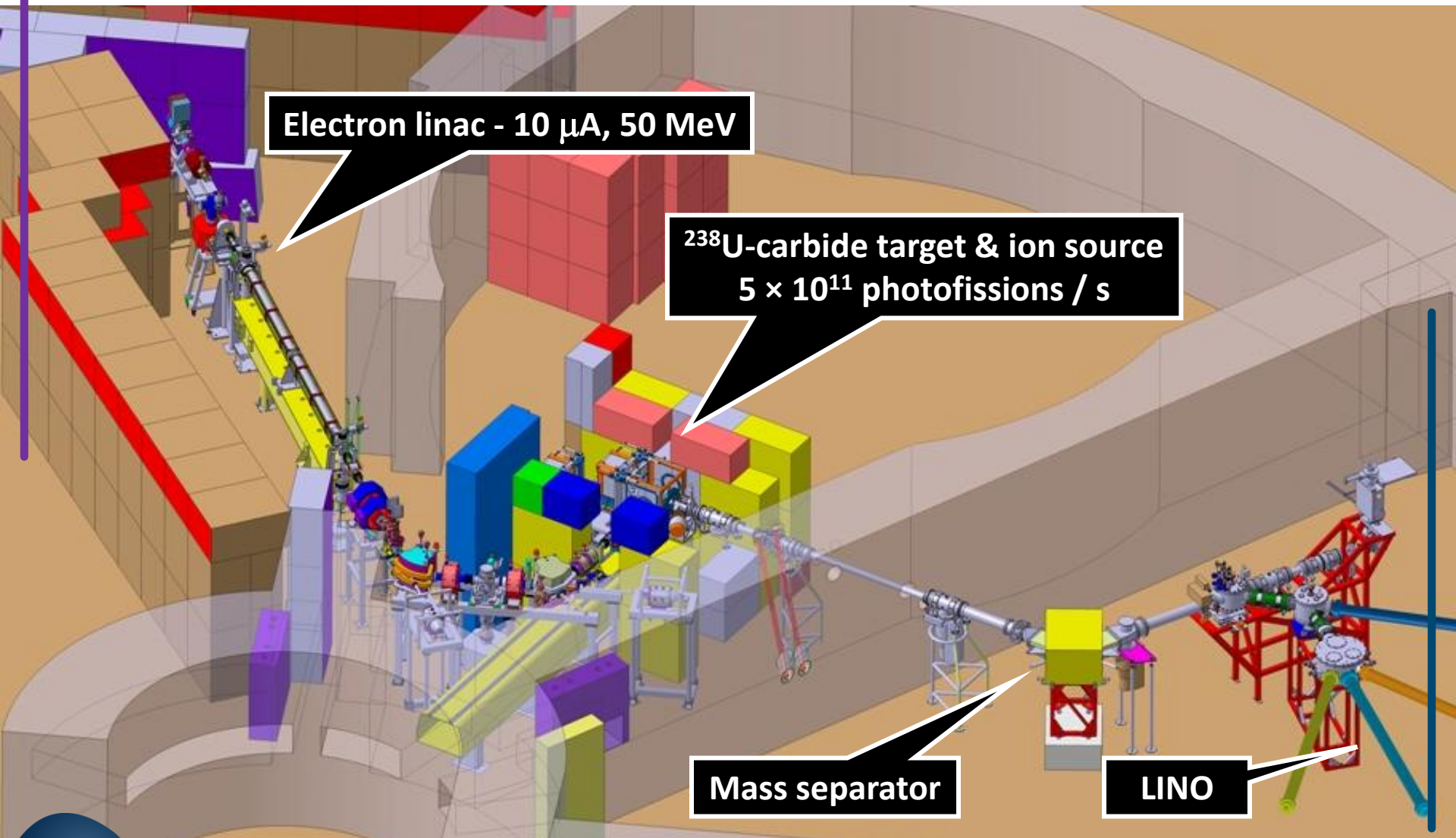


The Nuclear Shell Model

IPN

ALTO

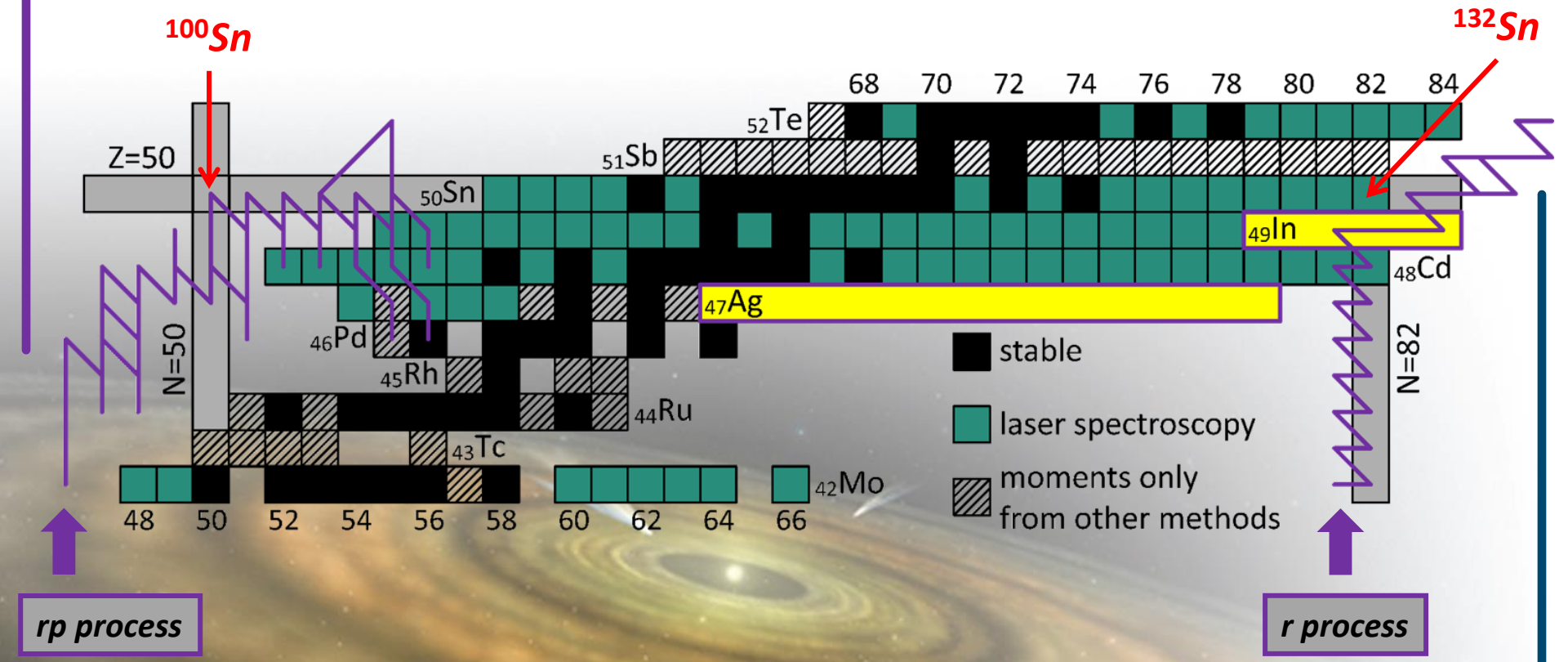
Accélérateur Linéaire et Tandem à Orsay

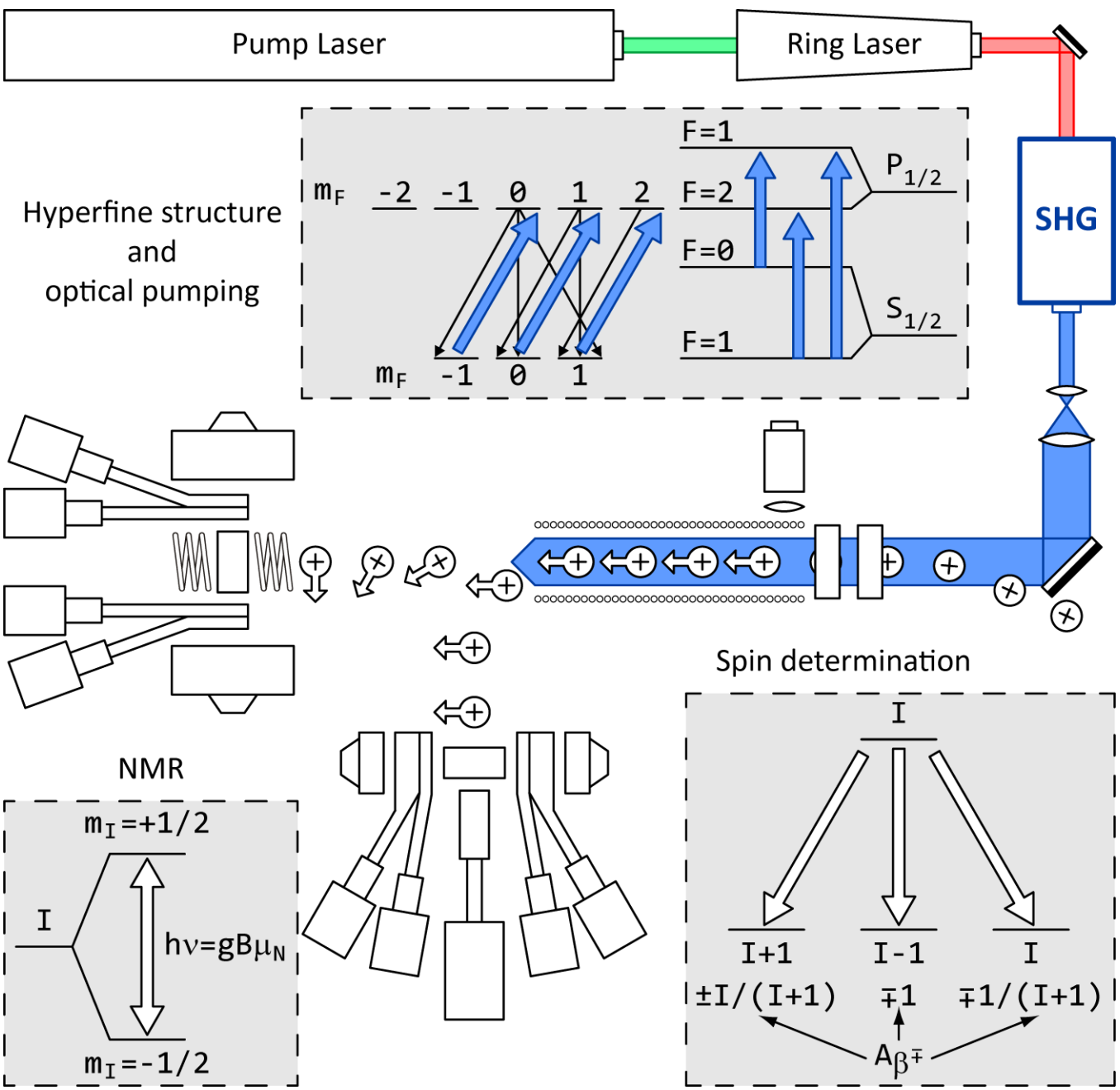


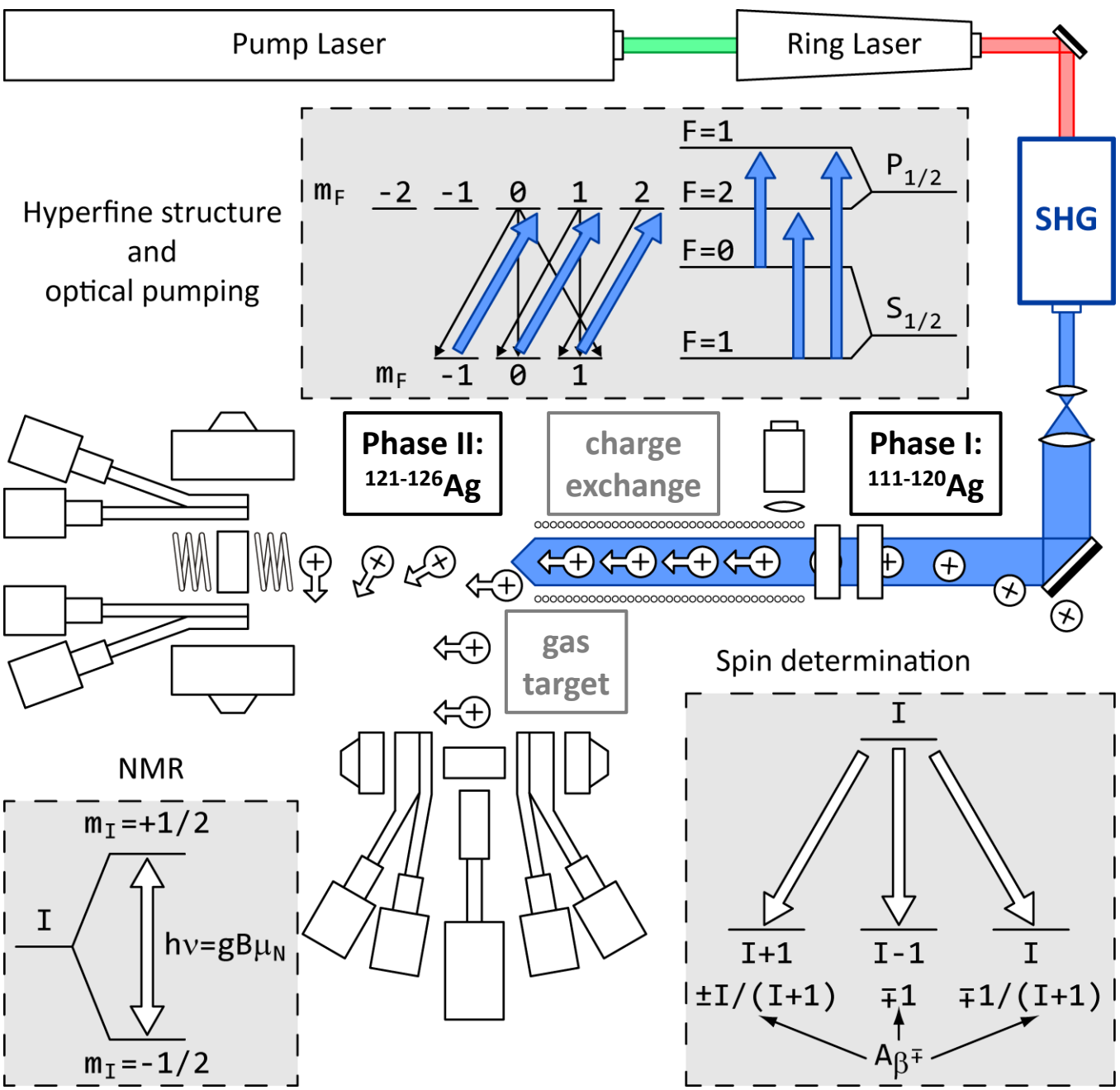
cnrs IN2P3 Les deux infinis

UNIVERSITÉ PARIS SUD

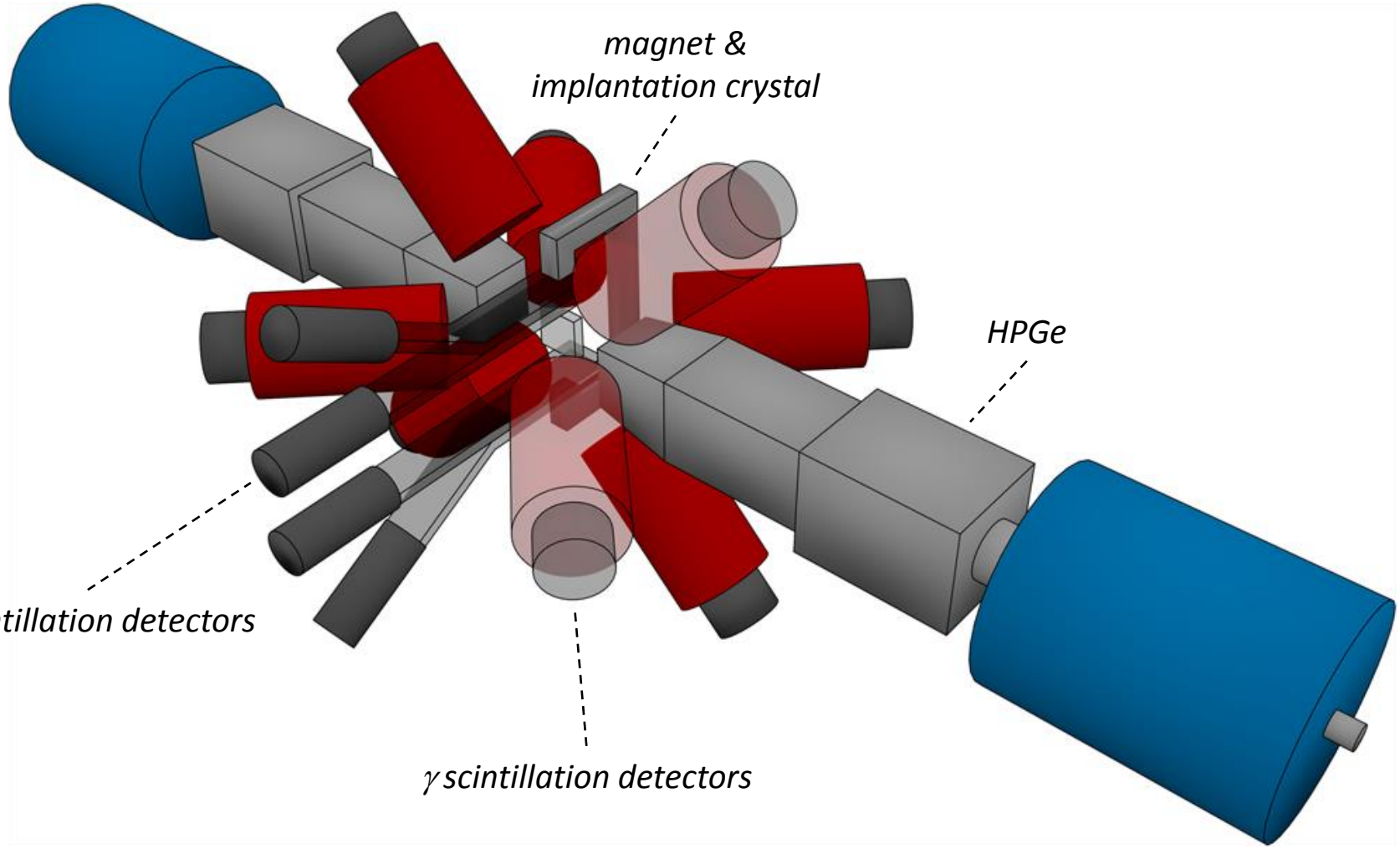
Laser spectroscopy of silver and indium at ALTO




Pump Laser
Ring Laser
SHG
Hyperfine structure
and
optical pumping
F=1
F=2
F=0
F=1
$P_{1/2}$
$S_{1/2}$
m_F -2 -1 0 1 2
m_F -1 0 1
NMR
m_I=+1/2
I
$h\nu=gB\mu_N$
m_I=-1/2
Spin determination
I
I+1
I-1
I
$\pm I/(I+1)$
∓ 1
$\mp 1/(I+1)$
$A\beta^{\mp}$


Pump Laser
Ring Laser
SHG
Hyperfine structure
and
optical pumping
F=1
F=2
F=0
F=1
$P_{1/2}$
$S_{1/2}$
m_F -2 -1 0 1 2
m_F -1 0 1
Phase II:
121-126Ag
charge
exchange
Phase I:
111-120Ag
gas
target
Spin determination
I
I+1
I-1
I
±I/(I+1)
∓1
∓1/(I+1)
$A_{\beta^\mp}$
NMR
m_I=+1/2
I
hν=gBμN
m_I=-1/2

Sketch of a possible layout for β - delayed γ detection



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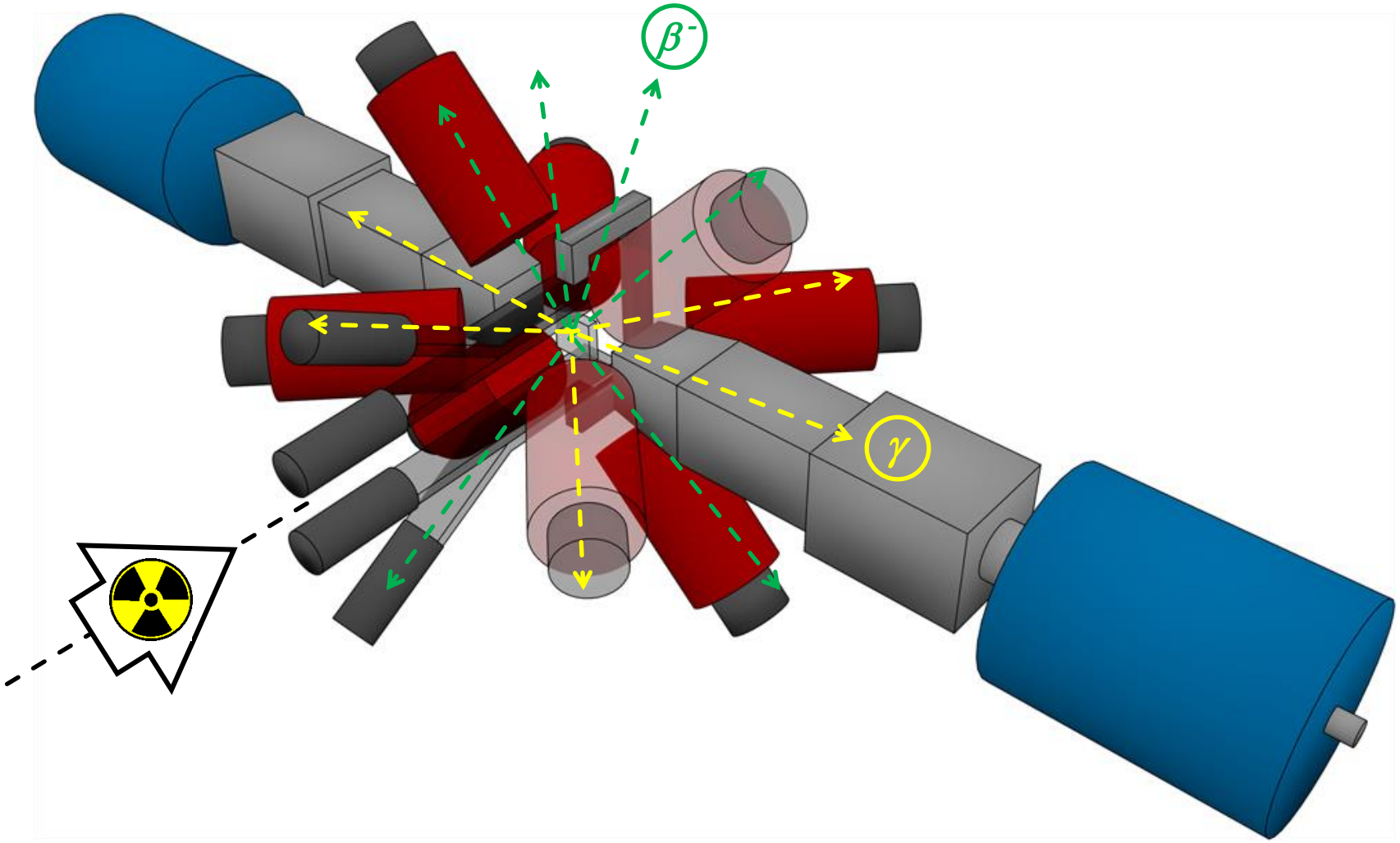
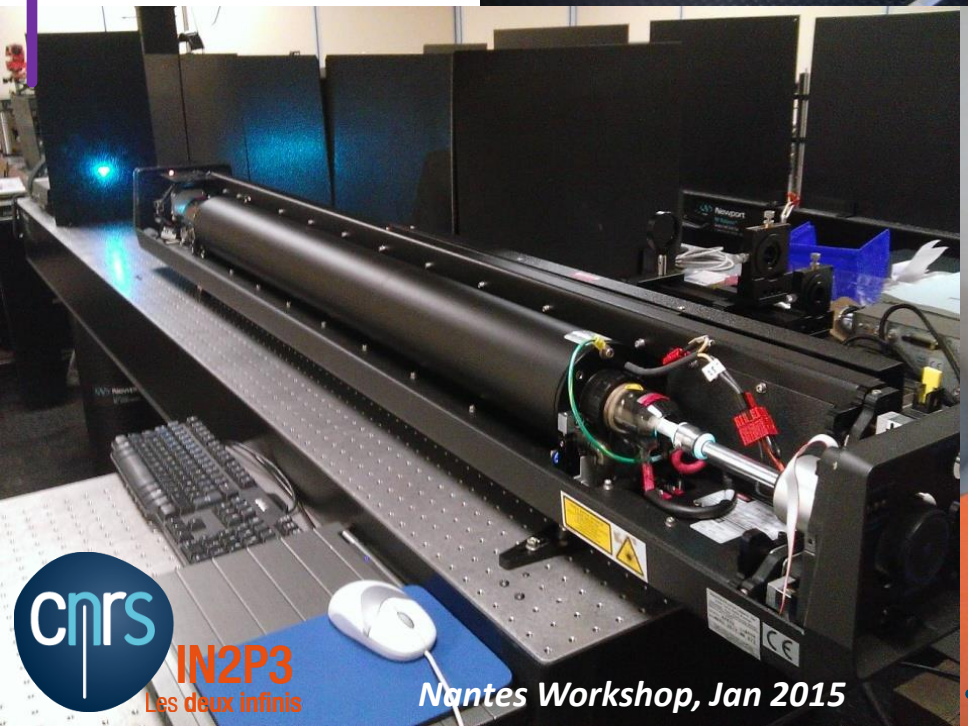


New Laser Room

Ar^+ pump laser



Ring Dye laser