

Collinear laser spectroscopy on Cr: from $N = Z$ towards $N = 40$

H. Heylen¹, B. Cheal², M.L. Bissell³, K. Blaum¹, R.F. Garcia Ruiz³, W. Gins⁴,
C. Gorges⁵, S. Kaufmann⁵, M. Kowalska⁶, J. Krämer⁵, S. Malbrunot-Ettenauer⁶,
G. Neyens⁴, R. Neugart^{1,7}, L. Vázquez⁸, W. Nörtershäuser⁵, R. Sánchez⁹, C. Wraith²,
L. Xie³, Z.Y. Xu⁴, X.F. Yang⁴, D.T. Yordanov⁸

¹*Max-Planck-Institut für Kernphysik, D-69117 Heidelberg, Germany*

²*Oliver Lodge Laboratory, Oxford Street, University of Liverpool, L69 7ZE, United Kingdom*

³*The University of Manchester, Manchester M13 9PL, United Kingdom*

⁴*KU Leuven, Instituut voor Kern- en Stralingsfysica, 3001 Leuven, Belgium*

⁵*Institut für Kernphysik, TU Darmstadt, D-64289 Darmstadt, Germany*

⁶*ISOLDE, Experimental Physics Department, CERN, CH-1211 Geneva 23, Switzerland*

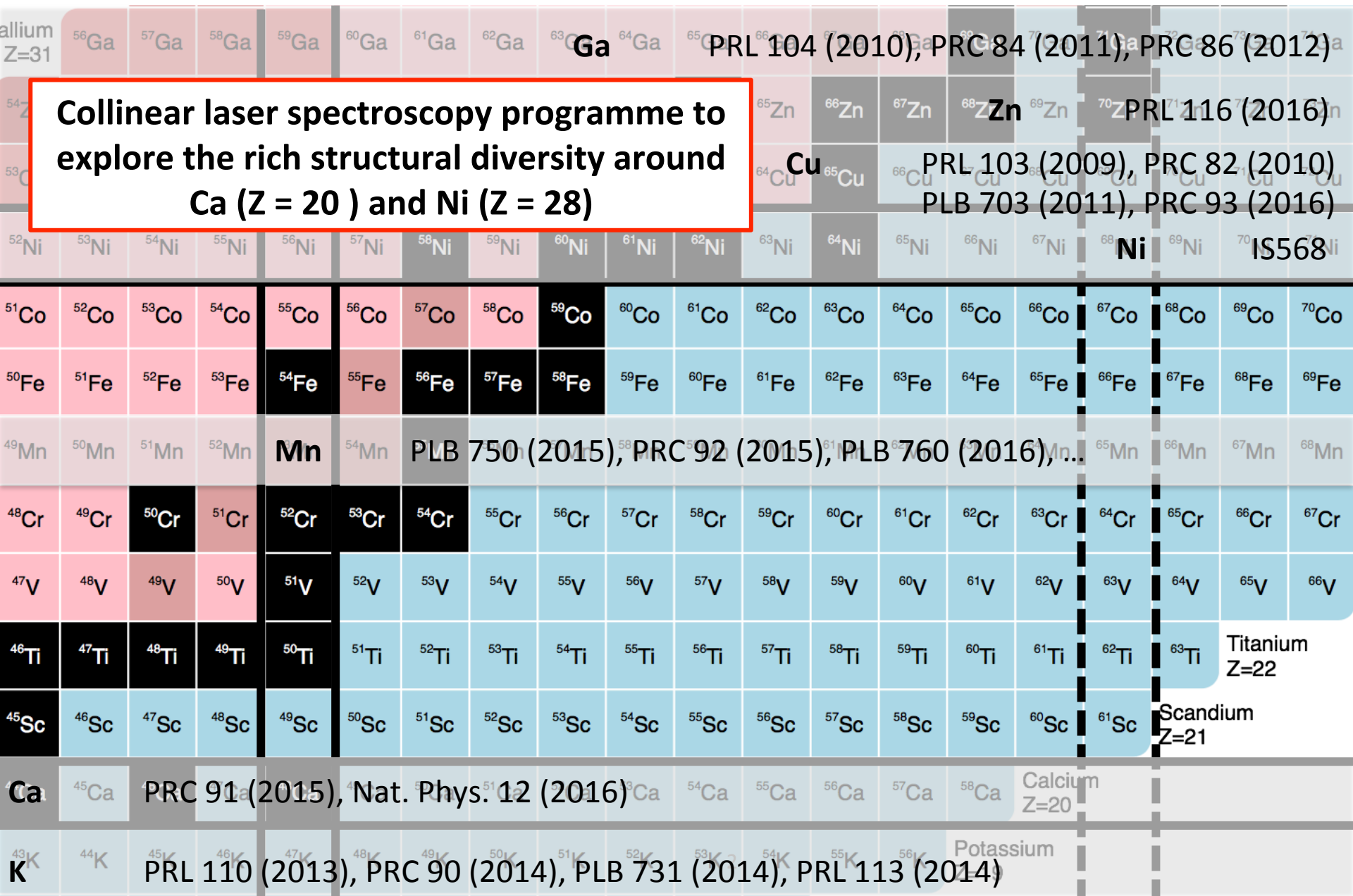
⁷*Institut für Kernchemie, Universität Mainz, D-55128 Mainz, Germany*

⁸*Institut de Physique Nucléaire, CNRS-IN2P3, Université Paris-Sud, Paris-Saclay, 91406 Orsay, France*

⁹*GSI Helmholtzzentrum für Schwerionenforschung, D-64291 Darmstadt, Germany*

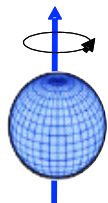
Introduction

Collinear laser spectroscopy programme to explore the rich structural diversity around Ca ($Z = 20$) and Ni ($Z = 28$)

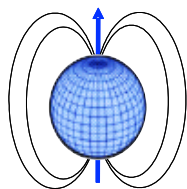


Introduction

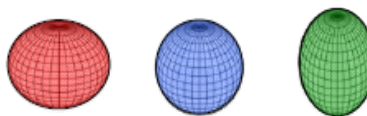
Investigate evolution of single-particle and collective behaviour along the **Cr** isotopic chain using collinear laser spectroscopy



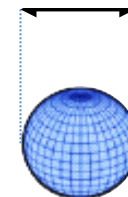
Spin I



Magnetic moment μ



Quadrupole moment Q_s



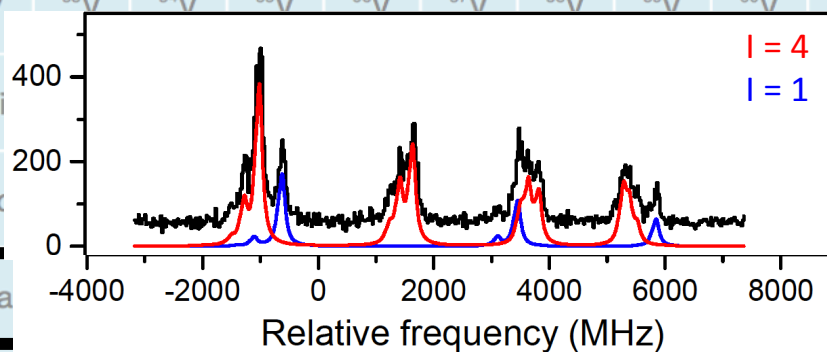
Mean-square charge radii $\delta\langle r^2 \rangle$

N = Z = 24

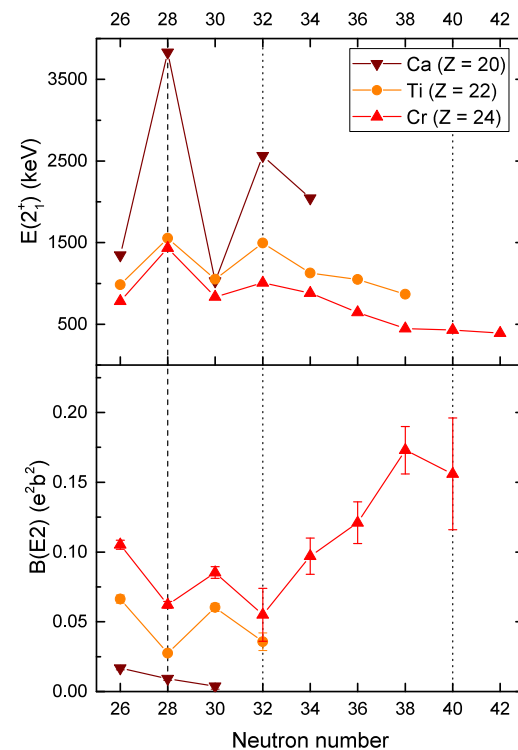
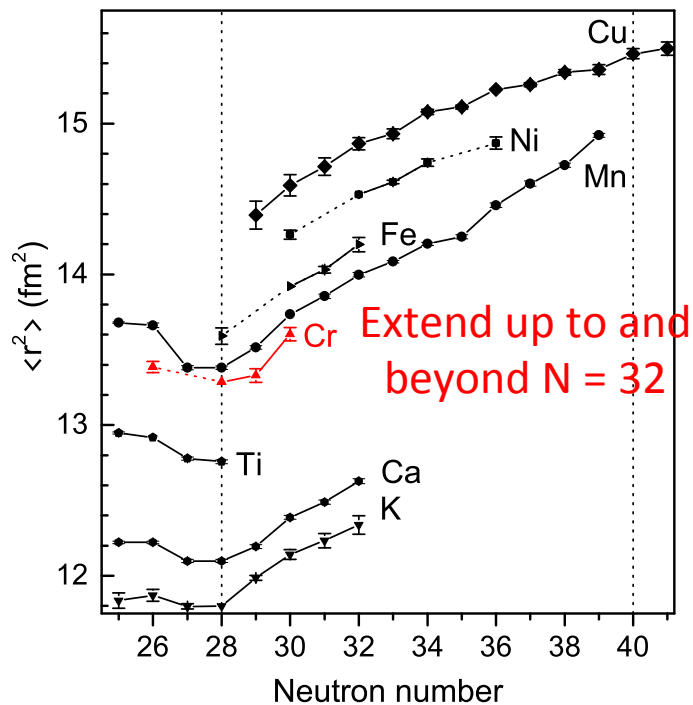
Cr (Z = 24)

N = 32?

Deformation towards N = 40

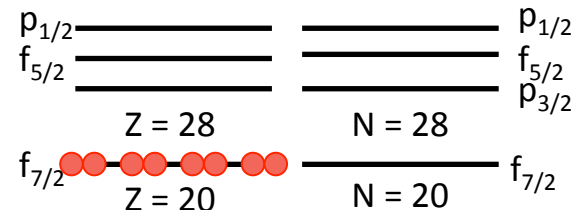


Physics case

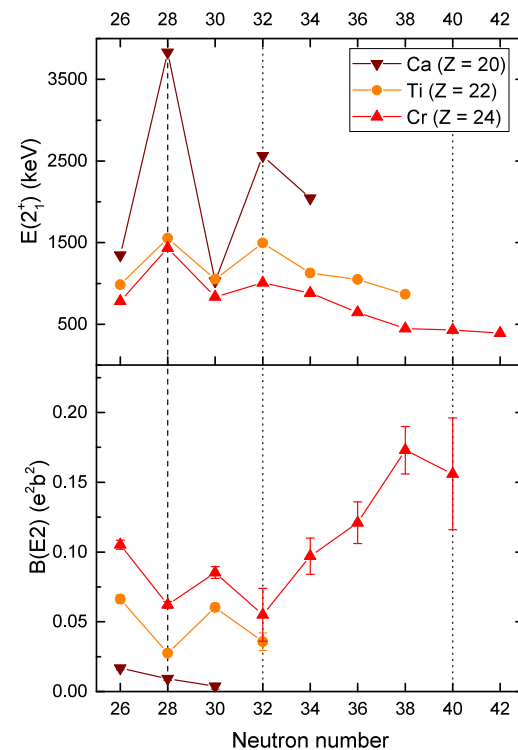
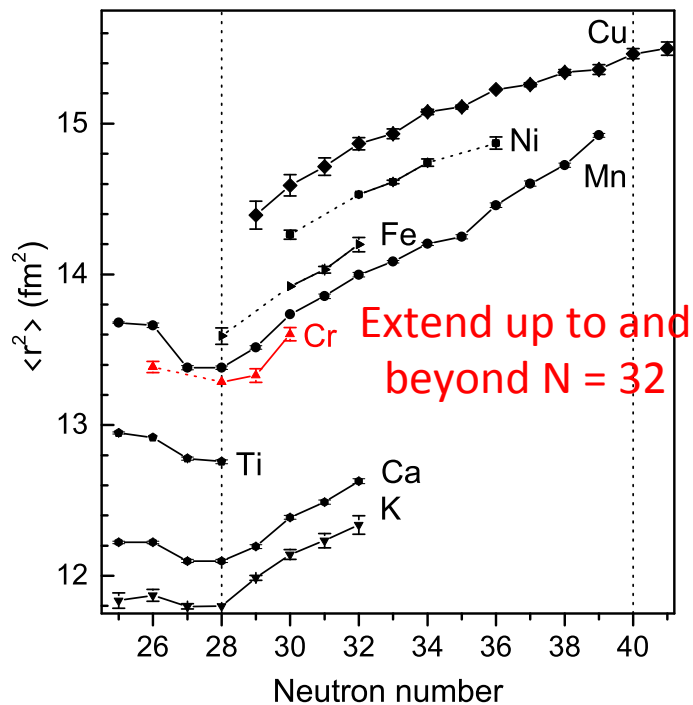


New magic number at N = 32?

- Migration of $\nu f_{5/2}$ when $\pi f_{7/2}$ gets emptied from $Z = 28$ towards $Z = 20$
- Magic features in systematics of Ca, Ti and Cr at $N = 32$... BUT mean-square charge radius of $^{52}\text{Ca}_{32}$ is unexpectedly large? [Nat. Phys. 12 (2016)]

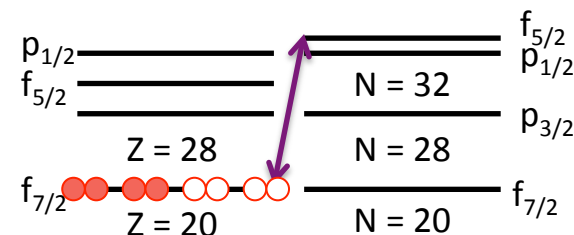


Physics case

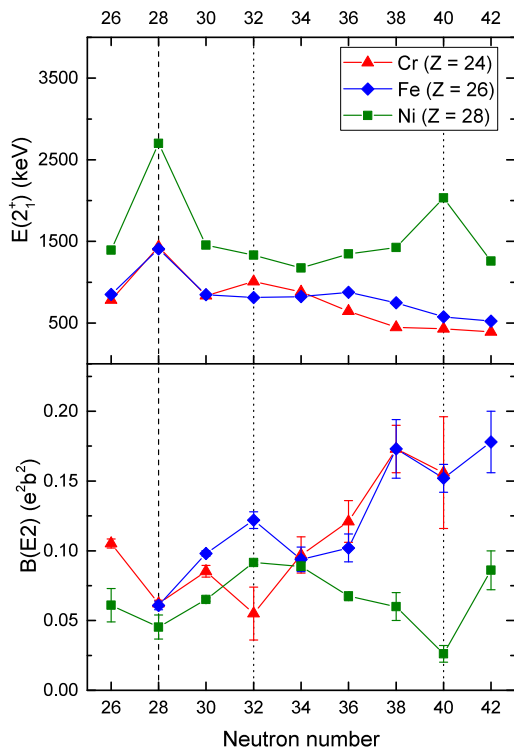


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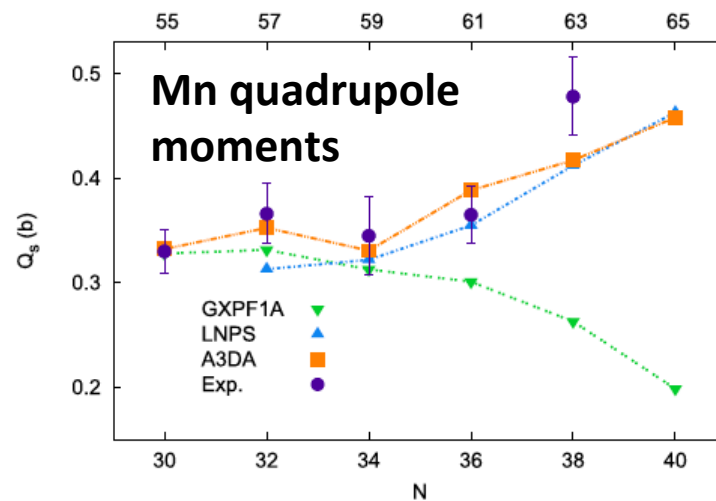
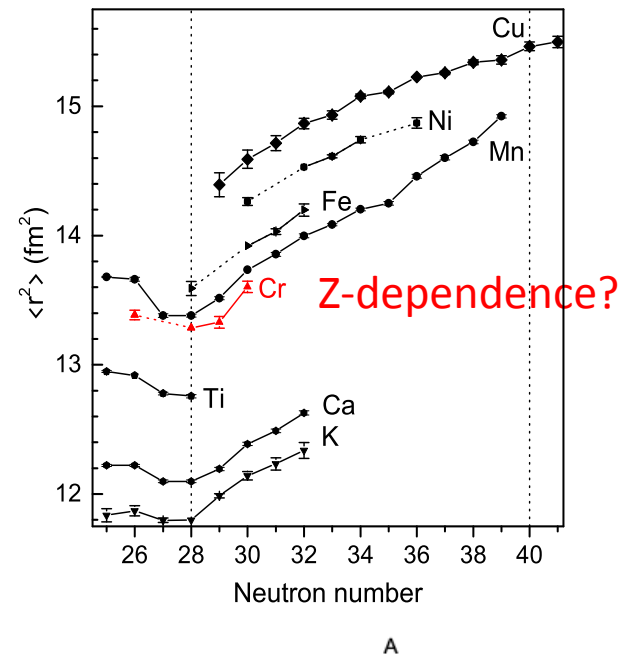


Physics case

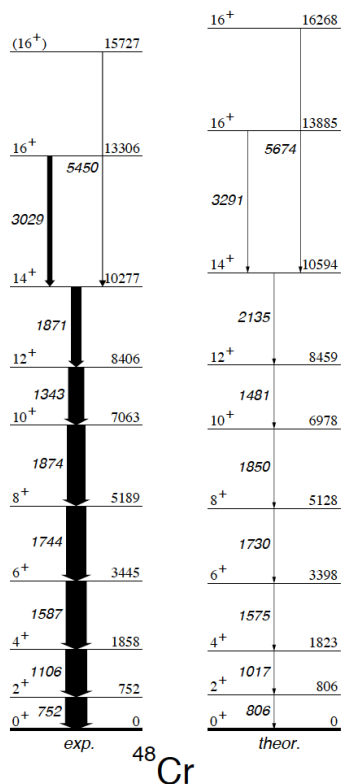


Onset of deformation below ^{68}Ni

- First systematic investigation of spins, moments and radii in Mn (Z = 25) [PLB 750 (2015), PRC 92 (2015), PLB 760 (2016)]
- Complementary to recently measured masses (ISOLTRAP - IS532)



Physics case



N = Z = 24

- Coherent contribution of protons and neutrons in half-filled $f_{7/2}$ orbital

	N	I^π	μ (μ_N)	Q_s (b)
^{49}Cr	25	$5/2^-$	0.476(3)	-
^{51}Cr	27	$7/2^-$	(-) $0.934(5)$	-
^{53}Cr	29	$3/2^-$	$-0.47454(3)$	$-0.15(5)$
^{55}Cr	31	$3/2^-$	-	-
^{57}Cr	33	$(3/2)^-$	-	-
^{59}Cr	35	$(1/2)^-$	-	-
^{61}Cr	37	$(5/2)^-$	-	-

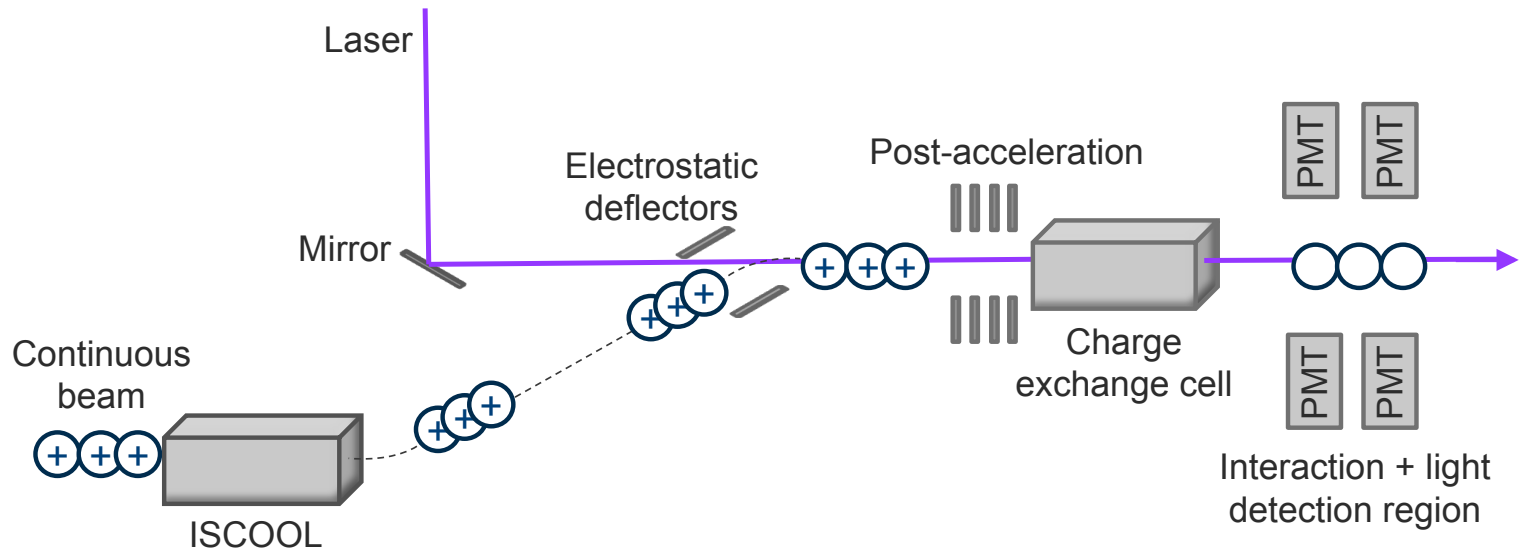
Limited information on

- Spins
- Magnetic moments
- Quadrupole moments
- Mean-square charge radii

Level schemes

Test recent shell model interactions (ex. LNPS)

Collinear laser spectroscopy

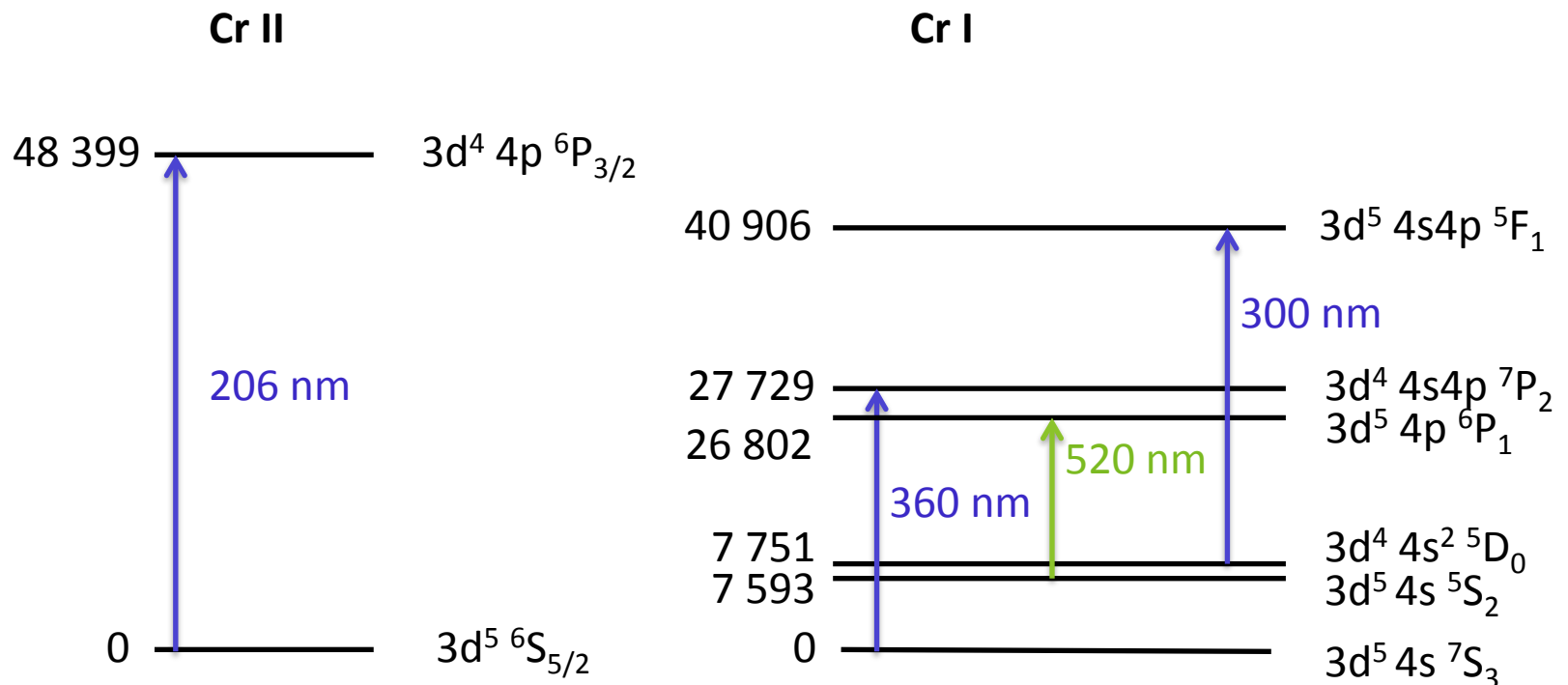


- Doppler broadening reduction at 30 – 40 keV
→ **High resolution**
- Bunched beams:
→ **10^4 background suppression**

Experiment

Test on stable beams to determine best candidate:

- Sensitive to μ , Q_s , $\delta\langle r^2 \rangle$
- Efficient

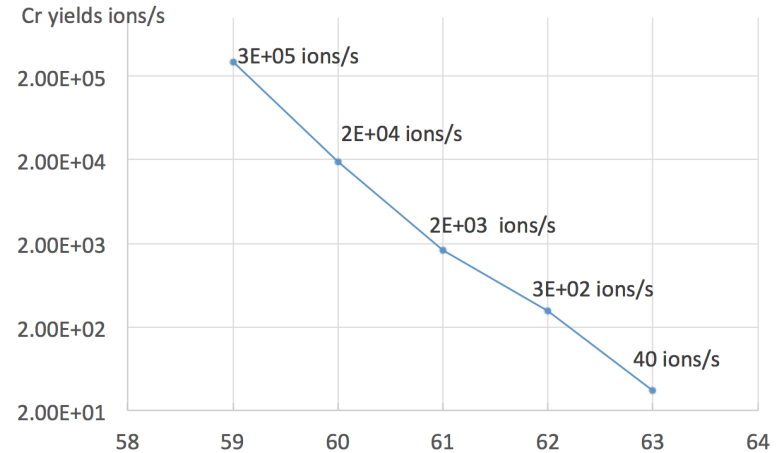


Beam time request

Production

- UC_x target on HRS + ISCOOL
 - RILIS
- Benefit from increased yields due to development of laser ionization scheme

Experimental yields from ISOLTRAP



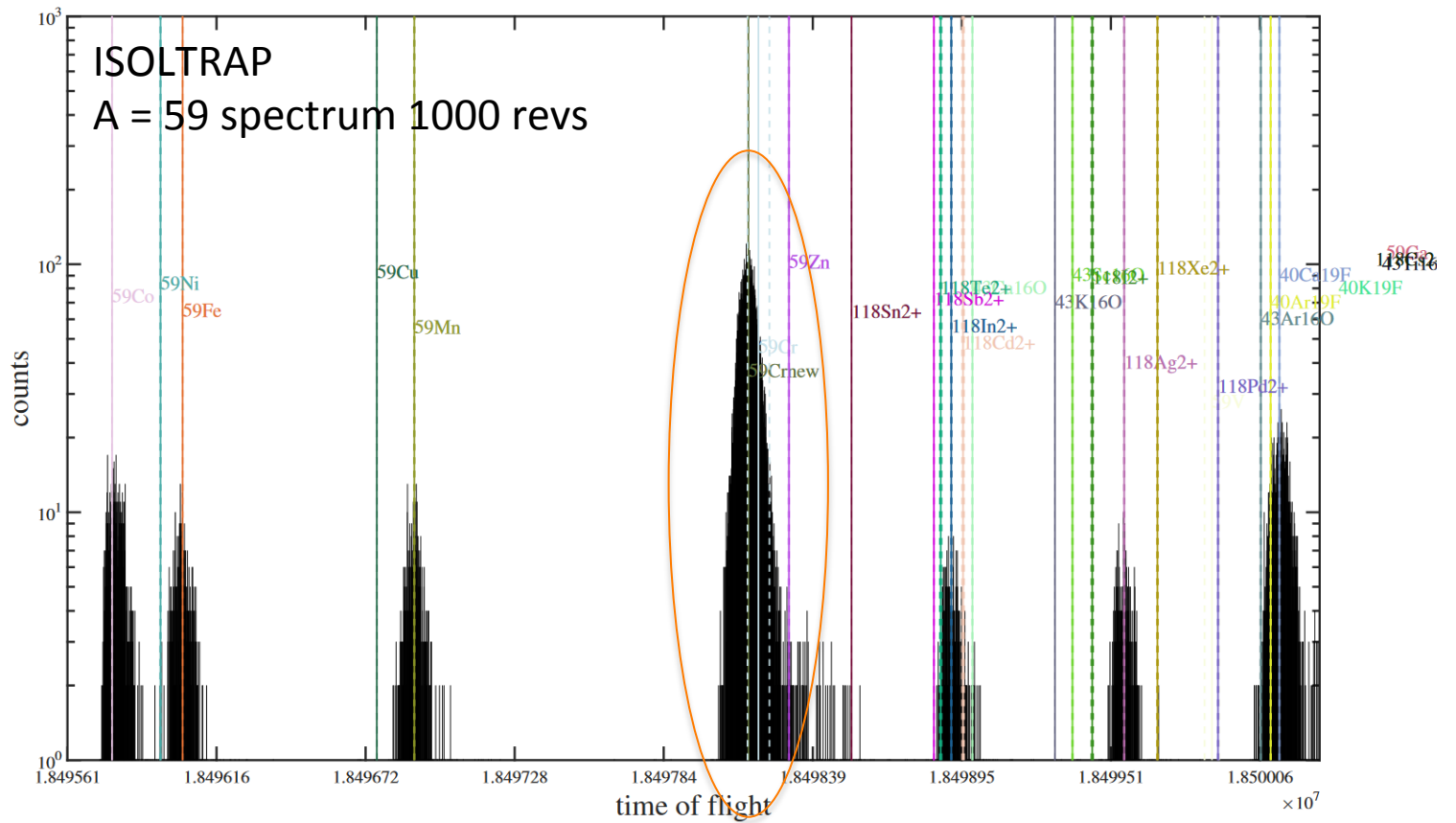
	Yield (UC _x + RILIS)	Number of shifts
⁵⁵⁻⁵⁹ Cr	> 10 ⁵ ions/s	5
^{48,49,60} Cr	~ 2 · 10 ⁴ ions/s	6
⁶¹ Cr	2 · 10 ³ ions/s	3
^{50,52-54} Cr	stable	3
^{52,53} Cr	stable	4

Total: 14

+ 3 shifts of stable beam just before the experiment

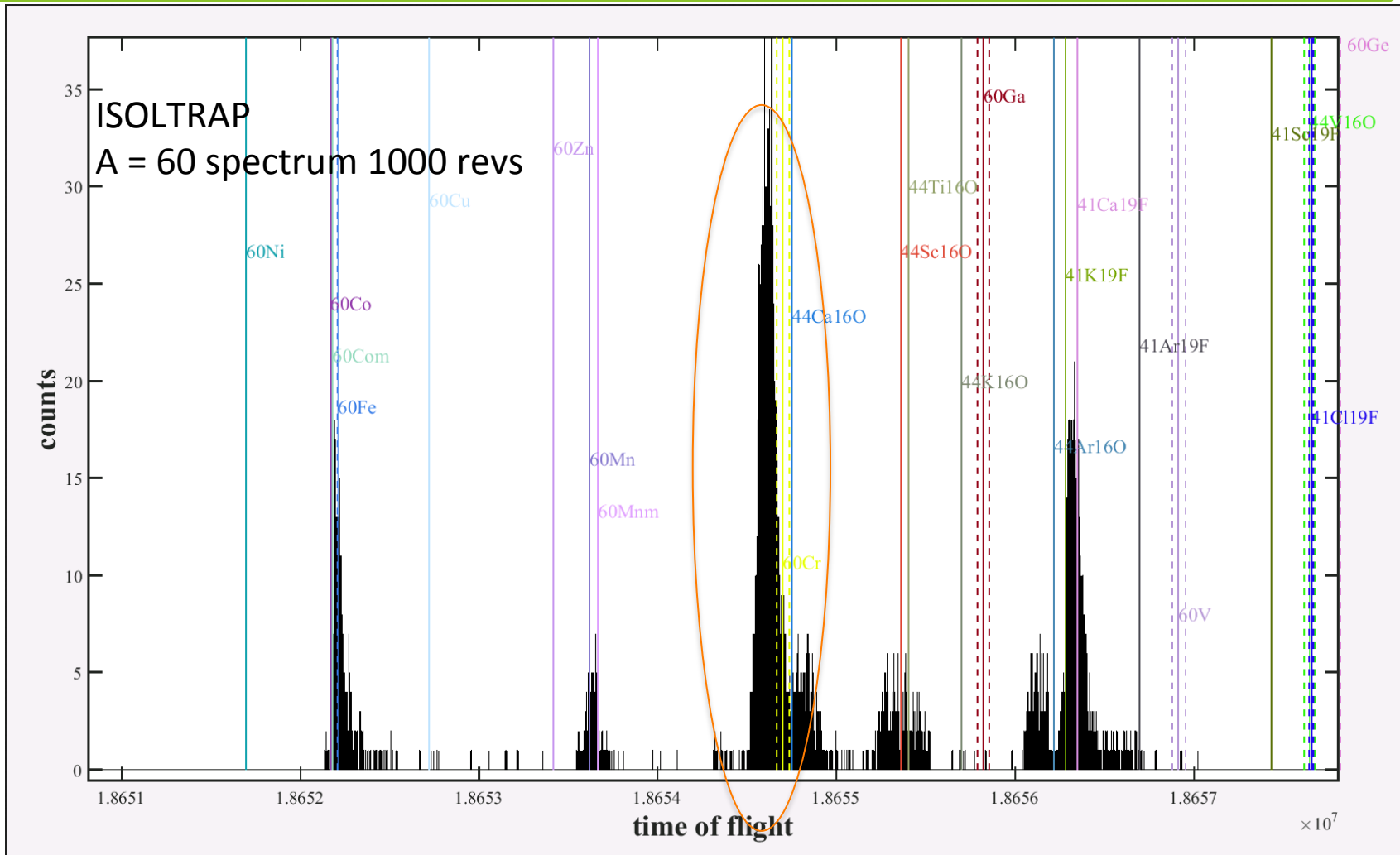
+ 4 shifts of stable beam on a separate occasion to verify the transition





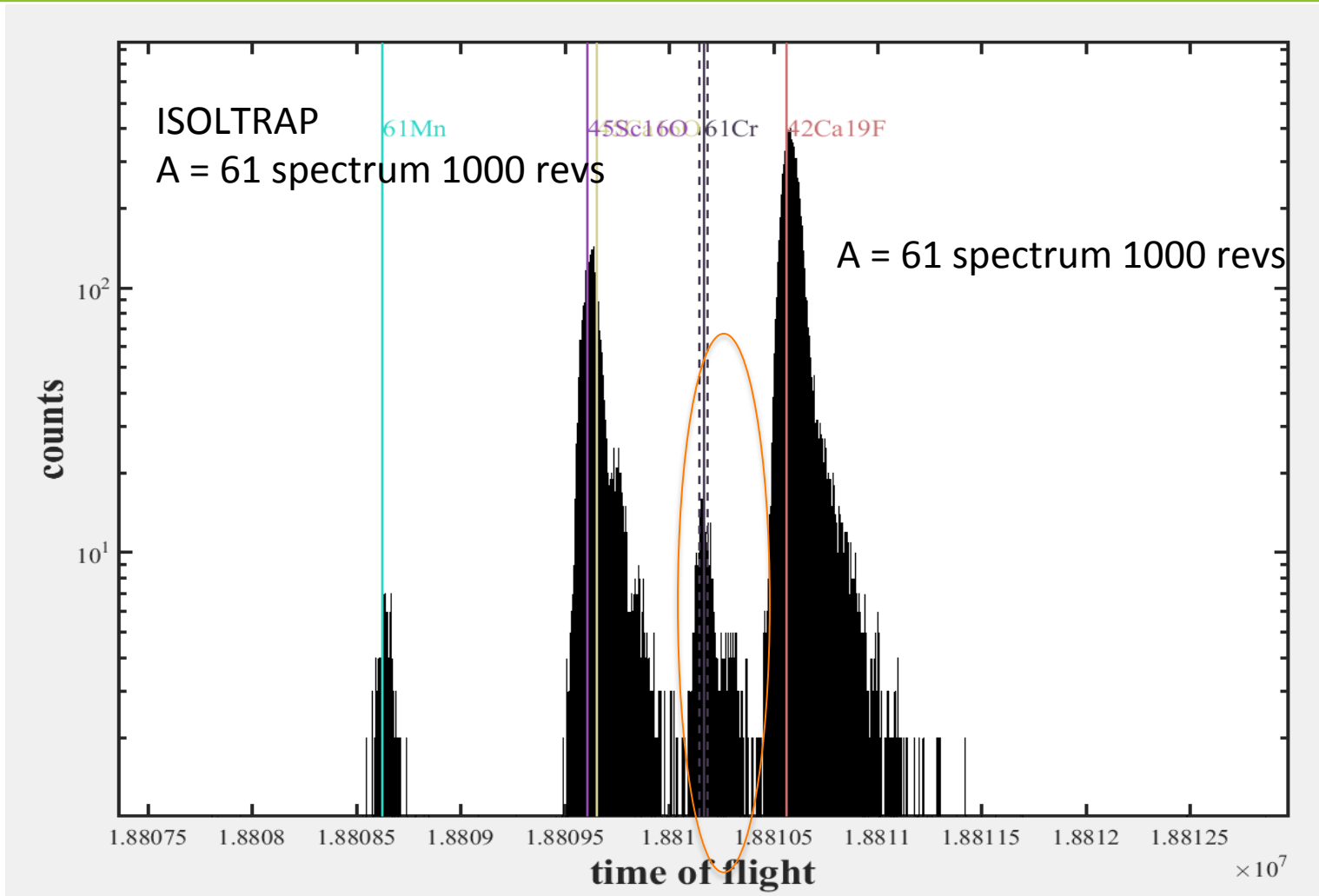
59Cr $\rightarrow 3 \cdot 10^5$ ions/s

ISCOOL limit $5 \cdot 10^6$ ions/s



60Cr \rightarrow $2 \cdot 10^4$ ions/s

ISCOOL limit $5 \cdot 10^6$ ions/s



61Cr -> $2 \cdot 10^3$ ions/s
 Contaminants < 10^5 ion/s

ISCOOL limit $5 \cdot 10^6$ ions/s



Masses and charge radii

