Laser nuclear spin polarization of radioactive isotopes at TRIUMF

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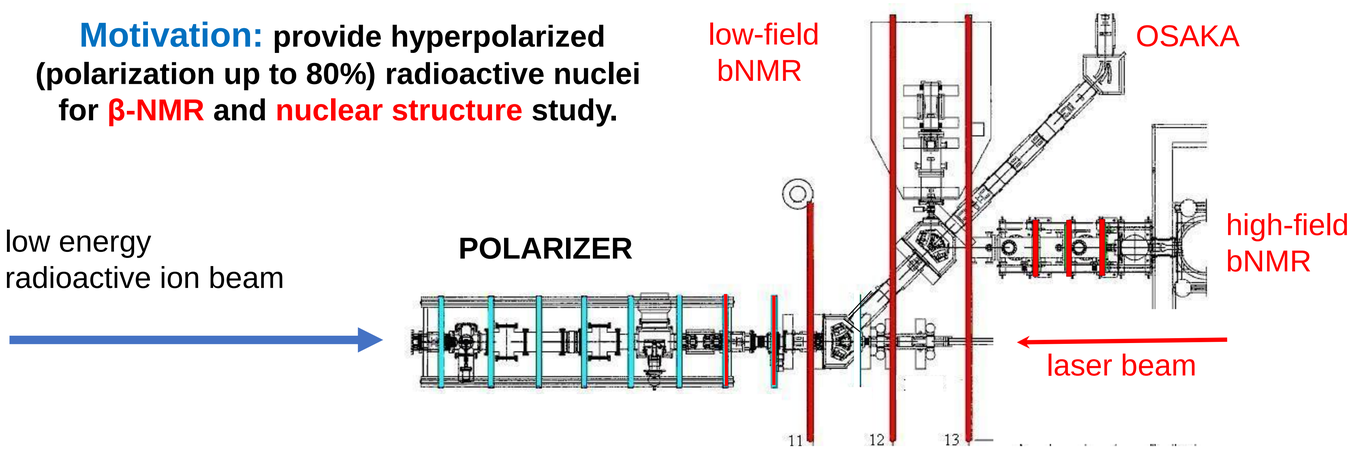
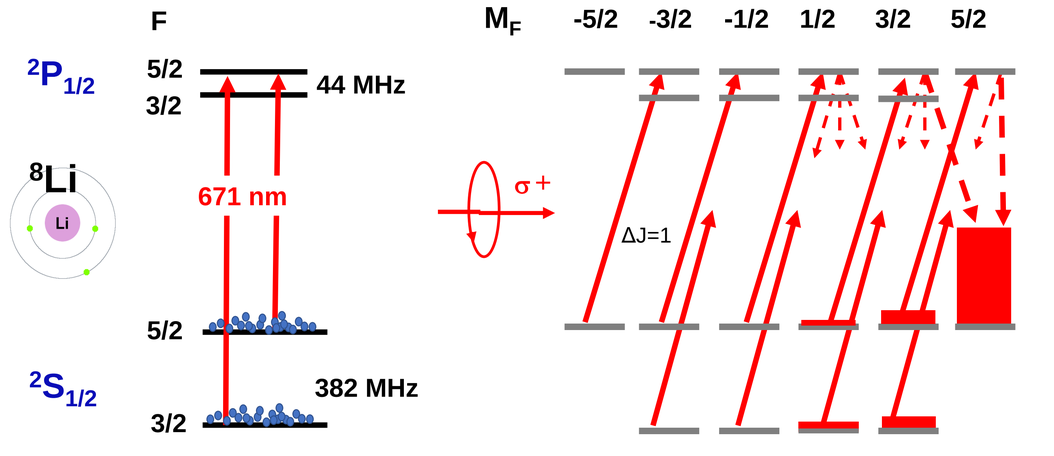
EMIS XIX
RISP/IBS
Deajeon, Korea

NUCLEAR POLARIZATION FACILITY

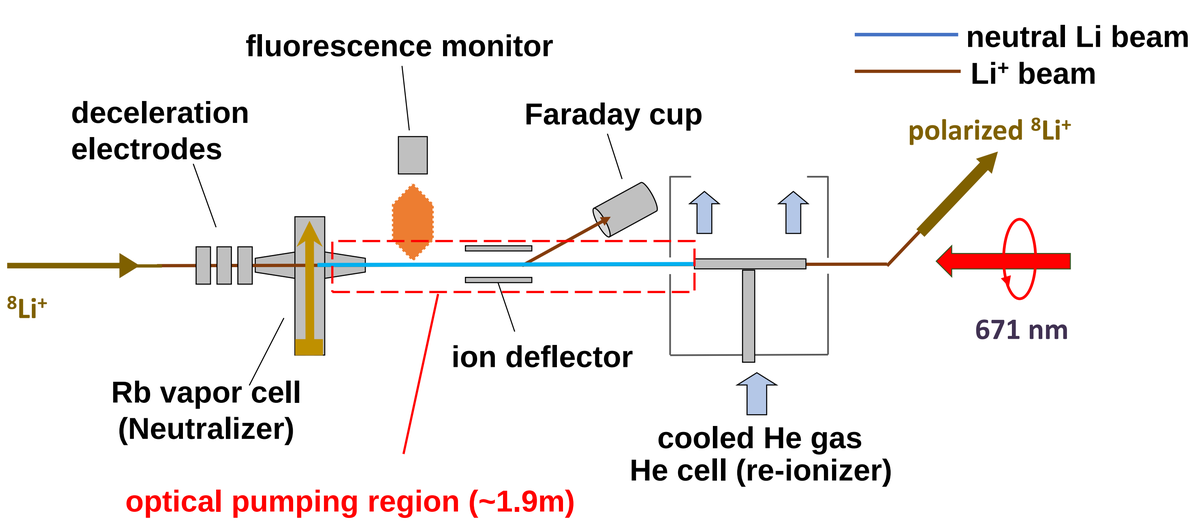
Motivation: **provide hyperpolarized (polarization up to 80%) radioactive nuclei for β-NMR and nuclear structure study.**

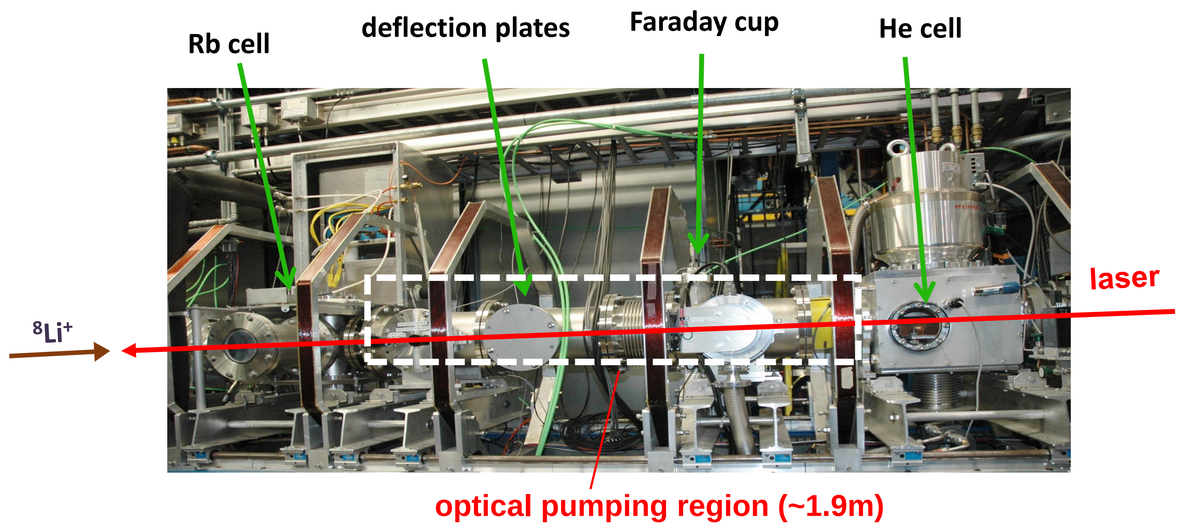


OPTICAL PUMPING



BEAMLINE CONGIGURATION





RECENT UPGRAGES

polarizer beamline upgrades:

new cubic beamlines for light collection and optical pumping region:

- improved access and configuration changes, isolated Rb charge exchange cell

new heating power supply for Rb cell:

- T_ reservoir stability from ±1% to ± 0.1%, with better resolution to adjust neutralization rate

data acquisition system upgrades:

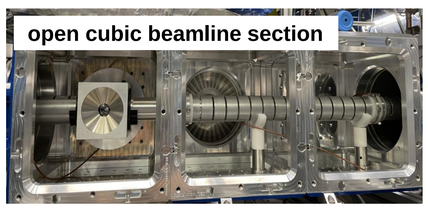
- MIDAS pol system upgrade and new python DAQ system

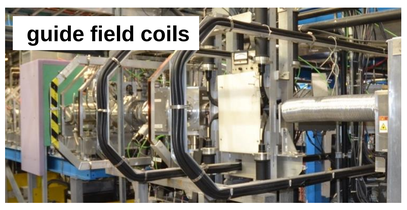
magnetic guide filed coil to OSAKA beamline:

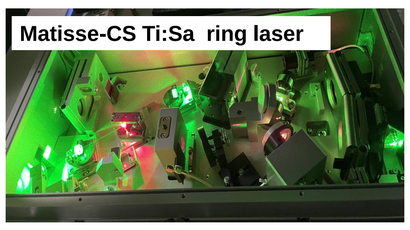
- Conserve the nuclear-spin-polarization of ^{32,33}Mg+ to OSAKA detector station.

laser system additions:

additional lasers: 1x ring-dye laser and 2x Ti:Sa ring-laser systems to enable optical pumping of complex atomic systems







RECENT DEVELOPMENT RESULTS

β-NMR to study Ac complexes in biophysical environments to develop ^{225}Ac-based radiopharmaceuticals

method: ***beta detected nuclear magnetic resonance*** **β-NMR requires nuclear-spine-polarized radioactive isotope beams**

candidate isotopes: ***short lifetime T & anisotropic β-decay, e.g.***

isotopes	T(s)	spin	decay	ISAC production rate
^{230}Ac	122	1	β-	2×10^4
^{232}Ac	119	1	β-	1×10^4

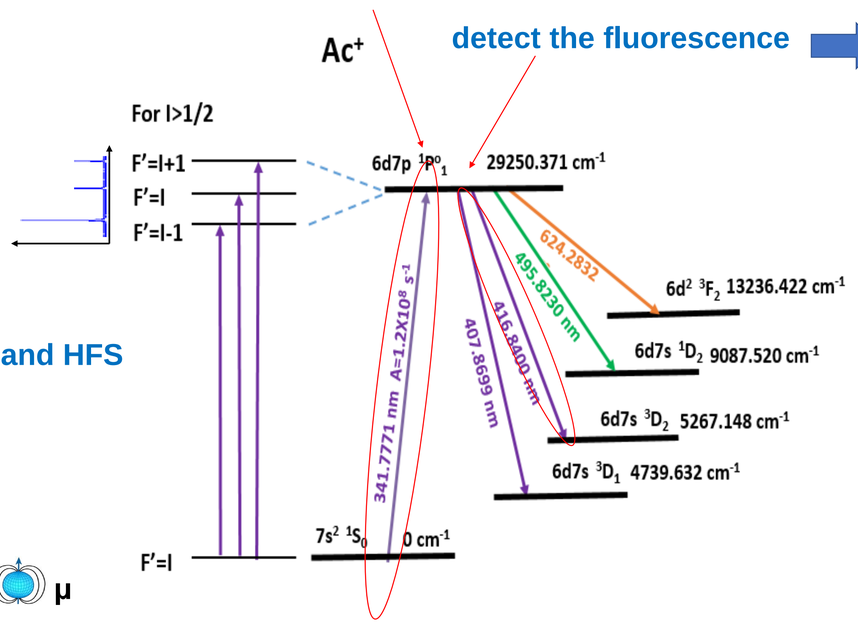
challenges: **for exotic isotopes, such as ^{230}Ac and ^{232}Ac, the IS and HFS are often unknown.**

development: **collinear laser spectroscopy of neutron-rich Ac.**

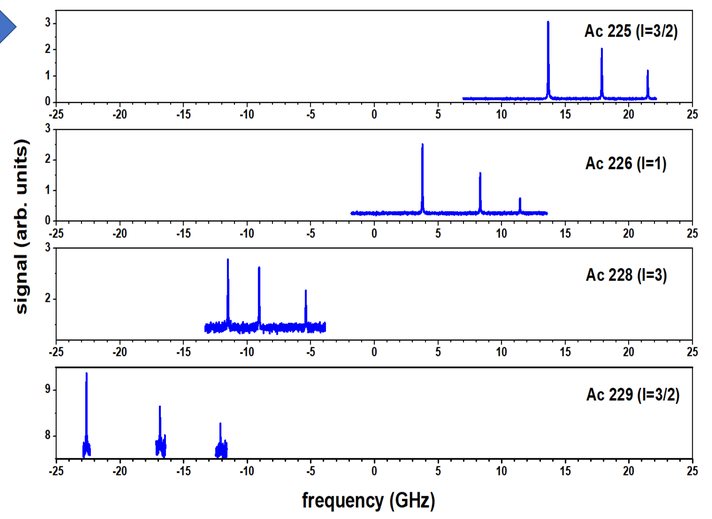
spectroscopic results also give information on:

- mean squared charge radii δ<r^2>; r
- nuclear spin I and nuclear magnetic dipole moments μ; I μ
- nuclear quadrupole moments Q. Q<0 Q=0 Q>0

excitation transition



high resolution Ac spectrum (linewidth:~40MHz); clearly resolved hyperfine structure



collaboration with life sciences (M. Stachura)

OUTLOOK

Material science

Life science

The polarizer facility has been routinely providing ^{8}Li, ^{9}Li and ^{31}Mg+ for the studies of material science, life science, nuclear physics, and fundamental symmetries at TRIUMF-ISAC since commissioning in 2000. To meet demands from emerging research of β-NMR in nuclear physics, biomedical and material science at ISAC, laser polarization for novel isotope beams, such as ^{230,232}Ac , ^{58,74}Cu, and ^{32}Na is requested.

To polarize these isotopes, investigation of polarization schemes is critical, especially for isotopes whose atomic properties are unknown. To polarize elements without suitable closed atomic transitions, multiple lasers are needed for repumping.

Additional upgrades of the polarizer beamline and the laser systems are underway. We are planning to install a stable ion source for the polarizer beamline; design and test an atomic polarization detector; expand the wavelength range of our laser system; and investigate novel ionization mechanism to deliver nuclear-spin-polarized isotope beams.

Nuclear science

Fundamental symmetries

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