Aluminium Measurement Status

COLLAPS collaboration meeting

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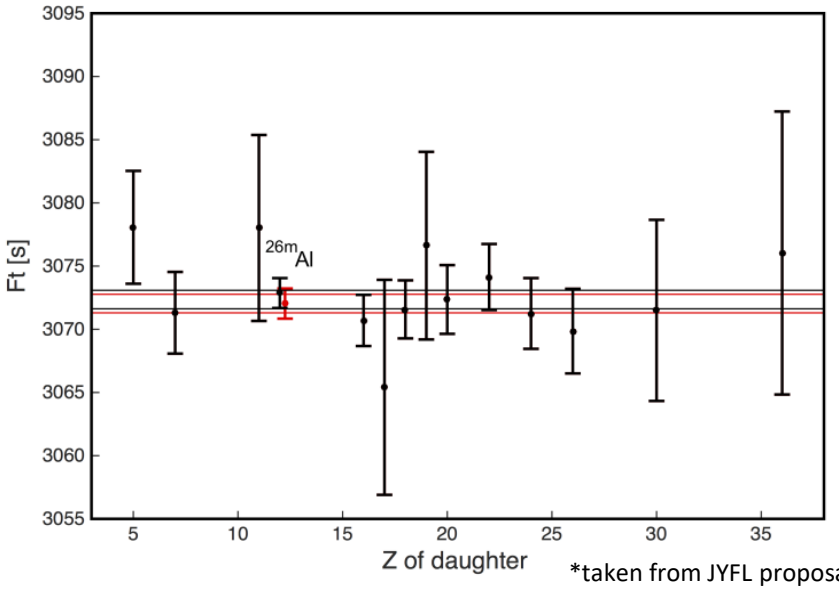
10.2.2022

Importance of ^{26m}Al

- Superallowed $0^+ \rightarrow 0^+$ β emitters are used in the determination of V_{ud} in CKM matrix to test predicted unitarity of CKM
- 15 precision cases used in determination of V_{ud}
- ^{26m}Al is the most accurately known such case



*taken from JYFL proposal

Importance of ^{26m}Al

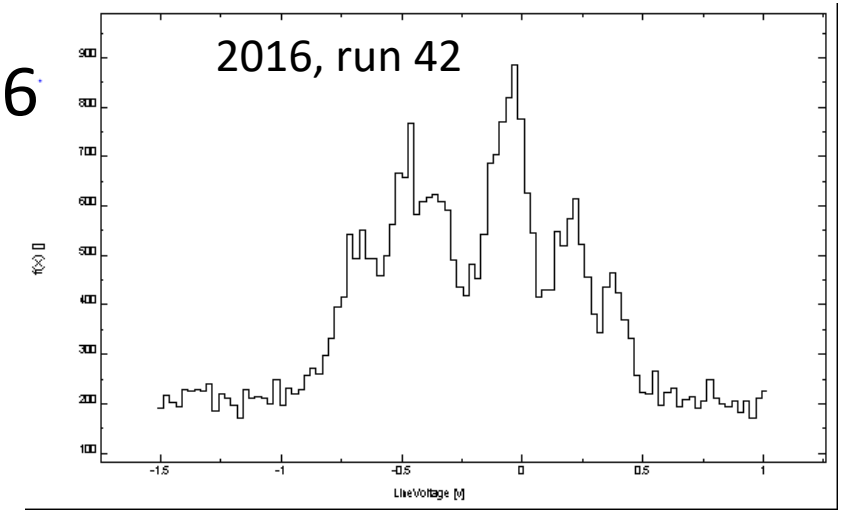
- The charge radii of these emitters play a role in (small) theoretical corrections in regards to radial overlap corrections of the isospin-symmetry-breaking corrections based on the underlying model spaces

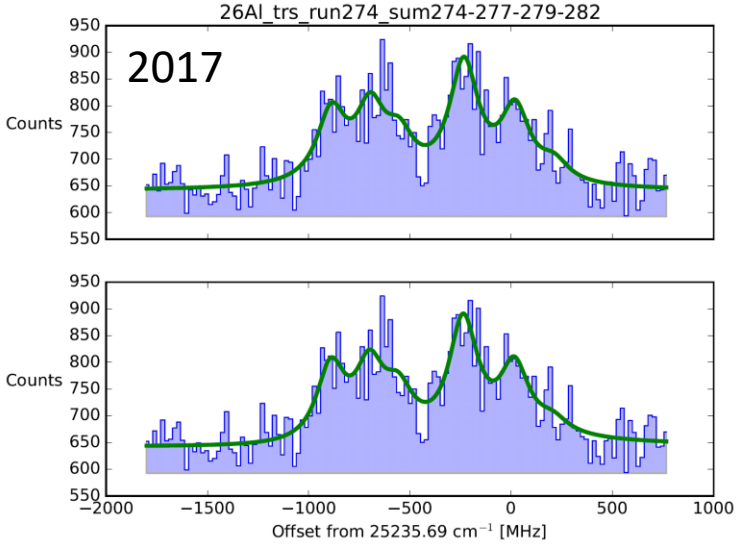
- Charge radius of ^{26m}Al unknown and was extrapolated as 3.04(2) fm in the past

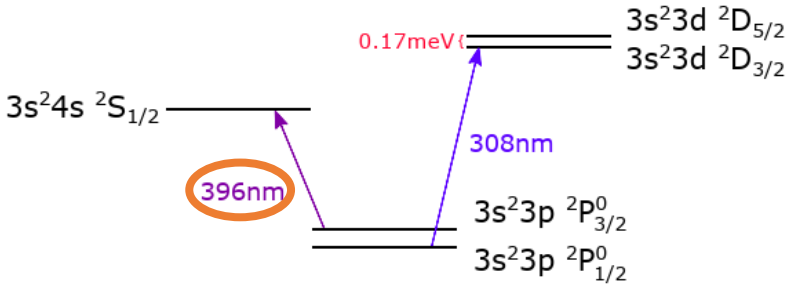
- Measurements at COLLAPS hinted at higher value than the extrapolated one

Previous Measurements @COLLAPS

- Two aluminium beamtimes at COLLAPS in 2016 and 2017 for $^{26\text{-}32}$Al
- Lower statistics in measurements of ^{26}Al in 2017 and far less runs than in 2016
- Initial analysis done by Hanne and Wouter
- PRC publication of $^{27\text{-}32}$Al



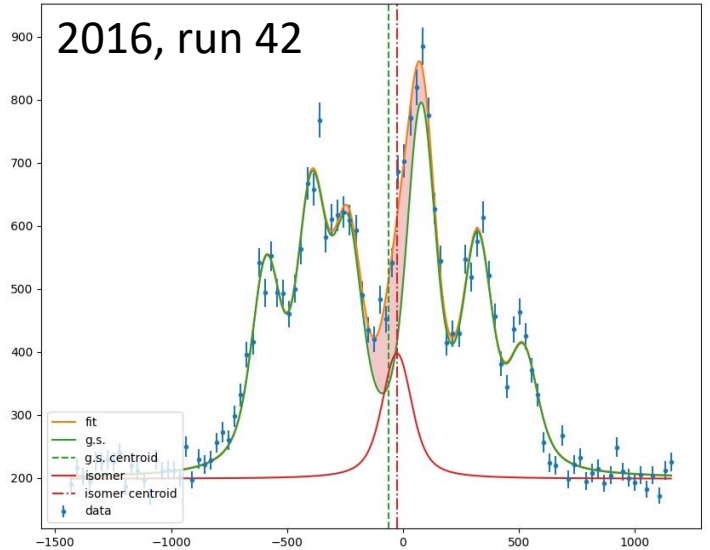




*taken from COLLAPS lablog

Very(!) Preliminary Results

- Racah intensities have been fixed
- Simultaneous fits with shared HF parameters
- No in-depth sidepeak/constraint analysis yet



- Agreement with literature for HF parameters:

	Parameter	Fit value [MHz]	Lit. value [MHz]
^{26}Al	A(P3/2)	37.9(2)	36.53(48) †
	A(S1/2)	169.9(4)	-
	B(P3/2)	39.0(18)	33.2(37) †

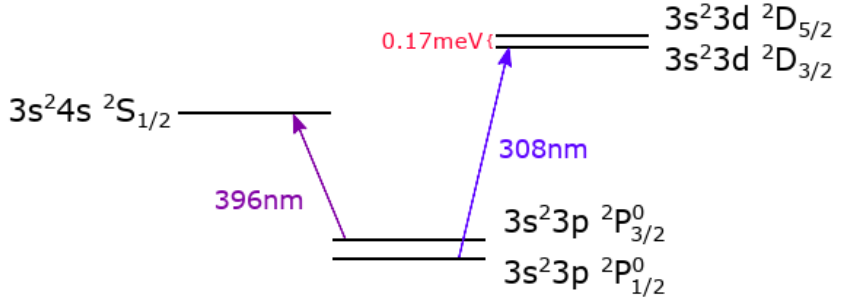
	Parameter	Fit value [MHz]	Lit. value [MHz]
^{27}Al	A(P3/2)	94.2(1)	94.33(4) ††
	A(S1/2)	430.6(5)	431.11(9) ††
	B(P3/2)	19.8(9)	18.1(2) ††

† DOI: 10.1088/0954-3899/23/9/015

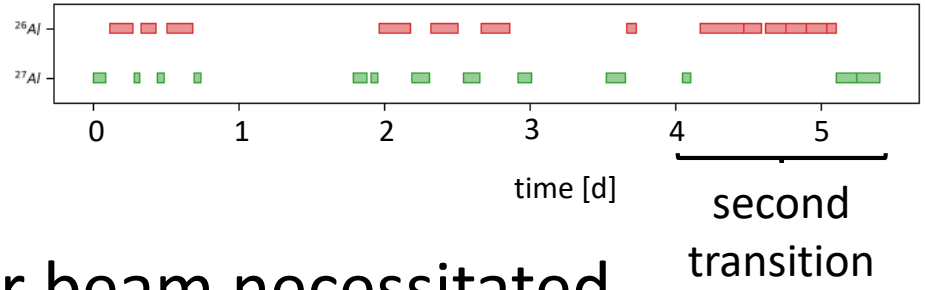
†† Hanne's paper

JYFL Proposal

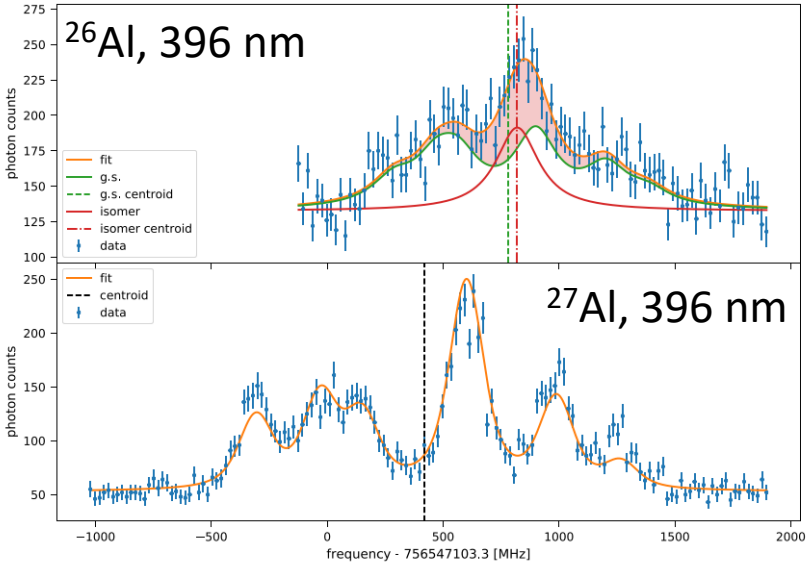
- COLLAPS data of ^{26m}Al hinted at higher charge radius than what was used for corrections in V_{ud} determination
- Proposal to measure $^{24\text{-}28}$Al at JYFL submitted by Hanne at IGISOL
- More favourable isomer:g.s. production ratio for ^{26,26m}Al at IGISOL (~5-25 times larger)
- Same transition that was used for the COLLAPS experiment

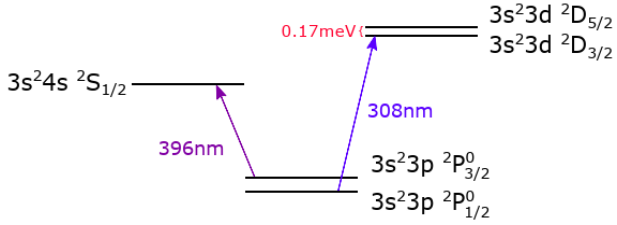


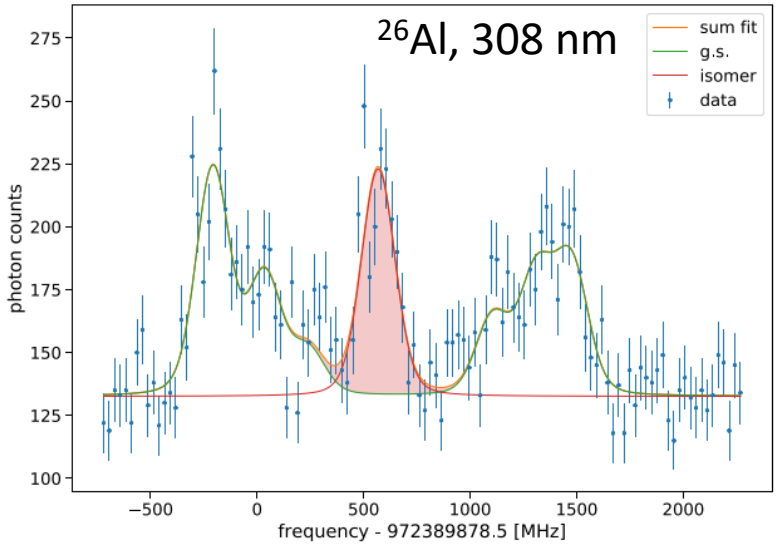
JYFL Beamtime



- Beamtime started with ^{26,27}Al
- Two separate sodium blockages of the laser beam necessitated venting of the CLS beamline
- Decision was made to measure second transition (@308 nm) over the weekend instead of changing target for ^{24,25}Al





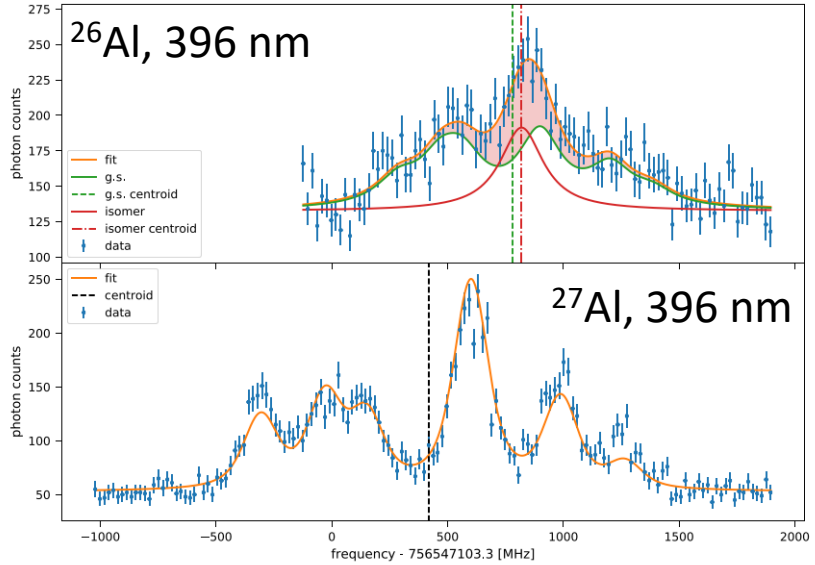


JYFL Results for 396nm transition

- Independent cross confirmation of results with Bradley, Ross and Elliott still in progress
- A-ratio was fixed to the precise value established in the COLLAPS experiment
- Racah intensities have been fixed
- Results for HF parameters show agreement with literature values:

	Parameter	Fit value [MHz]	Lit. value [MHz]
^{26}Al	$A(P_{3/2})$	36.54(50)	36.53(48)†
	$A(S_{1/2})$	166.8(23)[a]	-
	$B(P_{3/2})$	44(8)	33.2(37)†

	Parameter	Fit value [MHz]	Lit. value [MHz]
^{27}Al	$A(P_{3/2})$	94.79(35)	94.33(4)††
	$A(S_{1/2})$	-	431.11(9)††
	$B(P_{3/2})$	16.3(33)	18.1(2)††



† DOI: 10.1088/0954-3899/23/9/015

†† Hanne's paper

Comparison for 396nm COLLAPS & JYFL

- Results and prelim. results agree very well within statistical uncertainties:

Isotope	$\delta\nu^{27,A}$ COLLAPS	$\delta\nu^{27,A}$ JYFL	$\sqrt{\langle r^2\rangle^A}$ COLLAPS	$\sqrt{\langle r^2\rangle^A}$ JYFL
^{26}Al	359.3(30)	360.7(36)	3.092(6)	3.095(11){12}
^{26m}Al	378.1(160)	378.8(65)	3.132(34)	3.133(16){12}
	(stat. unc.)	(stat. unc.)	(stat. unc.)	(stat.+sys.]{phys. calc.}

- Charge radius of ^{26m}Al ~4.5 standard deviations larger than the assumed value of 3.04(2) fm

Next Steps

- JYFL data
  - Finish cross-check with Liverpool group
  - Employ second transition to constrain isomer:g.s. ratio to improve stat. error
- COLLAPS data
  - In-depth analysis of COLLAPS data on ^{26,26m}Al regarding the isotope shifts and charge radii
- Publication
  - With combined data

Status Summary

Item	Responsible	Status
JYFL analysis	Peter	Done
JYFL cross-check	Elliott, Ross, Peter	In progress
COLLAPS ^{26,26m,27}Al analysis	Peter	In progress
COLLAPS cross-check	Wouter, Hanne	
Publication	Peter	

Discussion

Reference Signal in 2016/2017