SFB 1245 Workshop 2017
Mainz, 05.10.2017
Julian Kahlbow for TP A06
PI: T. Aumann, D. Rossi

TECHNISCHE UNIVERSITÄT DARMSTADT

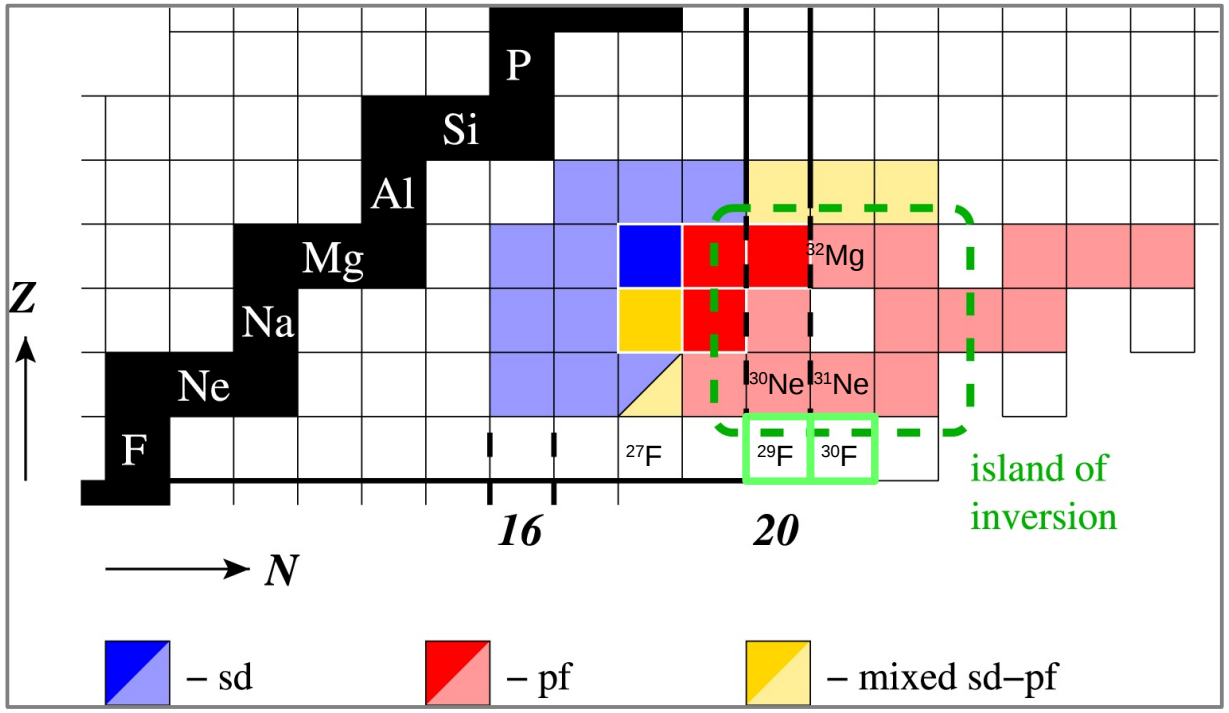
Neutron-unbound States at the low-Z Shore of the Island of Inversion

SAMURAI

RIKEN NISHINA CENTER

SFB 1245

The “Island of Inversion“



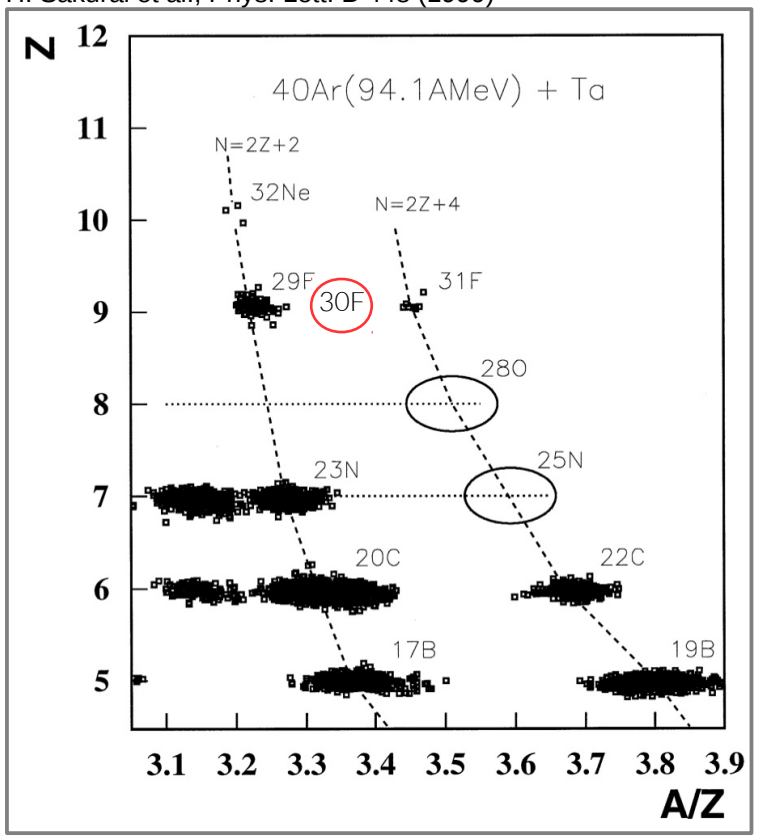
P.A. Butler et al., J. Phys. G: Nucl. Part. Phys. 44 (2017)

$$^{30}\mathrm{Ne} \xrightarrow{-p} {}^{29}\mathrm{F}^{*} \longrightarrow {}^{27}\mathrm{F} + 2n$$

$$^{31}\mathrm{Ne} \xrightarrow{-p} {}^{30}\mathrm{F} \longrightarrow {}^{29}\mathrm{F} + n$$

What is known about ^{30}F ?

H. Sakurai et al., Phys. Lett. B 448 (1999)



ADOPTED LEVELS for ^{30}F

Author: M. SHAMSUZZOHA BASUNIA Citation: Nuclear Data Sheets 111, 2331 (2010)

Full ENSDF file

Q(β-)=2.51E4 keV *SY* S_n= -4.E2 keV *SY*

E_{level} (keV)	$T_{1/2}$
0.0	% n = ?

NNDC 2017

^{30}F is neutron-unbound … that‘s it

$$^{31}\mathrm{Ne} \xrightarrow{-p} {}^{29}\mathrm{F} + n$$

TP A04: Shell model interactions from Chiral Effective Field Theory could provide predictions?

What is known about ^{29}F?

$$^{30}\mathrm{Ne} \xrightarrow{-p} {}^{29}\mathrm{F}^{*} \longrightarrow {}^{27}\mathrm{F} + 2n$$

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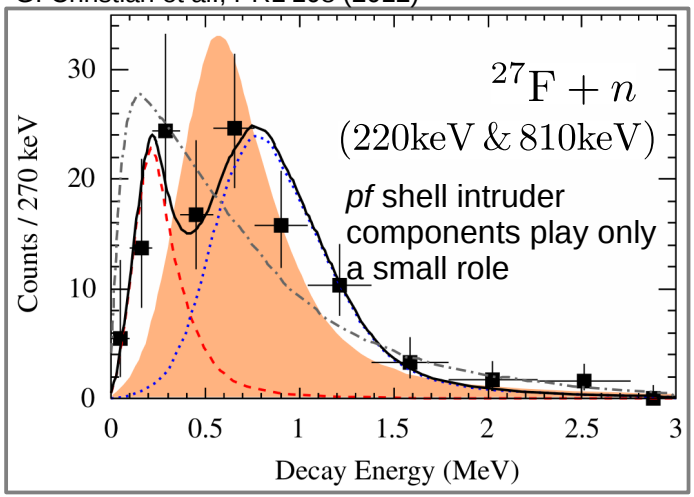
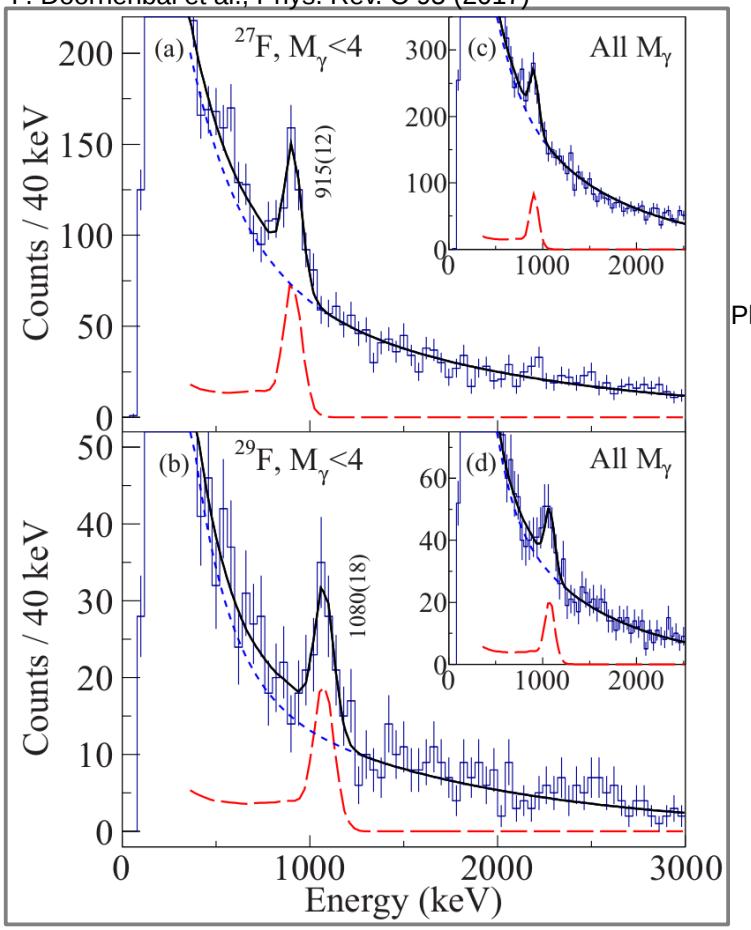
^{9}Be(^{29}Ne, ^{28}F) @ NSCL

G. Christian et al., PRL 108 (2012)



In-beam gamma spectroscopy CH_2/C(^{30}Ne,^{29,27}F)

P. Doornenbal et al., Phys. Rev. C 95 (2017)



& 504(15)keV, 777(19)keV

Z. Elekes et al., Phys. Lett. B 599 (2004)

$1/2^+$ exc. state (only bound excited state?)

The low-Z shore of the “Island of Inversion“

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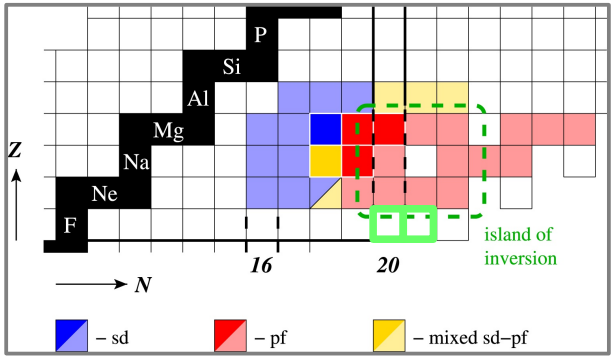
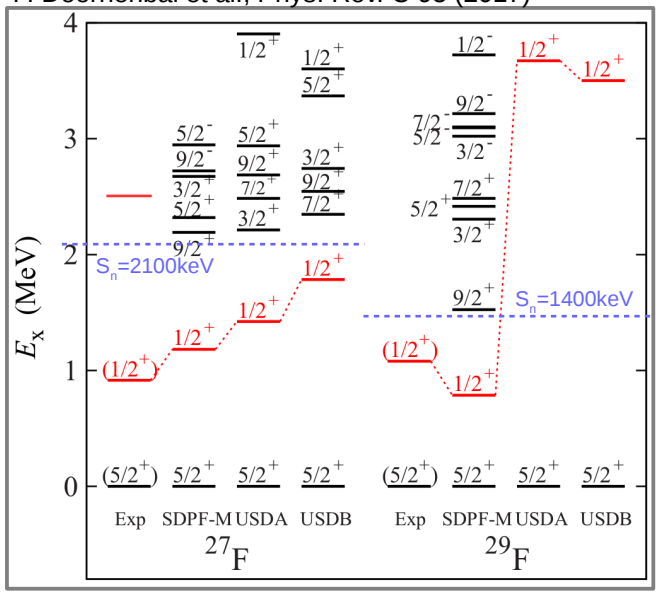


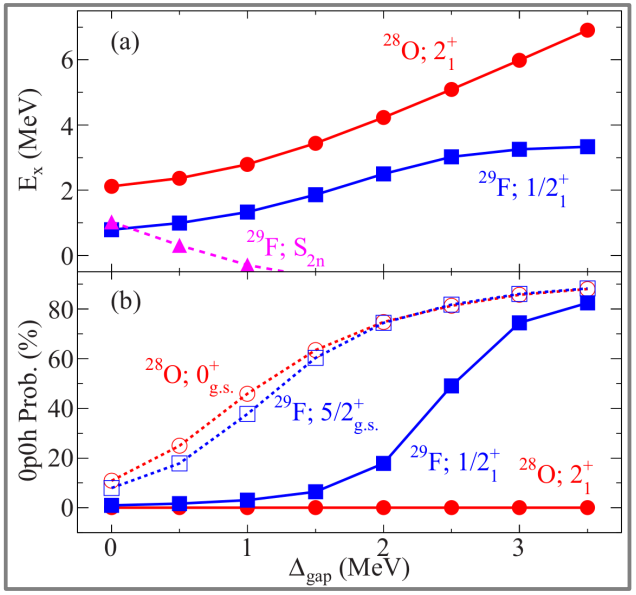
- Interplay:
  heaviest O isotopes ↔ F isotopes ↔ Island of Inversion
  2p2h & 4p4h *pf*-shell configurations are crucial

- neutron-unbound states provide more complete picture
  (also *f* & *p* wave access)

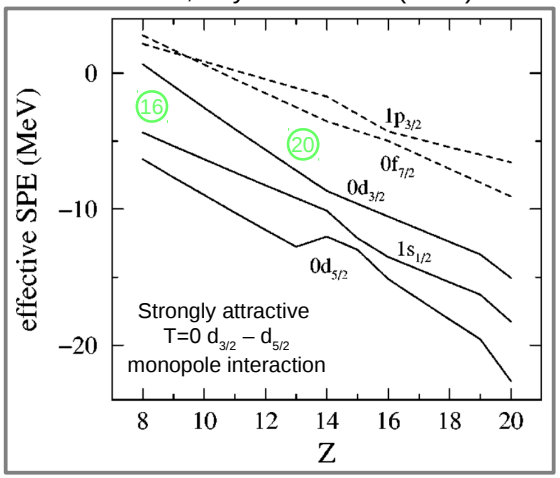
P.A. Butler et al., J. Phys. G: Nucl. Part. Phys. 44 (2017)

P. Doornenbal et al., Phys. Rev. C 95 (2017)





Y. Utsuno et al., Phys. Rev. C 60 (1999)



Spectroscopy of neutron-rich Oxygen Isotopes at the RI Beam Factory

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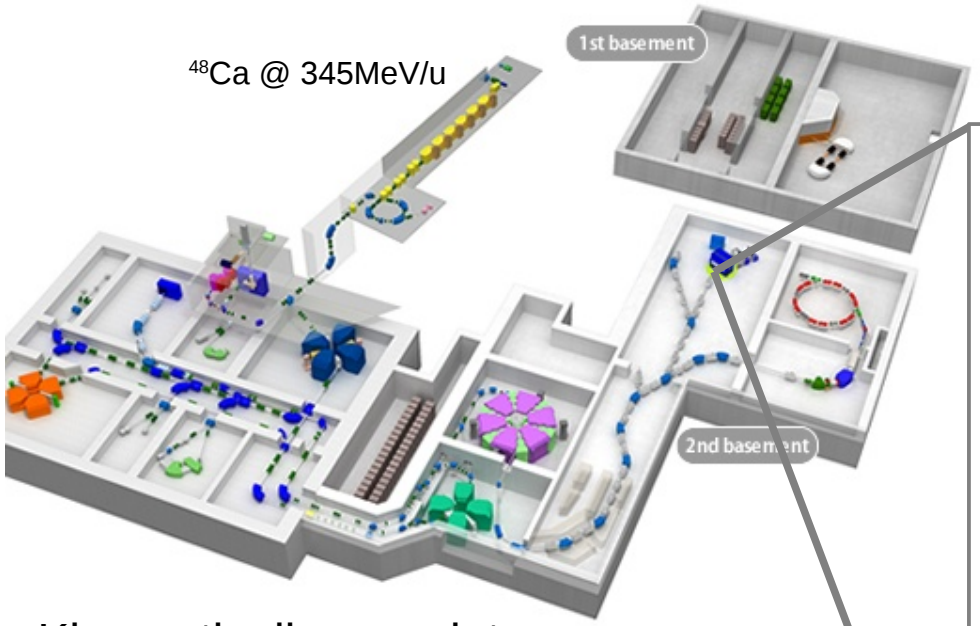
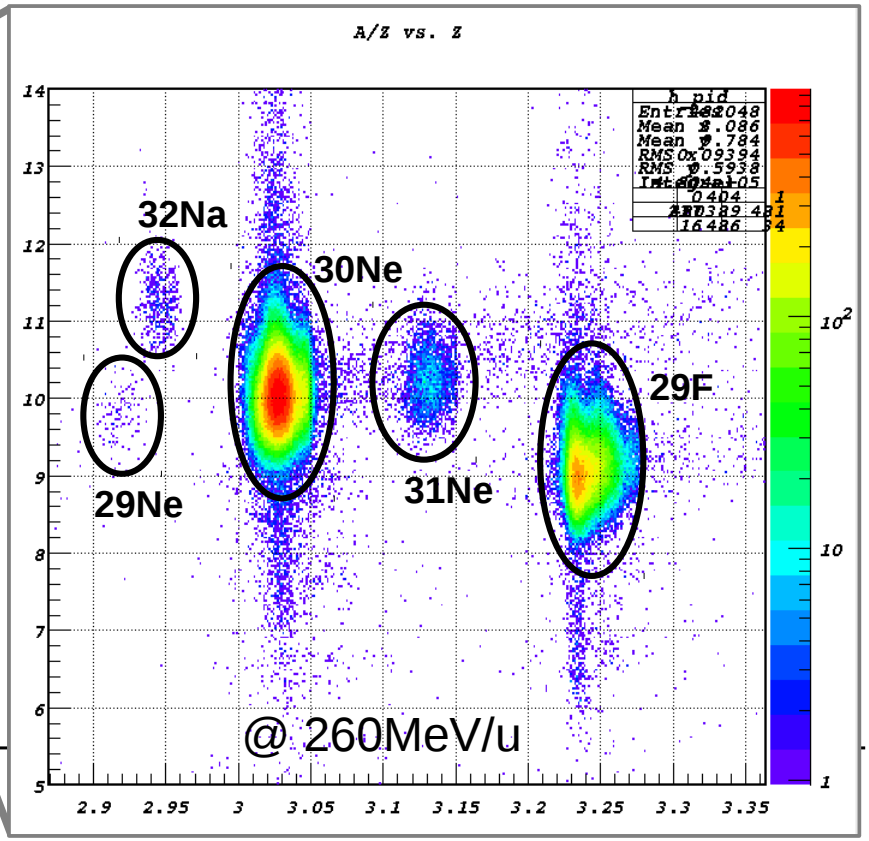
Spokesperson: Y. Kondo (Tokyo Inst. of Technology)
"Spectroscopy of ^{27}O & ^{28}O"

$$^{29}\mathrm{F} \xrightarrow{-p} {}^{28}\mathrm{O} \longrightarrow {}^{24}\mathrm{O} + 4n$$

$$^{29}\mathrm{Ne} \xrightarrow{-2p} {}^{27}\mathrm{O} \longrightarrow {}^{24}\mathrm{O} + 3n$$





Kinematically complete measurements with radioactive beams in inverse kinematics at high energies

SAMURAI Experimental Setup

Superconducting **A**nalyzer for **Mu**lti-particles from **Ra**dio **I**sotope Beams

(SAMURAI + MINOS + DALI2 + NeuLAND)

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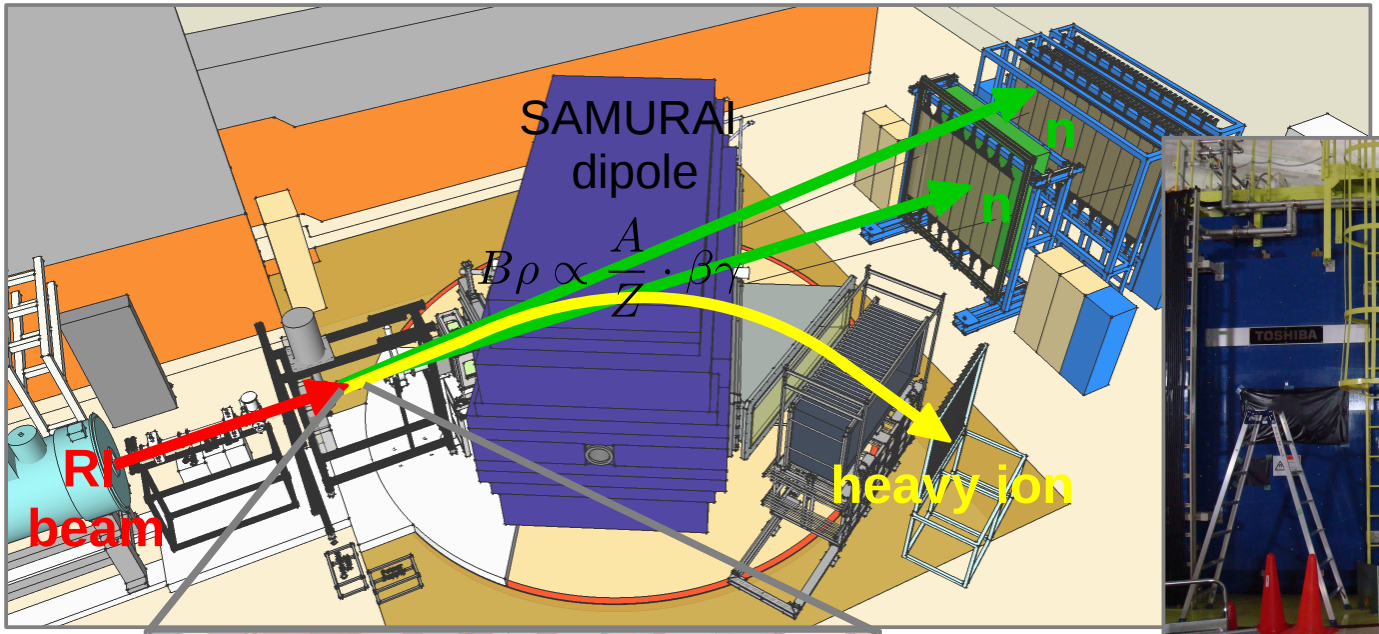
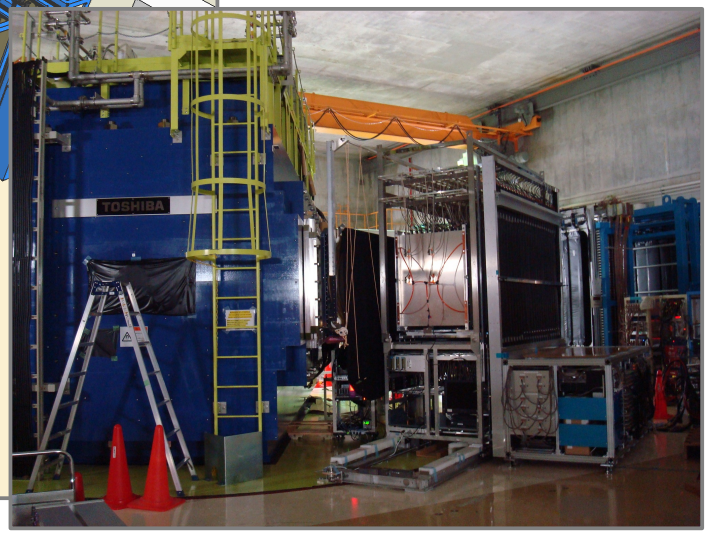
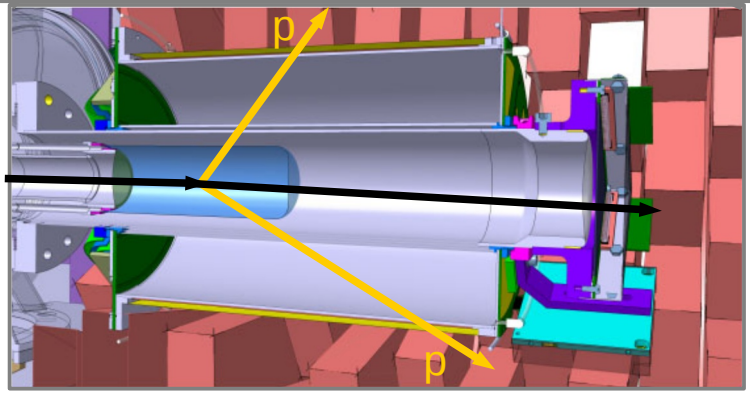






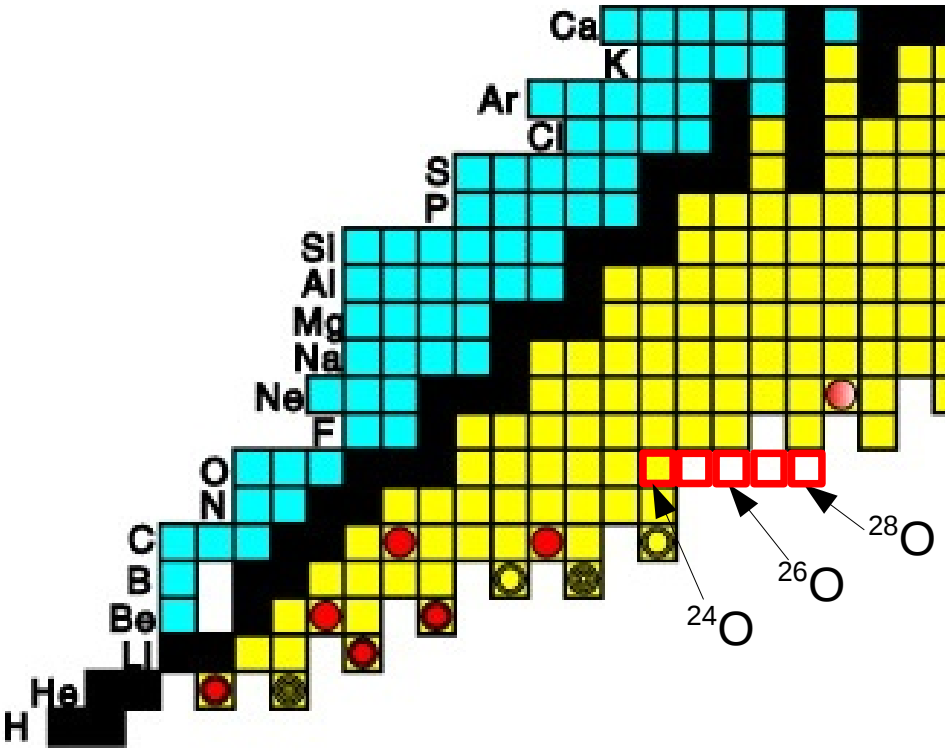
MINOS

Liquid H_2 target + Vertex Tracker

- high luminosity
- good vertex pos. resolution for (p,2p)

A. Obertelli et al., Eur. Phys. J. A 50 (2014)

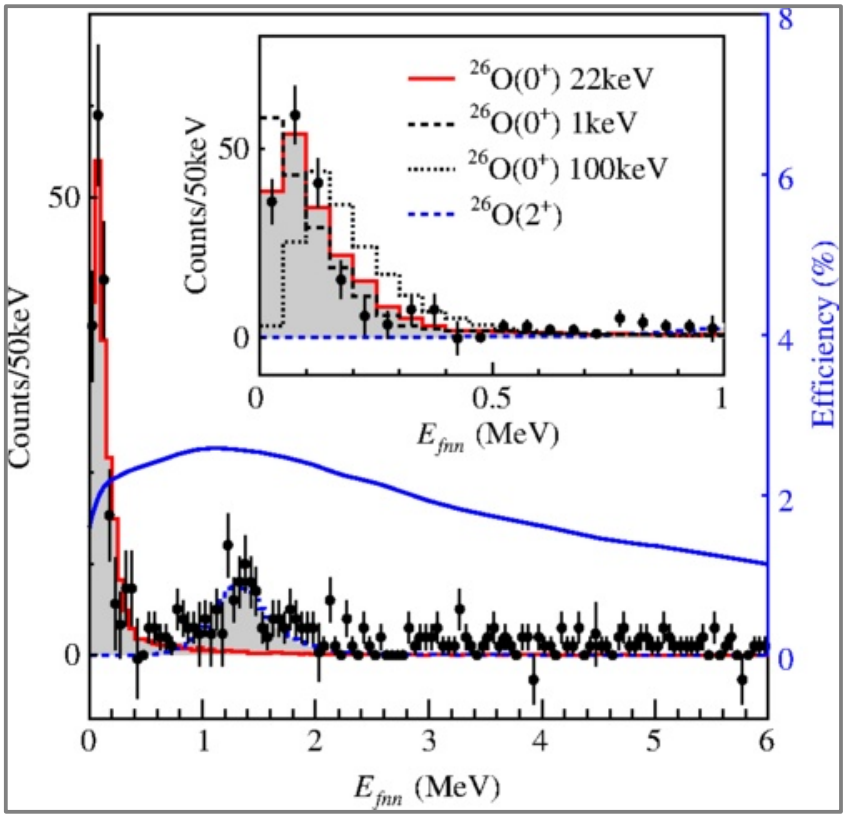
Oxygen Anomaly



- Neutron dripline exp. known up to Z=8
- ^{24}O (doubly magic) is last bound Oxygen isotope
- Dripline theoretically reproduced only by including 3N forces
- ^{26}O is true 2n emitter

T. Aumann & T. Nakamura, Physica Scripta, Volume 2013, T152

^{26}O – A barely unbound system



Y. Kondo et al., PRL 116, 102503 (2016)

RIBF Experiment (Japan)

$$E_r = 18 \pm 3(\mathrm{stat}) \pm 4(\mathrm{syst})\,\mathrm{keV}$$

$$E_r(2^+) = 1.28^{+0.11}_{-0.08}\,\mathrm{MeV}$$

^{26}O – A neutron-radioactive Nucleus?

- Predictions by L. Grigorenko et al. (PRL 111 (4) (2013) 042501) :

  Angular barrier of *d* wave valence neutrons could cause lifetime in ps range

- Measurement at NSCL

  (Z. Kohley et al., PRL 110, 152501 (2013)):

$$\tau = 6.5^{+1.6}_{-2.2}(\mathrm{stat}) \pm 4.3(\mathrm{syst})\,\mathrm{ps}$$

^{26}O – A neutron-radioactive Nucleus? A new and precise method

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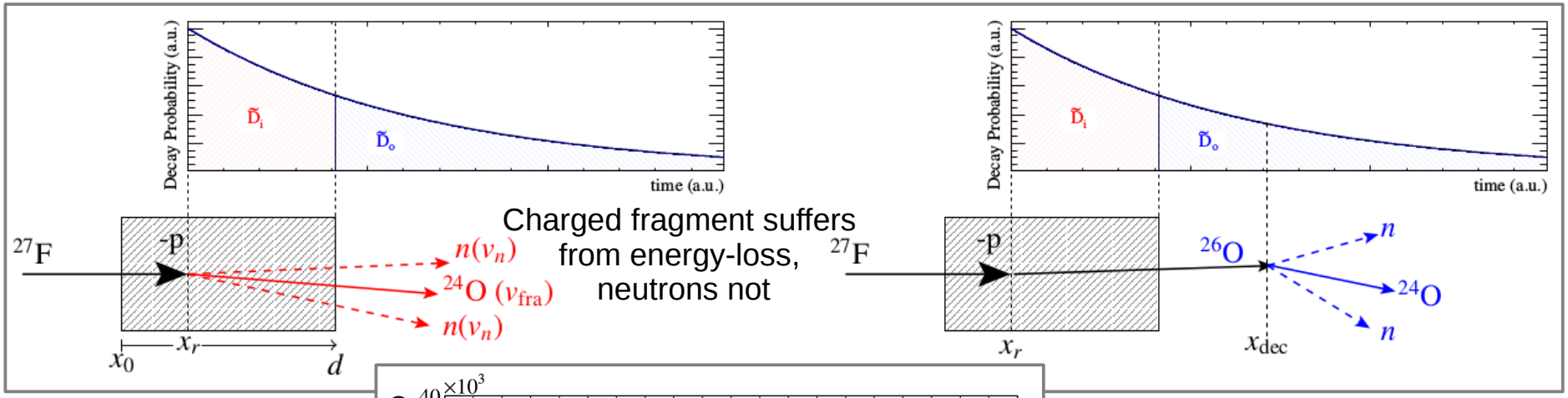
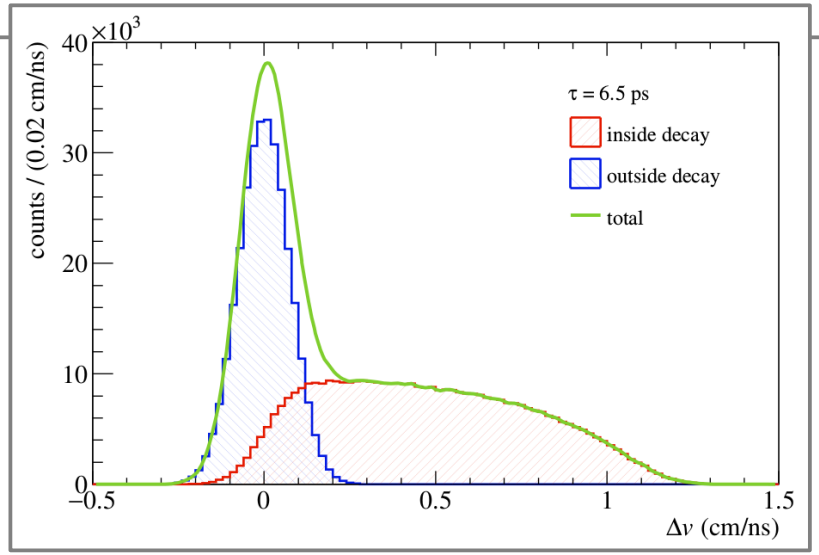


→ Lifetime from ratio of decays in the target to decays outside the target ($\Delta v = v_n - v_{fra}$)



Simulation results optimised for

- lifetime,
- target thickness,
- target material,
- beam energy

JK, C. Caesar et al., NIM A 866, 265 (2017)

^{26}O – A neutron-radioactive Nucleus? A new and precise method

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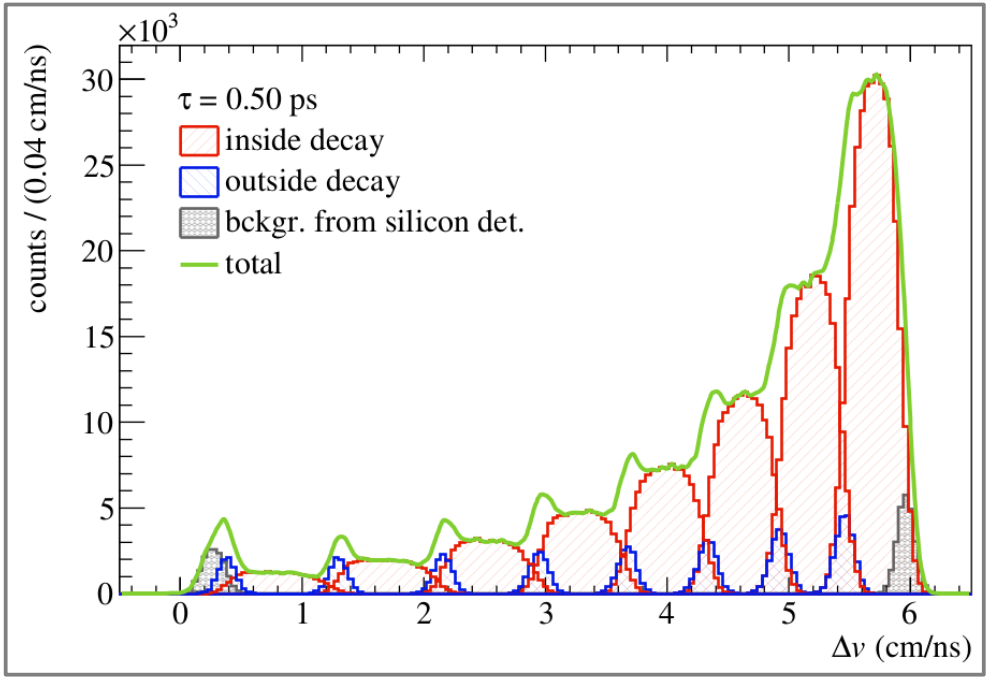
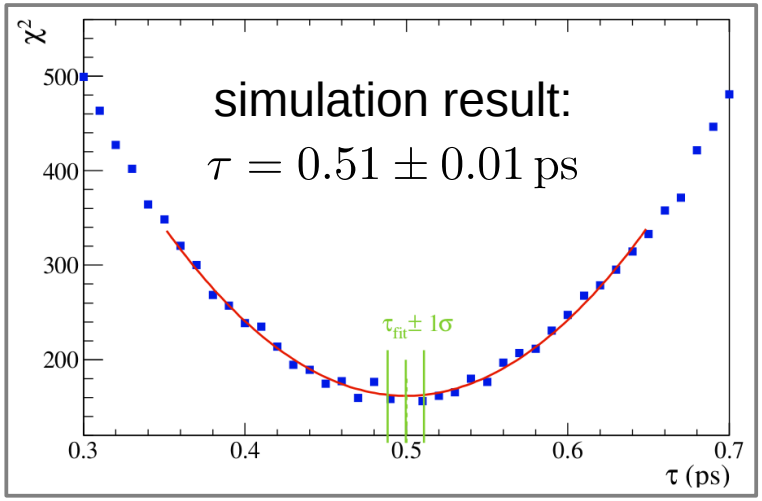
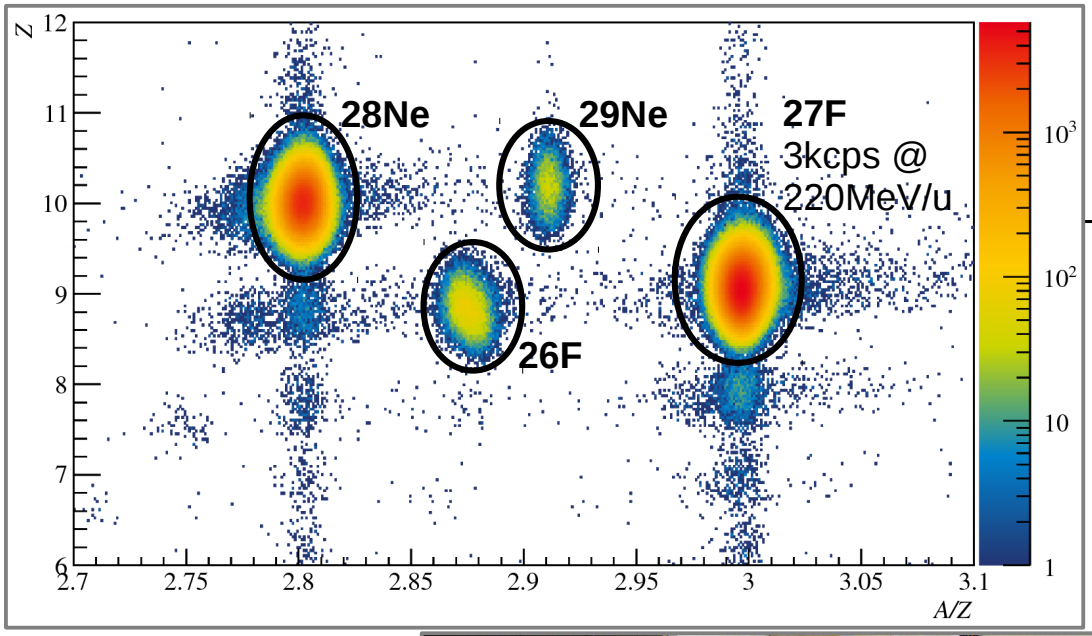
And using several targets ...





→ the experiment has been performed in Dec. 2016 at SAMURAI (C. Caesar)



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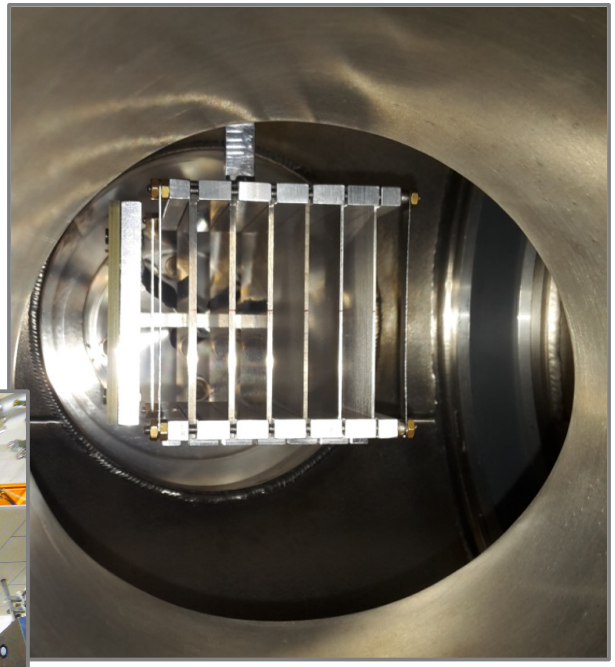
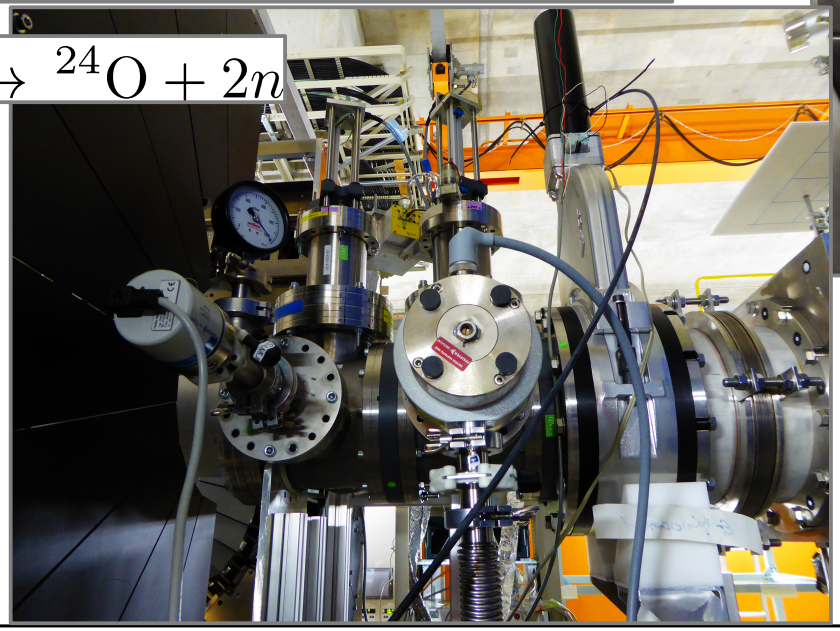


$$^{27}\mathrm{F} \xrightarrow{-p} {}^{26}\mathrm{O} \longrightarrow {}^{24}\mathrm{O} + 2n$$



4 x W + 2 x Pt targets:
14.6g/cm²

Summary

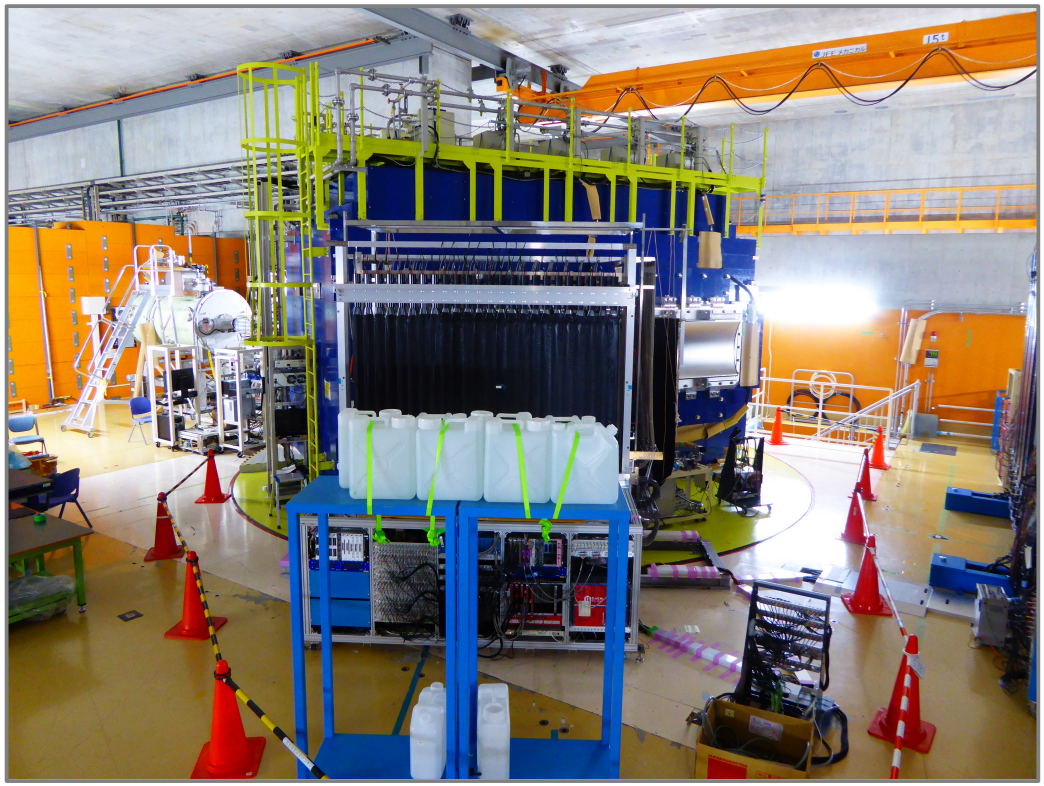
We have recently finished a 2-year experimental campaign at the RIKEN Nishina Center:

<u>TP A06</u>

- $^{29}\mathrm{F} \xrightarrow{-p} {}^{28}\mathrm{O}^{*} \longrightarrow {}^{24}\mathrm{O} + 4n$
- Ground-state Lifetime of ^{26}O
- "Tetraneutron" (F. Schindler)

<u>TP A05</u>

- "Soft Dipole ^{6,8}He" (C. Lehr)
- Coulomb Break-up of ^{31}Ne



Thank You for Your Attention.

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Y.Kondo N.L.Achouri H.Al Falou L.Atar T.Aumann H.Baba K.Boretzky C.Caesar D.Calvet H.Chae N.Chiga A.Corsi H.L.Crawford F.Delaunay A.Delbart Q.Deshayes Zs.Dombrádi C.Douma Z.Elekes P.Fallon I.Gašparić J.-M.Gheller J.Gibelin A.Gillibert M.N.Harakeh A.Hirayama C.R.Hoffman M.Holl A.Horvat Á.Horváth J.W.Hwang T.Isobe J.Kahlbow N.Kalantar-Nayestanaki S.Kawase S.Kim K.Kisamori T.Kobayashi D.Körper S.Koyama I.Kuti V.Lapoux S.Lindberg F.M.Marqués S.Masuoka J.Mayer K.Miki T.Murakami M.A.Najafi T.Nakamura K.Nakano N.Nakatsuka T.Nilsson A.Obertelli F.de Oliveira Santos N.A.Orr H.Otsu T.Ozaki V.Panin S.Paschalis A.Revel D.Rossi A.T.Saito T.Saito M.Sasano H.Sato Y.Satou H.Scheit F.Schindler P.Schrock M.Shikata Y.Shimizu H.Simon D.Sohler O.Sorlin L.Stuhl S.Takeuchi M.Tanaka M.Thoennessen H.Törnqvist Y.Togano T.Tomai J.Tscheuschner J.Tsubota T.Uesaka H.Wang Z.Yang K.Yoneda **for the SAMURAI21 Collaboration**

C.Caesar J.Kahlbow V.Panin D.S.Ahn L.Atar T.Aumann H.Baba K.Boretzky H.Chae N.Chiga S.Choi M.L.Cortes Sua D.Cortina-Gil Q.Deshayes P.Doornenbal Z.Elekes N.Fukuda I.Gasparic K.I.Hahn Z.Halasz A.Hirayama J.Hwang N.Inabe T.Isobe S.Kim T.Kobayashi D.Körper Y.Kondo Y.Kubota I.Kuti C.Lehr S.Lindberg M.Marques M.Matsumoto T.Murakami I.Murray T.Nakamura T.Nilsson H.Otsu S.Paschalis M.Parlog M.Petri D.Rossi A.Saito M.Sasano H.Scheit P.Schrock Y.Shimizu H.Simon D.Sohler S.Storck L.Stuhl H.Suzuki I.Syndikus H.Takeda H.Törnqvist T.Togano T.Tomai T.Uesaka H.Yamada Z.Yang M.Yasuda K.I.Yoneda **for the SAMURAI20 Collaboration**