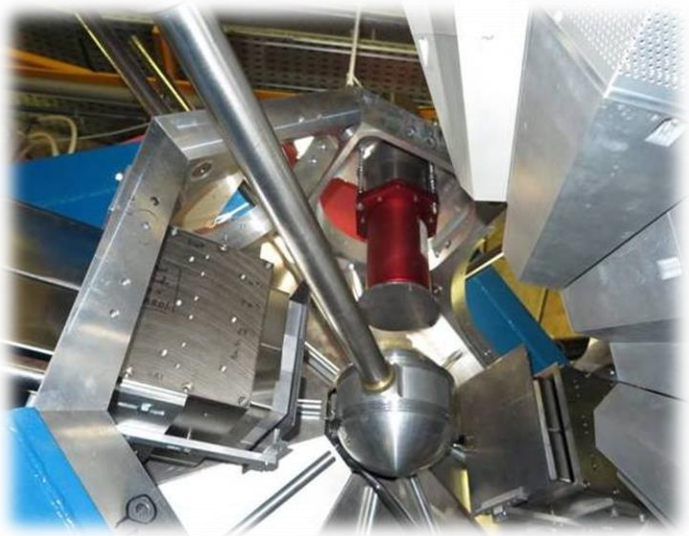
PARIS Collaboration Meeting

Legnaro (Italy), 28-29 November 2019



Status of the e676 experiment with AGATA+PARIS+VAMOS

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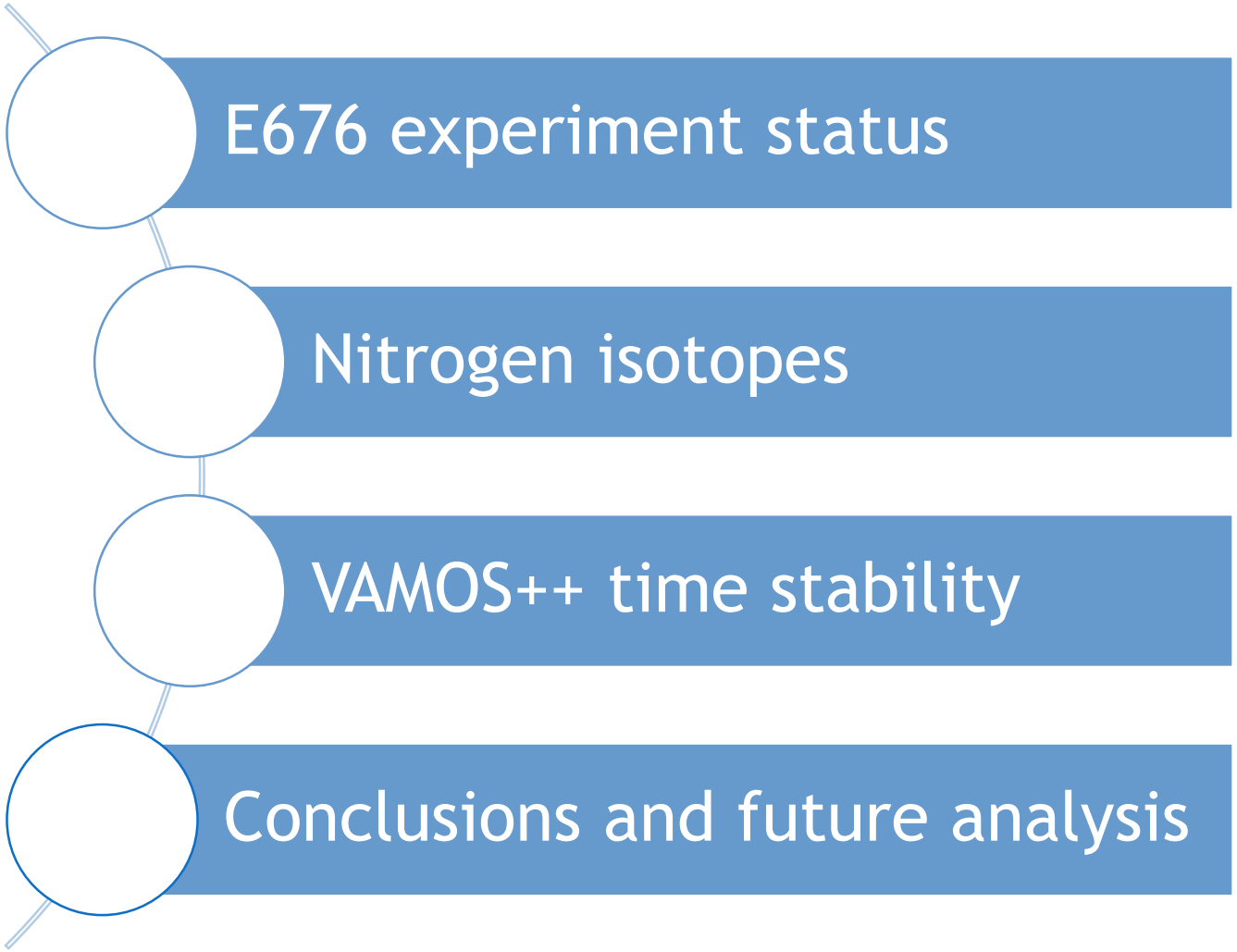
E676 experiment

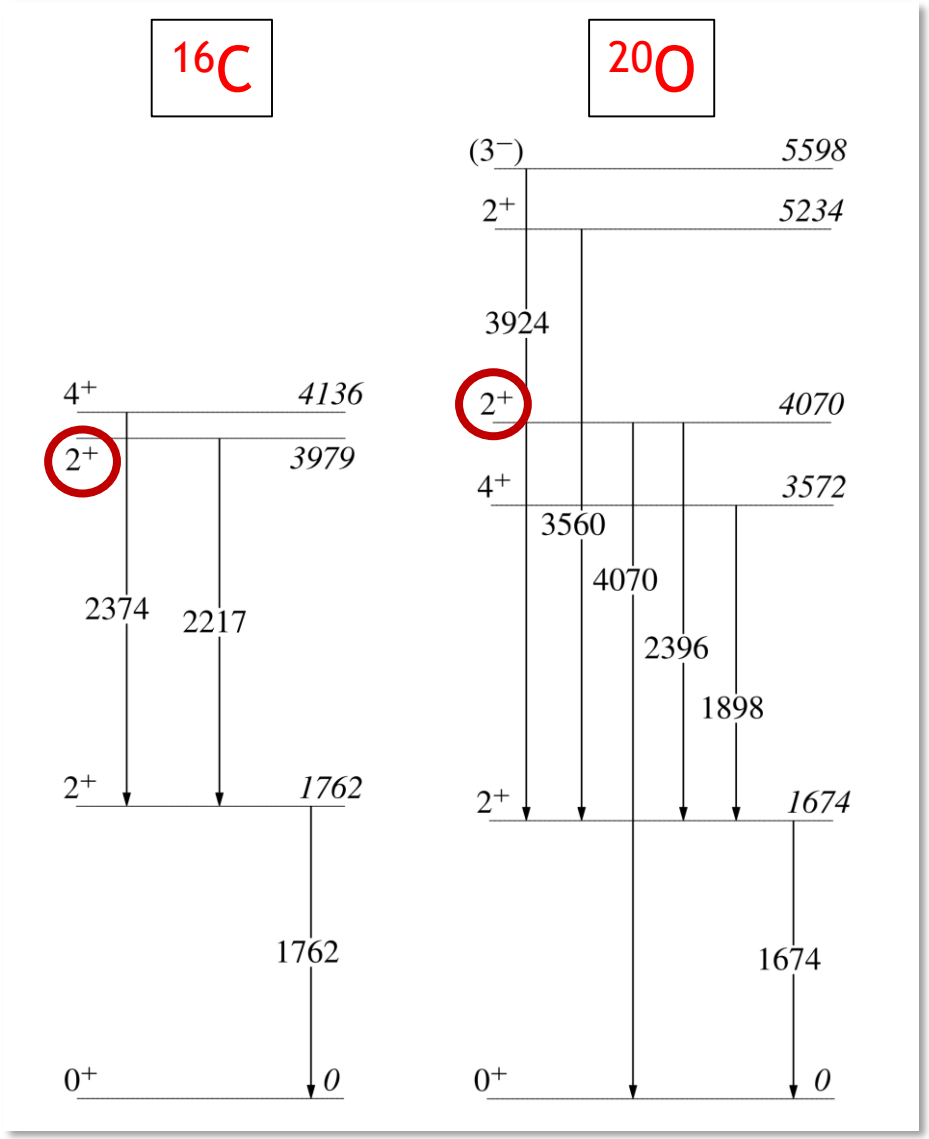
Spokepersons: S. Leoni, B. Fornal, M. Ciemała

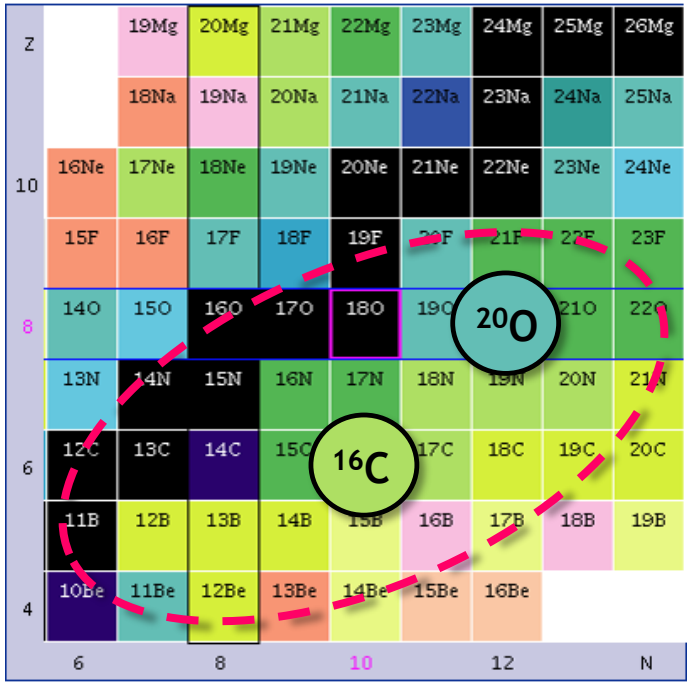
Outline


E676 experiment status
Nitrogen isotopes
VAMOS++ time stability
Conclusions and future analysis

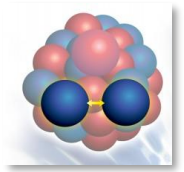
Physics case

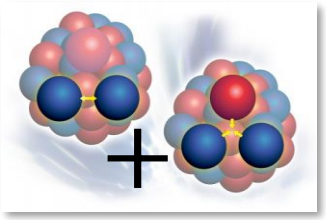
- **MAIN GOAL:** lifetime measurement of the 2_2^+ state in even-even nuclei of ^{16}C and ^{20}O





- Strong sensitivity to the details of the NN and NNN terms pointed out by theoretical calculations

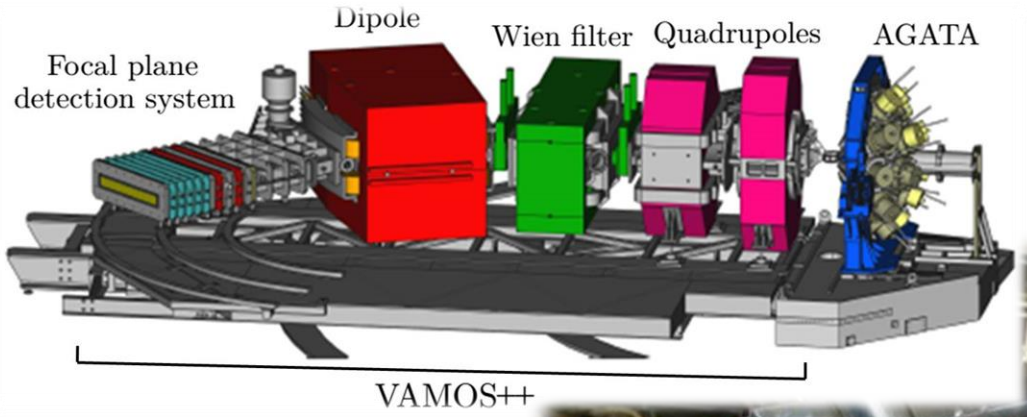


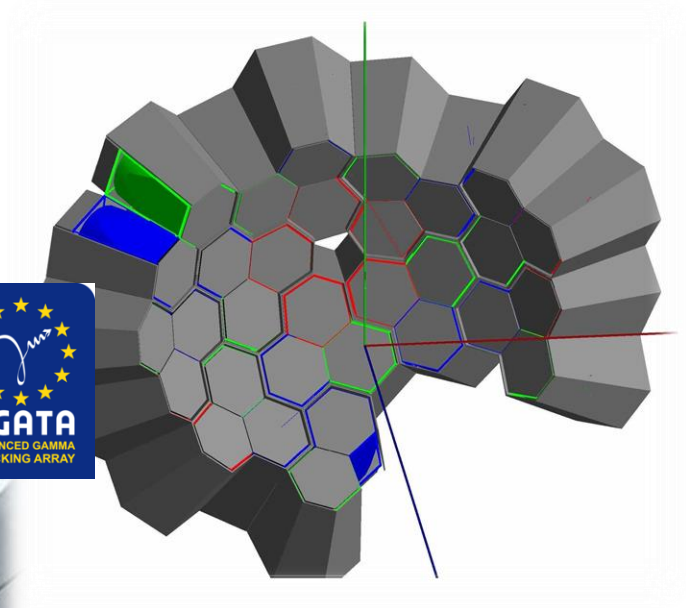


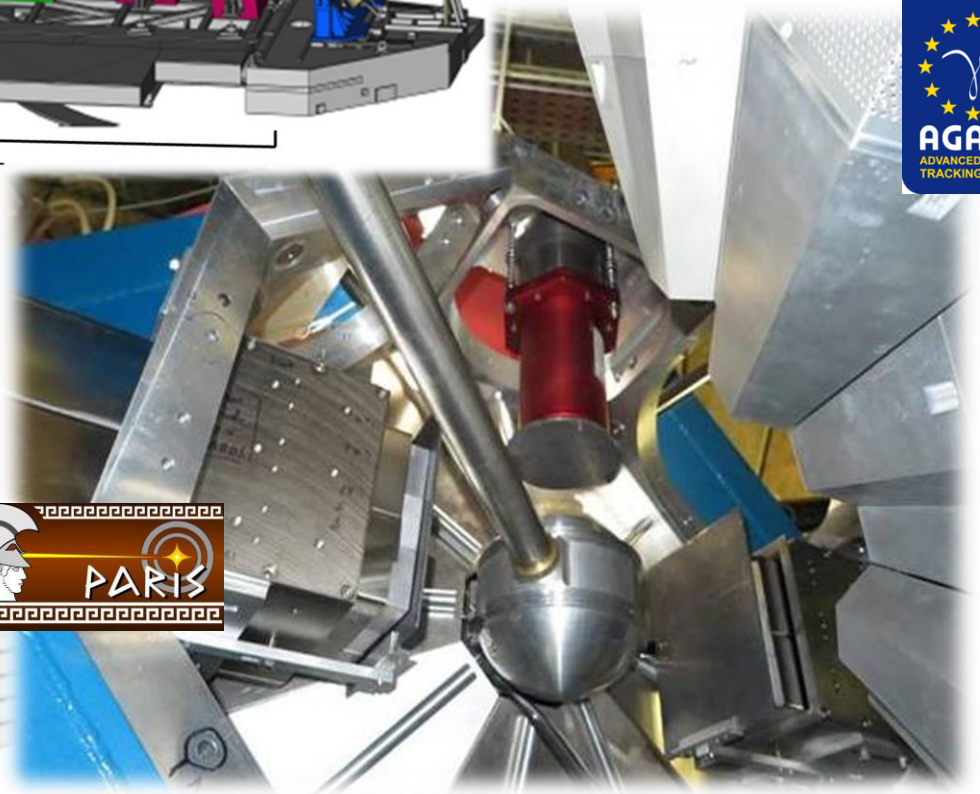
Nucleus	Excited state	Lifetime NN [ps]	Lifetime NN + NNN [ps]
^{16}C	2_2^+	0.36	0.08
^{20}O	2_2^+	0.32	0.20

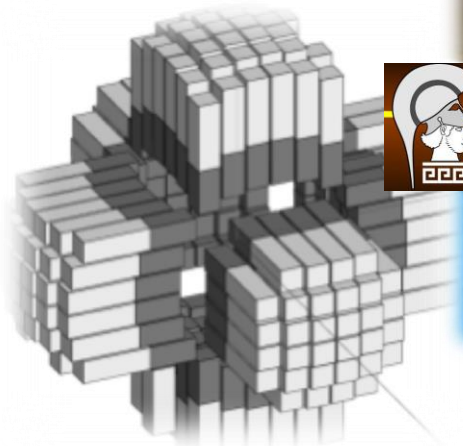
Setup

Experiment performed in GANIL (France) in July 2017









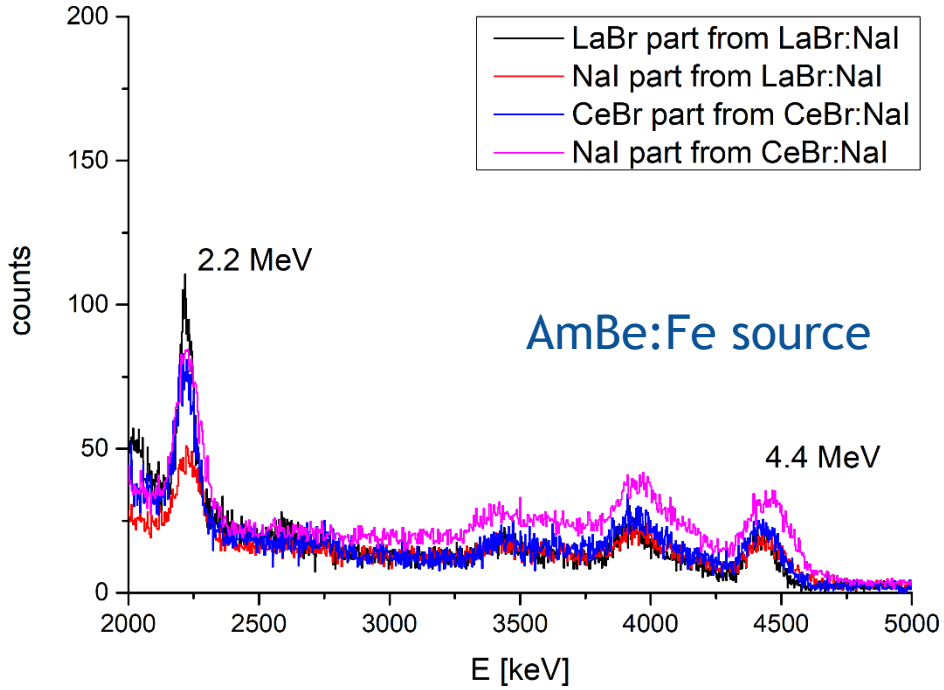
^{18}O (7 MeV/A) on ^{181}Ta (6 mg/cm^2)

- **AGATA** (10 TC+ 1 DC=32 crystals)
  31 crystals working
- **PARIS**-Demonstrator @ 23 cm
  2 Clusters + 2 Large volume $LaBr_3$
- **VAMOS++** @ 45°

PARIS specifics

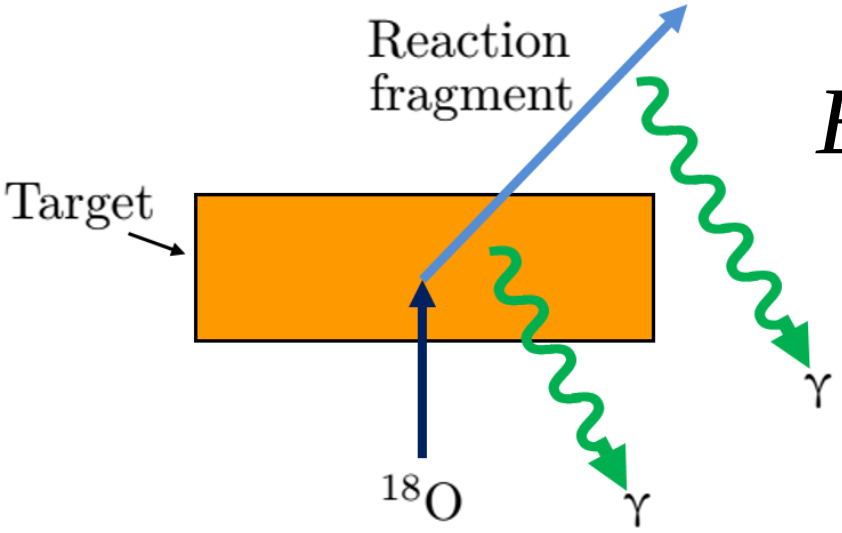
1 $LaBr_3$-NaI cluster
1 $CeBr_3$-NaI cluster → Placed in magnetic shield and with 4 mm lead in front

- Electronic signal collected with PARIS Pro NIM module
- FAST and SLOW outputs
- PARIS signals read as integral part of the VAMOS++ electronics
- Count rate limited to 7kHz
- Thresholds: NaI ~ 400 keV; LaBr ~ 150 keV
- Calibrated with ^{60}Co and AmBe:Fe sources

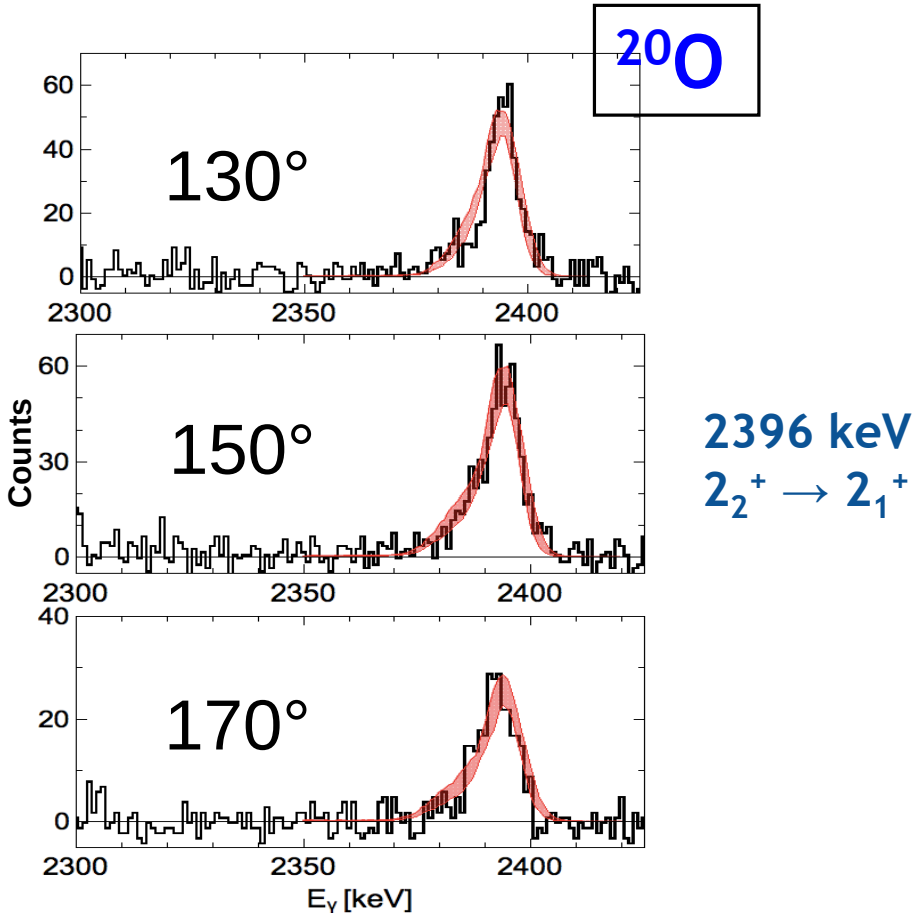


Experimental approach

^{18}O (7MeV/A) + ^{181}Ta (6 mg/cm^2)



$$E_\gamma' = E_\gamma\left(1+\frac{v}{c}\cos\theta\right)$$



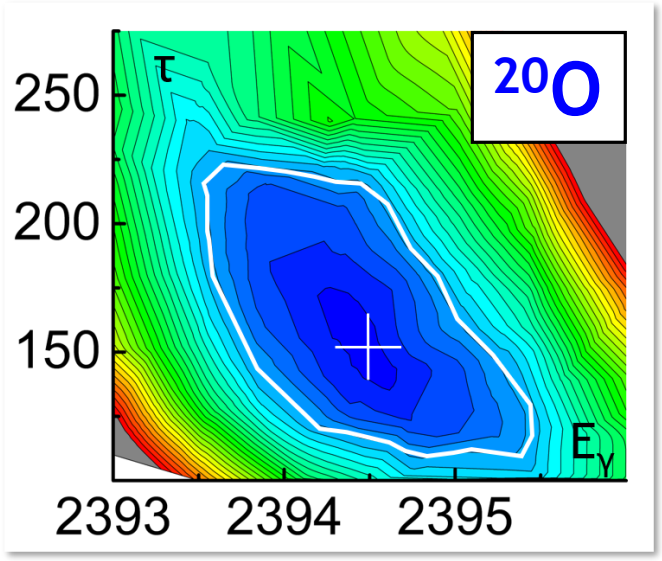
- Peak lineshape analysis: **Doppler shift** due to γ emission inside the target
  - Target-crossing time of the order of **100 fs → short lifetimes**
    - **Small effect** (few keV)
- Complete **simulation** of the process and comparison with experimental data

Experiment status

- ✓ ^{16}C and ^{20}O 2_2^+ states lifetimes measured → PRL paper under referral process
- ✓ Technique validated → Technical paper in preparation

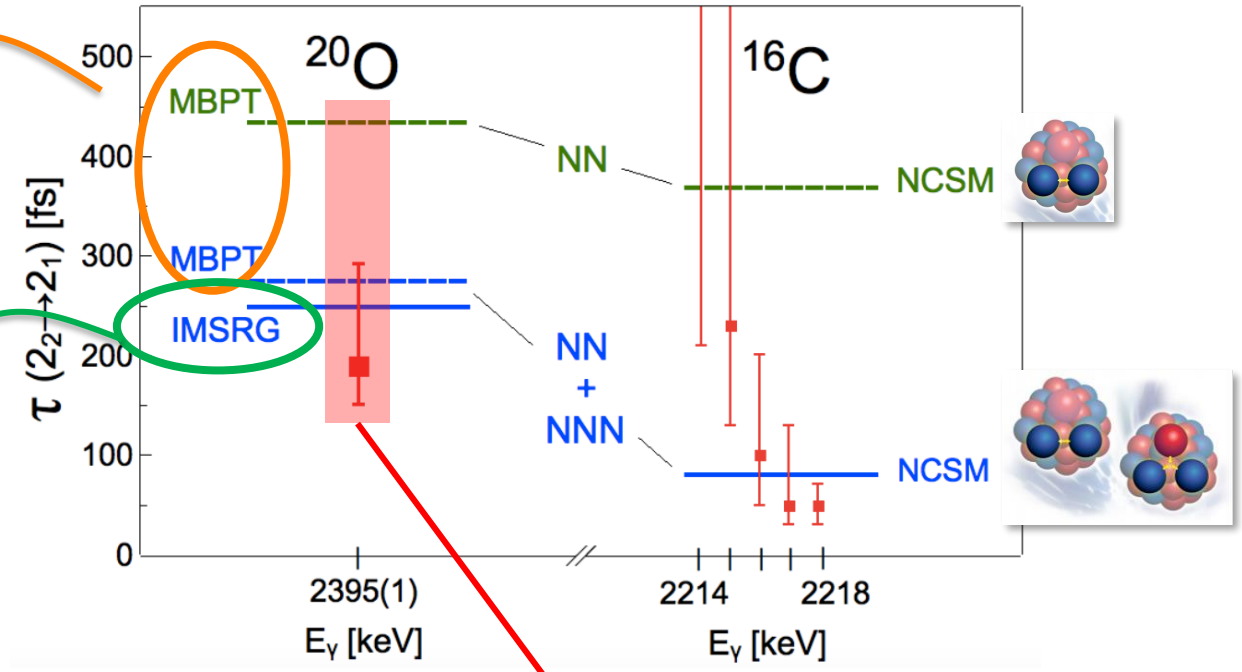
Clear need for three-body term

$\tau = 150^{+80}_{-30}$ fs



Many-Body Perturbation Theory

In-Medium Similarity Renormalization Group (IMSRG)

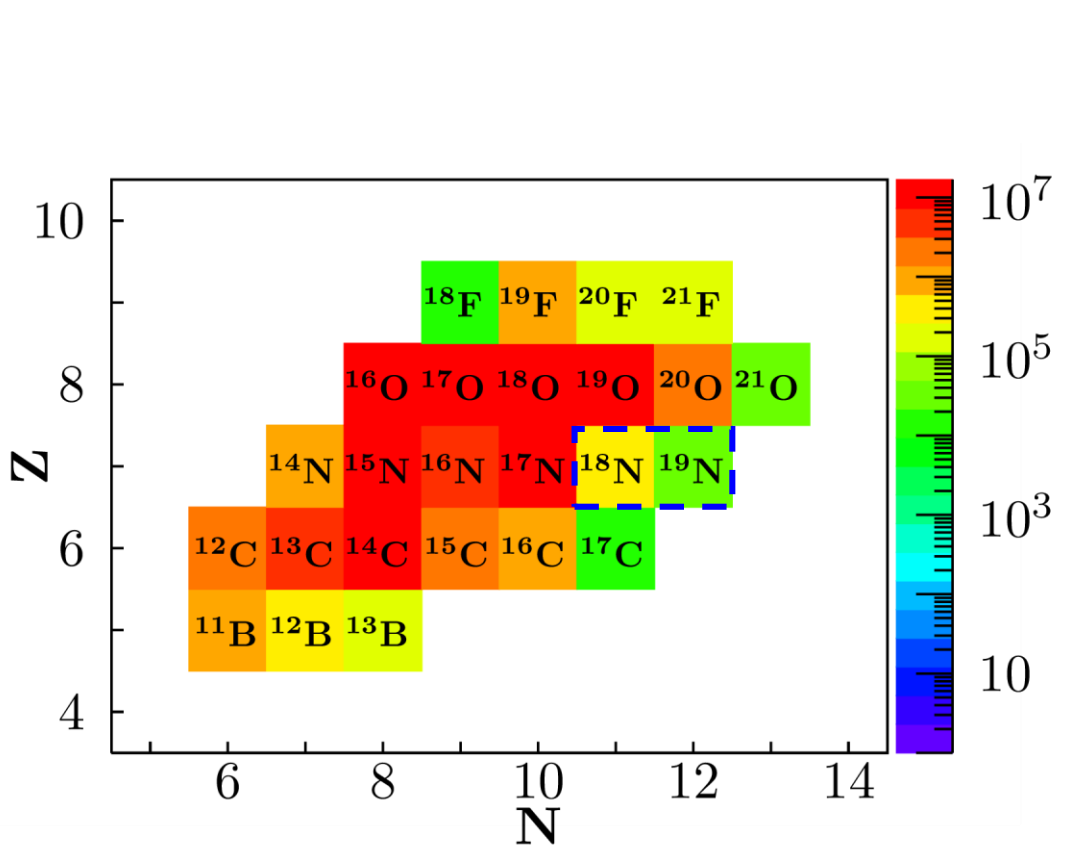


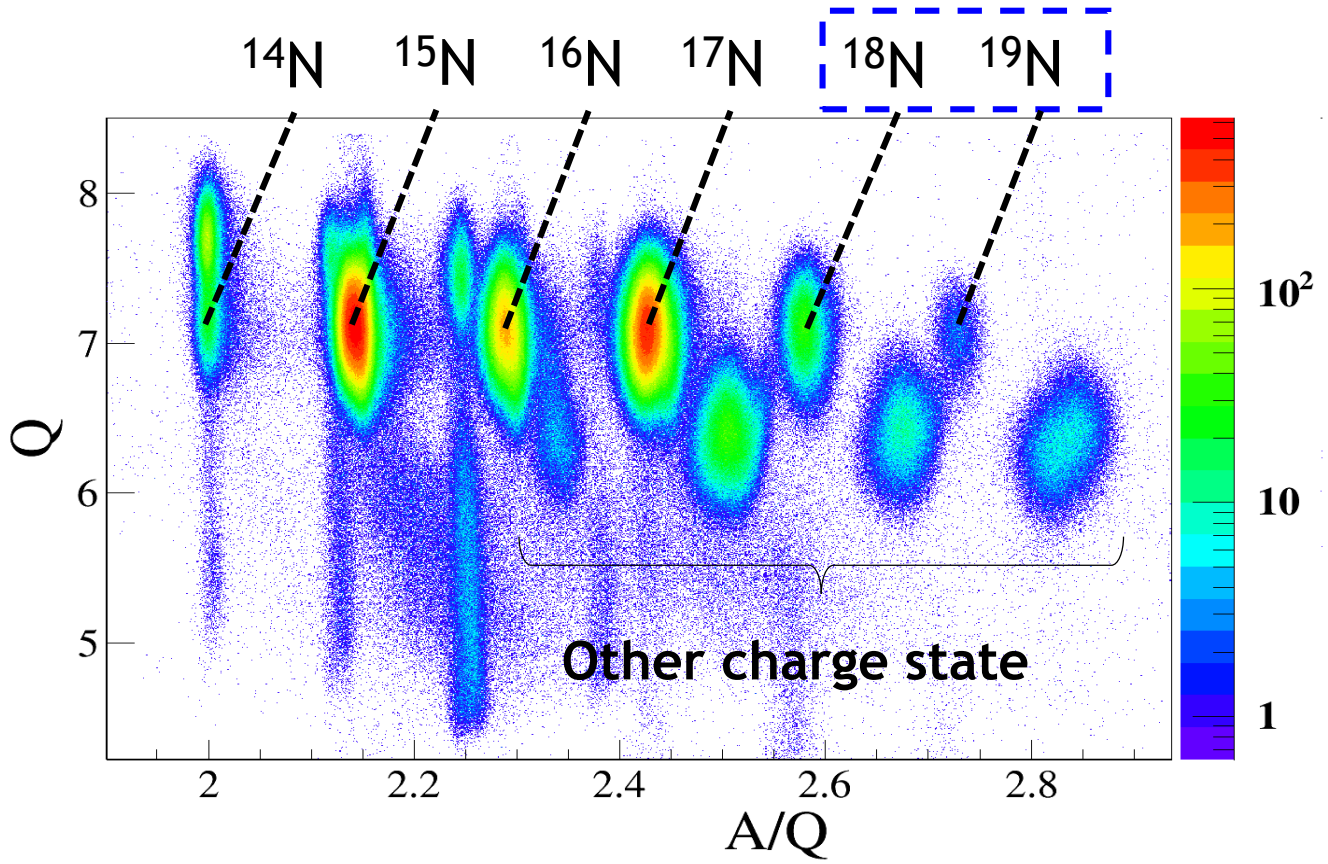
NO sensitivity with conventional HPGe detectors

Ongoing:

- Gamma spectroscopy of other by products of the reaction

Nitrogen isotopes



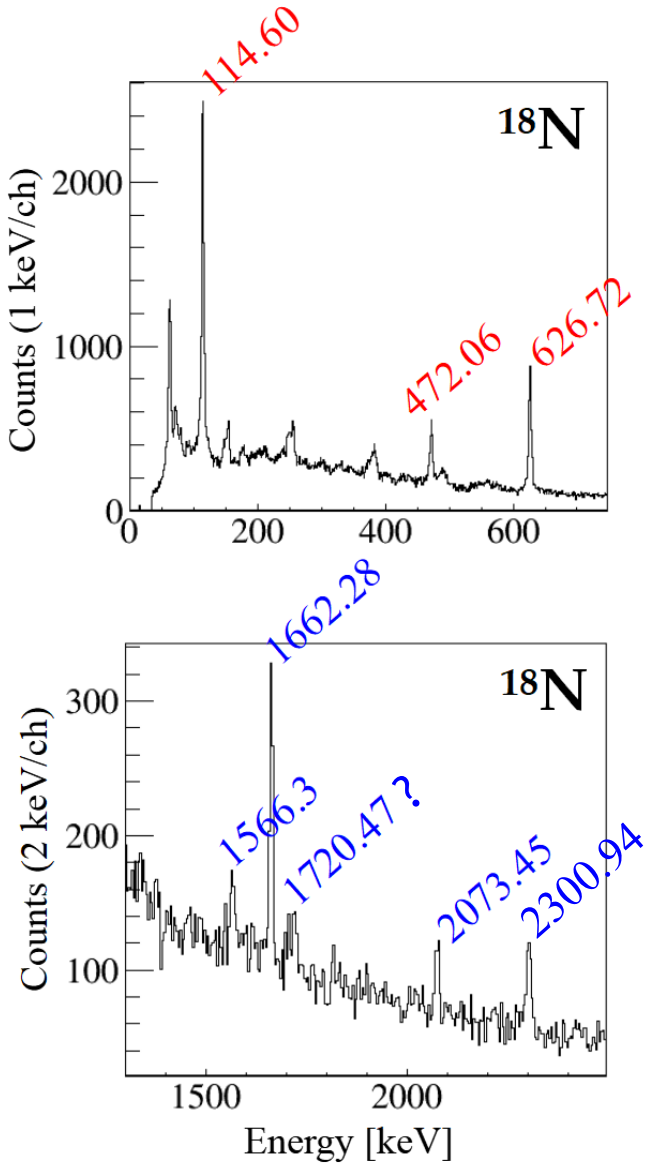


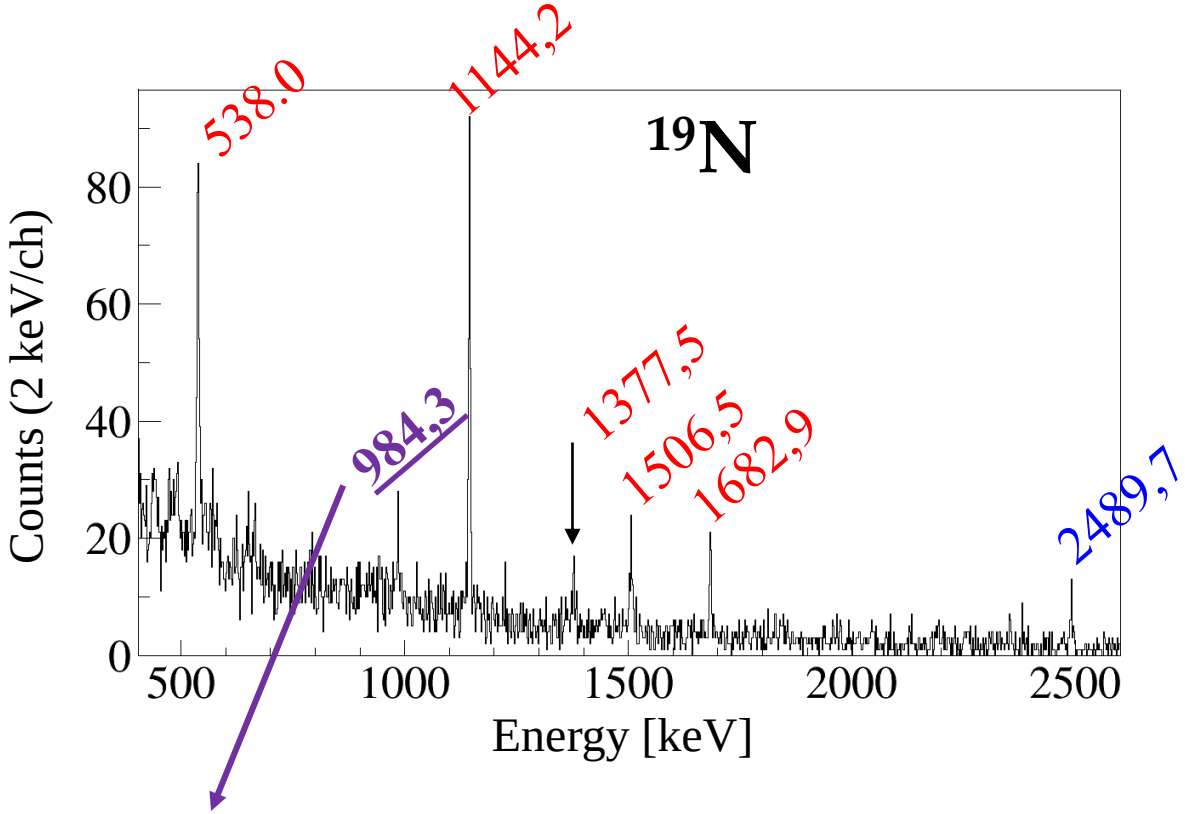
^{18}O (7 MeV/A) on ^{181}Ta (6 mg/cm^2)

Reaction products (deep-inelastic reaction): main focus on **^{18,19}N** isotopes

Nitrogen isotopes: AGATA

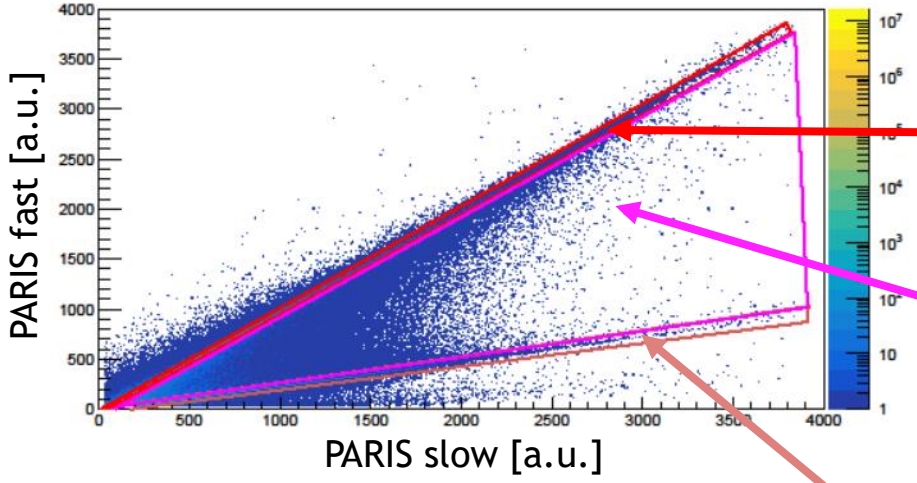
- New gamma rays
- Known gamma rays

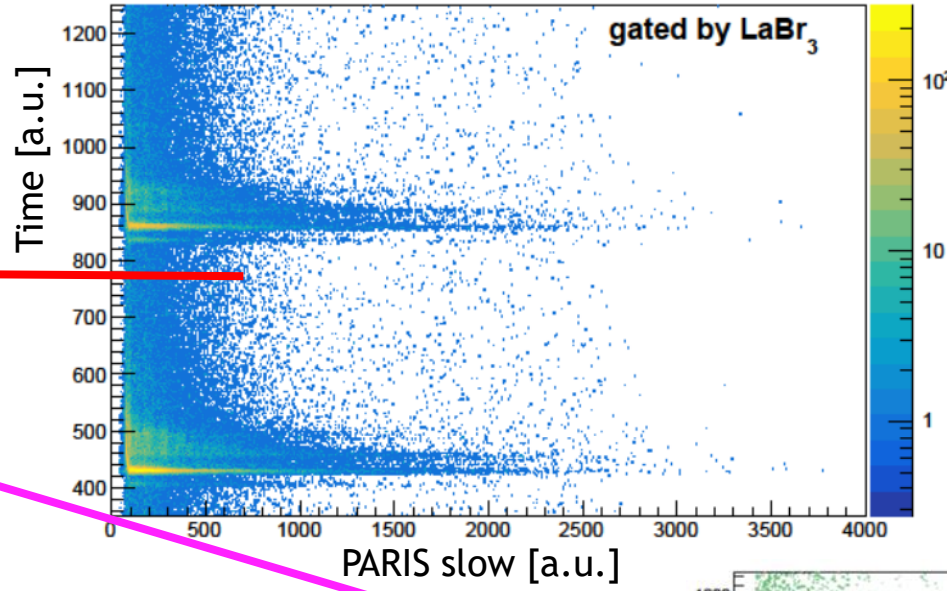




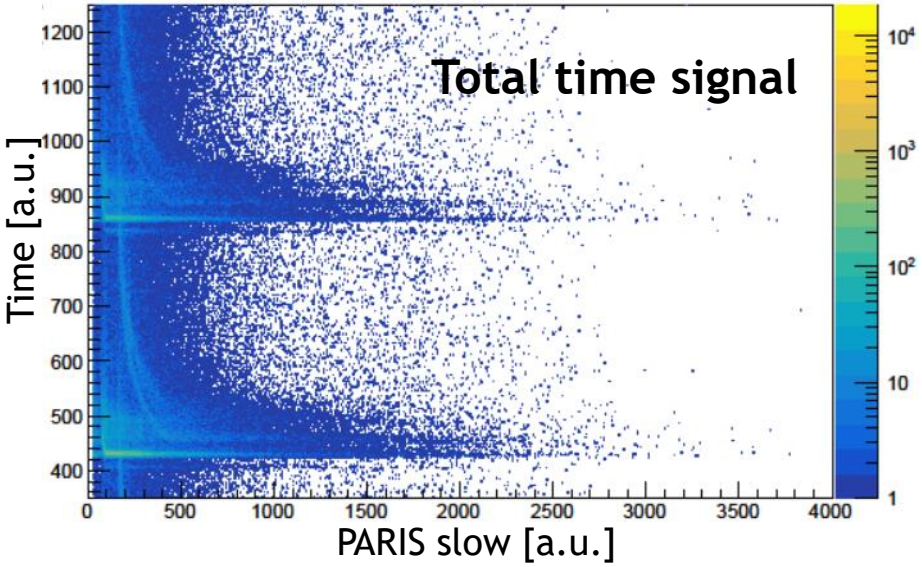
^{19}N peak or contaminant? → Check in PARIS at 90°

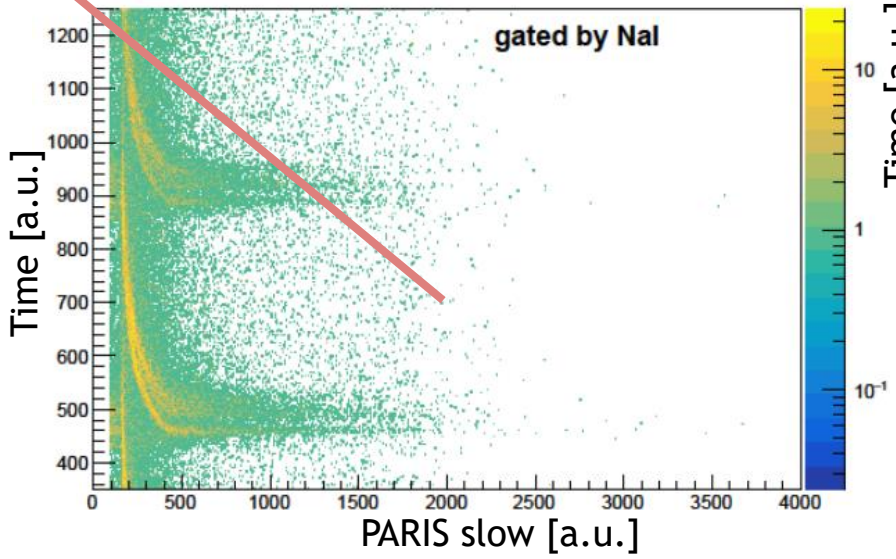
PARIS time

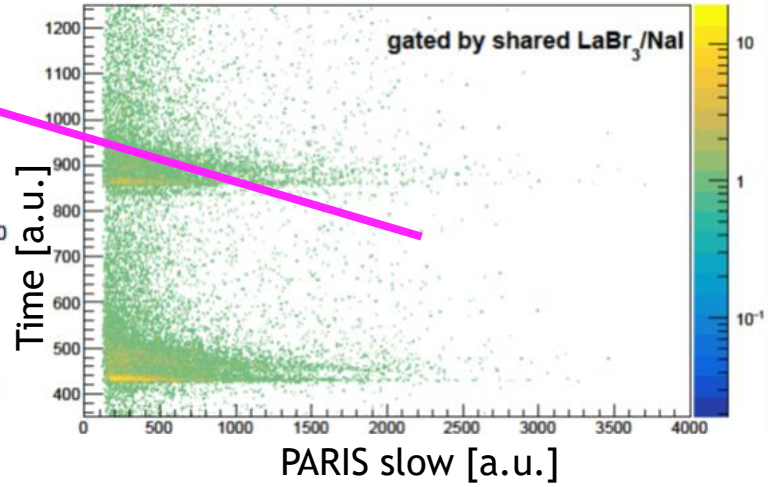




RF → start;
PARIS → stop



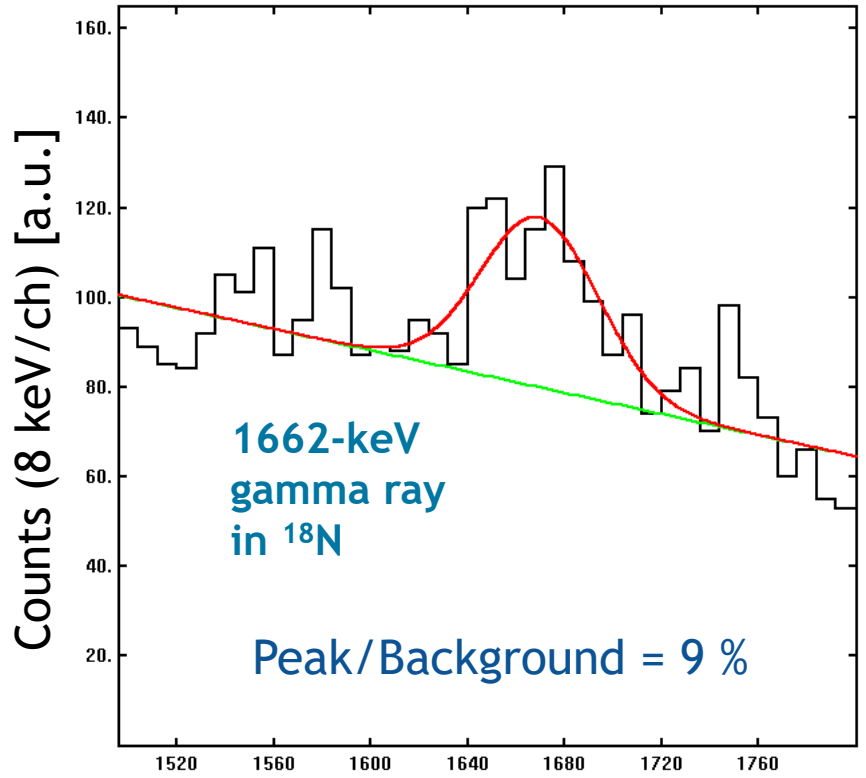




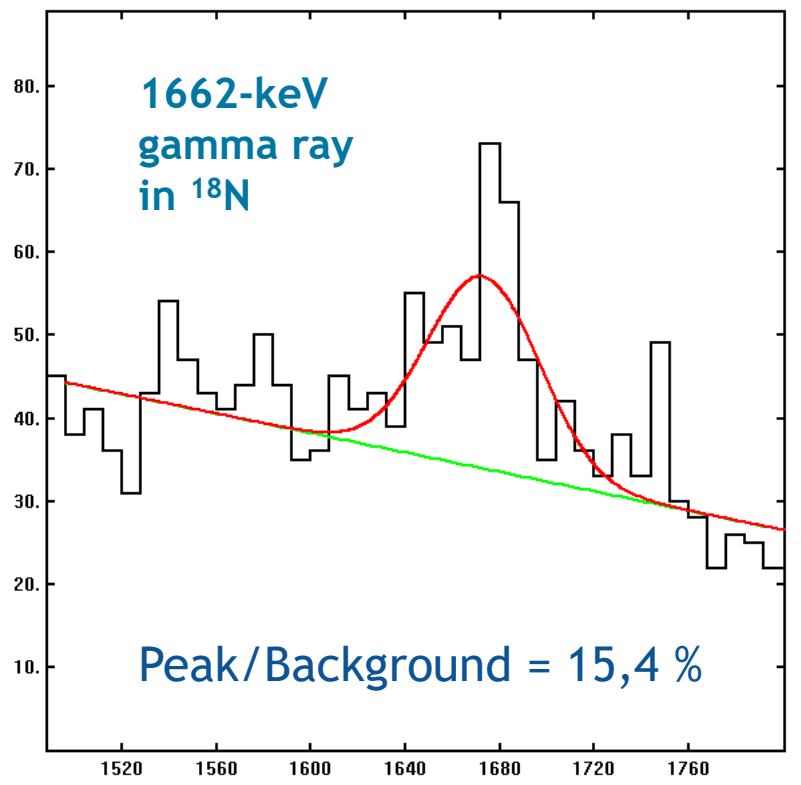
Wide vs. Tight time gate

± 2 ns in $LaBr_3$ and NaI

Wide time gate



Tight time gate



Energy [keV]

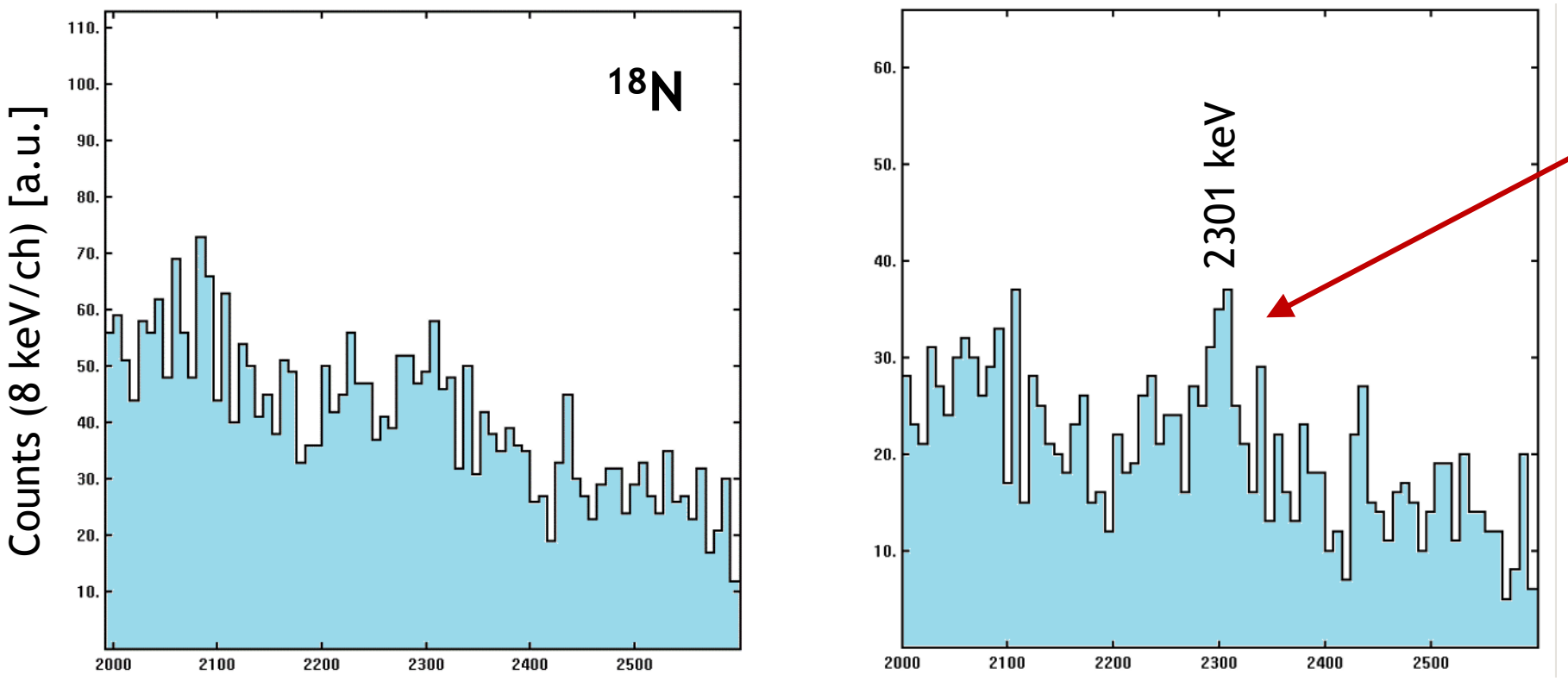
± 1 ns in $LaBr_3$ and NaI

Decrease in the peak area: 40%

2301-keV peak in ^{18}N

Wide time gate

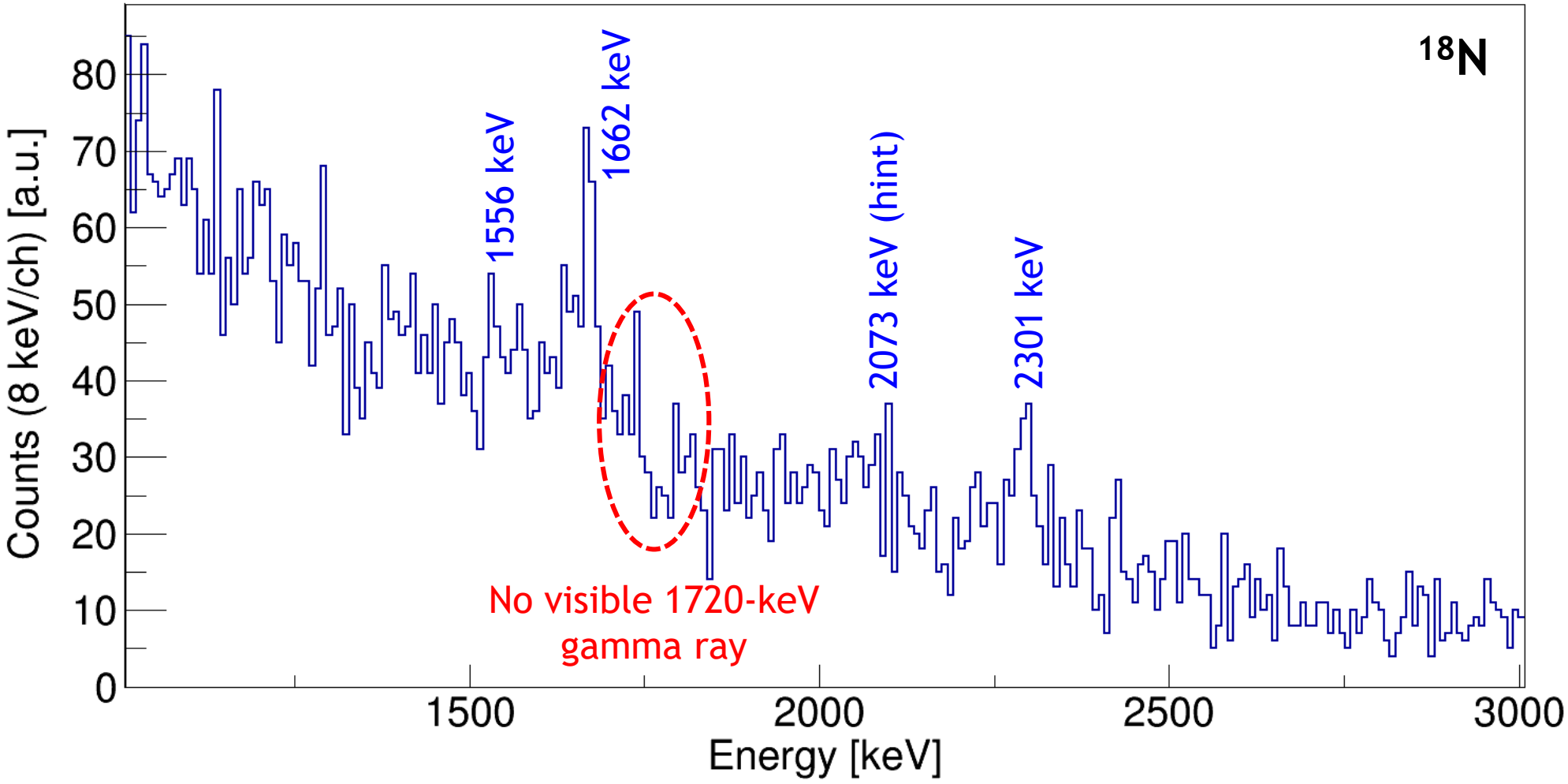
Tight time gate



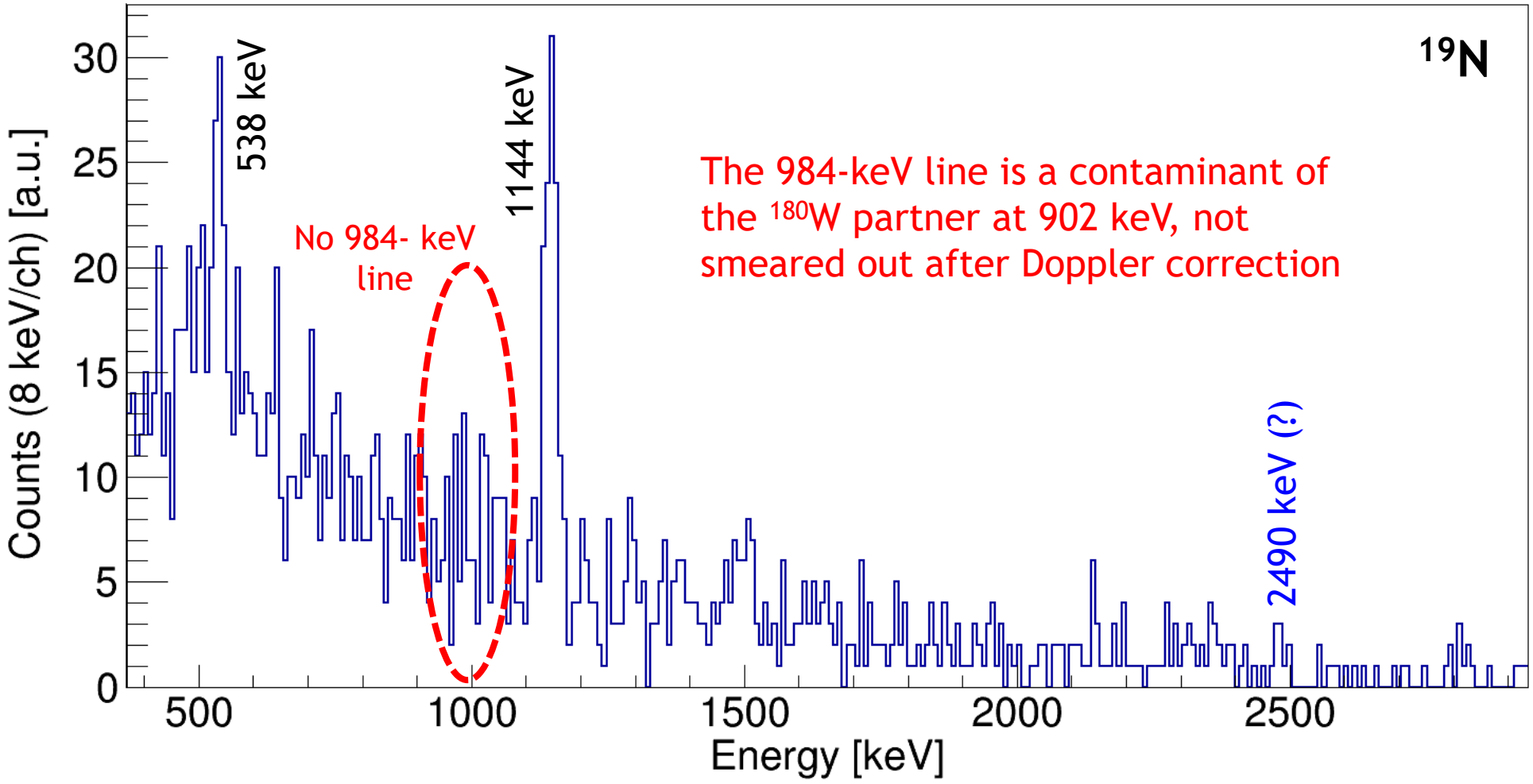
Better visible peak

PARIS energy spectra

^{18}N: PARIS energy spectrum

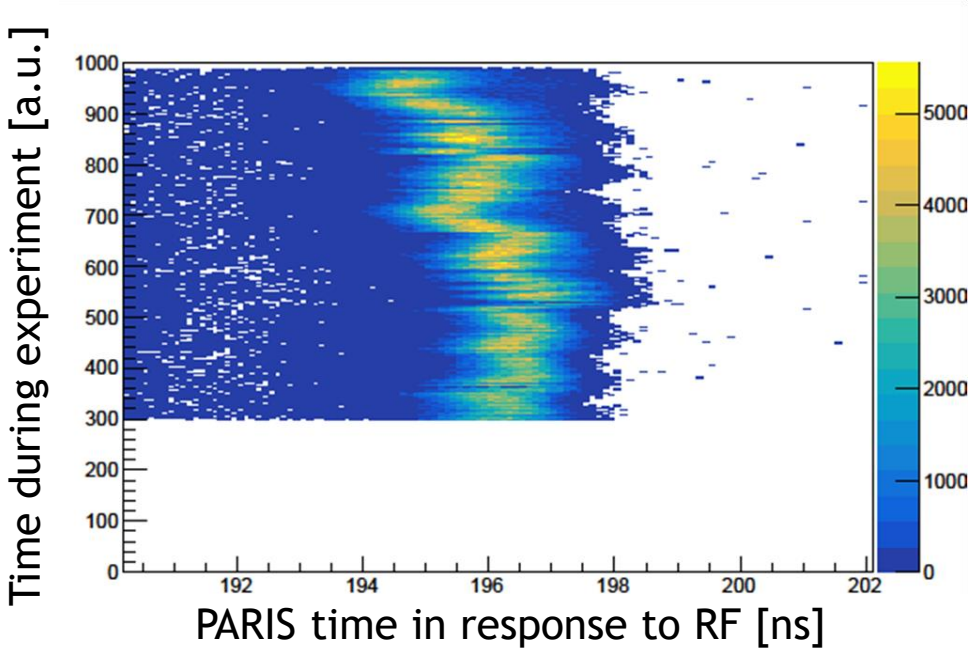


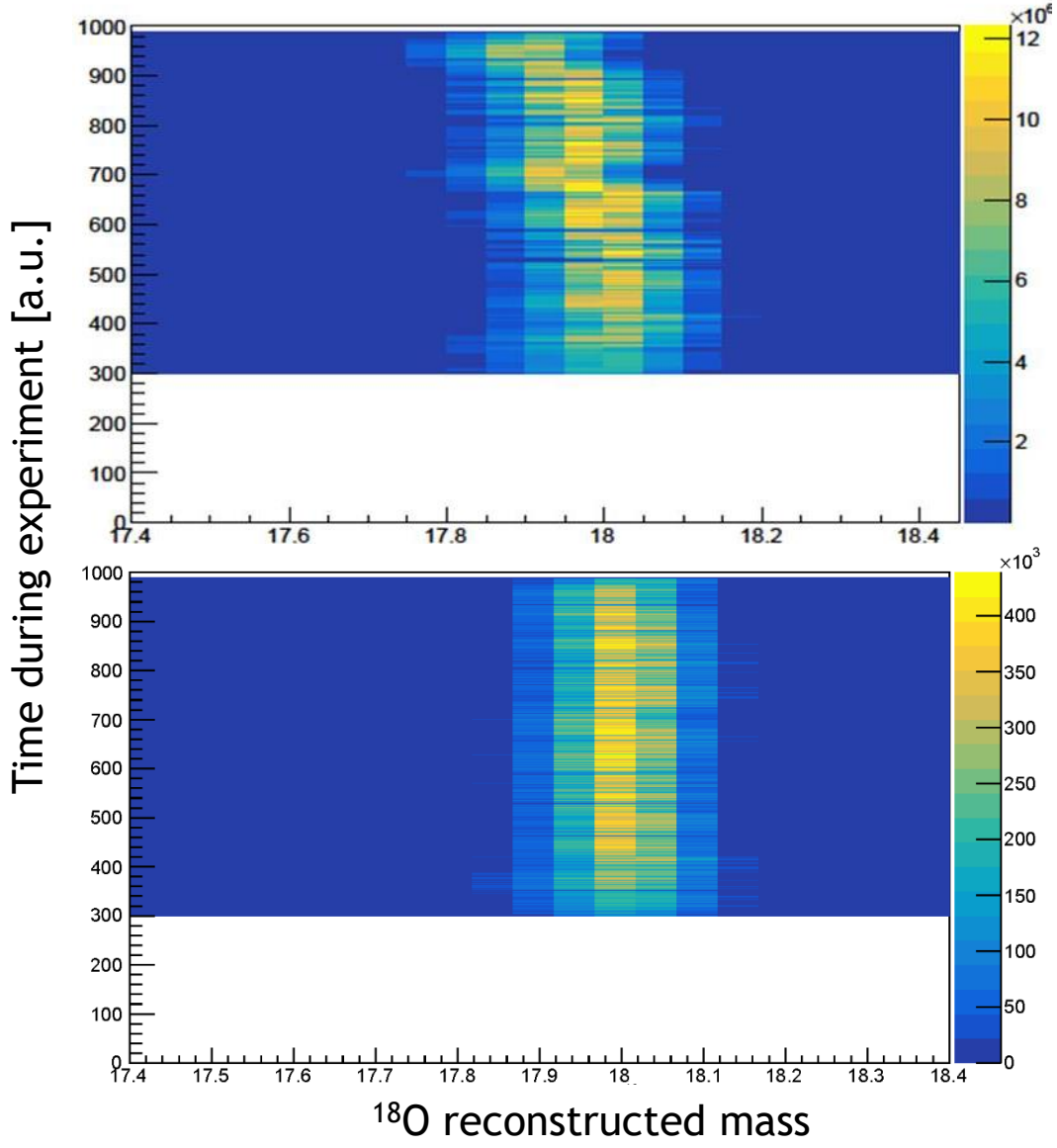
^{19}N: PARIS energy spectrum



VAMOS++ time correction

Good PARIS time response





Conclusions

Completed:

✓ ^{16}C and ^{20}O 2_2^+ states lifetimes measured → PRL paper under referral process

✓ Technique validated → Technical paper in preparation

Ongoing:

- Gamma spectroscopy of other by products of the reaction

Future investigation:

- Spin/parity assignments and angular correlations and distributions

Collaborators

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VAMOS+AGATA+PARIS collaboration
E676 experiment @GANIL

IFJ PAN

INFN

Istituto Nazionale di Fisica Nucleare

AGATA
ADVANCED GAMMA TRACKING ARRAY

UNIVERSITÀ DEGLI STUDI DI MILANO

PARIS Collaboration Meeting
Legnaro (Italy), 28-29 November 2019

PARIS

Thank you