Analysis Report: Experiment s467

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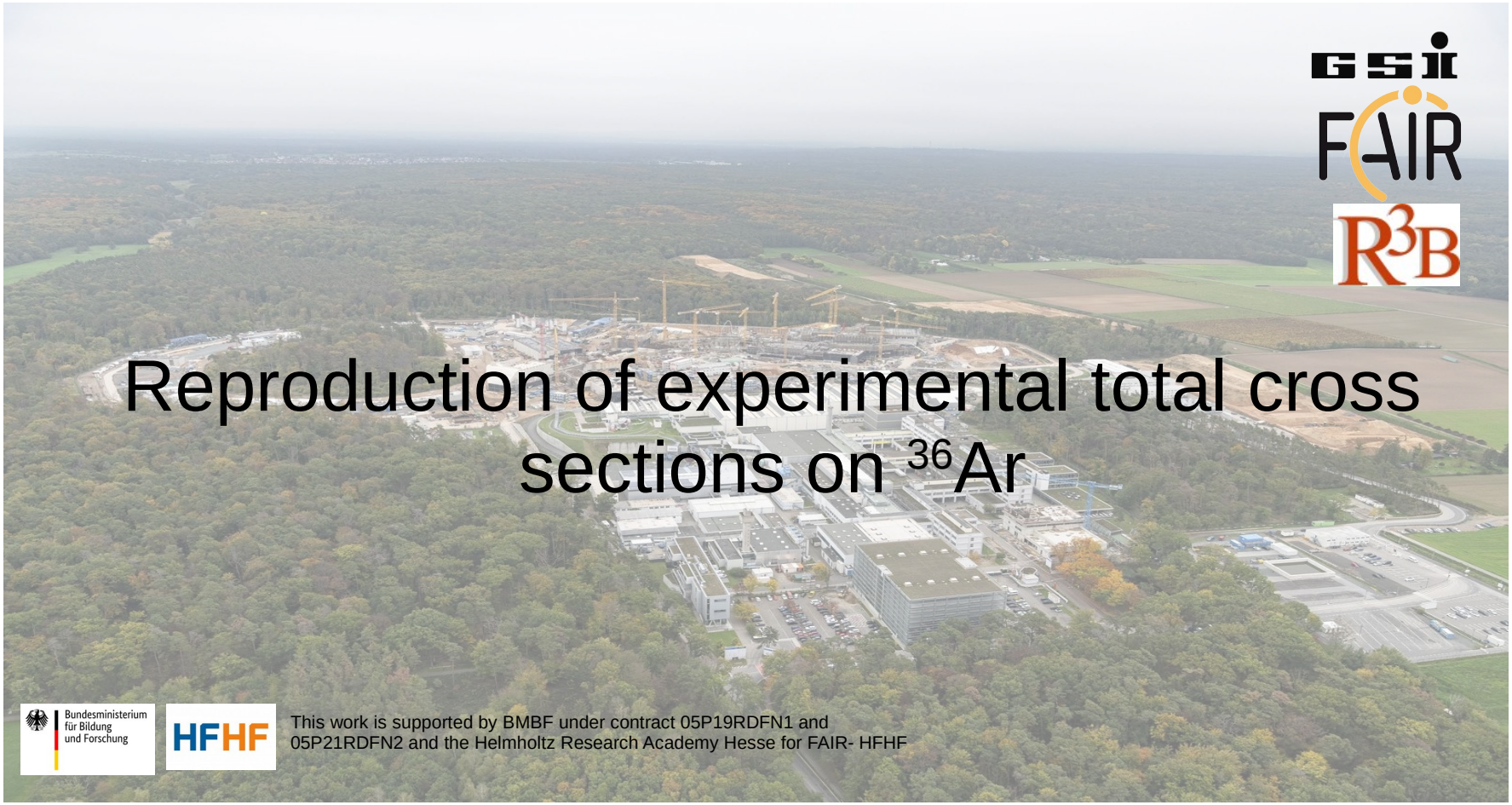

GSI FAIR R3B

Reproduction of experimental total cross sections on ^{36}Ar

Bundesministerium für Bildung und Forschung

HFHF

This work is supported by BMBF under contract 05P19RDFN1 and 05P21RDFN2 and the Helmholtz Research Academy Hesse for FAIR- HFHF

Start of the story: Test case $^{36}Ar \rightarrow {}^{35}Cl$

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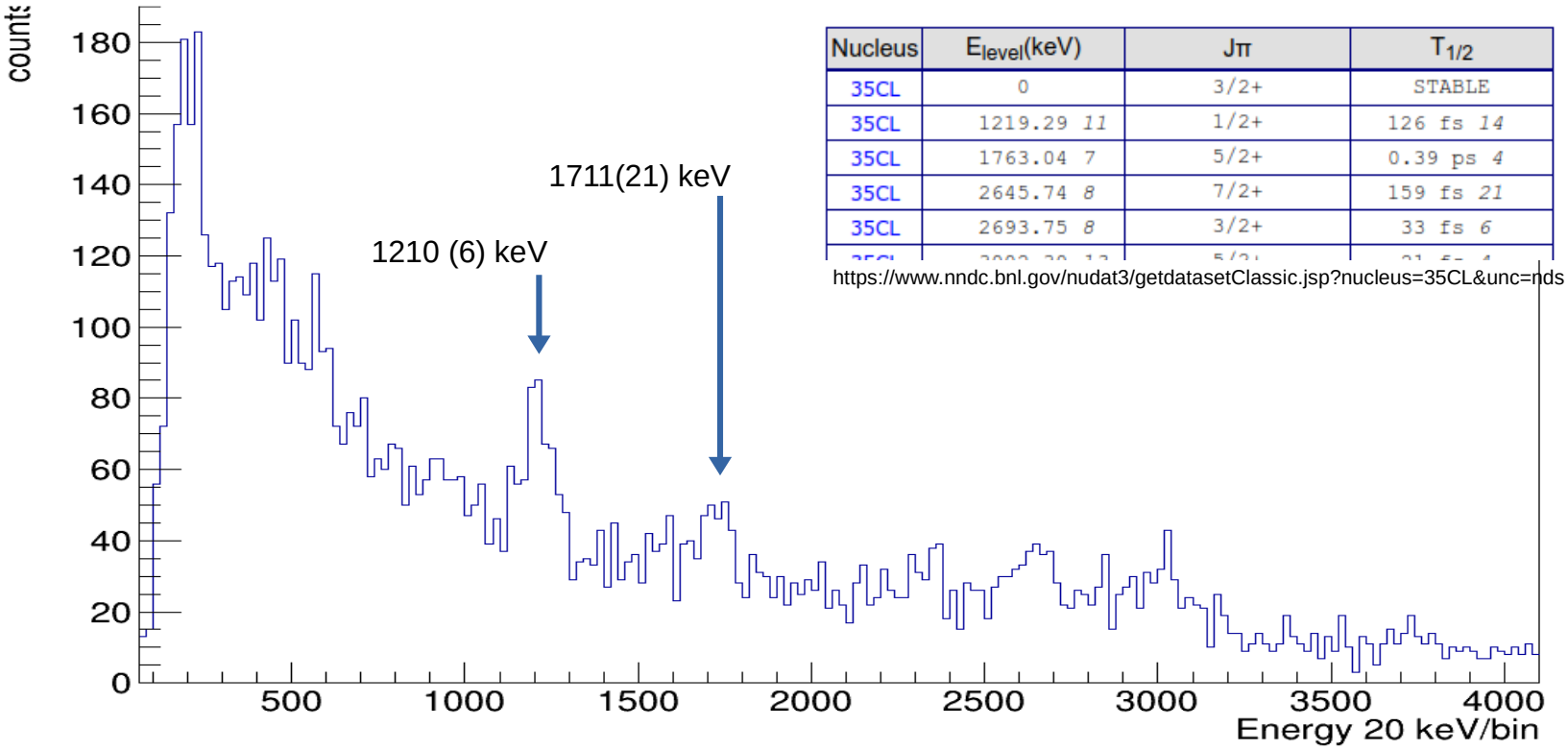
- Selection: $^{36}Ar \rightarrow {}^{35}Cl$:
- All hits E<20MeV
- Cluster algorithm default cluster size 0.25 rad x 0.25 rad



Nucleus	E_{level}(keV)	Jπ	$T_{1/2}$
35CL	0	3/2+	STABLE
35CL	1219.29 *11*	1/2+	126 fs *14*
35CL	1763.04 *7*	5/2+	0.39 ps *4*
35CL	2645.74 *8*	7/2+	159 fs *21*
35CL	2693.75 *8*	3/2+	33 fs *6*

https://www.nndc.bnl.gov/nudat3/getdatasetClassic.jsp?nucleus=35CL&unc=nds

Gating on QFS reactions & gammas

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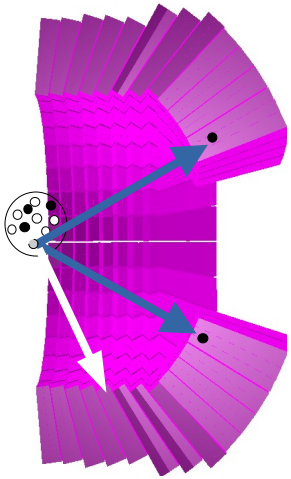

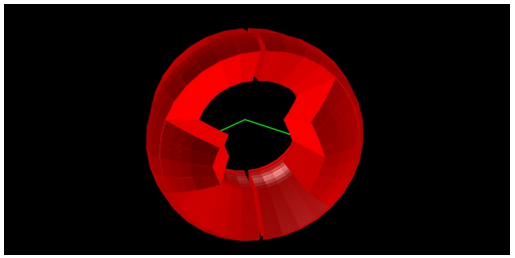

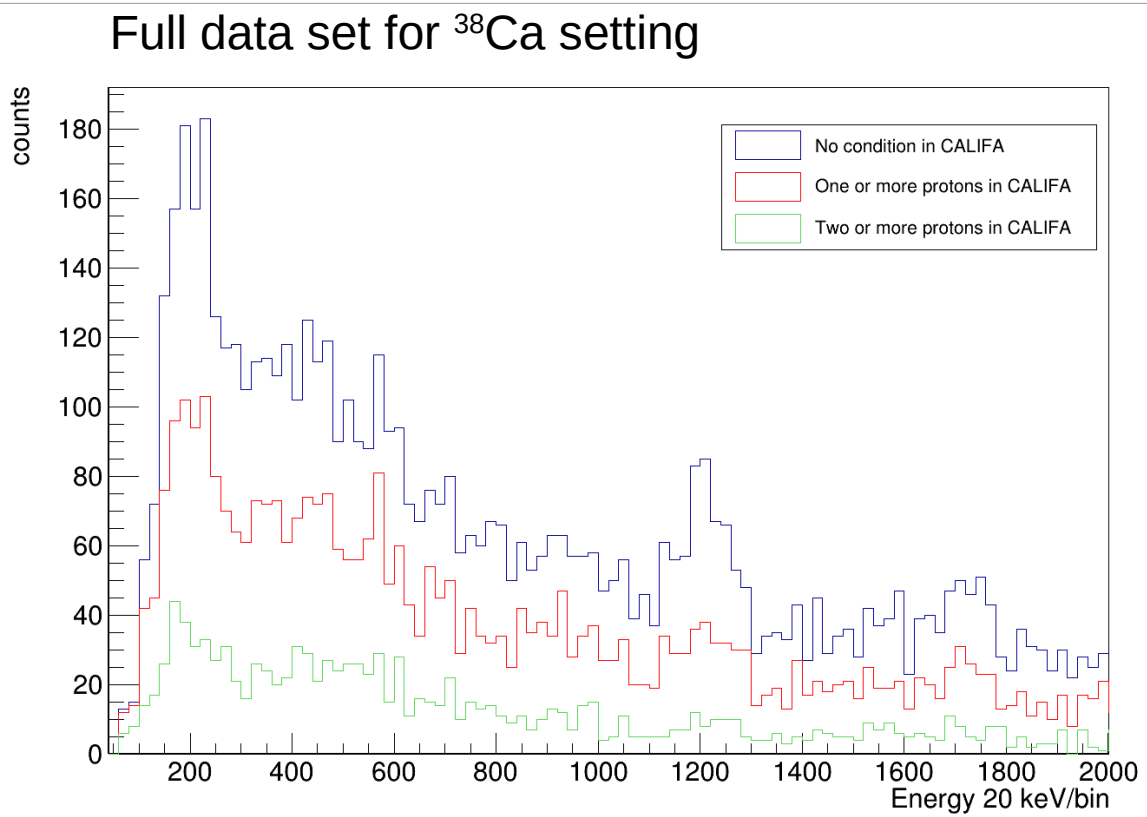

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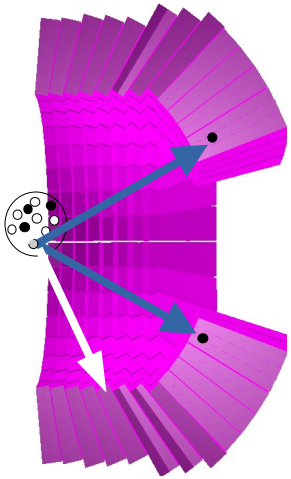
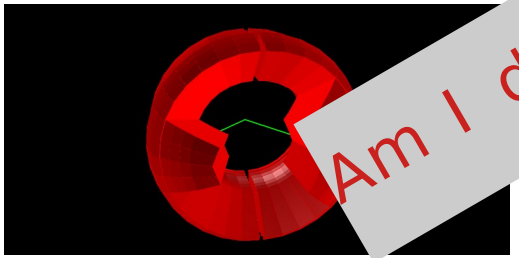
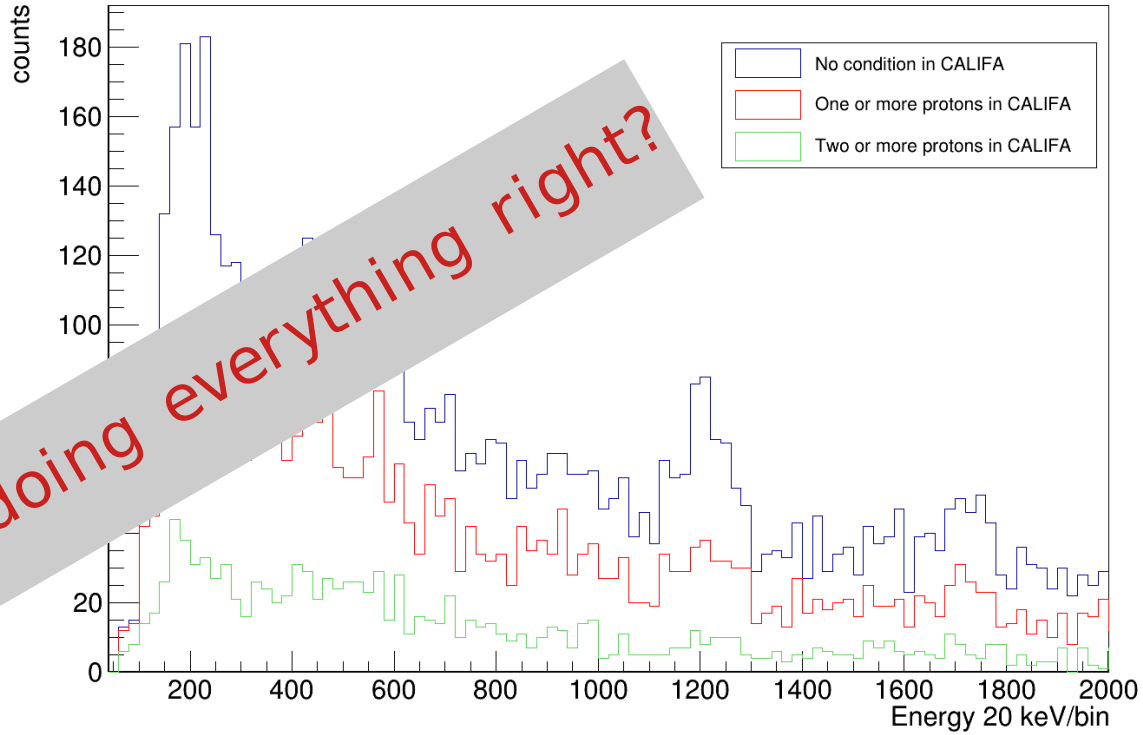




Full data set for ^{38}Ca setting



Am I doing everything right?

Step by step approach

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- Goal:
  - Check the data for consistency
  - Check if the analysis code is working properly
  - Learn the details of the calculations
  - Are the amount of gammas we see reasonable?

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- Pick the test case ^{36}Ar@405 MeV/A and search for available data
  - Total reaction cross sections on C target at 1GeV/A available
  - Total reaction cross sections on C and H at 361 MeV/A available

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  - Total reaction cross sections on C target at 1GeV/A available
  - Total reaction cross sections on C and H at 361 MeV/A available
- Produce the total reaction cross sections and do a sanity check
  - FRS and Tracking data are okay, analysis code works properly and the calculations are correct

^{36}Ar on C target

- Select ^{36}Ar as incoming in FRS (I_X)
- Count the not reacted ^{36}Ar in tracking (U_X) and subtract the incoming to get the number of reacted particles

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- Correct with the empty runs for efficiency losses and reactions with the detectors and souroundings

$$R_C(^{36}Ar) = I_C(^{36}Ar) - U_C(^{36}Ar) - \frac{I_C(^{36}Ar)}{I_{em}(^{36}Ar)} \cdot \left(I_{em}(^{36}Ar) - U_{em}(^{36}Ar)\right)$$

Total reaction cross section ^{36}Ar on C

- I_C: 881444, U_C: 656828, I_{em}: 69370, U_{em}: 60805
- Target C: ρ=1.84 g/cm^3, d=1.086 cm, A=12.0107 g/mol & N_A

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1290(16) mb @361 MeV/A

Total and elemental fragmentation cross-sections for ^{36}Ar projectiles in mb

E_{target} (A MeV)	361	361	359
Target	H	C	Al
σ_{tot}	466.2 ± 21.9	1290.8 ± 16.1	1763.5 ± 26.9
$\sigma(Z_F = 17)$	86.7 ± 7.7	122.7 ± 4.7	154.9 ± 8.2
$\sigma(Z_F = 16)$	94.7 ± 8.2	124.3 ± 5.1	142.1 ± 7.6
$\sigma(Z_F = 15)$	51.3 ± 6.0	79.9 ± 3.6	93.7 ± 5.9
$\sigma(Z_F = 14)$	71.2 ± 7.2	91.3 ± 4.0	111.5 ± 6.9
$\sigma(Z_F = 13)$	27.5 ± 4.3	57.0 ± 3.1	78.5 ± 5.6
$\sigma(Z_F = 12)$	30.6 ± 4.8	71.9 ± 3.4	84.3 ± 5.7
$\sigma(Z_F = 11)$	13.6 ± 3.7	37.4 ± 2.7	48.1 ± 4.4
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$\sigma(Z_F = 9)$	5.5 ± 3.1	29.1 ± 2.4	38.1 ± 4.0
$\sigma(Z_F = 8)$	13.9 ± 3.7	53.4 ± 3.1	56.0 ± 4.4
$\sigma(Z_F = 7)$	8.5 ± 3.6	31.0 ± 2.7	42.0 ± 4.1

G. Iancu et al. / Radiation Measurements 39 (2005) 525 – 533

1386(14) mb @940 MeV/A

Table 2
Interaction cross sections (σ_I) for Ar and Cl isotopes with carbon targets

Nucleus	Mean energy/A (MeV)	σ_I (mb)
^{31}Ar	940	1358 ± 34
^{32}Ar	940	1317 ± 33
^{33}Ar	950	1330 ± 32
^{34}Ar	950	1356 ± 14
^{35}Ar	955	1369 ± 15
^{36}Ar[a]	945	1386 ± 14
^{36}Ar[b]	940	1386 ± 23
^{37}Ar	945	1378 ± 15

A. Ozawa et al. / Nuclear Physics A 709 (2002) 60–72

Total reaction cross section on Hydrogen

- Two approaches:
  - $$R_{H_2} = R_{CH_2} - \frac{I_{CH_2}}{I_{CT}}\frac{T_{CH_2}}{T_{CT}} \times R_{CT} - \left(1 - \frac{T_{CH_2}}{T_{CT}}\right)\frac{I_{CH_2}}{I_{ET}} \times R_{ET},$$

    Valerii Panin, Fully Exclusive Measurements of Quasi-Free Single-Nucleon Knockout Reactions in Inverse Kinematics, 2012
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G. Iancu et al. / Radiation Measurements 39 (2005) 525 – 533

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466(22) mb @361 MeV/A

Total reaction cross section on Hydrogen

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Very simple approach

Summary up to this point

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- The results pointing into the right direction
- Several corrections need to be applied
  - Full total reaction cross section formula
  - Account for losses of particles in the different targets
  - A propper cut on the unreacted particles
  - …

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- Recevied already some feedback and paper (a lot) to read and improve the calculation

Summary

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- Goal:
  - ~~Check if the analysis code is working properly~~
  - ~~Learn the details of the calculations~~
  - Check the data for consistency
  - Are the amount of gammas we see reasonable?

Next steps

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- Check the total reaction cross section on Hydrogen again with improved calculations
- Do a proper uncertainty calculation
- One can calculate the total reaction cross section from Ar on Hydrogen
- Spectroscopic factors are available for ^{35}Cl from a pick up reaction ^{36}Ar(d,τ)^{35}Cl. Use this information to make an assumption of expected gammas

Enjoy a non political picture

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