Hypertriton @ A1 and Hyper Database

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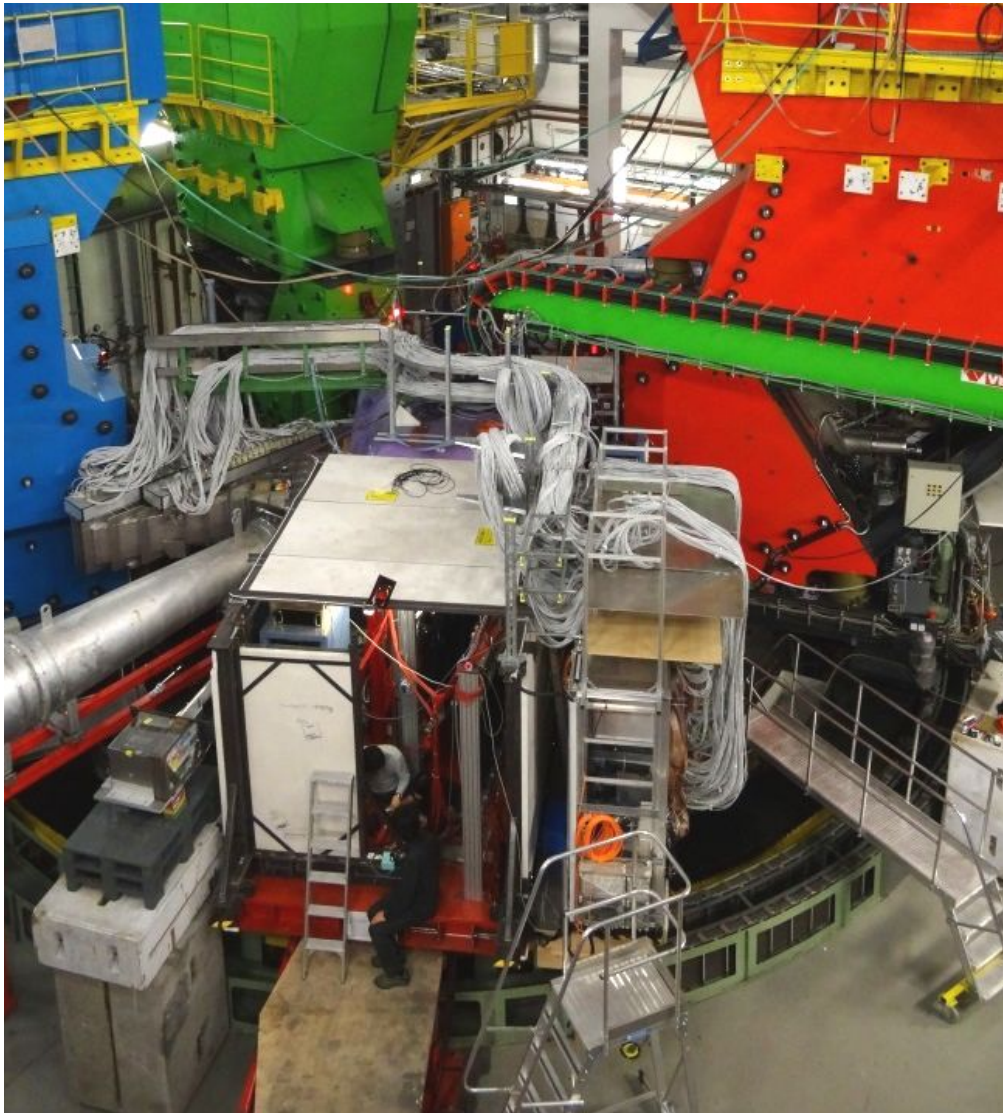
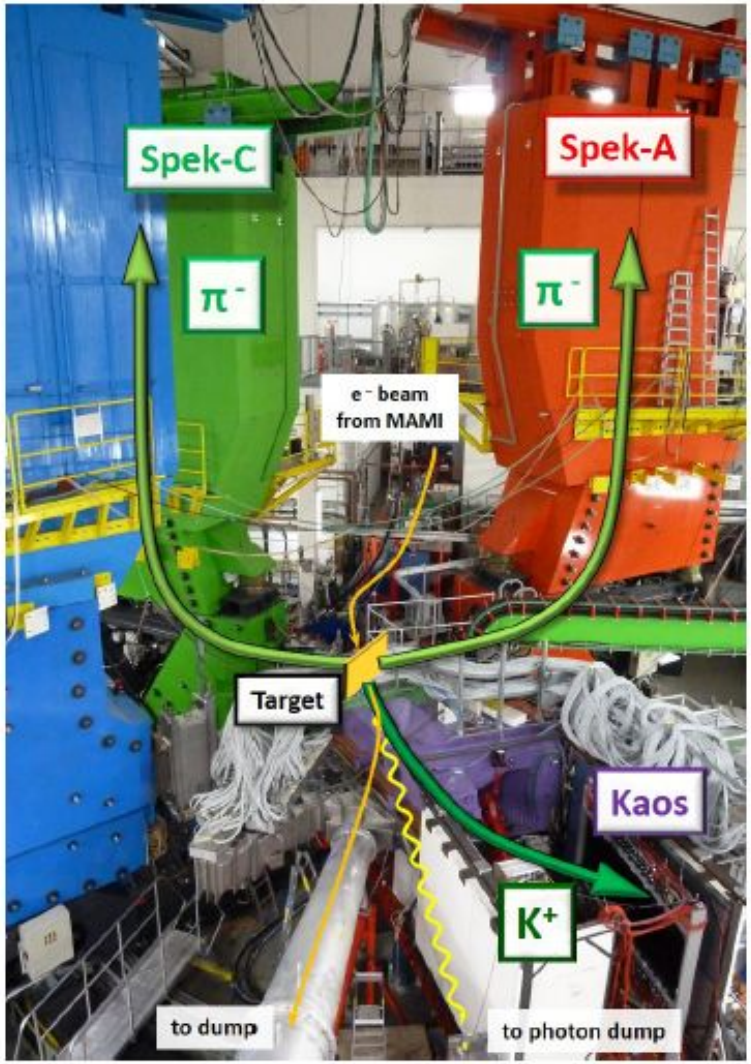
JGU Mainz

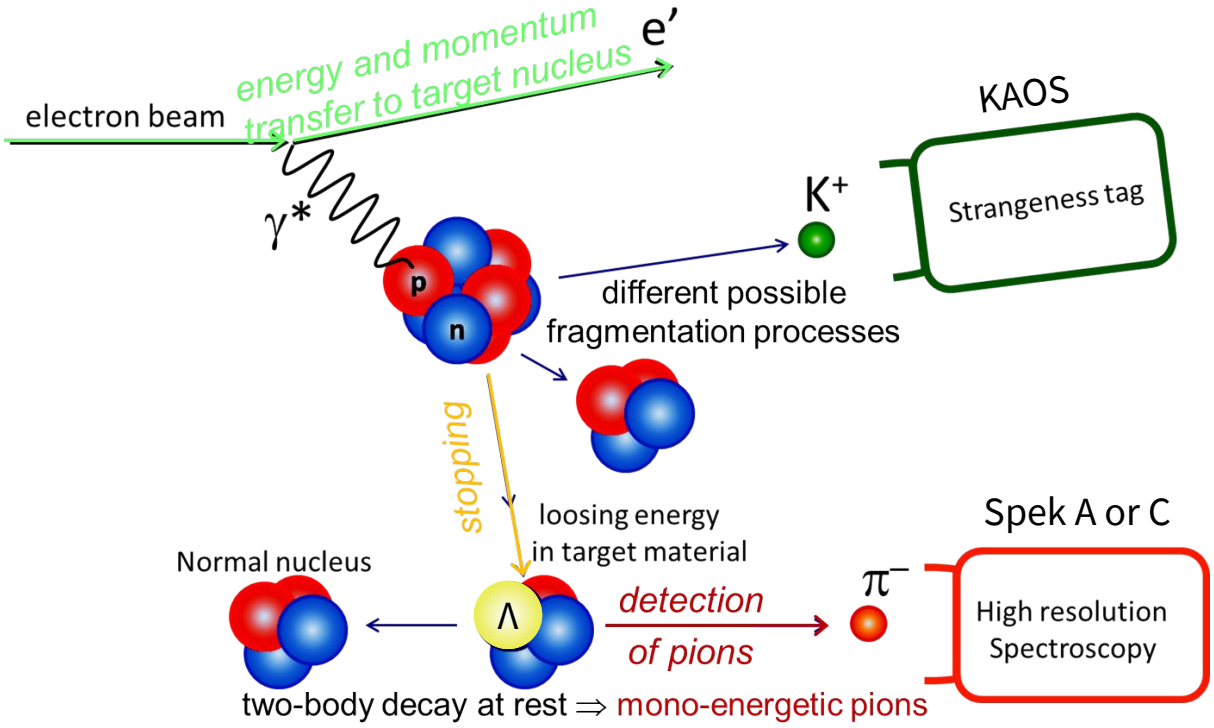
05.11.2020



Part I: Hypernuclear Physics @A1



Mass measurement via electron scattering:



$$M_{\mathrm{HYP}} = \sqrt{M_{\mathrm{ncl}}^2 + p_{\pi^-}^2} + \sqrt{M_{\pi^-}^2 + p_{\pi^-}^2}$$

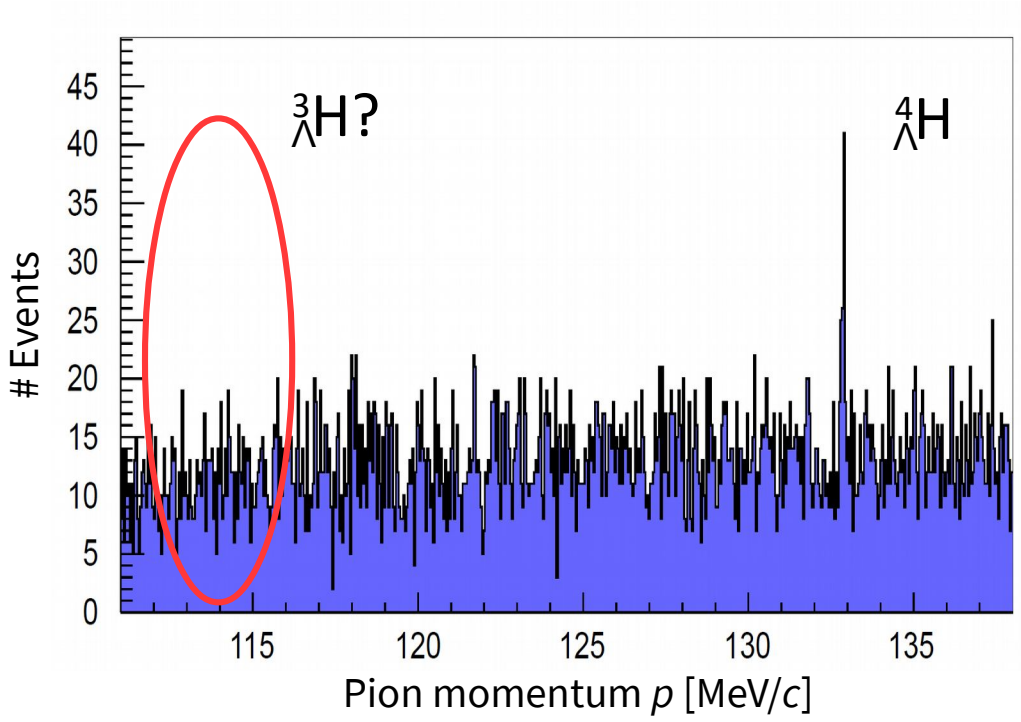
Hypernuclear Physics @A1 – 2014

2014: decay of $^{3}_{\Lambda}\mathrm{H}$ not observed @ 125 µm ^{9}Be

2021: target with increased luminosity

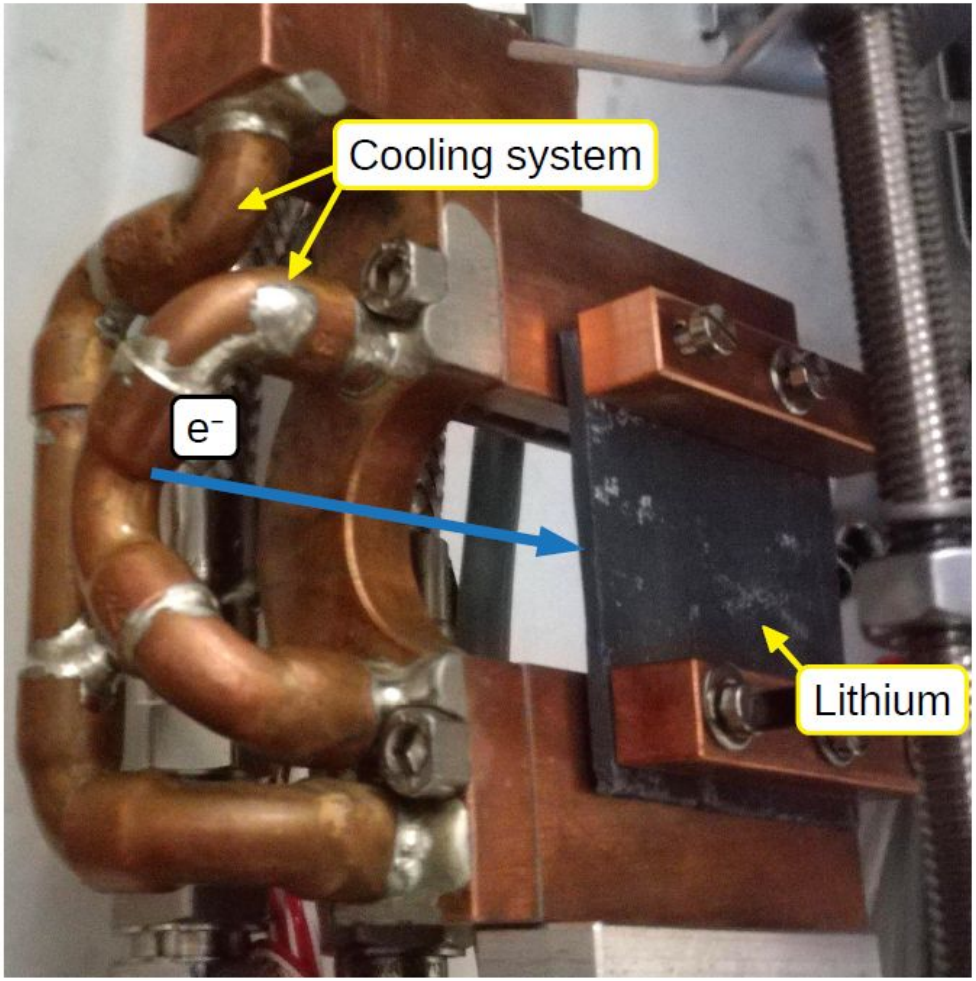
lower mass number for less background?

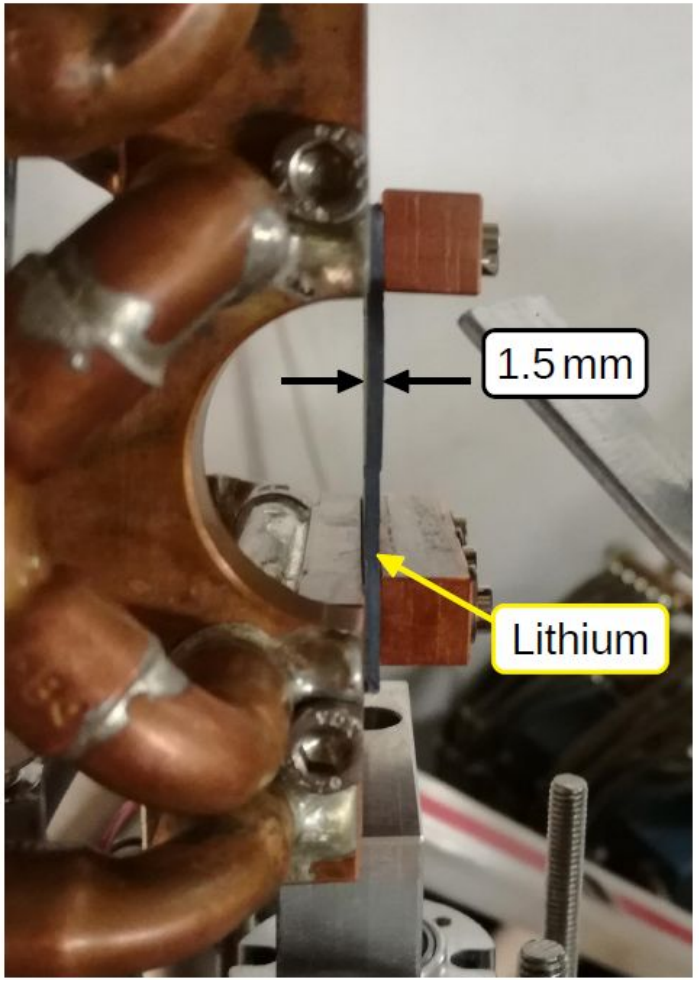
5 cm $^{6/7}$Li target



F. Schulz 2015

5. Target Prototype – 2019





by P. Herrmann and P. Klag

Target Alignment with Thermal Camera

alignment via theodolite difficult:

- long target length
- high reactivity of Li
- incoming beam @17°

  → other solution needed

thermal camera:

- orientation via target itself
- observation of deposited heat by beam
- two cameras filming long side of target

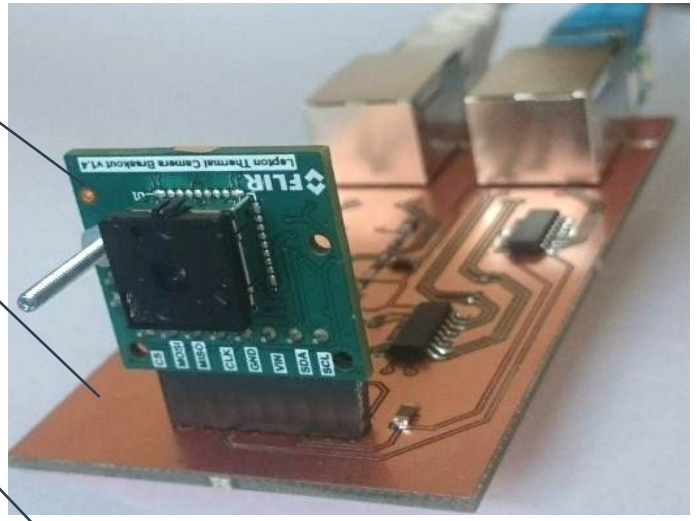
cam module

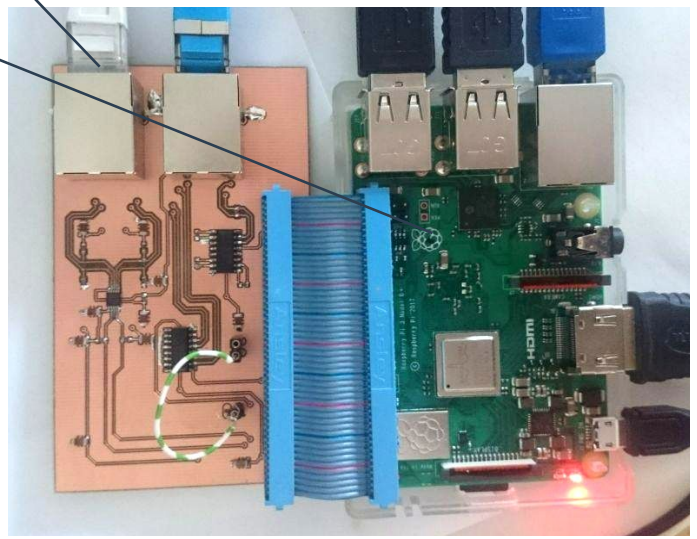
spi to LVDS converter

LVDS back to spi

raspberry pi

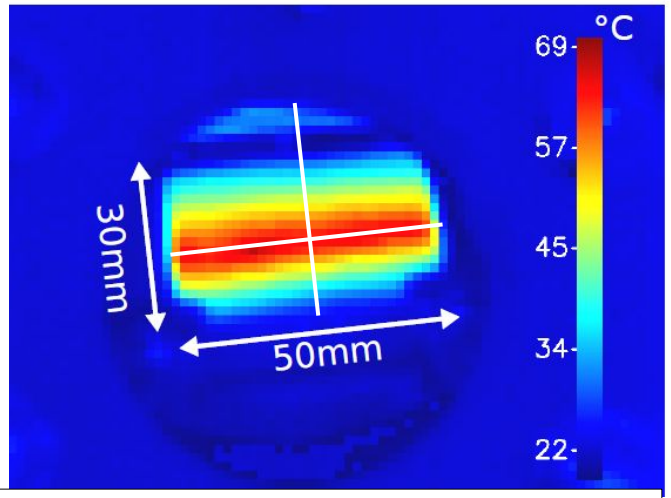
by J. Geratz and P. Klag





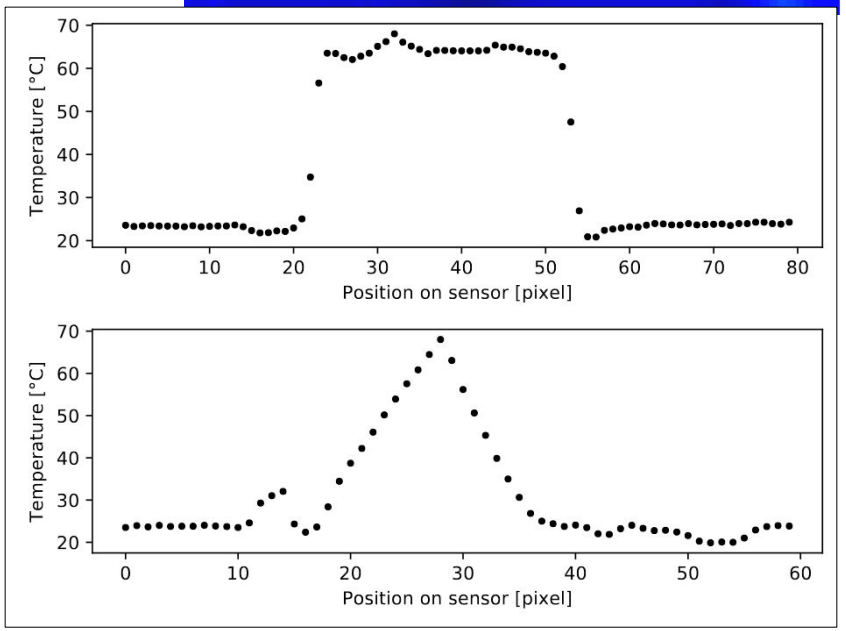
First Lithium Target Test @X1

Temperature distribution of Lithium recorded with thermal cam and infra red optics



Details:

- Beam Energy: 855 MeV
- Beam Current: 10 µA
- Maximal Temperature: ~ 70°C



➡ cam allows target alignment

➡ successful cooling

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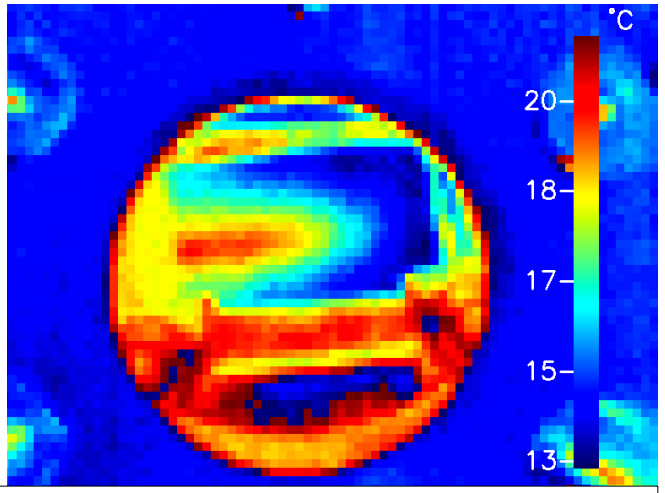

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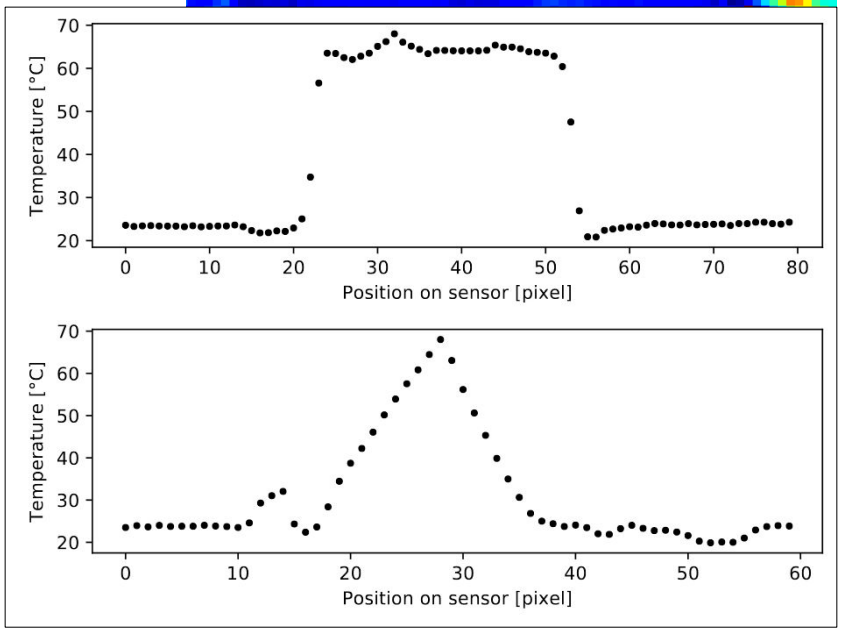

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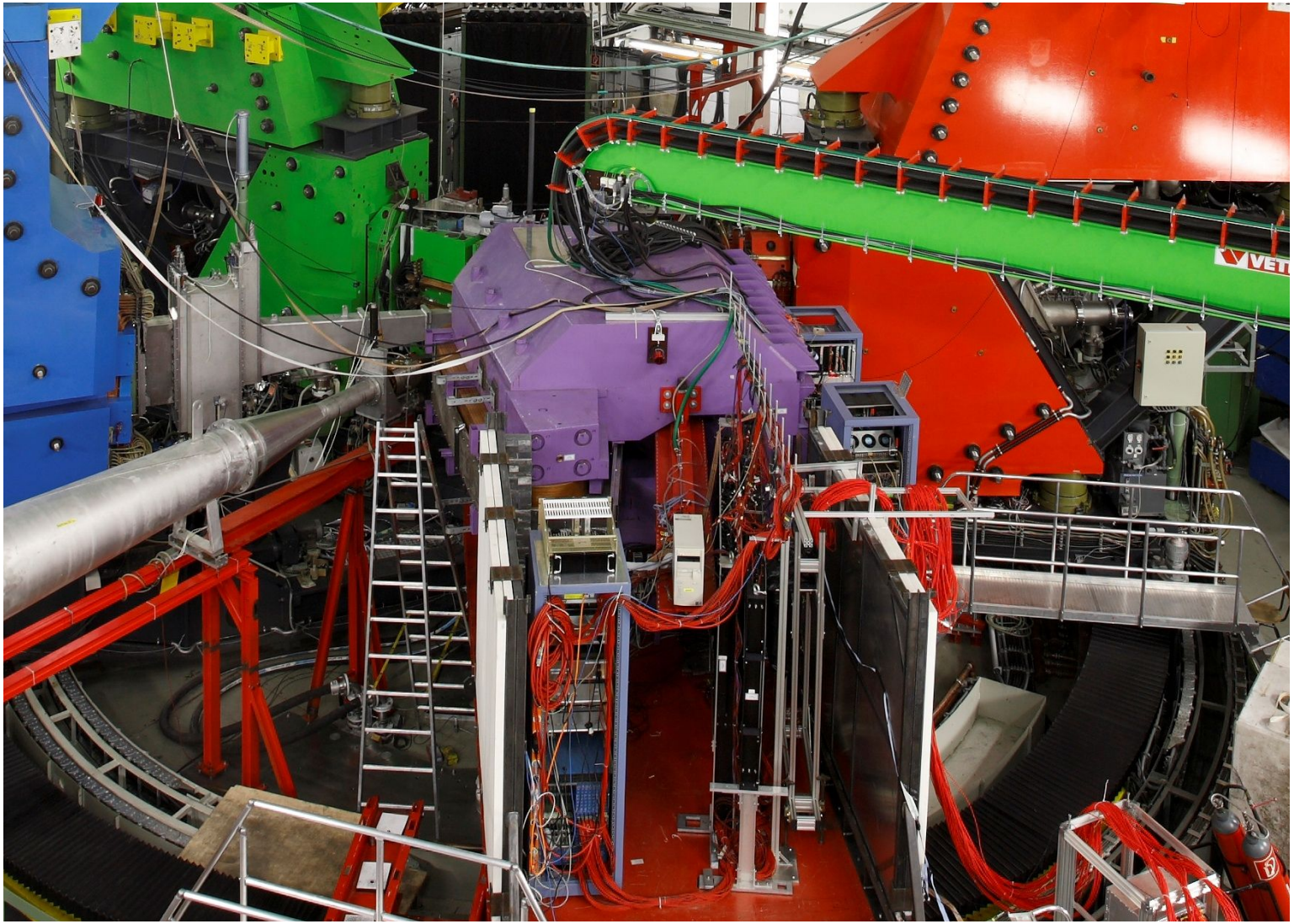
Status of KAOS



Status of KAOS

Detectors:

Scintillators:
- HV repaired
- PMTs checked

Cherenkov Detector:
- PMTs checked
- **Status of aerogel?**

Coincidence Logic:
- almost complete
- made logic plan
- **test run needed**

Basics:

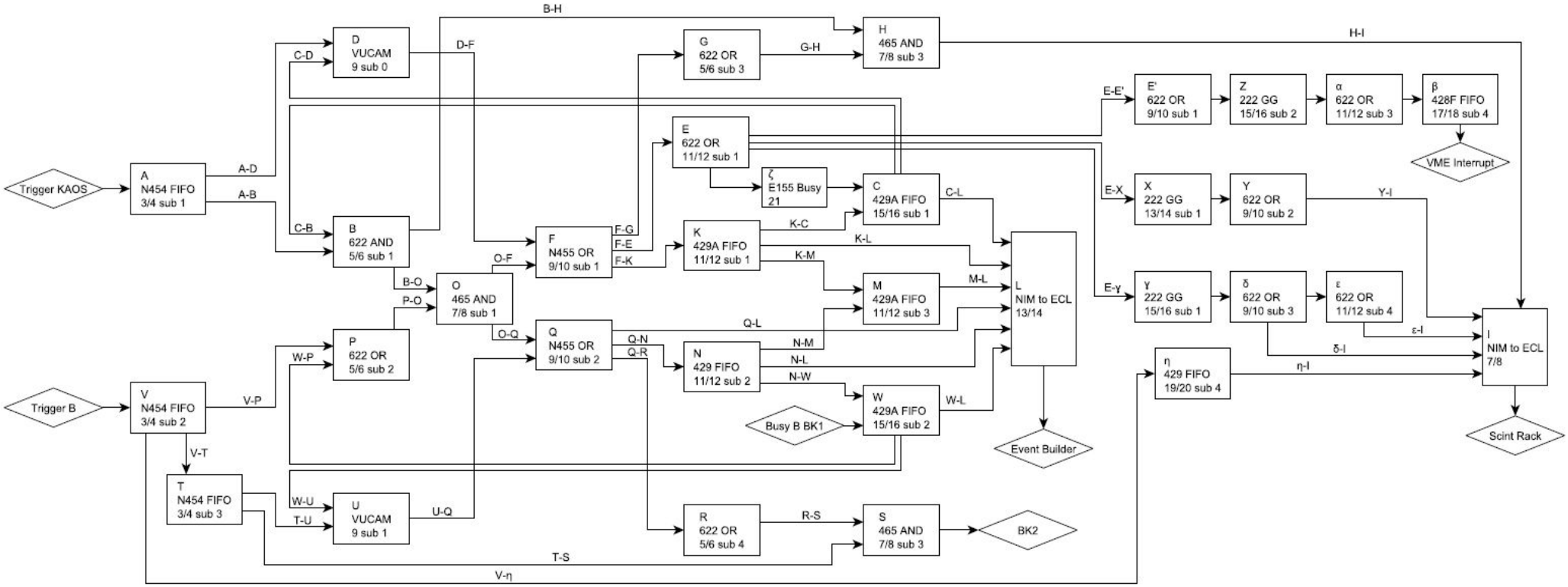
Vacuum Chamber:
- equipment complete
- all pumps working

Dipole Magnet:
- first low current test successful

Experiment Control:
- replaced frontend pc
- **complete software**

Moving KAOS:
- **polish iron plates**
- **check equipment**

KAOS Coincidence Logic



A: KAOS Trigger	F:	K:	P: B Trigger and Not Busy	U: B Scaler	Z:	ε:
B: KAOS Trigger and Not Busy	G:	L:	Q:	V: B Trigger	α:	ζ:
C: KAOS Busy	H:	M:	R:	W: B Busy	β:	η:
D: KAOS Scaler	I: start Scint. ADC/TDC readout	N:	S:	X:	γ:	
E: Interrupt	J: -	O: valid Trigger B and KAOS	T: B Trigger	Y:	δ:	

Hypertriton – Future –

Until end of 2020:

- finish experiment control:

  → control all devices, supplies, etc. from counting room

- start coincidence logic debugging

- design of special target chamber

In 2021:

- Cherenkov detector

- check FPGA trigger

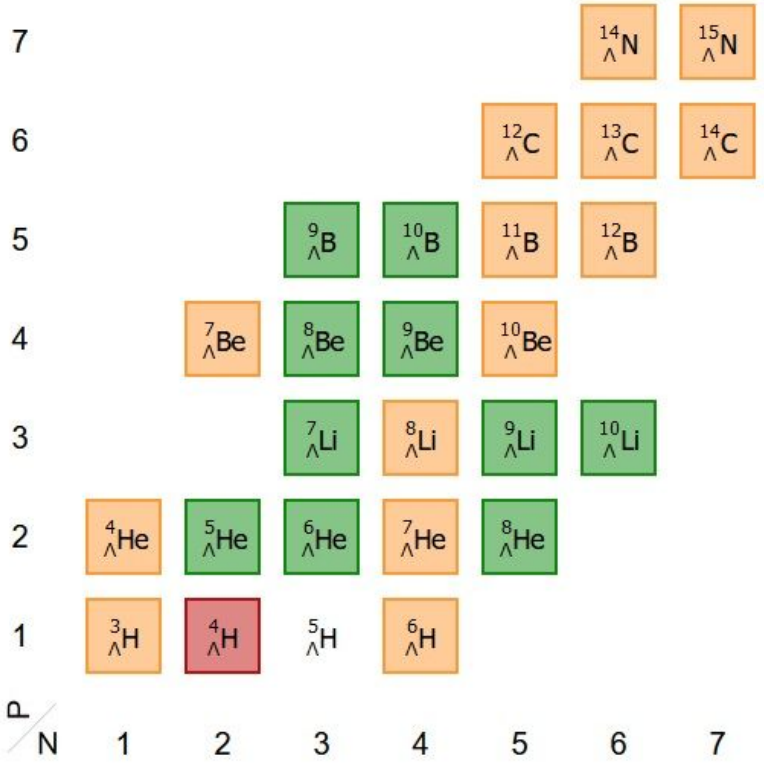
- first cosmics in spring?

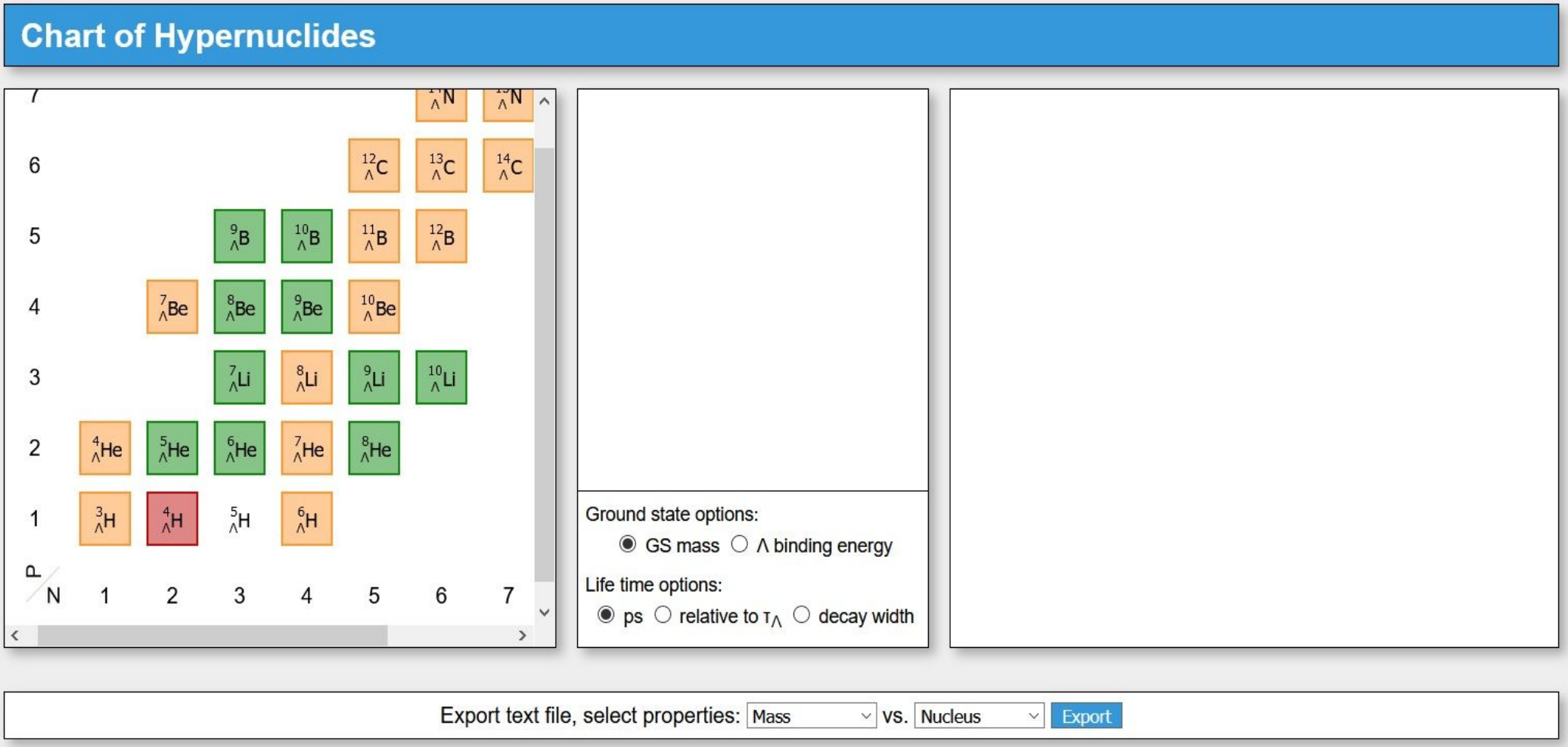
- beamtime in summer?

Part II: Hypernuclear Database

Idea:

- worldwide collection of hypernuclear data
- compute world averages (analogous to PDG)
- accessible to everyone via web
- interactive playing around with data
- offer download of plots, data, references
- **best activity during home office**

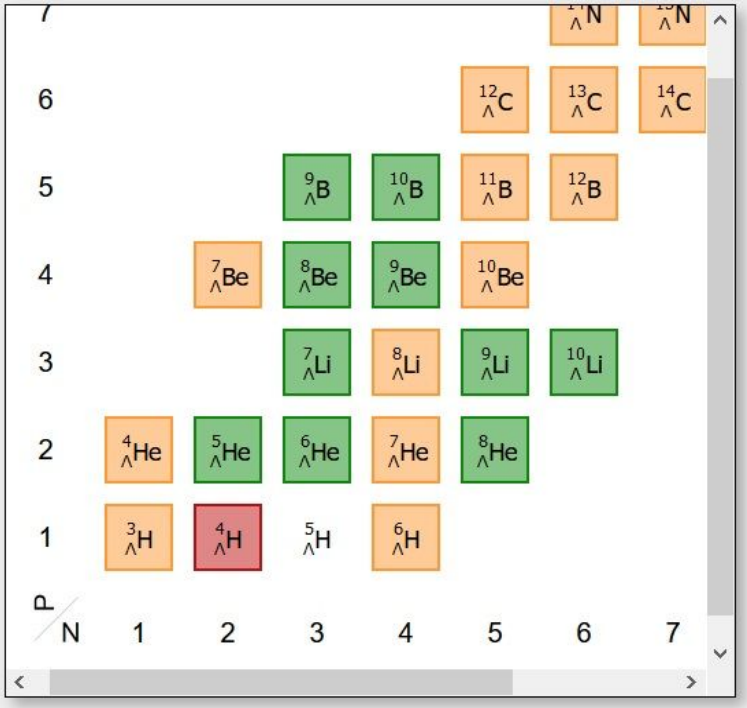




First draft at: *https://hypernuclei.kph.uni-mainz.de/page.html*

- work in progress
- sql database under construction
- right now filled with fake data

Chart of Hypernuclides



$^{7}_{\Lambda}$Lithium

- Non-strange core: ^{6}Li
  - mass m_{GS} = 5601.518 MeV/c^2
  - mean life time: stable
- Decays:
  - two body: $^{7}_{\Lambda}\text{Li} \rightarrow {}^{7}\text{Be} + \pi^-$

Ground state options:

(●) GS mass ( ) Λ binding energy

Life time options:

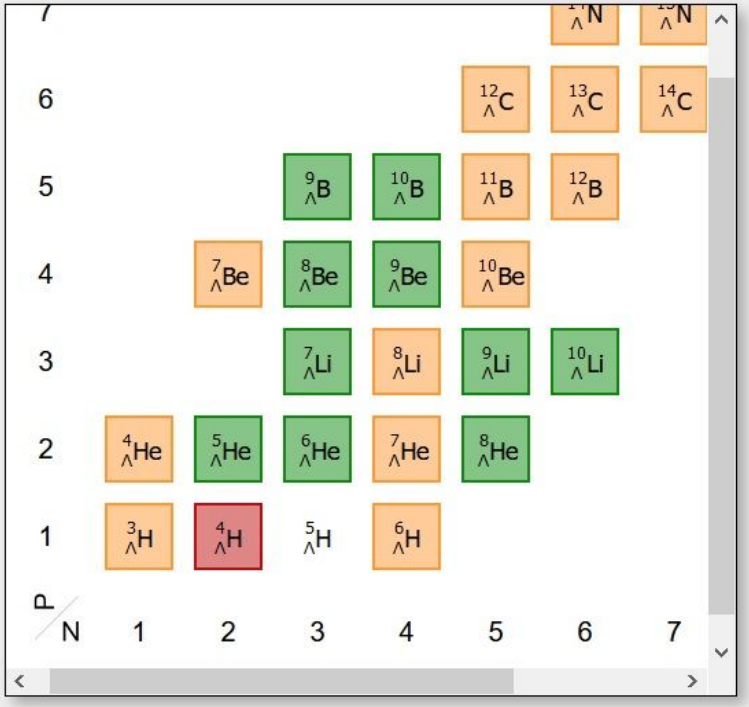
(●) ps ( ) relative to τ_Λ ( ) decay width

$^{7}_{\Lambda}$Li

Ground State: Ground State Mass	$J^P = \frac{1}{2}^+$	6711.64 ± 0.09 MeV/c^2
Excited States		
Lifetime τ		213.00 ± 3.26 ps
Two Body Decays		
Decay Thresholds		

Export text file, select properties: Mass vs. Nucleus Export

Chart of Hypernuclides



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Life time options:

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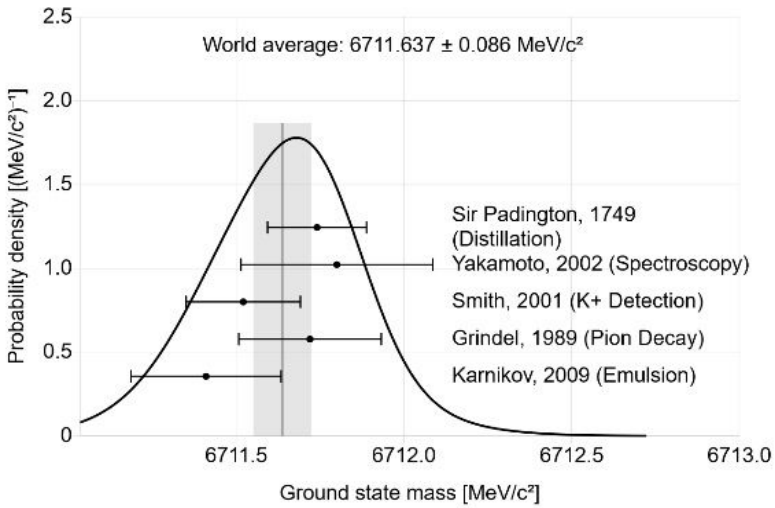
$^{7}_{\Lambda}$Li: Ground state mass



$^{7}_{\Lambda}$Li

Ground State: Ground State Mass		$J^P = \frac{1+}{2}$		6711.64 ± 0.09 MeV/c^2	
Ground state mass [MeV/c²]	Weight	X², Σ = 2.47	Author	Method	Ref.
☑ 6711.41 ± 0.20 (stat.) ± 0.10 (sys.)	0.15	1.03	Karnikov	Emulsion	BibTeX
☑ 6711.72 ± 0.14 (stat.) ± 0.16 (sys.)	0.16	0.15	Grindel	Pion Decay	BibTeX
☑ 6711.52 ± 0.11 (stat.) ± 0.13 (sys.)	0.26	0.47	Smith	K+ Detection	BibTeX
☑ 6711.80 ± 0.17 (stat.) ± 0.23 (sys.)	0.09	0.32	Yakamoto	Spectroscopy	BibTeX
☑ 6711.74 ± 0.13 (stat.) ± 0.07 (sys.)	0.34	0.49	Sir Padington	Distillation	BibTeX
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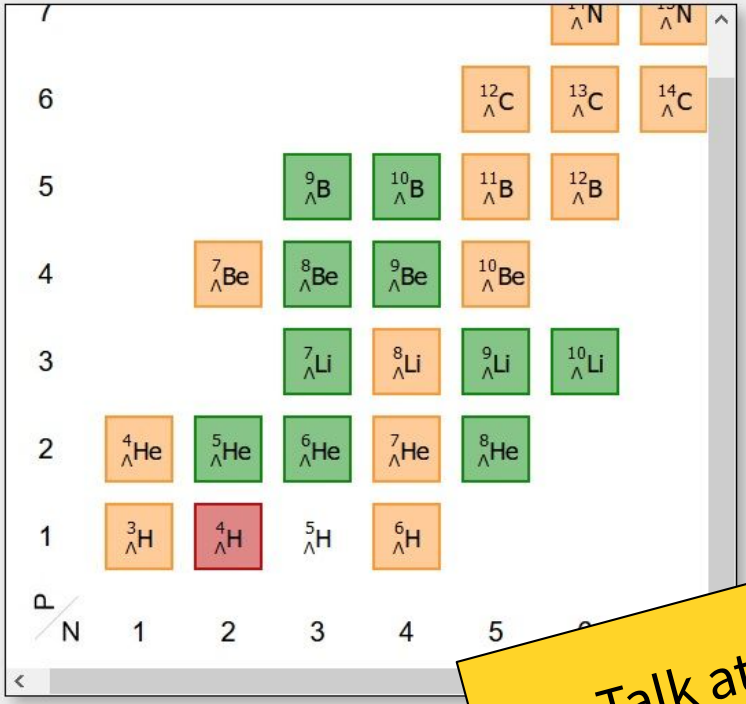

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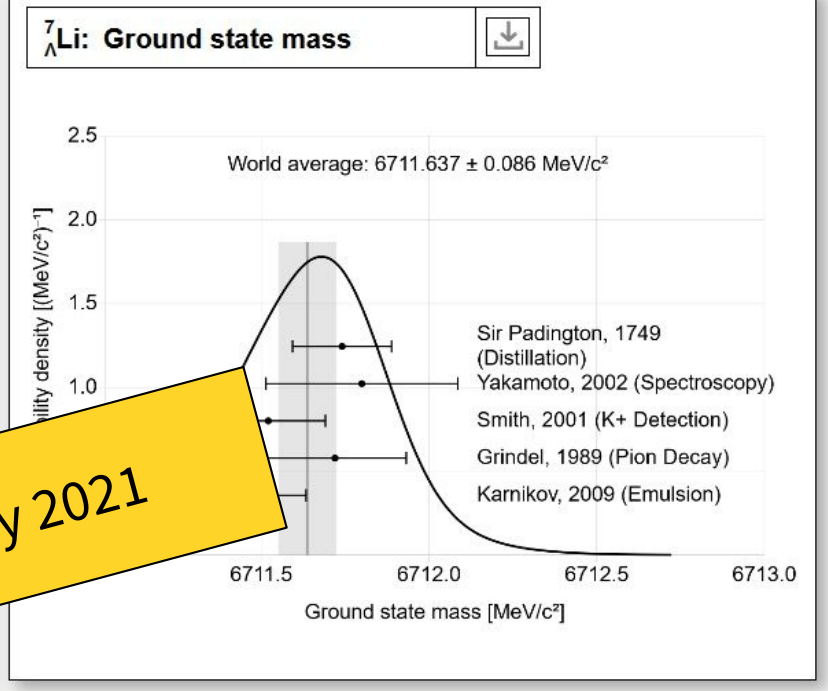
Ground state opti…

…ecay width



Talk at THEIA-REIMEI in early 2021

$^{7}_{\Lambda}$Li

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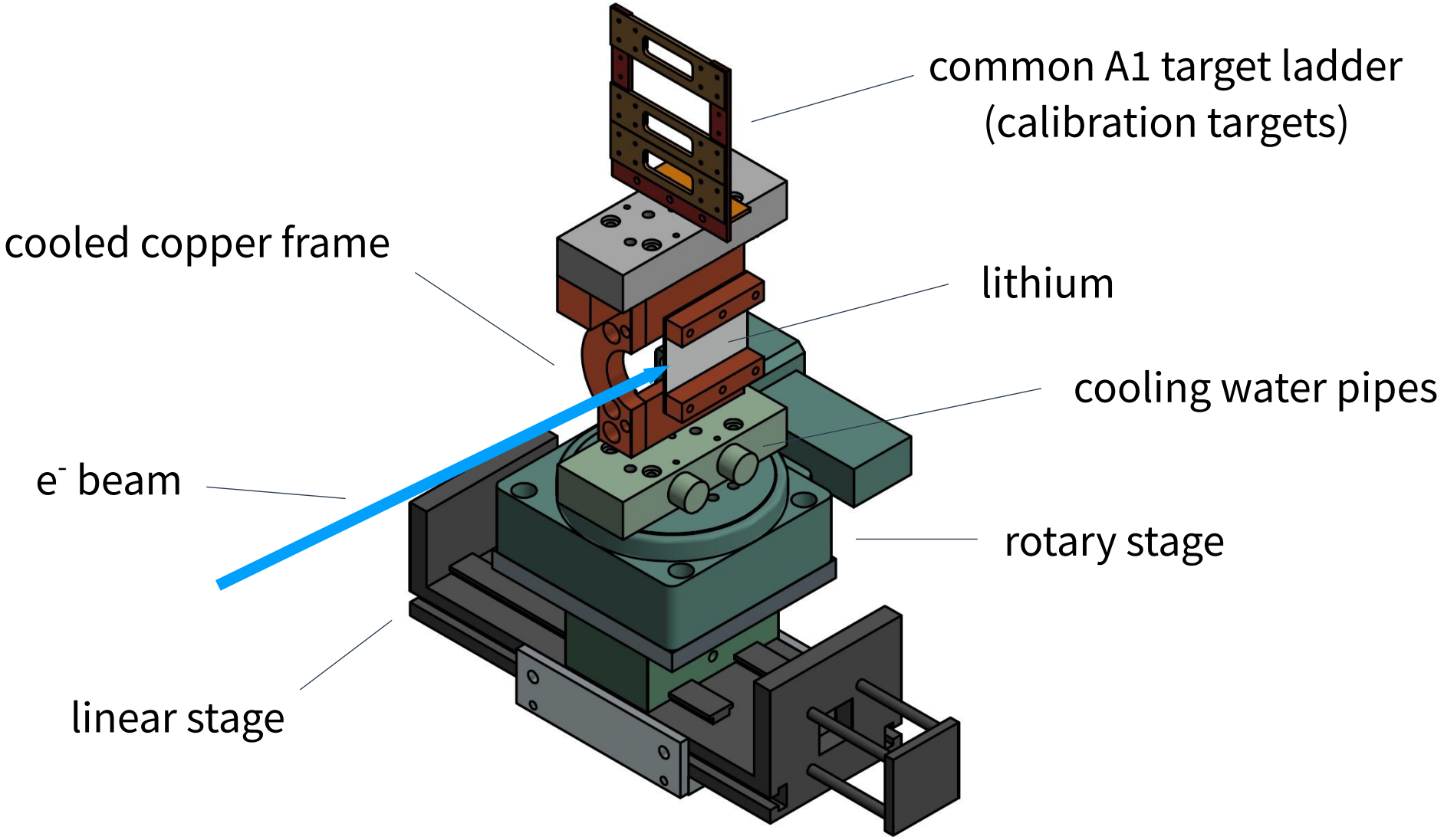
Excited States					
Lifetime τ					213.00 ± 3.26 ps
Two Body Decays					

Target Construction

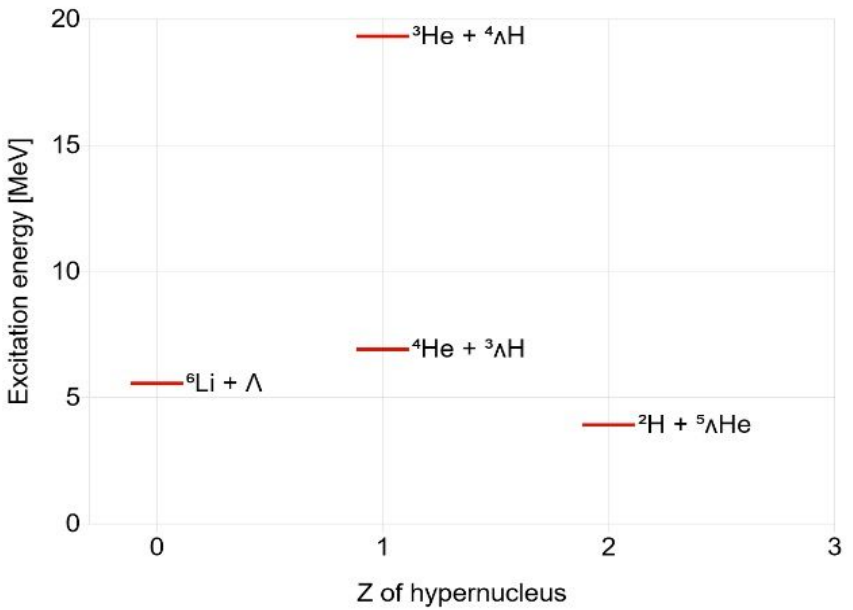


Lifetime τ 213.00 ± 3.26 ps

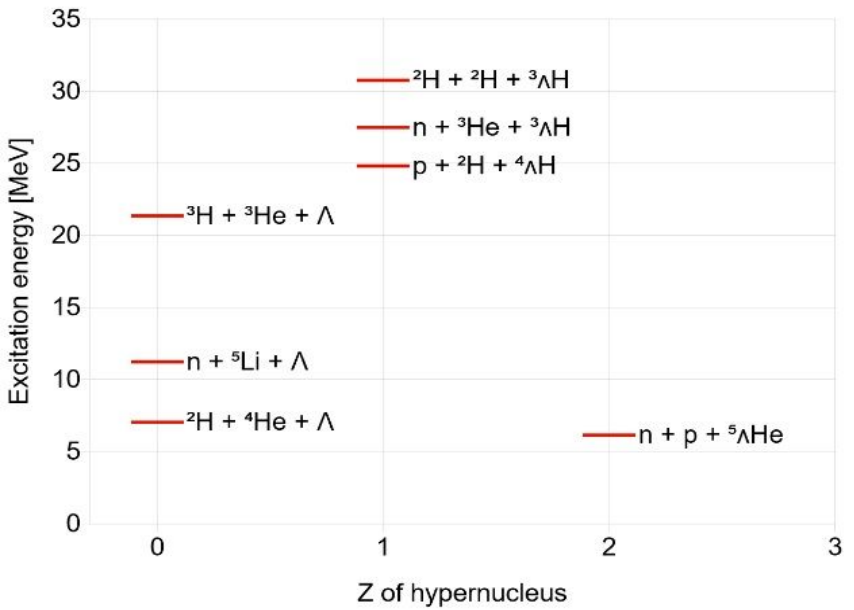
Two Body Decays

Decay Thresholds

Two Body Fragmentations



Three Body Fragmentations



Threshold Energies and Plot Customization

Minimal Energy: 0 Maximal Energy: 10 Maximal Width: 3

Two Body Channel	Ex. Energy [MeV]	Width [μeV]
☑ ²H + ⁵ΛHe	3.918	-
☑ ³He + ⁴ΛH	19.319	-
☑ ⁴He + ³ΛH	6.909	-
☑ ⁶Li + Λ	5.564	2.502

Three Body Channel	Ex. Energy [MeV]	Width [μeV]
☑ n + p + ⁵ΛHe	6.142	-
☑ n + ³He + ³ΛH	27.486	-
☑ n + ⁵Li + Λ	11.227	2.502
☑ p + ²H + ⁴ΛH	24.812	-
☐ p + ³H + ³ΛH	26.721	-
☐ p + ⁵He + Λ	10.149	2.502