

Denim 2015



Novel Signal Processing for Event Recording and Qualification in a Large Area TOF PSD System

Contact info

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Layout

- **NEAT-II @ HZB**
“Large Area TOF PSD System”
- **Data Acquisition System**
“Event Recording
in a Large Area TOF PSD System”
- **Digital Signal Processing**
“Novel Signal Processing
for Event Qualification”
- **Summary**

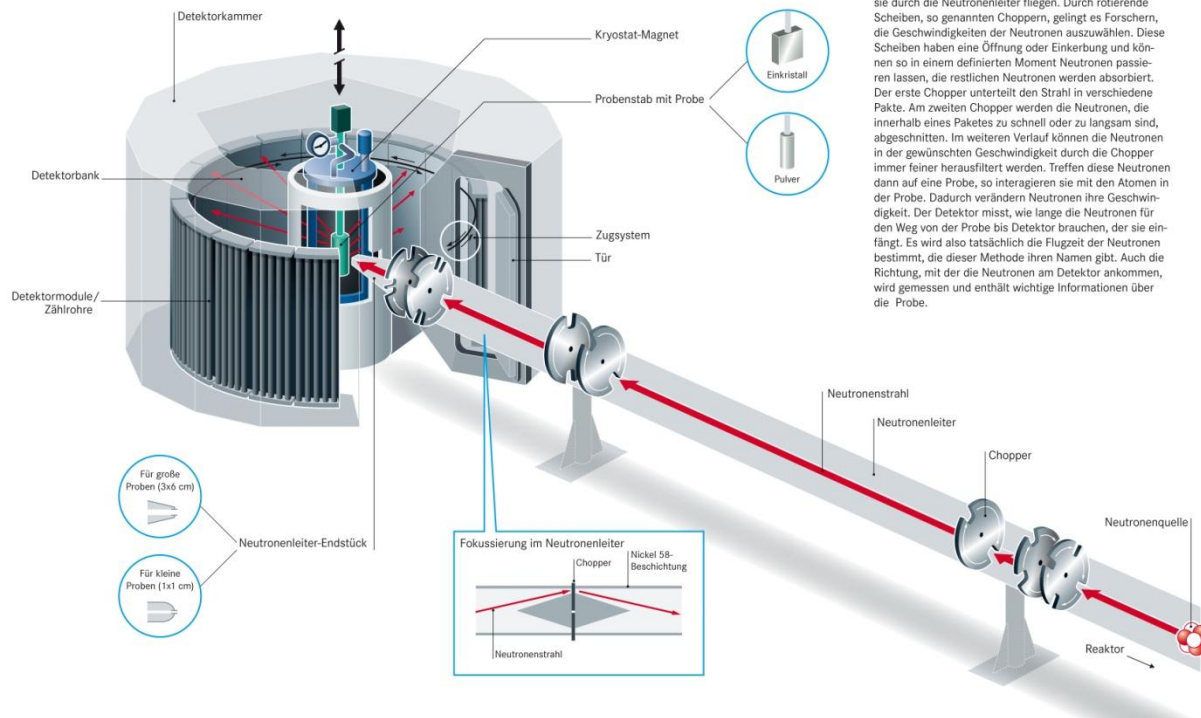
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NEAT-II @ HZB – Overview

Flugzeitspektrometer NEAT II

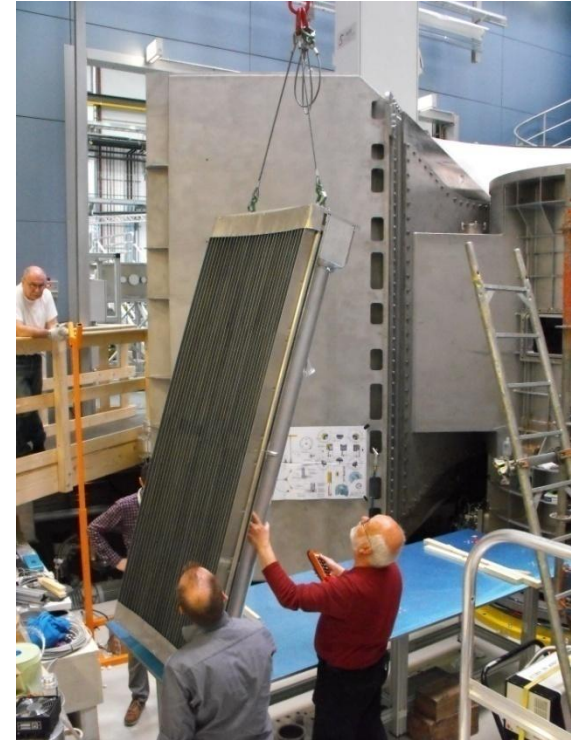
Infografik: E. Strickert



Die Neutronen gelangen von der Neutronenquelle BER II über Neutronenleiter zur Probe. Die Neutronen haben unterschiedliche Geschwindigkeiten (Wellenlängen), wenn sie durch die Neutronenleiter fliegen. Durch rotierende Scheiben, so genannten Chopperrn, gelingt es Forschern, die Geschwindigkeiten der Neutronen auszuwählen. Diese Scheiben haben eine Öffnung oder Einkerbung und können so in einem definierten Moment Neutronen passieren lassen, die restlichen Neutronen werden absorbiert. Der erste Chopper unterteilt den Strahl in verschiedene Pakete. Am zweiten Chopper werden die Neutronen, die innerhalb eines Paketes zu schnell oder zu langsam sind, abgeschnitten. Im weiteren Verlauf können die Neutronen in der gewünschten Geschwindigkeit durch die Chopper immer feiner herausfiltert werden. Treffen diese Neutronen dann auf eine Probe, so interagieren sie mit den Atomen in der Probe. Dadurch verändern Neutronen ihre Geschwindigkeit. Der Detektor misst, wie lange die Neutronen für den Weg von der Probe bis Detektor brauchen, der sie einfängt. Es wird also tatsächlich die Flugzeit der Neutronen bestimmt, die dieser Methode ihren Namen gibt. Auch die Richtung, mit der die Neutronen am Detektor ankommen, wird gemessen und enthält wichtige Informationen über die Probe.

Detector System @ NEAT II

- 400+ ^3He PSD tubes (Reuter-Stokes / 2m long)
- 32 tubes / module – 13 modules



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(re: yesterday's talk by G. Günther)

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(re: yesterday's talk by G. Günther)
- PSD using charge division method
- DAQ system with
 - 2D beam monitor
 - 7 chopper system
 - sample environment data

Solution details

- Proprietary “tailor made” mechanical solution
 - Interfaces to vacuum chamber & transport system
- Proprietary analog electronics
 - Preamplifiers with minimal signal shaping
- Sampling ADC based digitalization
 - 20 ns sampling time
- FPGA based signal processing
 - Based on NI hardware
- “Hard core” Event Recording DAQ system
 - 400+ detectors & 2D beam monitor

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DAQ @ Neat II - Overview

- Time-of-Flight enabled system
 - 100 ns TOF resolution
 - for detectors and 2D beam monitor
- Event Records for EVERYTHING
 - neutron hits
 - monitor hits
 - choppers
 - sample environment variables
- 100 absolute timestamps (48 bits: 300+ days)
- Time synchronization between 3 subsystems
 - 5-10-15 m separation

Event Records

Events:																
Neutron event Examples: tube# 210 tube# 266	code*	tube code LSB's	sition (0..10)	confid1	confid2	confid3	TOF			Time Stamp						
	0x00/0x01						sec	msec	usec	day	hour	min	sec	msec	usec	
	0x00	0xD2	0x003D	0x23	0x45	0x67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	0x01	0x0A	0x005A	0x34	0x56	0x78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Monitor Event Example: monitor hit	code	reserved	32 bit signed: counts from start			reserved	TOF			Time Stamp						
	0x10		max. 2,147,483,647				sec	msec	usec	day	hour	min	sec	msec	usec	
	0x10	0x00	1,234,567			0x00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Chopper event Example: chopper #3	code	chopper code	reserved	event status	reserved	TOF			Time Stamp							
	0x11					sec	msec	usec	day	hour	min	sec	msec	usec		
	0x11	0x03	0x00	0x0F2B	0x00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Other event Example: Stroboscopic	code	input code	reserved	event status	reserved	TOF			Time Stamp							
	0x12					sec	msec	usec	day	hour	min	sec	msec	usec		
	0x12	0x06	0x00	0x0E14	0x00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Samp. Env. Event Example: samp. env. data	code	data source	bit signed d	reserved	reserved	fixed TOF			Time Stamp							
	0x40	temperature				sec	msec	usec	day	hour	min	sec	msec	usec		
	0x40	0x04	0x6EDC	0x00	0x00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Empty data Example: samp. env. data	code															
	0xFF															
	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	

Time Synchronization

- Between channels (2 ends of same tube)
 - >20 ns (NI)
- Between any two detectors
 - =100 ns (NI)
- Between detectors and 2D beam monitor
 - =100 ns (proprietary synchronization system)

Event Recording: REVISITING

- All events are recorded
even “bad” or “dubious” events can be!
- Measurements can be “replayed” with different filtering of events
 - TOF filtering
 - position filtering (background)
 - time filtering (e.g. loss of cold source)

Can we do better?

Revisiting based on Event Qualification

- Qualifiers (examples)
 - charge
 - pile-up
 - signal shape

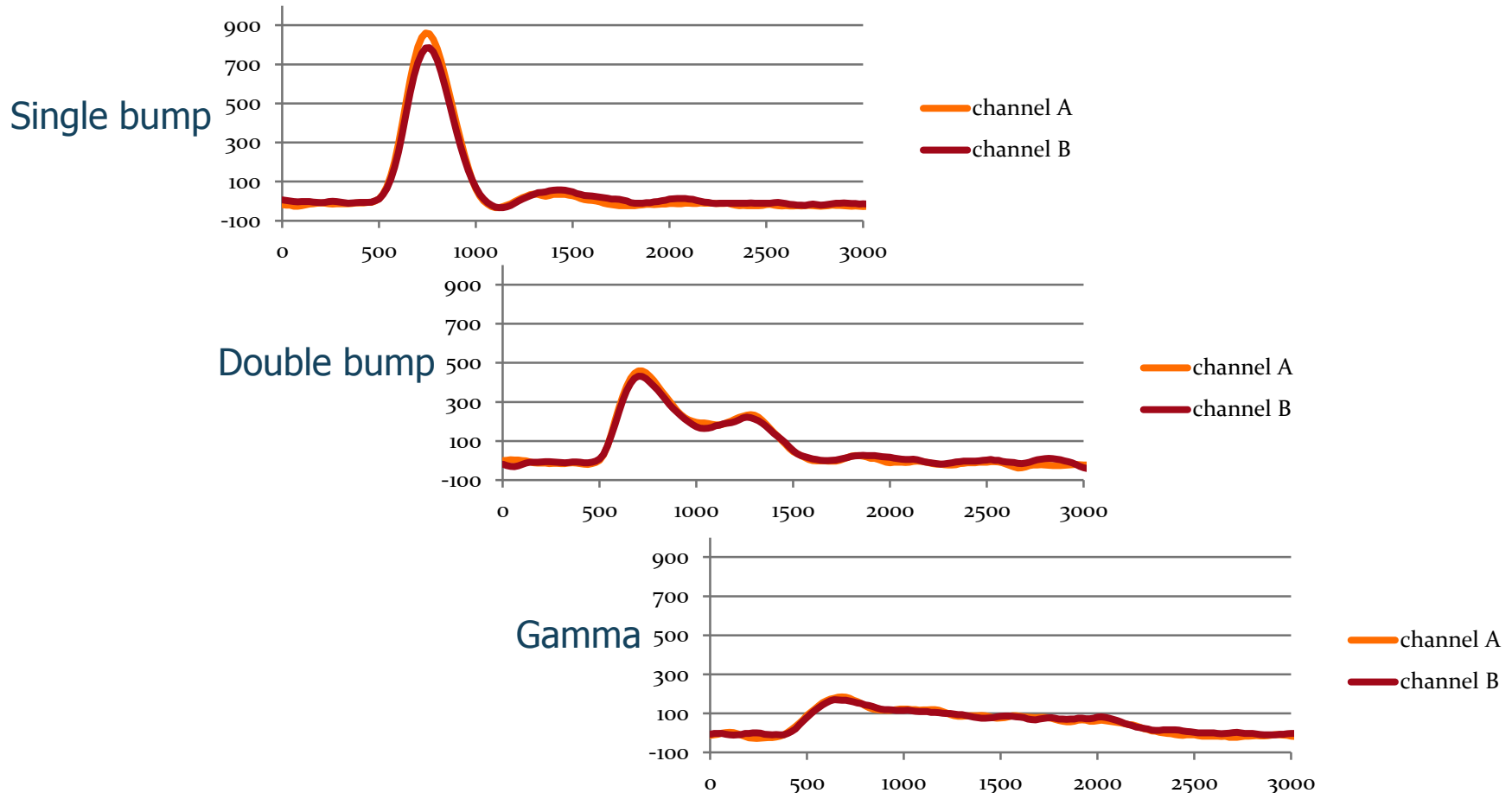
Don't need "hard" thresholds

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Signals with Sampling ADC

- Preamplifier time constant ~ 60 ns



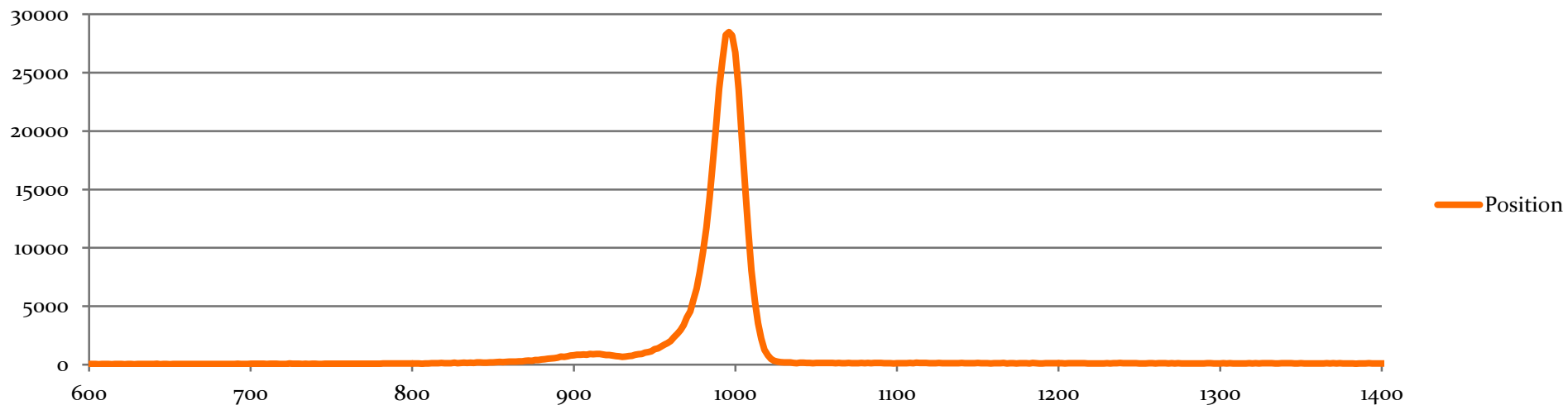
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 - **charge**
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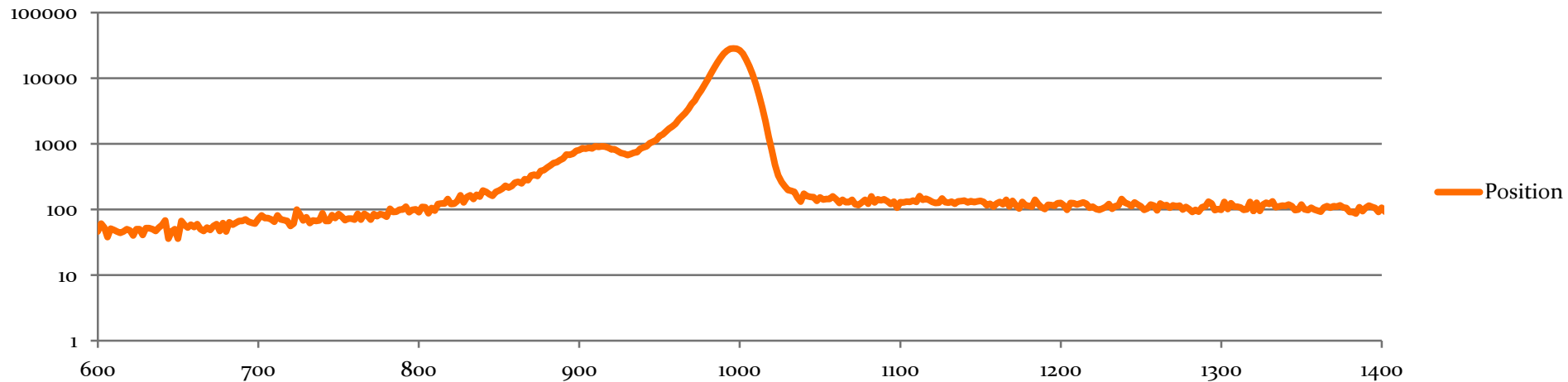
The initial measurement

Position

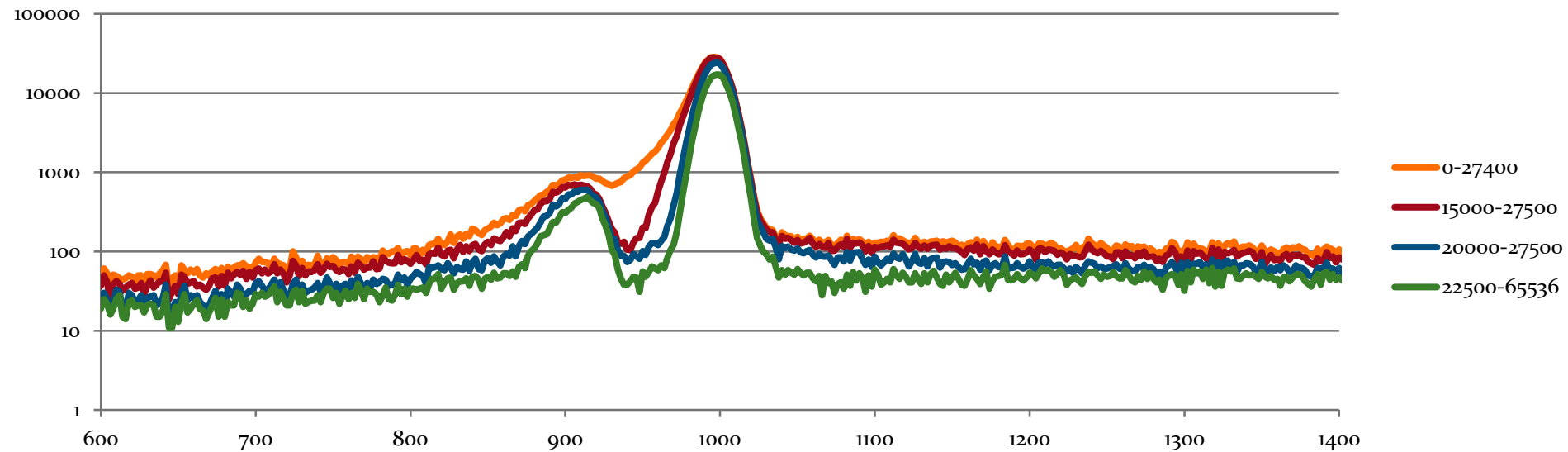


A sense of the background

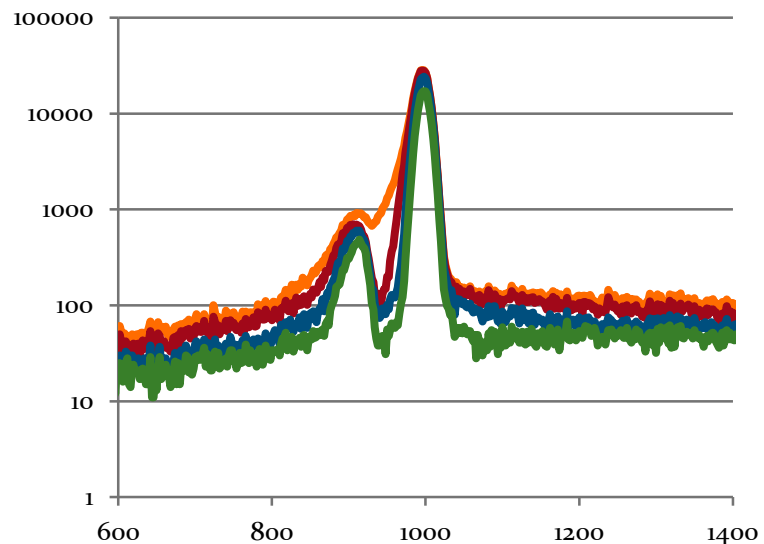
Position



Revisiting



Revisiting – the numbers



<u>charge</u>	<u>filtered hits</u>	<u>loss at peak</u>	<u>background suppression</u>
0-27400	0.00%	0.00%	0.00%
15000-27500	12.34%	1.63%	15.81%
20000-27500	34.51%	15.29%	43.43%
22500-65536	55.50%	39.72%	60.16%

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Summary

- Detector system for NEAT-II
 - Mechanics, signal processing, DAQ
 - 400+ ^3He tubes
- “Hard core” Event Recording DAQ
- Event Qualification
 - Sampling ADC + FPGA
- Revisiting + Event Qualification:
adjustable “cleanliness” of data off-line



Thanks for the attention

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