Denim 2015

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

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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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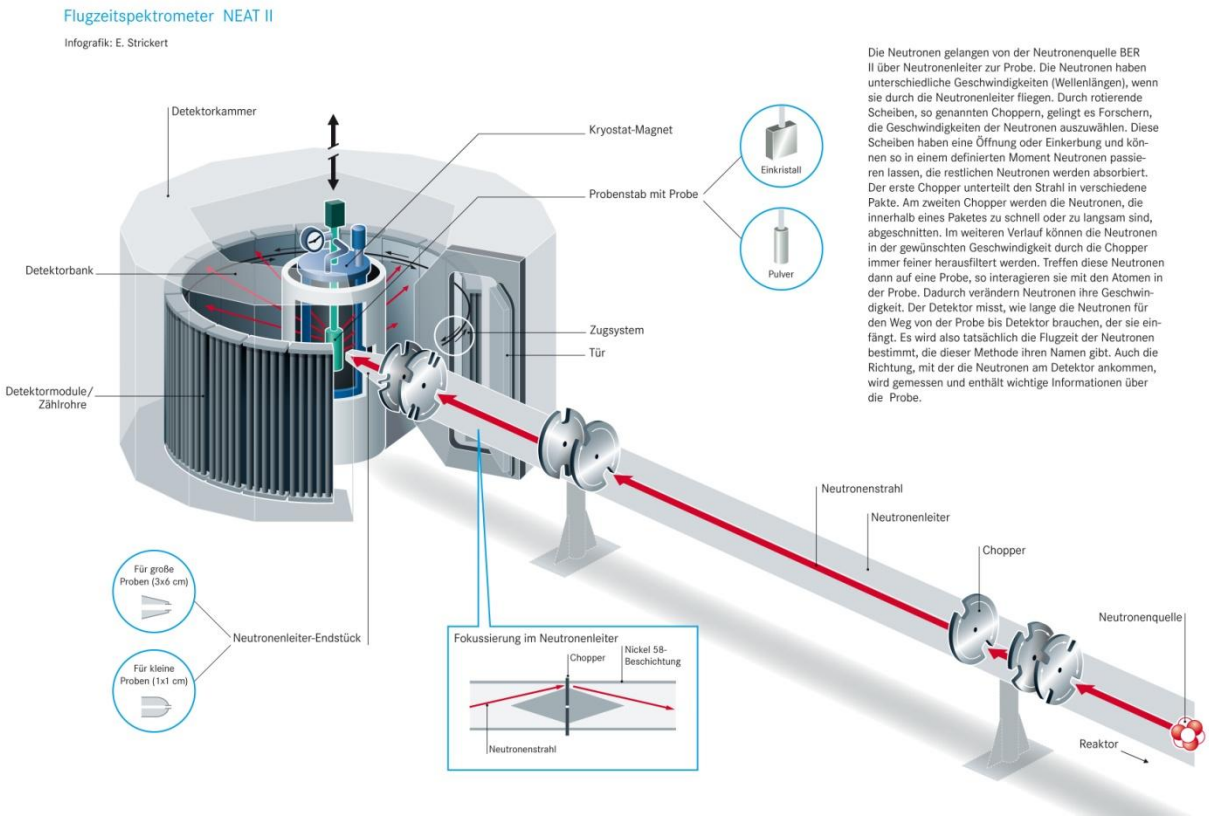
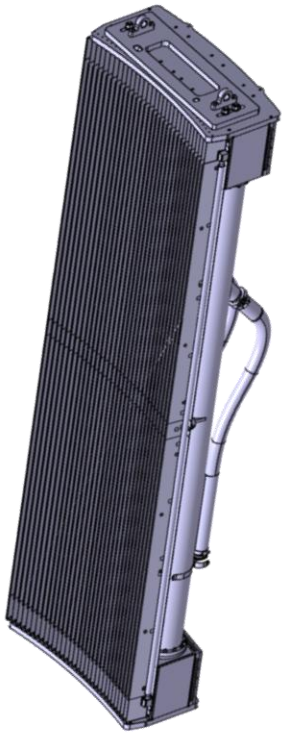
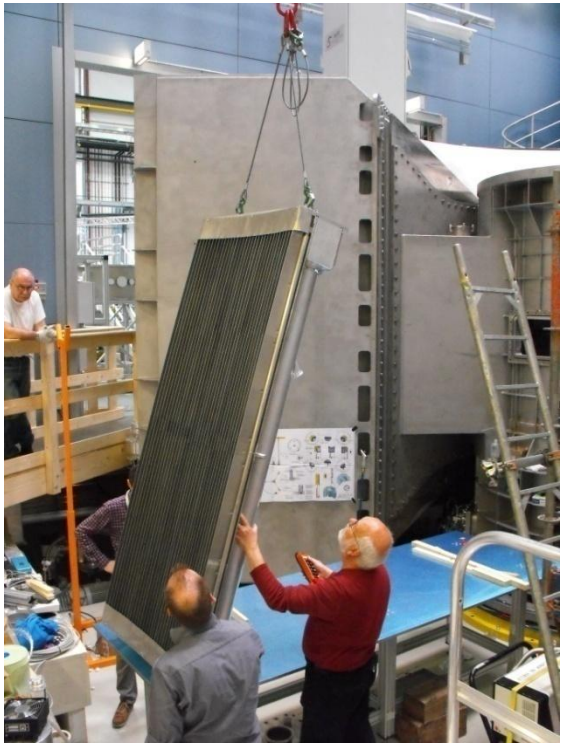
NEAT-II @ HZB – Overview



Detector System @ NEAT II

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





Detector System @ NEAT II

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- Mechanical support and assembly
- Built in collimator system
  (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

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Event Records

Events:																	
Neutron event	code*	tube code LSB's	sition (0..10	confid1	confid2	confid3	TOF			Time Stamp							
Examples:	0x00/0x01						sec	msec	usec	day	hour	min	sec	msec	usec		
tube# 210	0x00	0xD2	0x003D	0x23	0x45	0x67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
tube# 266	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	code	reserved	32 bit signed: counts from start			reserved	TOF			Time Stamp							
Example:	0x10		max. 2,147,483,647				sec	msec	usec	day	hour	min	sec	msec	usec		
monitor hit	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	code	chopper code	reserved	event status		reserved	TOF			Time Stamp							
Example:	0x11						sec	msec	usec	day	hour	min	sec	msec	usec		
chopper #3	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	code	input code	reserved	event status		reserved	TOF			Time Stamp							
Example:	0x12						sec	msec	usec	day	hour	min	sec	msec	usec		
Stroboscopic	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	code	data source	bit signed d	reserved		reserved	fixed TOF			Time Stamp							
Example:	0x40	temperature					sec	msec	usec	day	hour	min	sec	msec	usec		
samp. env. data	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	code																
Example:	0xFF																
samp. env. data	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

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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)

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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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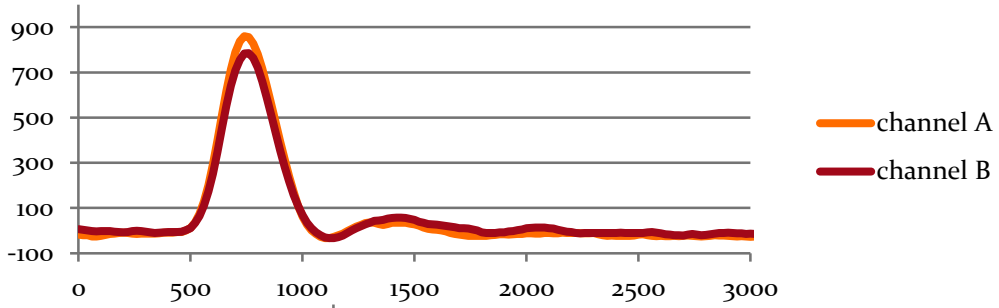
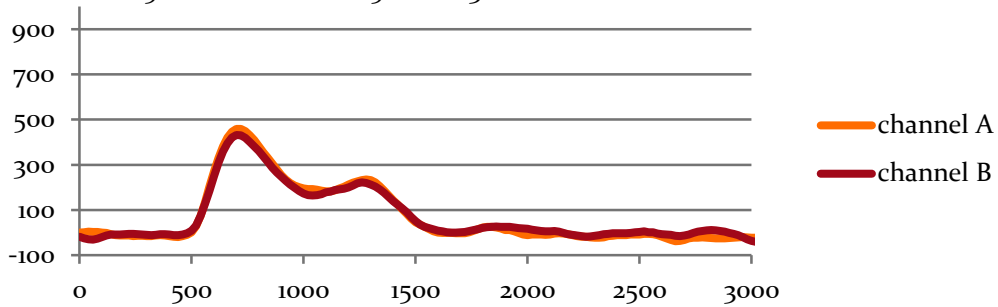
Signals with Sampling ADC

- Preamplifier time constant ~60 ns

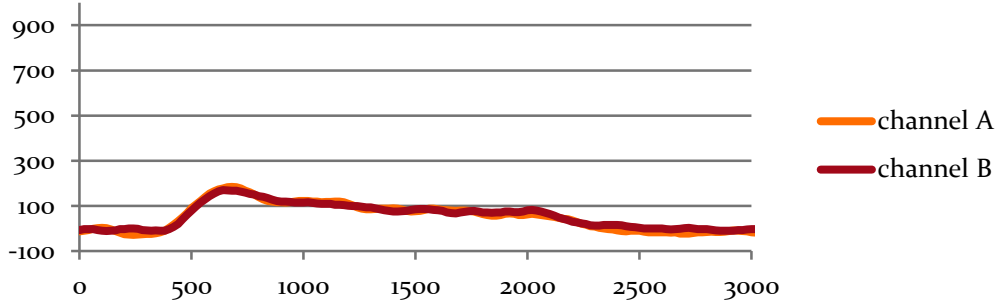
Single bump



Double bump



Gamma



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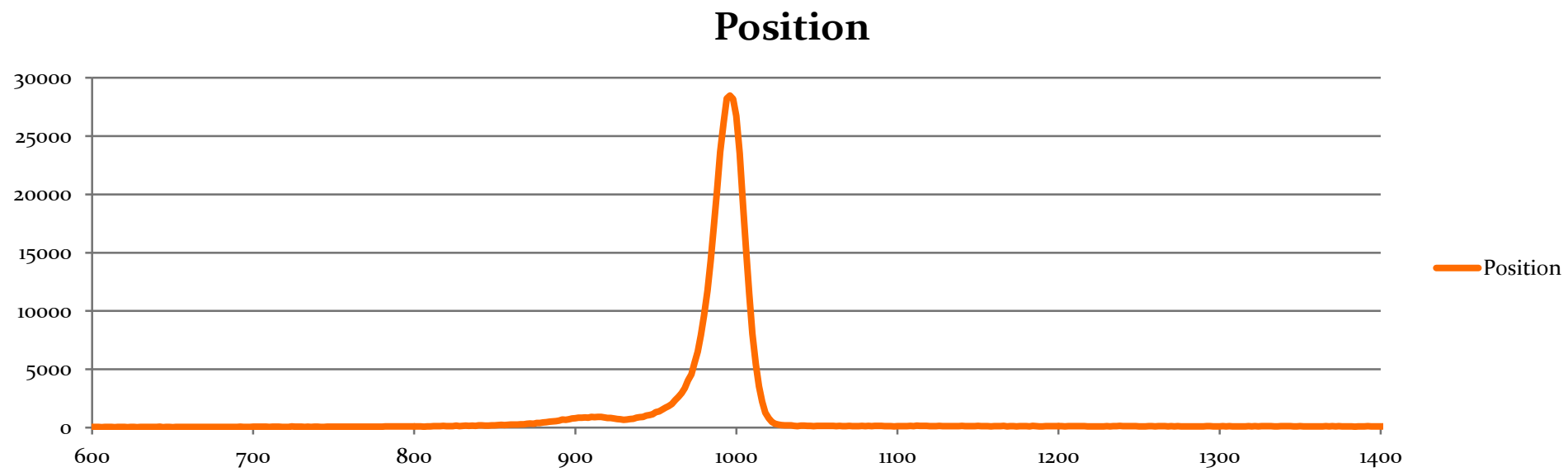
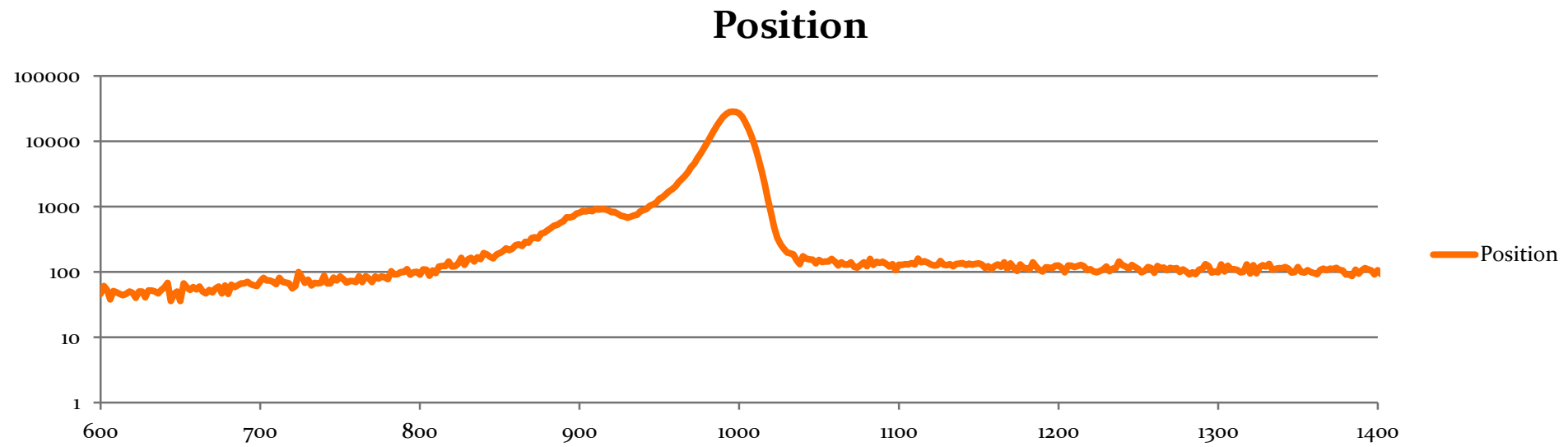
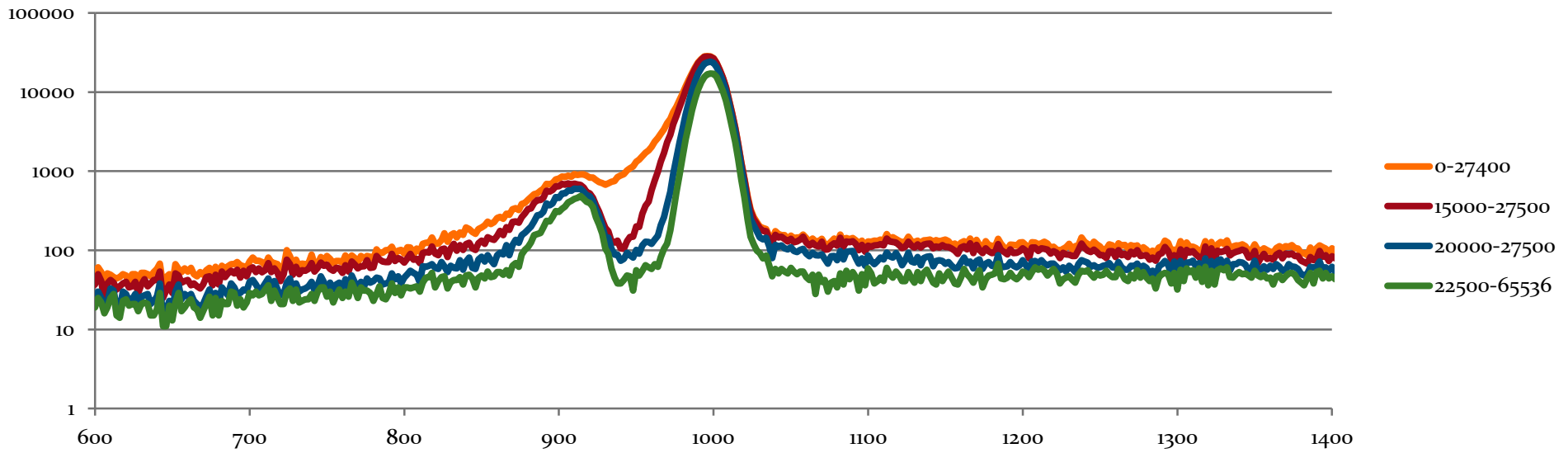
The initial measurement



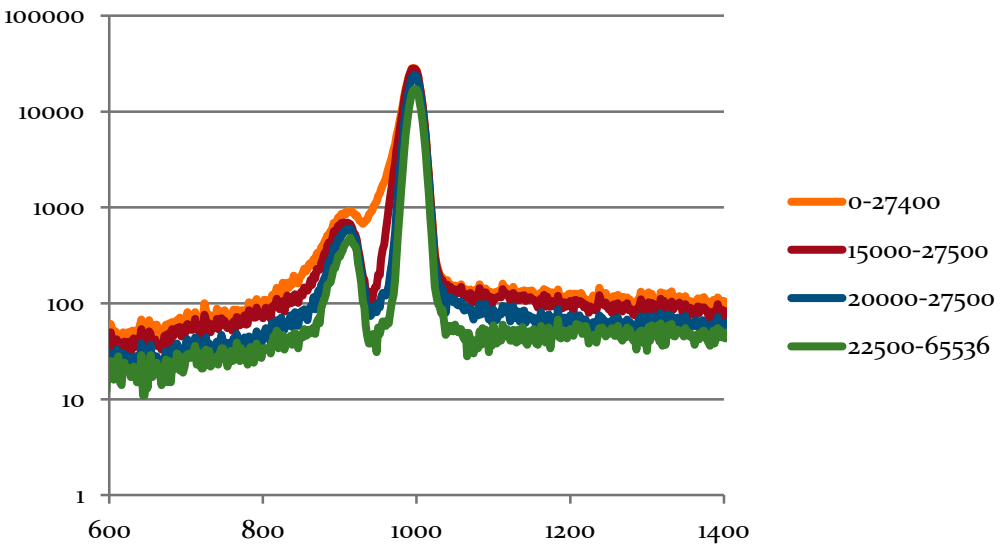
A sense of the background



Revisiting


100000
10000
1000
100
10
1
600
700
800
900
1000
1100
1200
1300
1400
0-27400
15000-27500
20000-27500
22500-65536

Revisiting – the numbers



charge	filtered hits	loss at peak	background suppression
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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- Detector system for NEAT-II
  - Mechanics, signal processing, DAQ
  - 400+ ^{3}He 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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