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# NP04 Status Update

**People at CERN this week** : Renan, Michaela, Manuel, Denise, Elisabetta, Gabriel and Laura

**Online support** : Federico, Esteban, Nacho, Julio, Anselmo, Anna, Alessandro

25/07/2024

# TASK LIST

- WAFFLES first release .....  
  
 → Julio is working on organizing the code in different folder to make it easy to use [1<sup>st</sup> Release on 26/07/2024]
- SPE Calibration of all channels ..... 
  - Take calibration runs with final configuration (3 OV) ..... 
  - Optimize bias voltages for all the channels ..... 
  - SPE template for 160 channels (once gain is equalized)..... 
- Data Deconvolution .....   
 → Renan implemented method in waffles. We are testing to make it work for all the channels.
- Physics analysis ..... 
  - Tau slow dedicated analysis
  - Light yield vs purity
  - Bi source analysis
  - ...
- PDS Trigger Primitives [Nacho DAPHNE firmware] → working on a decoder within the DAQ tools [Denise]

 Data management → **We need to converge in a final list of good-runs. Due to lack of space they need to move the rest to tape. [Decide a color scheme in the common spreadsheet]**

# Summary

During the last couple of weeks we solved some problems:

- DAPHNE board unresponsive [*controller 7*] → replaced with a spare board from Valencia
- Deployment of new DAPHNE firmware was unstable → we wanted to include the trigger primitives in the default firmware but we need time to clean up the clocks and the counters
- Different data throughput test DAPHNE - FELIX → understand the threshold to prevent DAPHNE from dropping packets before the FELIX sender + FELIX is keeping all the original packages.
- New data Controller for PDS → parallelized configuration [2 mins to 7s]

→ We understood and we solved all of them during last week together with DAQ team.

## PDS runs to take before 31/07/2024 [beam run]

- Calibration runs [3 OV]
- IV Curves
- Threshold vs bandwidth studies
- Tests with/without integrators in the acquisition chain

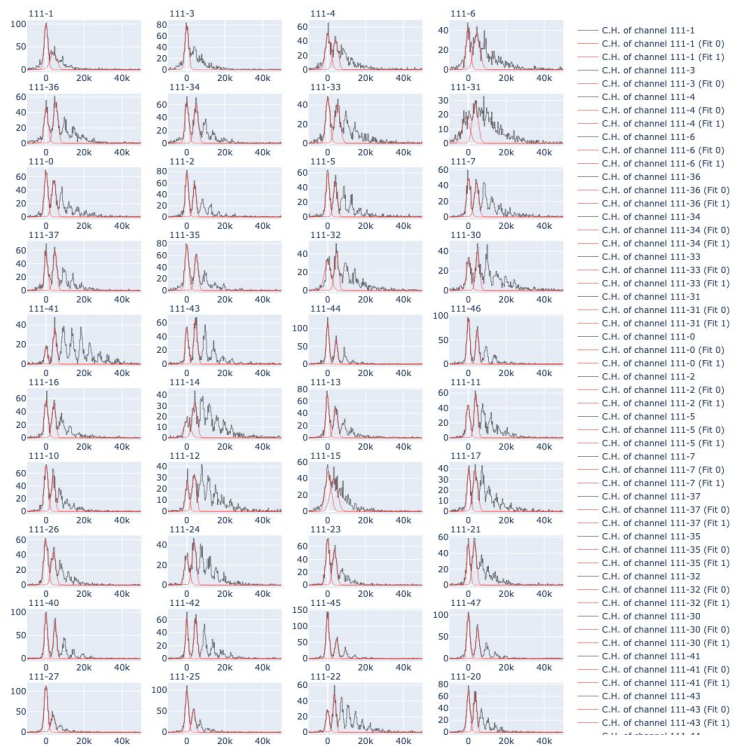
# SPE Calibration

OVERVOLTAGE+INTENSITY Calibration Runs APAs 12.										
									Calibration Run. Bias DCS:30V. Tests 270nm: SSP_config.pulse_mode:single, mask_channel:50, ticks_width:20, <b>Pulse_bias_percent_270nm:1400-2800</b> . Trigger_ad-hoc 0x7:20Hz. 20Hz daq trigger_rate.	
27898	09/07/2024	10:20	180 s	acervera	104,105,107,109	LED		<b>OV = HPK_2_FBK_3.5. 1400</b>	PDE 40%. LEDS on in diagonal	
27899	09/07/2024	10:24	180 s	acervera	104,105,107,109	LED		OV = HPK_2_FBK_3.5. <b>1800</b>	PDE 40%. LEDS on in diagonal	
27900	09/07/2024	10:29	180 s	acervera	104,105,107,109	LED		OV = HPK_2_FBK_3.5. <b>2200</b>	PDE 40%. LEDS on in diagonal	
27921	09/07/2024	12:03	180 s	acervera	104,105,107,109	LED		OV = HPK_2_FBK_3.5. <b>2800</b> . Notice this run was taken after all others in APAs 34	PDE 40%. LEDS on in diagonal	
27901	09/07/2024	10:34	180 s	acervera	104,105,107,109	LED		<b>OV = HPK_2.5_FBK_4.5. 2800</b> . Run with OV = HPK_2.5_FBK_4.5 by mistake	PDE 45%. LEDS on in diagonal	
27902	09/07/2024	10:40	180 s	acervera	104,105,107,109	LED		OV = HPK_2.5_FBK_4.5. <b>1400</b>	PDE 45%. LEDS on in diagonal	
27903	09/07/2024	10:45	180 s	acervera	104,105,107,109	LED		OV = HPK_2.5_FBK_4.5. <b>1800</b>	PDE 45%. LEDS on in diagonal	
27904	09/07/2024	10:50	180 s	acervera	104,105,107,109	LED		OV = HPK_2.5_FBK_4.5. <b>2200</b>	PDE 45%. LEDS on in diagonal	
27905	09/07/2024	10:55	180 s	acervera	104,105,107,109	LED		<b>OV = HPK_3_FBK_7. 1400</b>	PDE 50%. LEDS on in diagonal	
27906	09/07/2024	11:01	180 s	acervera	104,105,107,109	LED		OV = HPK_3_FBK_7. <b>1800</b>	PDE 50%. LEDS on in diagonal	
27907	09/07/2024	11:06	180 s	acervera	104,105,107,109	LED		OV = HPK_3_FBK_7. <b>2200</b>	PDE 50%. LEDS on in diagonal	
27908	09/07/2024	11:11	180 s	acervera	104,105,107,109	LED		OV = HPK_3_FBK_7. <b>2800</b>	PDE 50%. LEDS on in diagonal	

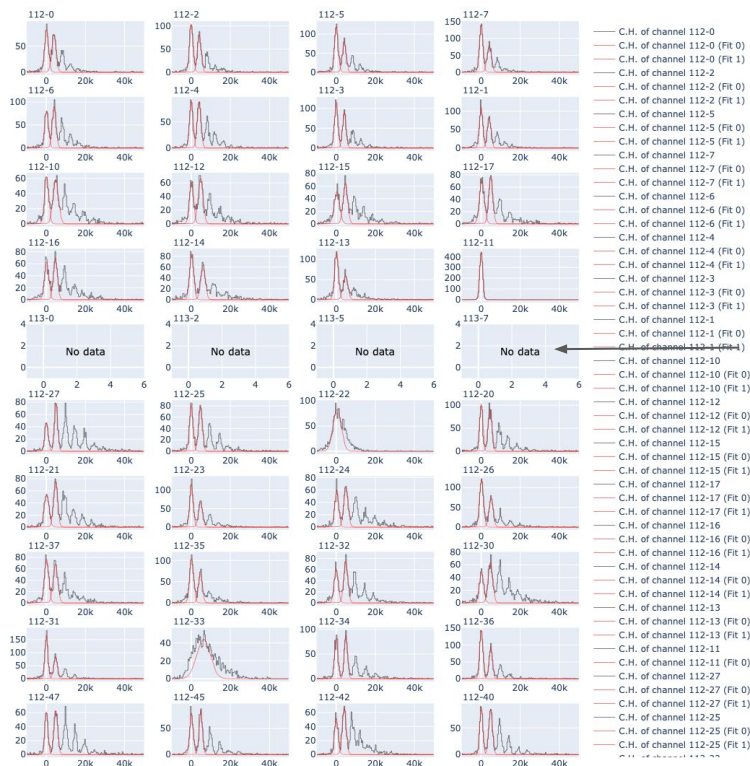
OVERVOLTAGE+INTENSITY Calibration Runs APAs 34.										
									Calibration Run. Bias DCS:30V. Tests 270nm: SSP_config.pulse_mode:single, <b>mask_channel:1,12</b> , ticks_width:1, <b>Pulse_bias_percent_270nm:1400-2000</b> . Trigger_ad-hoc 0x7:6250Hz. 20Hz daq trigger_rate.	
27909	09/07/2024	11:18	120 s	acervera	111,112,113	LED		<b>OV = HPK_3_FBK_7. mask_channel=1. bias_%=1400</b>	PDE 50%. LEDS on in center	
27910	09/07/2024	11:22	120 s	acervera	111,112,113	LED		OV = HPK_3_FBK_7. mask_channel=1. bias_%= <b>1600</b>	PDE 50%. LEDS on in center	
27911	09/07/2024	11:26	120 s	acervera	111,112,113	LED		OV = HPK_3_FBK_7. mask_channel=1. bias_%= <b>1800</b>	PDE 50%. LEDS on in center	
27912	09/07/2024	11:32	120 s	acervera	111,112,113	LED		OV = HPK_3_FBK_7. <b>mask_channel=12. bias_%=2000</b>	PDE 50%. LEDS only 2 diagonals	
27913	09/07/2024	11:39	60 s	acervera	111,112,113	LED		<b>OV = HPK_2.5_FBK_4.5. mask_channel=1. bias_%=1400</b>	PDE 45%. LEDS on in center	
27914	09/07/2024	11:41	60 s	acervera	111,112,113	LED		OV = HPK_2.5_FBK_4.5. mask_channel=1. bias_%= <b>1600</b>	PDE 45%. LEDS on in center	
27915	09/07/2024	11:44	60 s	acervera	111,112,113	LED		OV = HPK_2.5_FBK_4.5. mask_channel=1. bias_%= <b>1800</b>	PDE 45%. LEDS on in center	
27916	09/07/2024	11:47	60 s	acervera	111,112,113	LED		OV = HPK_2.5_FBK_4.5. <b>mask_channel=12. bias_%=2000</b>	PDE 45%. LEDS only 2 diagonals	
27917	09/07/2024	11:50	60 s	acervera	111,112,113	LED		<b>OV = HPK_2_FBK_3.5. mask_channel=1. bias_%=1400</b>	PDE 40%. LEDS on in center	
27918	09/07/2024	11:53	60 s	acervera	111,112,113	LED		OV = HPK_2_FBK_3.5. mask_channel=1. bias_%= <b>1600</b>	PDE 40%. LEDS on in center	
27919	09/07/2024	11:56	60 s	acervera	111,112,113	LED		OV = HPK_2_FBK_3.5. mask_channel=1. bias_%= <b>1800</b>	PDE 40%. LEDS on in center	
27920	09/07/2024	11:59	60 s	acervera	111,112,113	LED		OV = HPK_2_FBK_3.5. <b>mask_channel=12. bias_%=2000</b>	PDE 40%. LEDS only 2 diagonals	

# SPE Calibration

APA 3 - Runs 27562-27565, 27567, 27569



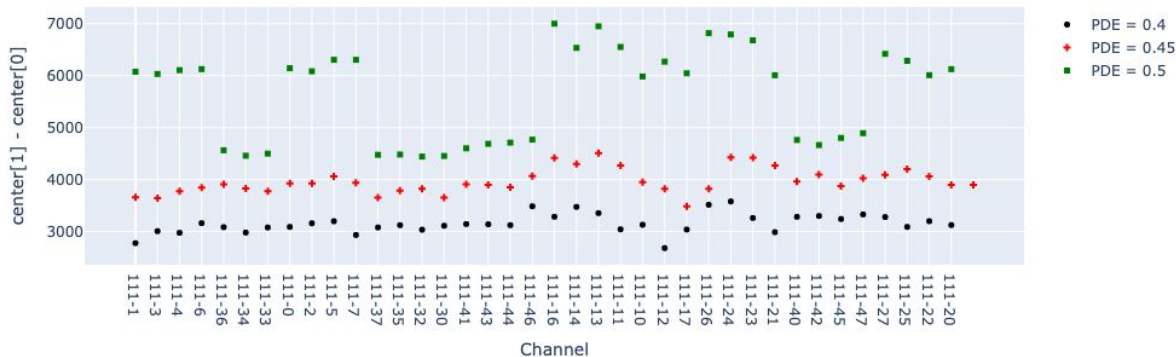
APA 4 - Runs 27562-27565



No signal for nominal overvoltage in ep 113 (FBK)

# SPE Calibration

Gain per channel in APA 3 - Runs 27909-27920



CHARACTERIZATION FROM FIT RESULTS (PER CHANNEL)

$$\text{Gain} = \mu_1 - \mu_0$$

$$SN_C = \frac{\text{Gain}}{\sqrt{\sigma_0^2 + \sigma_{1st}^2}}$$

Gain per channel in APA 4 - Runs 27909-27920



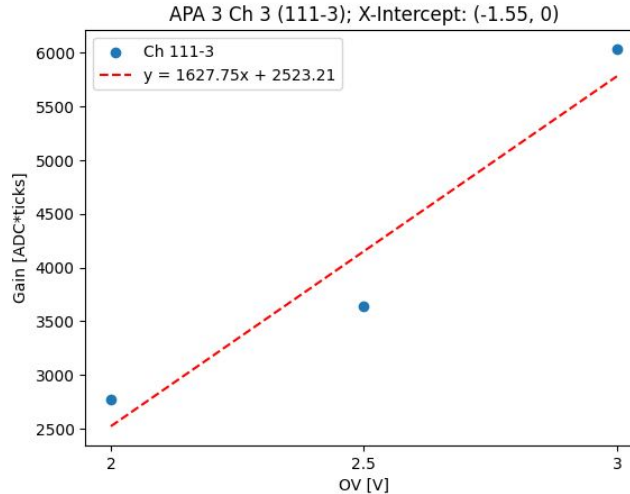
No signal for nominal overvoltage in ep 113 (FBK)  
Should we run with higher PDE for this module ?

Thanks Julio!

# Gain vs OV $\rightarrow V_{bd}$

Working in a new tab to organize the  $V_{bd}$  information we have:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	APA	Module ID	SC_ID	Ch#	LightGuide_ID	APAposition	APA Ch#	Vbd (V)						COMMENTS
2								Estimated	SC - IVs (NP04)	SC - LED (NP04)	CACTUS (SIPMs)	SC - LN2 (CIEMAT)	SC - LN2 (MIB)	
3	1	01	C04_F_E_04	1	ELJ_15714-01-04	8	8	26.78				26.80	-	
4	1		C03_F_E_03	2	ELJ_15714-01-03			26.78				26.86	-	
5	1		C01_F_E_01	3	ELJ_15714-01-01			26.76				26.65	-	
6	1		C02_F_E_02	4	ELJ_15714-01-02			26.77				26.81	-	

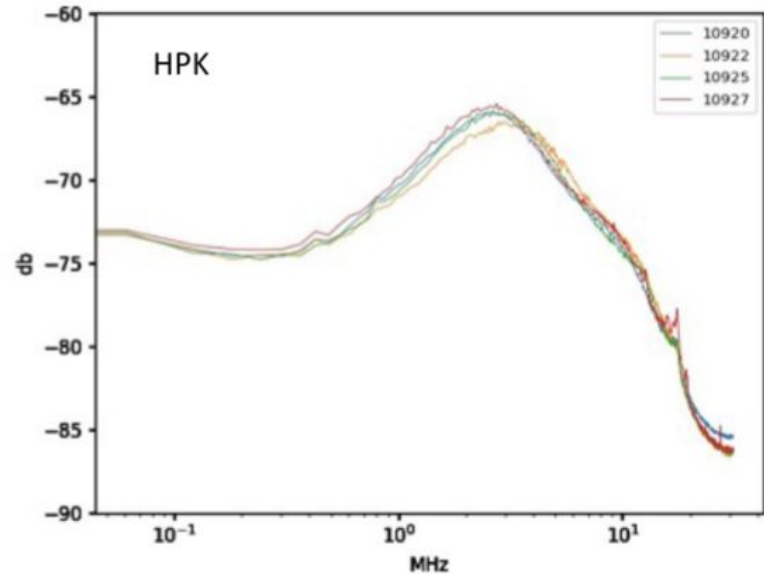
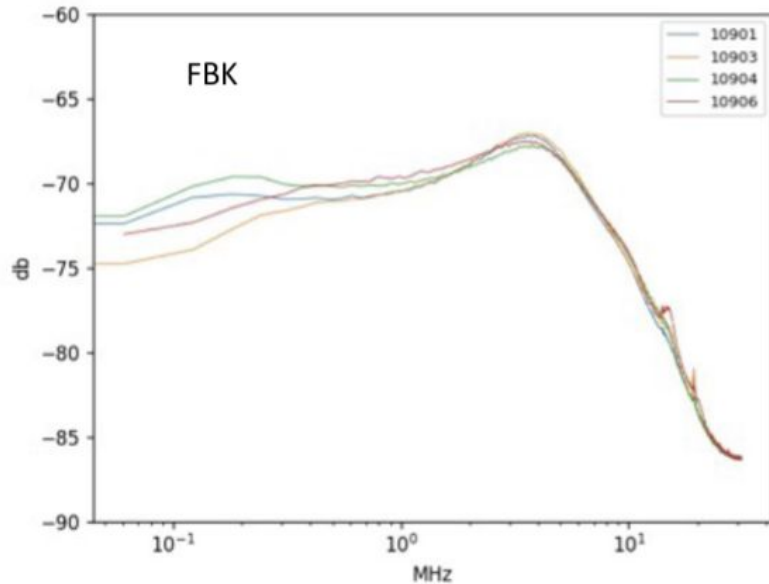


WORKING ON A FIT FOR ALL THE CHANNELS TO GET THE  $V_{bd}$  WITH THE LED CALIBRATION

# FFT [noise] investigations

FBK and HPK SiPMs show different power spectral densities of the noise

This might contribute in explaining the difference in SNR we observed (we already commented the difference in gain)

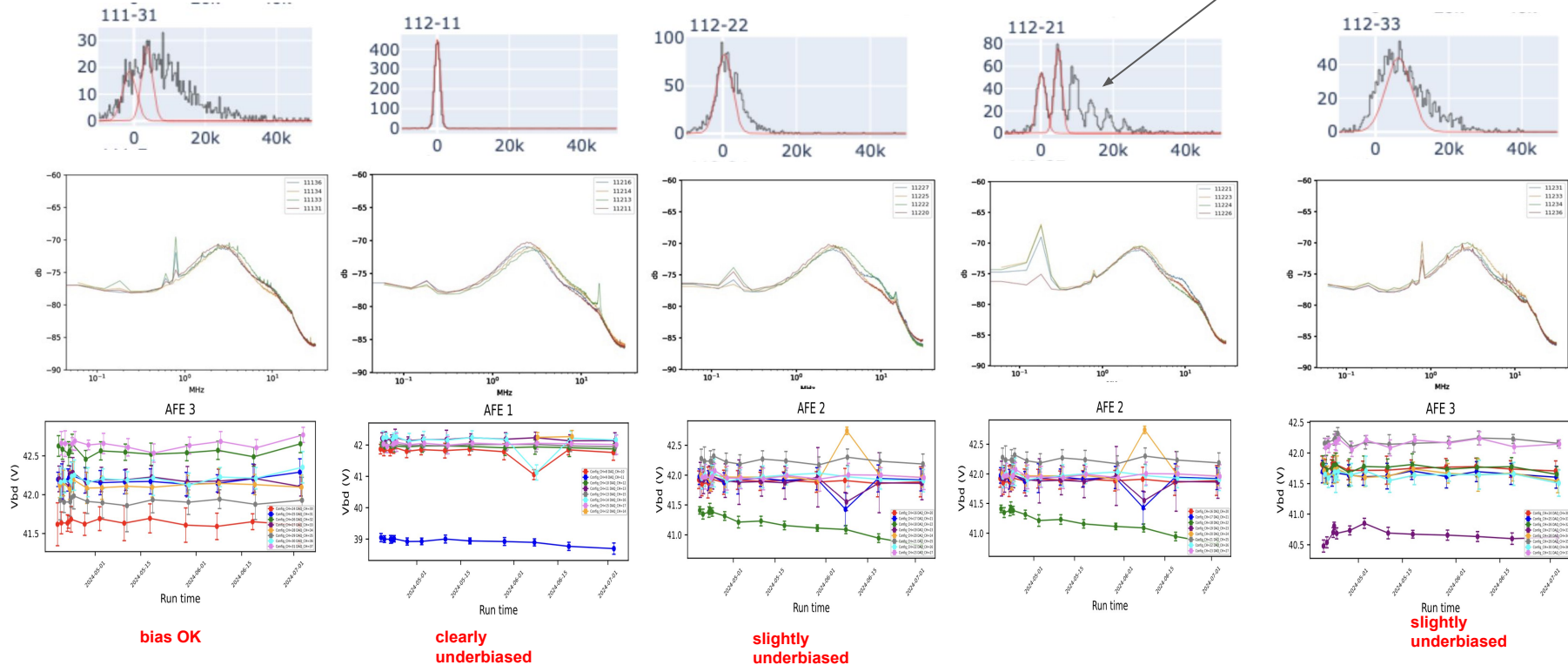


Thanks Federico!



# “Noisy” channels

Electronic noise OK in most channels, except 112-21/23/24/26 at 170 KHz, but does not affect S/N  
Most low S/N channels seems to be underbiased

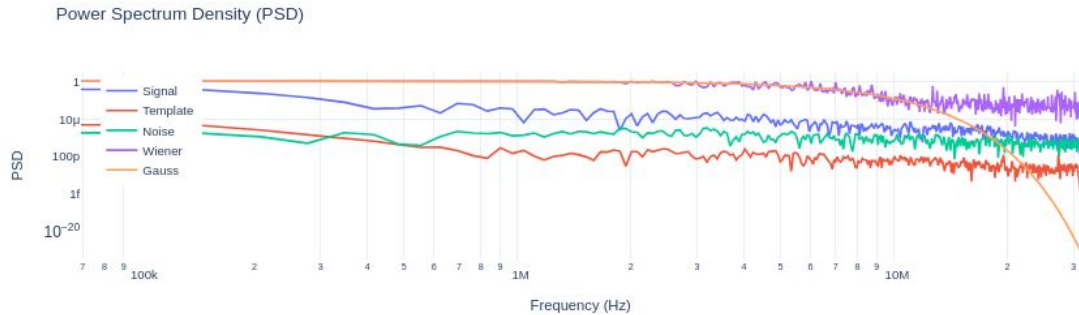


Thanks Federico!

# Deconvolution

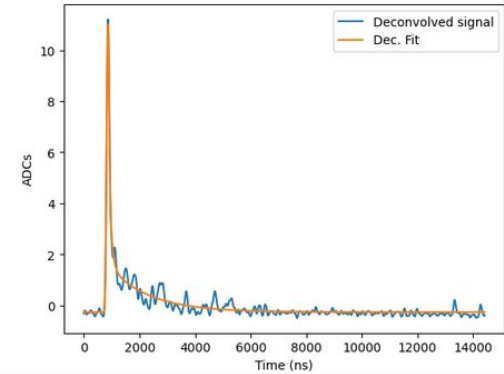
Method available in Waffles:

- Default: deconvolution with a gaussian filter, which is computed from the Wiener fit.



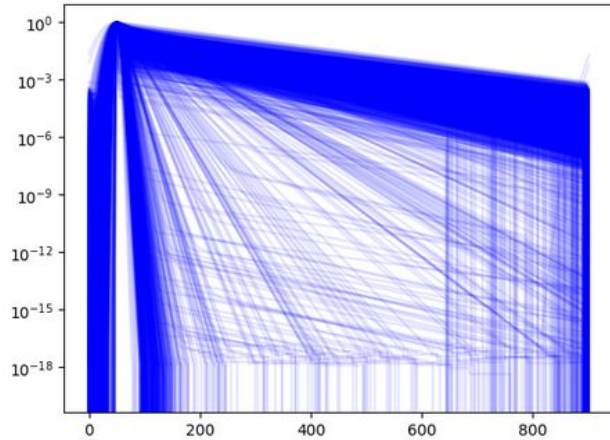
$$fit = \frac{A_S}{\sqrt{2}} e^{\frac{\sigma^2}{2\tau_S}} \text{Erfc}\left(\frac{t-t_0}{\sigma} + \frac{\sigma}{\tau_S}\right) e^{\frac{t-t_0}{\tau_S}} + \frac{A_I}{\sqrt{2}} e^{\frac{\sigma^2}{2\tau_I}} \text{Erfc}\left(\frac{t-t_0}{\sigma} + \frac{\sigma}{\tau_I}\right) e^{\frac{t-t_0}{\tau_I}} + \frac{A_F}{\sqrt{2}} e^{\frac{\sigma^2}{2\tau_F}} \text{Erfc}\left(\frac{t-t_0}{\sigma} + \frac{\sigma}{\tau_F}\right) e^{\frac{t-t_0}{\tau_F}}$$

Tau\_Slow (ns) = 1446.1278689654253 +- 87.12997864029239  
Tau\_Fast (ns) = 9.9999999999999881 +- 1.0266188770978144  
Tau\_Intermediary (ns) = 87.85009259617011 +- 5.933905203873364

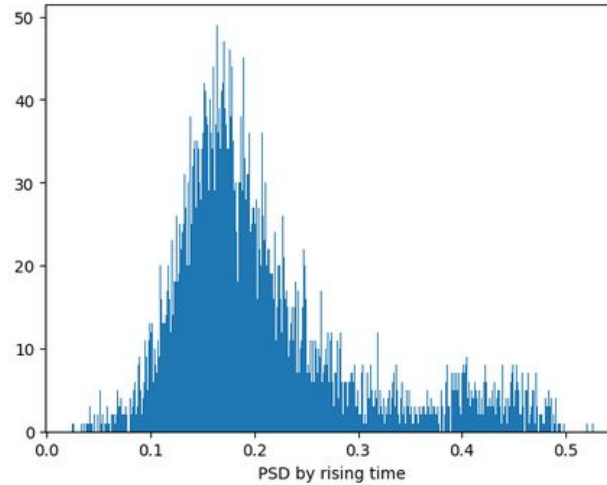


# Particle discrimination (Preliminary)

Individual deconvolved wvf [7 GeV]



Fast/Total charge Discriminator



We can distinguish two very different behaviours → Needs further investigation