LED tuning for PDS calibration

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NP04 PDS operation meeting - 20 June 2024

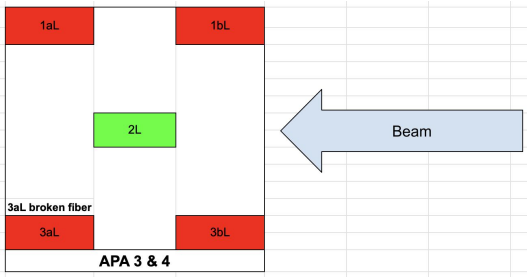
Introduction

- A preliminary analysis has been performed for the following data
    - **10 runs** for endpoints 111, 112 & 113 (**APAs 3 and 4**) taken on 14/06/2024
    - **11 runs** for endpoint 109 (**APA 2**) taken on 17/06/2024
    - ~30 runs for endpoints 104, 105 & 107 (APA 1) taken on 17-18/06/2024 **(ongoing analysis)**
- A 270-nm LED, biased with 30 V, was used in every case
- For each APA, the data taking consists of an scan of the `pulse_bias_percent_270nm` - this is the variable that lets us tune the LED light intensity. Its span is `[0, 4095]`
- We acquired roughly
    - 7k waveforms per channel and per run for APA 1
    - 5k waveforms per channel and per run for APAs 2, 3 & 4
- The goal is to **find a minimal set of LED configurations that yield at least one *proper* charge histograms for every channel in all four APAs**

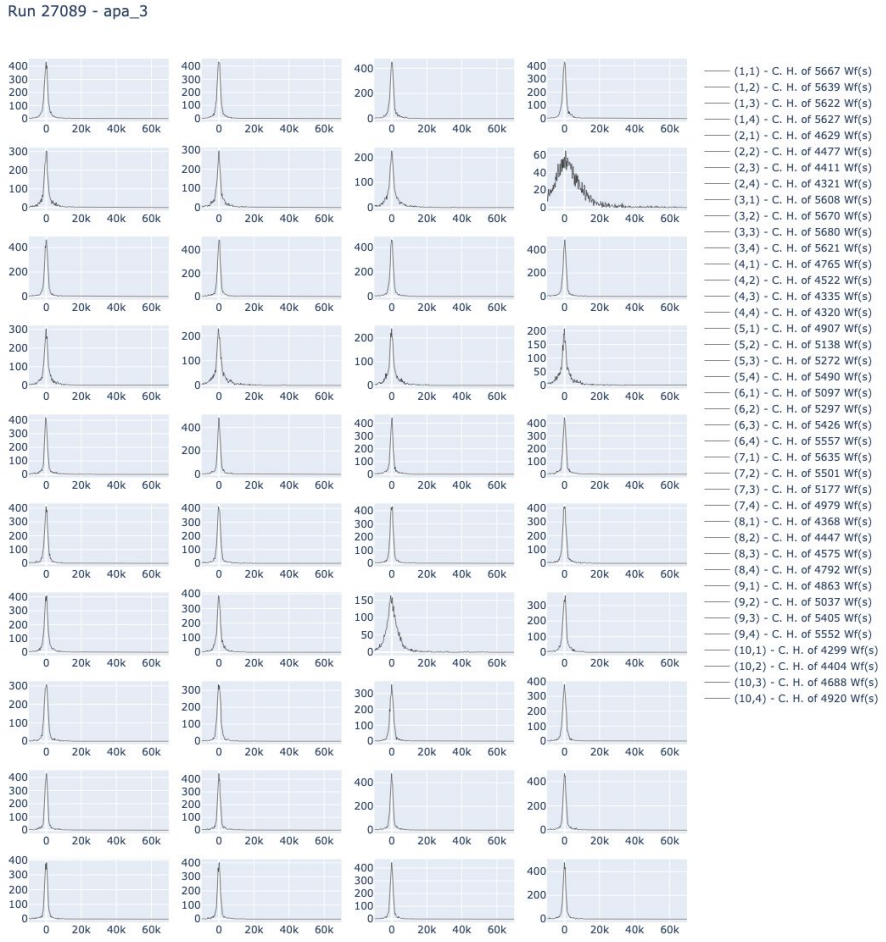
APAs 3 & 4

- A preliminary analysis of the data for **10 runs** with endpoints 111, 112 and 113 (**APAs 3 and 4**) taken on 14/06/2024 has been performed
  - Light was pointing to the center of APAs 3 & 4 plane (`channel_mask = 1`)
  - LED coupled to polymicro fiber - `ticks_width = 1` (4 ns)
  - 10 runs in total (`27089-27098`) - `90` seconds each
  - Scanning `pulse_bias_percent_270nm` from `400` to `2200` in steps of `200`
  - `10` Hz DAQ trigger rate
  - `6250` Hz trigger ad-hoc `0x7`
  - `~5000` waveforms per channel and per run
- For most channels, we found at least one LED configuration which yields a *proper* calibration charge histograms

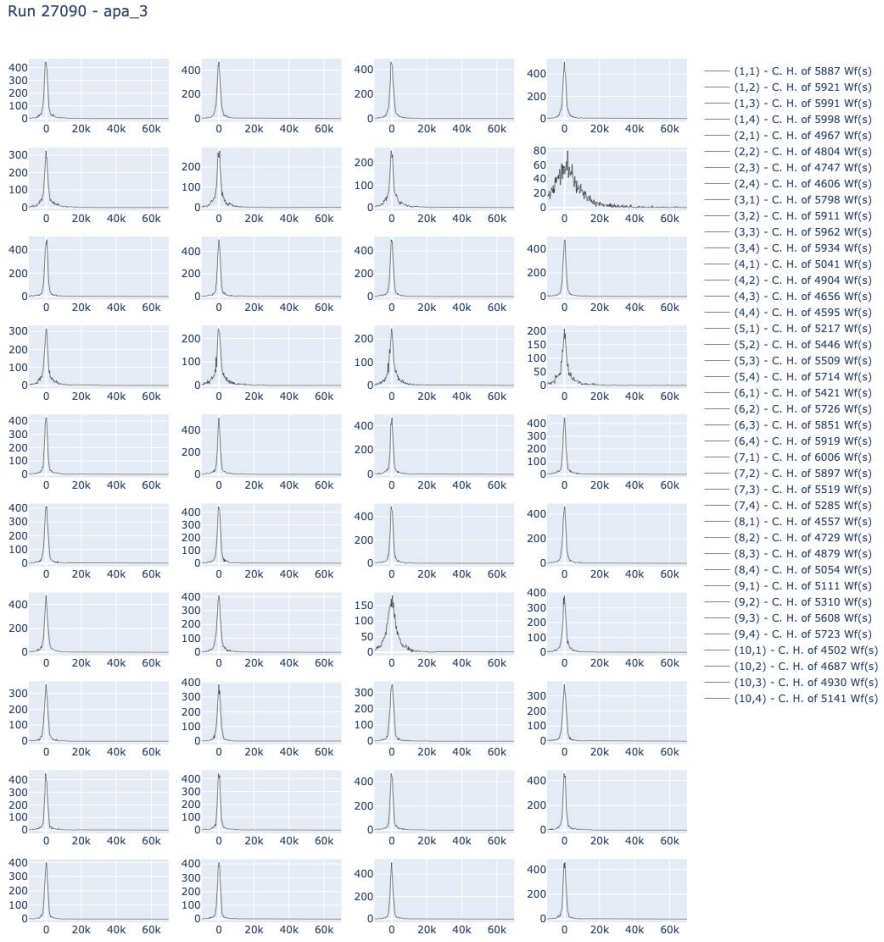
Run number	Date	Start time	End/run time	Shifter	PDS expert	Active Endpoints	# triggers	type	Configuration
	Changes in seed to correct a typo --> solved errors in APA34 configurations. THRESHOLD set back to 9000 and redout is back!! 🥳								
27089	14/06/2024	17:32	90 s	lperez		111,112,113		LED	Calibration Run. Bias DCS:30V. Trigger ad-hoc 0x7 set to 6250Hz. 10Hz daq trigger rate. runtime 90 s. Tests 270nm: SSP_config. **mask_channel:1,** ticks_width:1, **Pulse_bias_percent_270nm: 400**
27090	14/06/2024	17:36	90 s	lperez		111,112,113		LED	Pulse_bias_percent_270nm: 600
27091	14/06/2024	17:39	90 s	lperez		111,112,113		LED	Pulse_bias_percent_270nm: 800
27092	14/06/2024	17:42	90 s	lperez		111,112,113		LED	Pulse_bias_percent_270nm: 1000
27093	14/06/2024	17:46	90 s	lperez		111,112,113		LED	Pulse_bias_percent_270nm: 1200
27094	14/06/2024	17:52	90 s	lperez		111,112,113		LED	Pulse_bias_percent_270nm: 1400
27095	14/06/2024	17:54	90 s	lperez		111,112,113		LED	Pulse_bias_percent_270nm: 1600
27096	14/06/2024	17:56	90 s	lperez		111,112,113		LED	Pulse_bias_percent_270nm: 1800
27097	14/06/2024	17:59	90 s	lperez		111,112,113		LED	Pulse_bias_percent_270nm: 2000
27098	14/06/2024	18:03	90 s	lperez		111,112,113		LED	Pulse_bias_percent_270nm: 2200

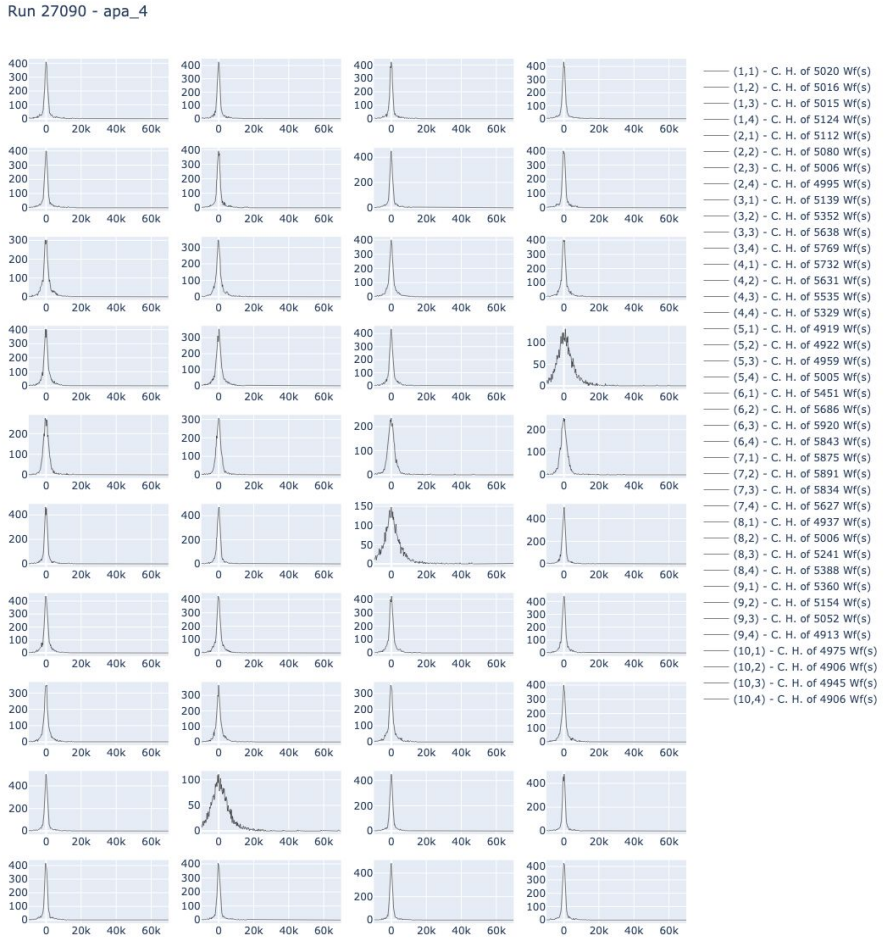


pulse_bias_percent_270nm = 400

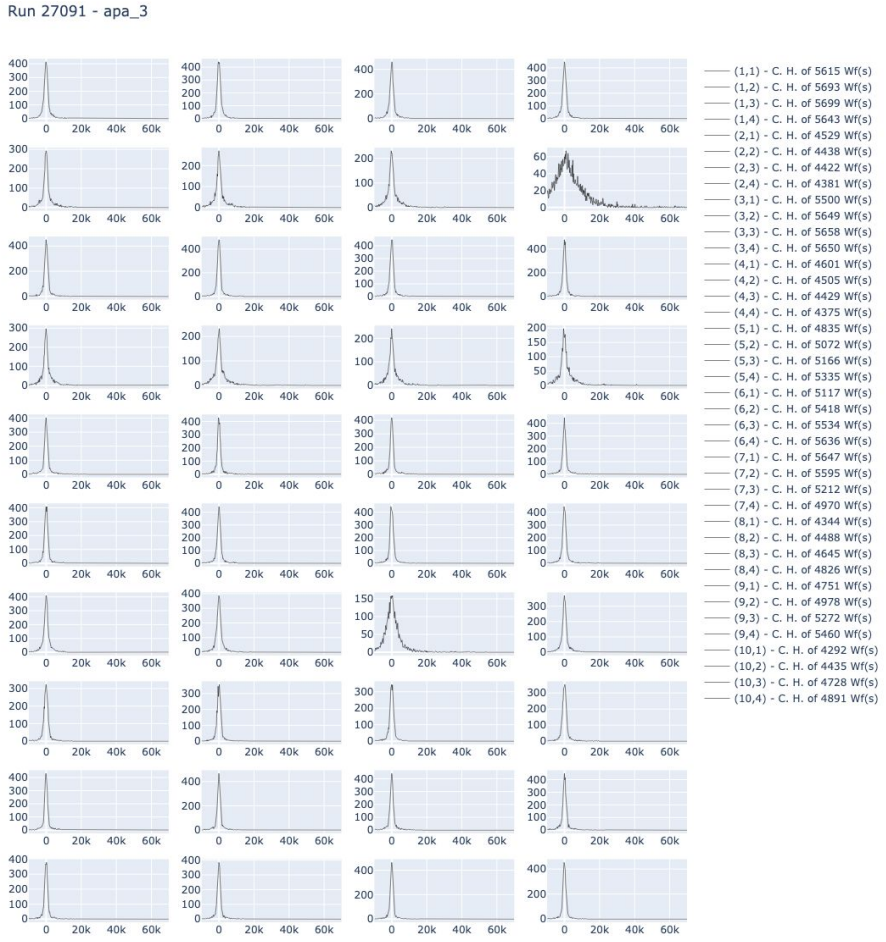


pulse_bias_percent_270nm = 600

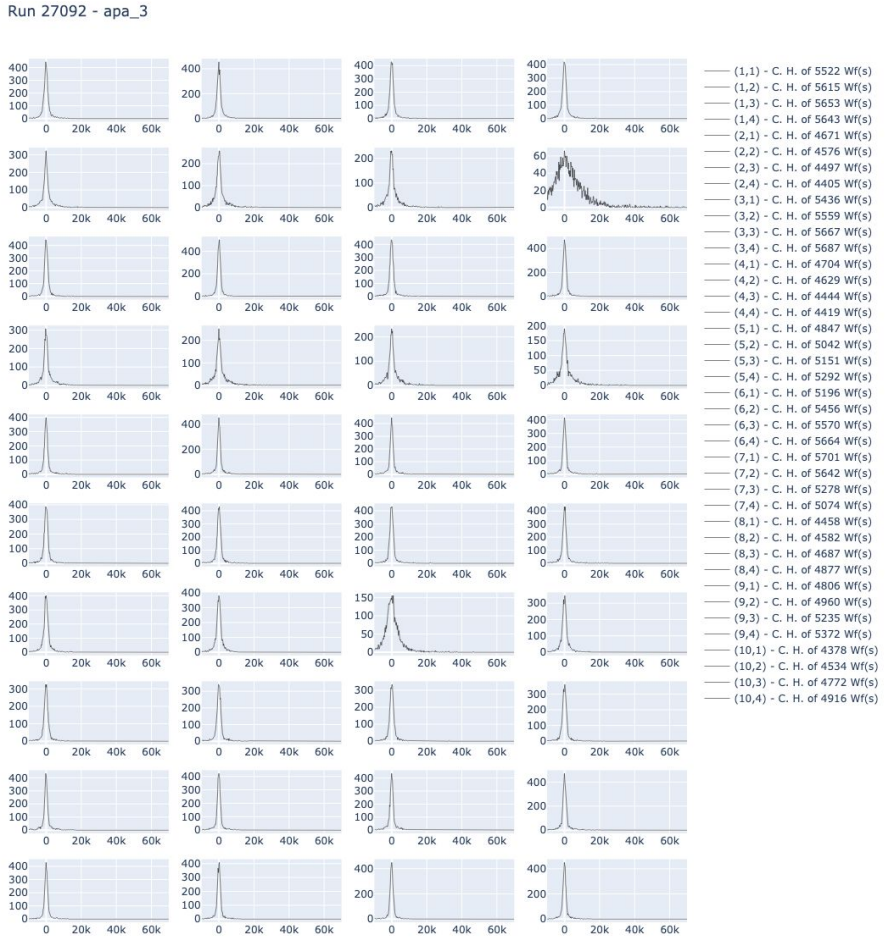




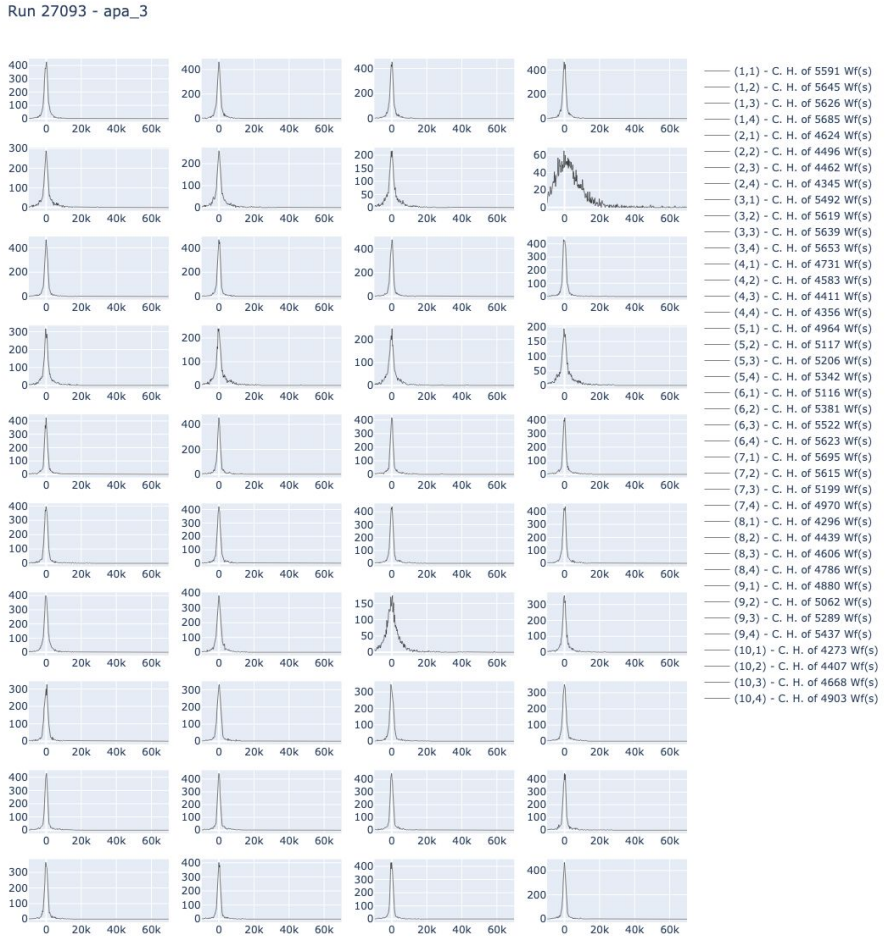
pulse_bias_percent_270nm = 800



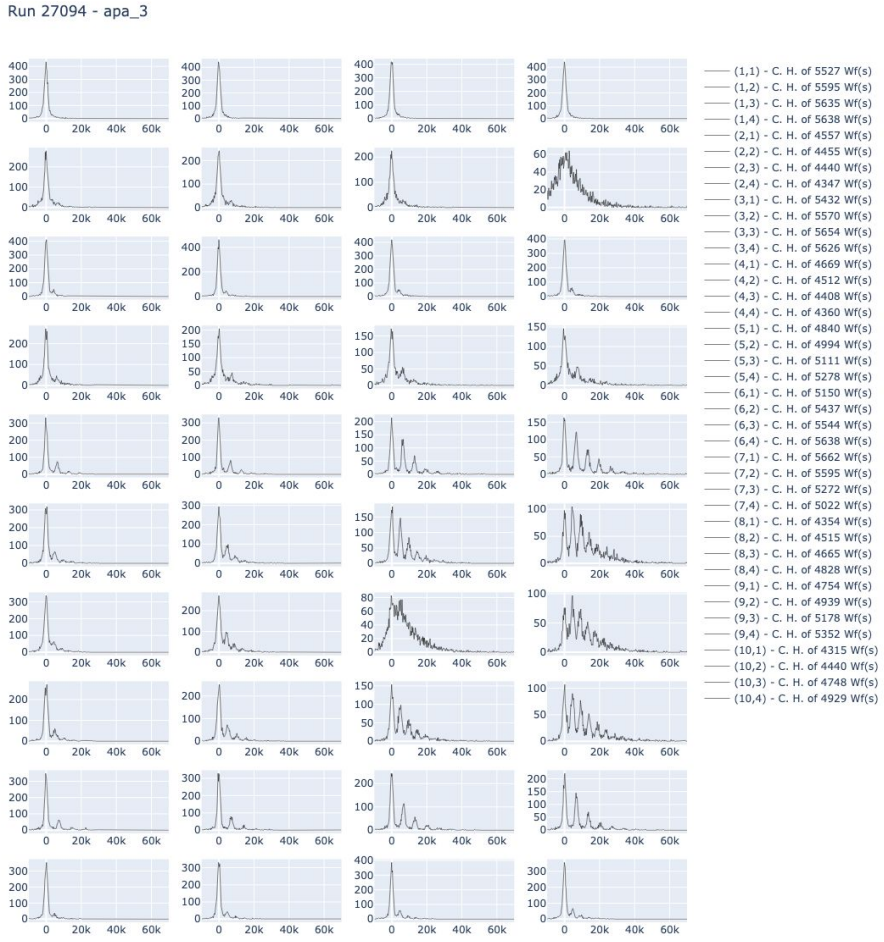
pulse_bias_percent_270nm = 1000



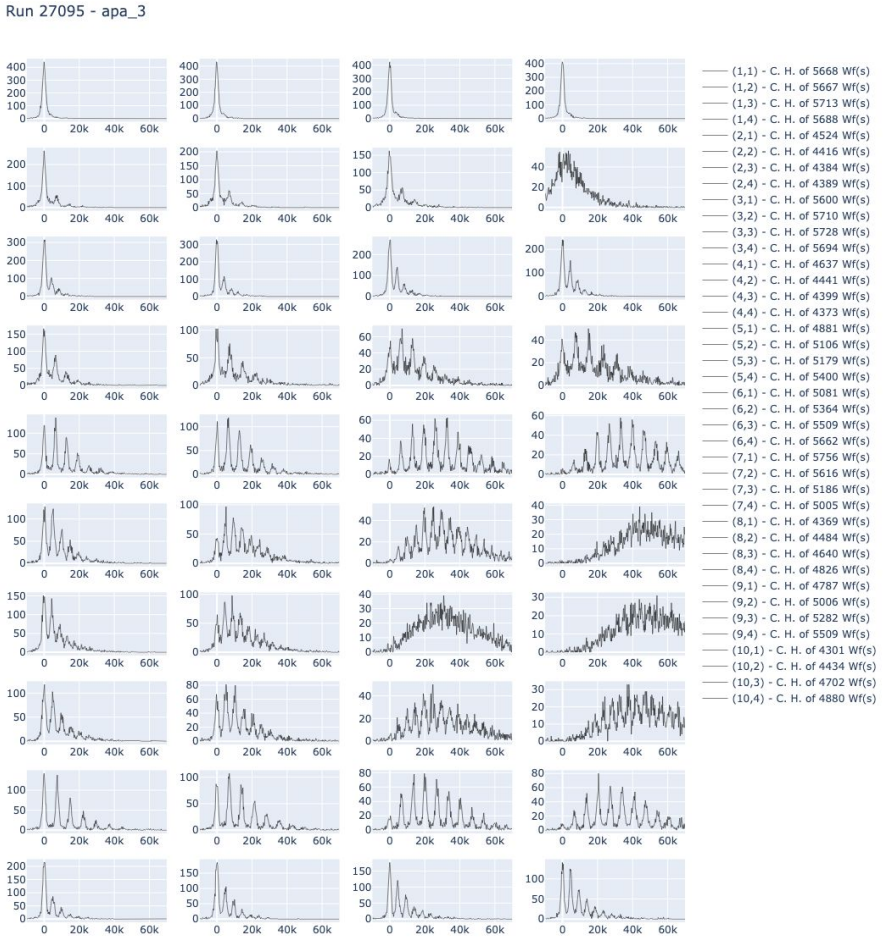
pulse_bias_percent_270nm = 1200

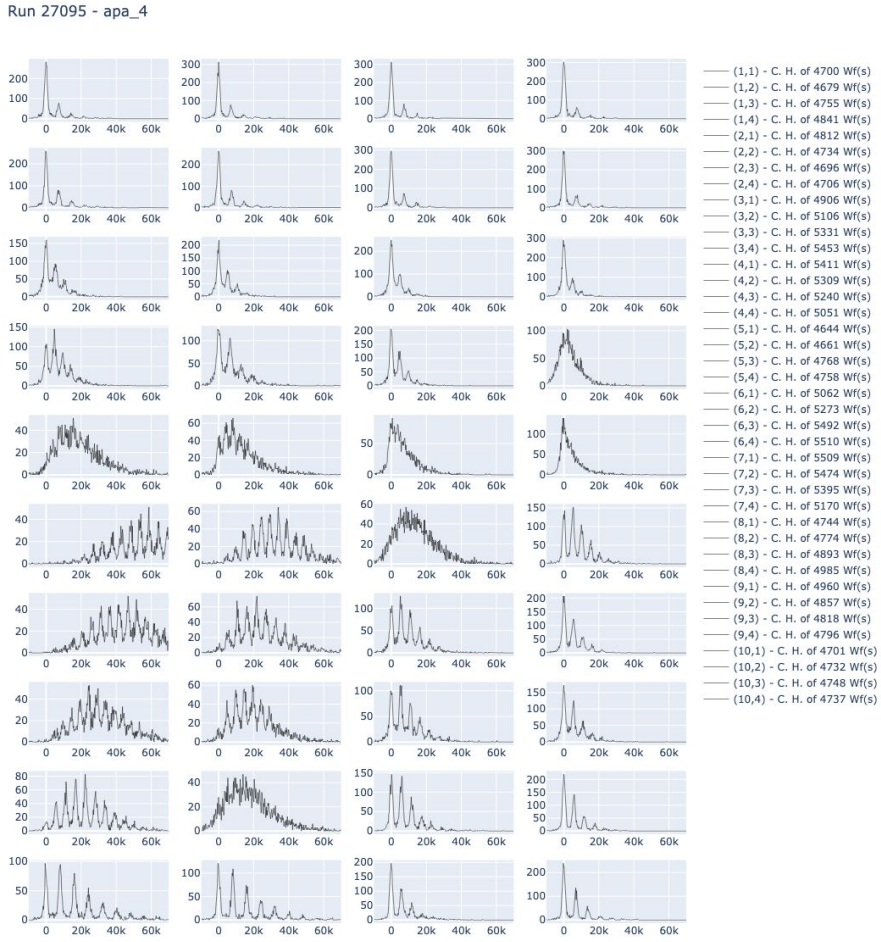


pulse_bias_percent_270nm = 1400

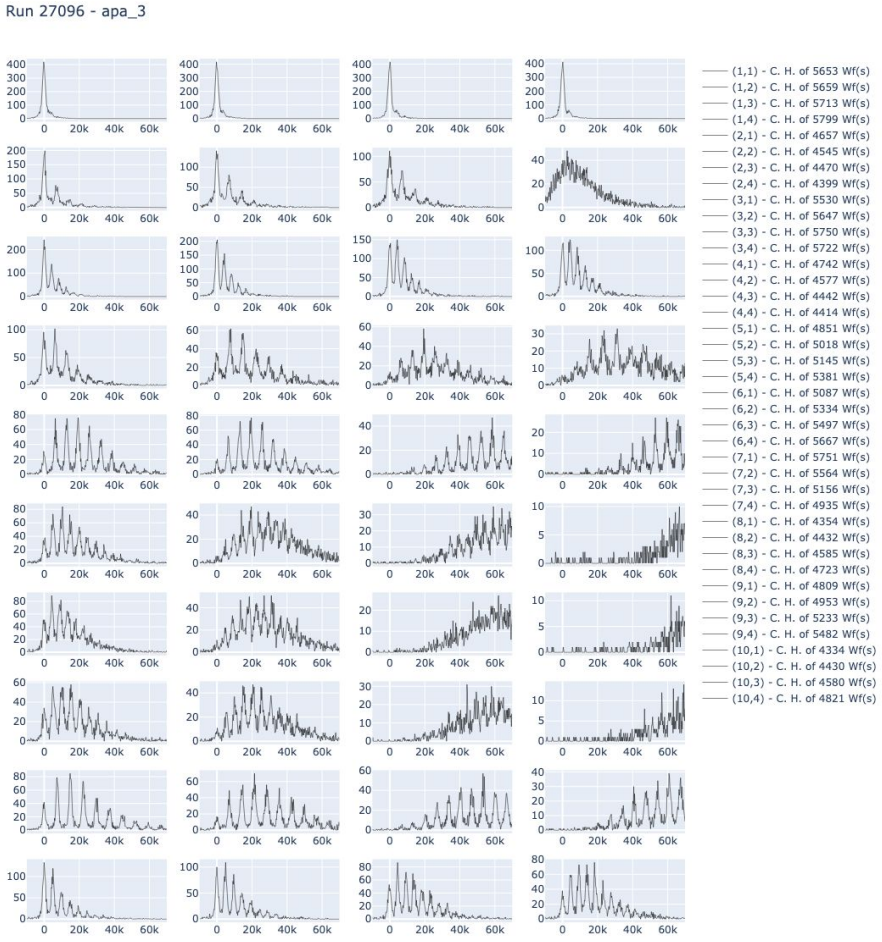


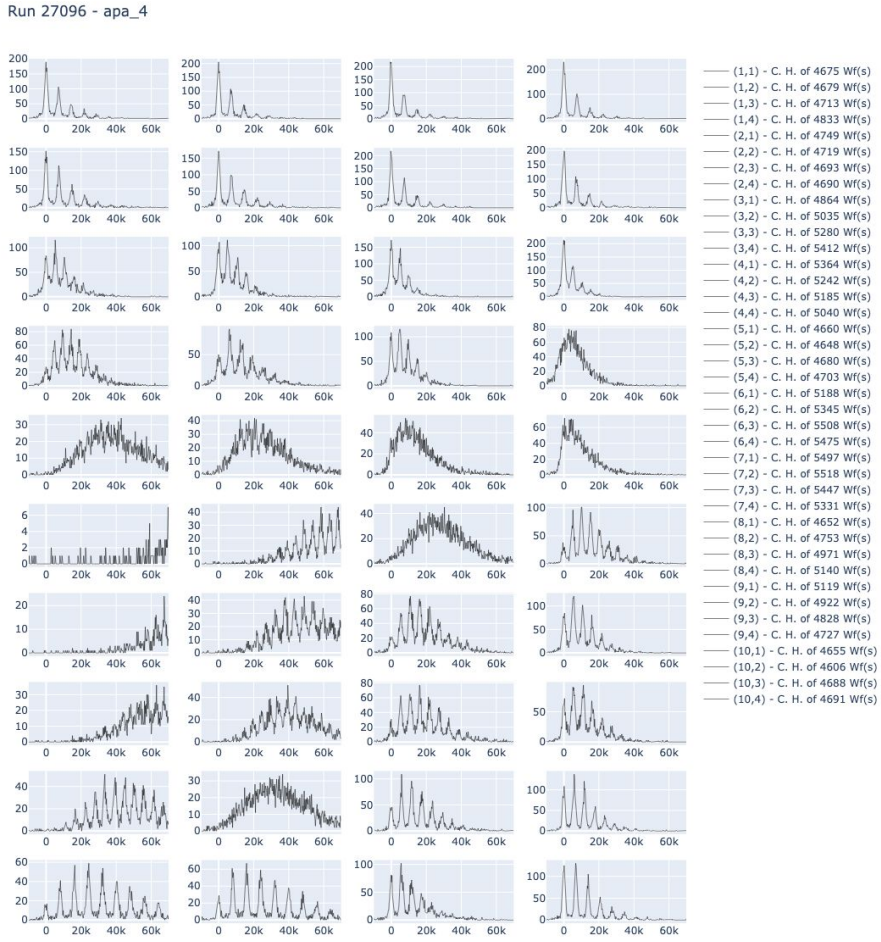
pulse_bias_percent_270nm = 1600



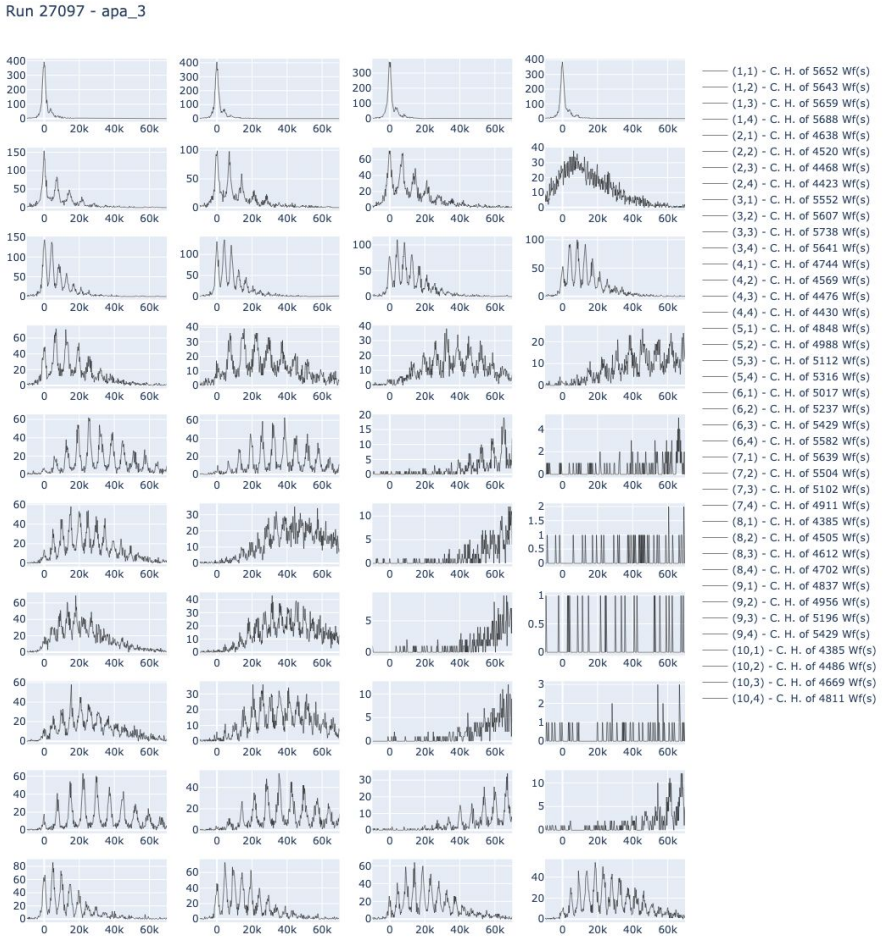


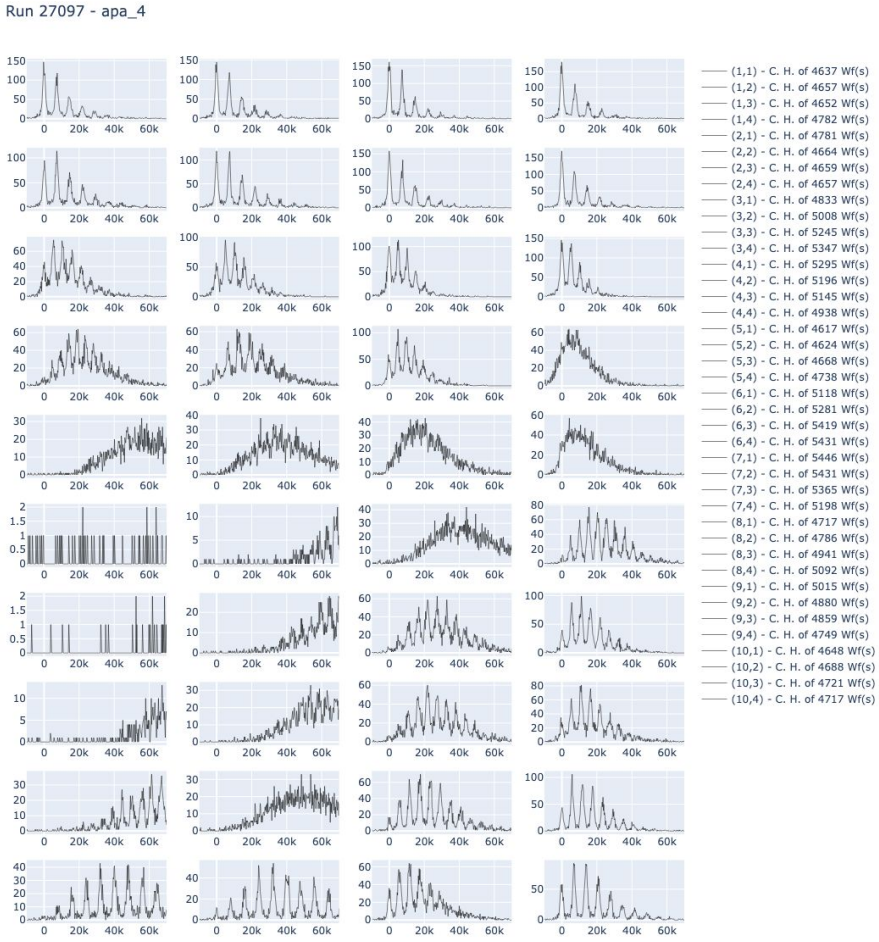
pulse_bias_percent_270nm = 1800



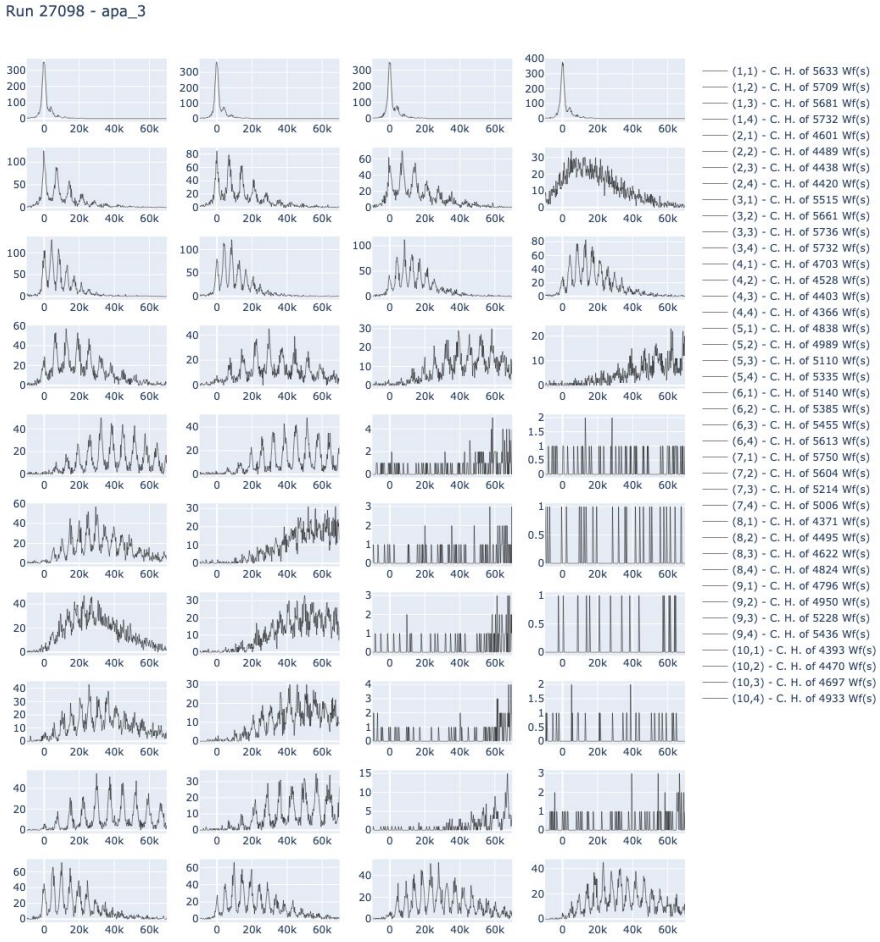


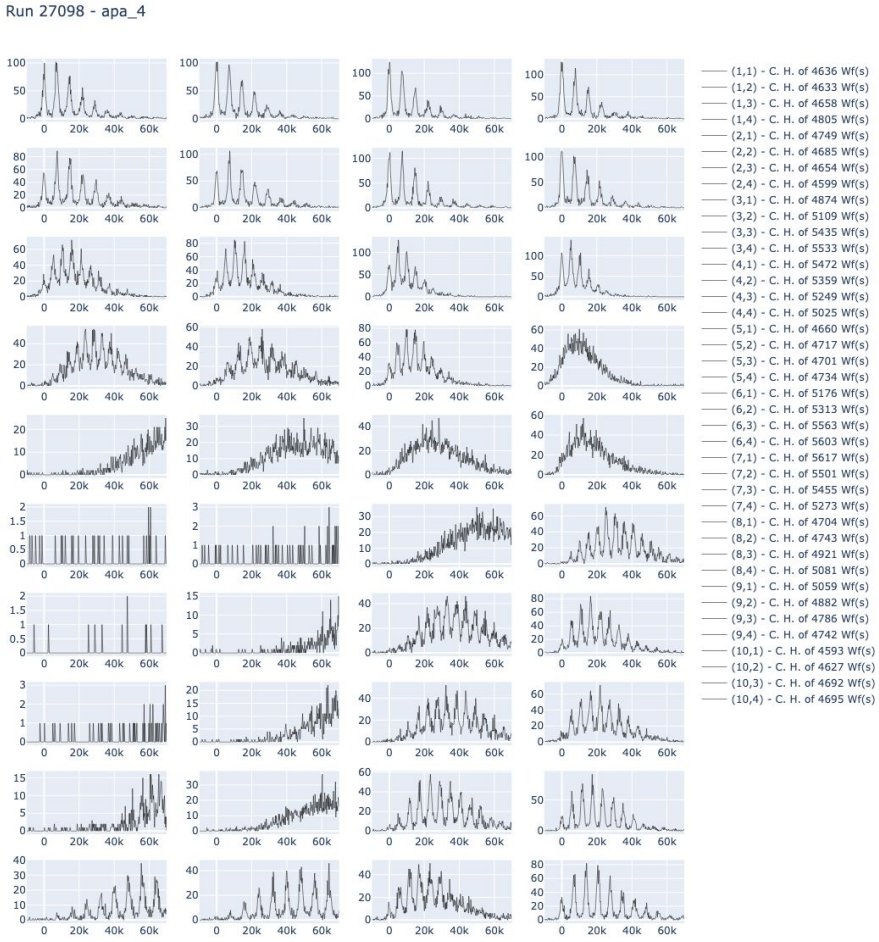
pulse_bias_percent_270nm = 2000





pulse_bias_percent_270nm = 2200





APAs 3 & 4

Preliminary estimation of optimal `pulse_bias_percent_270nm` for calibration, per channel

APA 3

>>2200	>>2200	>>2200	>>2200
≳ 2200	2000	2000	-
2000-2200	≲ 2000	1800	1800
1800	1600-1800	1400-1600	1400-1600
1600	1600	≳ 1400	≳ 1400
1600	1400-1600	≳ 1400	≲ 1400
≳ 1600	1400-1600	-	≲ 1400
≳ 1600	≲ 1600	≳ 1400	≳ 1400
1600	≲ 1600	≳ 1400	≳ 1400
1800-2000	≲ 1800	1600-1800	≳ 1600

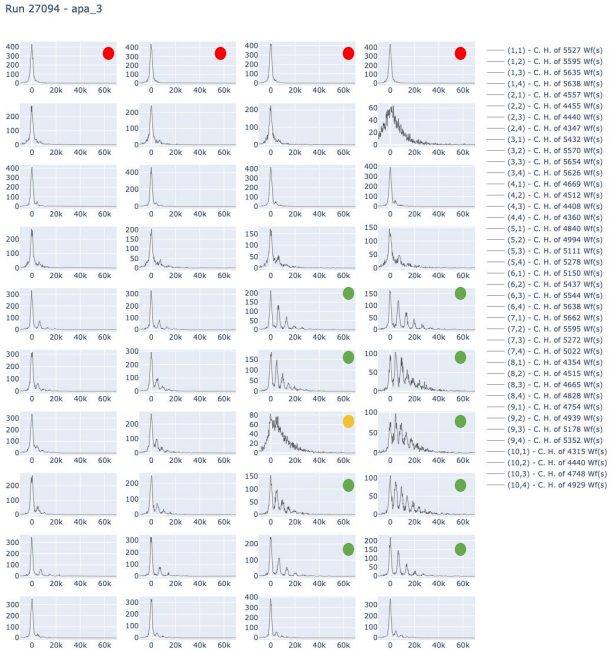
APA 4

≲ 2200	≳ 2200	≳ 2200	≳ 2200
2000	2000	≲ 2200	≳ 2200
1600-1800	1800	2000	≳ 2200
≲ 1600	≳ 1600	≲ 1800	-
1400-1600	<1600	1600	1600-1800
<1400	1400	-	≲ 1600
≲ 1400	>1400	≲ 1600	1600-1800
≳ 1400	≳ 1400	1600	1600-1800
≳ 1400	-	≳ 1600	1600-1800
1600	≳ 1600	1600-1800	1800

These are the `pulse_bias_percent_270nm` which yield roughly the same amount of 0-PE and 1-PE events, but we could cope with worse (but viable) situations for the sake of reducing the amount of minimal LED configuration, p.e. :

LED tuning proposal for APAs 3 & 4

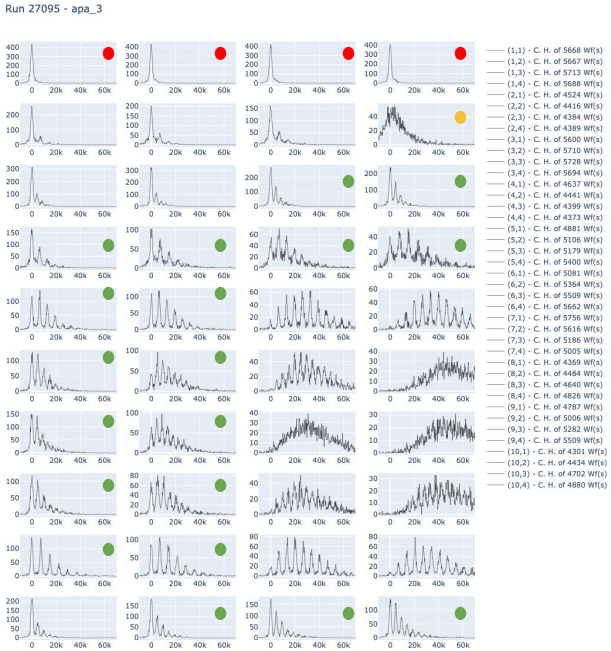
`pulse_bias_percent_270nm = 1400`

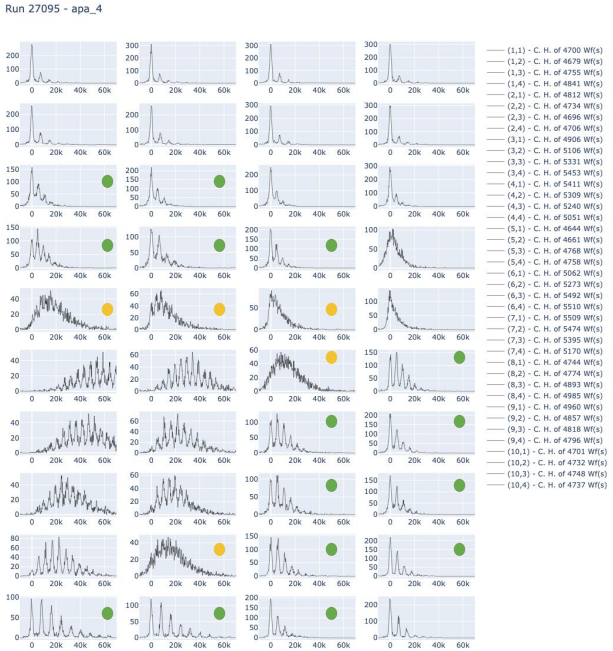


These are the `pulse_bias_percent_270nm` which yield roughly the same amount of 0-PE and 1-PE events, but we could cope with worse (but viable) situations for the sake of reducing the amount of minimal LED configuration, p.e. :

LED tuning proposal for APAs 3 & 4

`pulse_bias_percent_270nm = 1600`

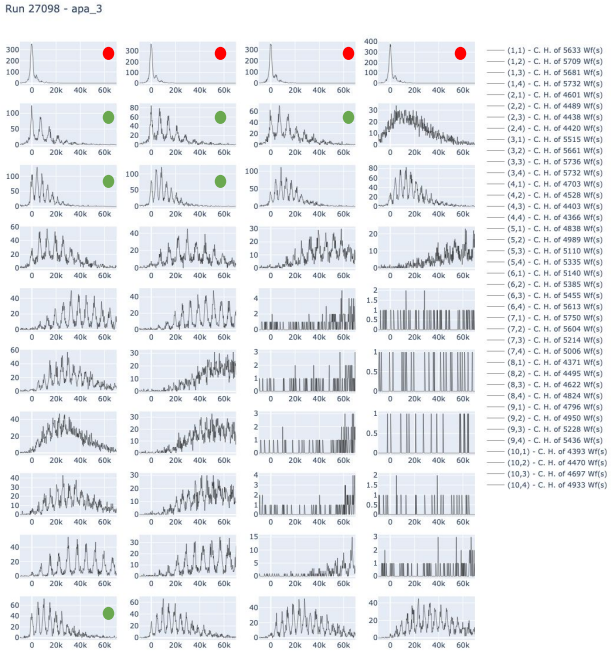


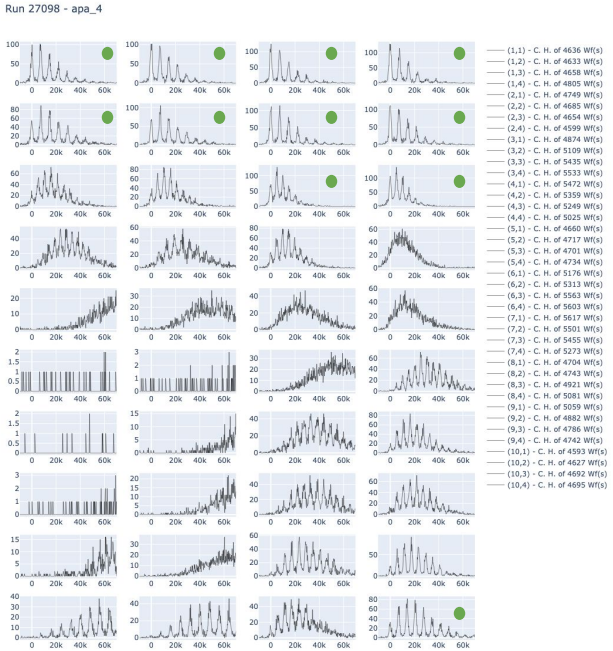


These are the `pulse_bias_percent_270nm` which yield roughly the same amount of 0-PE and 1-PE events, but we could cope with worse (but viable) situations for the sake of reducing the amount of minimal LED configuration, p.e. :

LED tuning proposal for APAs 3 & 4

`pulse_bias_percent_270nm = 2200`



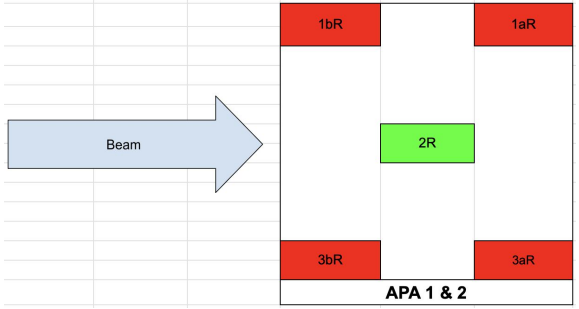


These are the `pulse_bias_percent_270nm` which yield roughly the same amount of 0-PE and 1-PE events, but we could cope with worse (but viable) situations for the sake of reducing the amount of minimal LED configuration, p.e. :

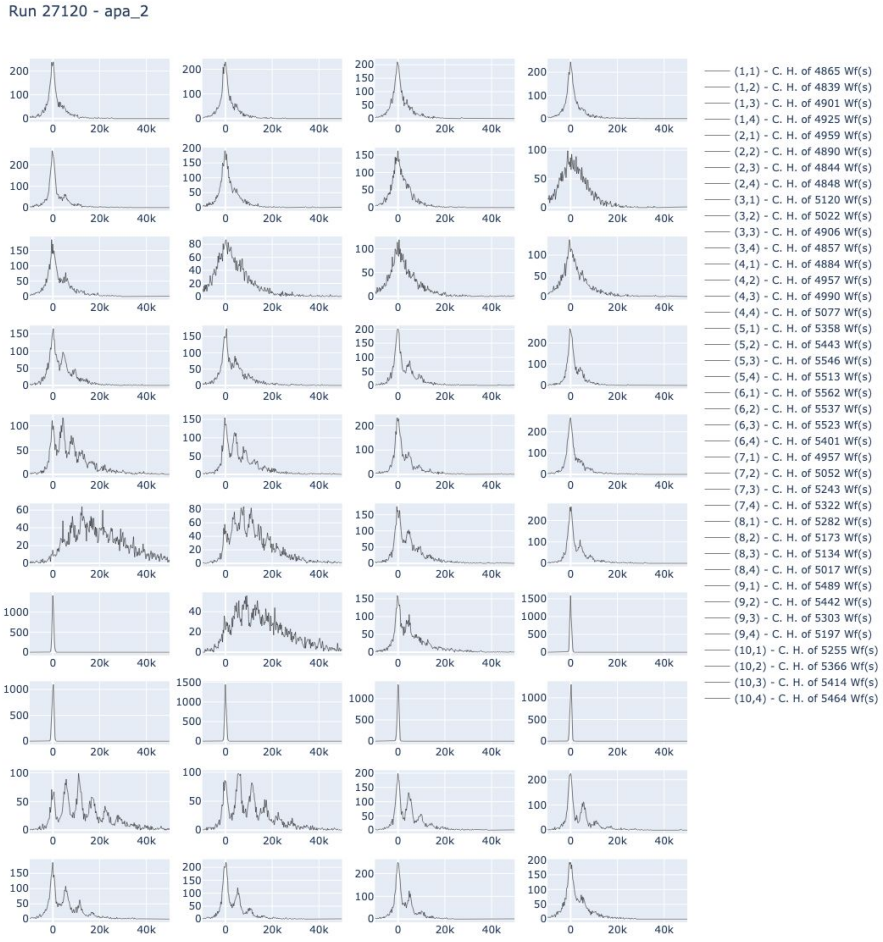
APA 2

- A preliminary analysis of the data for **11 runs** with endpoint 109 (**APA 2**) taken on 17/06/2024 has been performed
  - Light was pointing to the center of APAs 1 & 2 plane (`channel_mask = 16`)
  - LED coupled to **tefzel** fiber - `ticks_width = 5` (20 ns)
  - 11 runs in total (`27120-27130`) - `90` seconds each
  - Scanning `pulse_bias_percent_270nm` from `3090` to `4090` in steps of `100`
  - `10` Hz DAQ trigger rate
  - `6250` Hz trigger ad-hoc `0x7`
  - `~5000` waveforms per channel and per run
- We found almost no changes between different LED configurations - **tefzel** fiber might be attenuating the 270 nm LED light

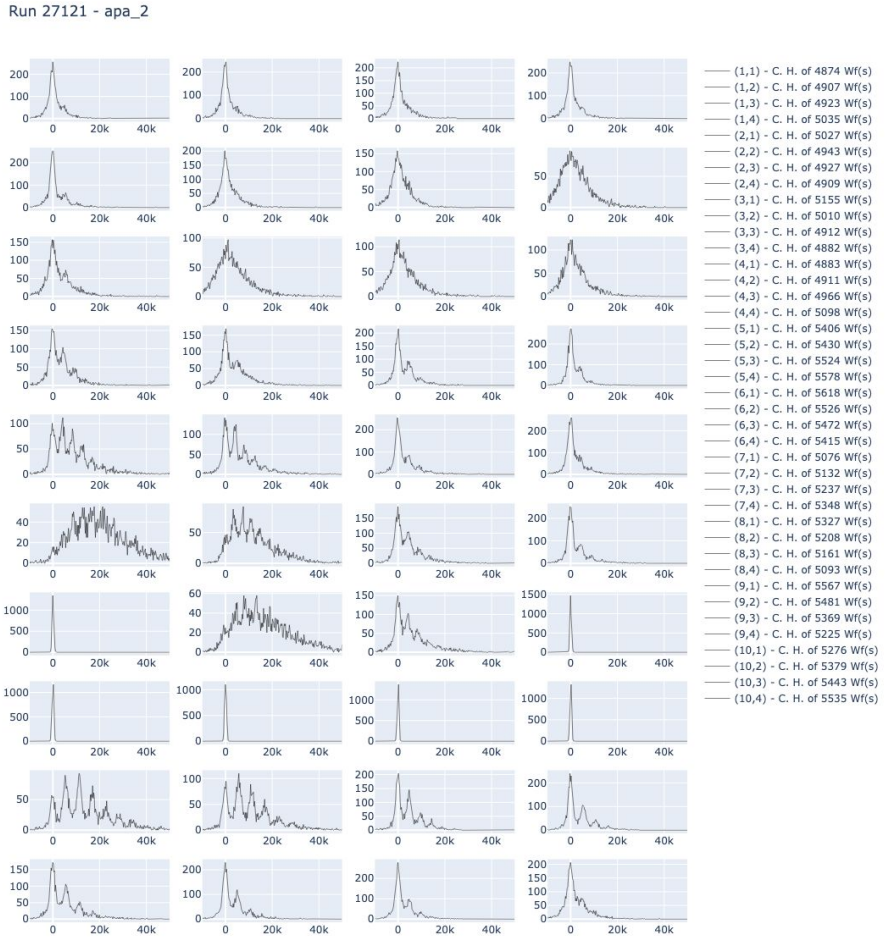
Run number	Date	Start time	End/run time	Shifter	PDS expert	Active Endpoints	# triggers	type	Configuration
27120	17/06/2024	17:23	90 s	lperez		109		LED	LED run. APA2. Tests 270nm: SSP_config. **pulse_mode: single, pulse_bias_percent_270nm: 3090. Ch_mask: 16**. pulse1_width_ticks: 5. Bias DCS: 30V. Trigger ad-hoc 0x7 set to 6250Hz. 10Hz daq trigger rate. runtime 90 s.
27121	17/06/2024		90 s	lperez		109		LED	Pulse_bias_percent_270nm: 3190
27122	17/06/2024		90 s	lperez		109		LED	Pulse_bias_percent_270nm: 3290
27123	17/06/2024		90 s	lperez		109		LED	Pulse_bias_percent_270nm: 3390
27124	17/06/2024		90 s	lperez		109		LED	Pulse_bias_percent_270nm: 3490
27125	17/06/2024		90 s	lperez		109		LED	Pulse_bias_percent_270nm: 3590
27126	17/06/2024		90 s	lperez		109		LED	Pulse_bias_percent_270nm: 3690
27127	17/06/2024		90 s	lperez		109		LED	Pulse_bias_percent_270nm: 3790
27128	17/06/2024		90 s	lperez		109		LED	Pulse_bias_percent_270nm: 3890
27129	17/06/2024		90 s	lperez		109		LED	Pulse_bias_percent_270nm: 3990
27130	17/06/2024		90 s	lperez		109		LED	Pulse_bias_percent_270nm: 4090



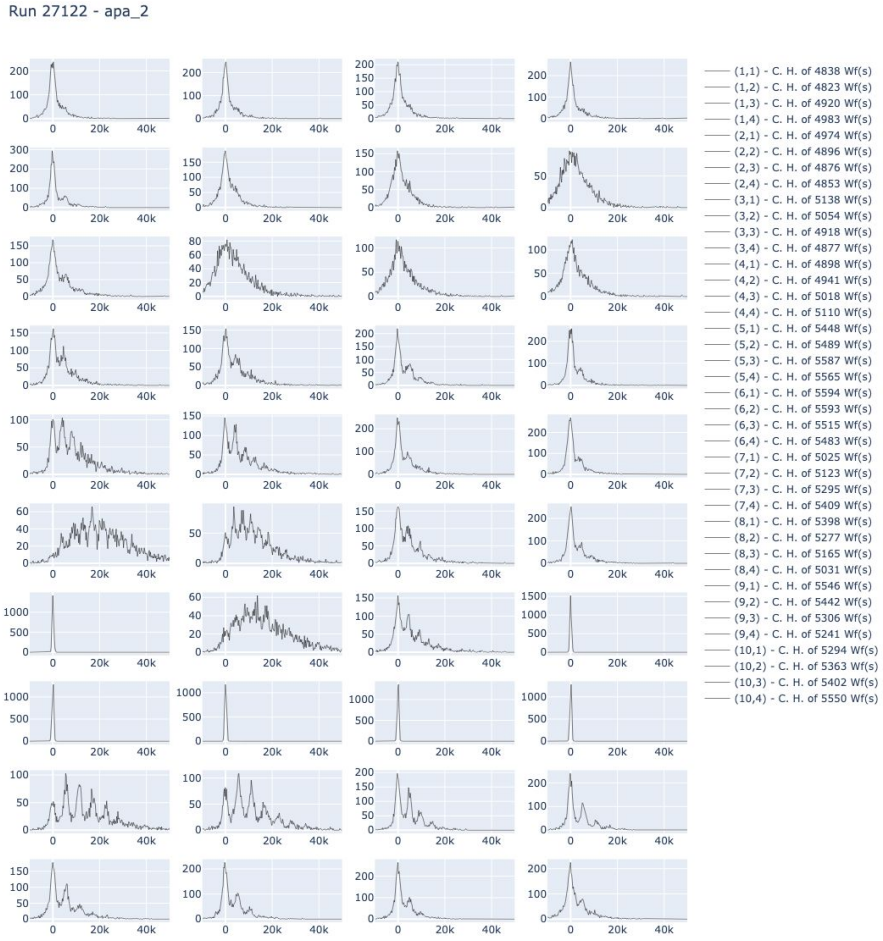
pulse_bias_percent_270nm = 3090



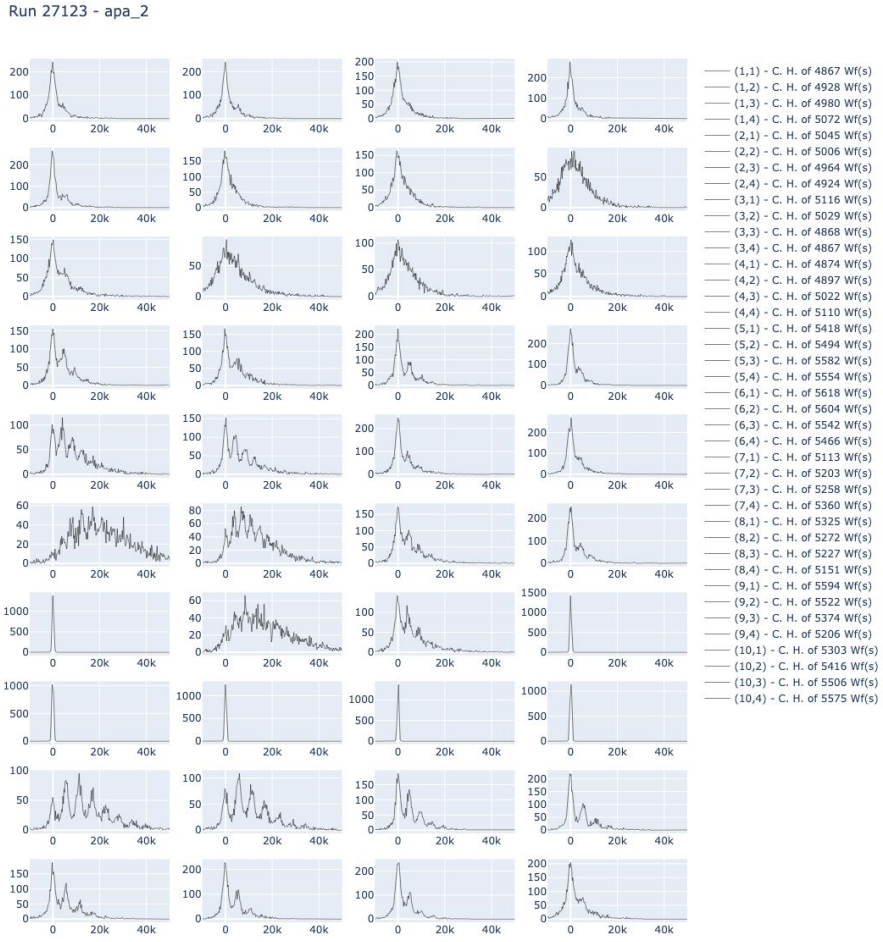
pulse_bias_percent_270nm = 3190



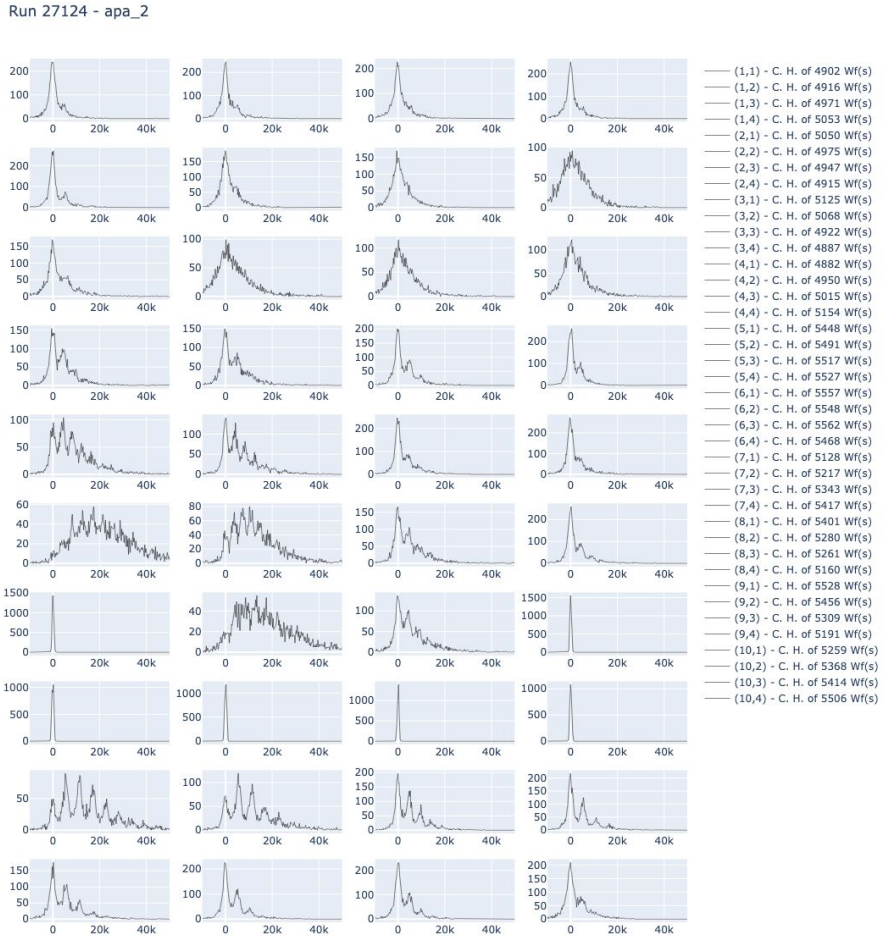
pulse_bias_percent_270nm = 3290



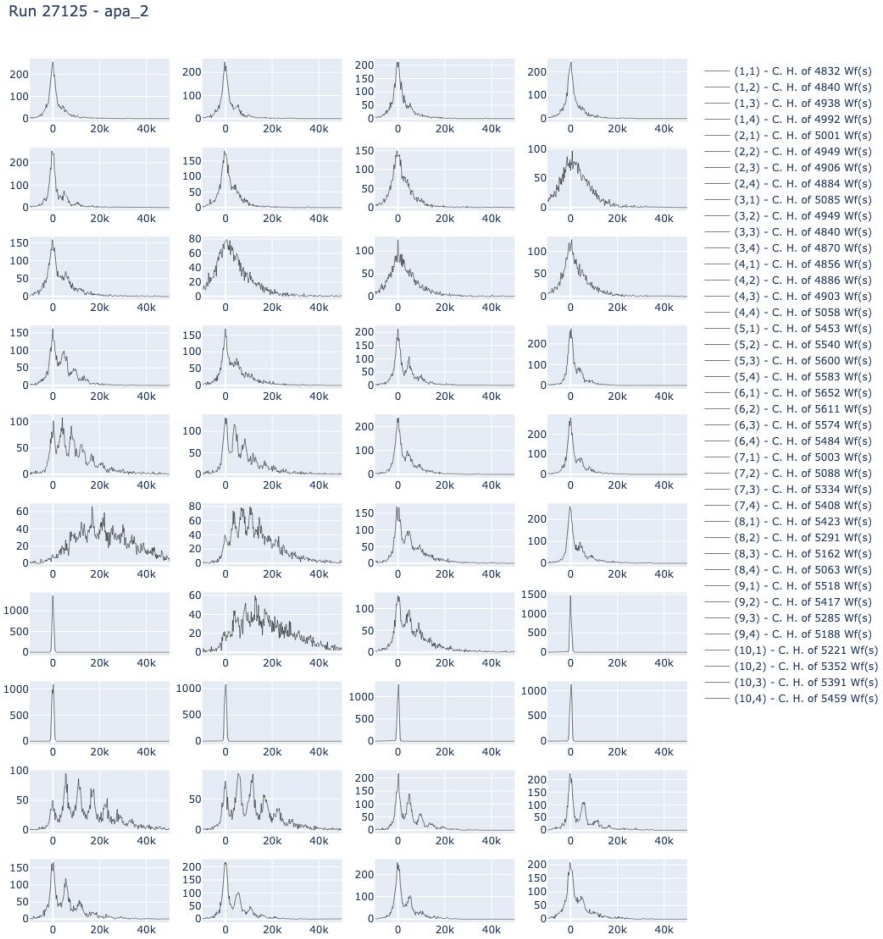
pulse_bias_percent_270nm = 3390



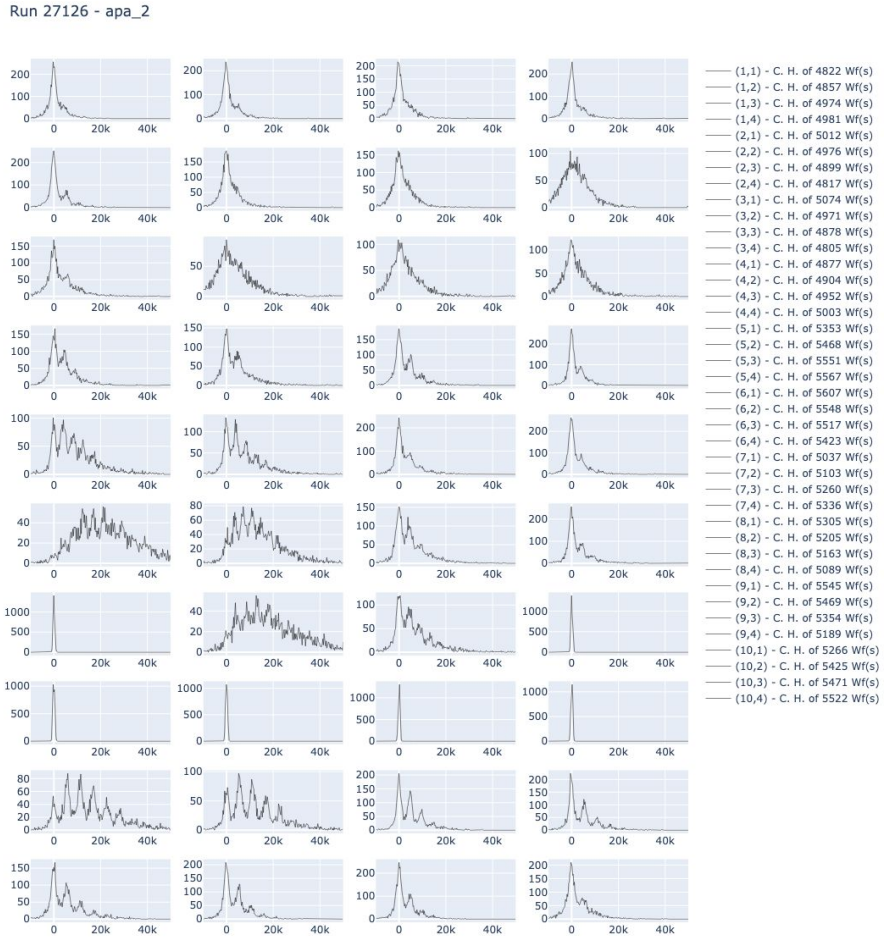
pulse_bias_percent_270nm = 3490



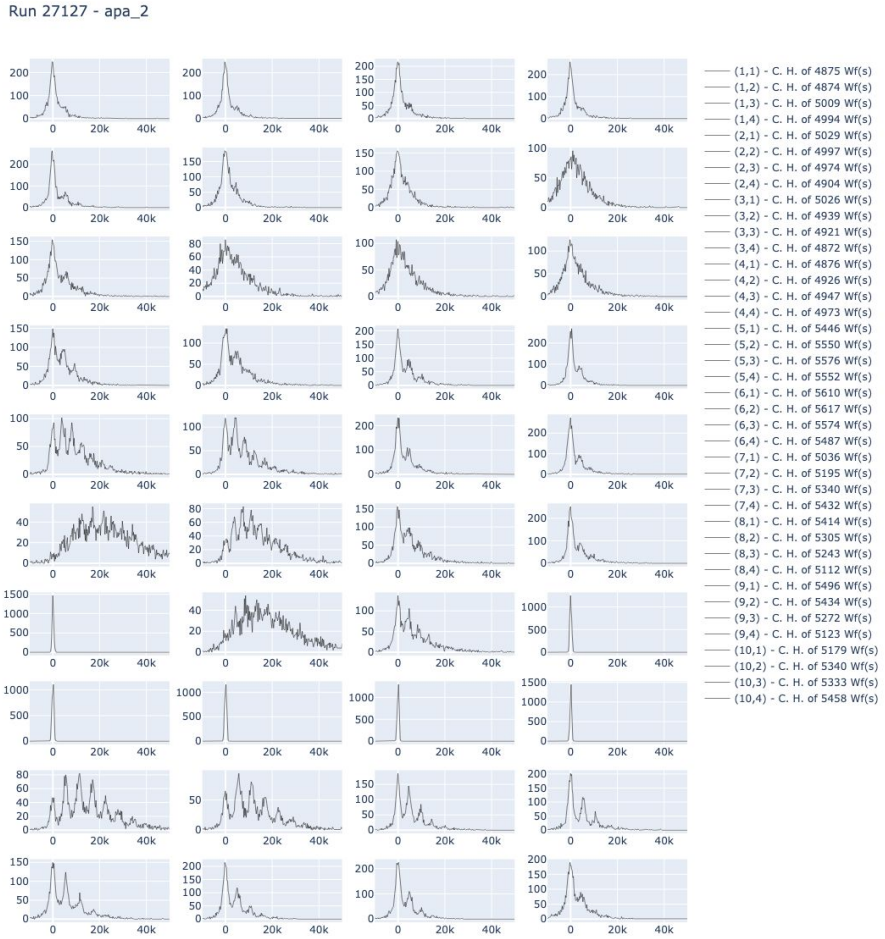
pulse_bias_percent_270nm = 3590



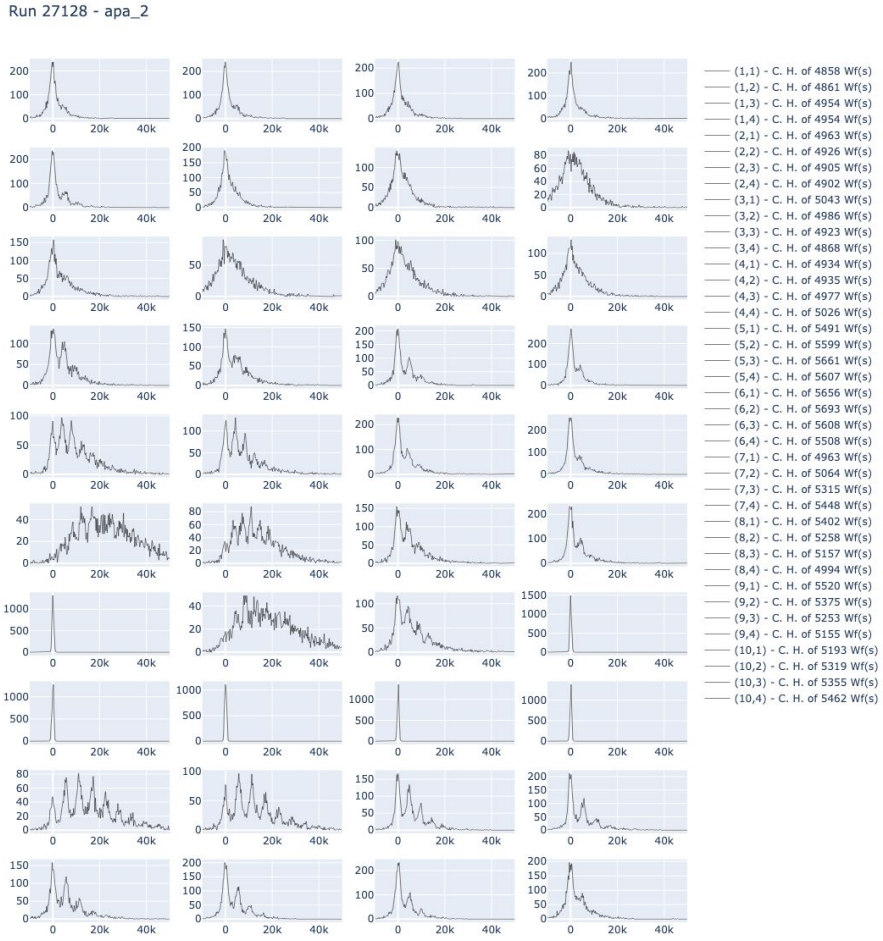
pulse_bias_percent_270nm = 3690



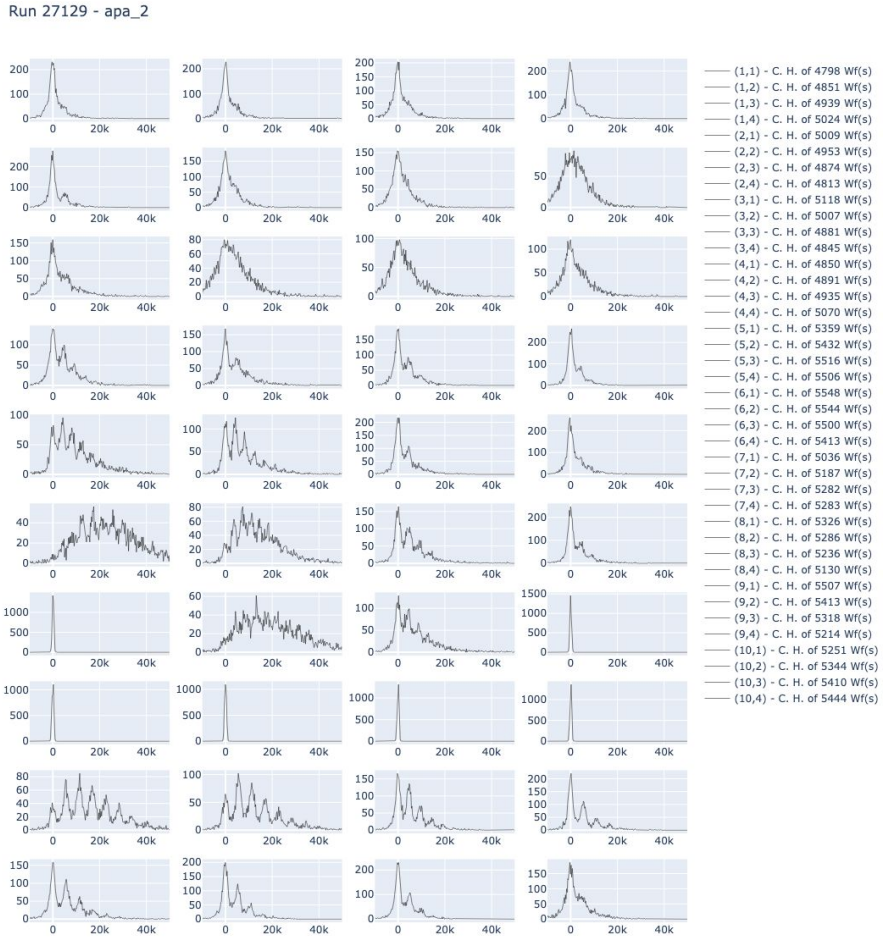
pulse_bias_percent_270nm = 3790



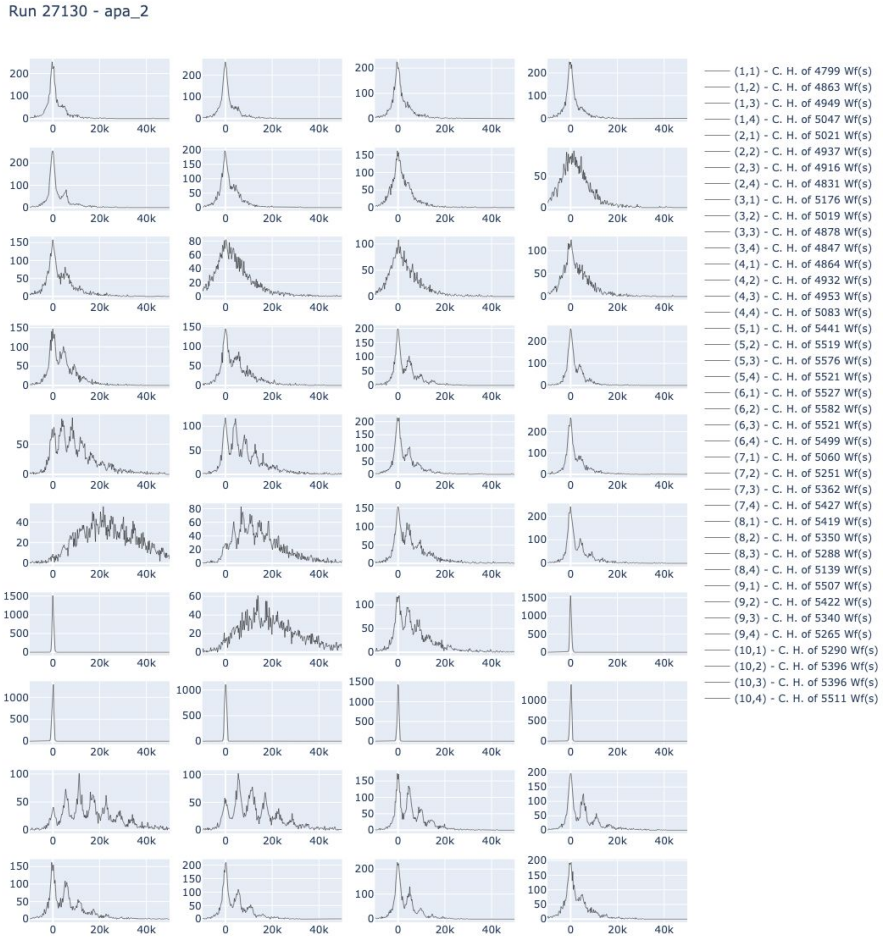
pulse_bias_percent_270nm = 3890



pulse_bias_percent_270nm = 3990



pulse_bias_percent_270nm = 4090



APA 1

- **Ongoing analysis** of the data for some runs with endpoints 104, 105 & 107 (**APA 1**) taken on 17-18/06/2024
  - Light was pointing to the center of APAs 1 & 2 plane (`channel_mask = 16`)
  - LED coupled to **tefzel** fiber - `ticks_width = 5` (20 ns)
  - There are ~30 available runs - `180` seconds each
  - Scanning `pulse_bias_percent_270nm` from `500` to `4045`
  - `20` Hz DAQ trigger rate
  - `20` Hz trigger ad-hoc `0x7`
  - `~7000` waveforms per channel and per run

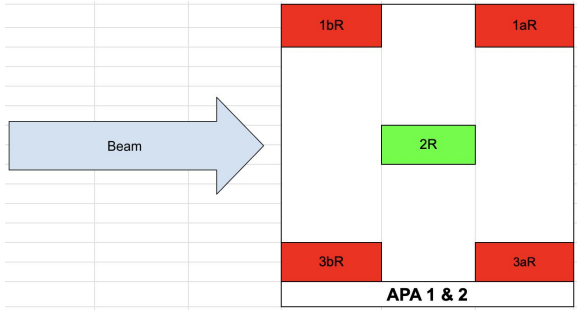
} Same configuration as for APA 2

→ But wider scan wrt APA 2

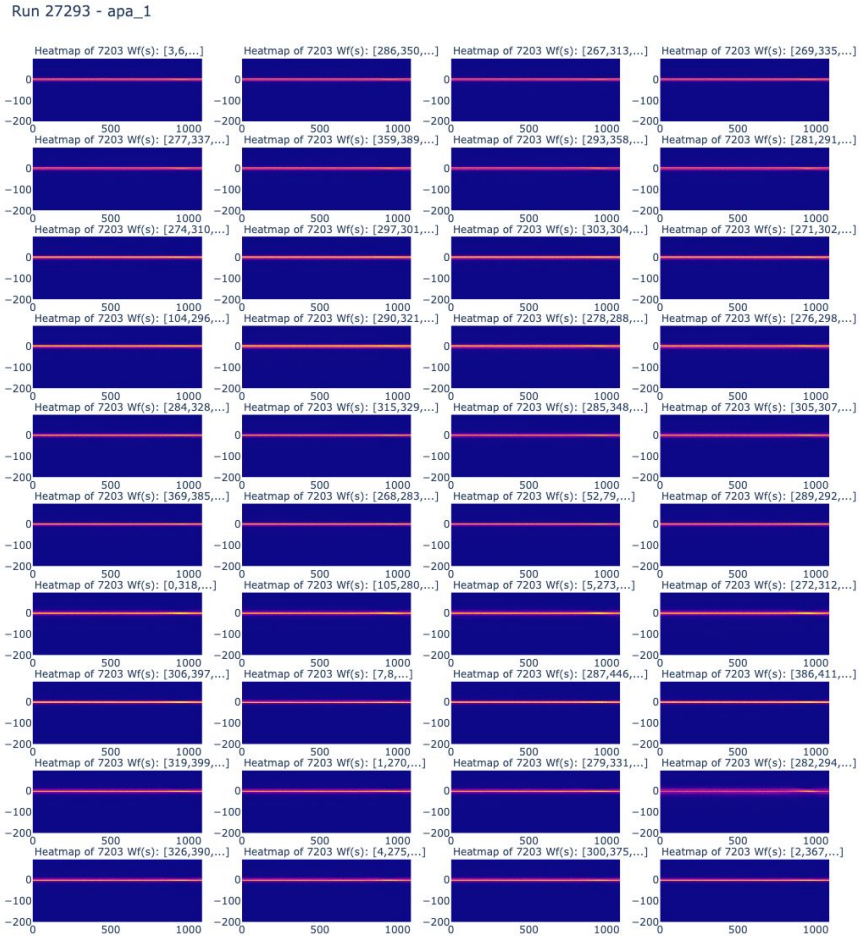
- Preliminary plots show that the detected amount of light
  - increases in the [`1000, 3045`] range of `pulse_bias_percent_270nm`,
  - but stays *roughly* the same in the [`3045, 4095`]

- The data seems *suitable* for calibration analysis, but the waveforms need to be aligned

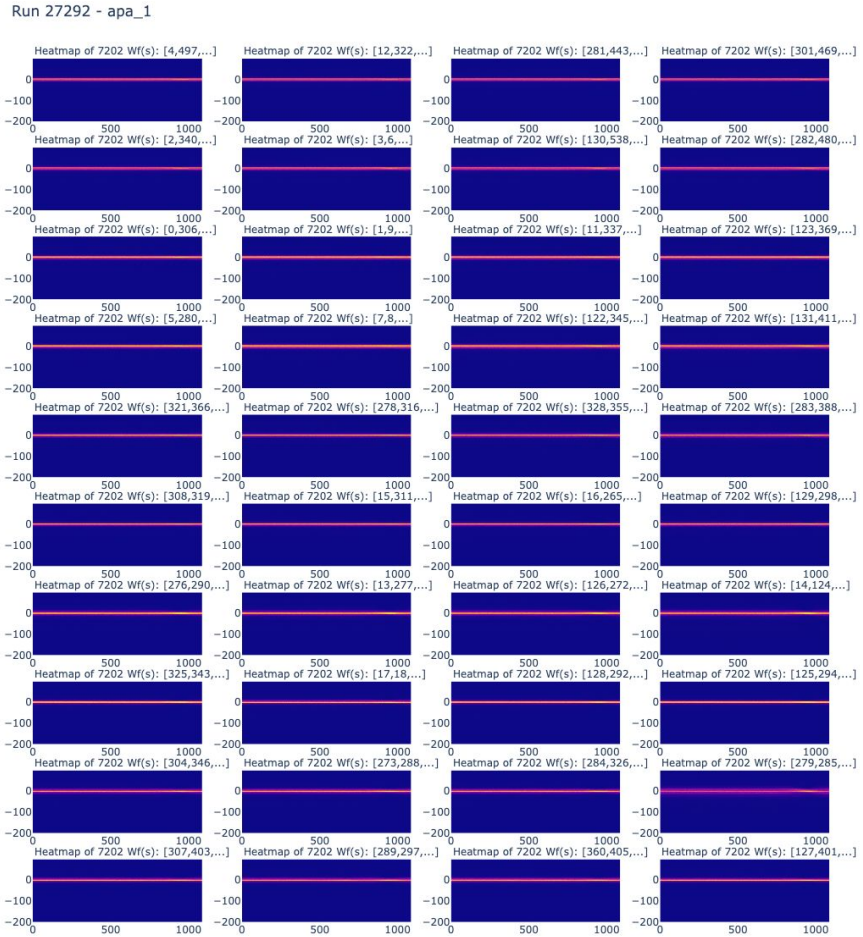
Run number	Date	Start time	End/run time	Shifter	PDS expert	Active Endpoints	# triggers	type	Configuration
27210	17/06/2024		180s	marroyav		104,105,107		LED	Calibration Run. Bias DCS:30V. Tests 270nm: SSP_config. pulse_mode:single, mask_channel:16, ticks_width:5, Pulse_bias_percent_270nm:4095. Trigger_ad-hoc 0x7:20Hz. 20Hz daq triger_rate.
27211	17/06/2024		180s	marroyav		104,105,107		LED	4045
27212	17/06/2024		180s	marroyav		104,105,107		LED	3995
27213	17/06/2024		180s	marroyav		104,105,107		LED	3945
27214	17/06/2024		180s	marroyav		104,105,107		LED	3895
27215	17/06/2024		180s	marroyav		104,105,107		LED	3845
27216	17/06/2024		180s	marroyav		104,105,107		LED	3795
27217	17/06/2024		180s	marroyav		104,105,107		LED	3745
27218	17/06/2024		180s	marroyav		104,105,107		LED	3695
27219	17/06/2024		180s	marroyav		104,105,107		LED	3645
27220	17/06/2024		180s	marroyav		104,105,107		LED	3595
27221	17/06/2024		180s	marroyav		104,105,107		LED	3545



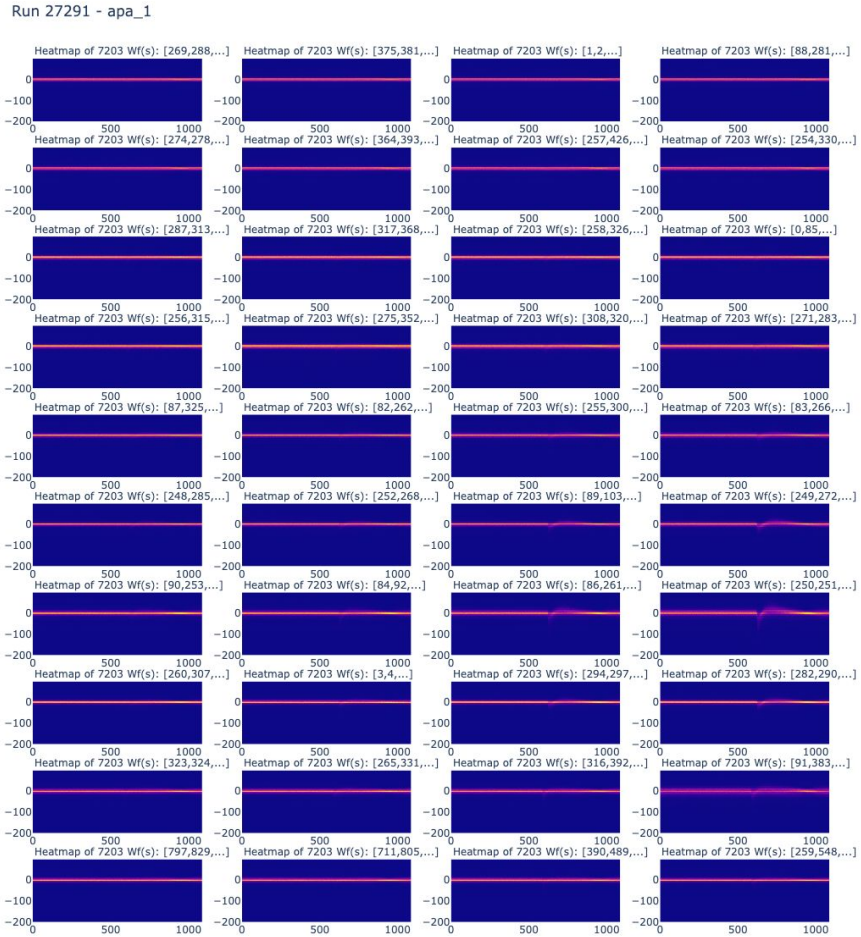
pulse_bias_percent_270nm = 500



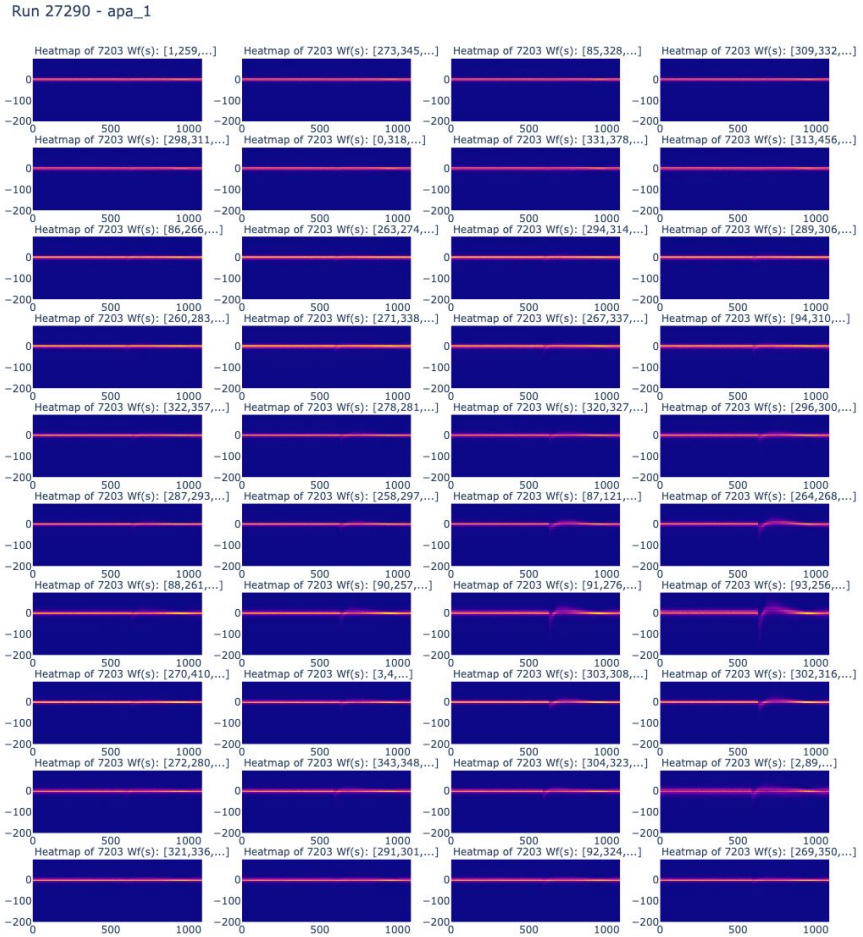
pulse_bias_percent_270nm = 1000



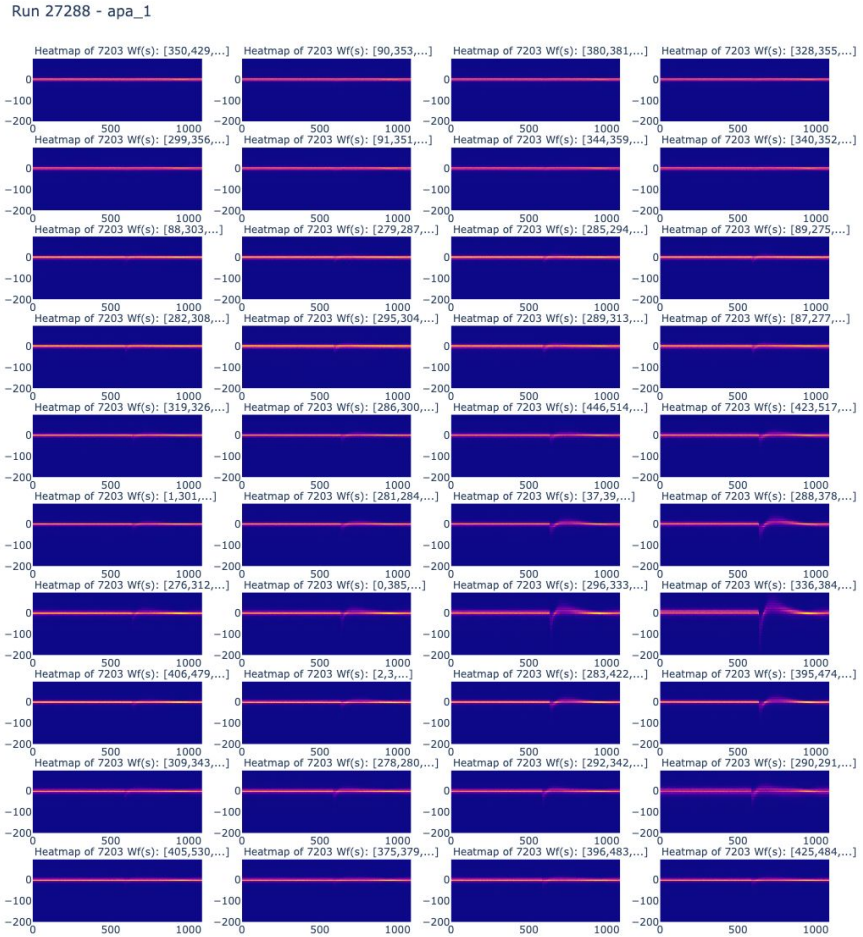
pulse_bias_percent_270nm = 1500



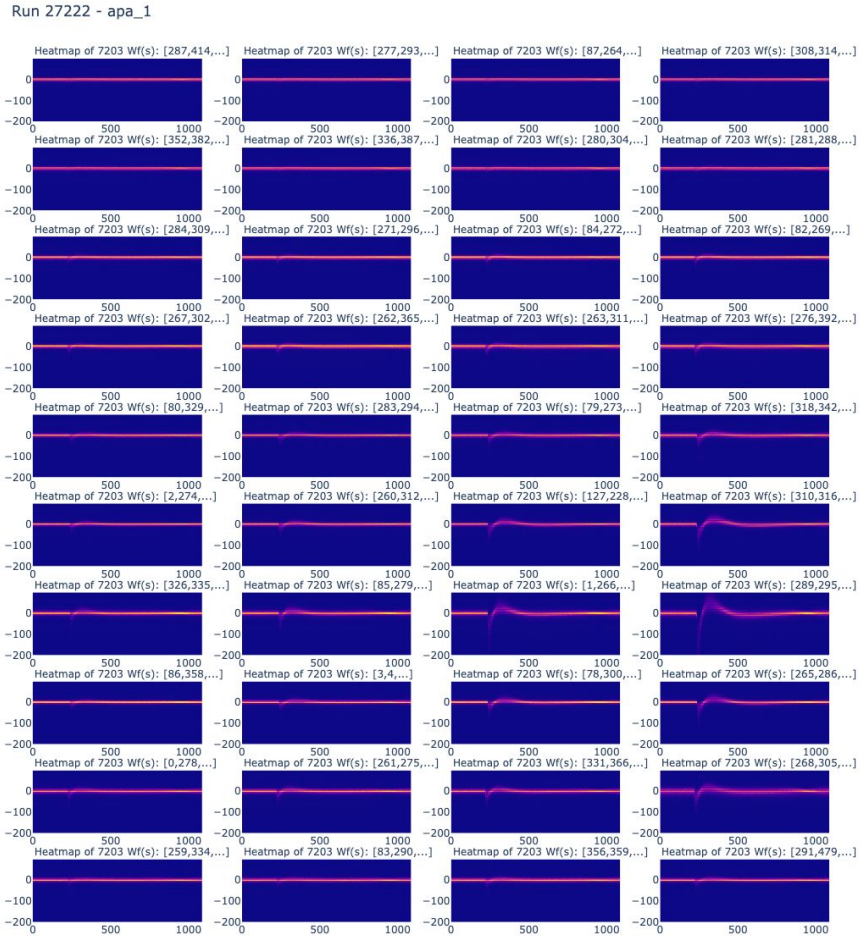
```
pulse_bias_percent_270nm = 2000
```



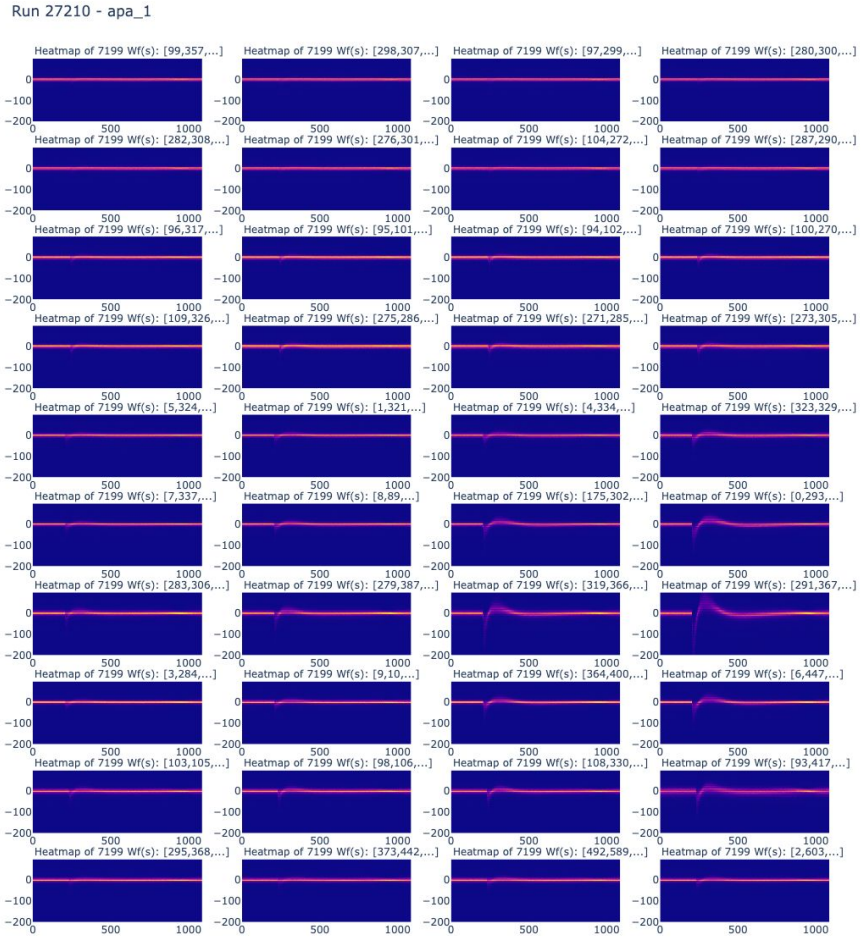
```
pulse_bias_percent_270nm = 2500
```



pulse_bias_percent_270nm = 3045



```
pulse_bias_percent_270nm = 4095
```



Conclusions

- APAs 3 & 4
  - We have almost all the data we require to tune the LED for APAs 3 & 4 calibration
- APAs 1 & 2
  - With the centered **tefzel** fiber we seem to have reached a plateau of the detected light wrt the `pulse_bias_percent_270nm`
    - increasing `ticks_width` beyond 5 (20 ns) we may detect more light (indeed, we needed to increase it from 1 to 5 in the past to see some light in APA 2)
  - This plateau configuration for the centered fiber seems OK to calibrate some of the channels APAs 1 & 2, but we will need to use other LED/fiber to calibrate channels placed at some corners of the APAs
  - APA 1 waveform alignment is a pending task (offline analysis)