

The PITZ GUN trip rate studies

21.03.2012 – 26.03.2012

- The gun trip rate analysis
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 - Typical Gun PMT and PD signals after readjustment
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General info about data taken for analysis

Time: 21.03.12 12:43 –
26.03.12 02:00
(week 12)

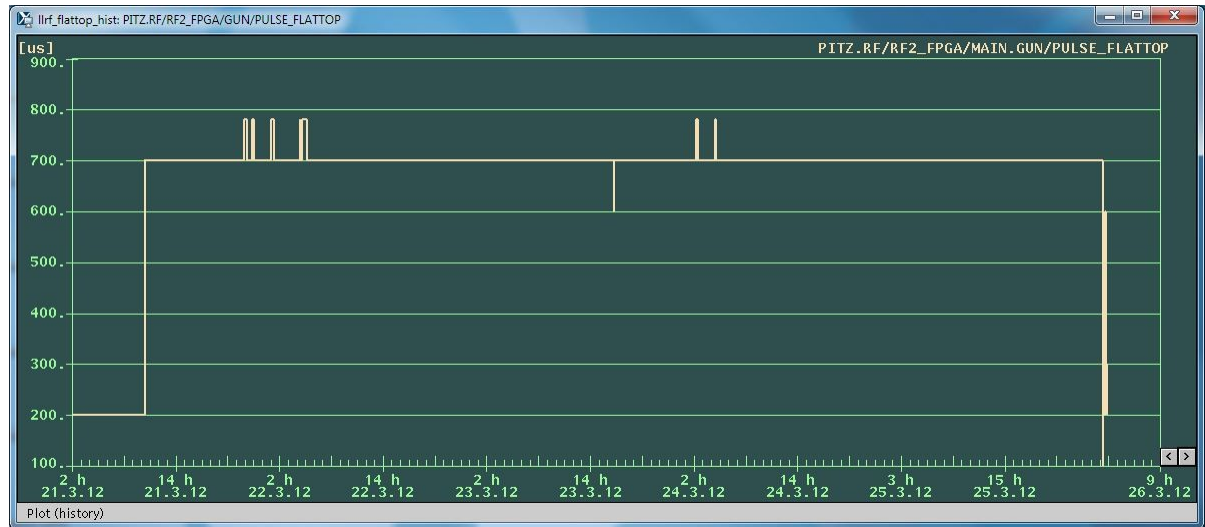
The gun RF Pulse length =
700 μ s

RF power levels in the
gun:

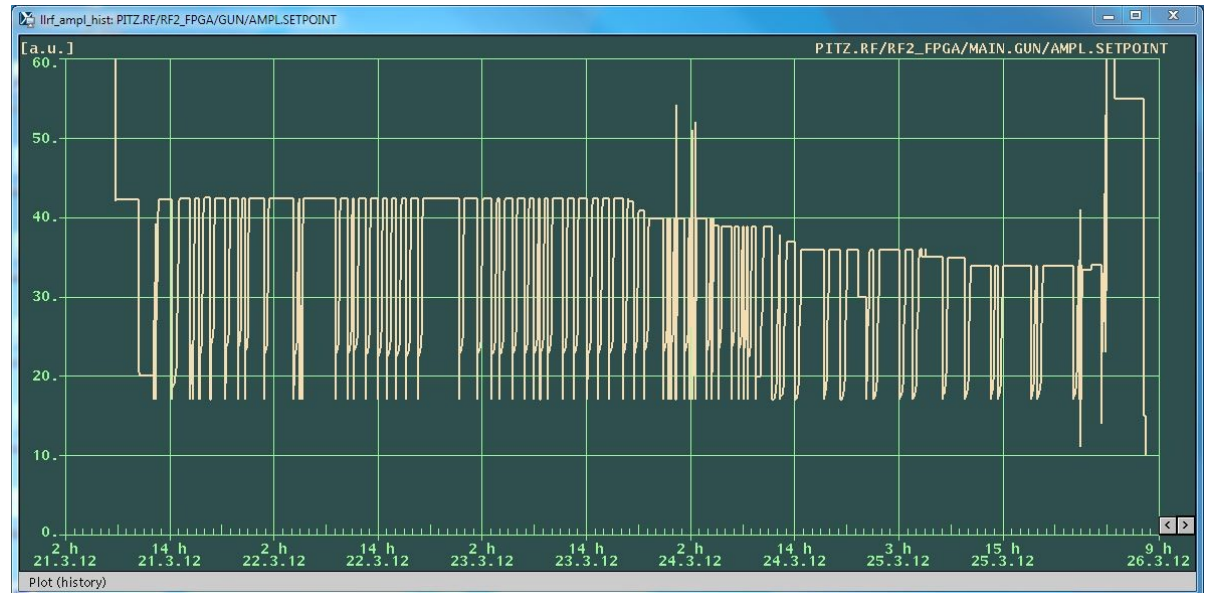
- 5.92 \pm 0.08 MW
- 5.72 \pm 0.04 MW
- 5.43 \pm 0.11 MW
- 5.10 \pm 0.10 MW
- 4.81 \pm 0.09 MW

The Booster – **OFF**
Vacuum valves between
gun and booster were
open

RF pulse length



Power Set Point



Analysis plan

- Test 1 - stable power periods in the Gun (Forward power - Reflected power (refl power < 0.2 MW)) calculations only with IL events check*.
- Test 2 - stable power periods calculations when the Gun Feed Back (FB) was ON (FB filter – ON) and with IL events check.
- Test 3 - stable power periods calculations with FB - ON and laser shutter was opened - charge at Low.ICT1 > 0.4 nC (Low.ICT1 charge filter – ON) and IL events check.

Test	RF → ON (Prefl<0.2MW)	FB is always ON	E-beam production (Q>0.4nC)
Test 1	+	-	-
Test 2	+	+	-
Test 3	+	+	+

* IL events check means checking of stable run (stable power in the gun) interruptions by interlock signal. If stable run period interrupted by not IL signal then this period is not included in further analysis

Power in the gun: 5.92 ± 0.08 MW

FB filter – OFF

Low.ICT1 charge filter - OFF

Results

Total number of interlocks: **35**

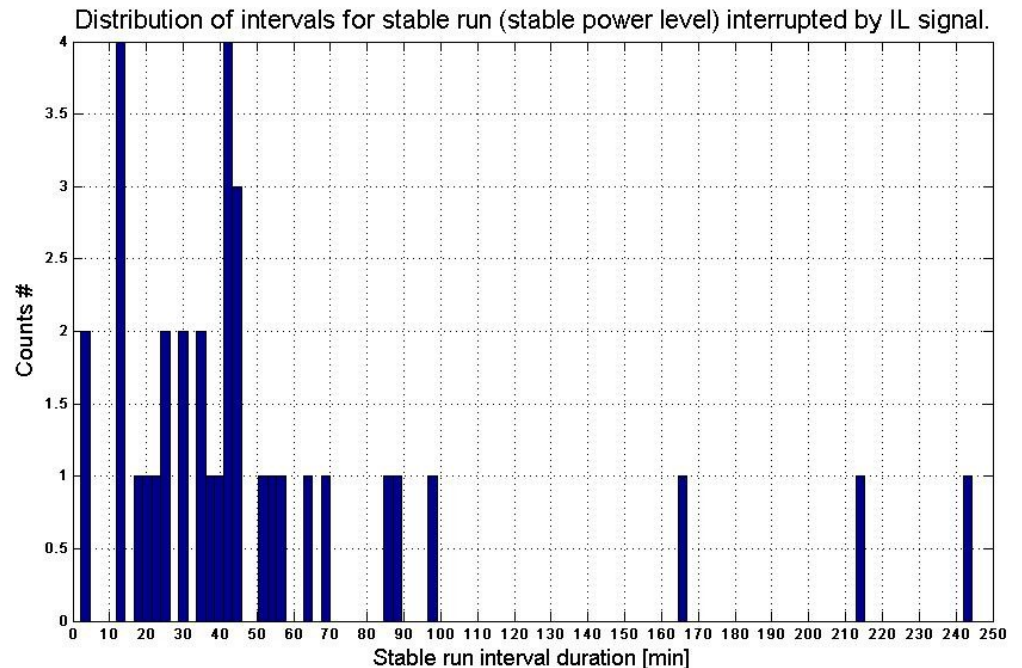
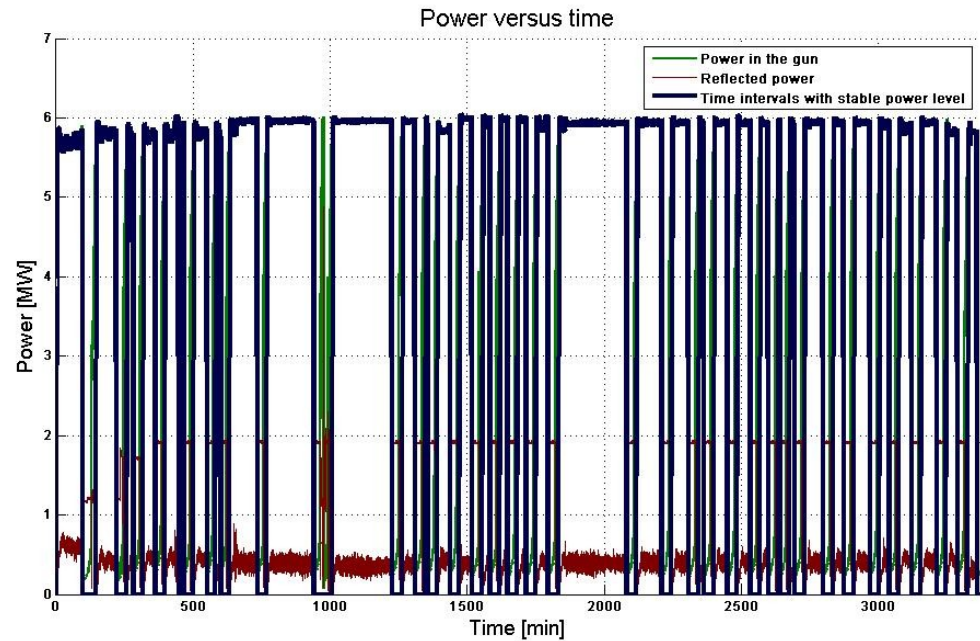
- 16 only Gun PMT interlocks
- 19 Gun PMT and Gun vacuum directional coupler interlocks

Number of interlocks visible for the booster IL detectors: **20**

- 2 only Booster PMT's in Cell1 and in Cell14
- 3 Booster PD in WG2 and PMT's in Cell1 and in Cell14
- 15 Booster PD's in WG1, WG2 and PMT's in Cell1 and in Cell14

Summary time: 1860.42 min

Trip rate: 1.129 IL's/Hour



Power in the gun: 5.92 ± 0.08 MW

FB filter – **ON**

Low.ICT1 charge filter - OFF

Results

Total number of interlocks: **29**

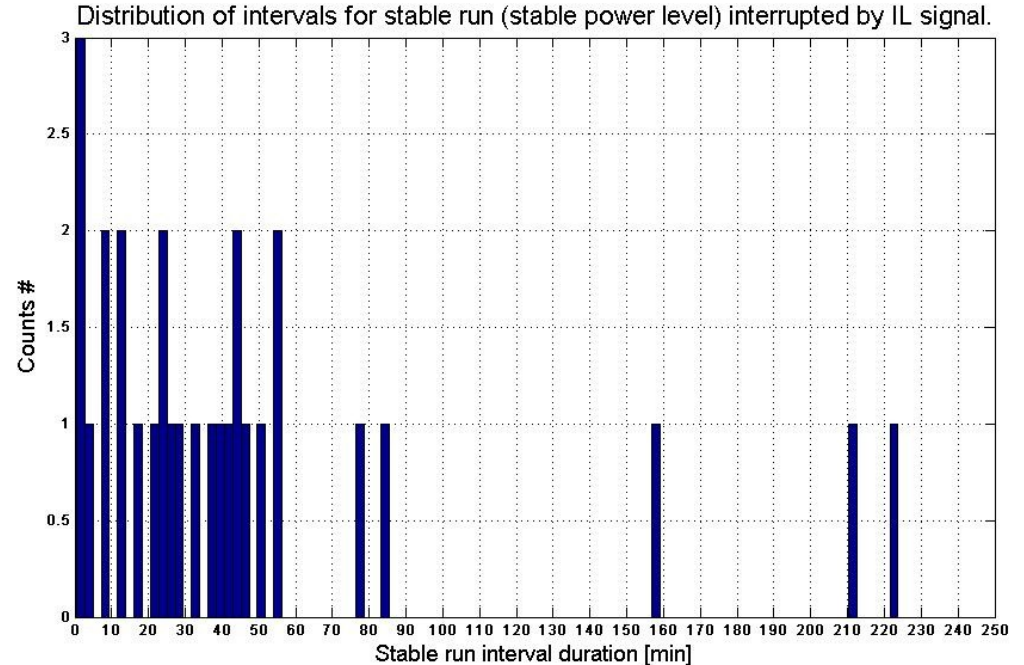
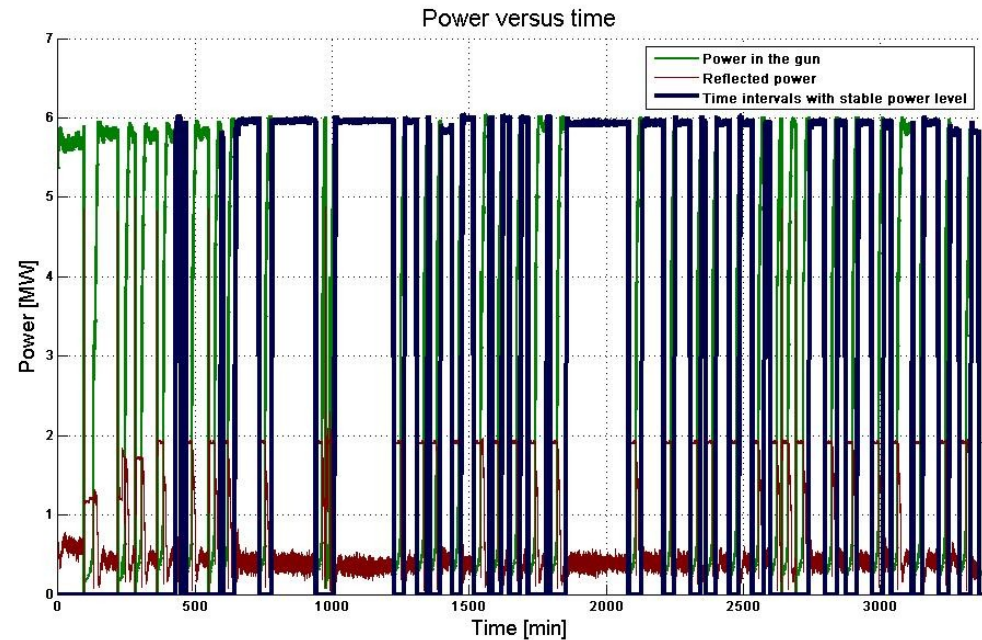
- 29 only Gun PMT interlocks

Number of interlocks visible for the booster IL detectors: **19**

- 1 only Booster PMT's in Cell1 and in Cell14
- 3 Booster PD in WG2 and PMT's in Cell1 and in Cell14
- 15 Booster PD's in WG1, WG2 and PMT's in Cell1 and in Cell14

Summary time: 1388.45 min

Trip rate: 1.253 IL's/Hour



Power in the gun: 5.92 ± 0.08 MW

FB filter – ON

Low.ICT1 charge filter - **ON**

Results

Total number of interlocks: **24**

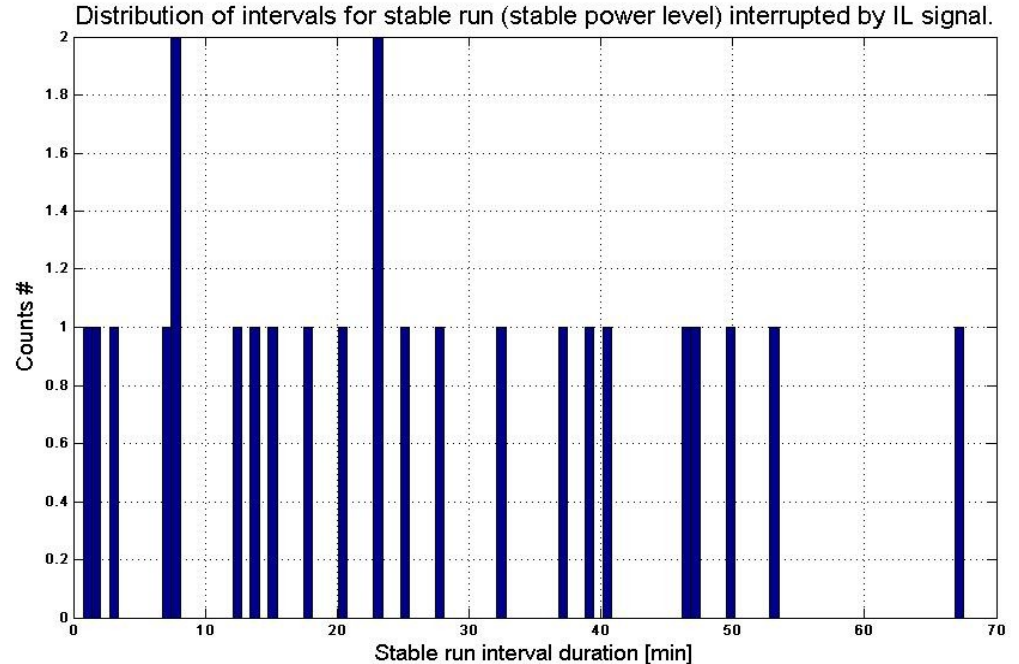
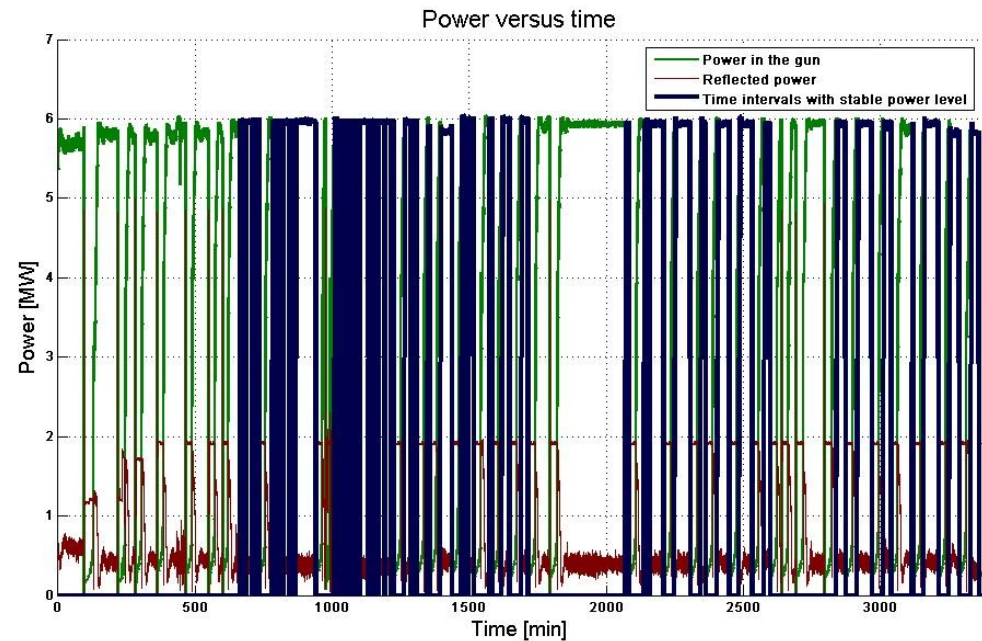
- 24 only Gun PMT interlocks

Number of interlocks visible for the booster IL detectors: **19**

- 1 only Booster PMT's in Cell1 and in Cell14
- 3 Booster PD in WG2 and PMT's in Cell1 and in Cell14
- 14 Booster PD's in WG1, WG2 and PMT's in Cell1 and in Cell14

Summary time: 620.08 min

Trip rate: 2.322 IL's/Hour



Power in the gun: 5.72 ± 0.04 MW

FB filter – OFF

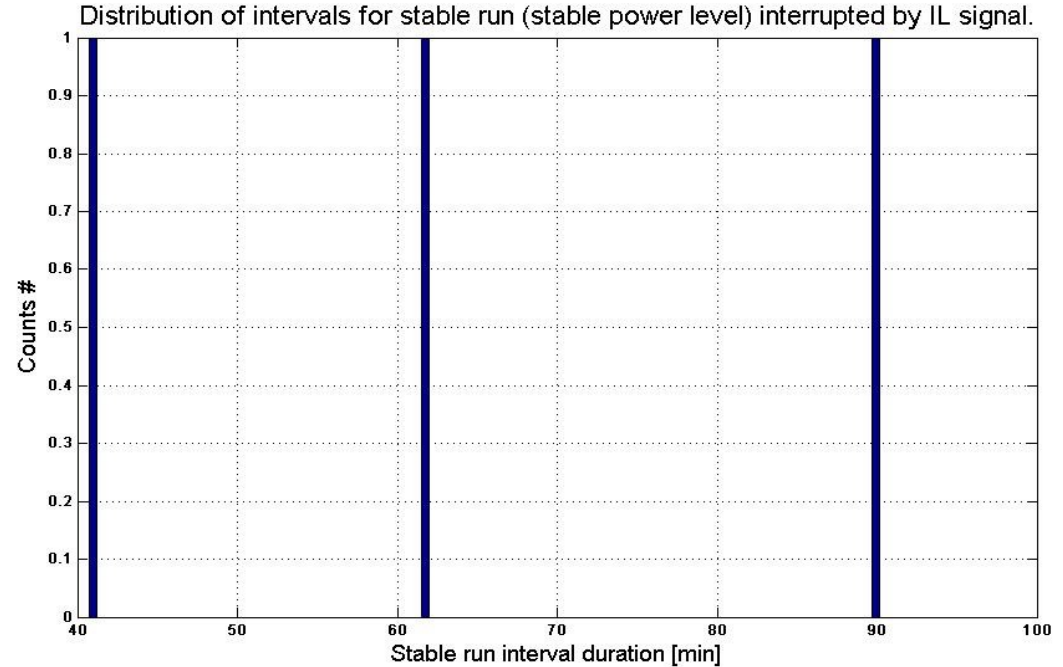
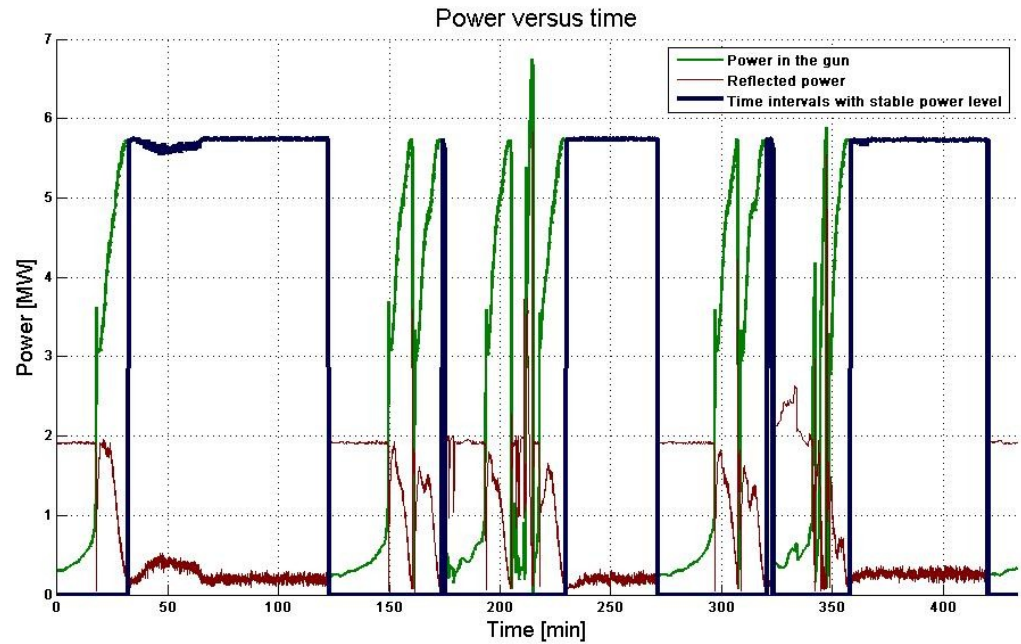
Low.ICT1 charge filter - OFF

Results

- Total number of interlocks: **3**
- 3 only Gun PMT interlocks

- Number of interlocks visible for the booster IL detectors: **3**
- 3 Booster PD in WG2 and PMT's in Cell1 and in Cell14

Summary time: 192.60 min
Trip rate: 0.935 IL's/Hour



Power in the gun: 5.72 ± 0.04 MW

FB filter – **ON**

Low.ICT1 charge filter - OFF

Results

Total number of interlocks: **3**

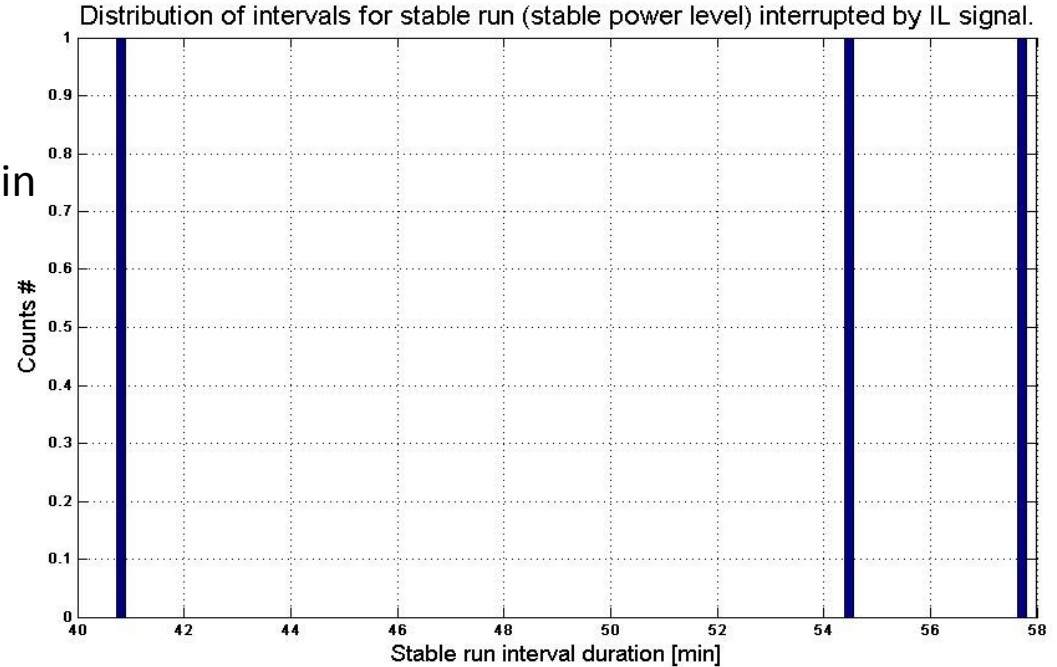
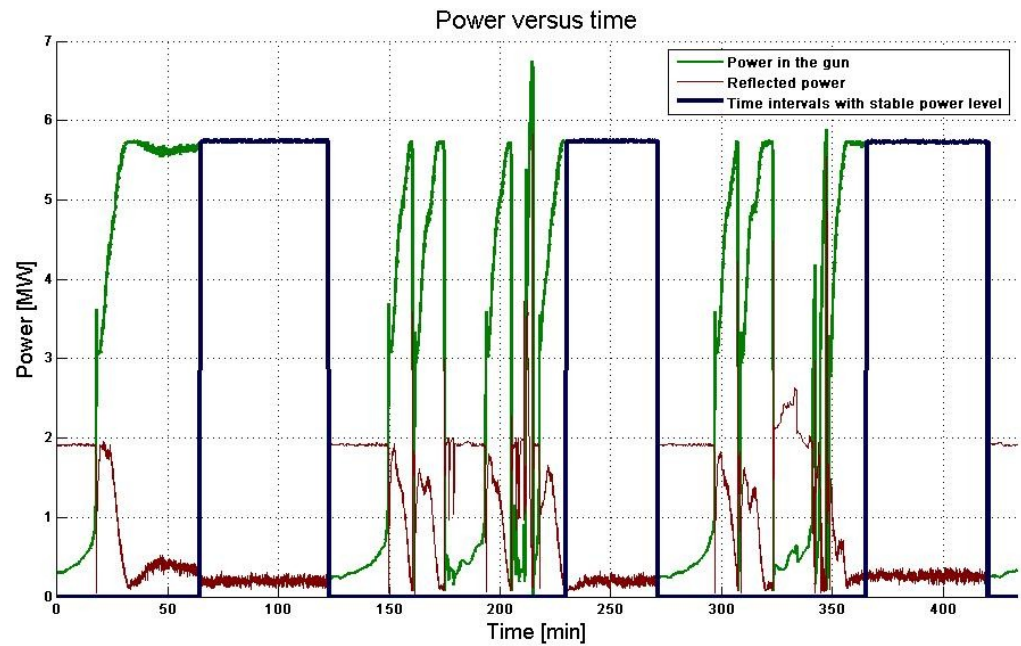
- 3 only Gun PMT interlocks

Number of interlocks visible for the booster IL detectors: **3**

- 3 Booster PD in WG2 and PMT's in Cell1 and in Cell14

Summary time: 153.00 min

Trip rate: 1.176 IL's/Hour



Power in the gun: 5.72 ± 0.04 MW

FB filter – ON

Low.ICT1 charge filter - **ON**

Results

Total number of interlocks: **3**

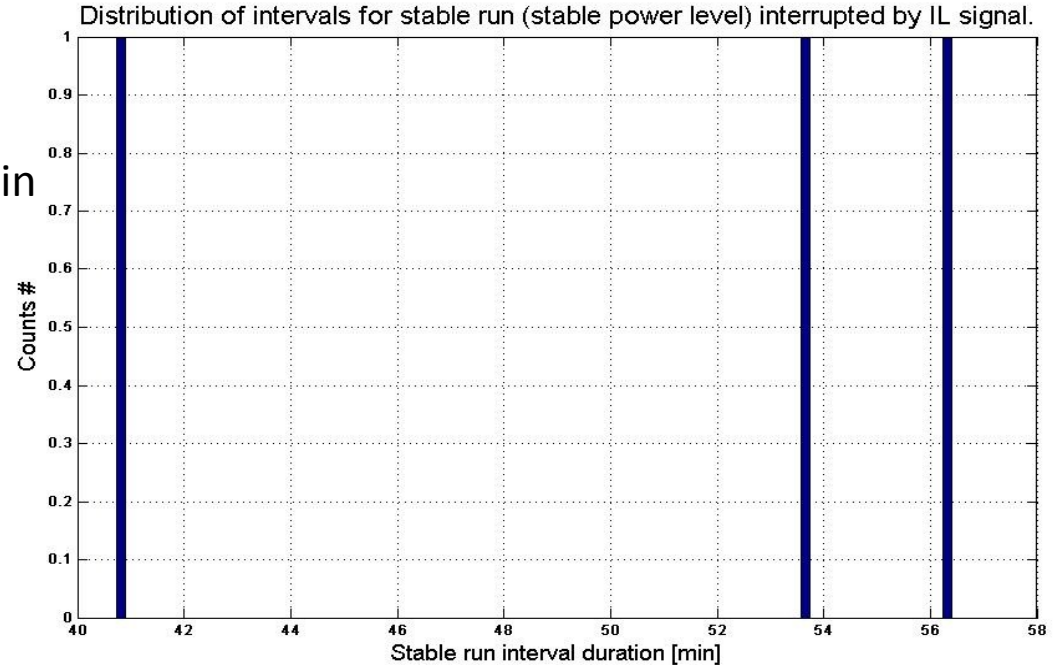
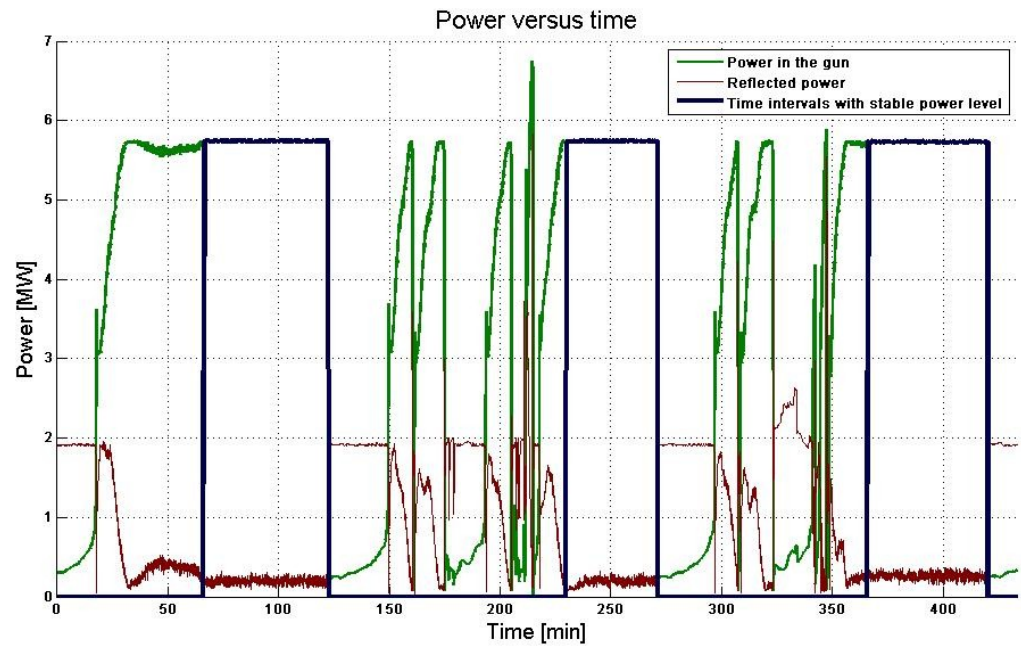
- 3 only Gun PMT interlocks

Number of interlocks visible for the booster IL detectors: **3**

- 3 Booster PD in WG2 and PMT's in Cell1 and in Cell14

Summary time: 150.83 min

Trip rate: 1.193 IL's/Hour



Power in the gun: 5.43 ± 0.11 MW

FB filter – OFF

Low.ICT1 charge filter - OFF

Results

Total number of interlocks: **6**

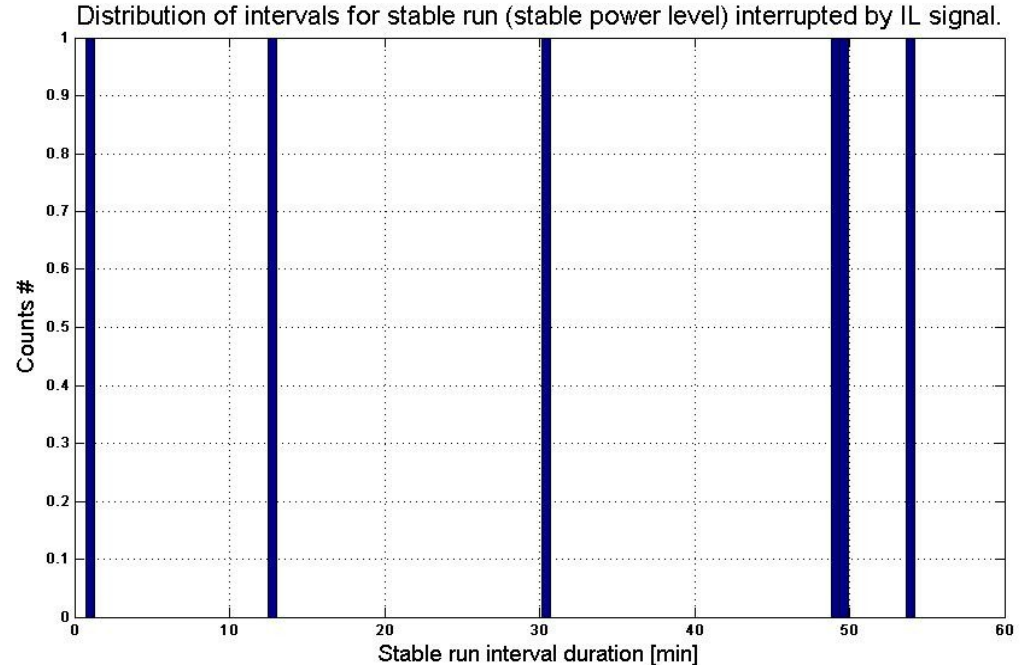
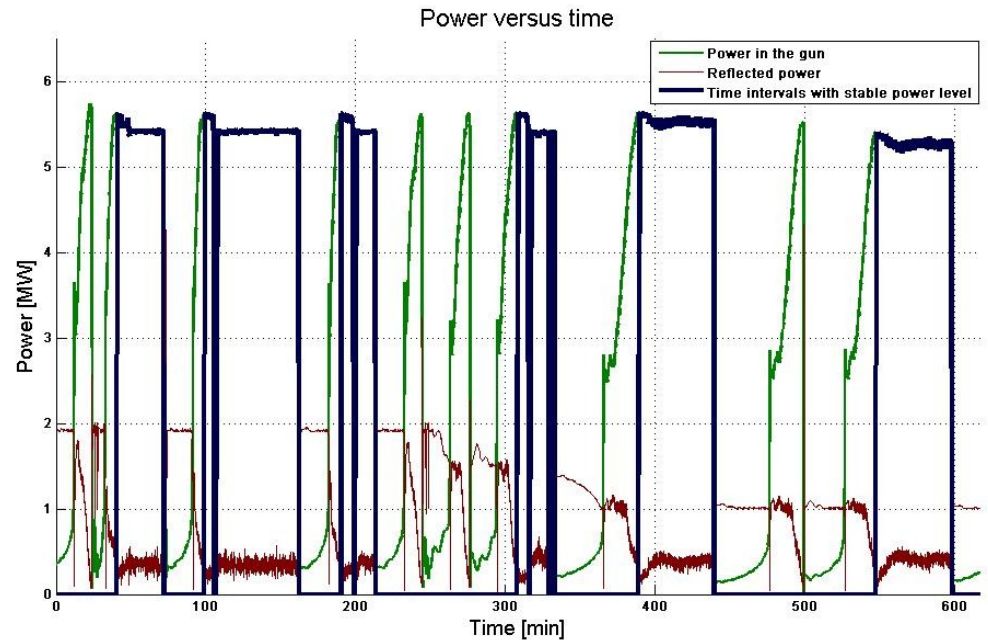
- 6 only Gun PMT interlocks

Number of interlocks visible for the booster IL detectors: **5**

- 5 Booster PD in WG2 and PMT's in Cell1 and in Cell14

Summary time: 197.05 min

Trip rate: 1.827 IL's/Hour



Power in the gun: 5.43 ± 0.11 MW

FB filter – **ON**

Low.ICT1 charge filter - OFF

Results

Total number of interlocks: **4**

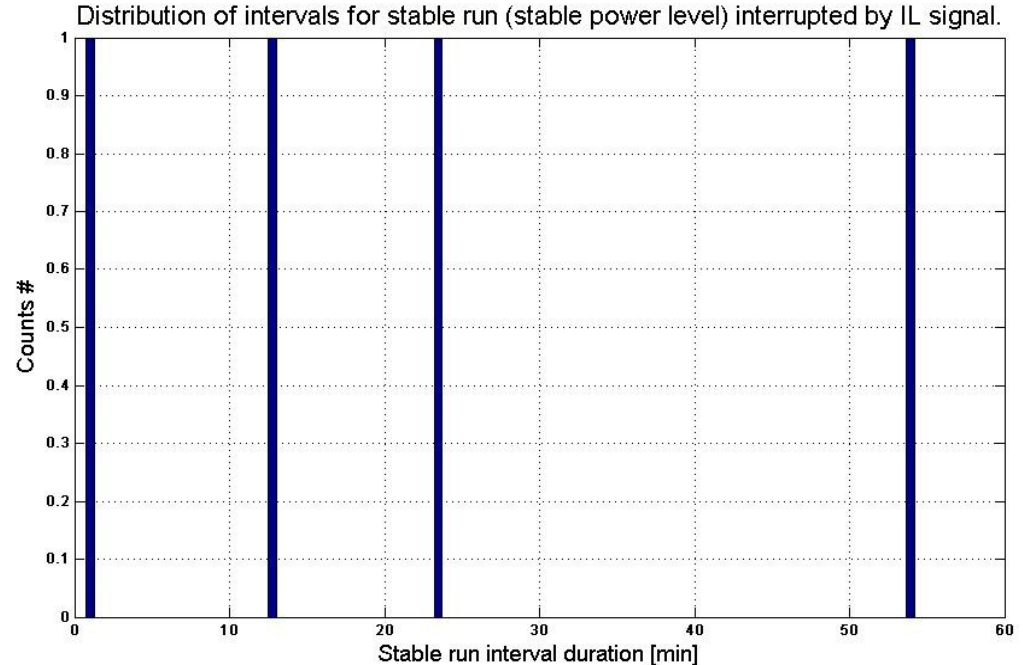
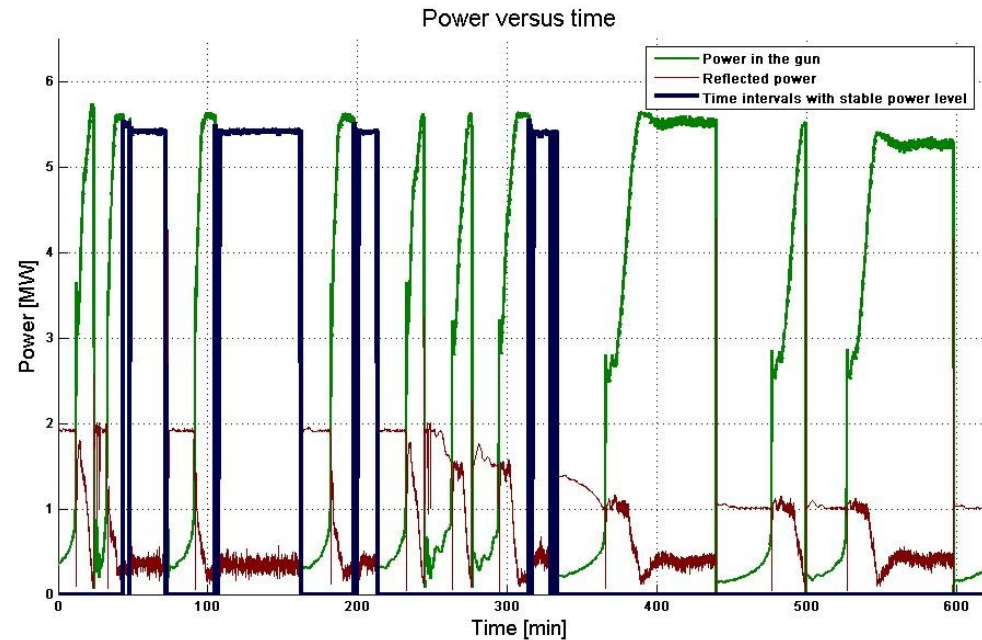
- 4 only Gun PMT interlocks

Number of interlocks visible for the booster IL detectors: **3**

- 3 Booster PD in WG2 and PMT's in Cell1 and in Cell14

Summary time: 90.87 min

Trip rate: 2.641 IL's/Hour



Power in the gun: 5.43 ± 0.11 MW

FB filter – ON

Low.ICT1 charge filter - **ON**

Results

Total number of interlocks: **4**

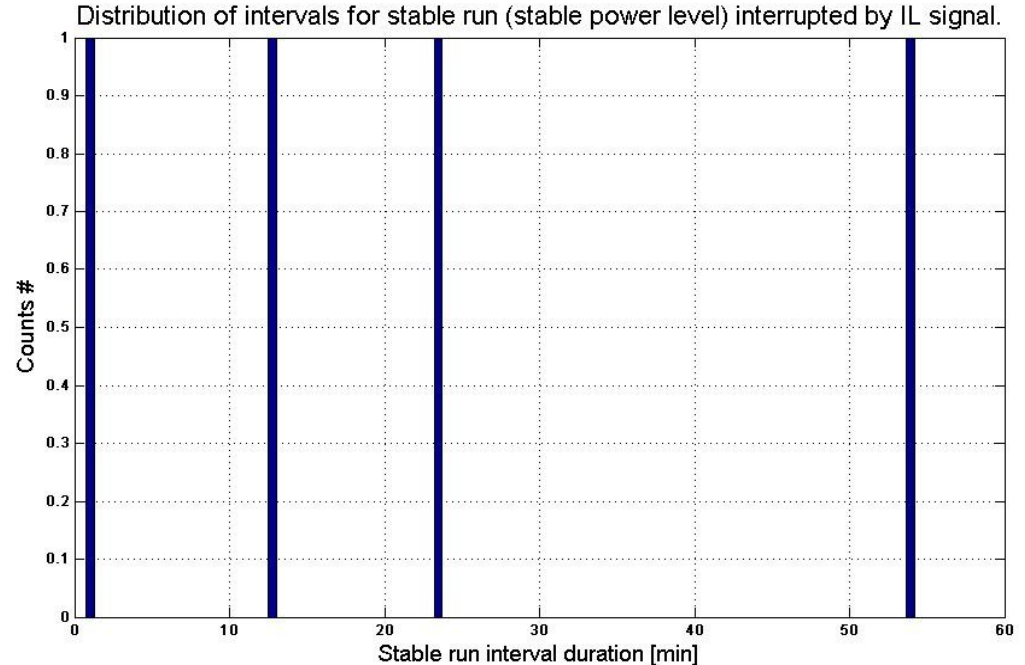
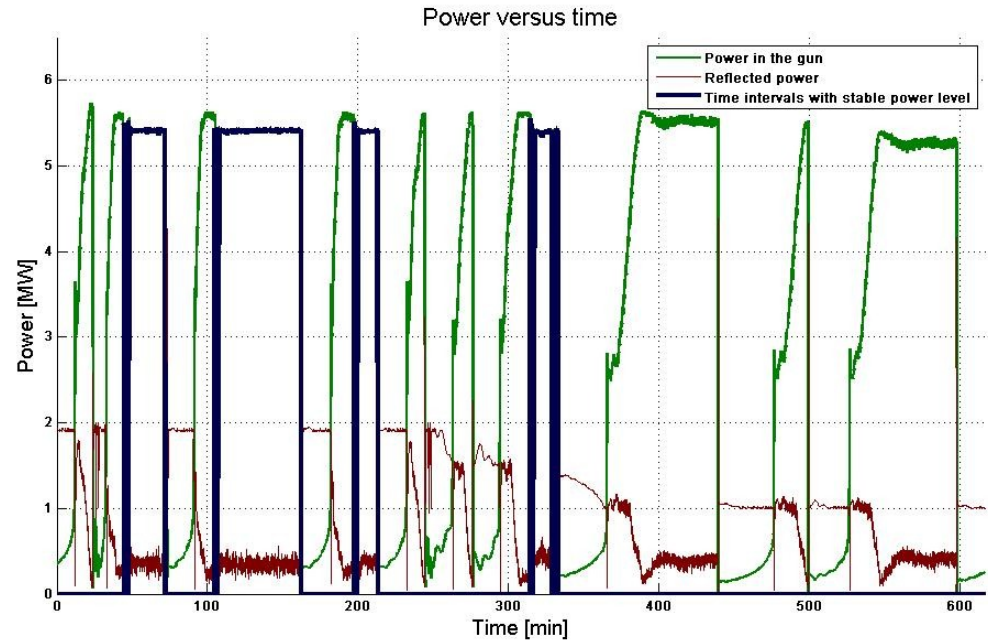
- 4 only Gun PMT interlocks

Number of interlocks visible for the booster IL detectors: **3**

- 3 Booster PD in WG2 and PMT's in Cell1 and in Cell14

Summary time: 90.87 min

Trip rate: 2.641 IL's/Hour



Power in the gun: 5.10 ± 0.10 MW

FB filter – OFF

Low.ICT1 charge filter - OFF

Results

Total number of interlocks: **4**

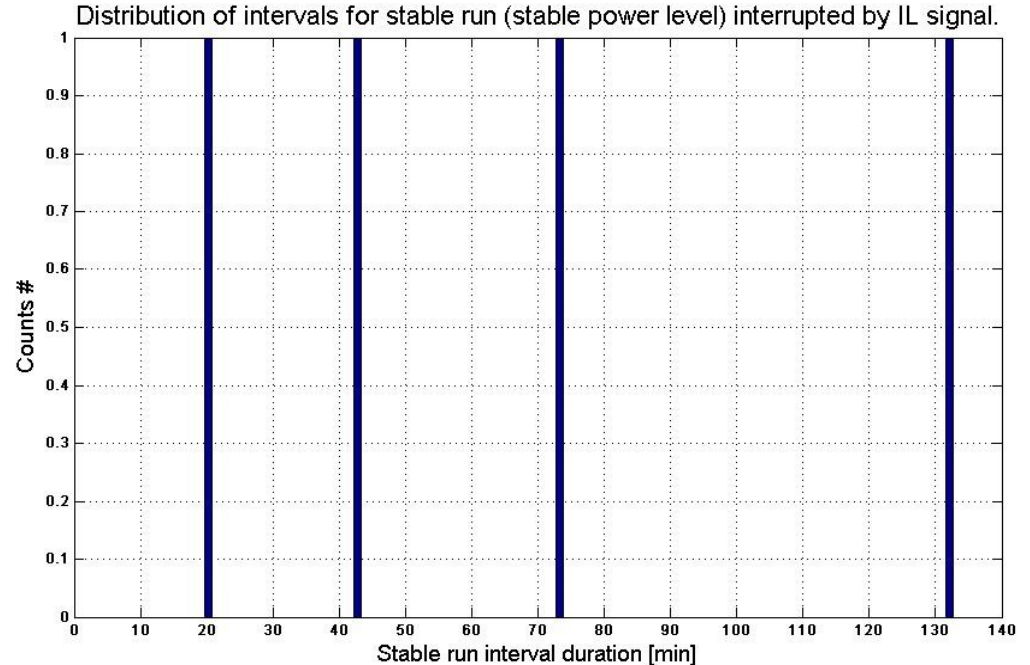
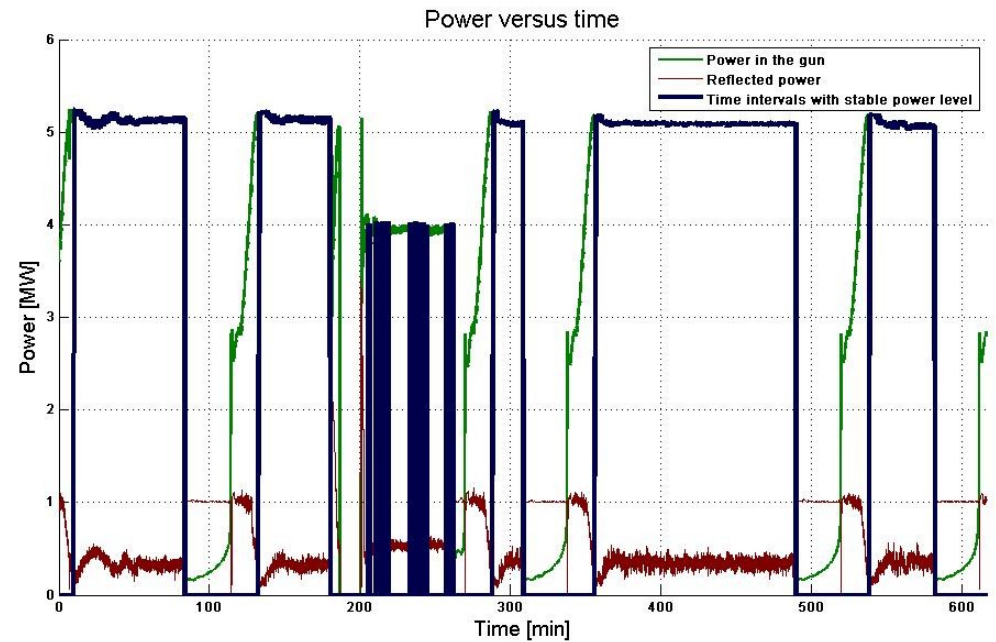
- 4 only Gun PMT interlocks

Number of interlocks visible for the booster IL detectors: **3**

- 1 only Booster PMT's in Cell1 and in Cell14
- 2 Booster PD in WG2 and PMT's in Cell1 and in Cell14

Summary time: 268.15 min

Trip rate: 0.895 IL's/Hour



Power in the gun: 5.10 ± 0.10 MW

FB filter – **ON**

Low.ICT1 charge filter - OFF

Results

Total number of interlocks: **4**

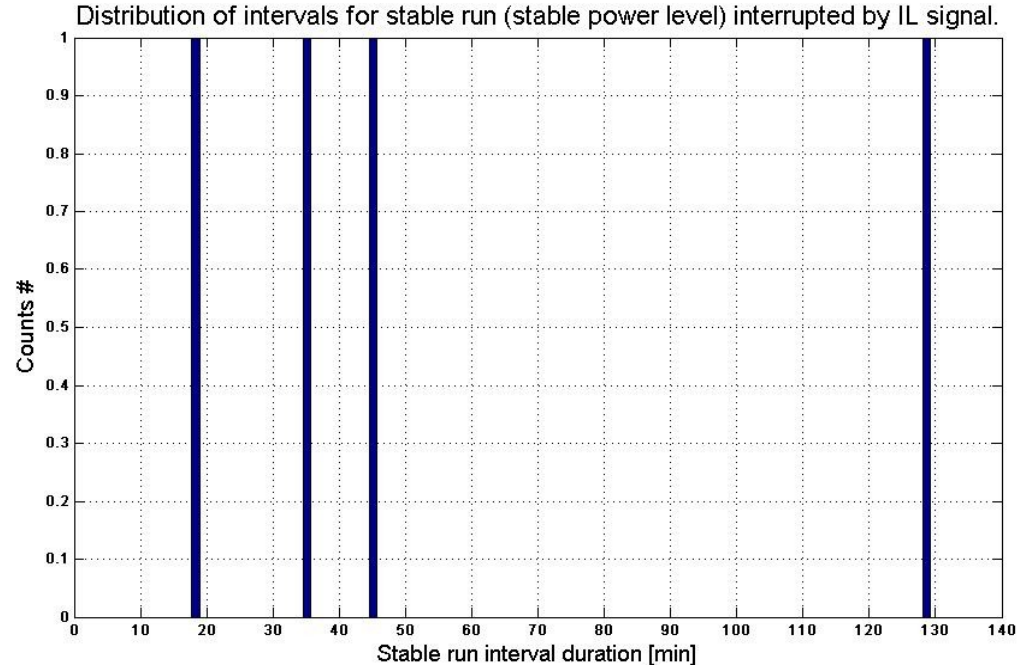
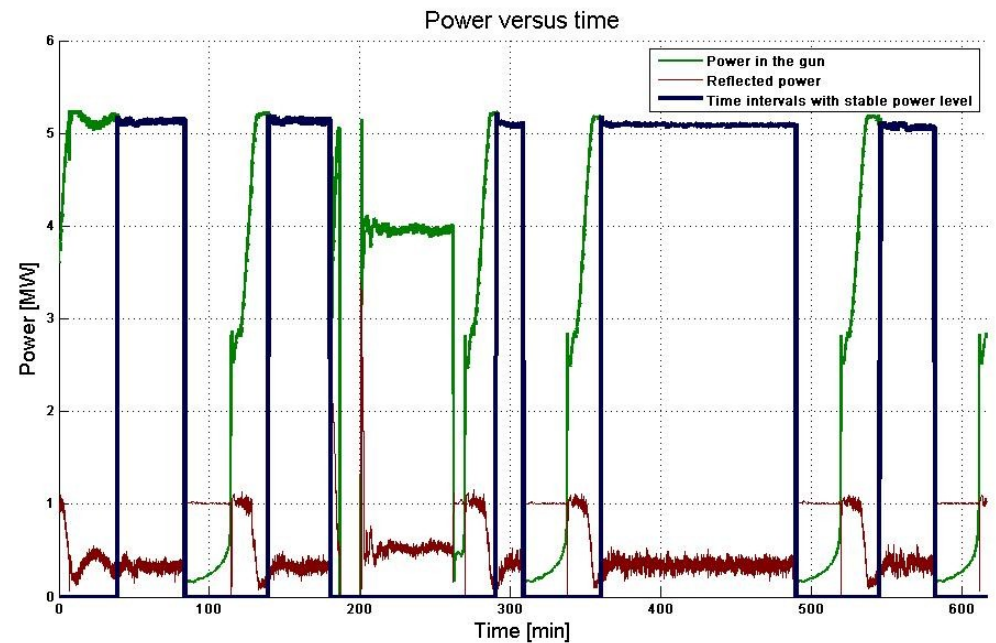
- 4 only Gun PMT interlocks

Number of interlocks visible for the booster IL detectors: **3**

- 1 only Booster PMT's in Cell1 and in Cell14
- 2 Booster PD in WG2 and PMT's in Cell1 and in Cell14

Summary time: 227.13 min

Trip rate: 1.057 IL's/Hour



Power in the gun: 5.10 ± 0.10 MW

FB filter – ON

Low.ICT1 charge filter - **ON**

Results

Total number of interlocks: **4**

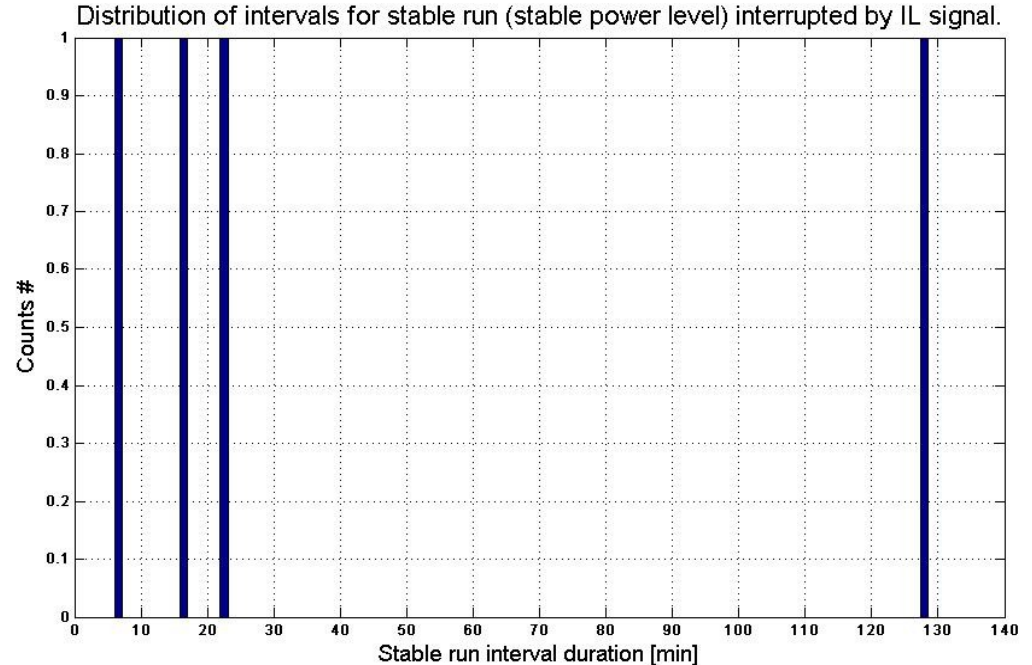
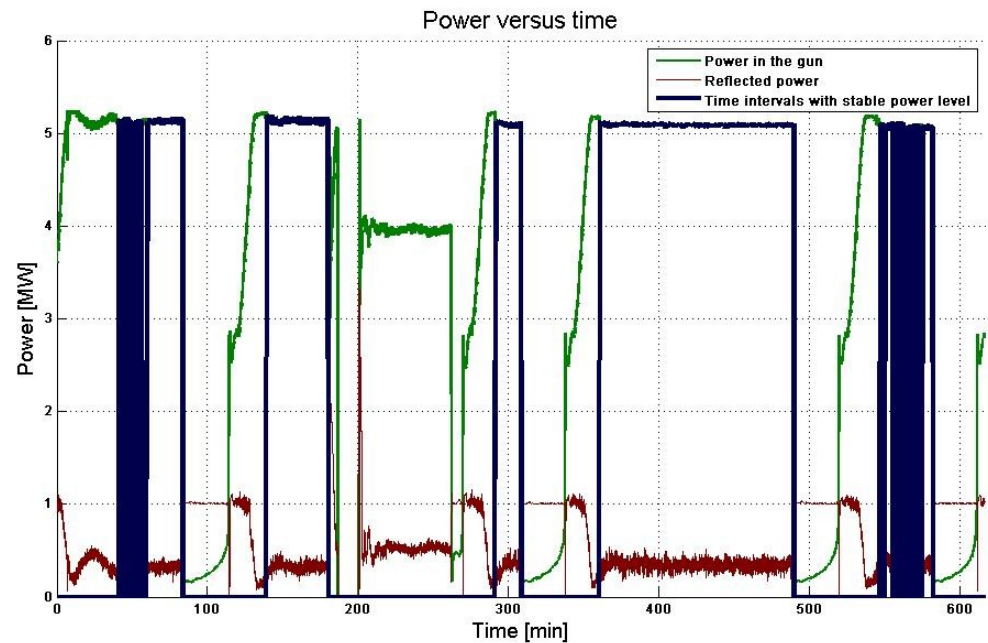
- 4 only Gun PMT interlocks

Number of interlocks visible for the booster IL detectors: **3**

- 1 only Booster PMT's in Cell1 and in Cell14
- 2 Booster PD in WG2 and PMT's in Cell1 and in Cell14

Summary time: 174.23 min

Trip rate: 1.377 IL's/Hour



Power in the gun: 4.81 ± 0.09 MW

FB filter – OFF

Low.ICT1 charge filter - OFF

Results

Total number of interlocks: **6**

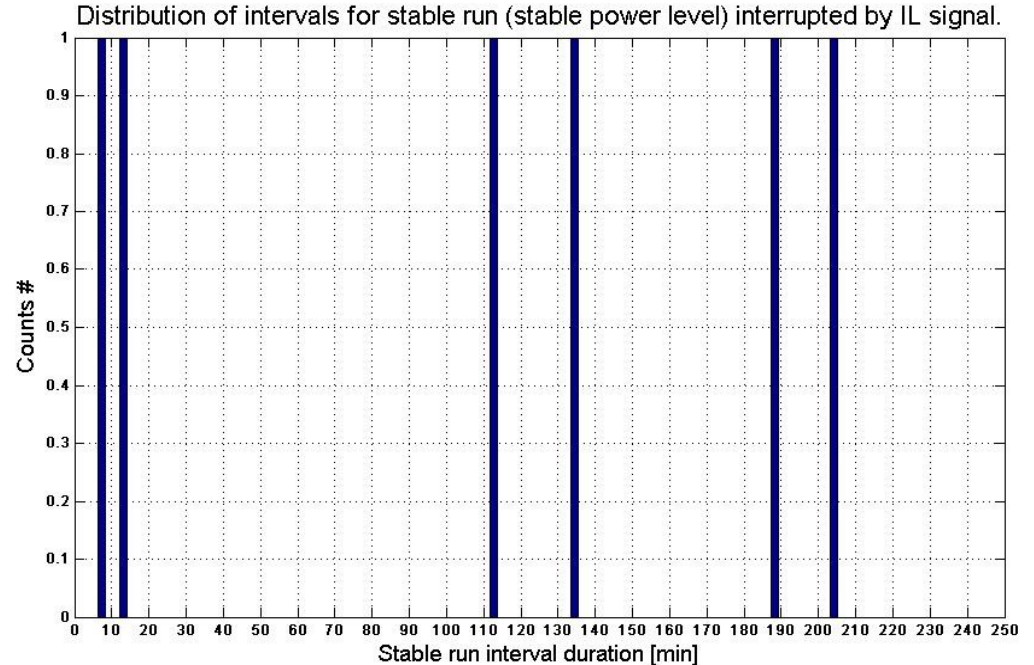
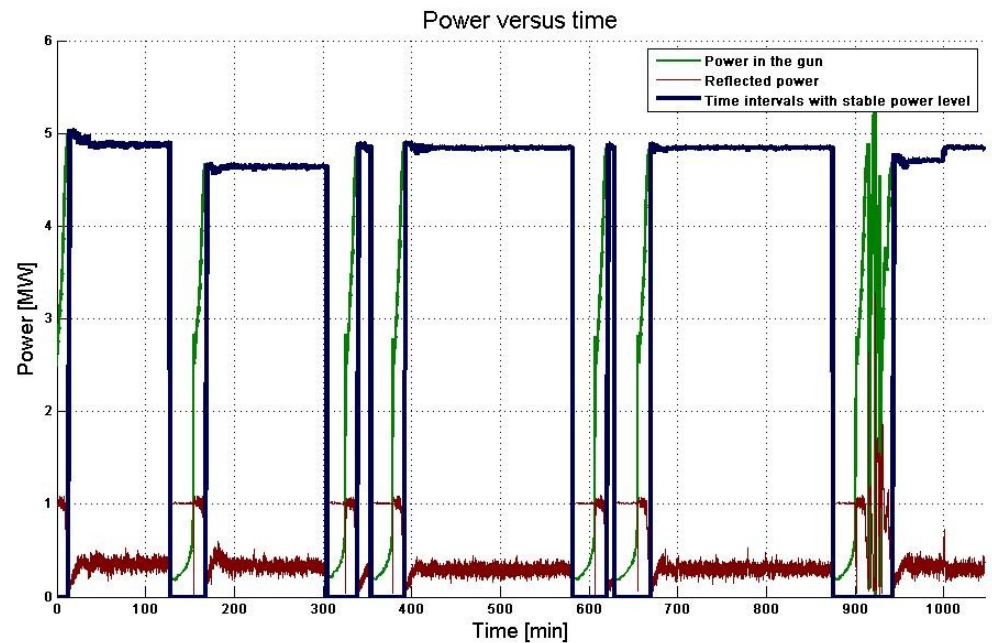
- 6 only Gun PMT interlocks

Number of interlocks visible for the booster IL detectors: **4**

- 4 Booster PD in WG2 and PMT's in Cell1 and in Cell14

Summary time: 660.23 min

Trip rate: 0.545 IL's/Hour



Power in the gun: 4.81 ± 0.09 MW

FB filter – **ON**

Low.ICT1 charge filter - OFF

Results

Total number of interlocks: **5**

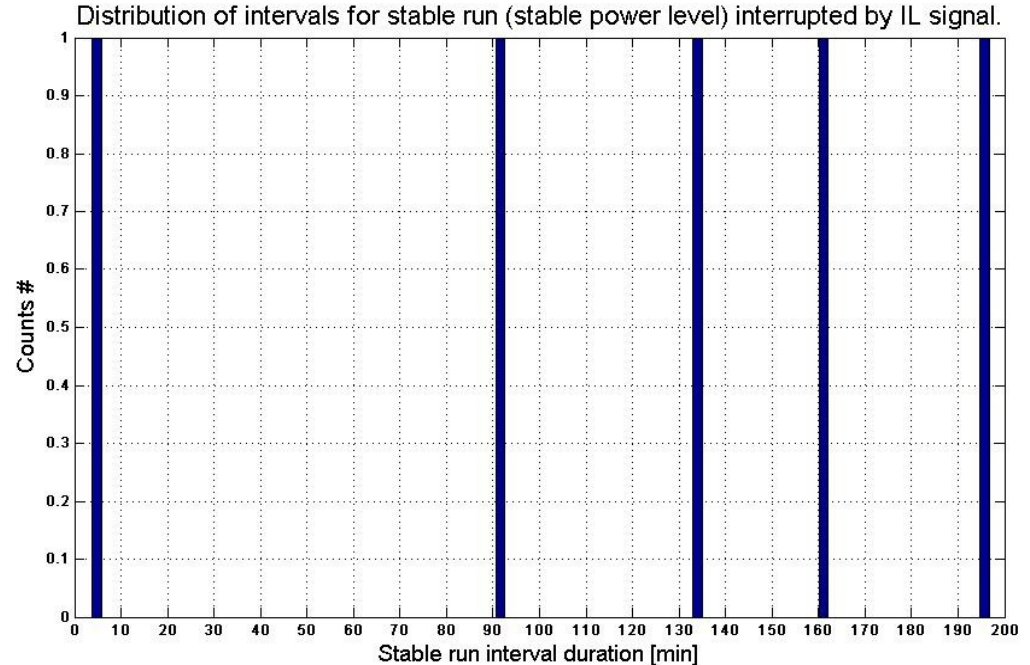
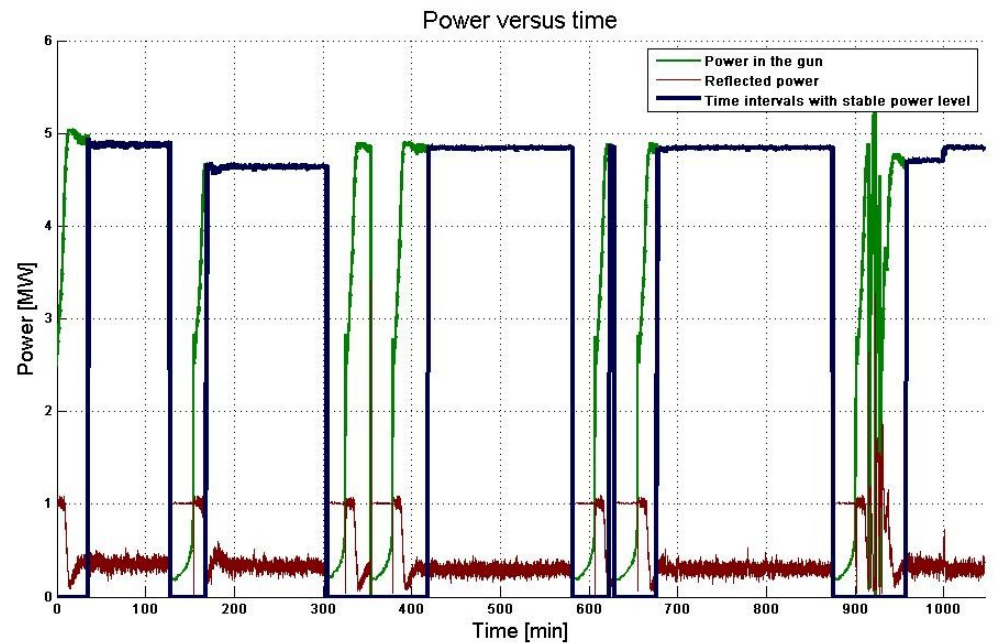
- 5 only Gun PMT interlocks

Number of interlocks visible for the booster IL detectors: **4**

- 4 Booster PD in WG2 and PMT's in Cell1 and in Cell14

Summary time: 588.98 min

Trip rate: 0.509 IL's/Hour



Power in the gun: 4.81 ± 0.09 MW

FB filter – ON

Low.ICT1 charge filter - **ON**

Results

Total number of interlocks: **5**

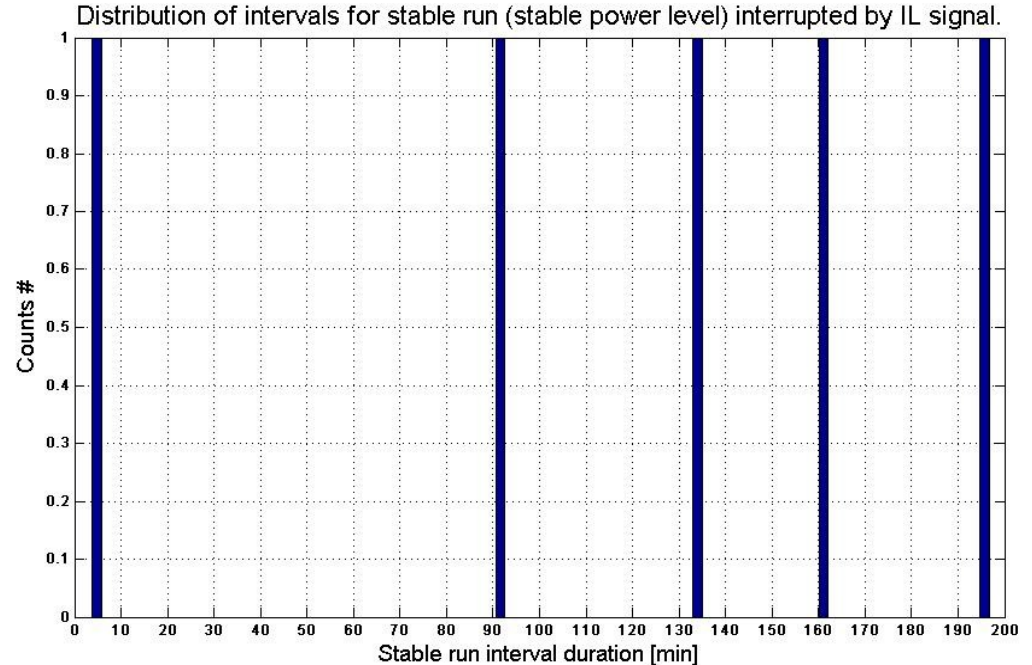
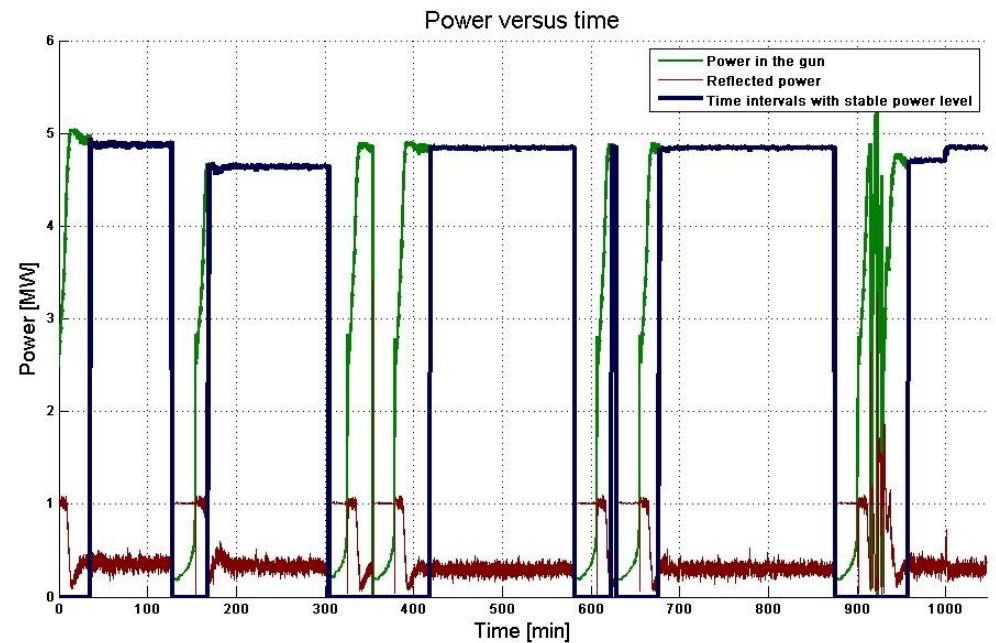
- 5 only Gun PMT interlocks

Number of interlocks visible for the booster IL detectors: **4**

- 4 Booster PD in WG2 and PMT's in Cell1 and in Cell14

Summary time: 588.98 min

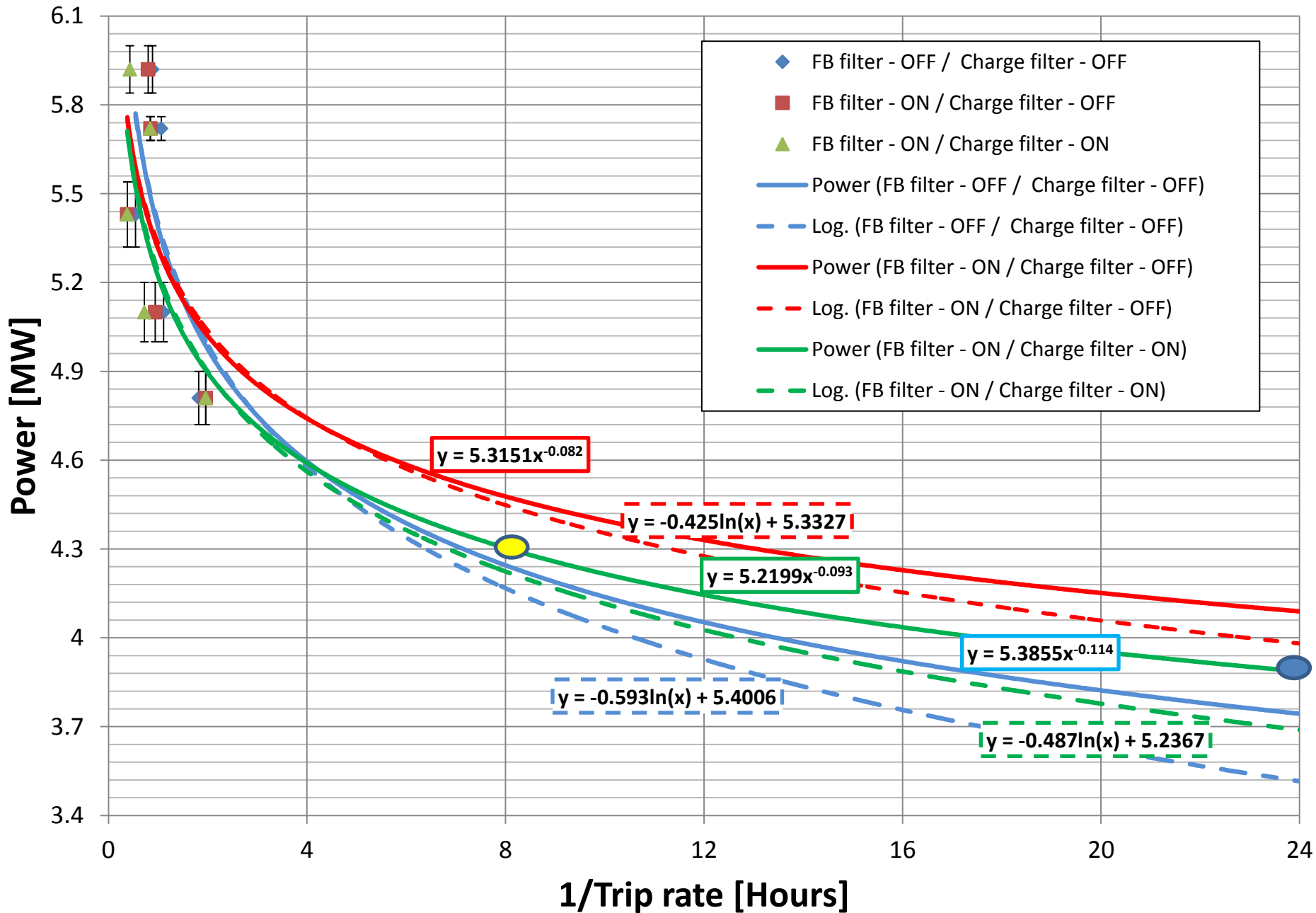
Trip rate: 0.509 IL's/Hour



SUMMARY

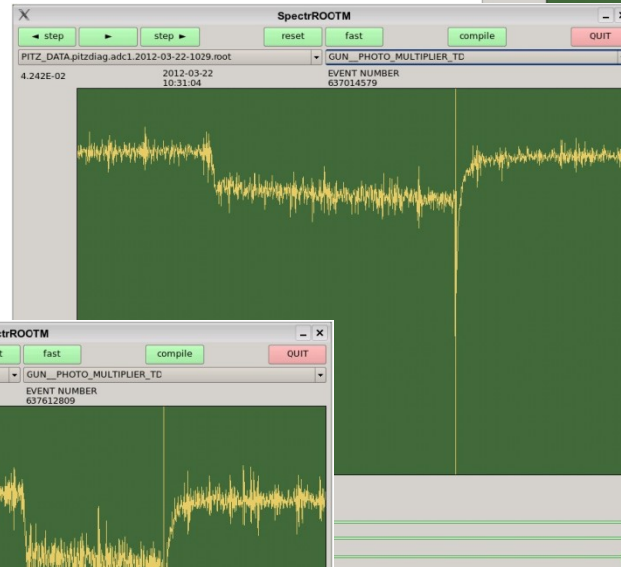
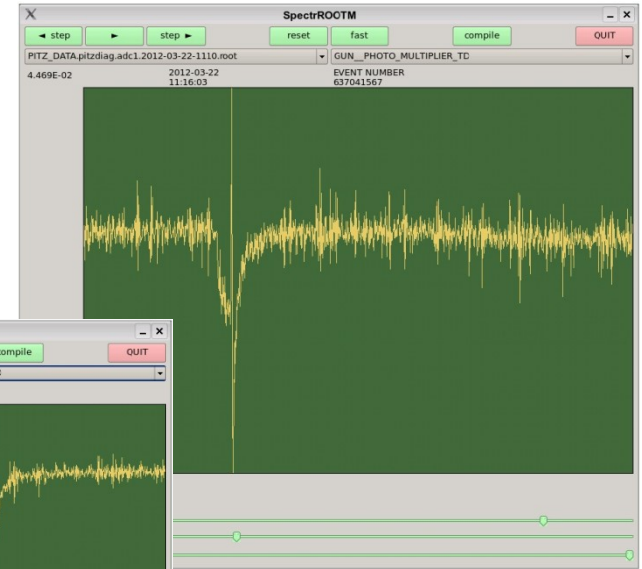
Power MW	FB filter – OFF Low.ICT1 charge filter - OFF			FB filter – ON Low.ICT1 charge filter - OFF			FB filter – ON Low.ICT1 charge filter - ON		
	No of Gun IL's / No of coupled booster IL's	Total time of stable periods [min]	Trip rate [1/hour]	No of Gun IL's / No of coupled booster IL's	Total time of stable periods [min]	Trip rate [1/hour]	No of Gun IL's / No of coupled booster IL's	Total time of stable periods [min]	Trip rate [1/hour]
5.95	35 / 20	1860.4	1.13	29 / 19	1388.5	1.25	24 / 19	620.08	2.32
5.75	3 / 3	192.60	0.94	3 / 3	153.00	1.18	3 / 3	150.83	1.19
5.40	6 / 5	197.05	1.83	4 / 3	90.87	2.64	4 / 3	90.87	2.64
5.10	4 / 3	268.15	0.90	4 / 3	227.13	1.06	4 / 3	174.23	1.38
4.85	6 / 4	660.23	0.55	5 / 4	588.98	0.51	5 / 4	588.98	0.51

Estimation of stable rf power levels



Typical Gun PMT signals (at time of long term tests)

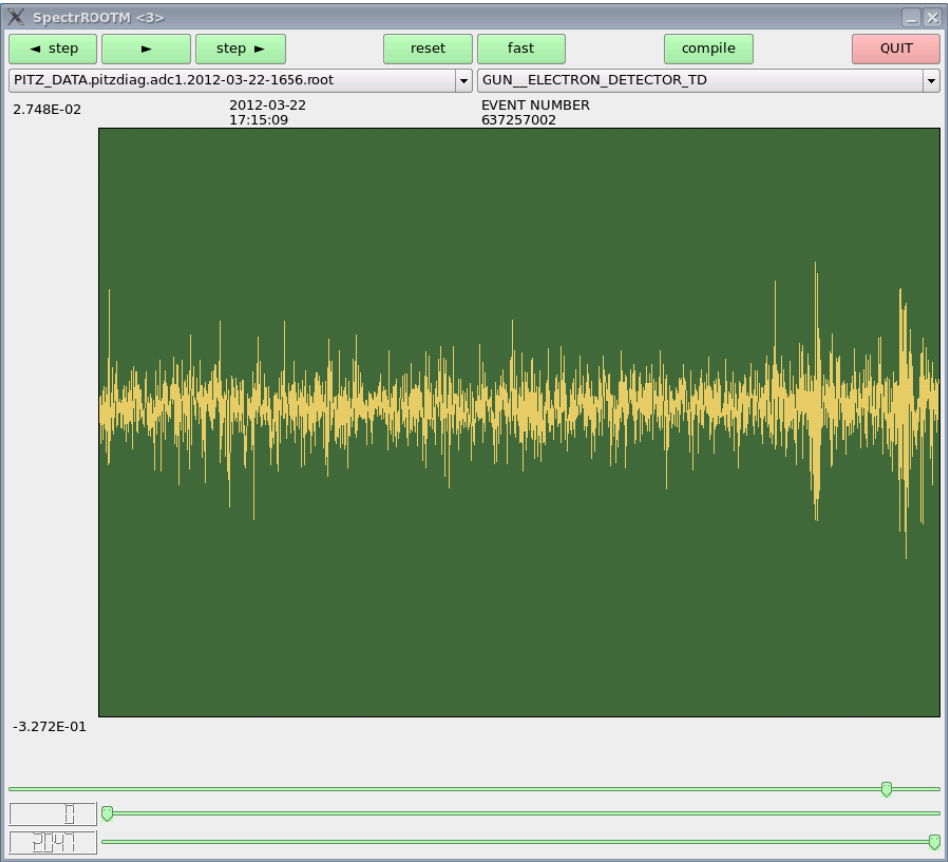
Typical base signal on the gun PMT detector



Typical gun PMT detector signals during interlock

Typical Gun e-det signals

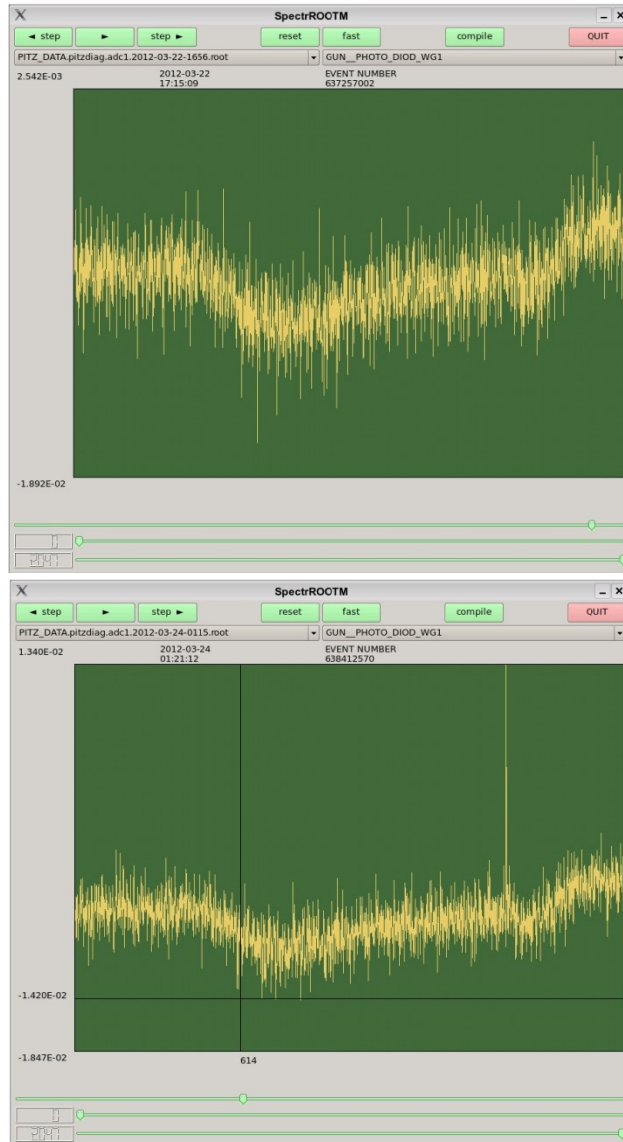
Typical base signal on the gun e-detector



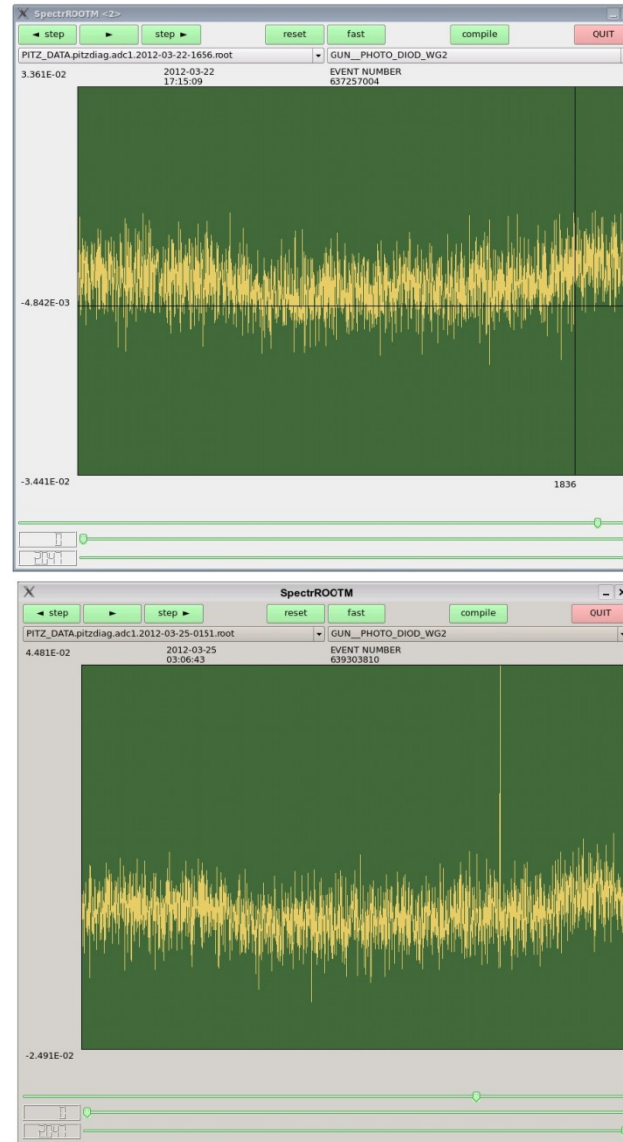
No gun e-detector interlocks was observed

Typical Gun PD's signals

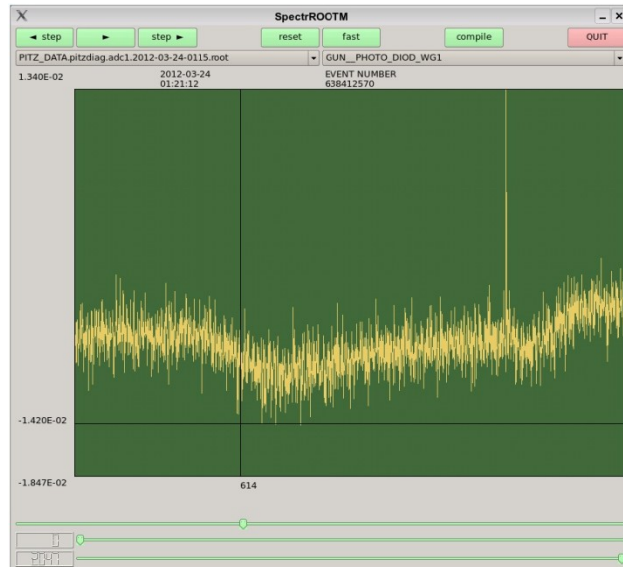
Typical base signal on the gun PD WG1 det



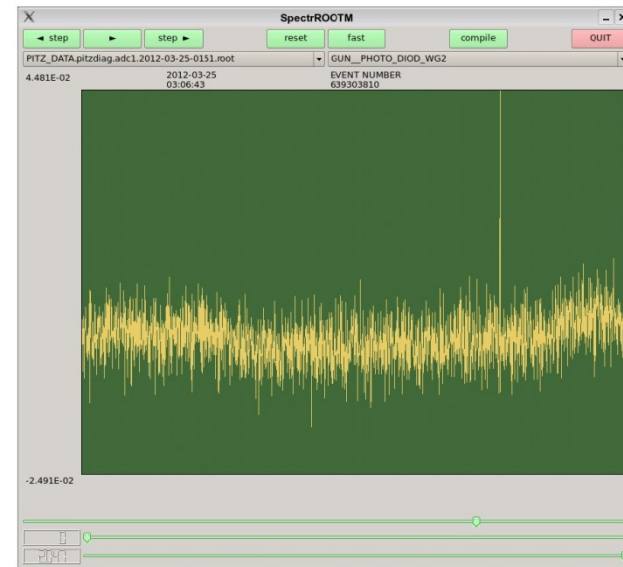
Typical base signal on the gun PD WG2 det



Typical PD WG1 det signal during interlock



Typical PD WG2 det signal during interlock



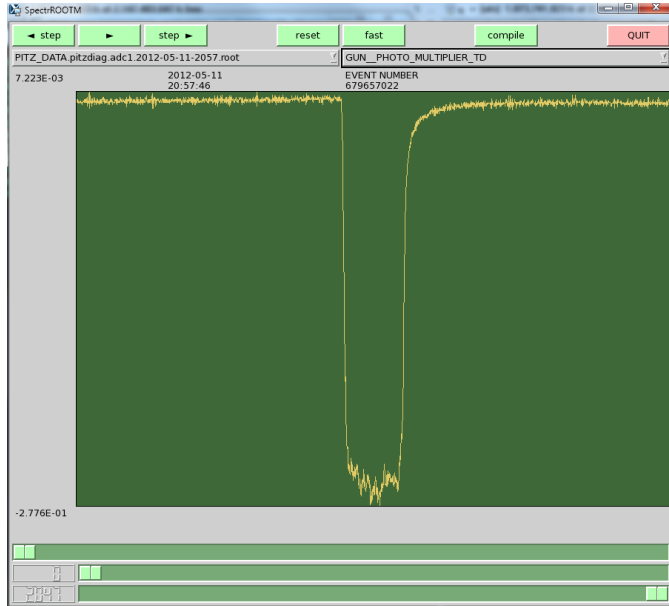
Conclusions and outlook

- Long-term tests performed on 21.03.2012 – 26.03.2012:
 - 700 us rf pulse duration at a maximum stable peak power level
 - FB switched ON after the stable gun cavity run achieved
 - Electron bunch train (650 pulses and $Q > 0.4 \text{ nC}$) production
 - The stability is rather far from the final goal (one interlock per WEEK !!!)
- The power trends yield:
 - one interlock per day at a peak power $< 4.1 \text{ MW}$ in the gun (? TBC)
 - one interlock per shift at a peak power $< 4.5 \text{ MW}$ in the gun (? TBC)
- Main reason of gun trips:
 - Gun PMT interlocks (100%)
 - Gun vacuum ILs – coupled with PMT - $\sim 50\%$ only at the highest peak power of 5.92 MW
 - Crosstalk with booster interlocks: mainly Booster PMT's in cell1/14 and PD in WG2 – always coupled with gun PMT IL (the booster was off and the valves between gun and booster were open)
- Long recovering time after interlocks: $> 40 \text{ min}$
- Several additional long term tests were performed, averaged trip rates are not much better, the detailed analysis is ongoing
- Additional RF conditioning is highly desirable! :
 - Starting short rf pulses and highest attainable peak power levels
 - Using updated IL signals (narrow band amplifier) – thresholds to be adjusted
- Afterwards new long term tests to be done:
 - Using the same approach as done
 - Or/and checking the power trend (e.g. $4.1..4.5 \text{ MW}$ in the gun)

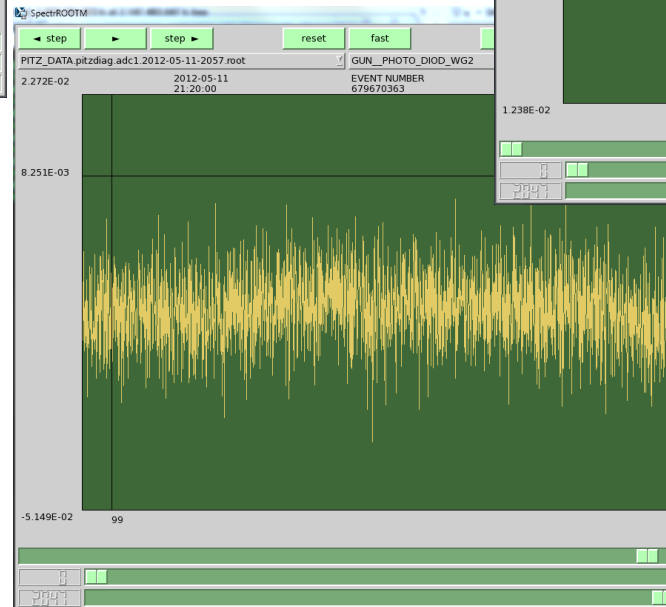
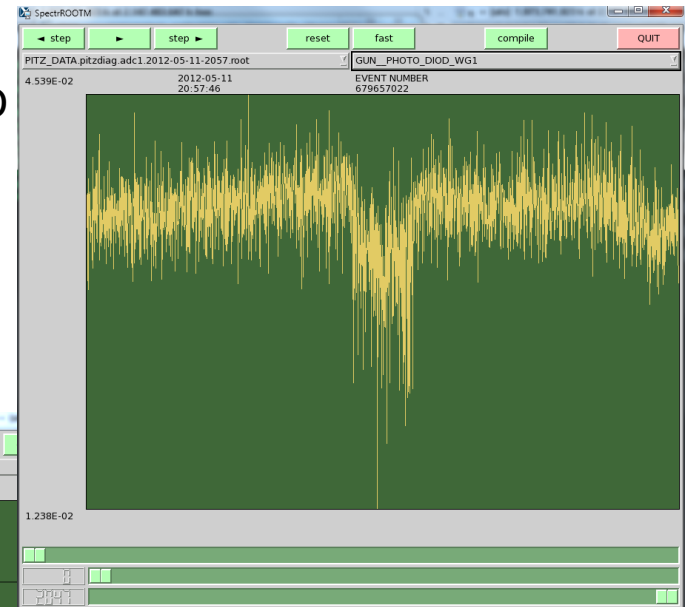
Additional slides

Typical Gun PMT and PD signals after readjustment electronics of detectors and threshold levels.

Typical signal on the gun PMT detector



Typical signal on the gun PD detector in WG1

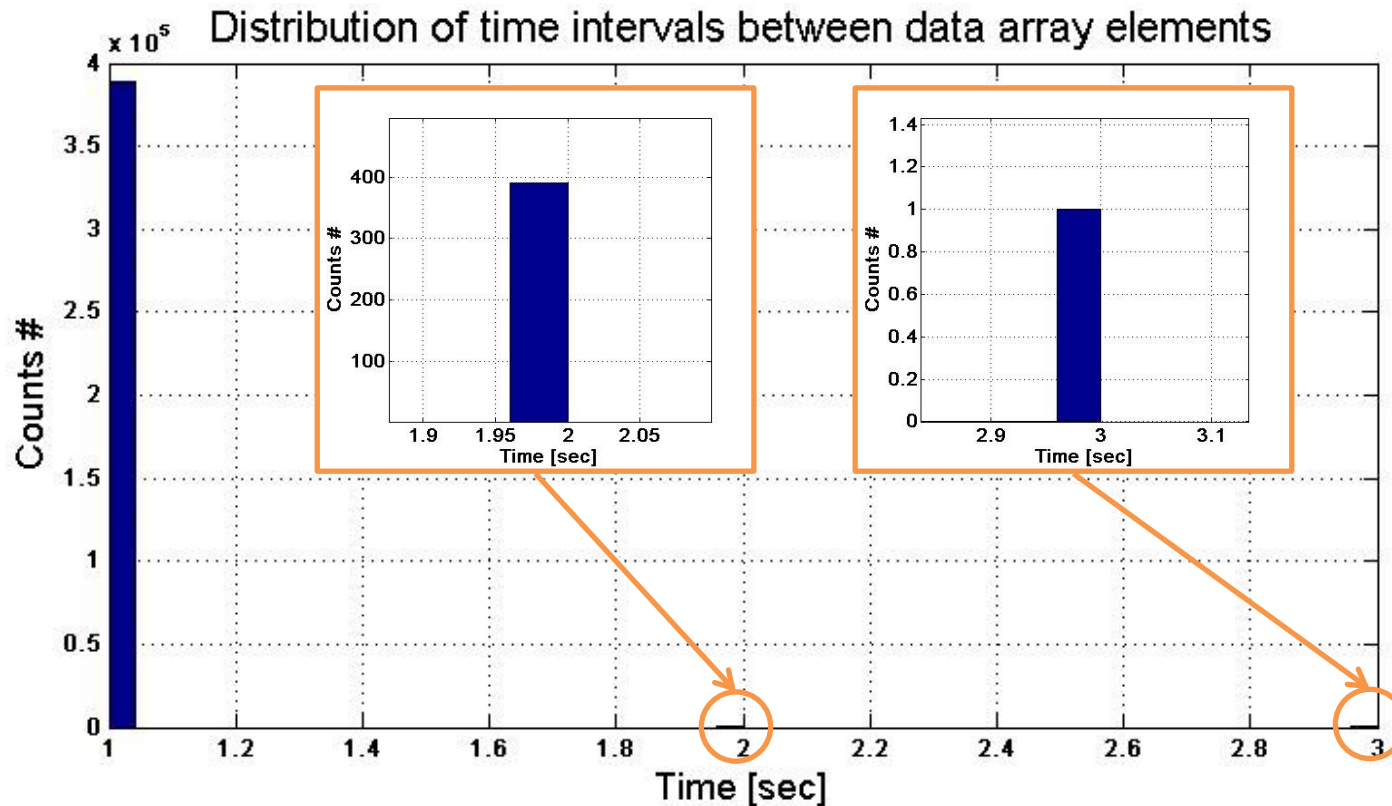


Typical signal on the gun PD detector in WG2

Missed events in the DAQ

The PITZ GUN trip rate analysis is based on data taken from the DAQ system. But among these data there are missed events due to technical troubles.

The power levels data saved in DAQ with repetition rate of 1 Hz. If time interval between data array elements more than 1 sec means that the event is missing.



The number of missed events is **0.101%**