Faul Tolerant Local and Monitoring Control Board
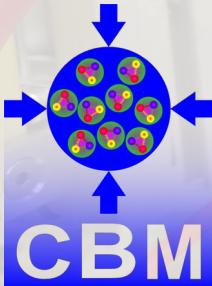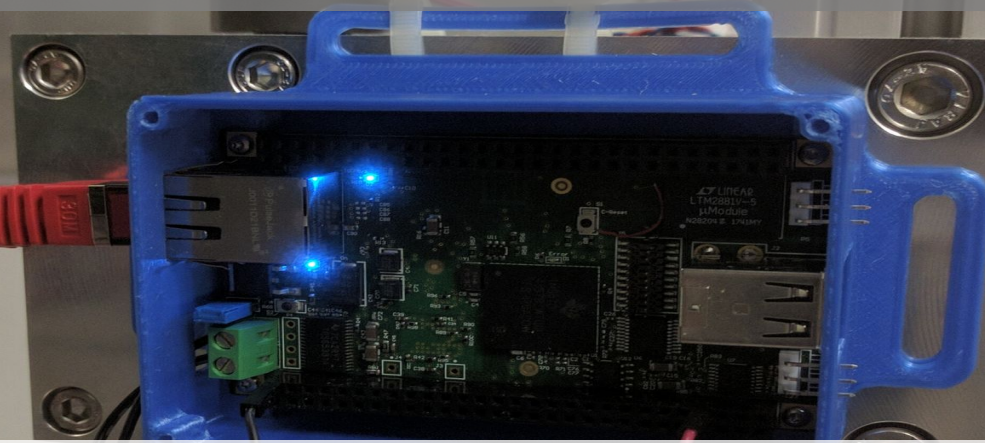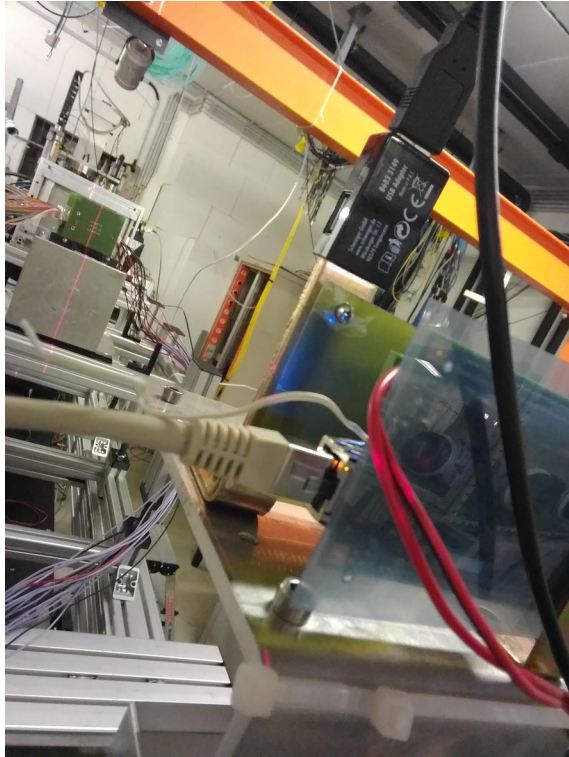
Research group Prof. Udo Kebschull
José Antonio Lucio Martínez

Infrastructure and Computer Systems in Data Processing
Goethe Universität Frankfurt

Beamtime conditions

- Beam

  - Cycle duration: 26s

 - Beam on: 2s

  - Intensity: 3*10^9

  - Energy: 2740MeV/c

EXPERIMENT: 4
Momentum: 2740 MeV/c
Cycle Duration: 26 s

| Name	Time/ms	Timer1	Timer2	Status	Activ
Pulsgenerator	0	600	600	---	1
diagnose	1	302	---	840	1
Libera aus	2	---	711	---	1
Bumper laden	120	610	---	---	1
Tims-warte1_01	129	601	---	---	1
Bumper starten	130	---	611	---	1
dipolstart	150	101	---	---	1
poco-start	153	100	100	---	1
fastTune_rauschen	751	901	---	---	1
BPM	6000	301	---	---	0
bb_an	6001	---	---	851	1
Libera an	6500	710	---	---	1
use1_on	6501	---	---	811	1
HF_kurz	6900	---	---	831	0
hf_kurz_bb_off	7500	---	---	831	0
TuneStripLine_an	7999	---	---	785	0
use1_off	8499	---	---	810	0
use2_on	8500	---	---	812	1
use12_on	8502	---	---	813	0
Timswarte2_1	10000	---	602	---	1
Timswarte2_2	12000	---	602	---	1

Beamtime conditions
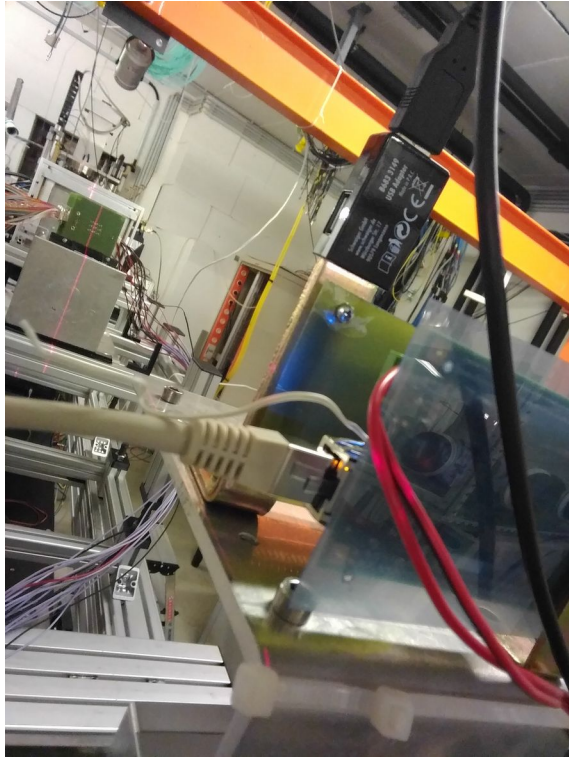
- Test covered
  - Raspberry and FTLMC
    - DC-DC converter
    - μC
  - EBT3 Dosimetry
    - Screws to locate components in film
  - Measure dcdc voltage
  - Binary server to check μC

DCDC Converter irradiation
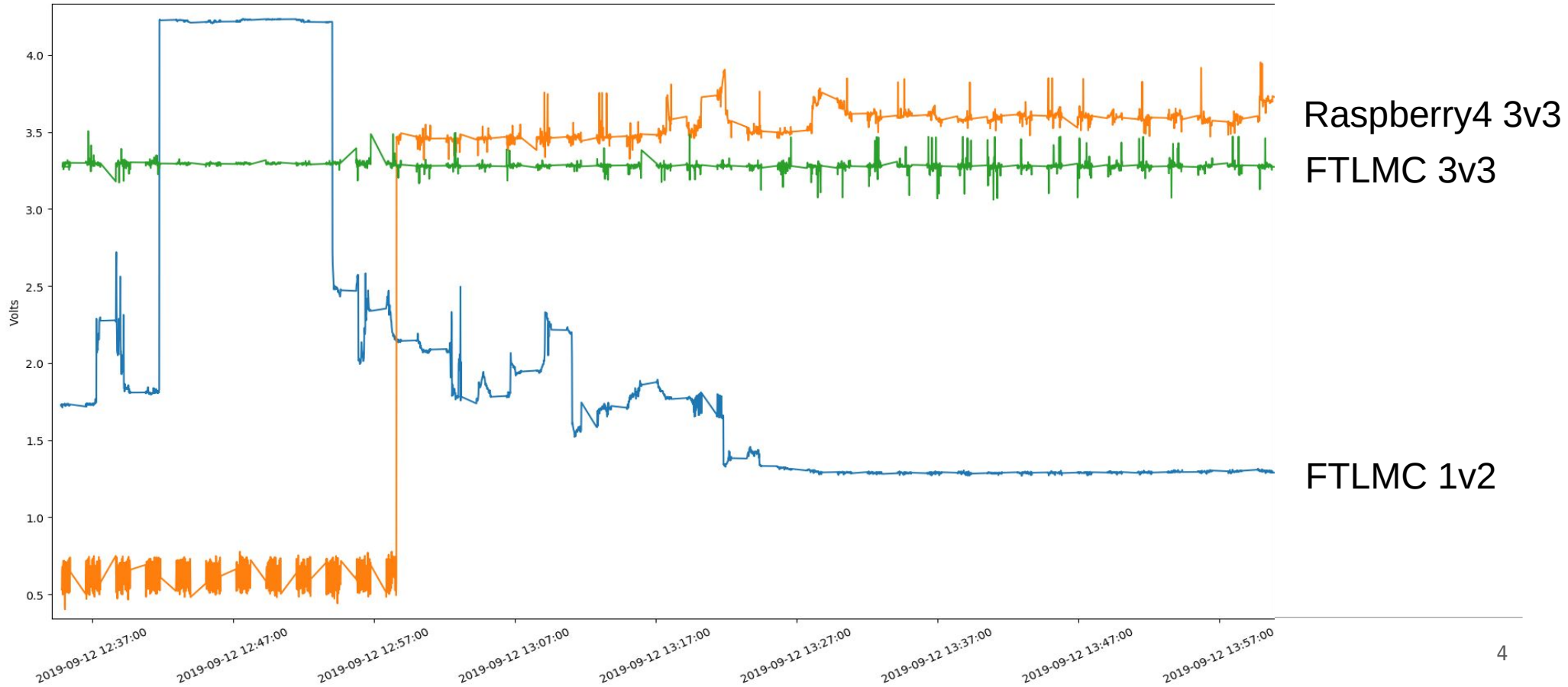
DCDC Converter irradiation- Reachability
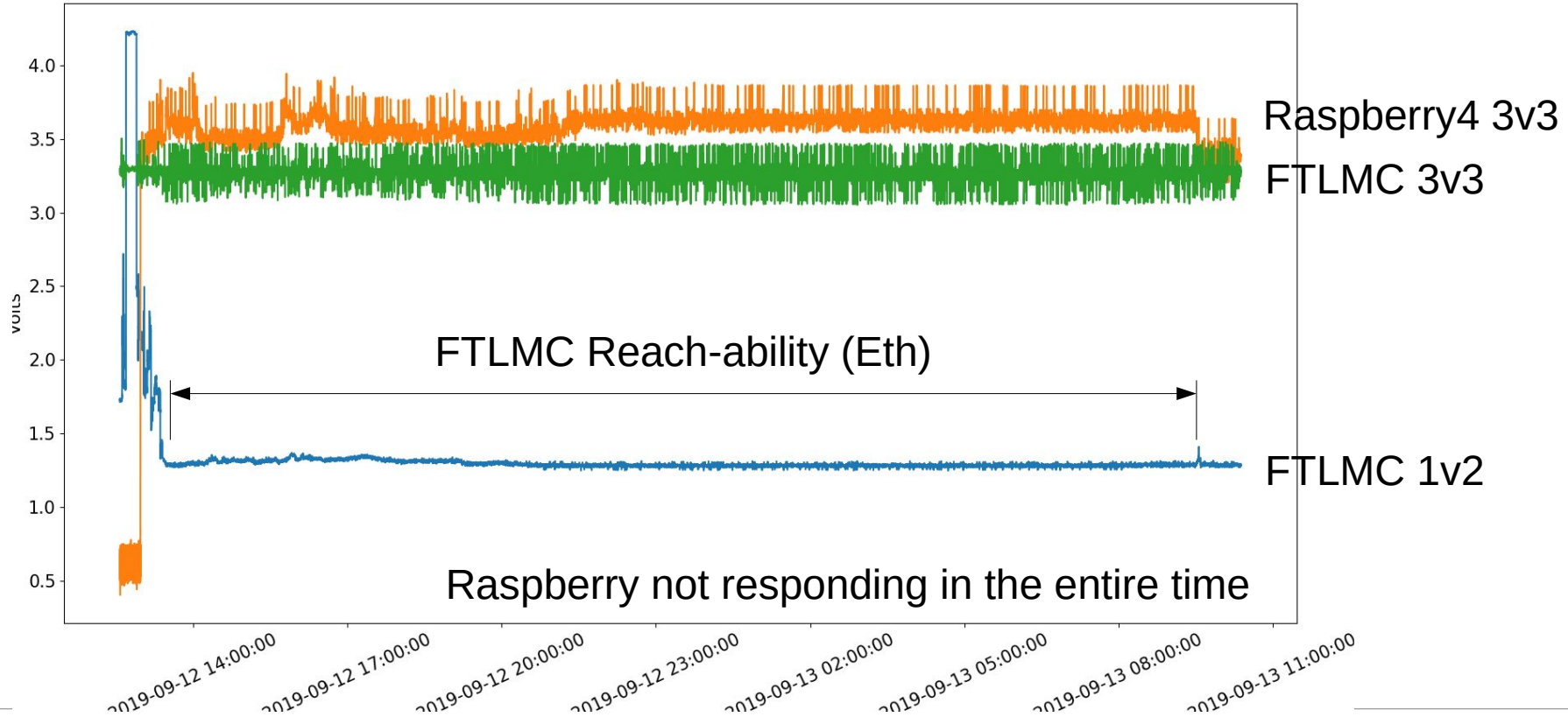
μC irradiation

- After DCDC irradiation, FTLMC DUT 1 was replaced by FTLMC DUT 2

- Raspberry 4 was replaced by raspberry3b

- No DCDC voltage measure was obtained in the μC irradiation

- Devices were probed through Ethernet traffic

- There are EBT3 films for both DCDC and μC irradiation, but only took cellphone pic from the second

- EBT3 DCDC film will be picked together with the DUTs on friday

μC irradiation-Initial Ethernet traffic

Raspberry stops responding

No.	Time	Source	Destination	Protocol	Length	Info
1593…	68188.599990	10.0.0.1	10.0.0.89	ICMP	98	Echo (ping) request id=0x6f18, seq=1914/31239, ttl=64 (no response found!)
1593…	68188.611894	AsustekC_09:e0:24	Raspberr_ed:9d:88	ARP	42	Who has 10.0.0.89? Tell 10.0.0.1
1593…	68189.453913	10.0.0.1	10.0.0.16	TCP	62	51779 → 80 [PSH, ACK] Seq=4305 Ack=2153 Win=14600 Len=8
1593…	68189.454308	10.0.0.16	10.0.0.1	TCP	60	80 → 51779 [PSH, ACK] Seq=2153 Ack=4313 Win=2712 Len=4
1593…	68189.454371	10.0.0.1	10.0.0.16	TCP	54	51779 → 80 [ACK] Seq=4313 Ack=2157 Win=14600 Len=0
1593…	68189.599973	10.0.0.1	10.0.0.89	ICMP	98	Echo (ping) request id=0x6f18, seq=1915/31495, ttl=64 (no response found!)
1593…	68189.613908	AsustekC_09:e0:24	Raspberr_ed:9d:88	ARP	42	Who has 10.0.0.89? Tell 10.0.0.1
1593…	68189.702744	10.0.0.80	10.255.255.255	UDP	60	1026 → 5065 Len=16
1593…	68190.453854	10.0.0.1	10.0.0.16	TCP	62	51779 → 80 [PSH, ACK] Seq=4313 Ack=2157 Win=14600 Len=8
1593…	68190.454211	10.0.0.16	10.0.0.1	TCP	60	80 → 51779 [PSH, ACK] Seq=2157 Ack=4321 Win=2704 Len=4
1593…	68190.454267	10.0.0.1	10.0.0.16	TCP	54	51779 → 80 [ACK] Seq=4321 Ack=2161 Win=14600 Len=0
1593…	68190.599968	10.0.0.1	10.0.0.89	ICMP	98	Echo (ping) request id=0x6f18, seq=1916/31751, ttl=64 (no response found!)
1593…	68191.453949	10.0.0.1	10.0.0.16	TCP	62	51779 → 80 [PSH, ACK] Seq=4321 Ack=2161 Win=14600 Len=8
1593…	68191.454321	10.0.0.16	10.0.0.1	TCP	60	80 → 51779 [PSH, ACK] Seq=2161 Ack=4329 Win=2696 Len=4
1593…	68191.454370	10.0.0.1	10.0.0.16	TCP	54	51779 → 80 [ACK] Seq=4329 Ack=2165 Win=14600 Len=0
1593…	68191.599938	AsustekC_09:e0:24	Broadcast	ARP	42	Who has 10.0.0.89? Tell 10.0.0.1
1593…	68192.453882	10.0.0.1	10.0.0.16	TCP	62	51779 → 80 [PSH, ACK] Seq=4329 Ack=2165 Win=14600 Len=8
1593…	68192.454243	10.0.0.16	10.0.0.1	TCP	60	80 → 51779 [PSH, ACK] Seq=2165 Ack=4337 Win=2688 Len=4
1593…	68192.454293	10.0.0.1	10.0.0.16	TCP	54	51779 → 80 [ACK] Seq=4337 Ack=2169 Win=14600 Len=0
1593…	68192.601859	AsustekC_09:e0:24	Broadcast	ARP	42	Who has 10.0.0.89? Tell 10.0.0.1
1593…	68193.453928	10.0.0.1	10.0.0.16	TCP	62	51779 → 80 [PSH, ACK] Seq=4337 Ack=2169 Win=14600 Len=8
1593…	68193.454306	10.0.0.16	10.0.0.1	TCP	60	80 → 51779 [PSH, ACK] Seq=2169 Ack=4345 Win=2680 Len=4
1594…	68193.454376	10.0.0.1	10.0.0.16	TCP	54	51779 → 80 [ACK] Seq=4345 Ack=2173 Win=14600 Len=0
1594…	68193.603911	AsustekC_09:e0:24	Broadcast	ARP	42	Who has 10.0.0.89? Tell 10.0.0.1
1594…	68194.453896	10.0.0.1	10.0.0.16	TCP	62	51779 → 80 [PSH, ACK] Seq=4345 Ack=2173 Win=14600 Len=8

```
Frame 159384: 42 bytes on wire (336 bits), 42 bytes captured (336 bits) on interface 0
  Interface id: 0 (p5p1)
  Encapsulation type: Ethernet (1)
  Arrival Time: Sep 14, 2019 11:33:23.026227000 CEST
```

IRI Tue, October 8, 2019
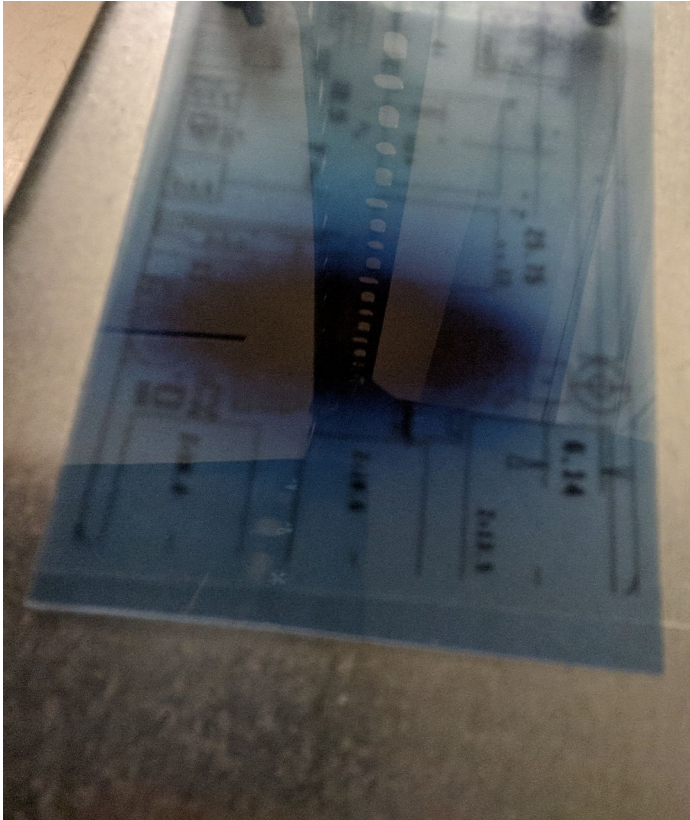
FTLMC binary server stops

Raspberry 3b μC irradiation

- Failed to establish ethernet conection 9 minutes after cave closed (probably when beam turned on)

- Ping used for probing

- Still to be picked up (cooling down)

- Unknown if is still operational after irradiation

IRI

FTLMC µC Irradiation
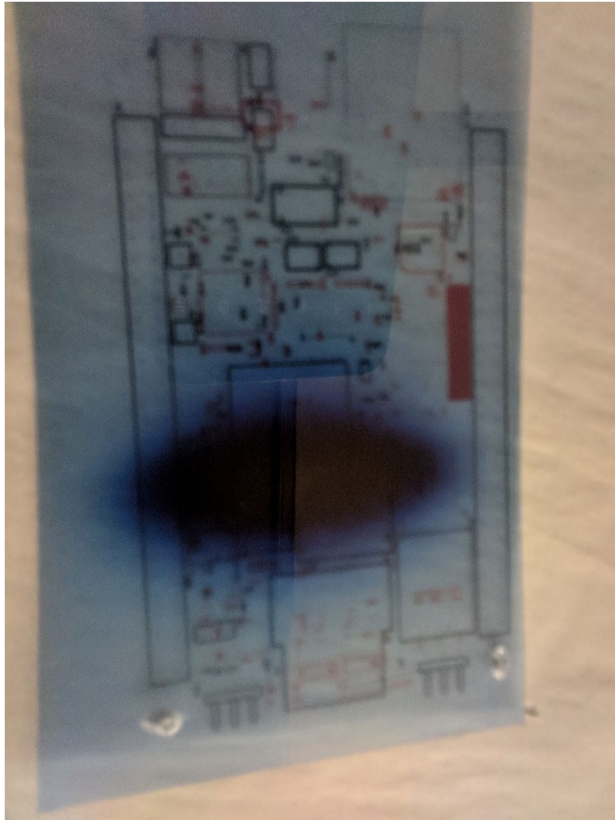
- FTLMC Ethernet binary server stopped responding after 30 minutes

- After 3 hours FTLMC binary server is again online for 3 minutes (ray on, high intensity)

- Same happens after 1 hr 45 minutes, this time for 8 minutes

- Unknown if DUT is operative after beamtime

- To be picked up in Jülich

Notes

- No picture of Beam in DCDC EBT3, film still to be picked up in Jülich

- XY frame fixed for the part from where the results where taken

- Two different FTLMC DUT used for DCDC converter irradiation and µC

- Raspberry4 used for DCDC converter irradiation

- Raspberry3b used for µC irradiation

IRI   Tue, October 8, 2019

Conclusion

- FTLMC DCDC converter is not radiation tolerant, but FTLMC kept working for more than 18 hours with DCDC in the high intensity beam after got stabilized from wide voltage variations.

- μC irradiation showed that TMS570 is not radiation tolerant, but it kept working for 30 minutes within the high intensity beam

- In former beam exposure it was demonstrated that as long as TMS570 is working, it scrubs its RAM memory in search for single and multiple event upsets, and corrects the SEUs

- Raspberry is not able to withstand radiation and did not seem to work at all in the high intensity beam