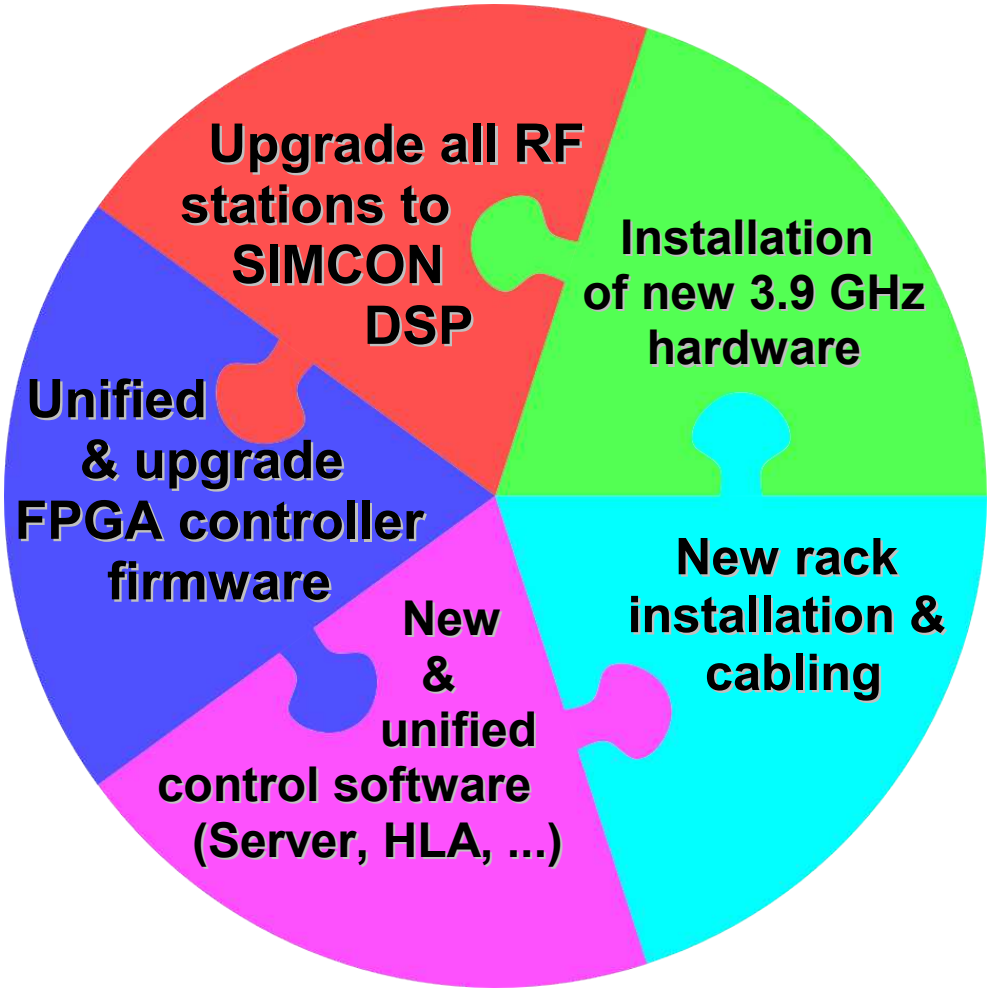
FLASH LLRF Injector re-cabling and improvements.

Matthias Hoffmann
FLASH Seminar, 12.10.2010

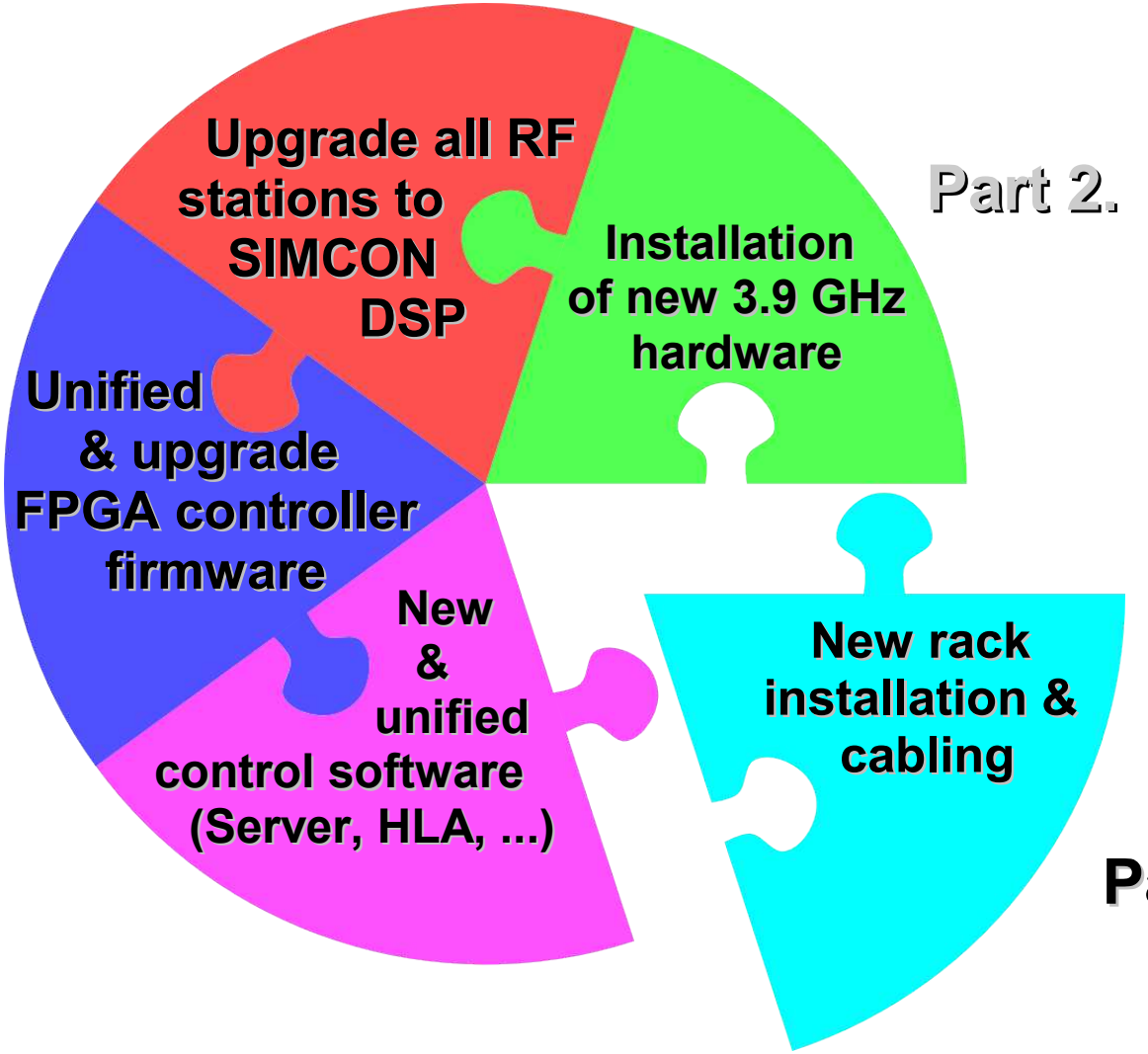
HELMHOLTZ ASSOCIATION

DESY

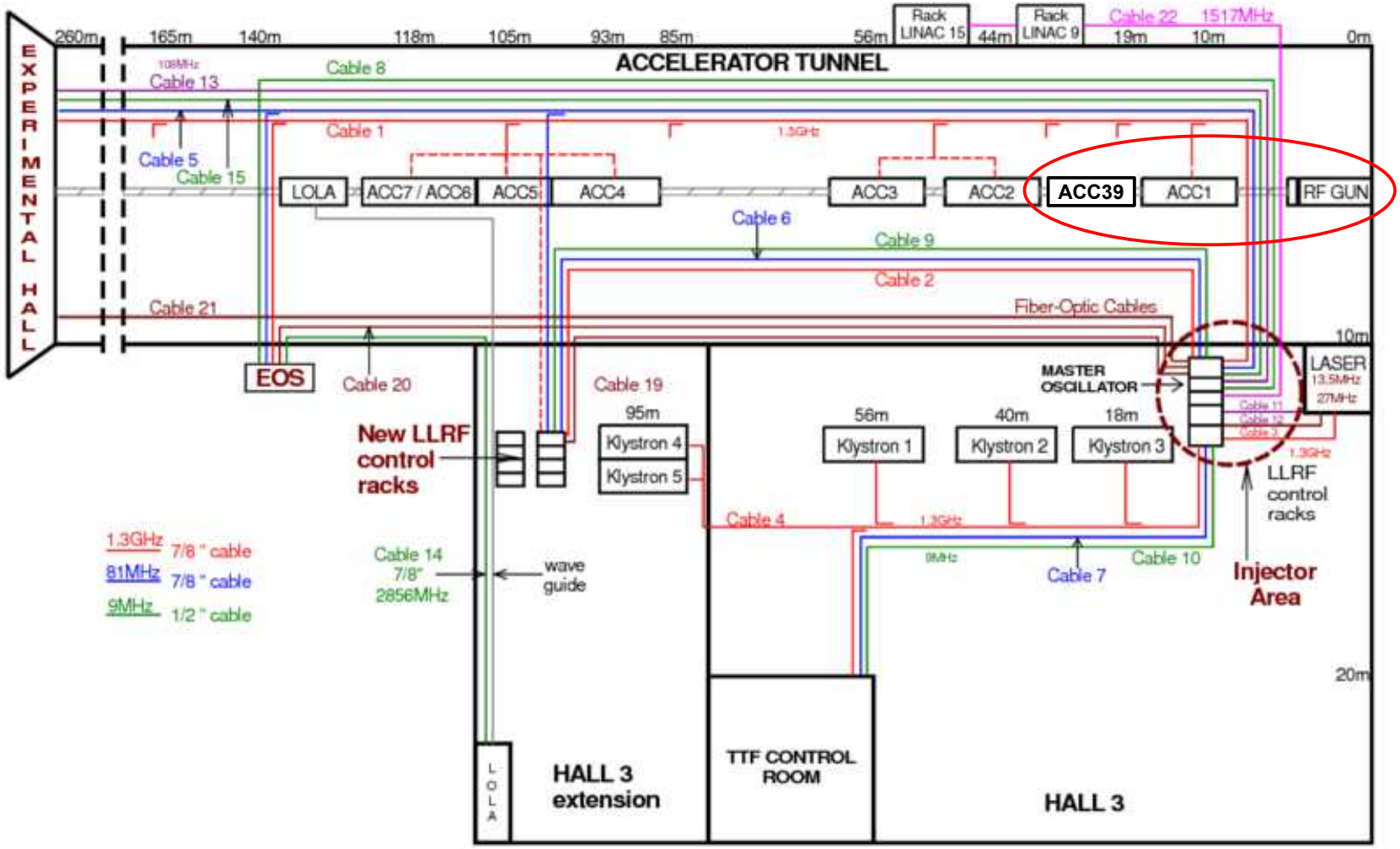
LLRF Upgrade during Shutdown.



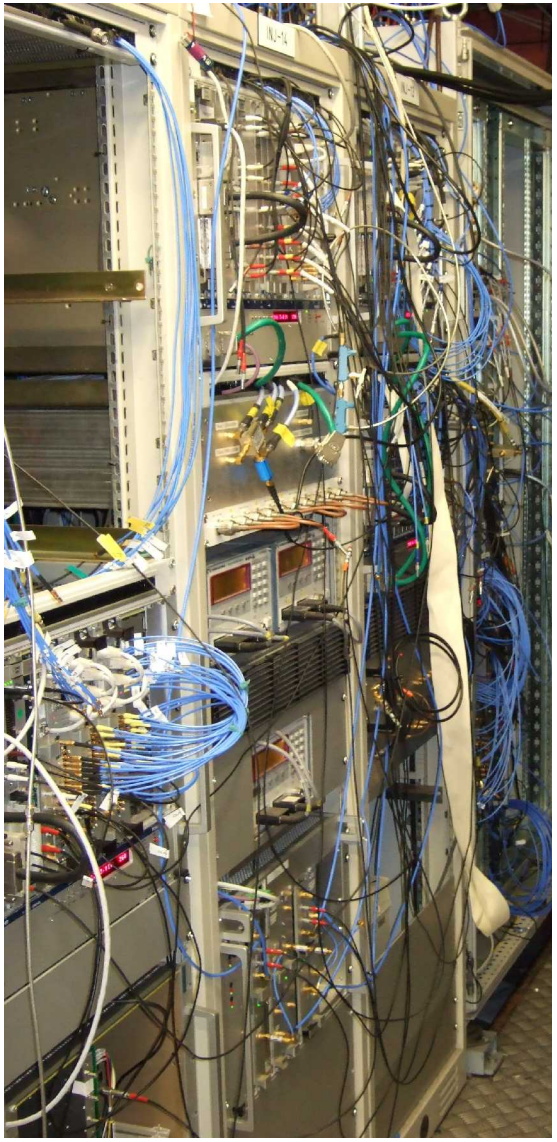
LLRF Upgrade during Shutdown.

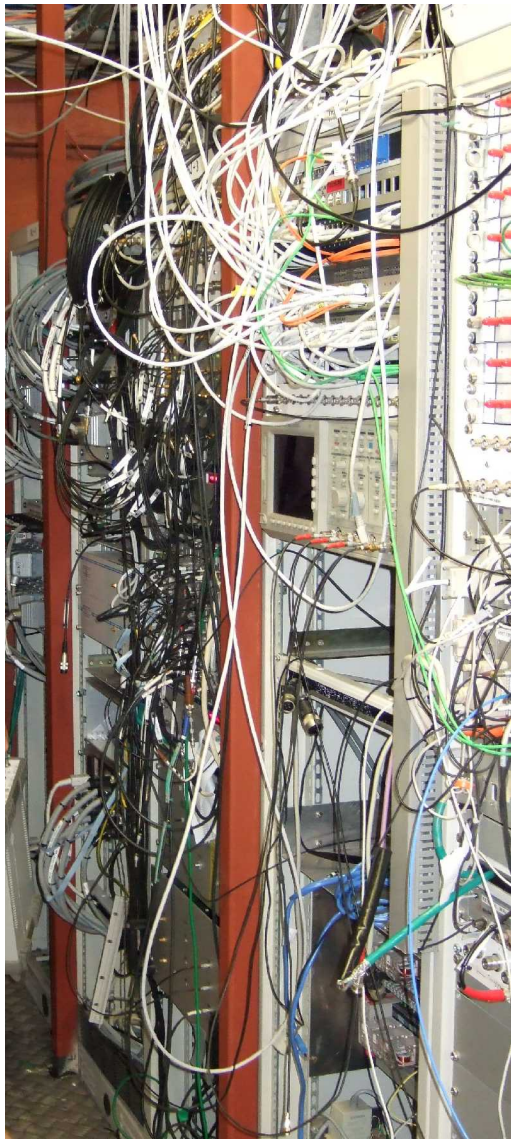


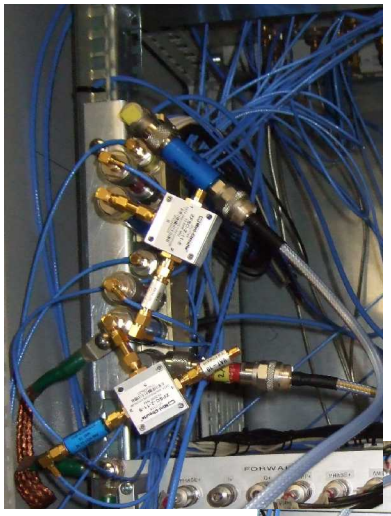
FLASH Overview.

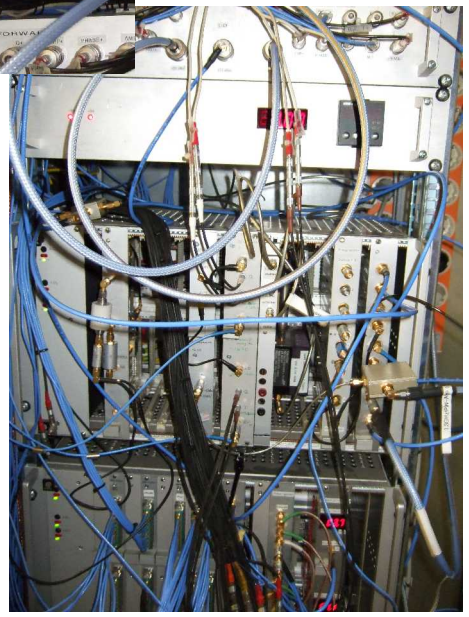


Old LLRF Injector Racks.

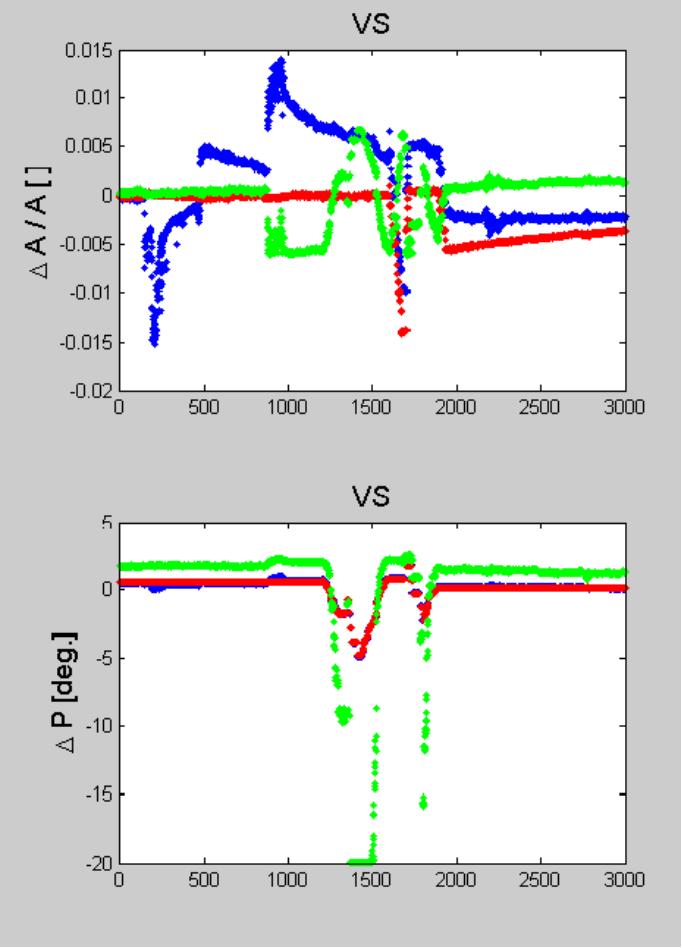




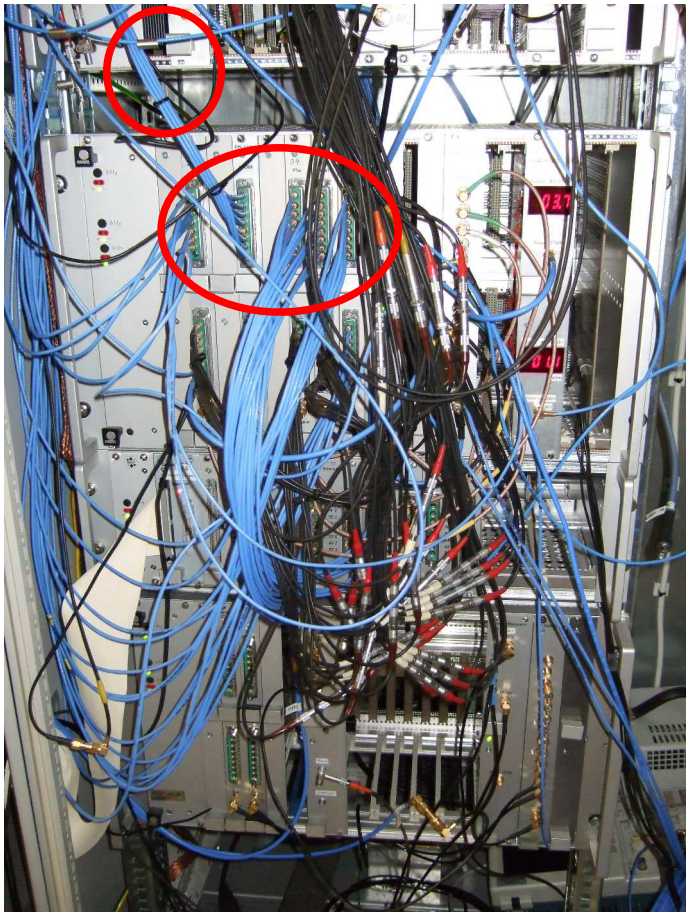




Problems with the old system.



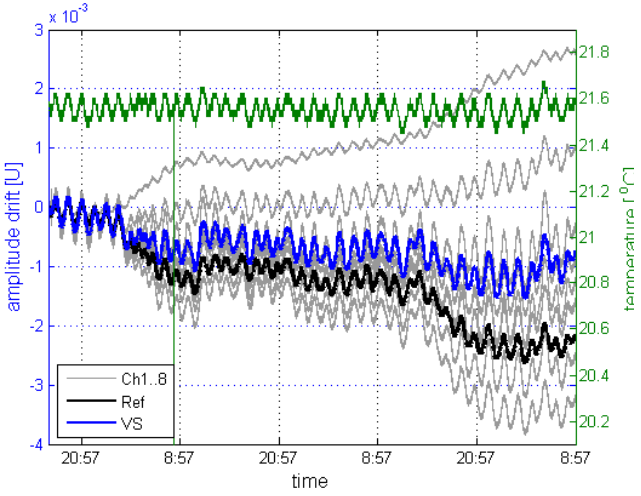
Critical RF cable and connector (e.g. at ACC1)



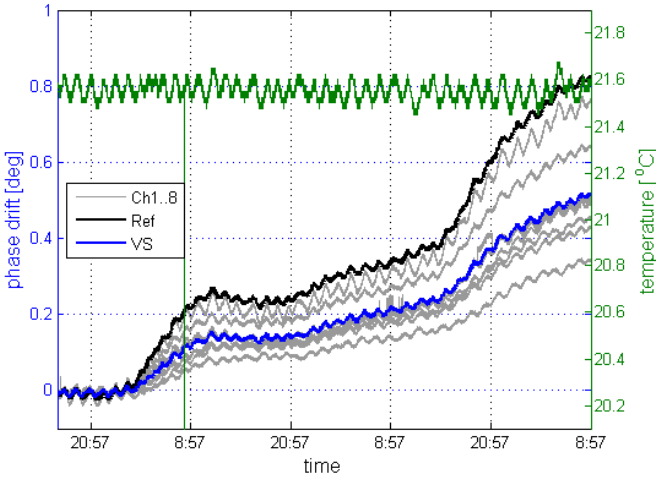
FLASH Seminar, 21.4.2009
"Beam Stability at FLASH – update", F. Ludwig

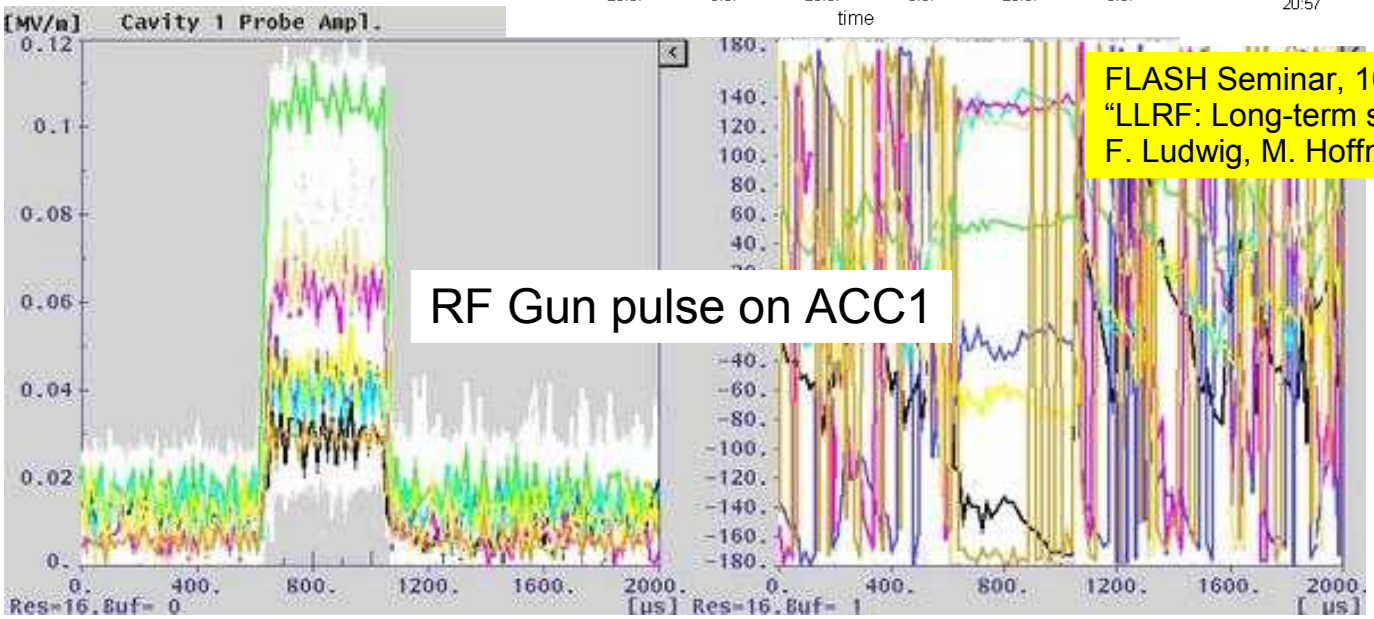
Problems with old System.

- Amplitude Drift :



- Phase Drift :





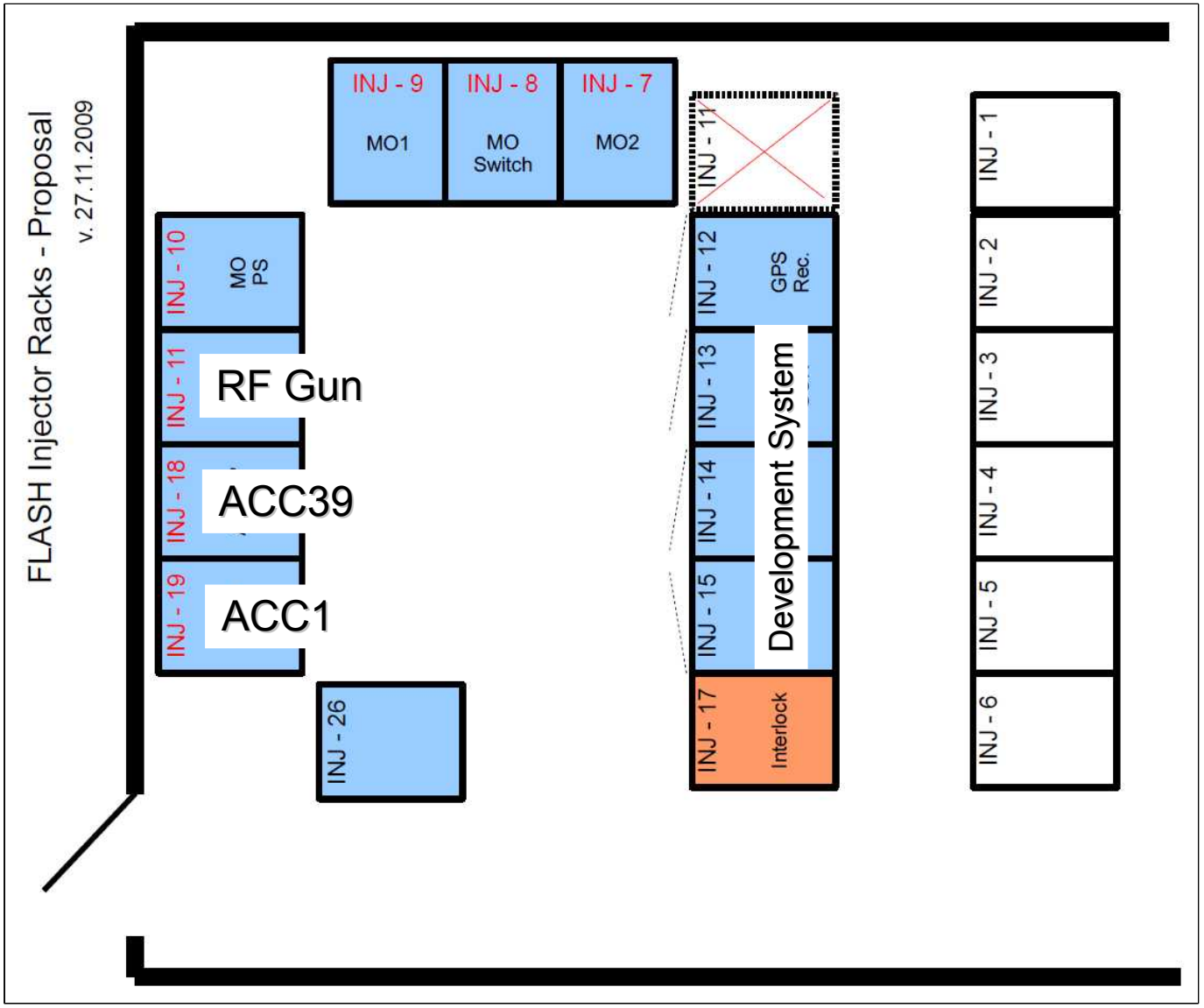
RF Gun pulse on ACC1

FLASH Seminar, 10.11.2009
"LLRF: Long-term stability improvements of ACC1",
F. Ludwig, M. Hoffmann

What was the plan.

- Move old LLRF system to racks of the development system
- Redistribution of the LLRF hardware
  - One rack for each system (ACC1, ACC39, RF Gun)
  - One MO signal (1.3GHz and 81 MHz) for each system (incl. decoupling by attenuators)
- Integration of new LLRF hardware for 3.9GHz system
  - 3.9GHz downconverter incl. external power supply.
  - 3.9GHz reference generation and distribution
  - 3.9GHz LO generation and distribution (3.954GHz)
  - Placeholder for drift calibration setup (probe signal of ACC1 and ACC39)
- Installation of new racks with doors and air-condition
  - For new development systems (xTCA)
  - Parallel system for RF Gun, ACC1 and ACC39

What was the plan.

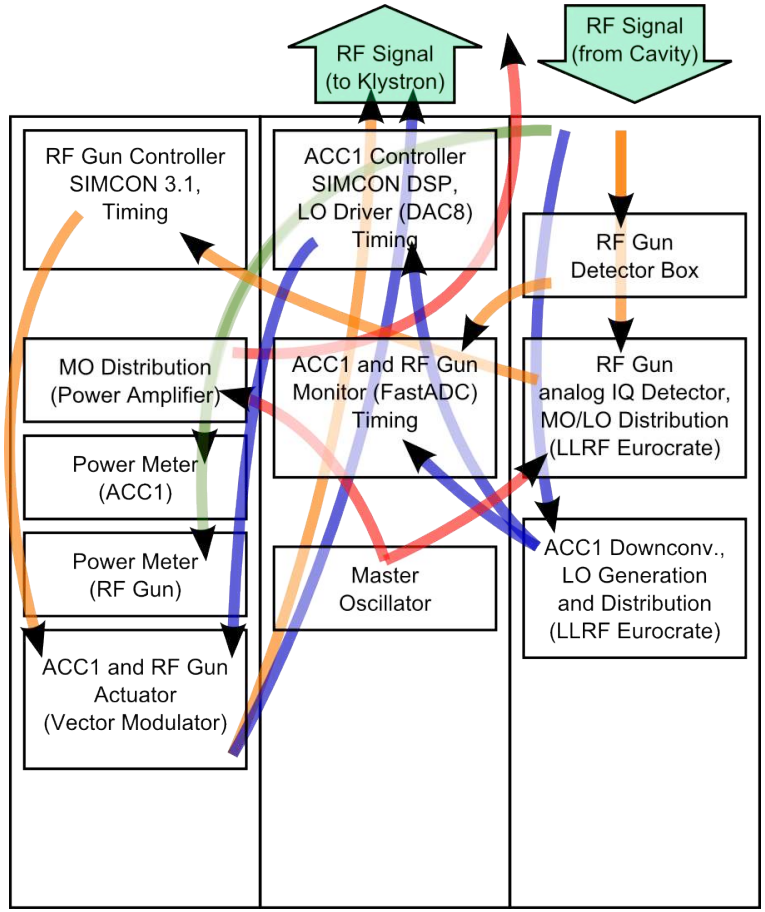


What was done.

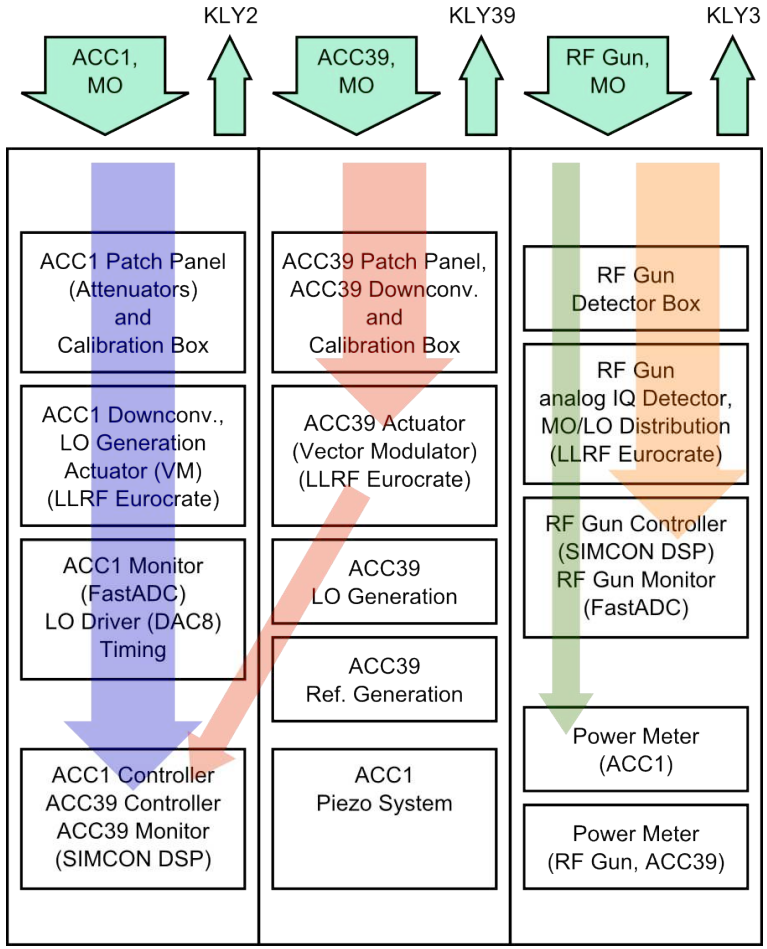
- Create system overview and cable lists of old LLRF system
- Remove old LLRF system and racks
- Reorganization of the system distribution within the racks
- Update system overview and cablelists for new LLRF system
- Organize and coordinate companies for cabling work:
  - Fa. ELSPEC for rack cabling
  - Fa. Wille for external cabling
- Optimization
  - Added patch panels within the racks for critical signals (mechanical stability)
  - Upgraded external cabling (½ inch cable)
  - Improved external cabling structure by patch panels
  - Power level adjustment
  - ...

Rack reorganization.

Previous LLRF rack layout



Current LLRF rack layout



Cabel lists.

Kabelplan_ACC1

Cable No.	Cable name	From			Description	Cable				To			Cable
		Rack	Crate/Device	Connector	Signal	Type	lenght	Con.typ 1	Con.typ 2	Rack	Crate/Device	Connector	
1	W1/Probe PPT A8	ACC1	Patch Panel Top	**A8**	1300 MHz Probe signal Cavity 1	LMR400UF		N-gerade	N-gerade	ACC1	Probe Patch Panel Back	J1	W1/ Pr
2	W2/Probe PPT A7	ACC1	Patch Panel Top	**A7**	1300 MHz Probe signal Cavity 2	LMR400UF		N-gerade	N-gerade	ACC1	Probe Patch Panel Back	J2	W2/ Pr
3	W3/Probe PPT A6	ACC1	Patch Panel Top	**A6**	1300 MHz Probe signal Cavity 3	LMR400UF		N-gerade	N-gerade	ACC1	Probe Patch Panel Back	J3	W3/ Pr
4	W4/Probe PPT A5												
5	W5/Probe PPT A4												
6	W6/Probe PPT A3												
7	W7/Probe PPT A2												
8	W8/Probe PPT A1												
9	W9/Probe PPP-F J1												
10	W10/Probe PPP-F J2												
11	W11/Probe PPP-F J3												
12	W12/Probe PPP-F J4												
13	W13/Probe PPP-F J5												
14	W14/Probe PPP-F J6												
15	W15/Probe PPP-F J7												
16	W16/Probe PPP-F J8												
17	W17/Probe CalB J1												
18	W18/Probe CalB J2												
19	W19/Probe CalB J3												
20	W20/Probe CalB J4												
21	W21/Probe CalB J5												
22	W22/Probe CalB J6												
23	W23/Probe CalB J7												
24	W24/Probe CalB J8												
25	W25/Forw PPT B8												
26	W26/Forw PPT B7												
27	W27/Forw PPT B6												
28	W28/Forw PPT B5												
29	W29/Forw PPT B4												
30	W30/Forw PPT B3												
31	W31/Forw PPT B2												
32	W32/Forw PPT B1												
33	W33/Forw FPP-F J1												
34	W34/Forw FPP-F J2												
35	W35/Forw FPP-F J3												
36	W36/Forw FPP-F J4												
37	W37/Forw FPP-F J5												

Kabelplan_RFGUN

Cable No.	Cable name	From			Description	Cable				To			Cab
		Rack	Crate/Unit	Connector	Signal	Type	lenght	Con 1	Con 2	Rack	Crate/Unit	Connector	
1	W1/Forw PPT A1	RF Gun	Patch Panel Top	**A1**	1300 MHz RF Gun Forward	LMR400UF		N-gerade	N-gerade	RF Gun	Power Splitter #1	In	W01
2	W2/Refl PPT A2	RF Gun	Patch Panel Top	**A2**	1300 MHz RF Gun Reflected	LMR400UF		N-gerade	N-gerade	RF Gun	Power Splitter #2	In	W02
3	W3/KlyDr VM_Dr RF_out	RF Gu											
4	W4/PA1 PPT A6	RF Gu											
5	W5/PA2 PPT A7	RF Gu											
6	W6/Kly3 PPT A8	RF Gu											
7	W7/Forw_I GDB F_I+	RF Gu											
8	W8/Forw_Q GDB F_Q+	RF Gu											
9	W9/Refl_I GDB R_I+	RF Gu											
10	W10/Refl_Q GDB R_Q+	RF Gu											
11	W11/DrImon SCD DAC3	RF Gu											
12	W12/DrQmon SCD DAC4	RF Gu											
13	W13/1300MHz PPT B7	RF Gu											
14	W14/81MHz PPT B8	RF Gu											
15													
16	W16/Forw PS1 Out1	RF Gu											
17	W17/Forw PS1 Out2	RF Gu											
18	W18/Forw PS1 Out3	RF Gu											
19	W19/Refl PS2 Out1	RF Gu											
20	W20/Refl PS2 Out2	RF Gu											
21	W21/Refl PS2 Out3	RF Gu											
22	W22/1300MHz MODis Out1	RF Gu											
23	W23/1300MHz MODis Out2	RF Gu											
24	W24/1300MHz MODis Out3	RF Gu											
25	W25/1300MHz MODis Out4	RF Gu											
26	W26/1300MHz MODis Out5	RF Gu											
27	W27/LO PPT B9	RF Gu											
28	W28/ForwI IQD I1	RF Gu											
29	W29/ForwQ IQD Q1	RF Gu											
30	W30/ReflI IQD I2	RF Gu											
31	W31/ReflQ IQD Q2	RF Gu											

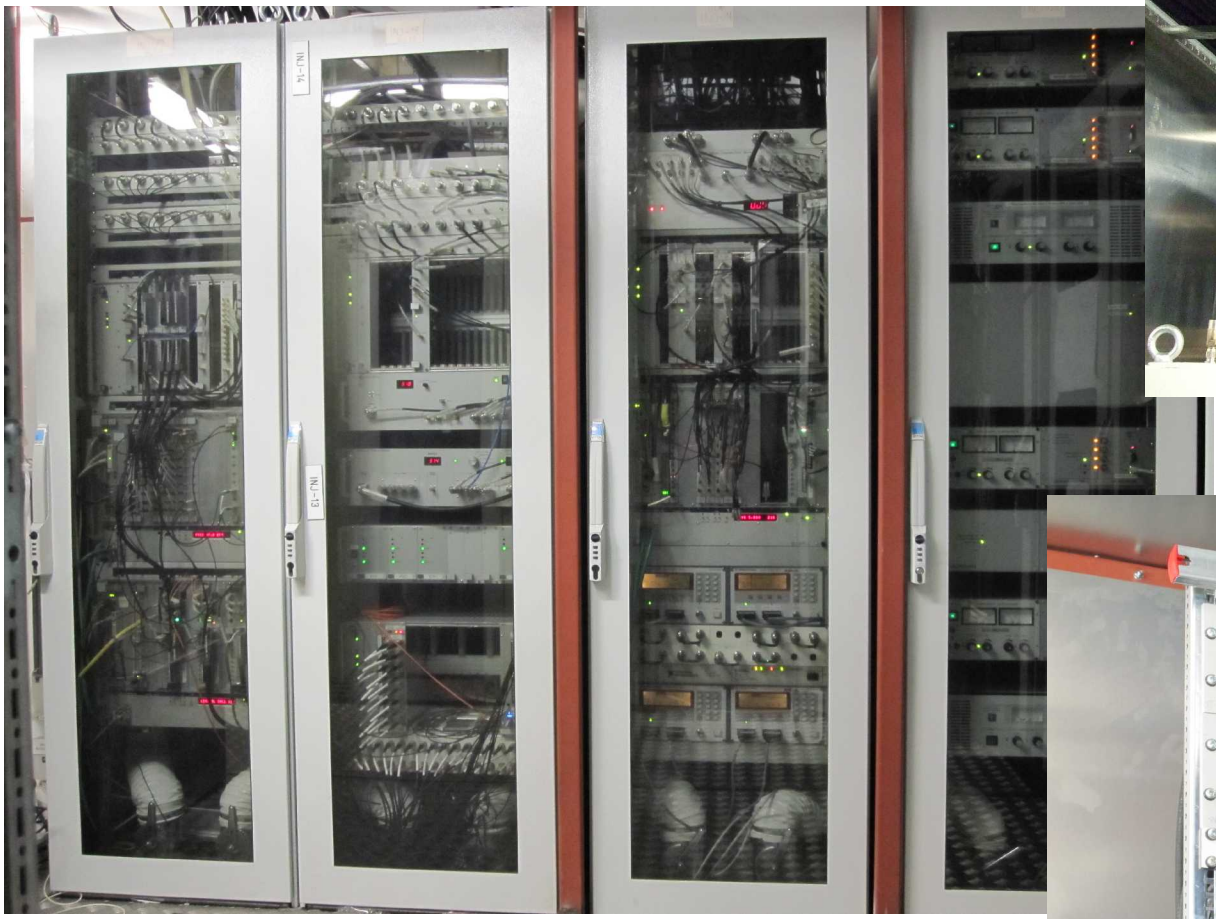
Kabelplan_ACC39

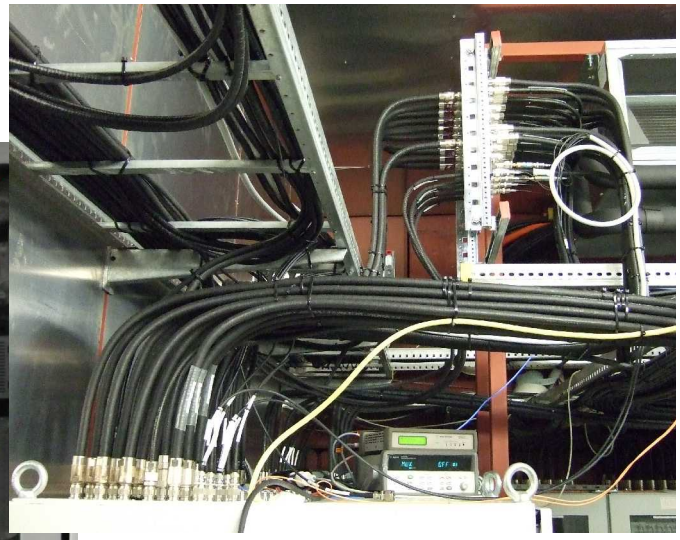
Cable No.	Cable name	From			Description	Cable				To			Cable name
		Rack	Crate	connector	Signal	Type	lenght	Conn 1	Conn 2	Rack	Crate	connector	
1	W1/Probe PPT A1	ACC39	Patch Panel Top	**A1**	3900 MHz probe signal cavity 1	LMR400UF		N-gerade	N-gerade	ACC39	Probe Patch Panel back	J1	W01/Probe PPP-B J1
2	W2/Probe PPT A2	ACC39	Patch Panel Top	**A2**	3900 MHz probe signal cavity 2	LMR400UF		N-gerade	N-gerade	ACC39	Probe Patch Panel back	J2	W02/Probe PPP-B J2
3	W3/Probe PPT A3	ACC39	Patch Panel Top	**A3**	3900 MHz probe signal cavity 3	LMR400UF		N-gerade	N-gerade	ACC39	Probe Patch Panel back	J3	W03/Probe PPP-B J3
4	W4/Probe PPT A4	ACC39	Patch Panel Top	**A4**	3900 MHz probe signal cavity 4	LMR400UF		N-gerade	N-gerade	ACC39	Probe Patch Panel back	J4	W04/Probe PPP-B J4
5	W5/Forw PPT B1	ACC39	Patch Panel Top	**B1**	3900 MHz forward signal cavity 1	LMR400UF		N-gerade	N-gerade	ACC39	Forward Patch Panel back	J1	W05/Forw FPP-B J1
6	W6/Forw PPT B2	ACC39	Patch Panel Top	**B2**	3900 MHz forward signal cavity 2	LMR400UF		N-gerade	N-gerade	ACC39	Forward Patch Panel back	J2	W06/Forw FPP-B J2
7	W7/Forw PPT B3	ACC39	Patch Panel Top	**B3**	3900 MHz forward signal cavity 3	LMR400UF		N-gerade	N-gerade	ACC39	Forward Patch Panel back	J3	W07/Forw FPP-B J3
8	W8/Forw PPT B4	ACC39	Patch Panel Top	**B4**	3900 MHz forward signal cavity 4	LMR400UF		N-gerade	N-gerade	ACC39	Forward Patch Panel back	J4	W08/Forw FPP-B J4
9	W9/Refl PPT B5	ACC39	Patch Panel Top	**B5**	3900 MHz reflected signal cavity 1	LMR400UF		N-gerade	N-gerade	ACC39	Reflected Patch Panel back	J1	W09/Refl RPP-B J1
10	W10/Refl PPT B6	ACC39	Patch Panel Top	**B6**	3900 MHz reflected signal cavity 2	LMR400UF		N-gerade	N-gerade	ACC39	Reflected Patch Panel back	J2	W10/Refl RPP-B J2
11	W11/Refl PPT B7	ACC39	Patch Panel Top	**B7**	3900 MHz reflected signal cavity 3	LMR400UF		N-gerade	N-gerade	ACC39	Reflected Patch Panel back	J3	W11/Refl RPP-B J3
12	W12/Refl PPT B8	ACC39	Patch Panel Top	**B8**	3900 MHz reflected signal cavity 4	LMR400UF		N-gerade	N-gerade	ACC39	Reflected Patch Panel back	J4	W12/Refl RPP-B J4
13	W13/KlyDr PPT A8	ACC39	Patch Panel Top	**A8**	3900 MHz Klystron Drive signal	LMR195UF		N-gerade	SMA-winkel	ACC39	VM – Drive	RF out	W13/KlyDr VM_Dr RF o
14	W14/PA PPT A6	ACC39	Patch Panel Top	**A6**	3900 MHz PreAmp Monitor	LMR400UF		N-gerade	N-gerade	ACC39	Reflected Patch Panel back	J7	W14/PA RPP-B J7
15	W15/Kly39 PPT A7	ACC39	Patch Panel Top	**A7**	3900 MHz Klystron output Monitor	LMR400UF		N-gerade	N-gerade	ACC39	Reflected Patch Panel back	J8	W15/Kly39 RPP-B J8
16	W16/1300MHz PPT A5	ACC39	Patch Panel Top	**A5**	1300 MHz MO Reference	LMR400UF		N-gerade	N-gerade	ACC39	3.9GHz Reference Generation	J1	W16/1300MHz RefGen J
17	W17/Probe PPP-F J1	ACC39	Probe Patch Panel front	J1	3900 MHz Probe signal cavity 1	MRC240AFB		N-gerade	SMA-gerade	ACC39	3.9GHz Downconverter #1	RF1	W17/Probe DWC1 RF1
18	W18/Probe PPP-F J2	ACC39	Probe Patch Panel front	J2	3900 MHz Probe signal cavity 2	MRC240AFB		N-gerade	SMA-gerade	ACC39	3.9GHz Downconverter #1	RF2	W18/Probe DWC1 RF2
19	W19/Probe PPP-F J3	ACC39	Probe Patch Panel front	J3	3900 MHz Probe signal cavity 3	MRC240AFB		N-gerade	SMA-gerade	ACC39	3.9GHz Downconverter #1	RF3	W19/Probe DWC1 RF3
20	W20/Probe PPP-F J4	ACC39	Probe Patch Panel front	J4	3900 MHz Probe signal cavity 4	MRC240AFB		N-gerade	SMA-gerade	ACC39	3.9GHz Downconverter #1	RF4	W20/Probe DWC1 RF4
21	W21/Forw FPP-F J1	ACC39	Forward Patch Panel front	J1	3900 MHz forward signal cavity 1	MRC240AFB		N-gerade	SMA-gerade	ACC39	3.9GHz Downconverter #2	RF1	W21/Forw DWC2 RF1
22	W22/Forw FPP-F J2	ACC39	Forward Patch Panel front	J2	3900 MHz forward signal cavity 2	MRC240AFB		N-gerade	SMA-gerade	ACC39	3.9GHz Downconverter #2	RF2	W22/Forw DWC2 RF2
23	W23/Forw FPP-F J3	ACC39	Forward Patch Panel front	J3	3900 MHz forward signal cavity 3	MRC240AFB		N-gerade	SMA-gerade	ACC39	3.9GHz Downconverter #2	RF3	W23/Forw DWC2 RF3
24	W24/Forw FPP-F J4	ACC39	Forward Patch Panel front	J4	3900 MHz forward signal cavity 4	MRC240AFB		N-gerade	SMA-gerade	ACC39	3.9GHz Downconverter #2	RF4	W24/Forw DWC2 RF4
25	W25/Refl RPP-F J1	ACC39	Reflected Patch Panel front	J1	3900 MHz reflected signal cavity 1	MRC240AFB		N-gerade	SMA-gerade	ACC39	3.9GHz Downconverter #3	RF1	W25/Refl DWC3 RF1
26	W26/Refl RPP-F J2	ACC39	Reflected Patch Panel front	J2	3900 MHz reflected signal cavity 2	MRC240AFB		N-gerade	SMA-gerade	ACC39	3.9GHz Downconverter #3	RF2	W26/Refl DWC3 RF2
27	W27/Refl RPP-F J3	ACC39	Reflected Patch Panel front	J3	3900 MHz reflected signal cavity 3	MRC240AFB		N-gerade	SMA-gerade	ACC39	3.9GHz Downconverter #3	RF3	W27/Refl DWC3 RF3
28	W28/Refl RPP-F J4	ACC39	Reflected Patch Panel front	J4	3900 MHz reflected signal cavity 4	MRC240AFB		N-gerade	SMA-gerade	ACC39	3.9GHz Downconverter #3	RF4	W28/Refl DWC3 RF4
29	W29/PA RPP-F J7	ACC39	Reflected Patch Panel front	J7	3900 MHz PreAmp Monitor	MRC240AFB		N-gerade	SMA-gerade	ACC39	3.9GHz Downconverter #3	RF7	W29/PA DWC3 RF7
30	W30/Kly39 RPP-F J8	ACC39	Reflected Patch Panel front	J8	3900 MHz Klystron output Monitor	MRC240AFB		N-gerade	SMA-gerade	ACC39	3.9GHz Downconverter #3	RF8	W30/Kly39 DWC3 RF8

9 x DIN A3 pages
~ 200 cables

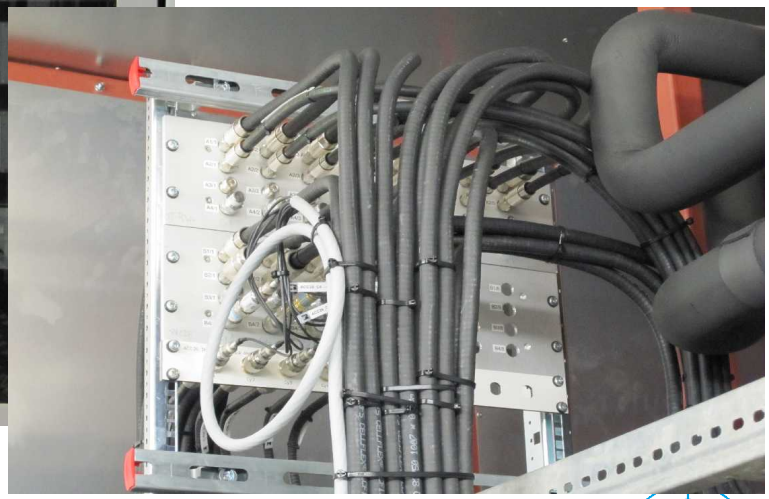
New LLRF Injector Racks.

ACC1 ACC39 RF Gun



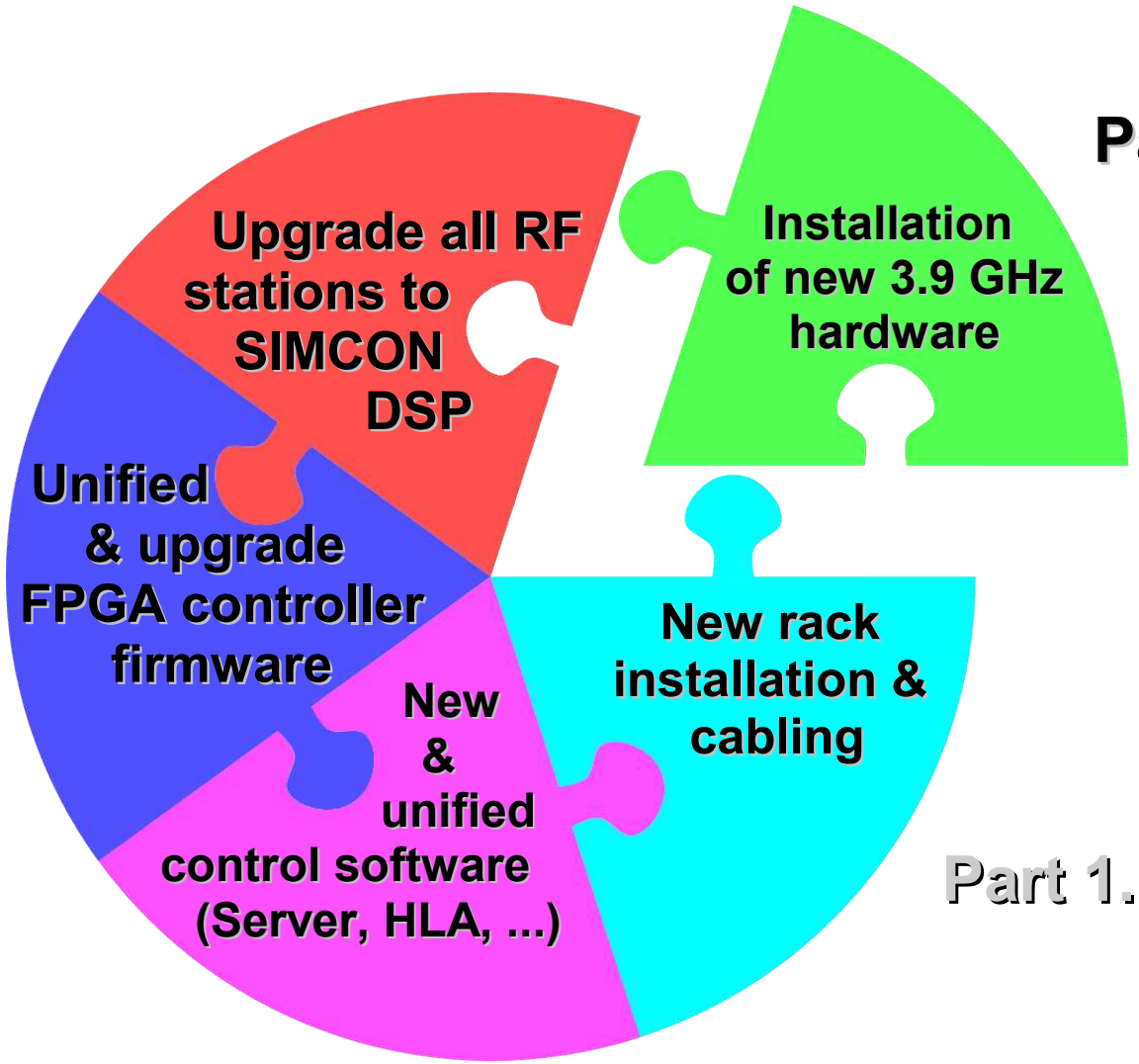


ACC39 patch panel



New racks for Development System

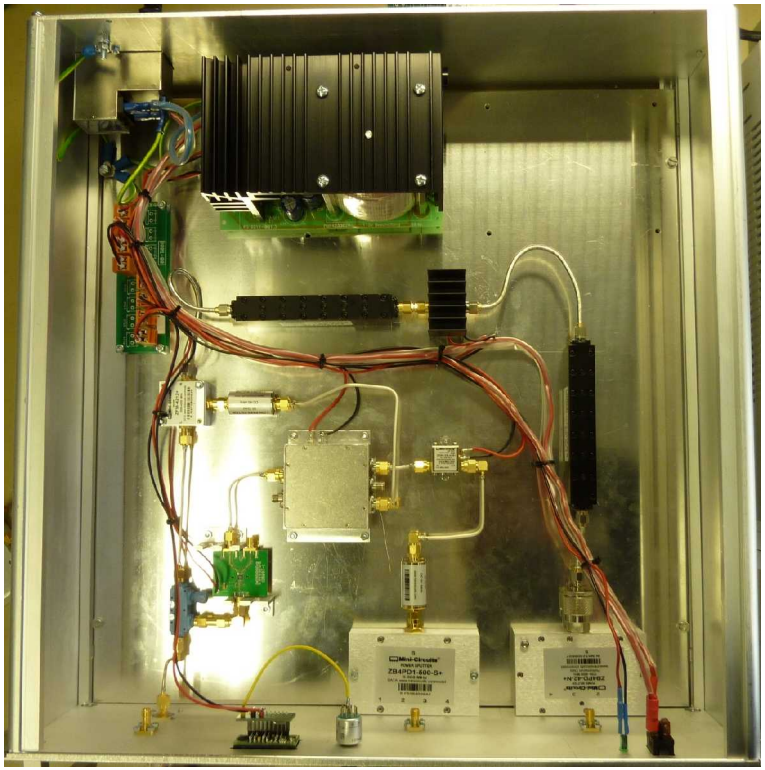
LLRF Upgrade during Shutdown.



3.9GHz Hardware Installation.

3.9GHz Generation Box

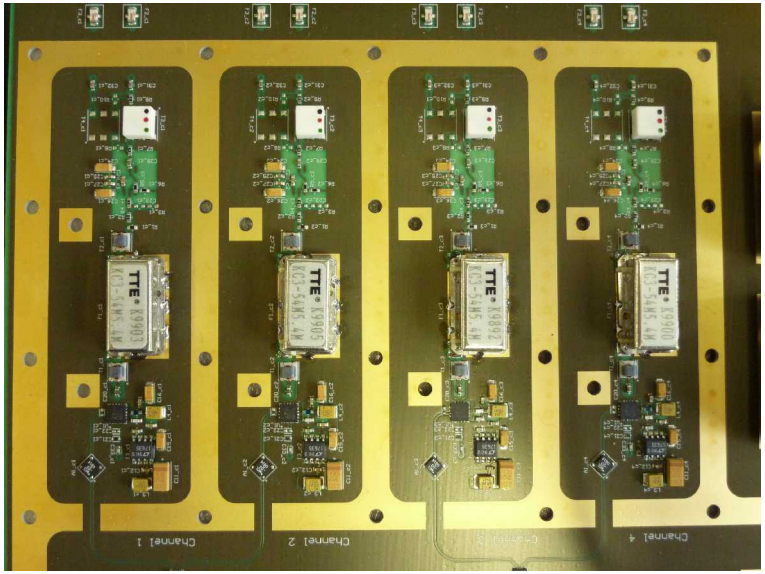
M. Żukociński, F. Ludwig



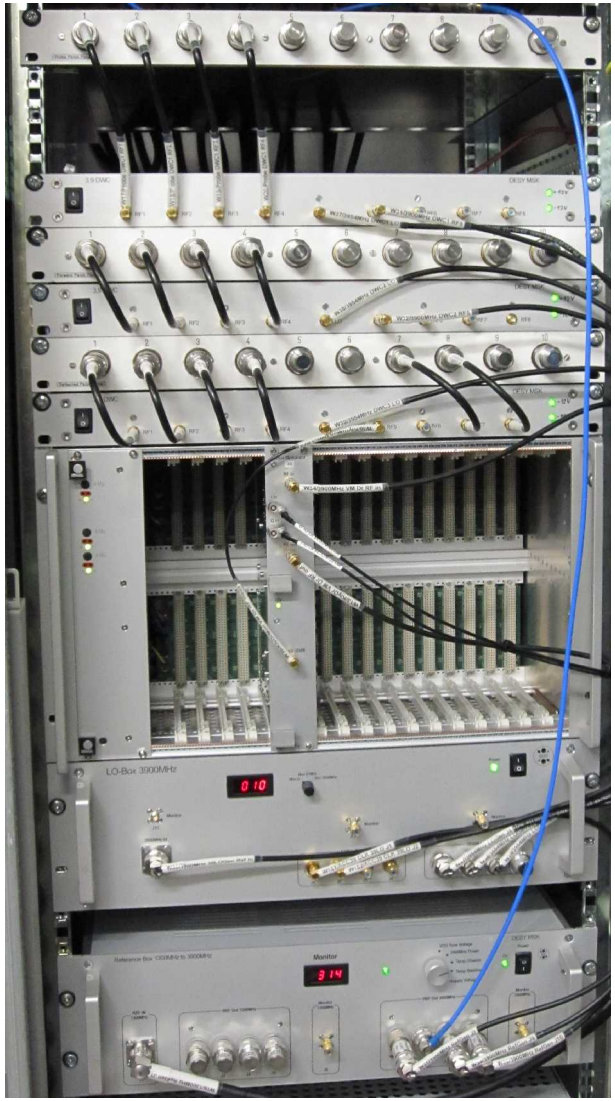
LO & CLK Generation Box

3.9GHz Hardware Installation.

3.9GHz Downconverter



J. Piekarski



Probe patch panel

(Calibration Box)

Downconverter

Fwd. patch panel

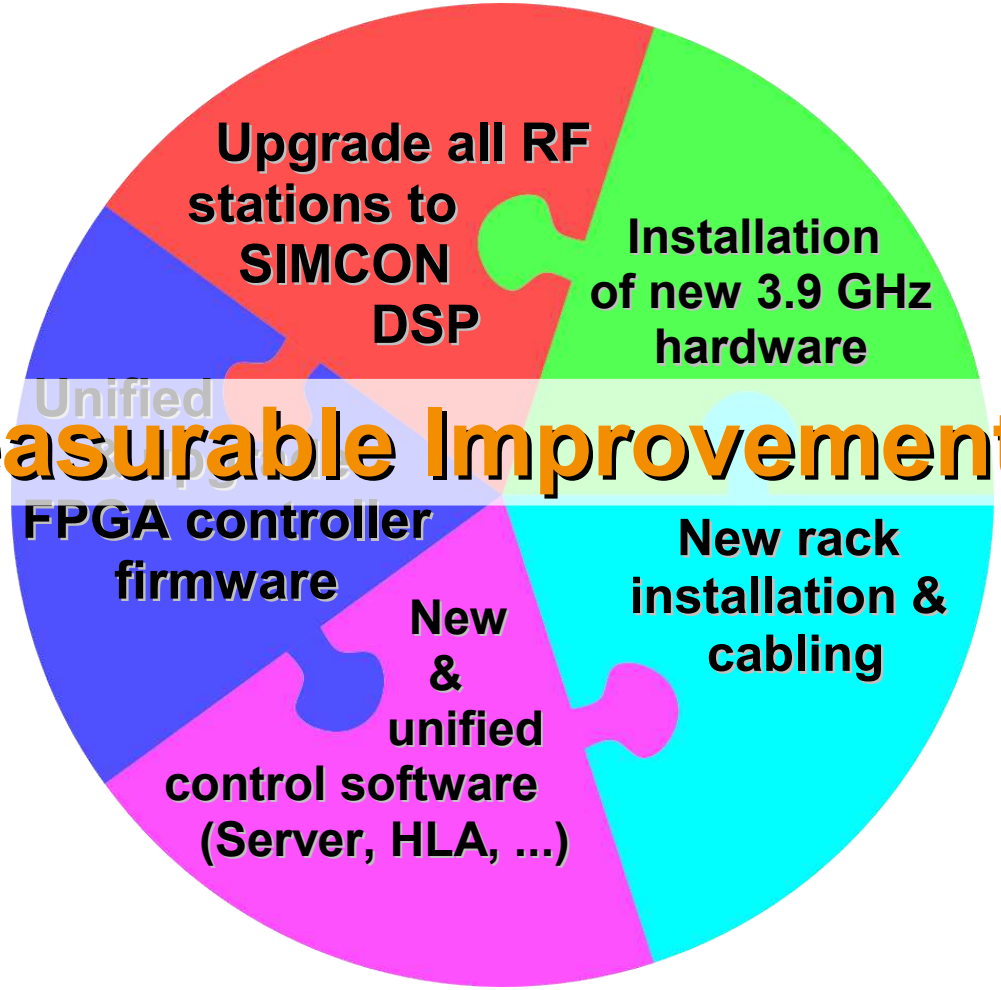
Refl. patch panel

Vector Modulator

LO Generation

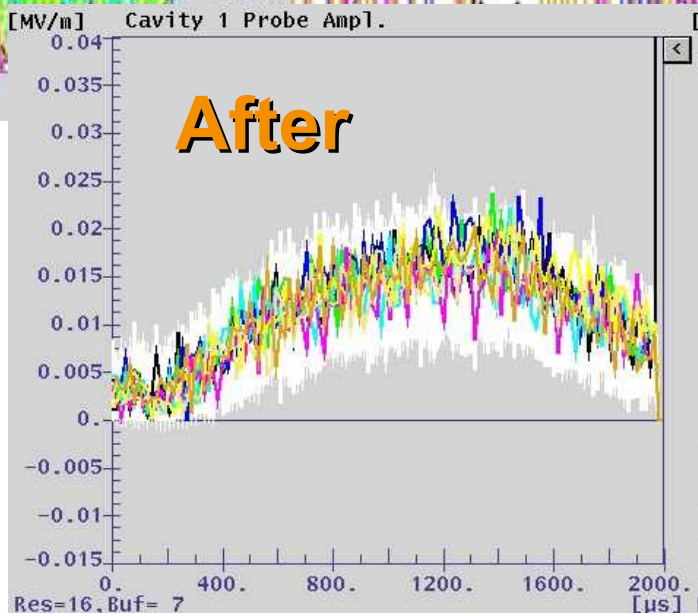
3.9GHz Generation

LLRF Upgrade during Shutdown.

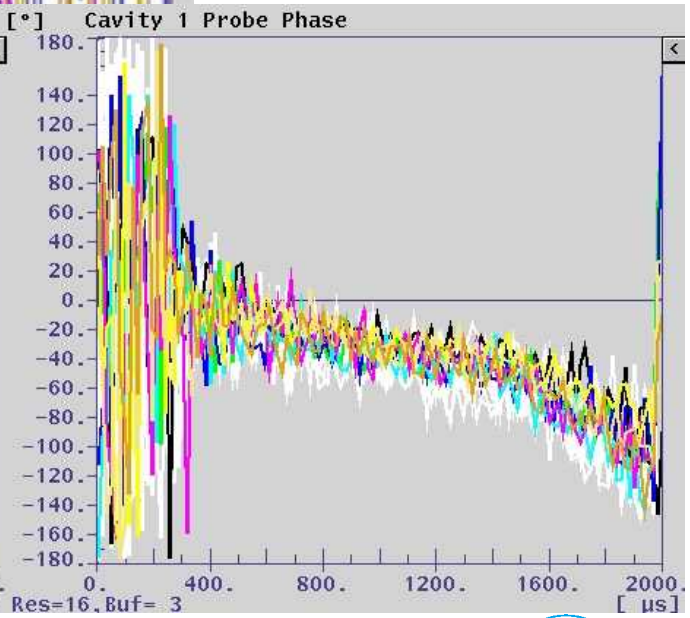


RF Gun Crosstalk.

Before



After

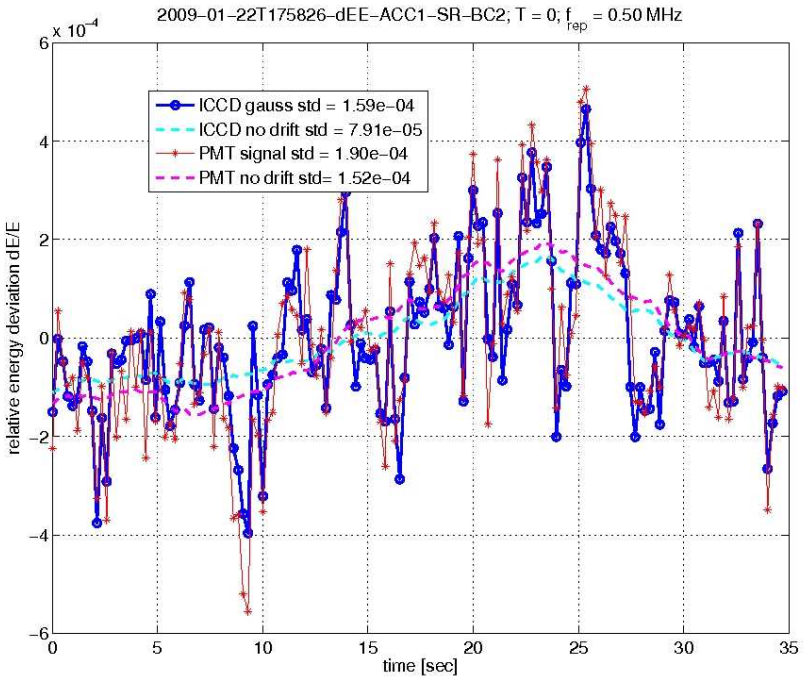


FLASH eLogbook

DESY

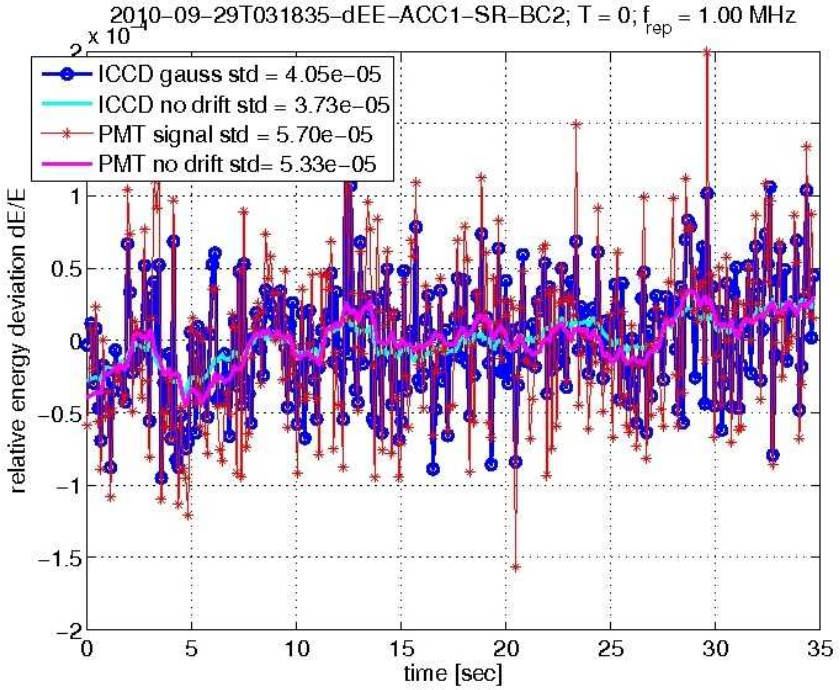
Energy stability.

Before



- FLASH elogbook 22.1.09 18.08h
- ACC1 off-crest
- Typical values of dE/E = 1.5e-4

After



- FLASH elogbook 29.9.10 03.21h
- ACC1, ACC39 on-crest
- Best results: dE/E = 0.5e-4

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Summary & Outlook.

- Cleaned up the LLRF injector racks
- System overview and cable lists are available
  - Wall in the injector hut, MSK folder, LLRF elogbook
- 3.9 GHz hardware installed succesfully
- Common statement from Operators: Machine is more stable

- New LLRF racks for development system installed
  - External cabling already prepared
  - Installation of air-condition
  - Installation of new hardware based on xTCA
- Before changes in hardware and/or cabling, MSK has to be informed!

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thanks for your attention!