Operational Experience with Phase Switches

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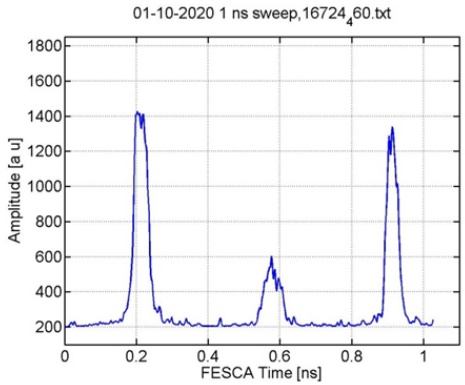
PHASE SWITCH IS FAST, below 10ns

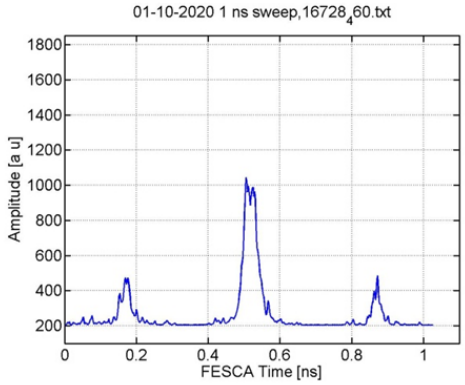
Fri 01-10-10 Streak Camera measurements

Streak camera data under the following link
https://ab-dep-op-elogbook.web.cern.ch/ab-dep-op-elogbook/elogbook/secure/attach.php?attachId=1111118&type=zip&fname=1n.zip

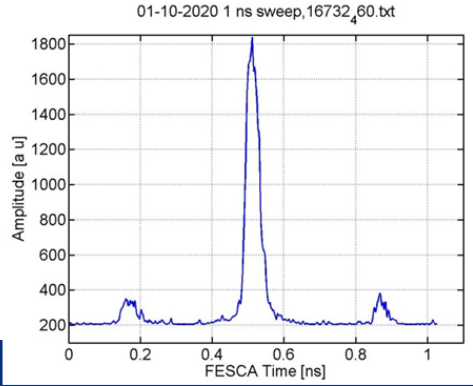
think we found the phase switch
we think that the phase switch occurs over 7/8 ns {to be checked offline}
measured from: 16724 460 to 16742 460



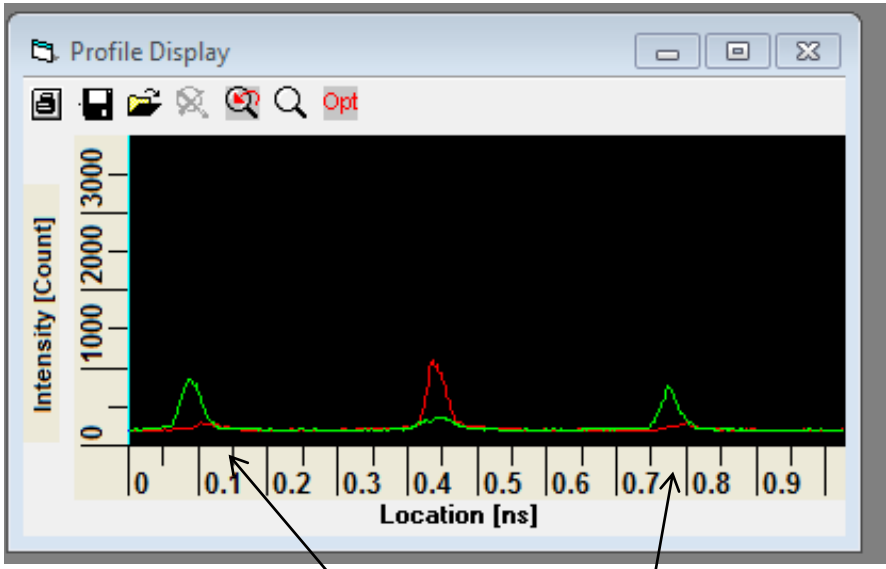
16724 ns



16728 ns



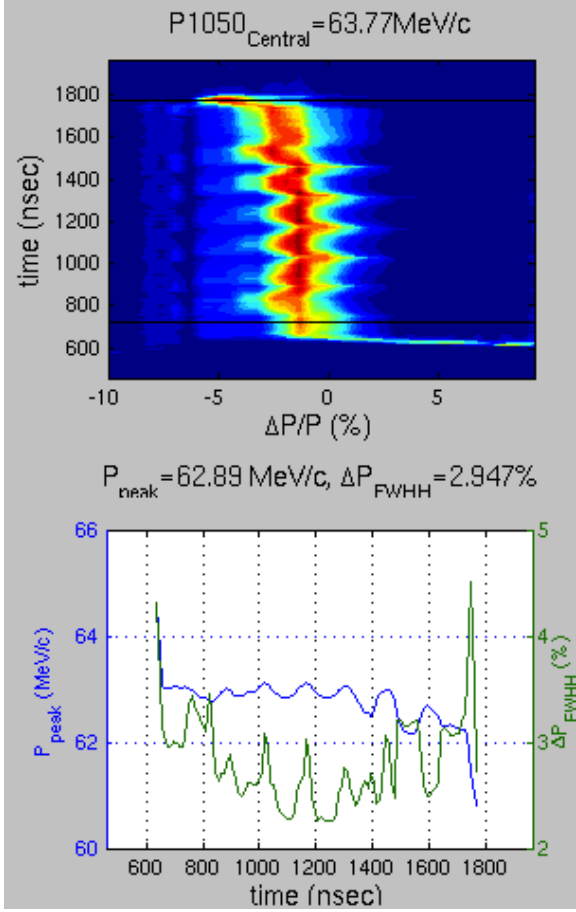
16732 ns

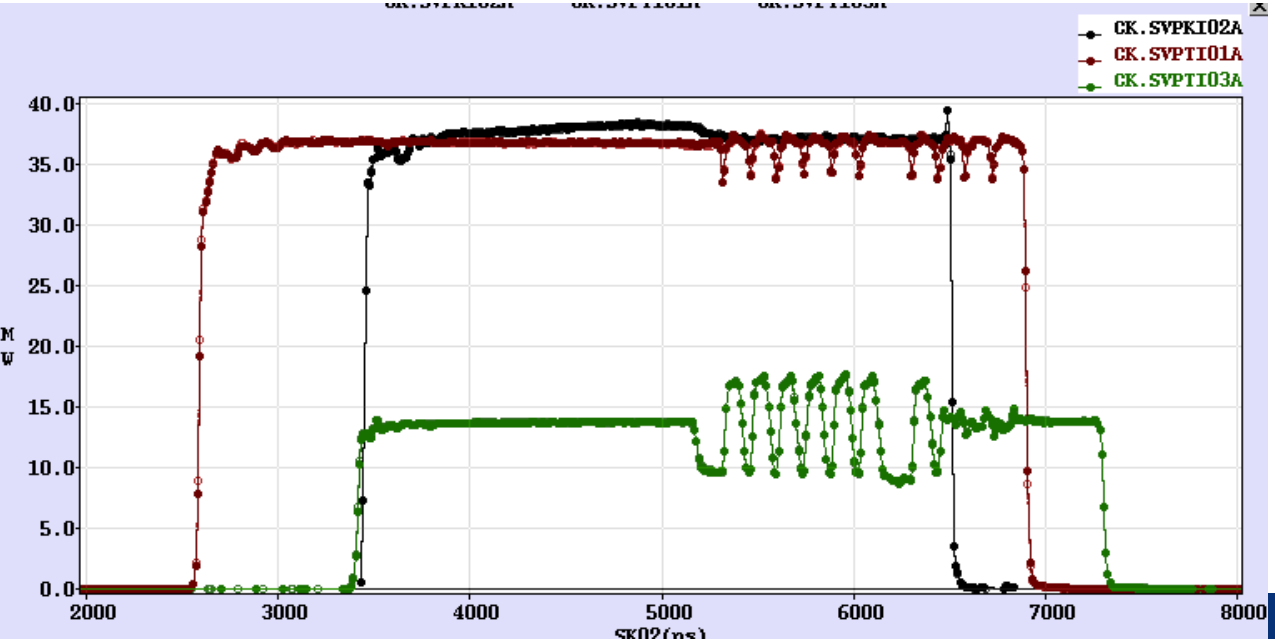


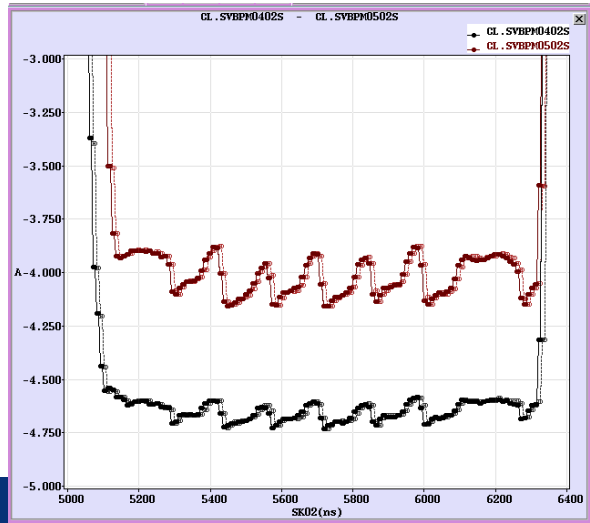
Misplaced?

After phase switch we observe more than 100ns transient on

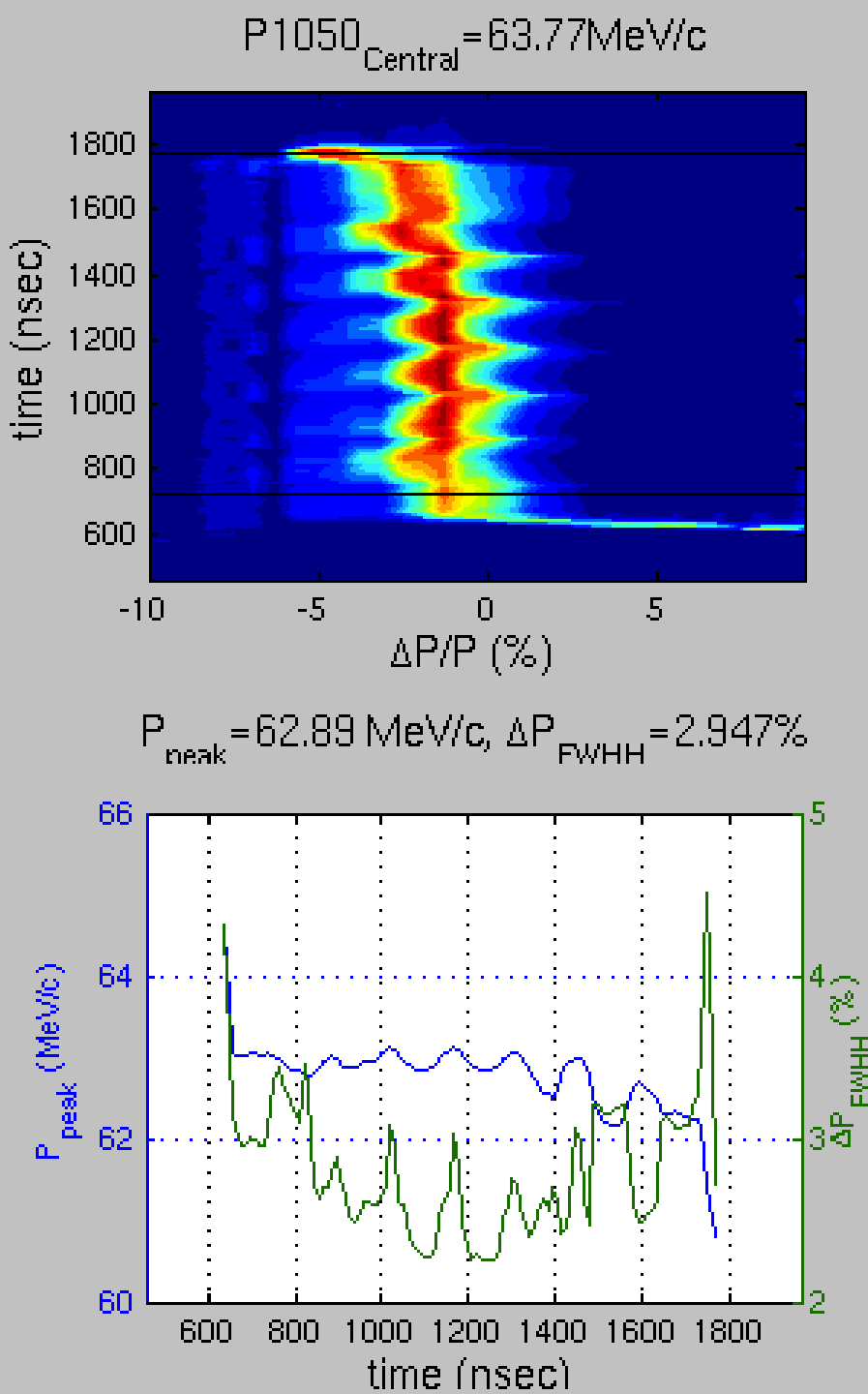
- TWT output (only if beam present)
- SHB output (only if beam present)
- Bunch length
- Beam current (capture efficiency)
- It gives effect on energy
- And position in dispersive sections
- Pulse needs more space



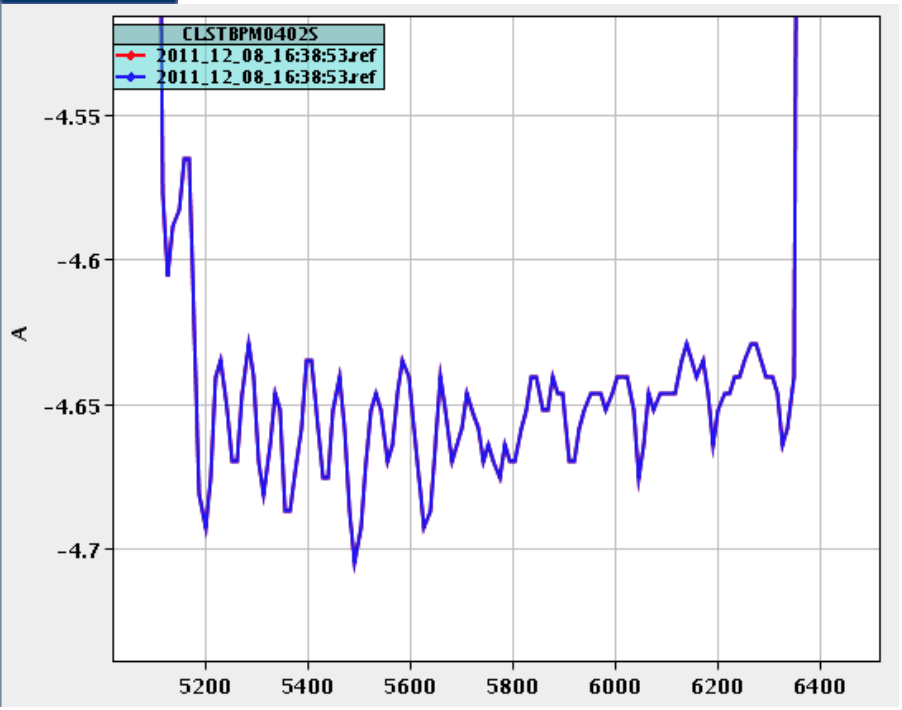


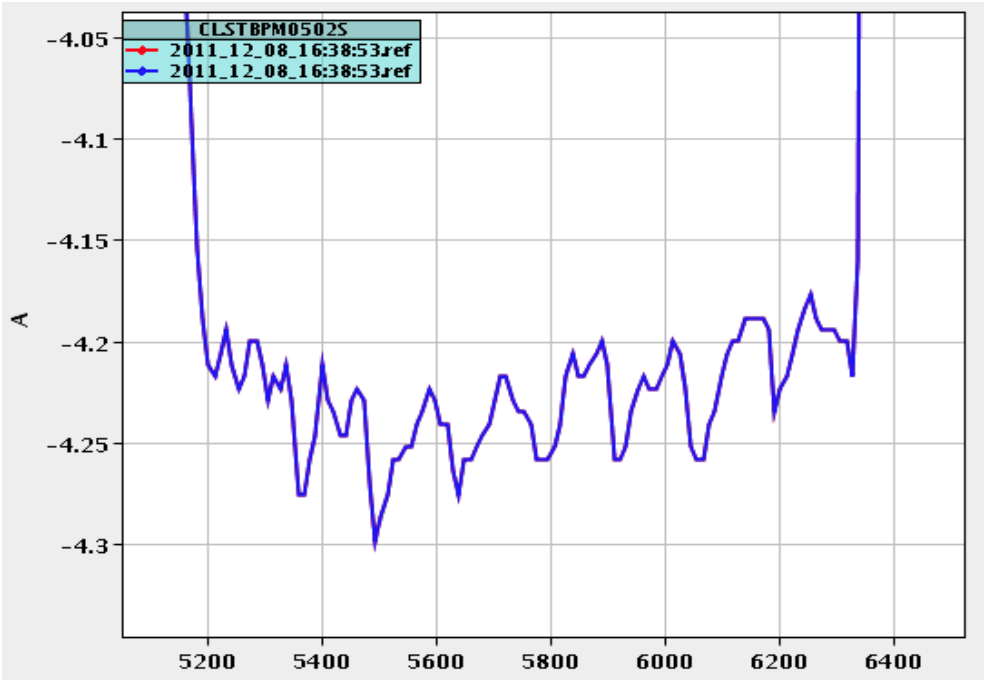


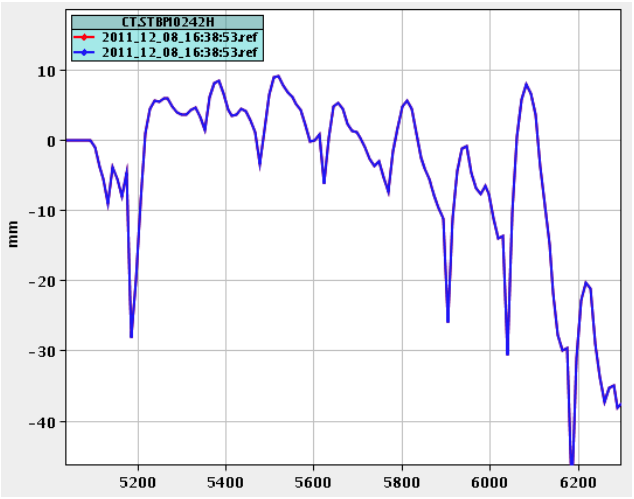
Beam energy


P1050Central=63.77MeV/c
time (nsec)
1800
1600
1400
1200
1000
800
600
-10
-5
0
5
ΔP/P (%)
Ppeak=62.89 MeV/c, ΔPFWHH=2.947%
66
64
62
60
Ppeak (MeV/c)
5
4
3
2
ΔPFWHH (%)
600
800
1000
1200
1400
1600
1800
time (nsec)

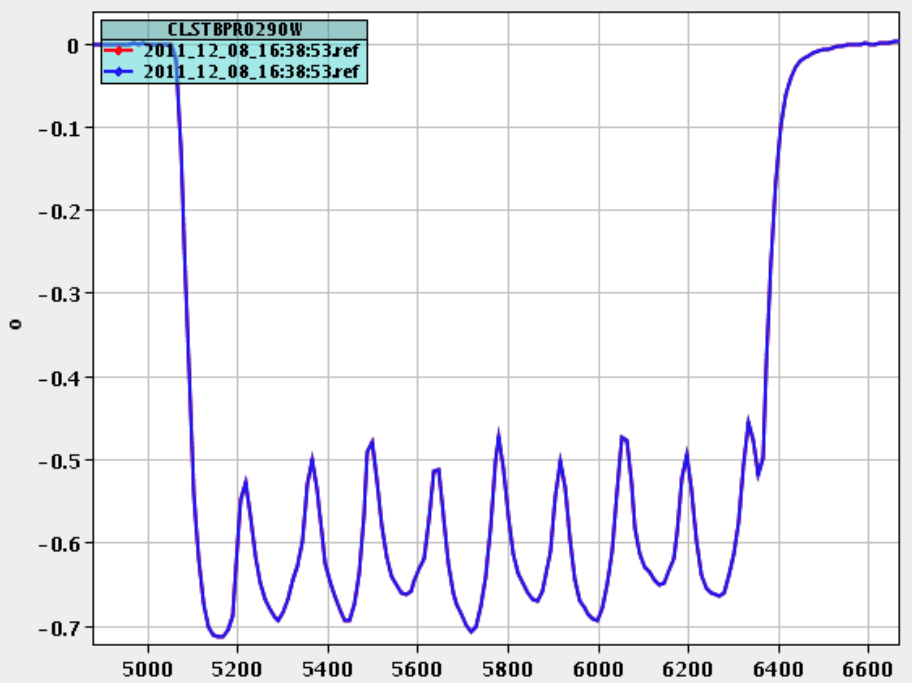
Beam current, 2011 factor 8 ref

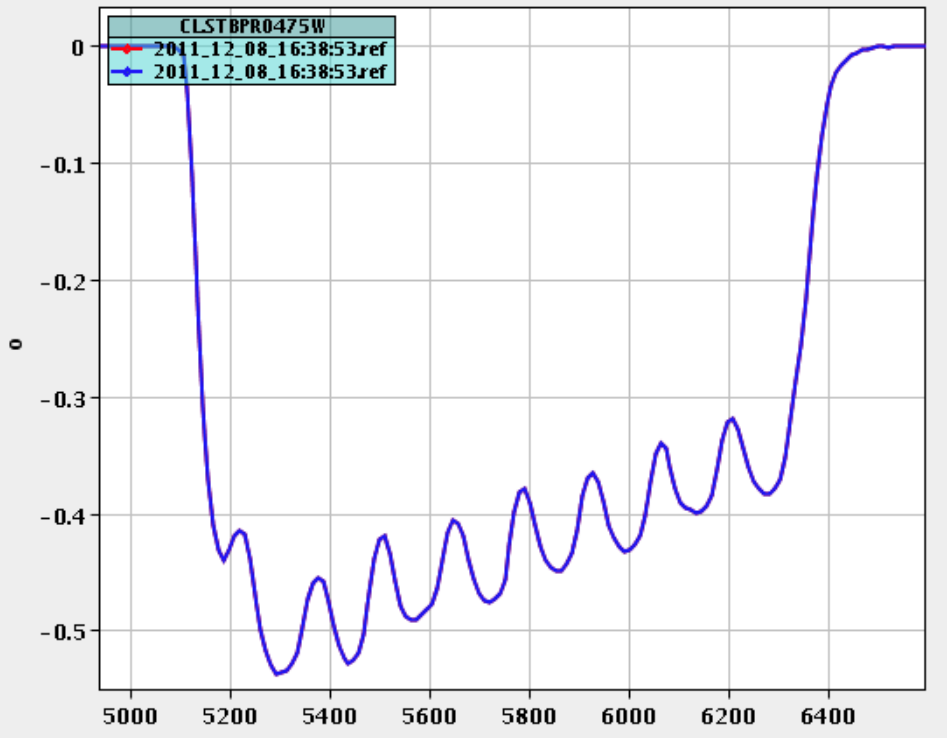




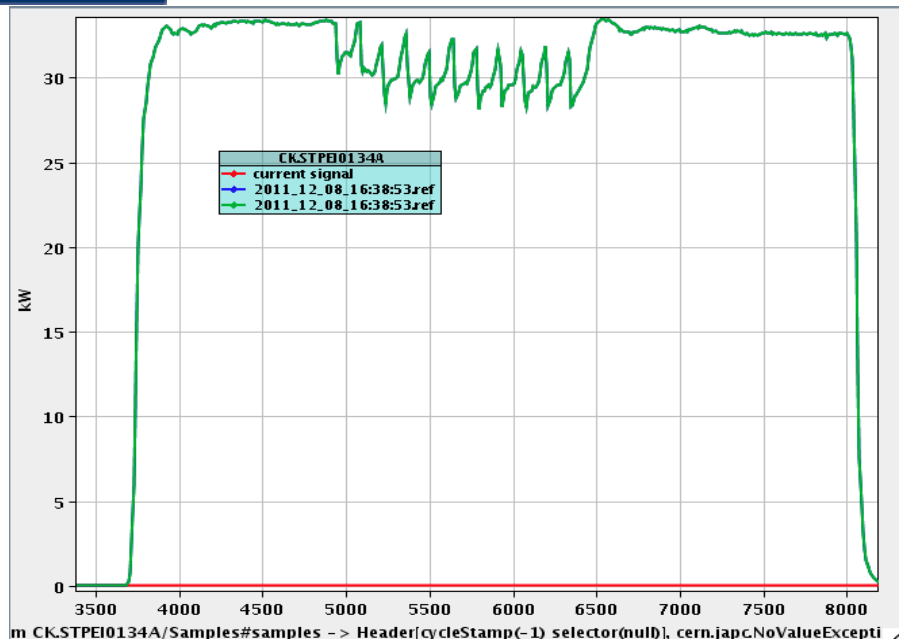


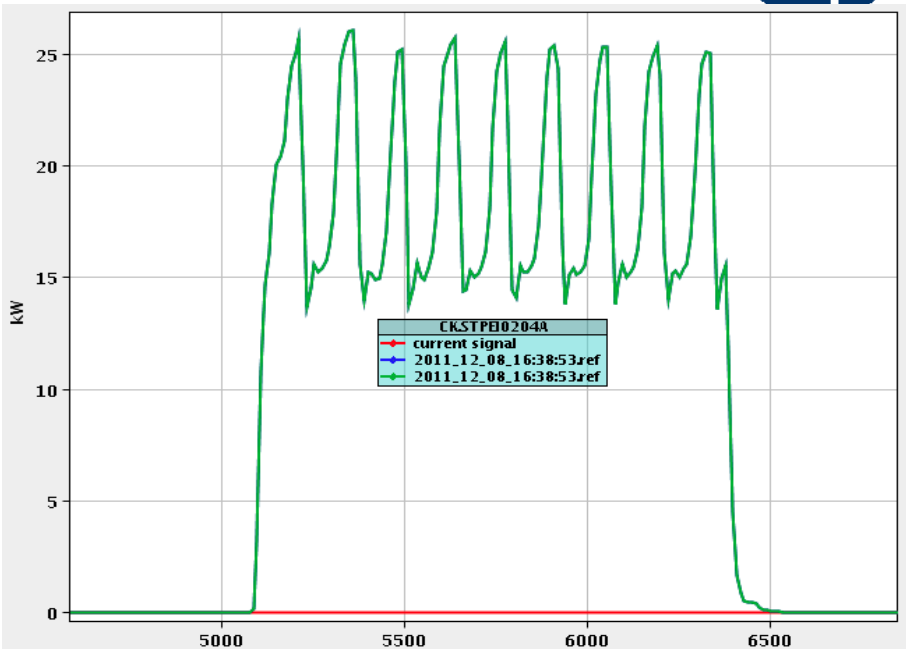
BPR-W

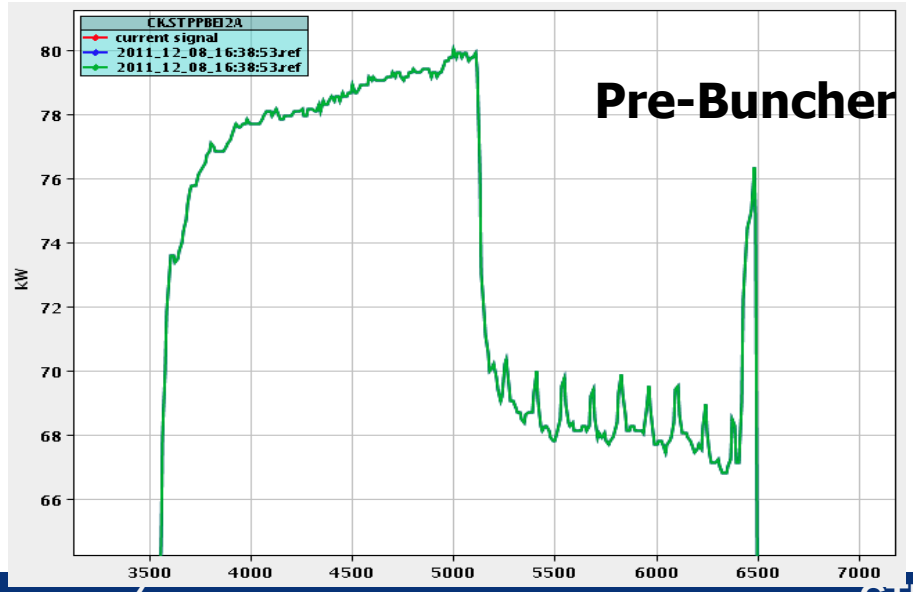

CLSTBPR0290W
2011_12_08_16:38:53.ref
2011_12_08_16:38:53.ref
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
5000
5200
5400
5600
5800
6000
6200
6400
6600

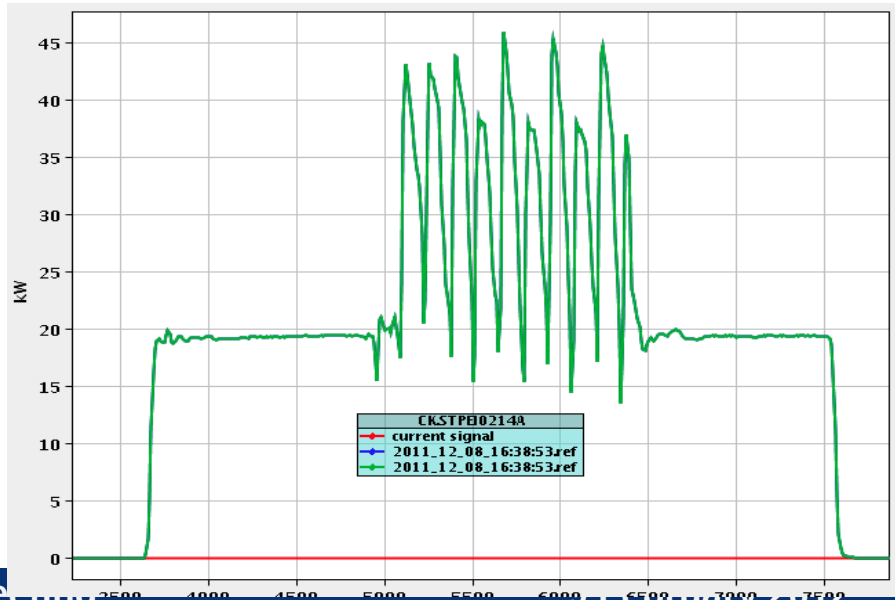

CLSTBPR0475W
2011_12_08_16:38:53.ref
2011_12_08_16:38:53.ref
0
-0.1
-0.2
-0.3
-0.4
-0.5
5000
5200
5400
5600
5800
6000
6200
6400

Cavity Exit, 2011 factor 8 ref



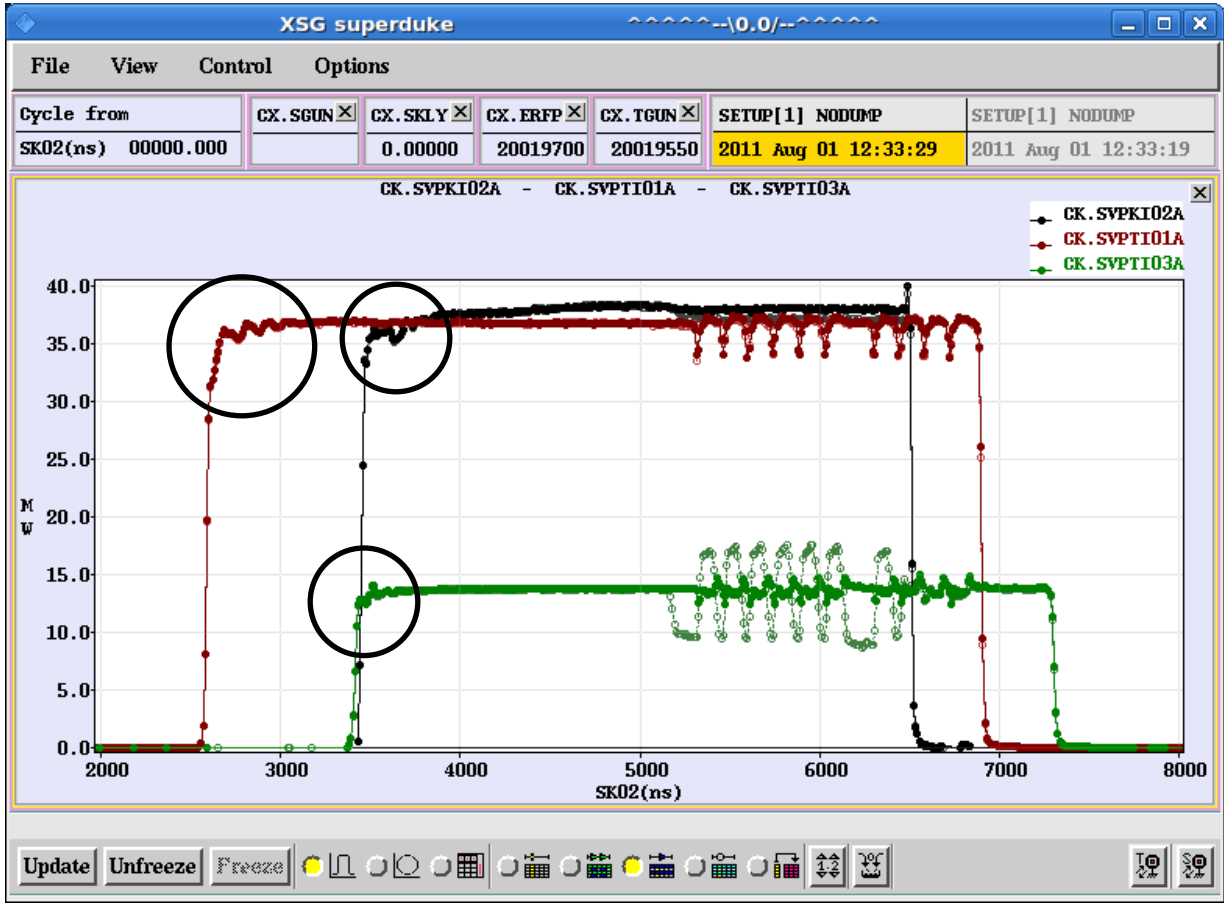






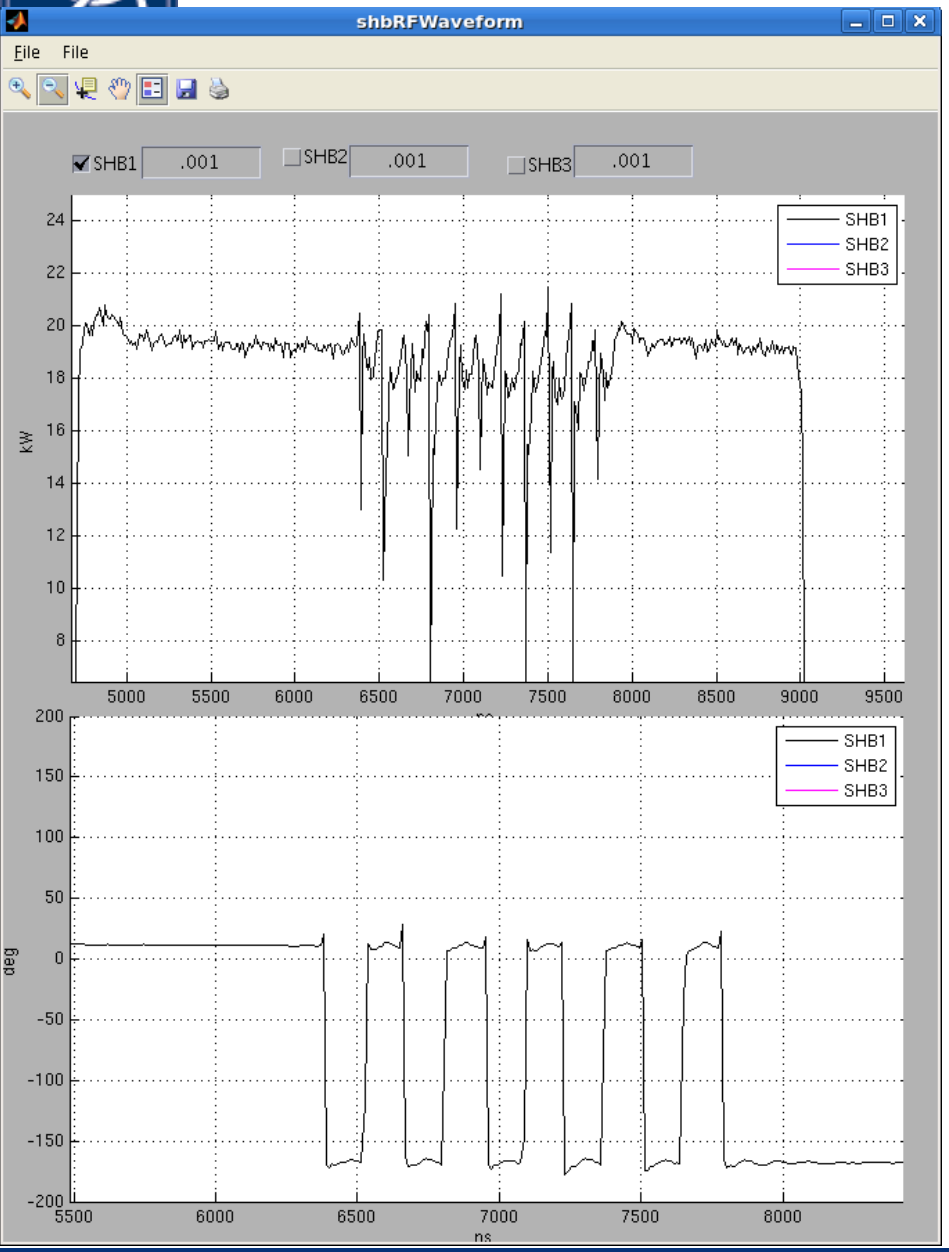
TWT exit, w. and w.o. beam

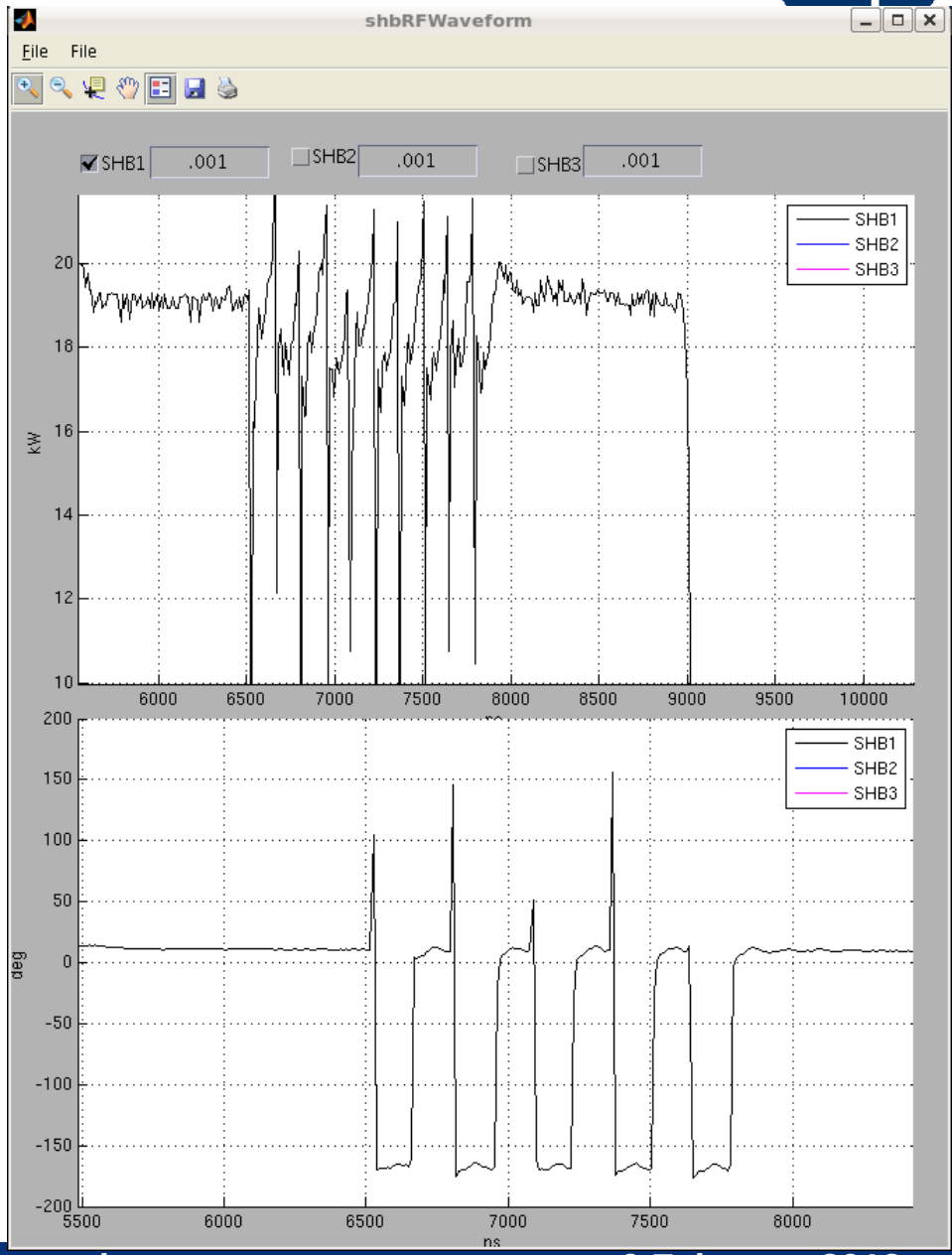
- No change on TWT1
- Big change on TWT3
  - Related to beam loading



IQ measurement

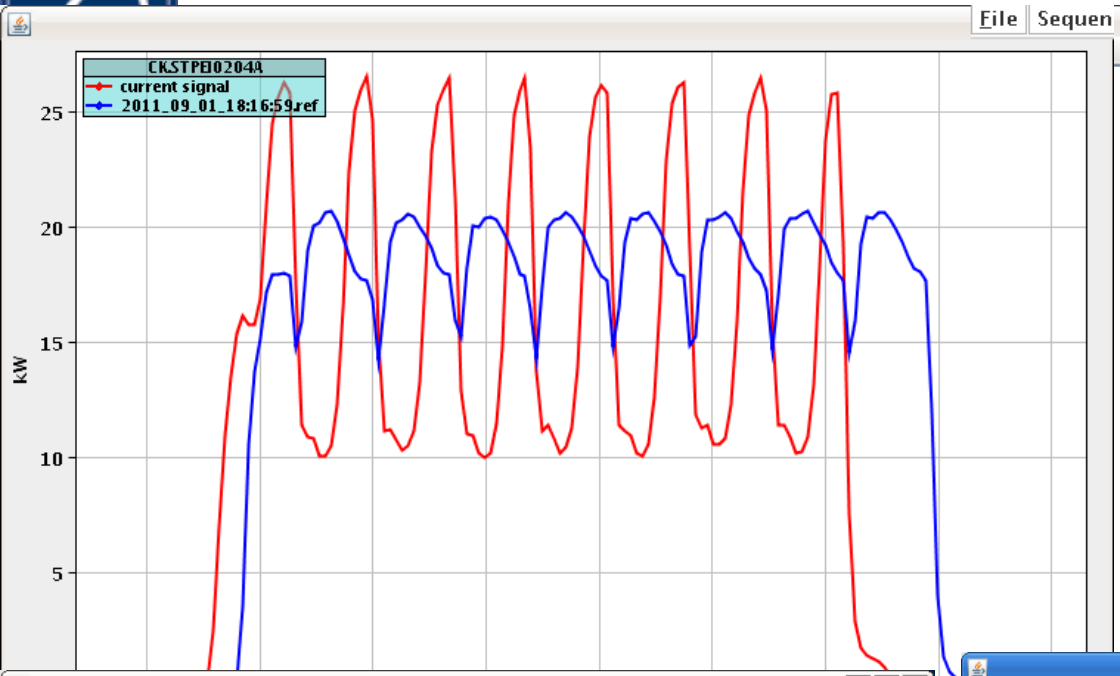
Monday 19-Sep-2011

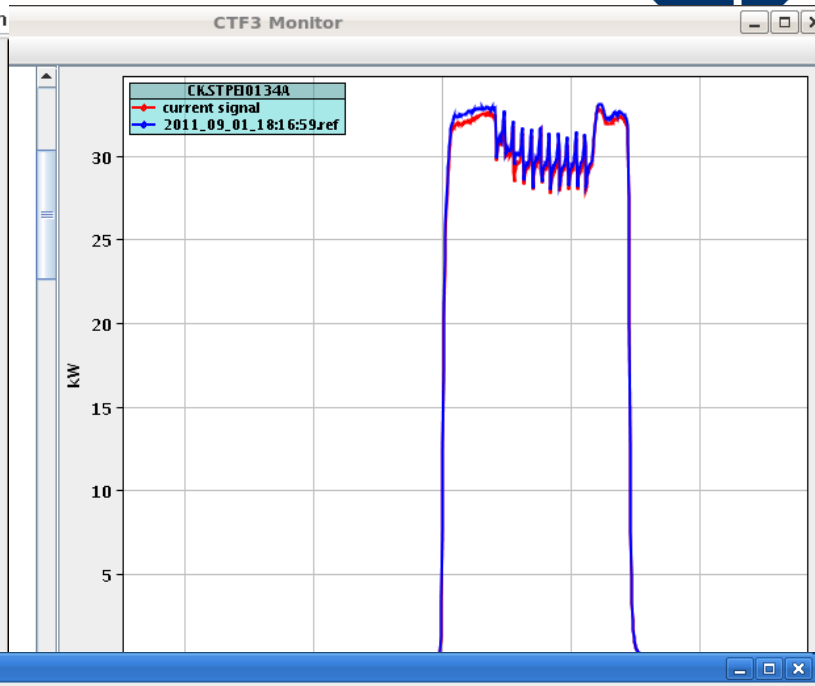


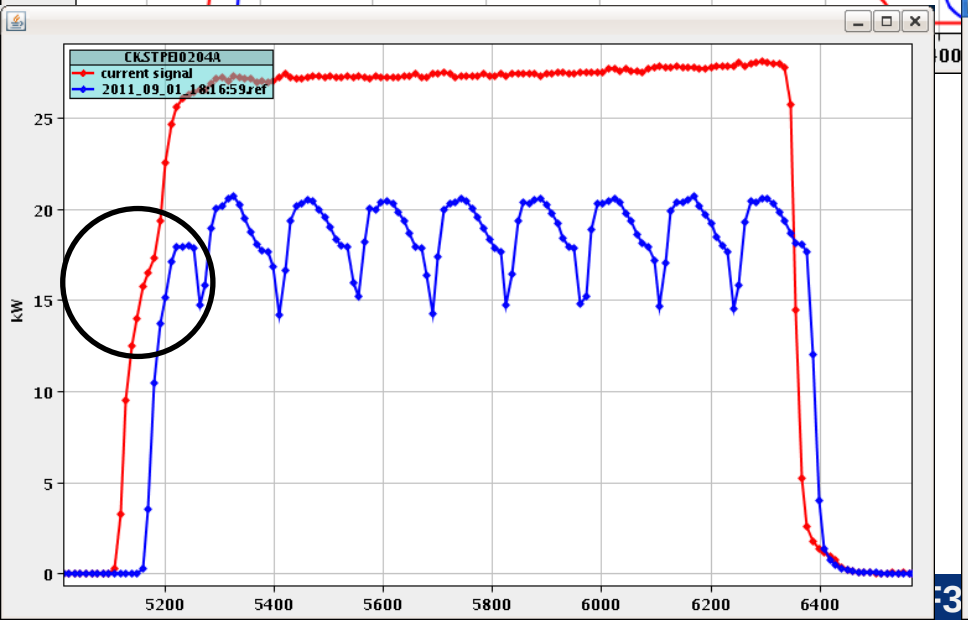


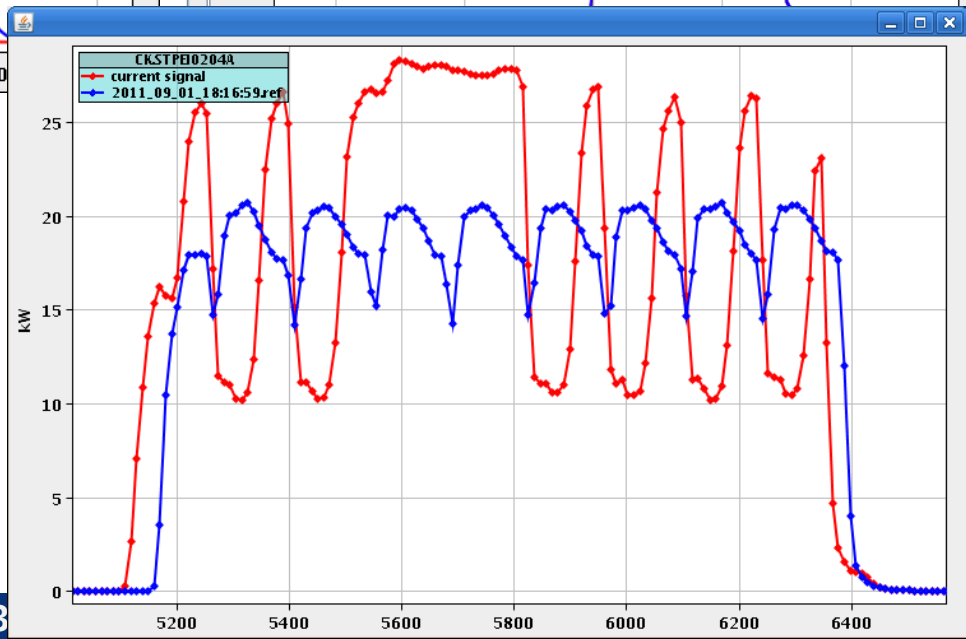
SHB exit, effect depends on phase

Friday 09-Sep-2011

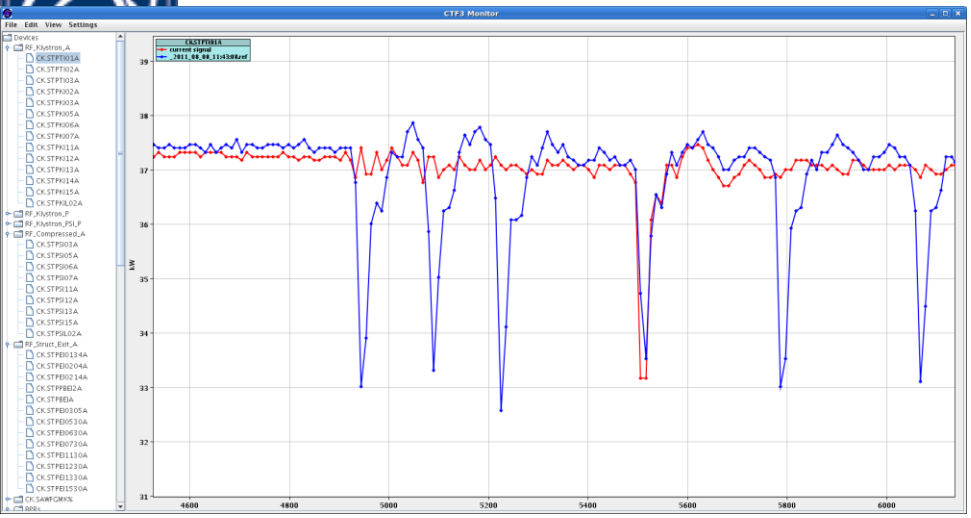


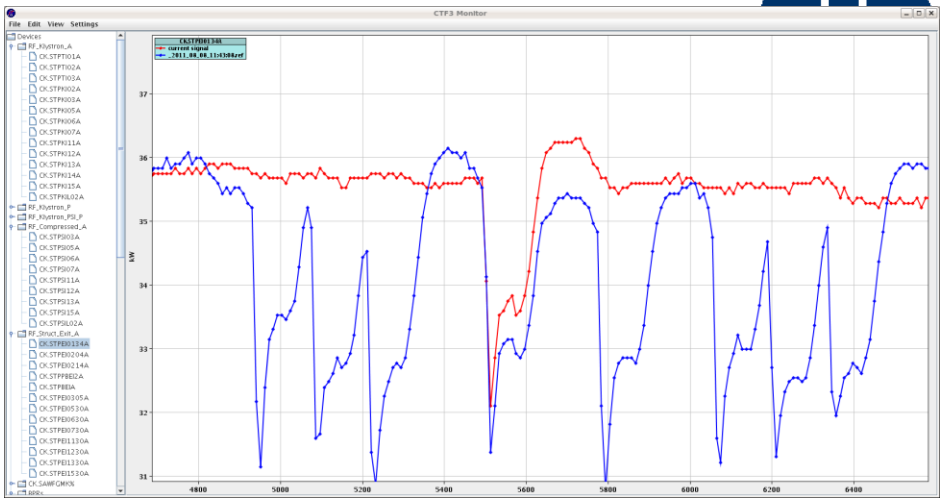




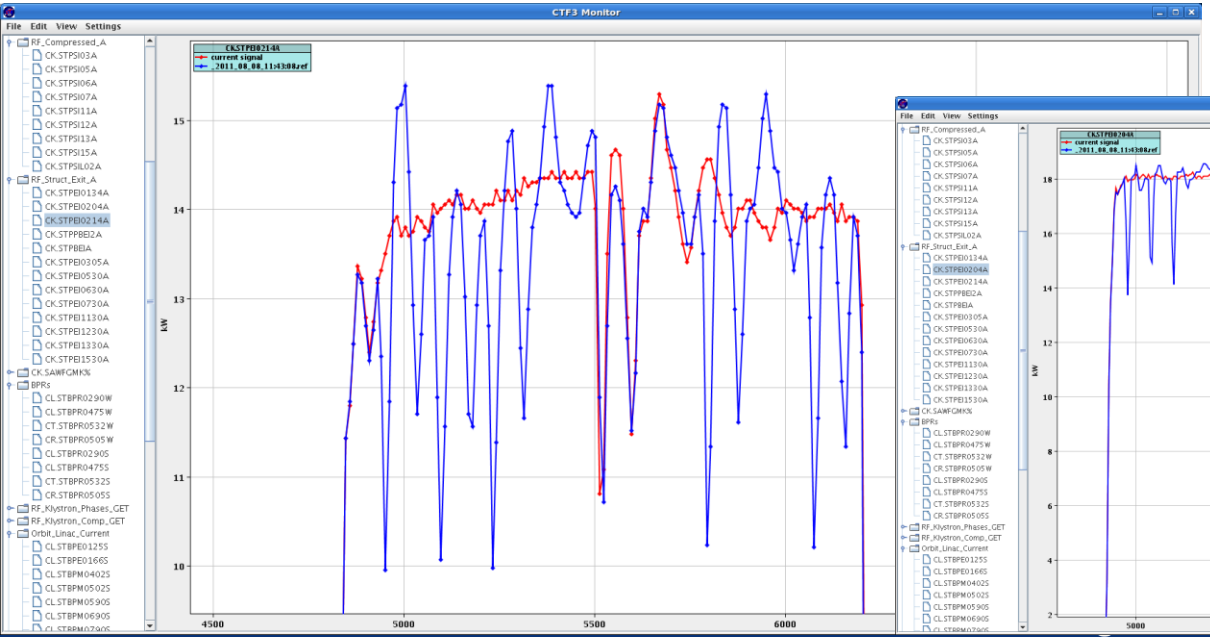


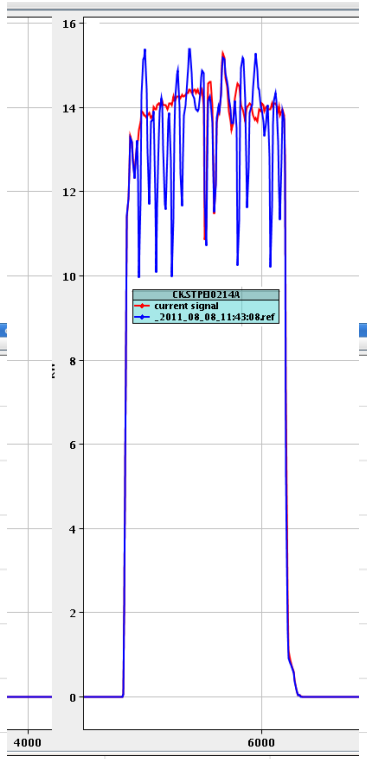
08-Aug-2011 Just one switch with only first SHB. (PS FT)





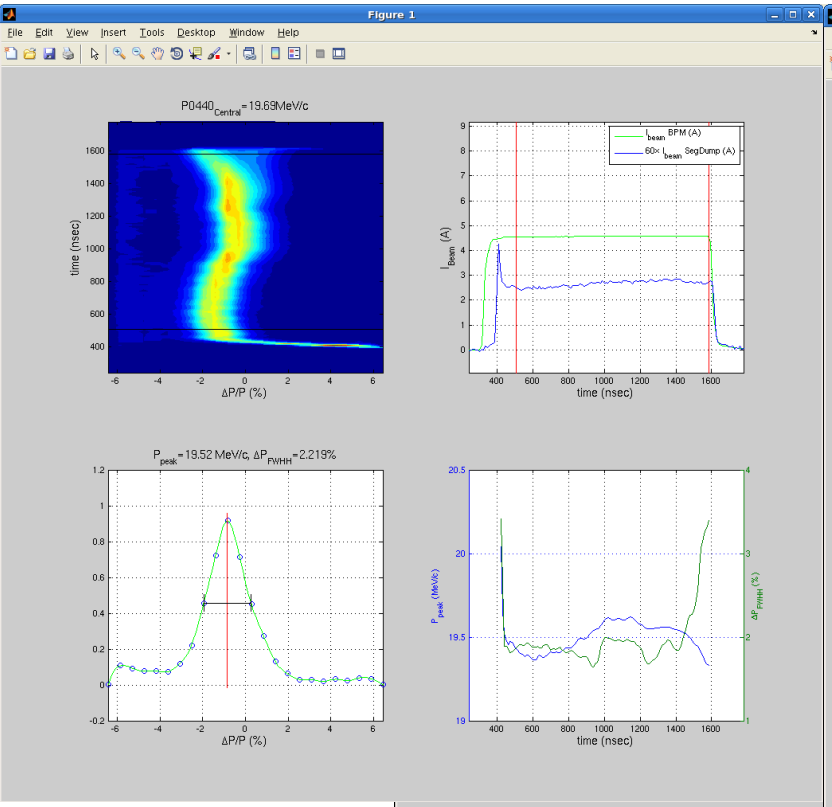
Ringing after a switch can take as long as 500ns



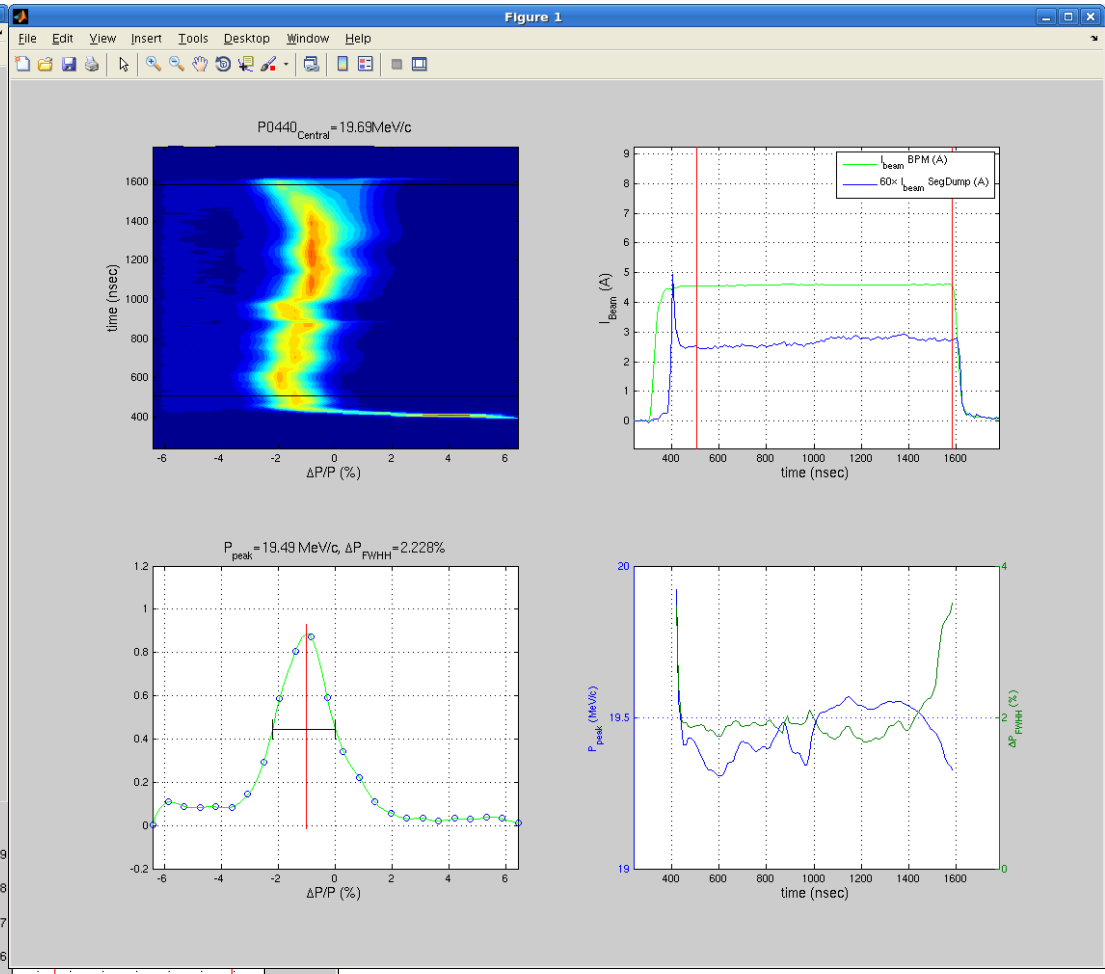


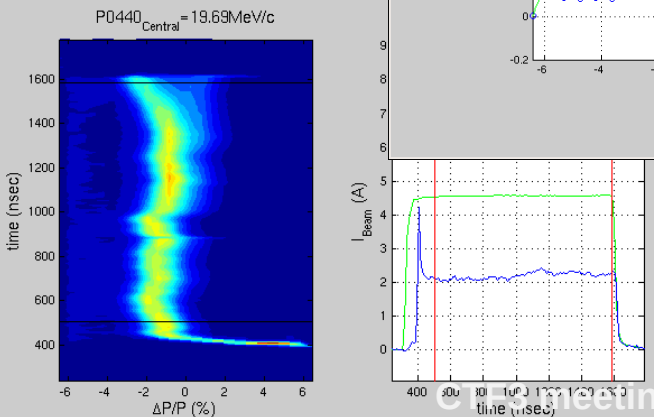
Fri 29-07-11 The same as previous, Spectro 4

No switch

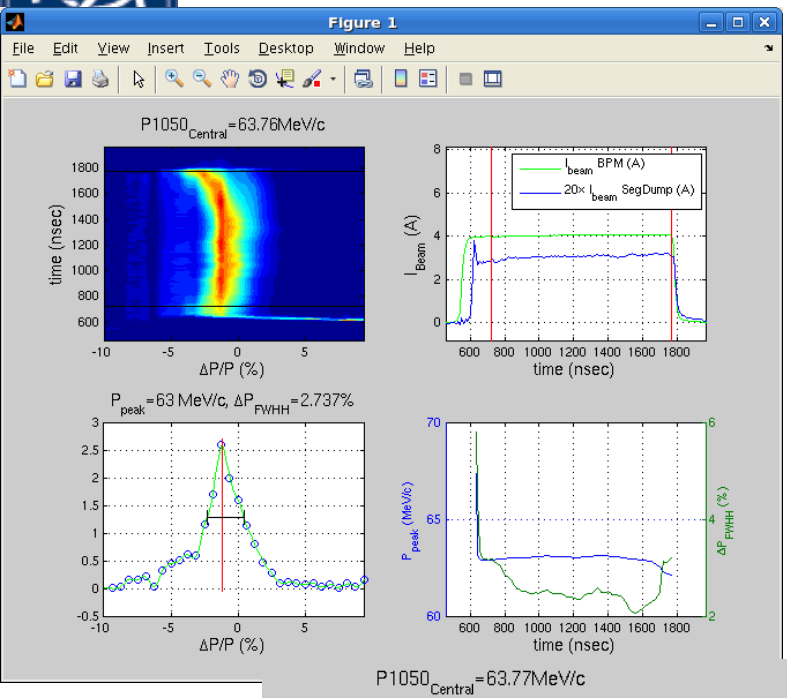


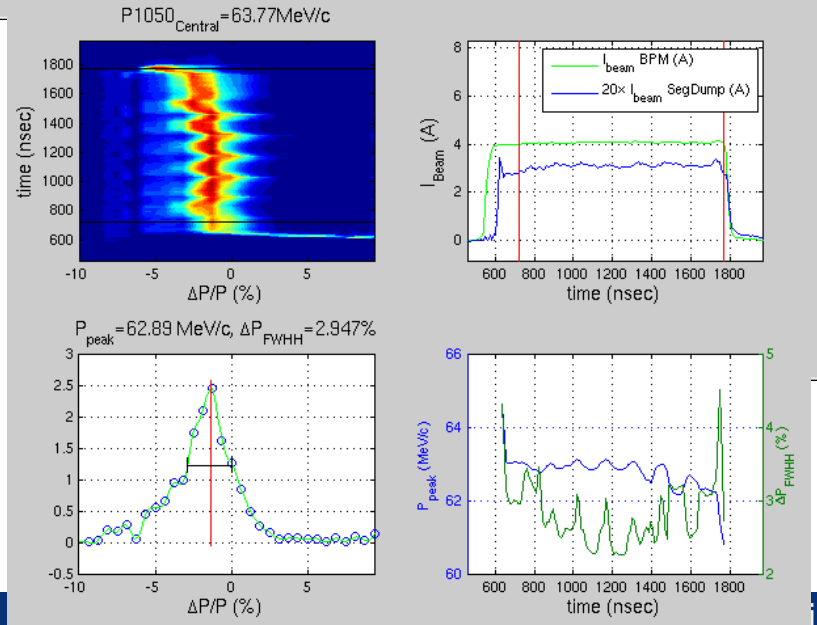
1 switch in

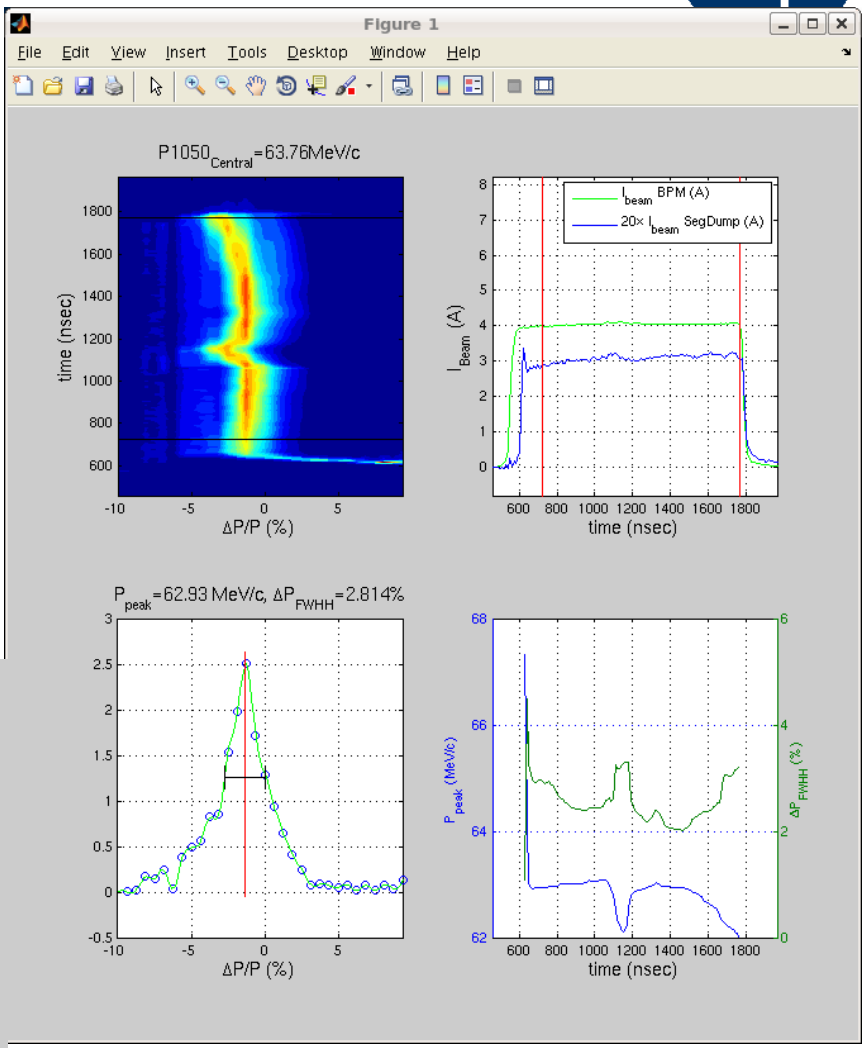




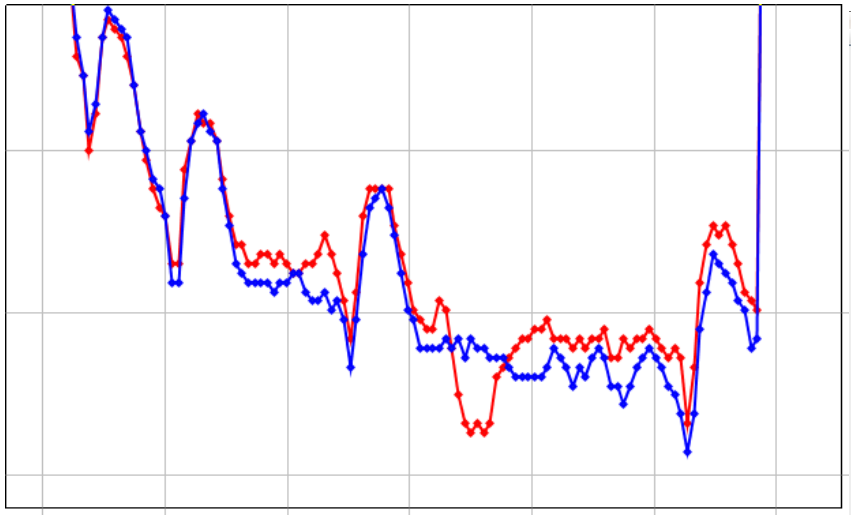
Fri 29-07-11 The same as previous, Spectro 10

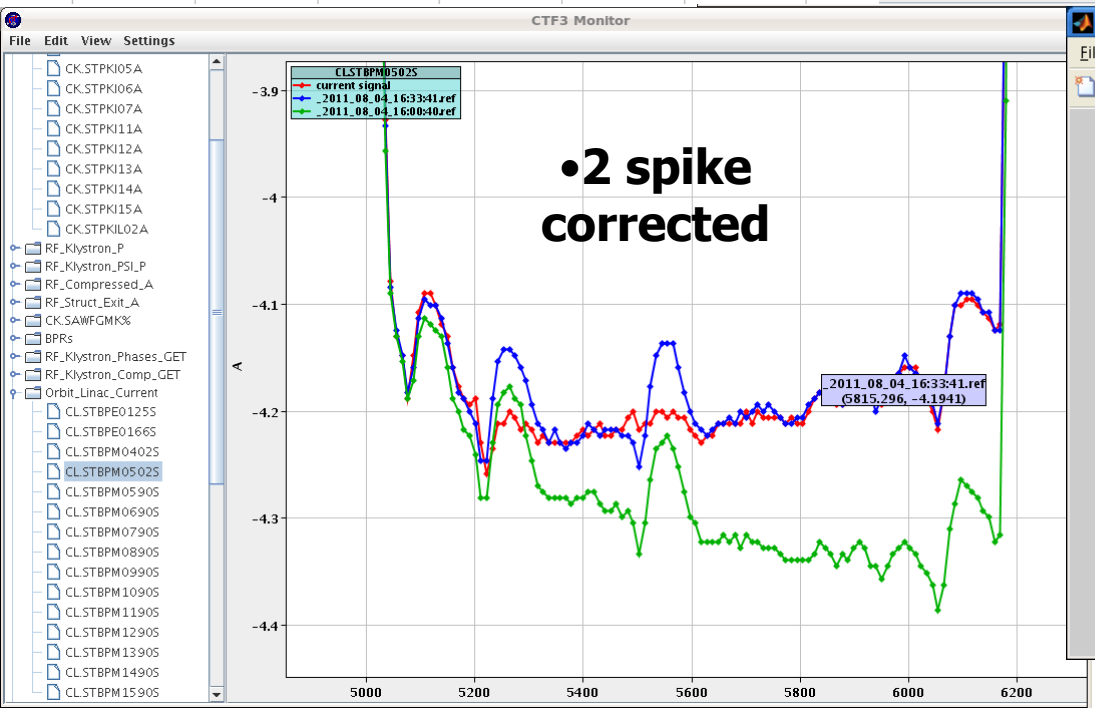


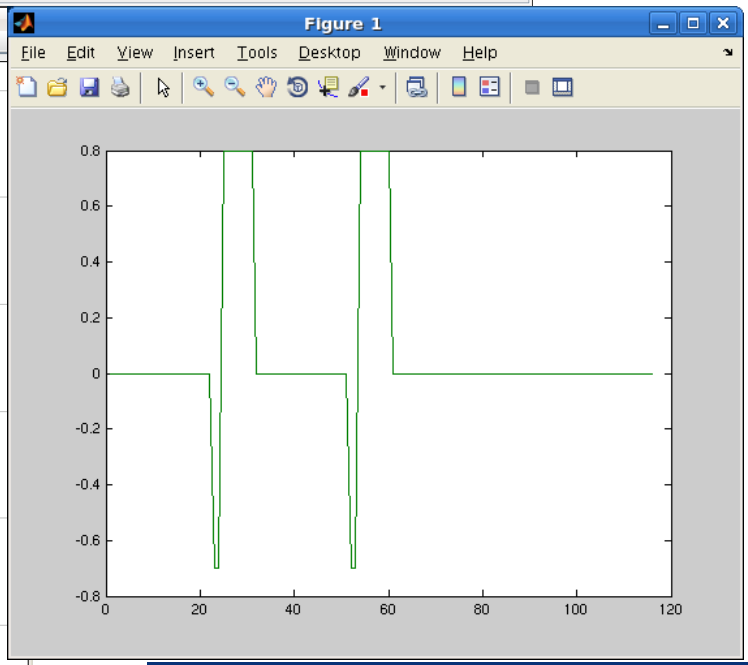




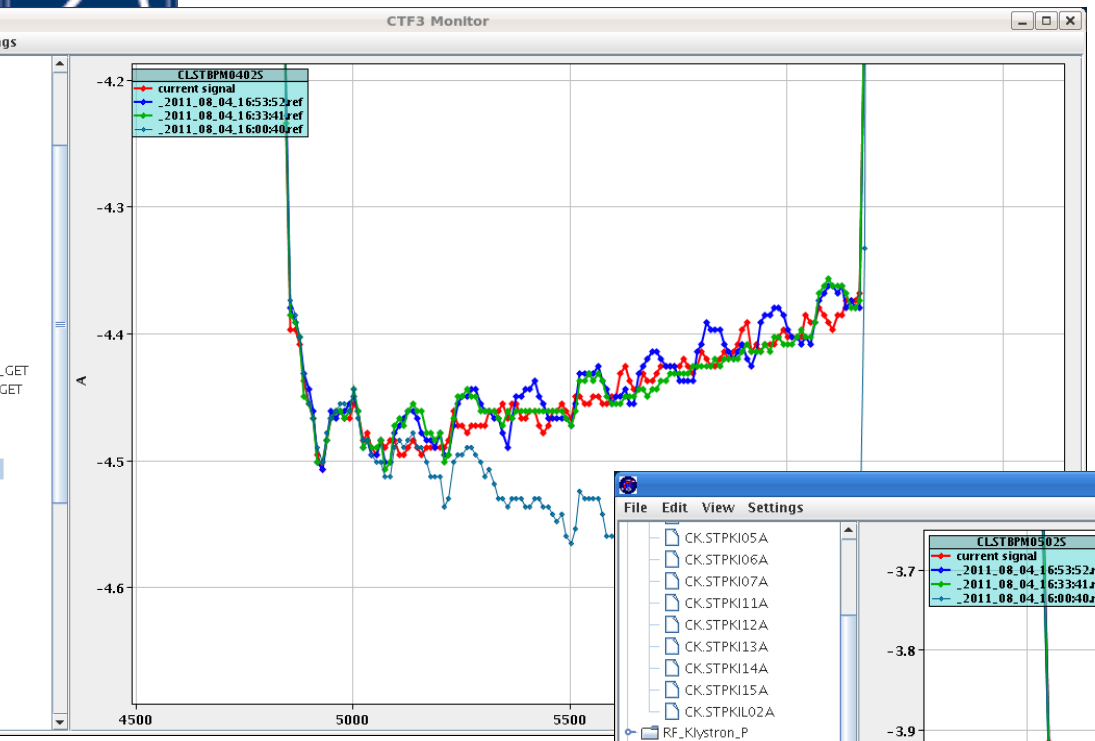
Corrections from the gun

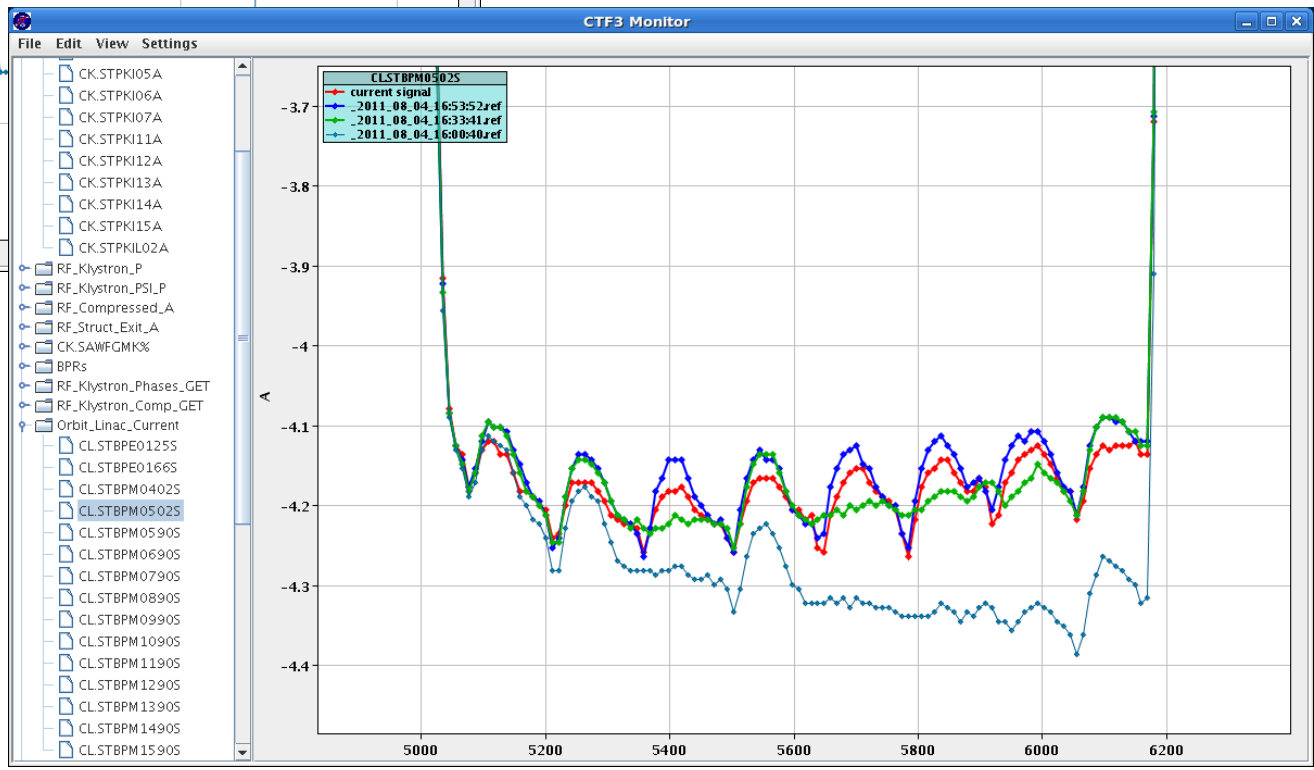






Corrections from the gun

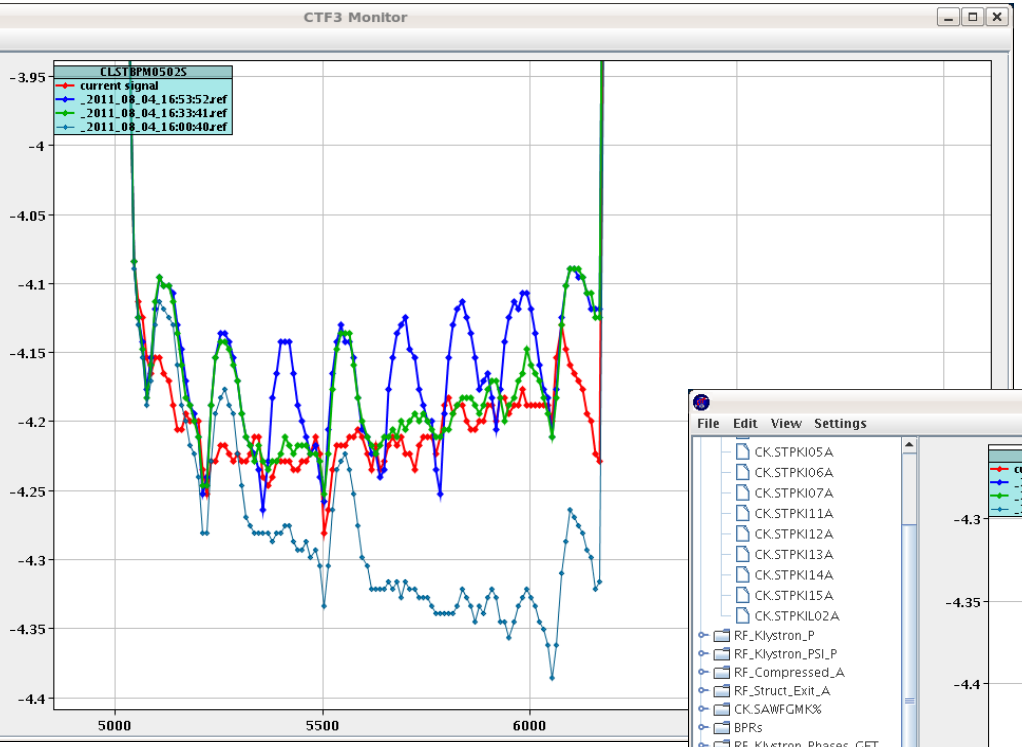


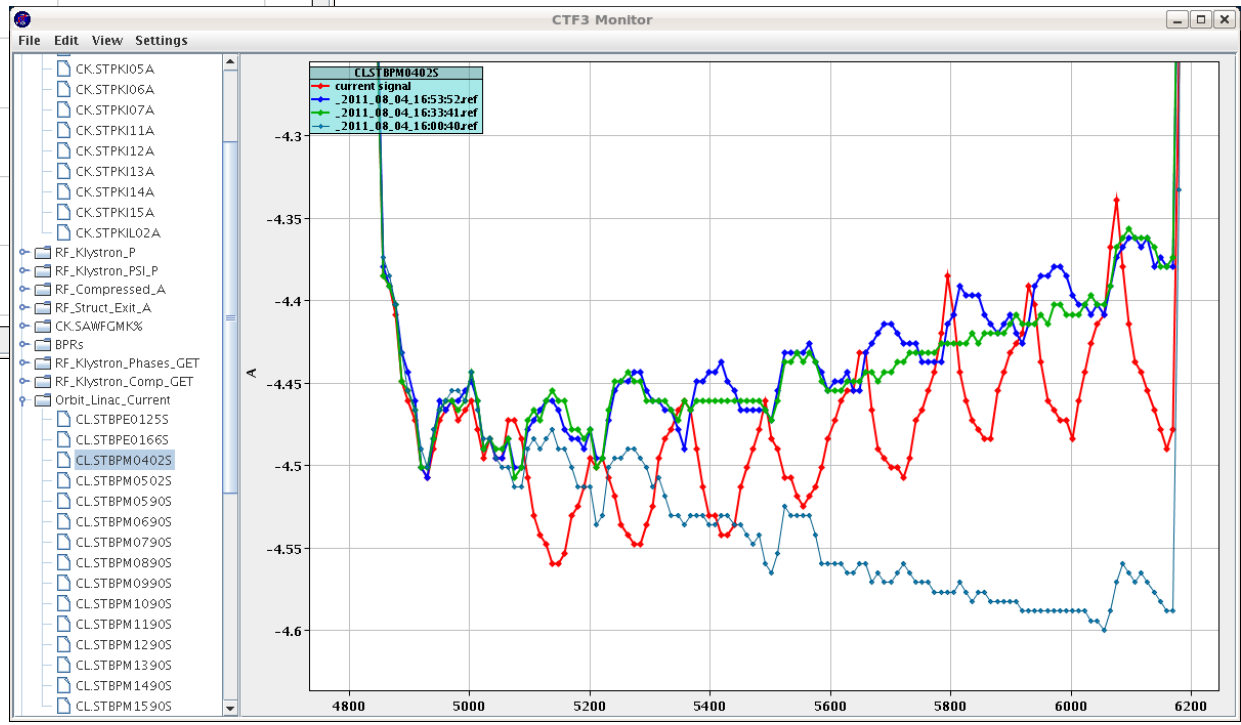


- **402 with switches and with correction**

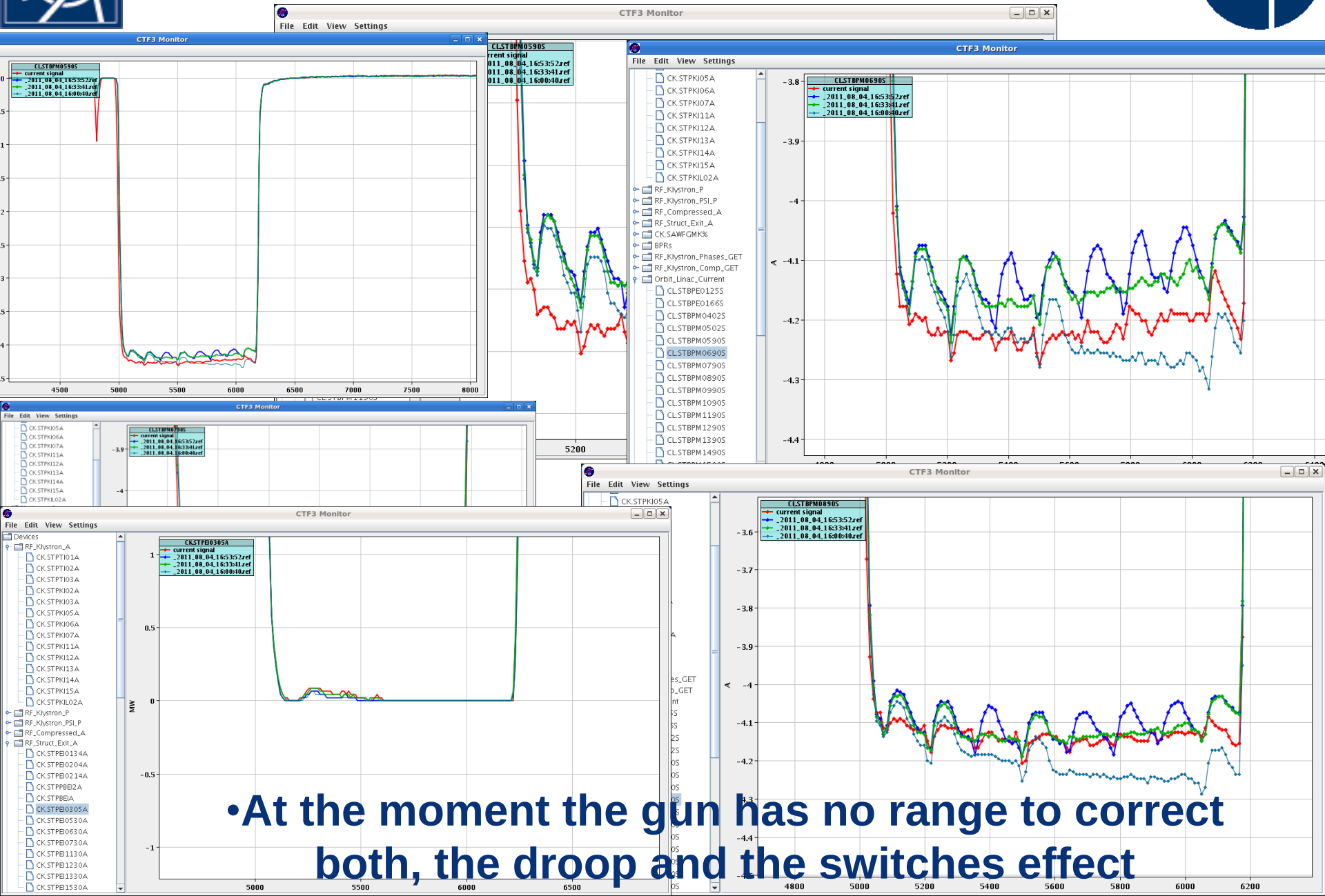
Corrections from the gun

- To get 502 flat we have to overcompensate 0402





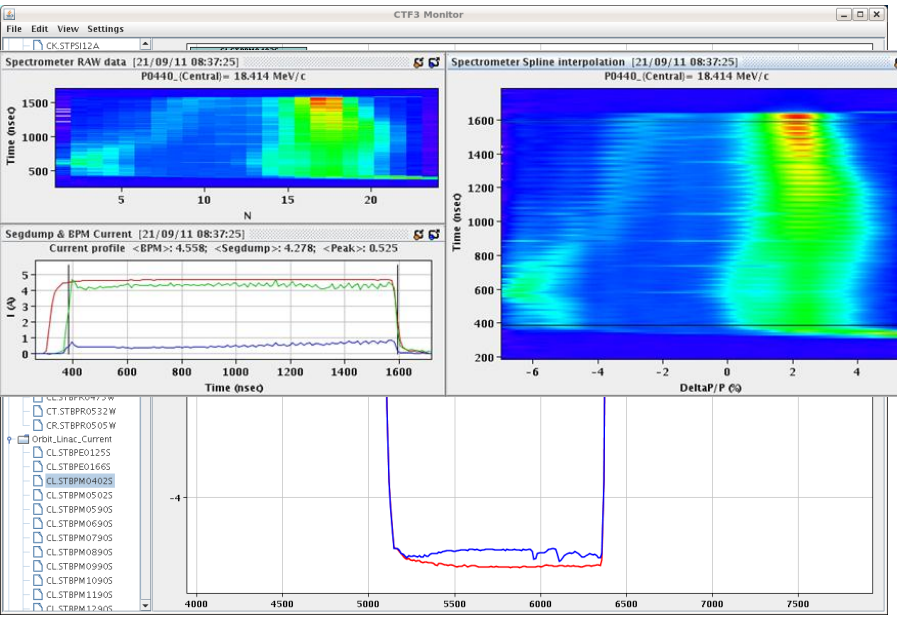
Corrections from the gun



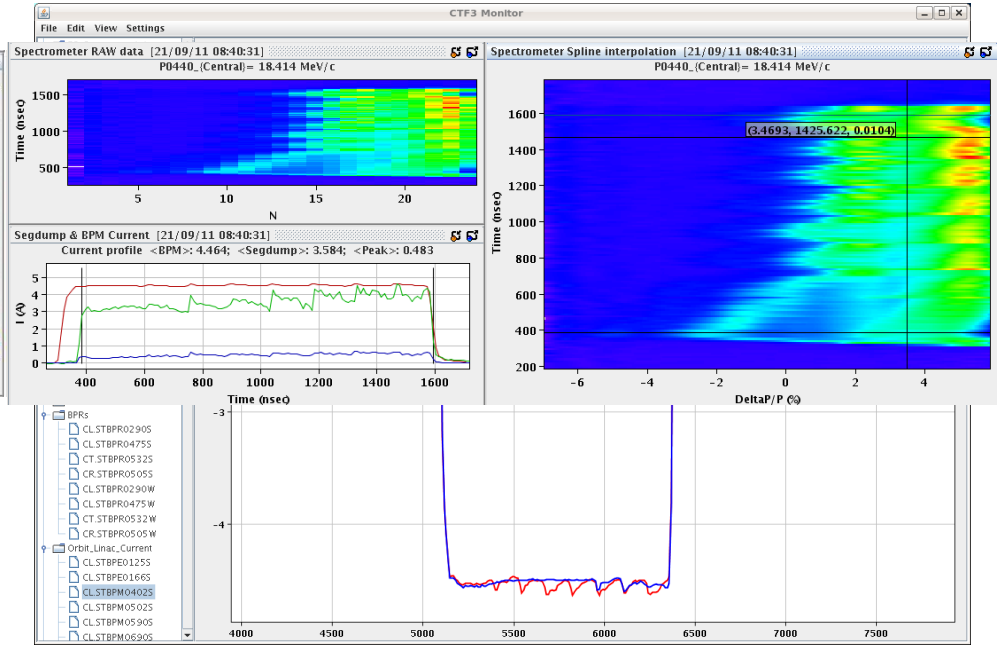
- At the moment the gun has no range to correct both, the droop and the switches effect

Wednesday 21-Sep-2011 DAY
Problem only with cavity 1?

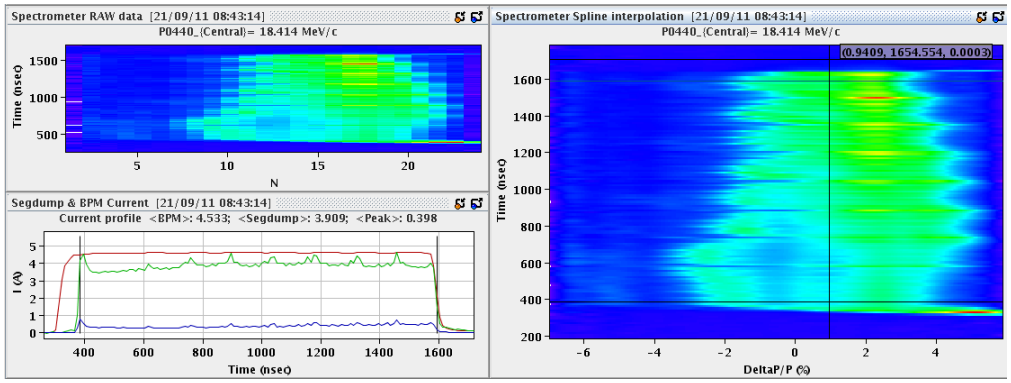
Only SHB03 in. (TP)

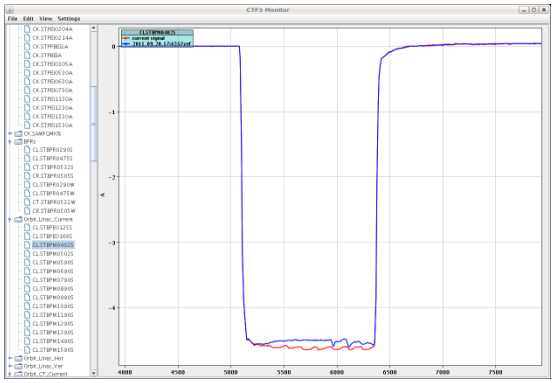


•Only SHB01 in. (TP)

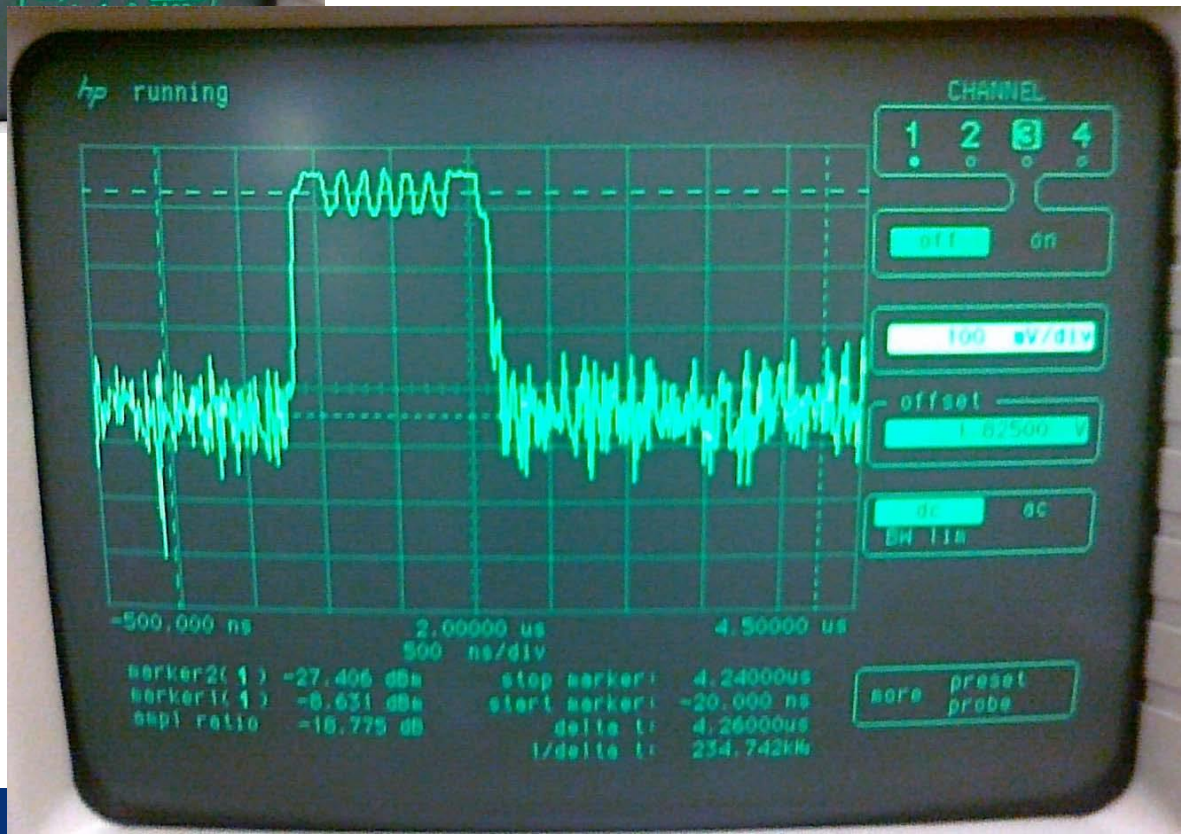


•Bot SHBs in. (TP)

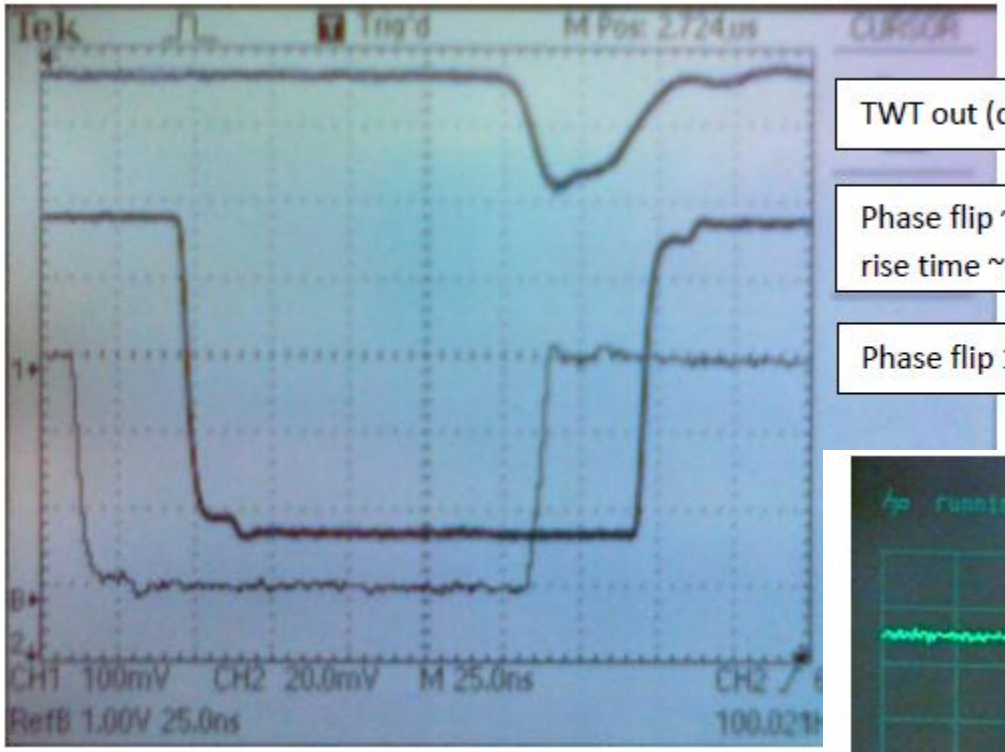




• UP: CW RF signal produced by switching system n.1 (modulator n.1 RF input);
•DOWN: pulsed RF output of TWT1.



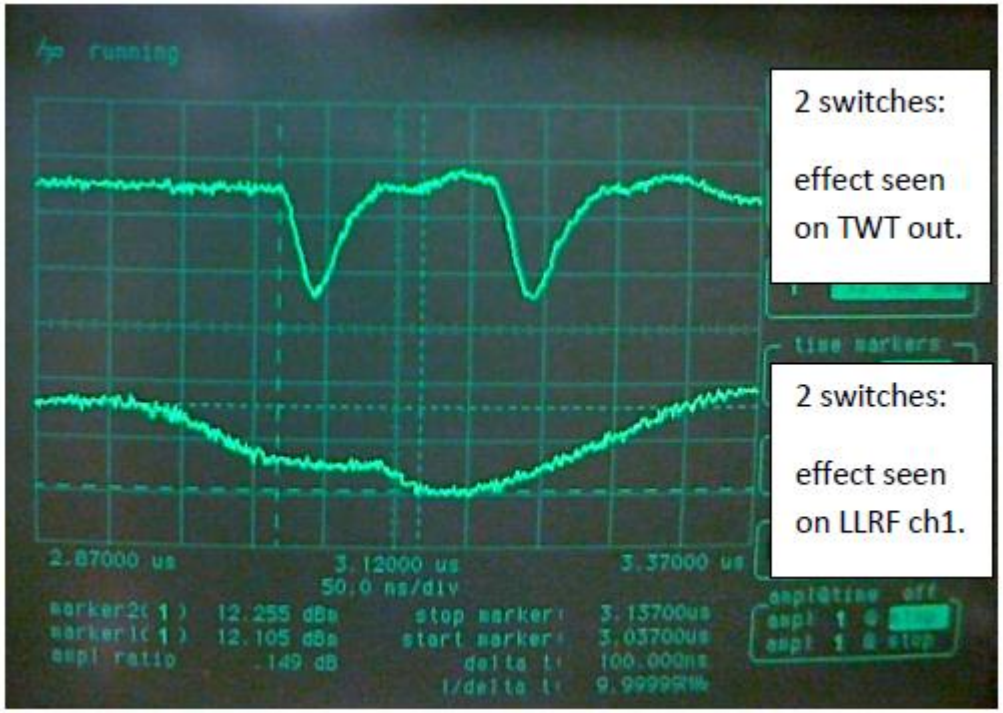
• Signal induced by the beam on SHB3 output.



TWT out (diode)

Phase flip ~180 deg (mixer)
rise time ~10 nsec

Phase flip 180 deg (TTL driver)



2 switches:

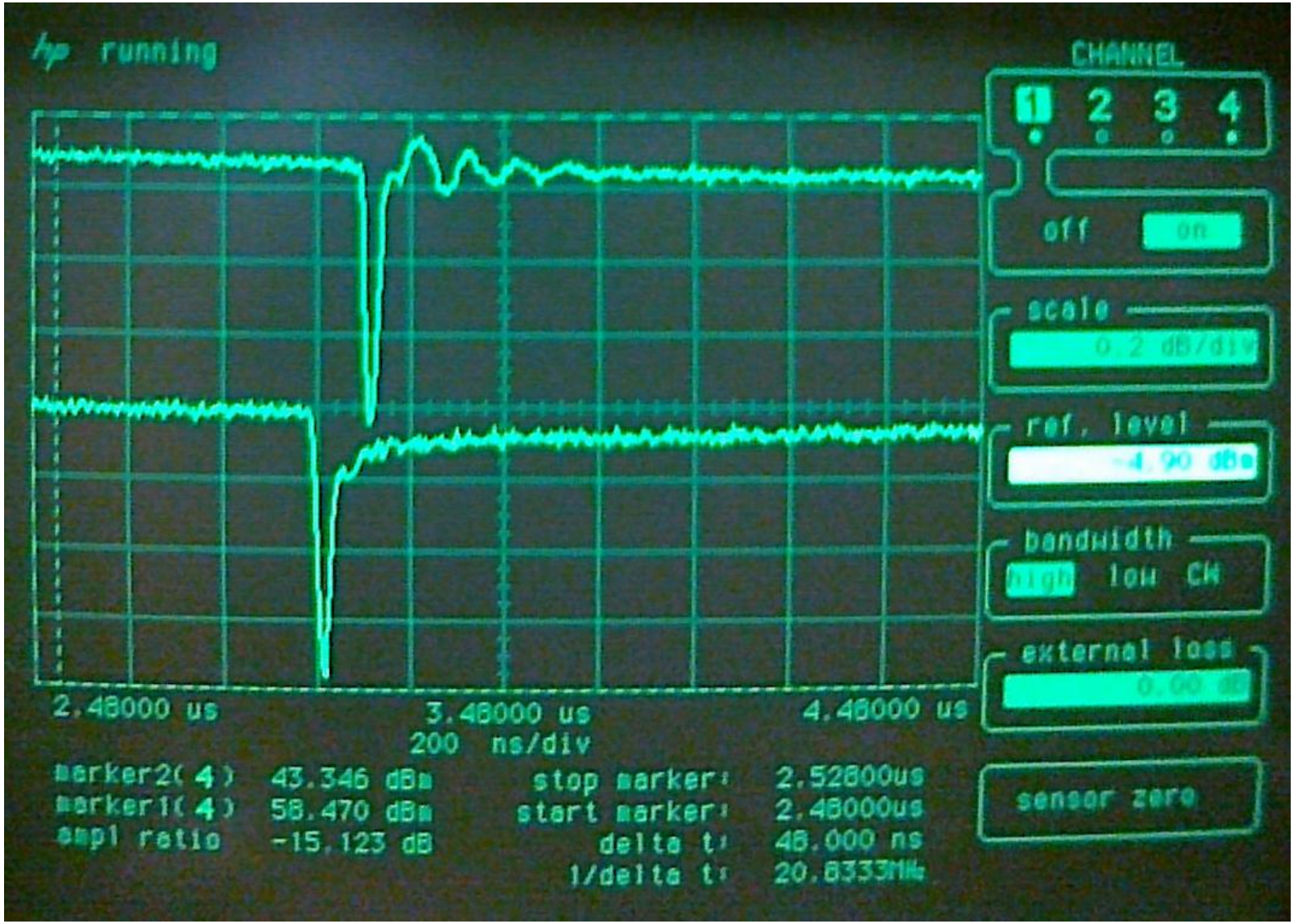
effect seen
on TWT out.

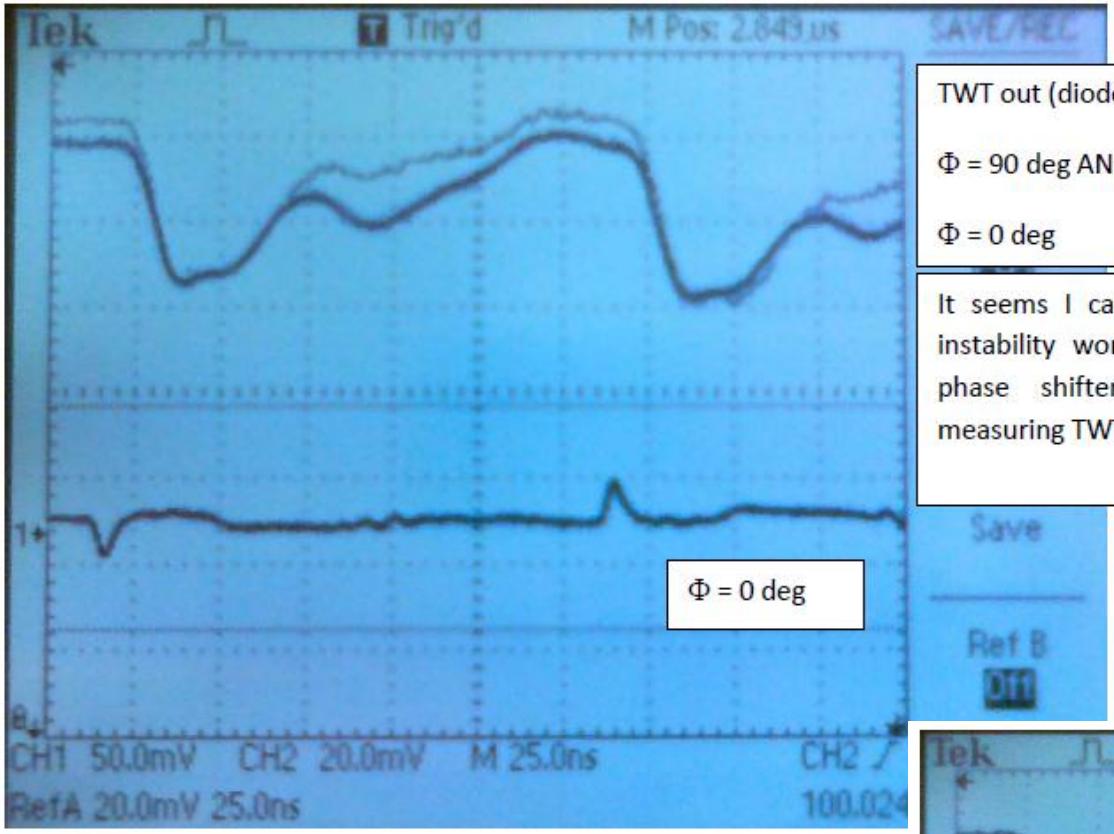
2 switches:

effect seen
on LLRF ch1.

08-Aug-2011

Luca measured the output of the TWT01 and it shows the ringing, as well.
In the image: UP is the signal TWT1_out; DOWN is the LLRF signal on ch1



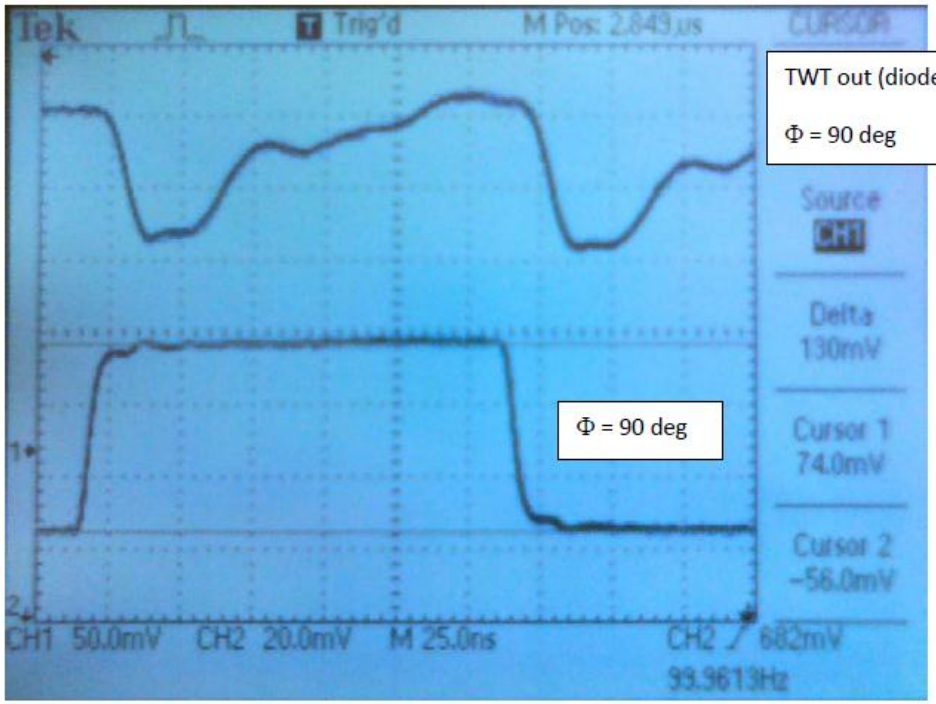


TWT out (diode)

Φ = 90 deg AND

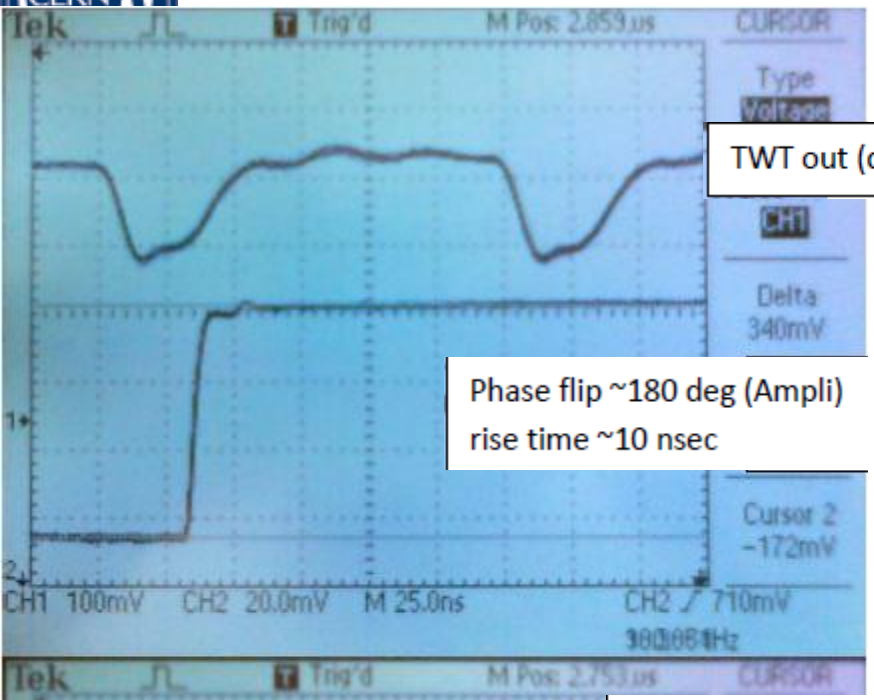
Φ = 0 deg

It seems I can shape the instability working on the phase shifter used for measuring TWT_out phase.



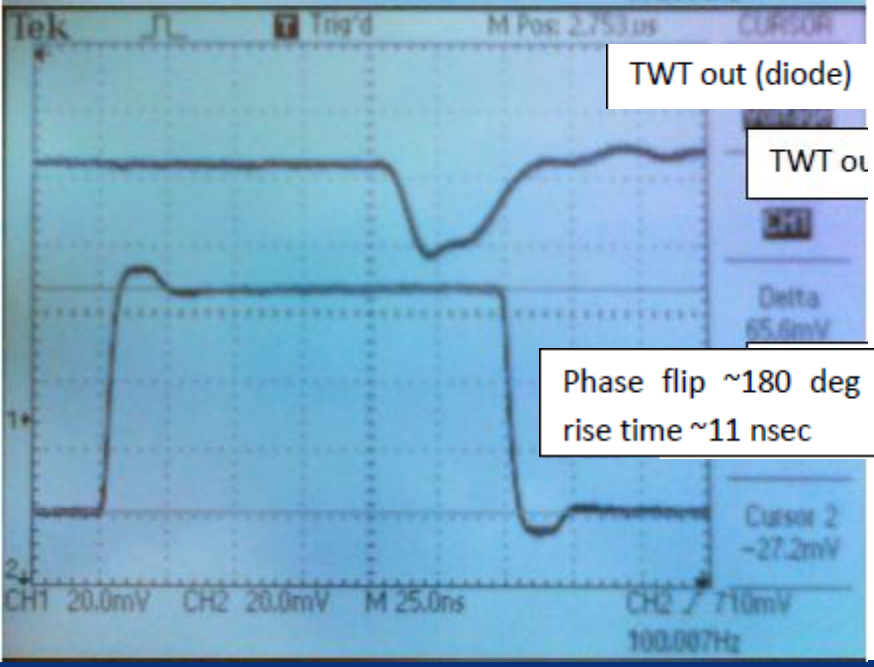
TWT out (diode)

Φ = 90 deg



TWT out (diode)

Phase flip ~180 deg (Ampli)
rise time ~10 nsec



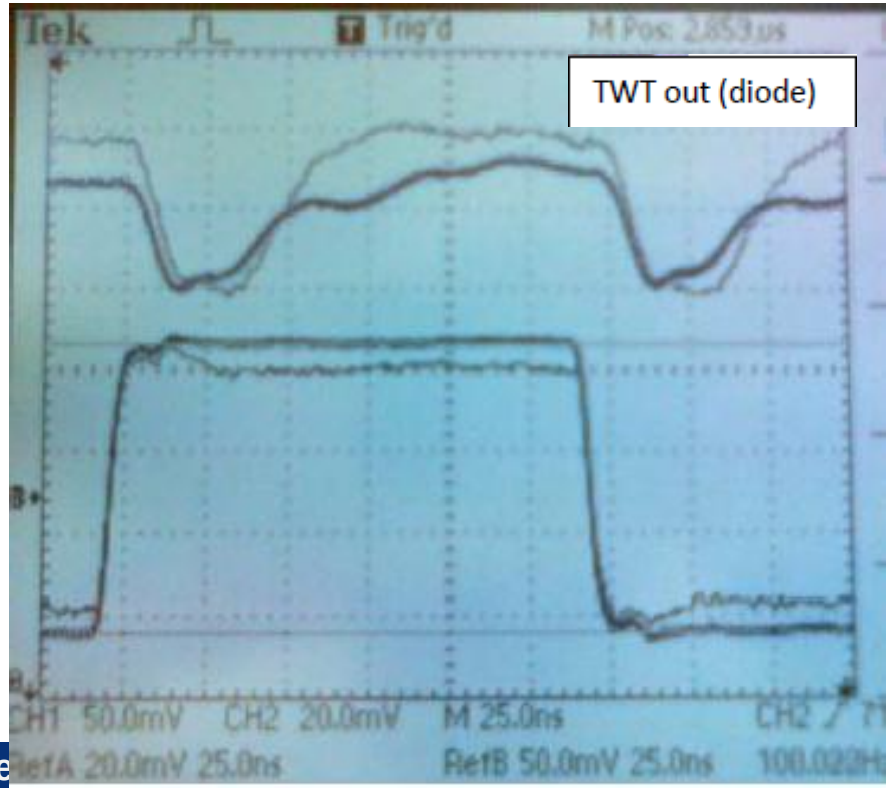
TWT out (diode)

TWT ou

Phase flip ~180 deg (I/Q)
rise time ~11 nsec

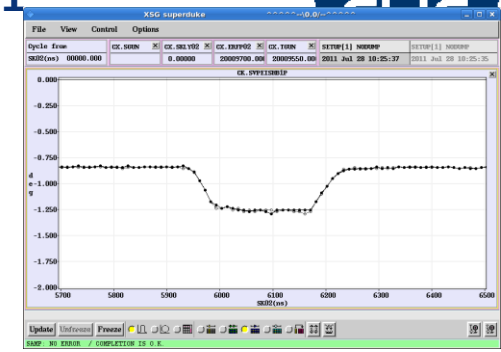
Phase flip ~180 deg (TWT)

It's clear we have to terminate the RF output of the C-Boxes for improving the reliability of the measurements.



TWT out (diode)

Thu 28-07-11
Programmed a 20 degree phase step on TWT01



- Ringing at the beginning of the pulse

XSG superduke

File View Control Options

Cycle from SK02(ns) 00000.000 | CX | CX 0.0 | CX 200 | CX 200 | SETUP[1] NODUMP 2011 Jul 28 08:51:25 | SETUP[1] NODUMP 2011 Jul 28 08:51:23

CK.SAPEISHB1I - CK.SAPEISHB1Q - CK.SAPEISHB2I - CK.SAPEISHB2Q

CK.SAPEISHB1I
CK.SAPEISHB1Q
CK.SAPEISHB2I
CK.SAPEISHB2Q

mV

CX.SKLY02

SK02(ns)

Update Unfreeze Freeze

SAMP: NO ERROR / COMPLETION IS O.K.

XSG superduke

File View Control Options

Cycle from SK02(ns) 00000.000 | CX | CX 0.0 | CX 200 | CX 200 | SETUP[1] NODUMP 2011 Jul 28 10:47:13 | SETUP[1] NODUMP 2011 Jul 28 10:47:11

CK.SAPEISHB1I - CK.SAPEISHB1Q - CK.SAPEISHB2I - CK.SAPEISHB2Q

CK.SAPEISHB1I
CK.SAPEISHB1Q
CK.SAPEISHB2I
CK.SAPEISHB2Q

mV

CX.SKLY02

SK02(ns)

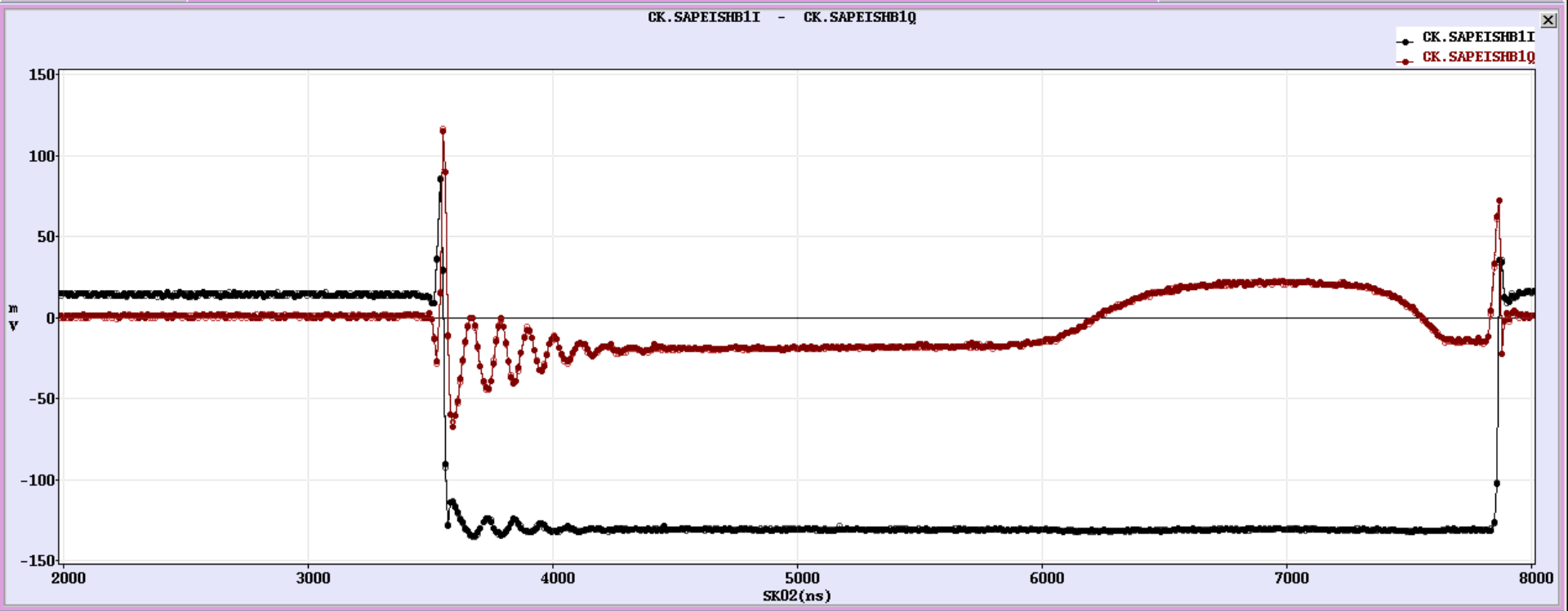
Update Unfreeze Freeze

SAMP: NO ERROR / COMPLETION IS O.K.

XSG superduke

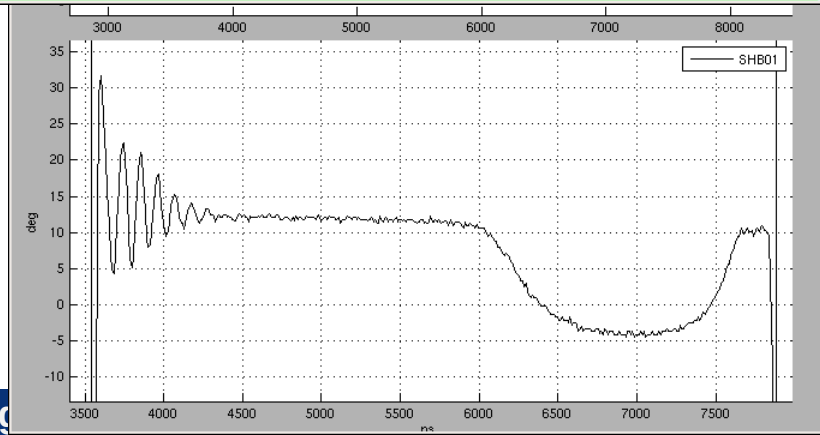
File View Control Options

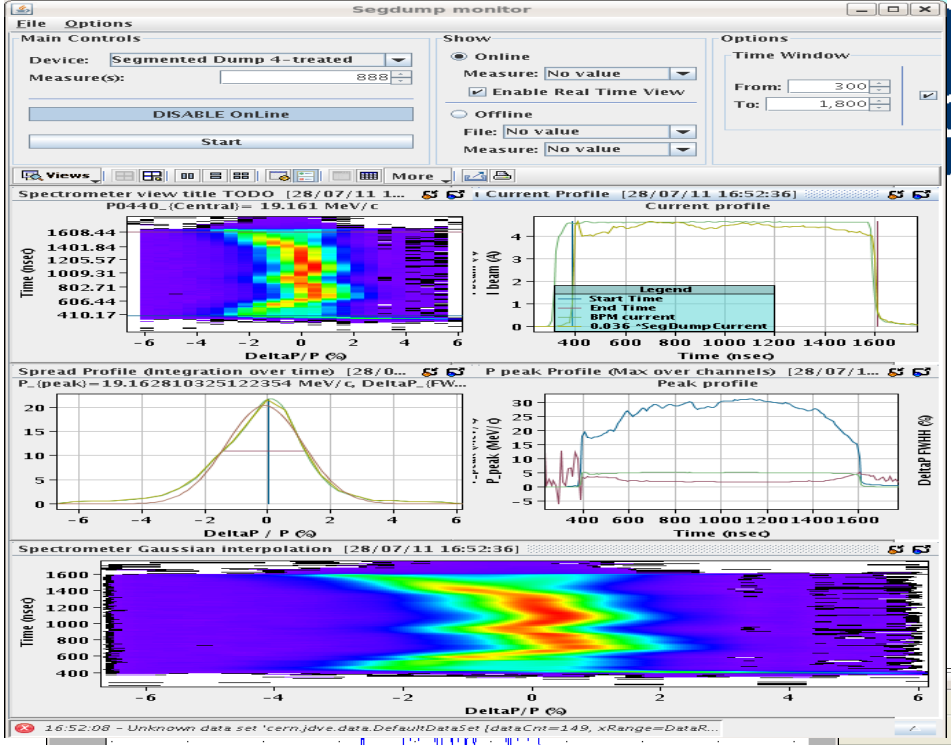
Cycle from	CX.SGUN	CX.SKLY02	CX.ERFP02	CX.TGUN	SETUP[1] NODUMP	SETUP[1] NODUMP
SK02(ns) 00000.000		0.00000	20015550.00000	20015400.00000	2011 Jul 28 16:05:24	2011 Jul 28 16:05:22

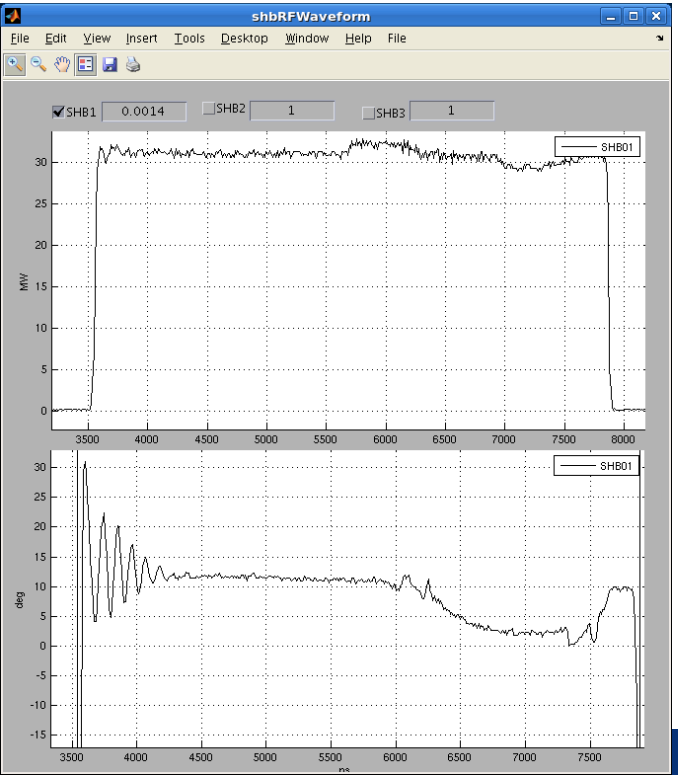


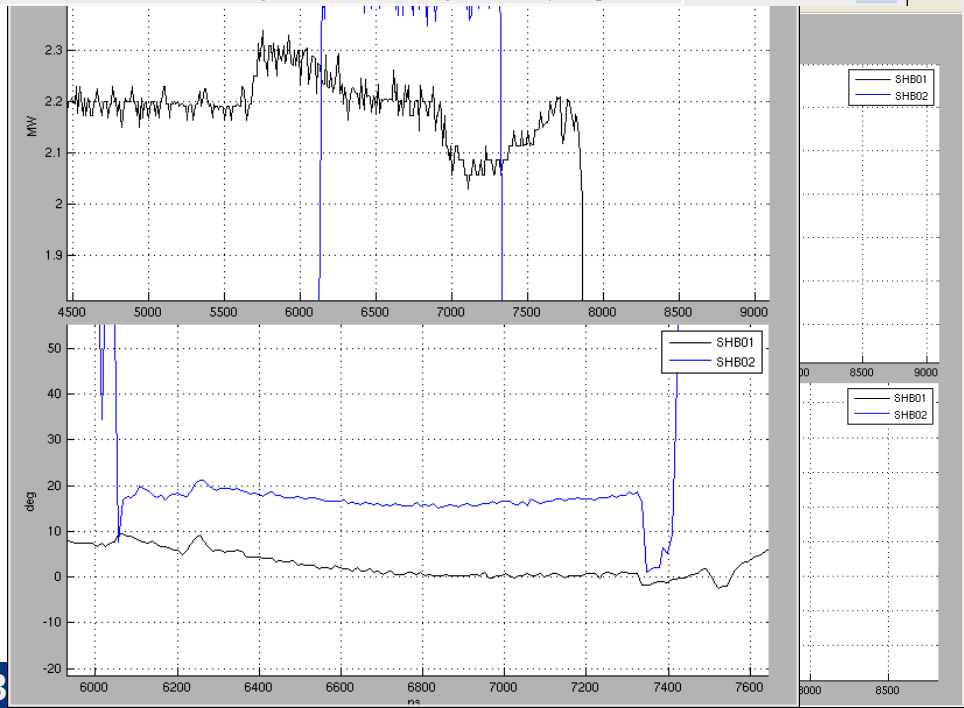
Update Unfreeze Freeze

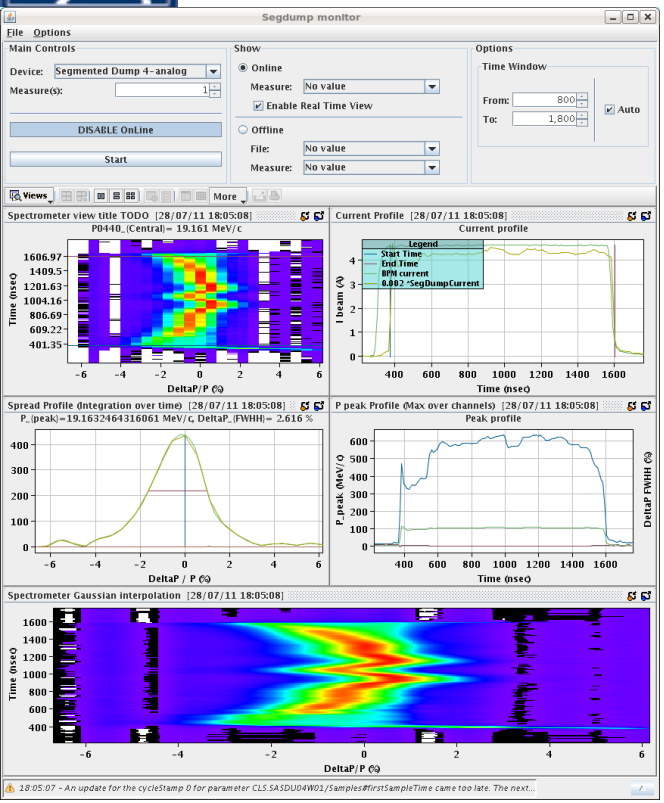
SAMP: NO ERROR / COMPLETION IS O.K.

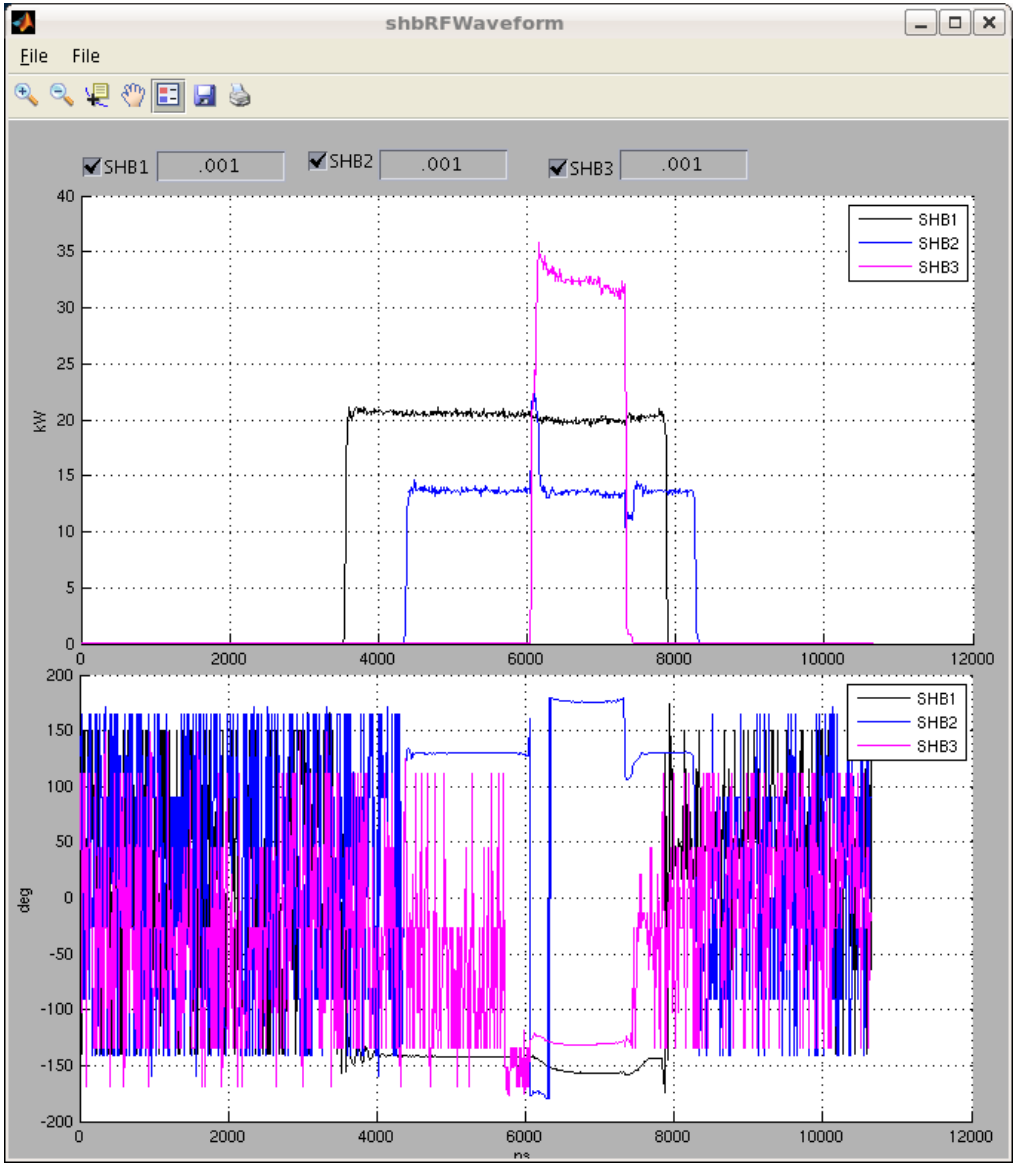



Segdump monitor
File Options
Main Controls
Device: Segmented Dump 4-treated
Measure(s): 888
DISABLE OnLine
Start
Show
Online
Measure: No value
Enable Real Time View
Offline
File: No value
Measure: No value
Options
Time Window
From: 300
To: 1,800
Views
More
Spectrometer view title TODO [28/07/11 1...
P0440_(Central)= 19.161 MeV/c
Time (nseq)
DeltaP/P (%)
Current Profile [28/07/11 16:52:36]
Current profile
I beam (A)
Time (nseq)
Legend
Start Time
End Time
BPM current
0.036 *SegDumpCurrent
Spread Profile (Integration over time) [28/0...
P_(peak)=19.162810325122354 MeV/c, DeltaP_(FW...
DeltaP / P (%)
P peak Profile (Max over channels) [28/07/1...
Peak profile
P_peak (MeV/c)
DeltaP FWHH (%)
Time (nseq)
Spectrometer Gaussian interpolation [28/07/11 16:52:36]
Time (nseq)
DeltaP/P (%)
16:52:08 - Unknown data set 'cern.jdve.data.DefaultDataSet [dataCnt=149, xRange=DataR...

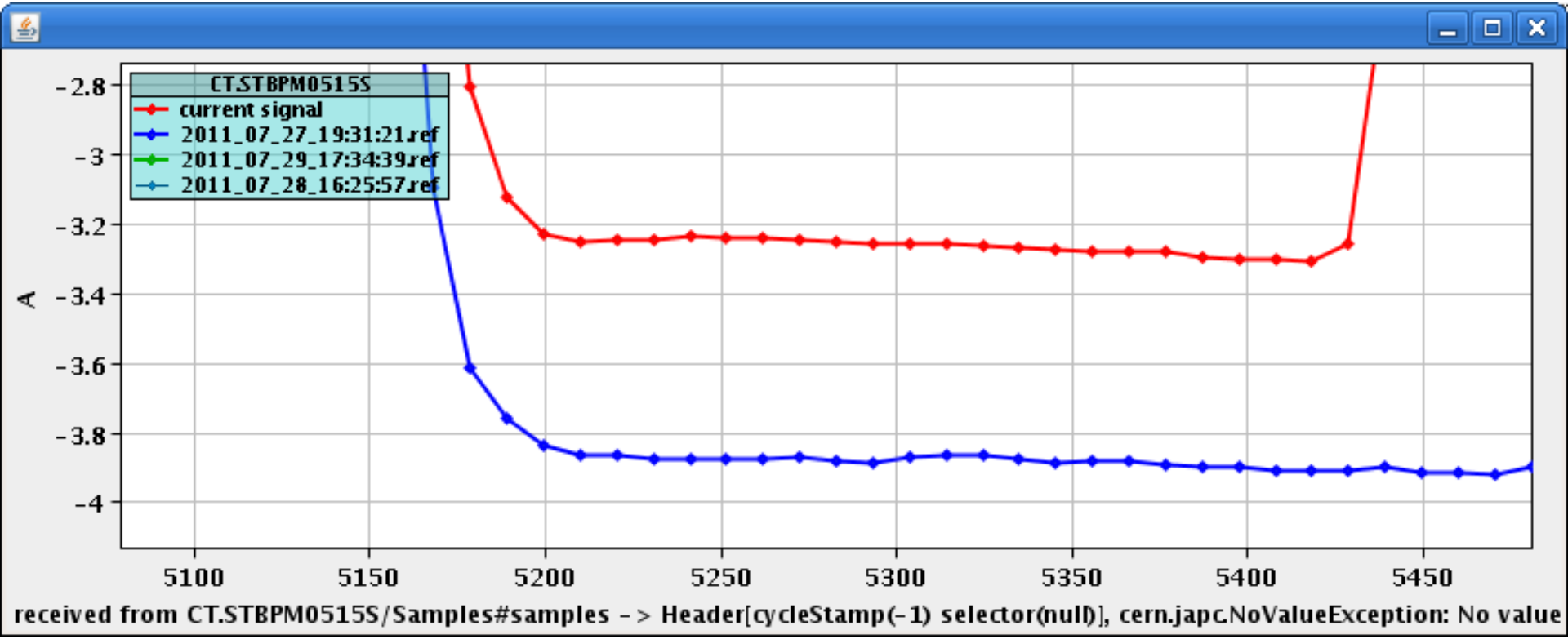

shbRFWaveform
File Edit View Insert Tools Desktop Window Help File
SHB1 0.0014
SHB2 1
SHB3 1
SHB01
MW
SHB01
deg
ns


MW
SHB01
SHB02
deg
SHB01
SHB02
ns


Segdump monitor
File Options
Main Controls
Device: Segmented Dump 4-analog
Measure(s): 1
DISABLE OnLine
Start
Show
Online
Measure: No value
Enable Real Time View
Offline
File: No value
Measure: No value
Options
Time Window
From: 800
To: 1,800
Auto
Views
More
Spectrometer view title TODO [28/07/11 18:05:08]
P0440_(Central)= 19.161 MeV/c
Time (nseQ)
DeltaP/P (%)
Current Profile [28/07/11 18:05:08]
Current profile
Legend
Start Time
End Time
BPM current
0.002 *SegDumpCurrent
I Beam (A)
Time (nseQ)
Spread Profile (integration over time) [28/07/11 18:05:08]
P_(peak)=19.16324643160 61 MeV/c, DeltaP_(FWHH)= 2.616 %
DeltaP / P (%)
P peak Profile (Max over channels) [28/07/11 18:05:08]
Peak profile
P_peak (MeV/c)
DeltaP FWHH (%)
Time (nseQ)
Spectrometer Gaussian interpolation [28/07/11 18:05:08]
Time (nseQ)
DeltaP/P (%)
18:05:07 - An update for the cycleStamp 0 for parameter CLS.SASDU04W01/Samples#firstSampleTime came too late. The next...

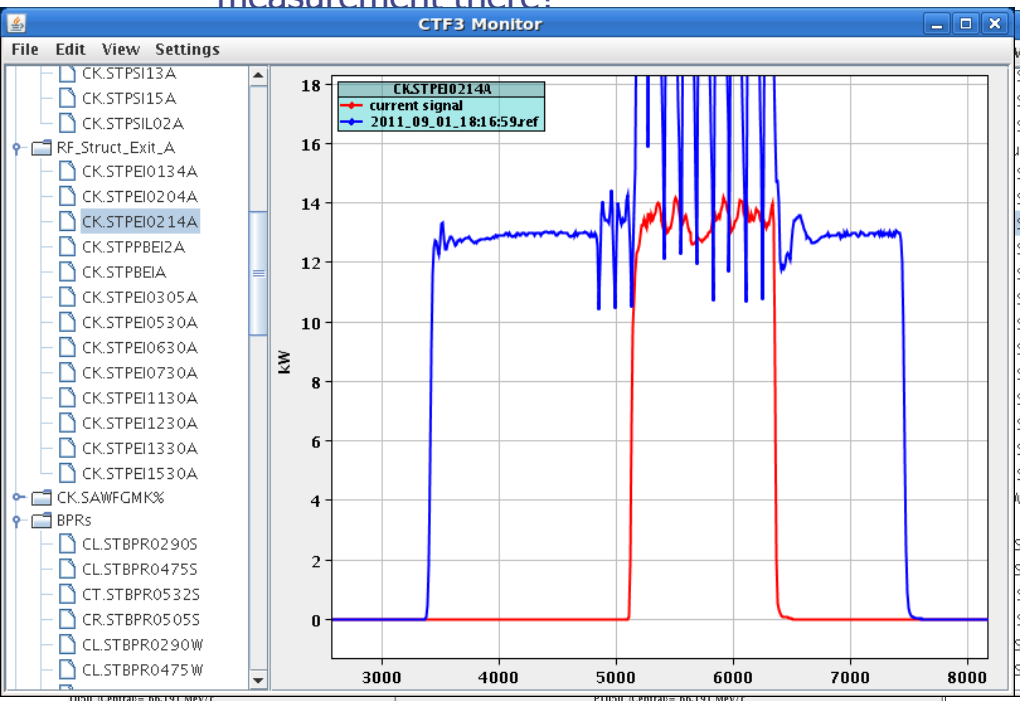

shbRFWaveform
File
File
SHB1
.001
SHB2
.001
SHB3
.001
kW
deg
SHB1
SHB2
SHB3

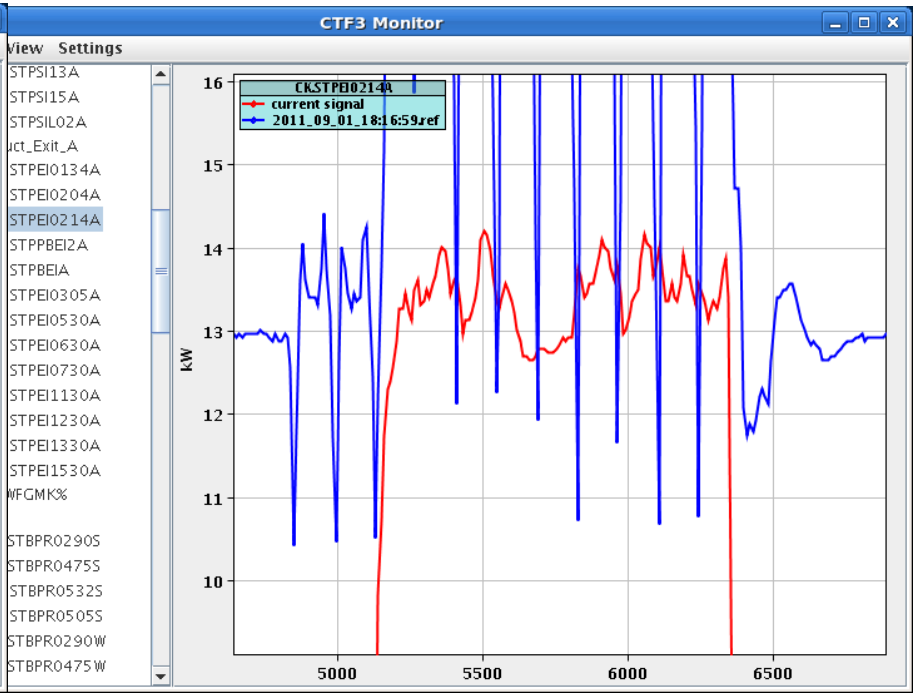
- Satellites 0.6A

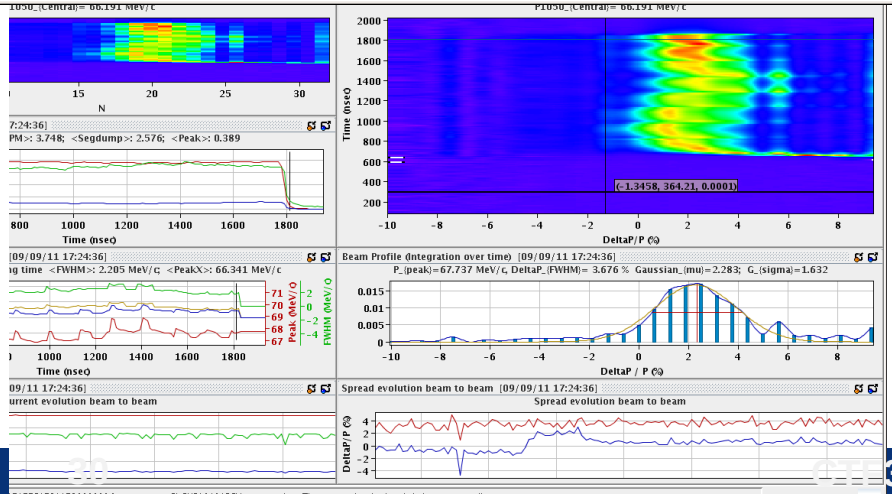


Friday 09-Sep-2011

"Delayed TWT03 after the beam and put switches on again (still two missing, as before). Loading on SHB03 looks reasonable. So is there a problem with SHB02 or only the measurement there? "

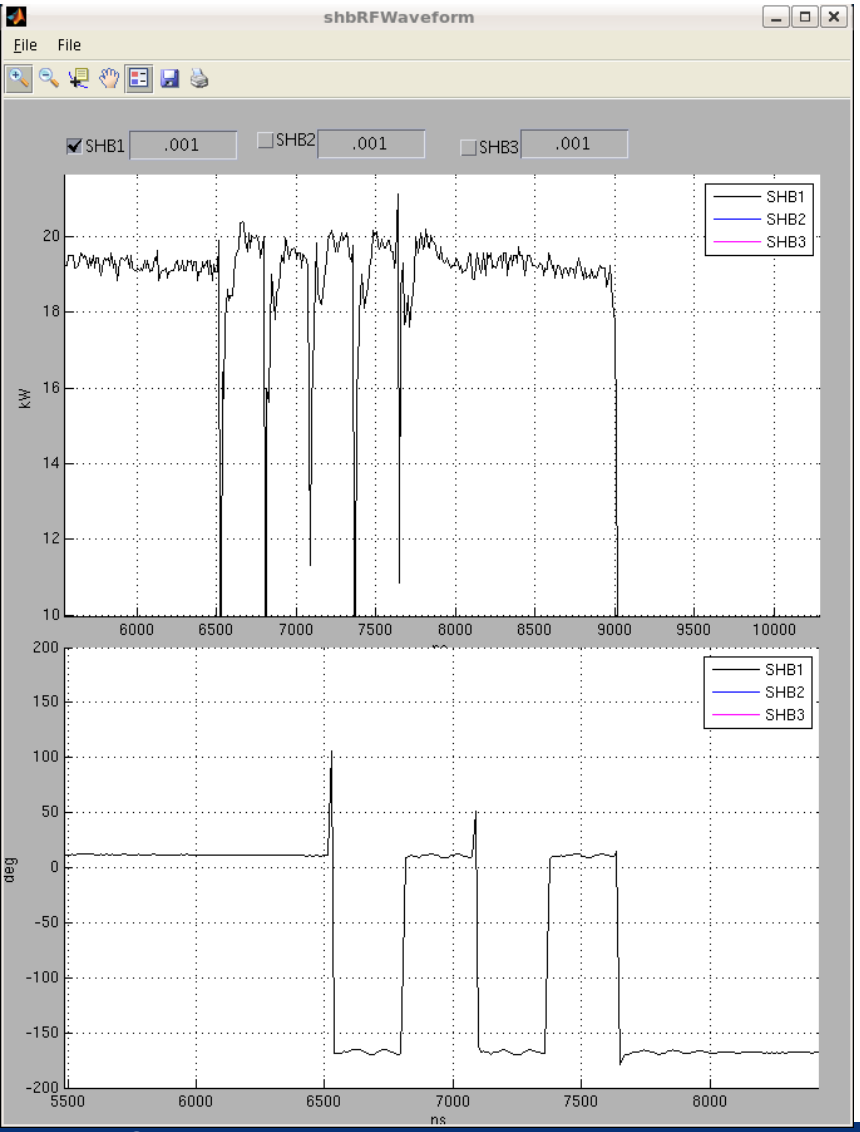


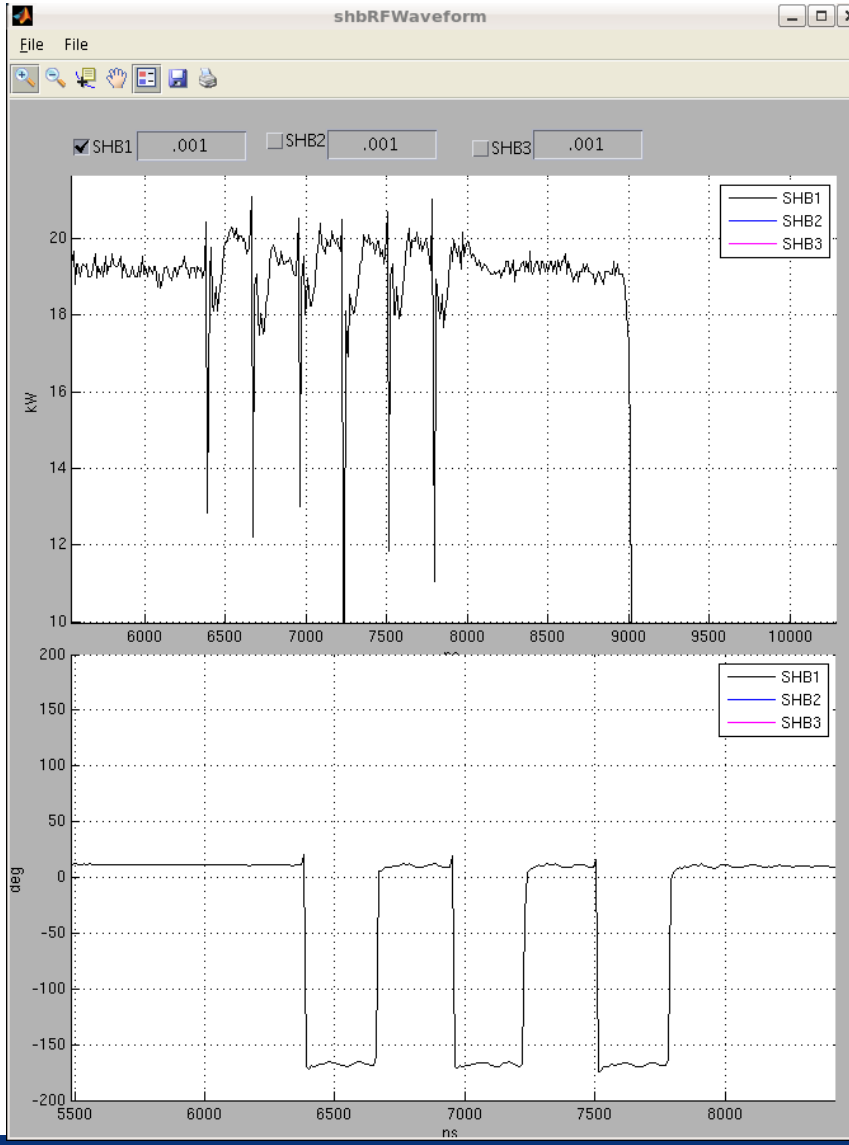




Monday 19-Sep-2011

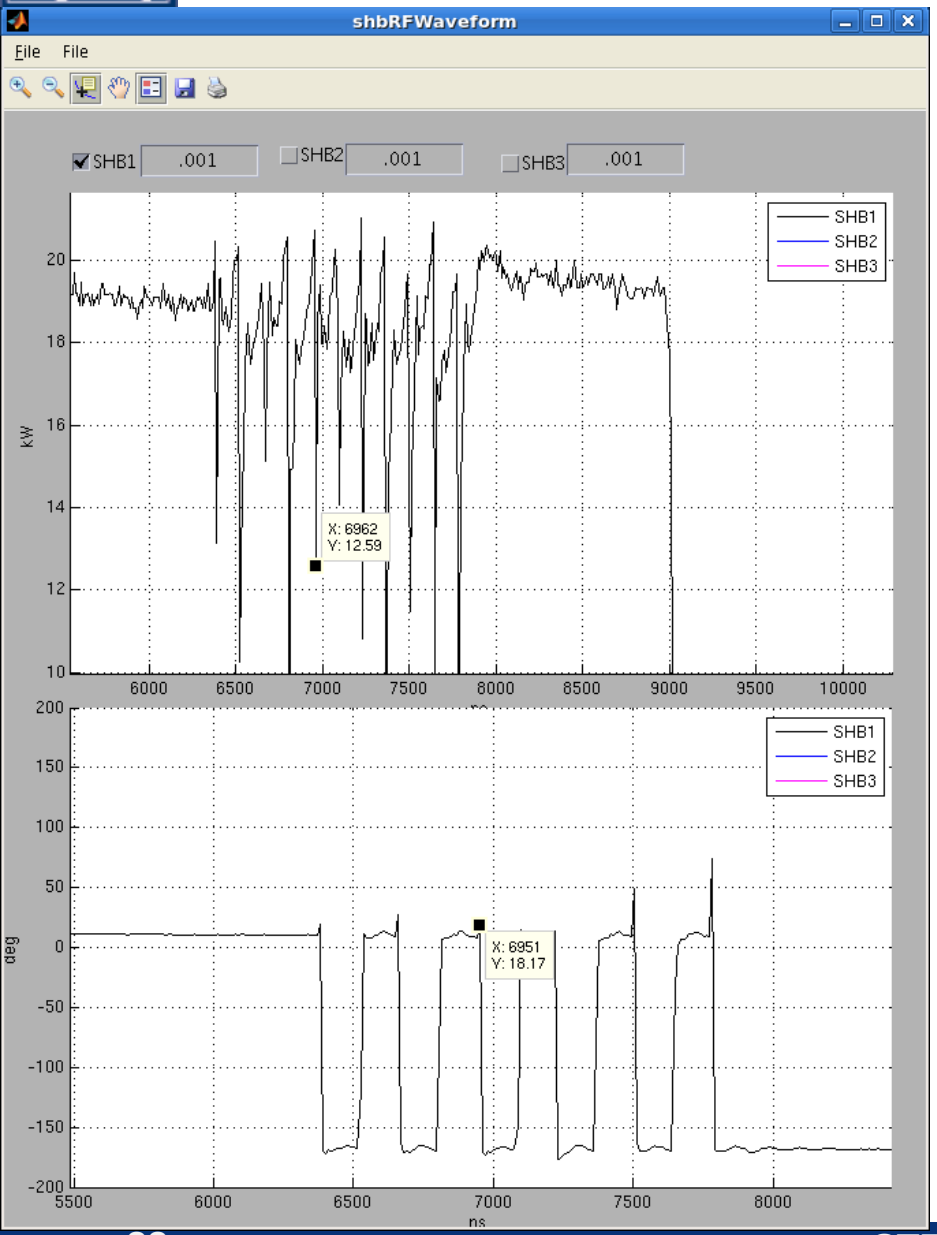
The raising time after a switch to nominal power is ~130 ns. We disable every second switch to let the power to get back to nominal. However the come back to a higher power instead.

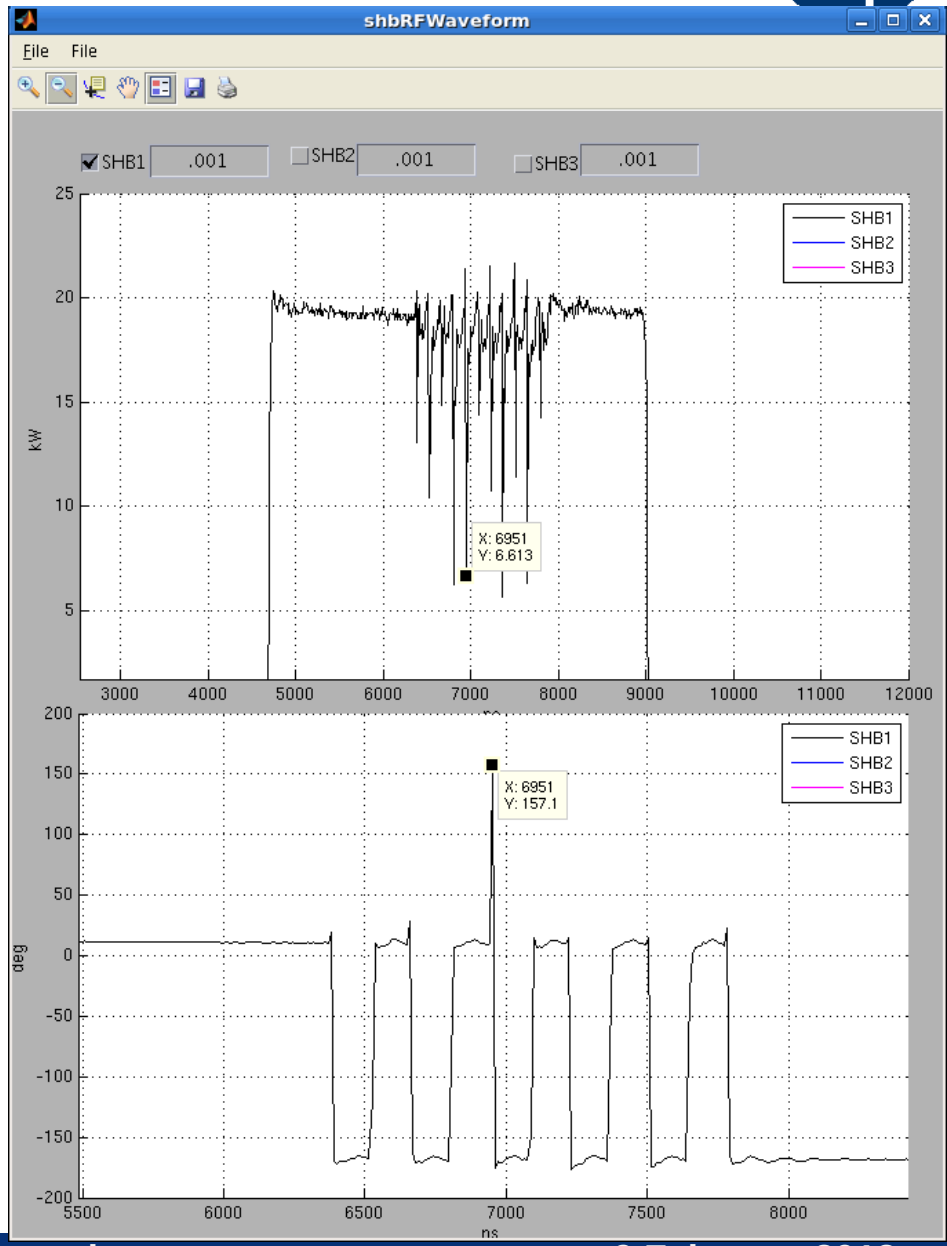




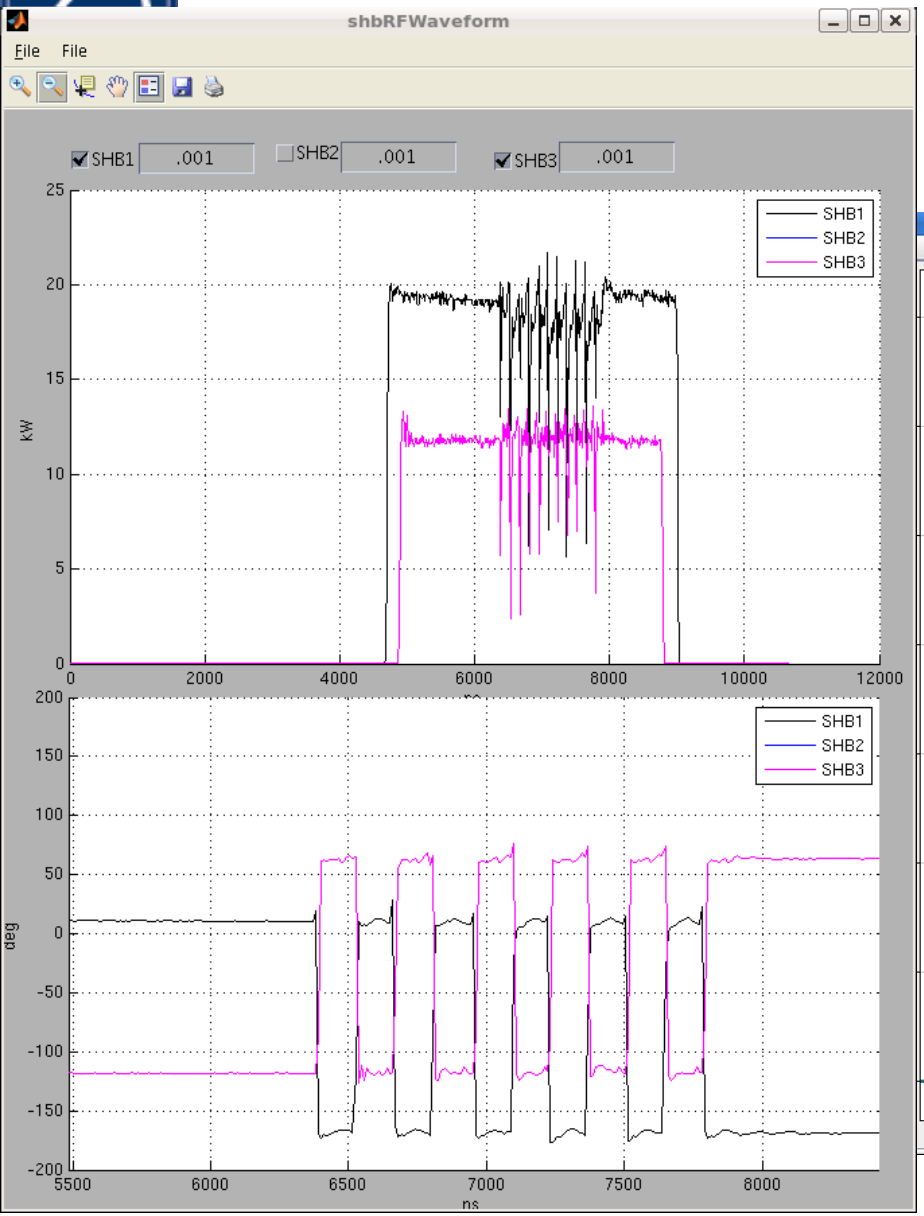
Monday 19-Sep-2011

•Effect of phase correction in the amplitude.

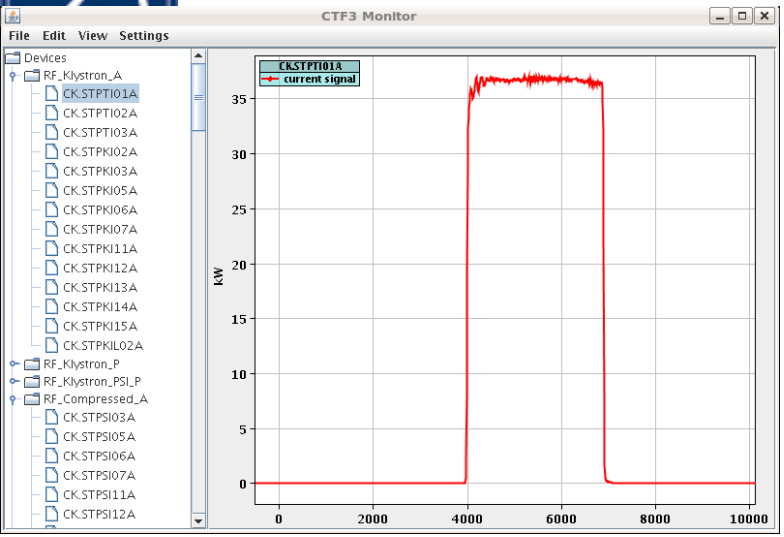


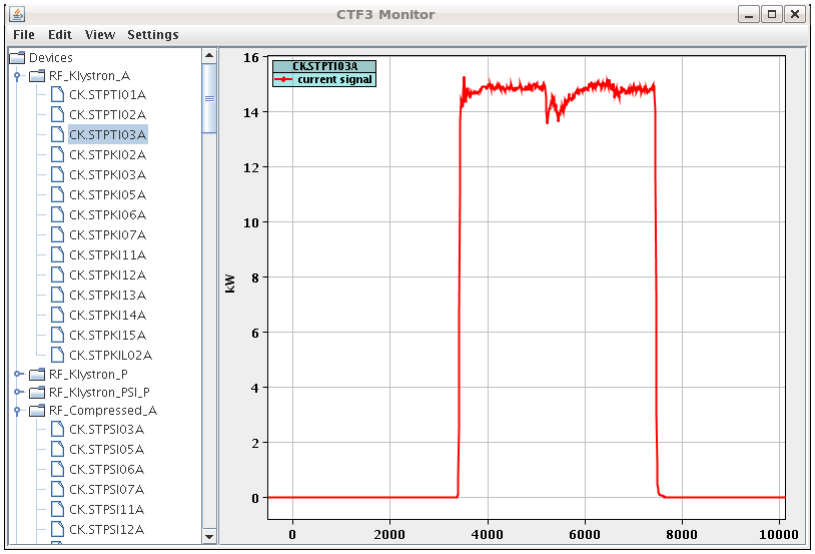


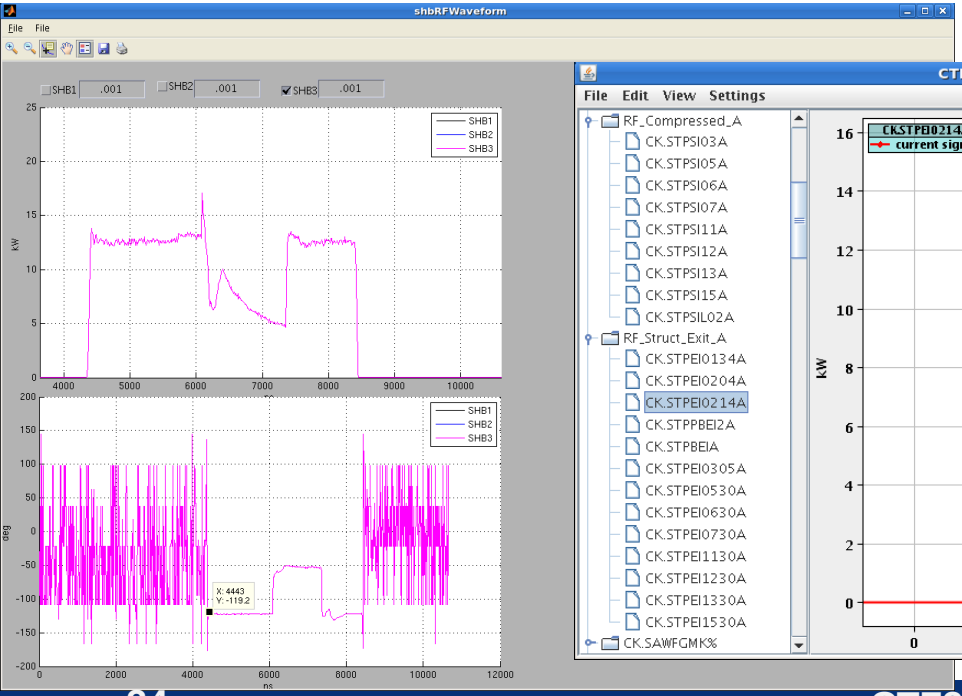
Monday 19-Sep-2011

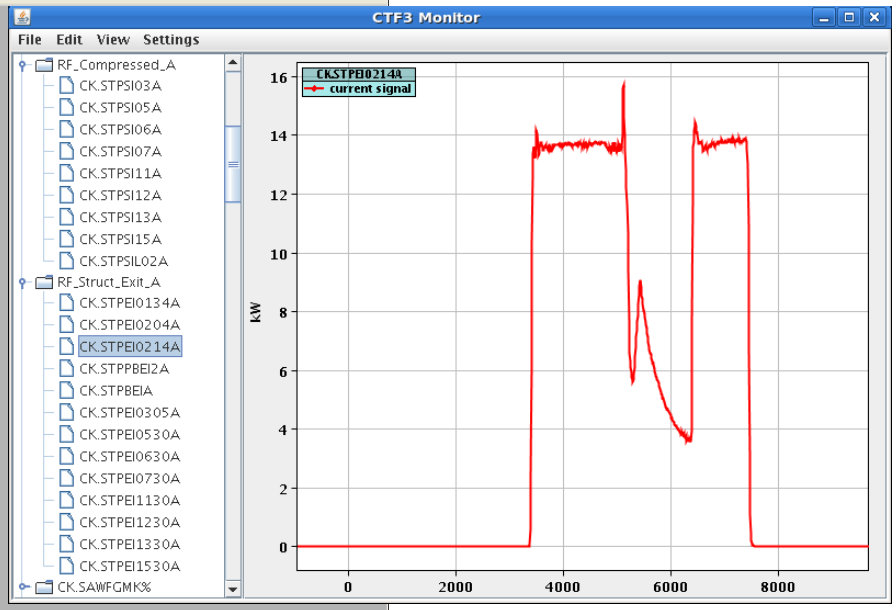


Wednesday 21-Sep-2011

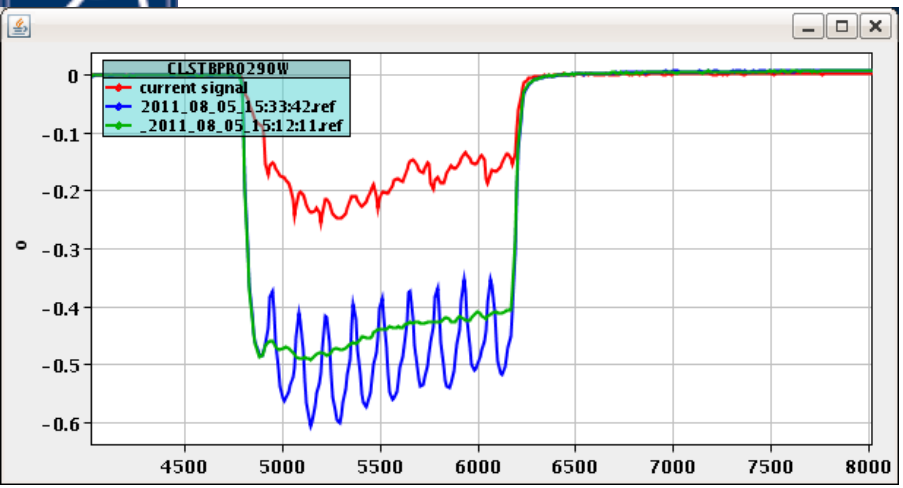


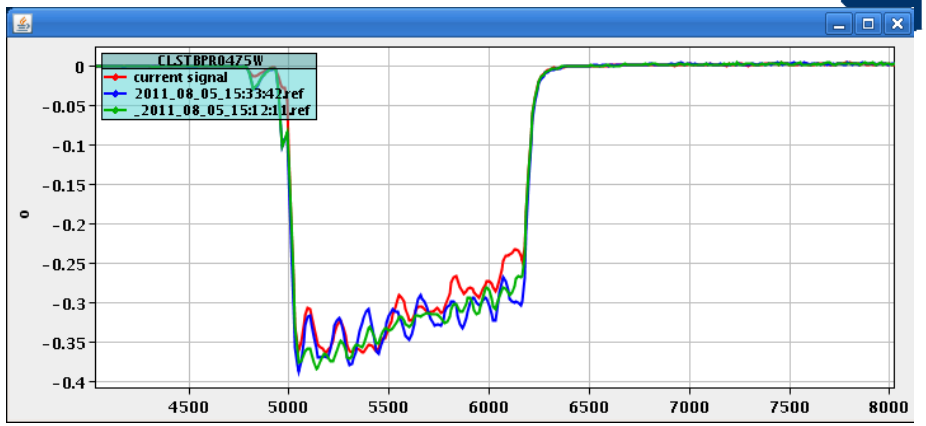


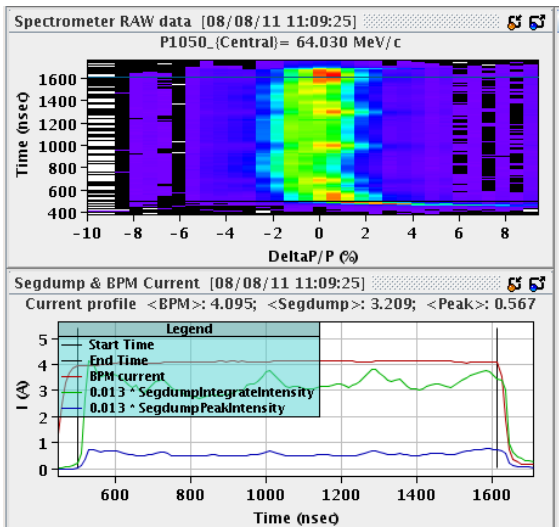


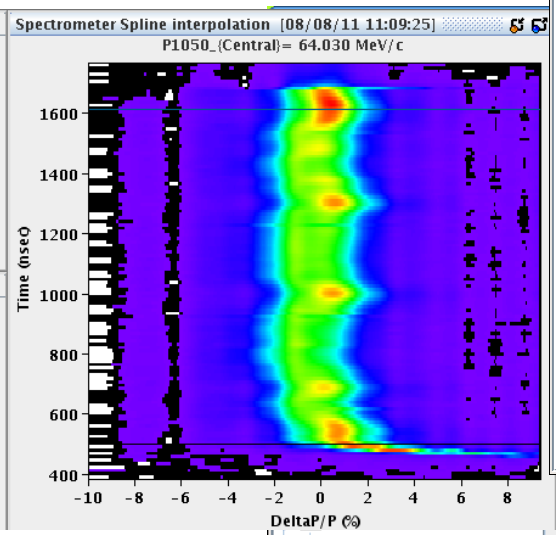


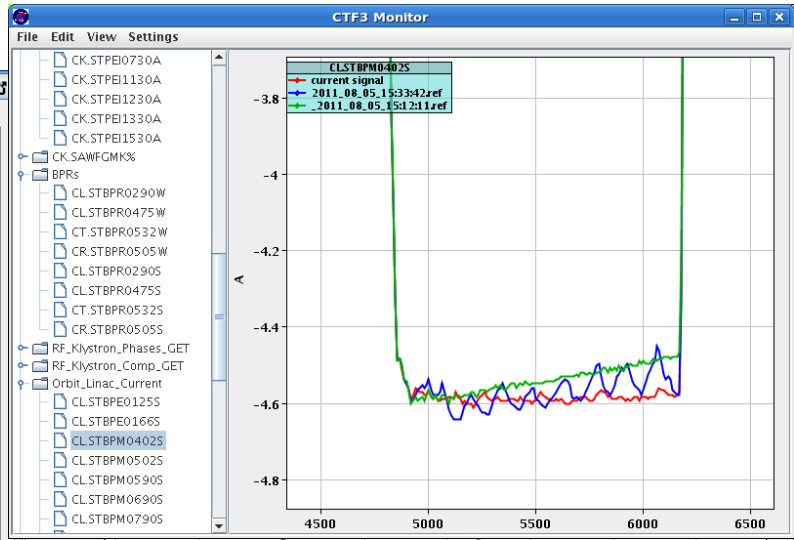
The effect of switches strongly depends on pre-buncher phase

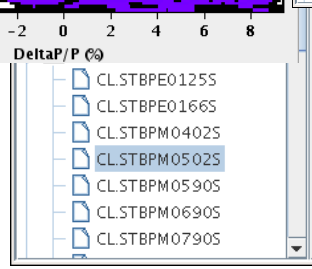


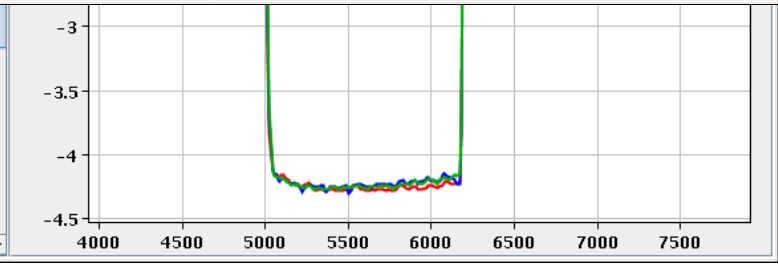




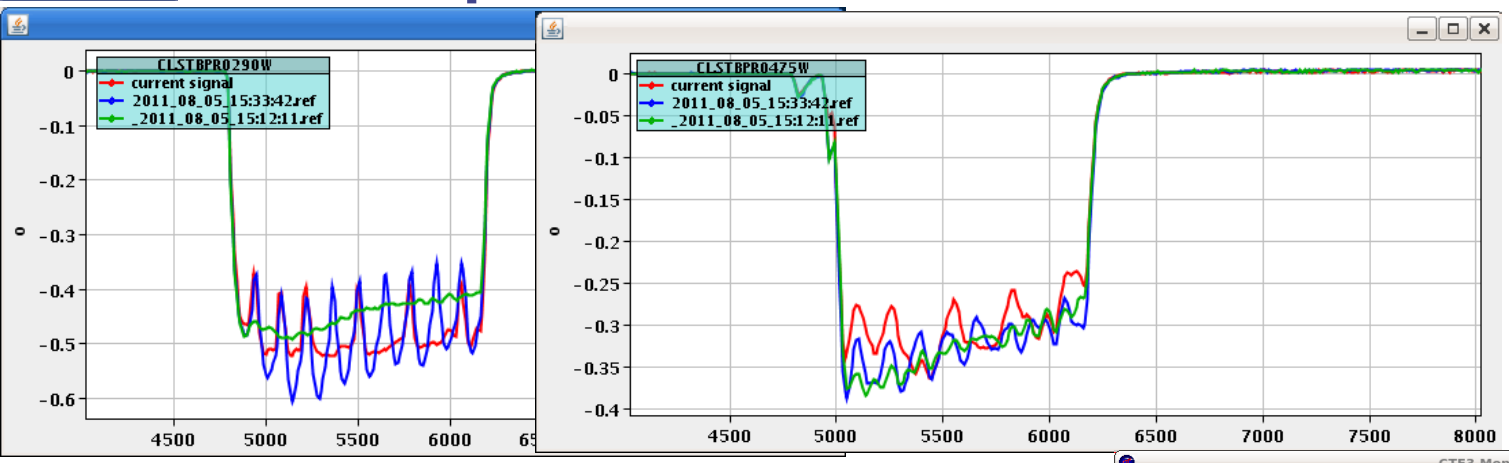


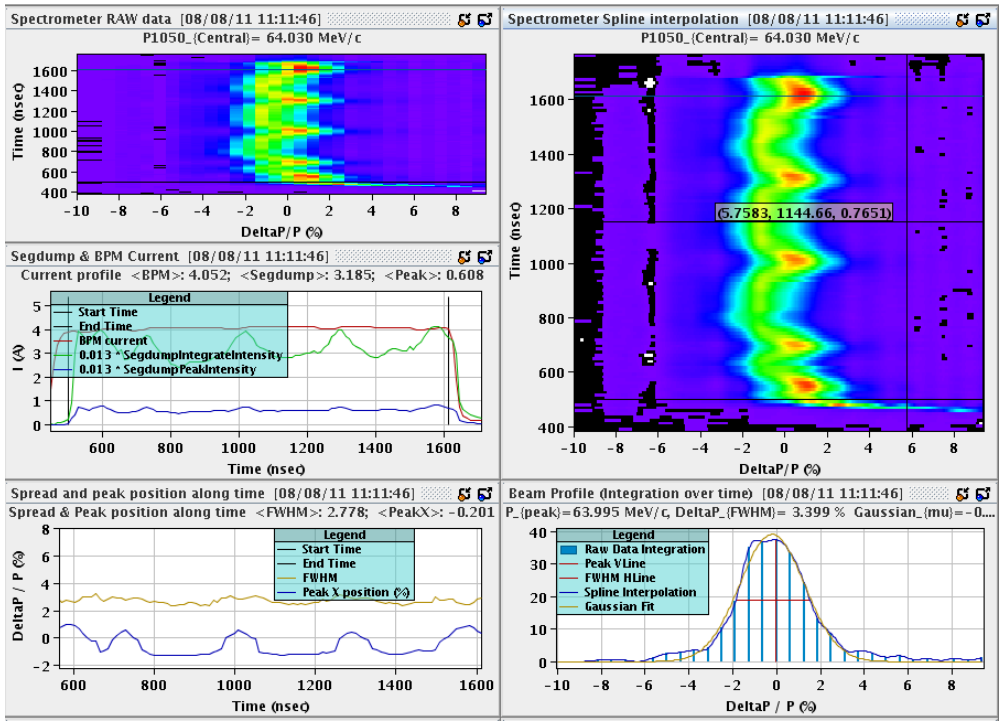


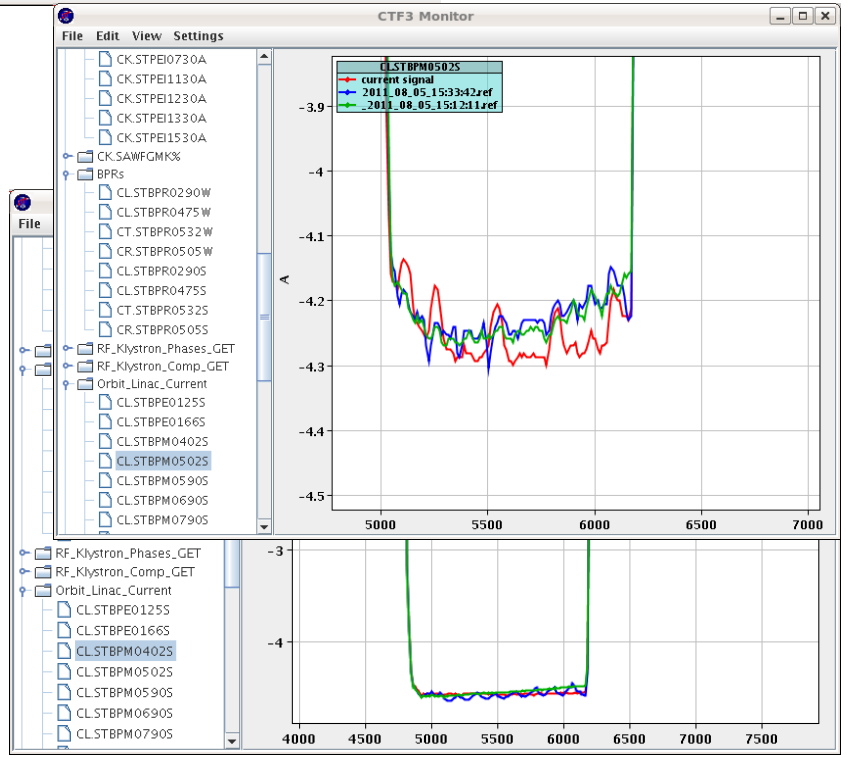




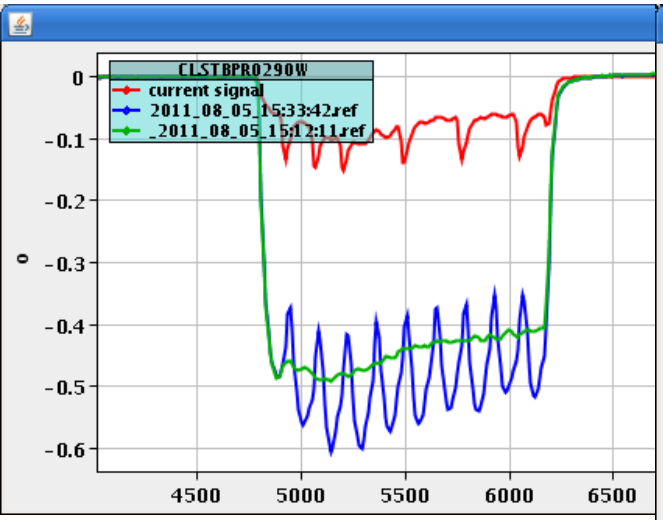
The effect of switches strongly depends on pre-buncher phase +70 units

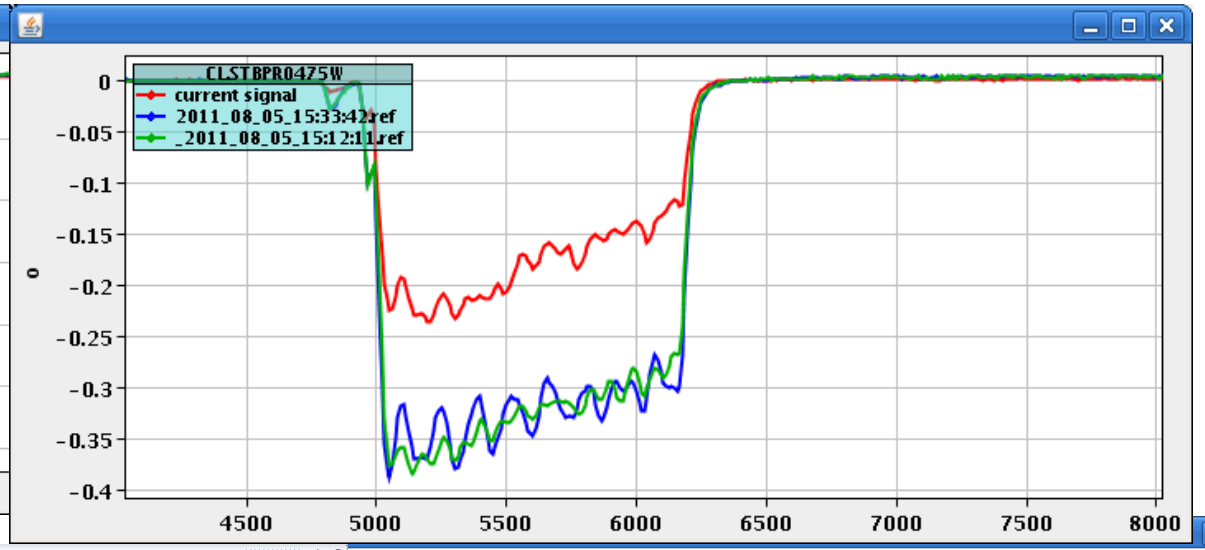


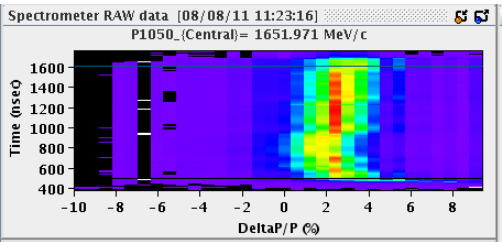


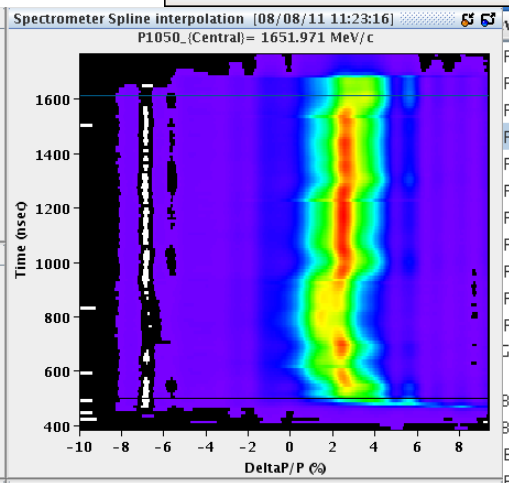


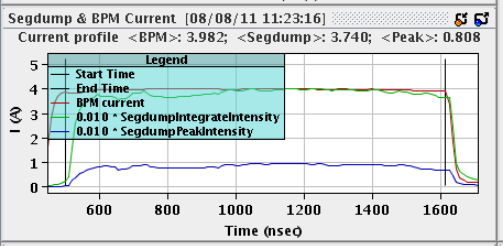
The effect of switches strongly depends on pre-buncher phase, adjusted to minimize the effect

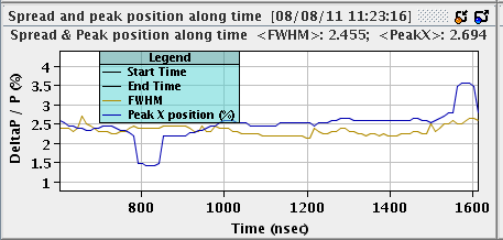


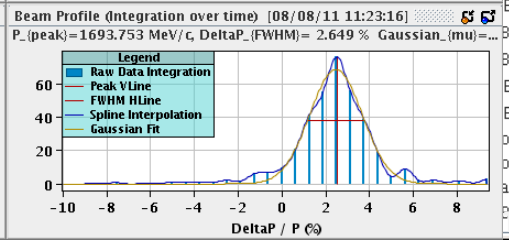


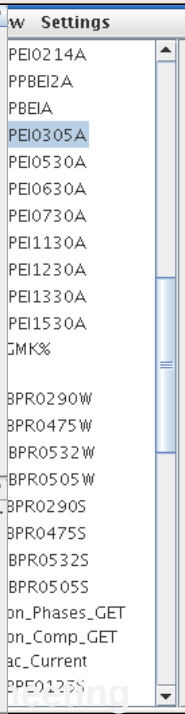


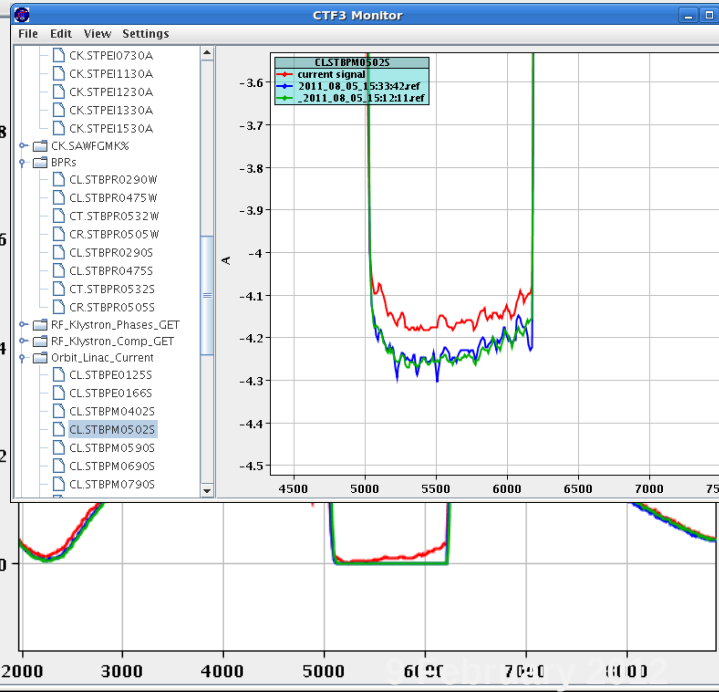




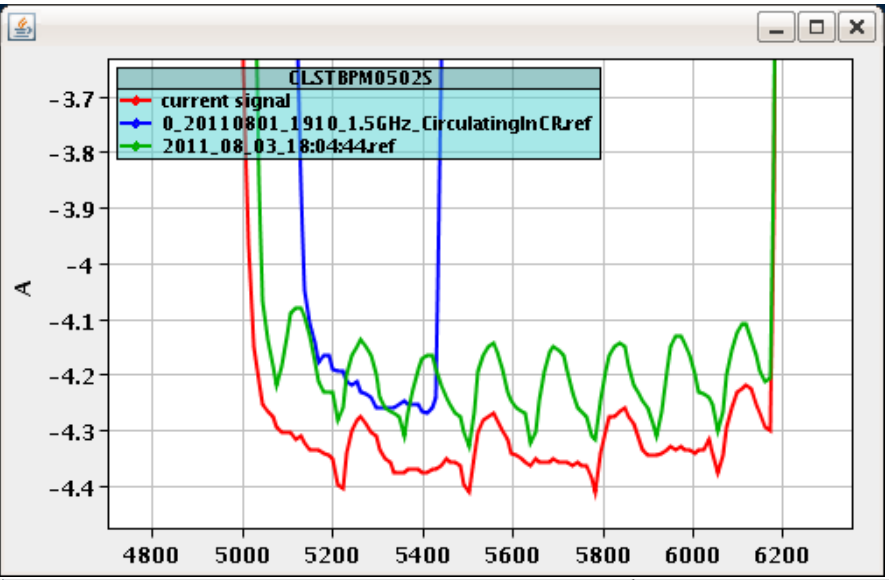


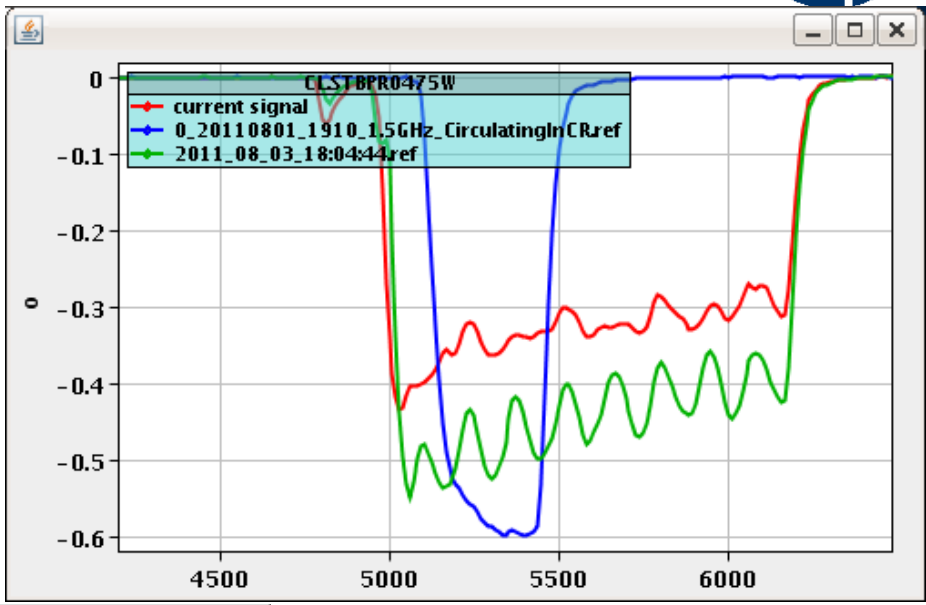


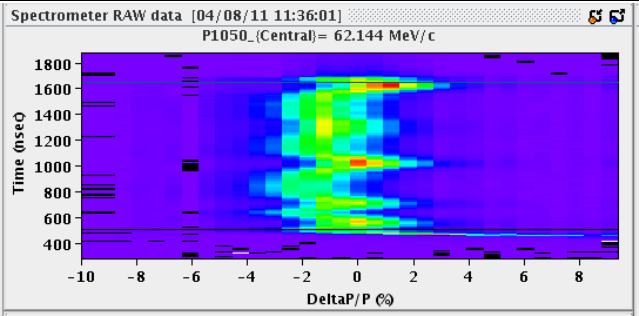


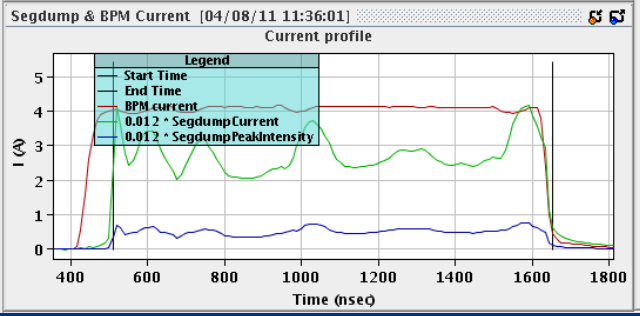


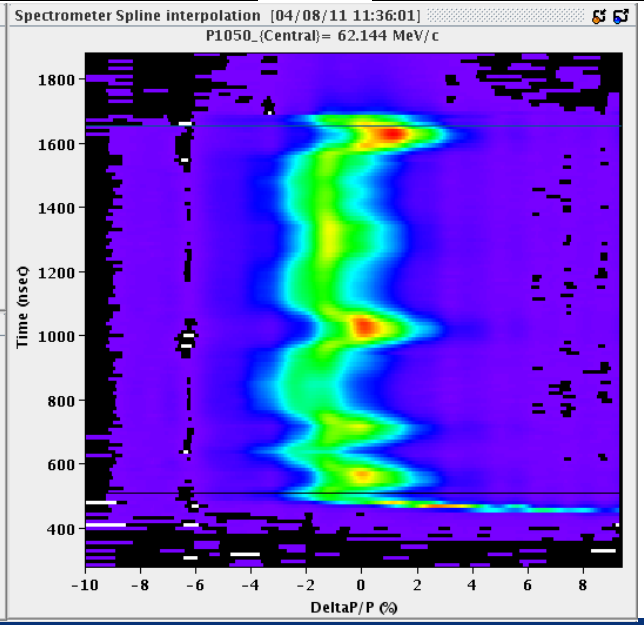
04-Aug-2011

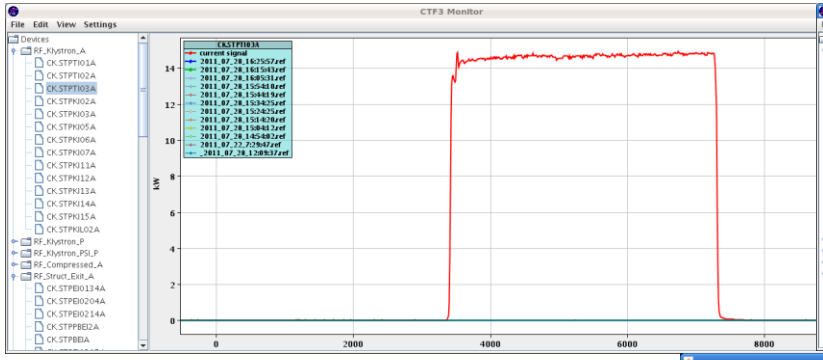

CLSTBPM0502S
current signal
0_20110801_1910_1.5GHz_CirculatingInCR.ref
2011_08_03_18:04:44.ref
A
-3.7
-3.8
-3.9
-4
-4.1
-4.2
-4.3
-4.4
4800
5000
5200
5400
5600
5800
6000
6200

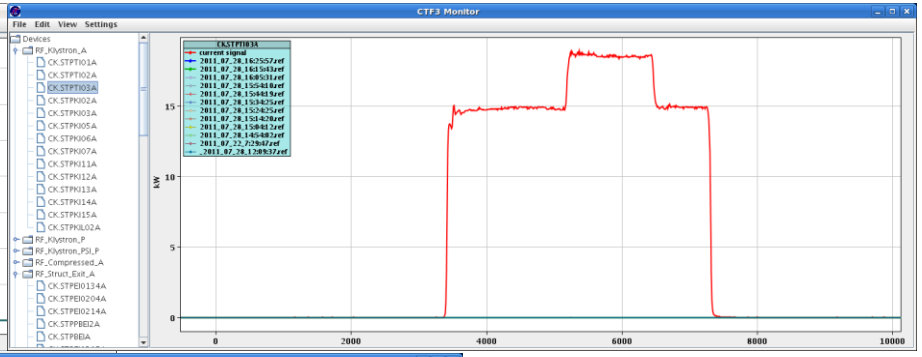

CLSTBPR0475W
current signal
0_20110801_1910_1.5GHz_CirculatingInCR.ref
2011_08_03_18:04:44.ref
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
4500
5000
5500
6000

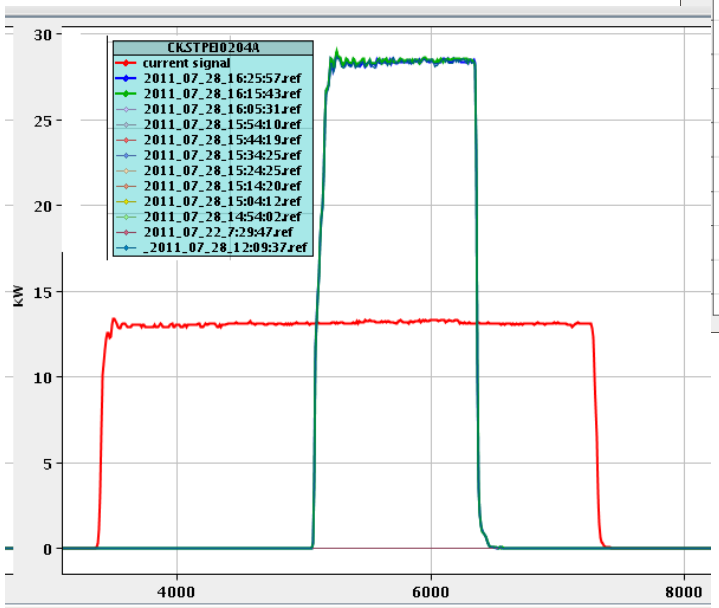

Spectrometer RAW data [04/08/11 11:36:01]
P1050_(Central)= 62.144 MeV/c
Time (nsec)
1800
1600
1400
1200
1000
800
600
400
-10
-8
-6
-4
-2
0
2
4
6
8
DeltaP/P (%)

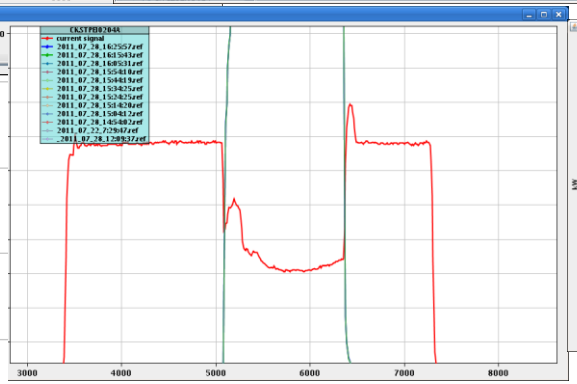

Segdump & BPM Current [04/08/11 11:36:01]
Current profile
Legend
Start Time
End Time
BPM current
0.012 * SegdumpCurrent
0.012 * SegdumpPeakIntensity
I (A)
5
4
3
2
1
0
400
600
800
1000
1200
1400
1600
1800
Time (nsec)

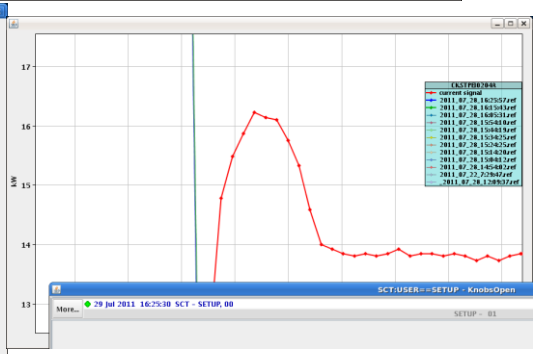

Spectrometer Spline interpolation [04/08/11 11:36:01]
P1050_(Central)= 62.144 MeV/c
Time (nsec)
1800
1600
1400
1200
1000
800
600
400
-10
-8
-6
-4
-2
0
2
4
6
8
DeltaP/P (%)

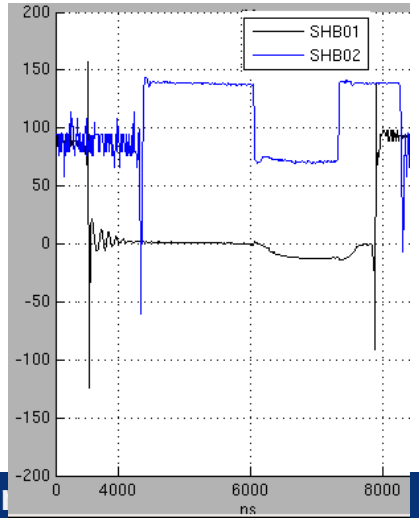

CTF3 Monitor
File Edit View Settings
Devices
RF_Klystron_A
CK.STPTI01A
CK.STPTI02A
CK.STPTI03A
CK.STPKI02A
CK.STPKI03A
CK.STPKI05A
CK.STPKI06A
CK.STPKI07A
CK.STPKI11A
CK.STPKI12A
CK.STPKI13A
CK.STPKI14A
CK.STPKI15A
CK.STPKIL02A
RF_Klystron_P
RF_Klystron_PSI_P
RF_Compressed_A
RF_Struct_Exit_A
CK.STPEI0134A
CK.STPEI0204A
CK.STPEI0214A
CK.STPPBEI2A
CK.STPBEIA
CKSTPEI03A
current signal
2011_07_28_16:25:57.ref
2011_07_28_16:15:43.ref
2011_07_28_16:05:31.ref
2011_07_28_15:54:10.ref
2011_07_28_15:44:19.ref
2011_07_28_15:34:25.ref
2011_07_28_15:24:20.ref
2011_07_28_15:14:20.ref
2011_07_28_15:04:12.ref
2011_07_28_14:54:02.ref
2011_07_22_7:29:47.ref
_2011_07_28_12:09:37.ref
kW

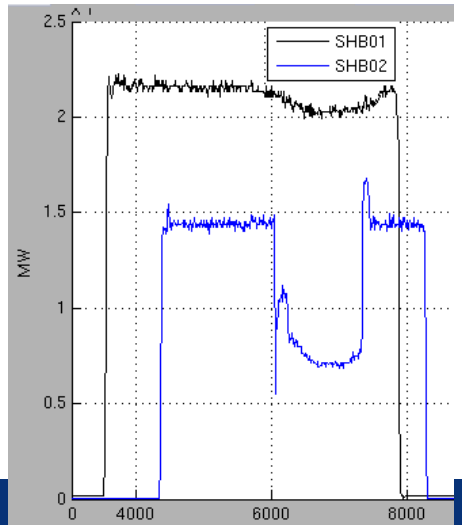

CTF3 Monitor
File Edit View Settings
Devices
RF_Klystron_A
CK.STPTI01A
CK.STPTI02A
CK.STPTI03A
CK.STPKI02A
CK.STPKI03A
CK.STPKI05A
CK.STPKI06A
CK.STPKI07A
CK.STPKI11A
CK.STPKI12A
CK.STPKI13A
CK.STPKI14A
CK.STPKI15A
CK.STPKIL02A
RF_Klystron_P
RF_Klystron_PSI_P
RF_Compressed_A
RF_Struct_Exit_A
CK.STPEI0134A
CK.STPEI0204A
CK.STPEI0214A
CK.STPPBEI2A
CK.STPBEIA
CKSTPEI03A
current signal
kW


CKSTPEI0204A
current signal
2011_07_28_16:25:57.ref
2011_07_28_16:15:43.ref
2011_07_28_16:05:31.ref
2011_07_28_15:54:10.ref
2011_07_28_15:44:19.ref
2011_07_28_15:34:25.ref
2011_07_28_15:24:25.ref
2011_07_28_15:14:20.ref
2011_07_28_15:04:12.ref
2011_07_28_14:54:02.ref
2011_07_22_7:29:47.ref
_2011_07_28_12:09:37.ref
kW

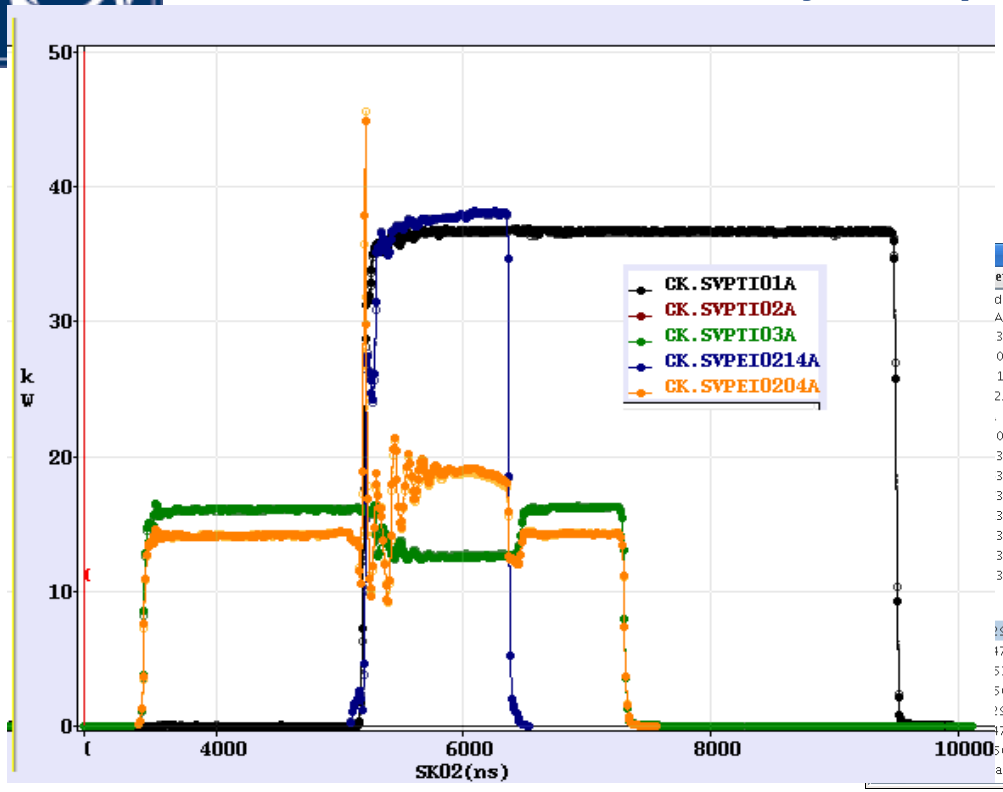

CKSTPEI0204A
current signal

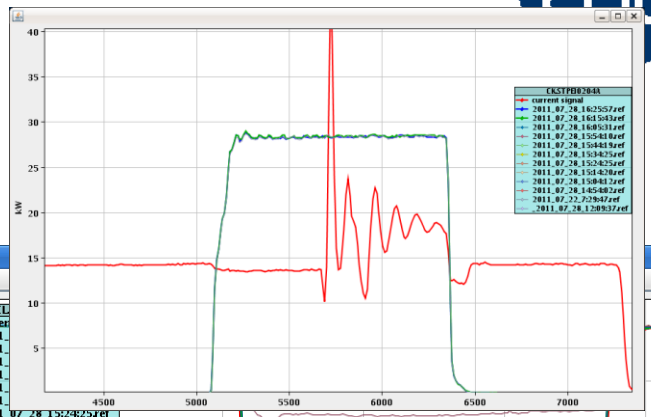

CKSTPEI0204A
current signal
SCT:USER==SETUP - KnobsOpen

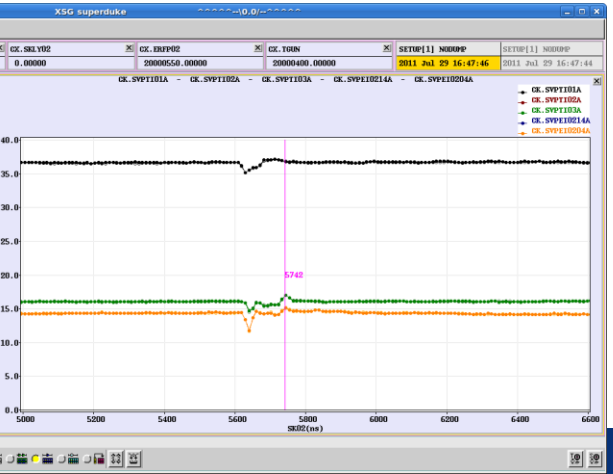

SHB01
SHB02
ns

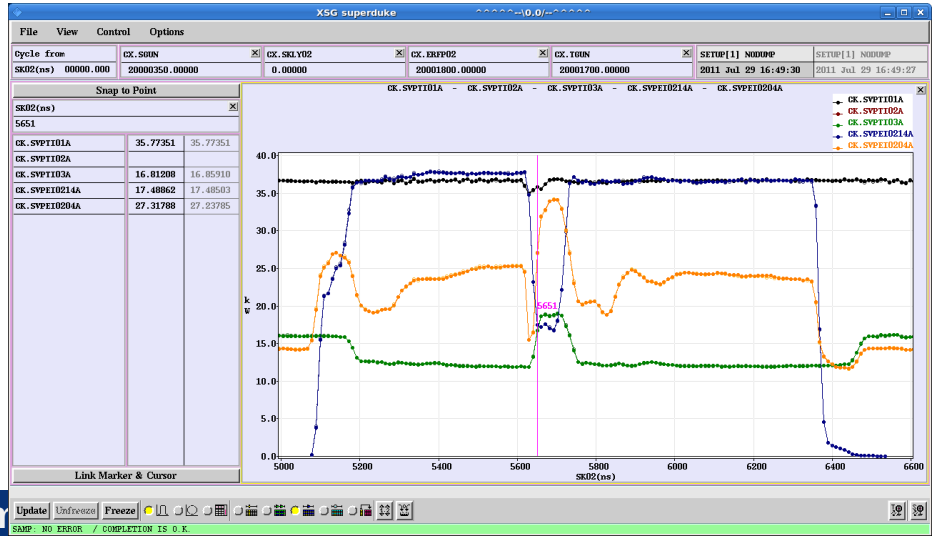

SHB01
SHB02
MW

Fri 29-07-11 Kind'a extreme situation, when the phases are not adjusted properly



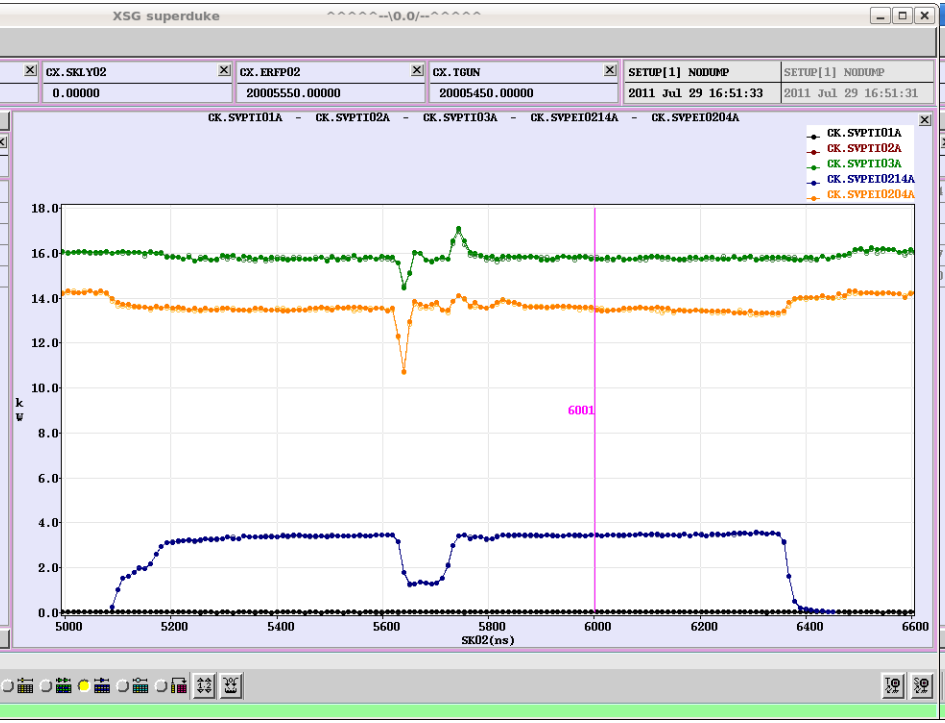




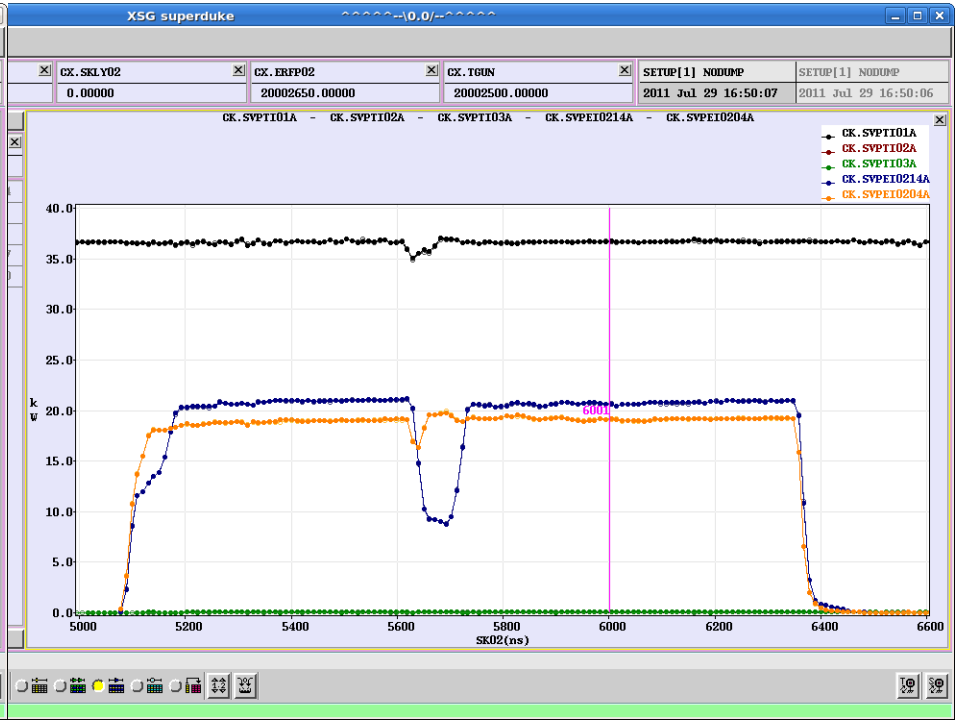


Fri 29-07-11 The same as previous, but

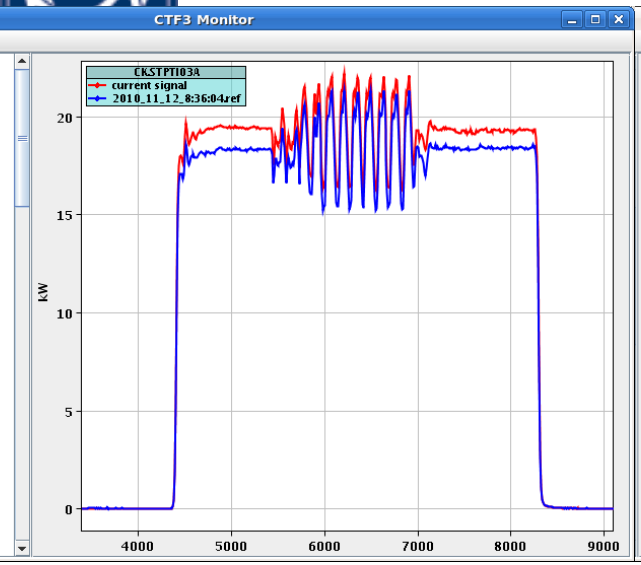
- **TWT1 moved away**

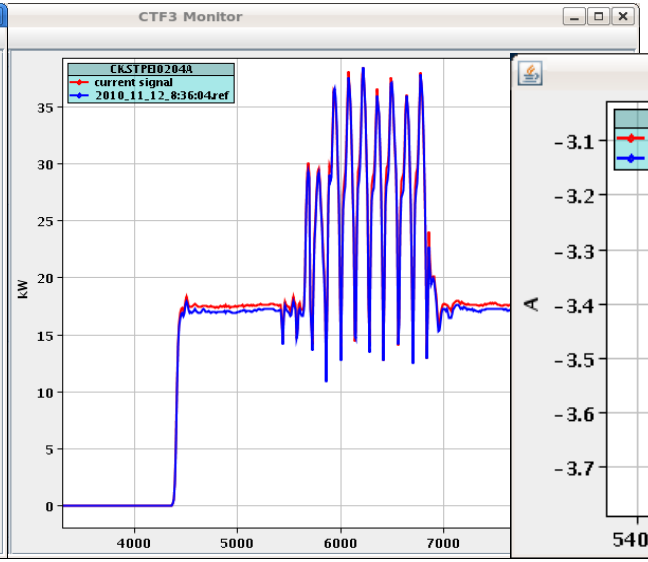


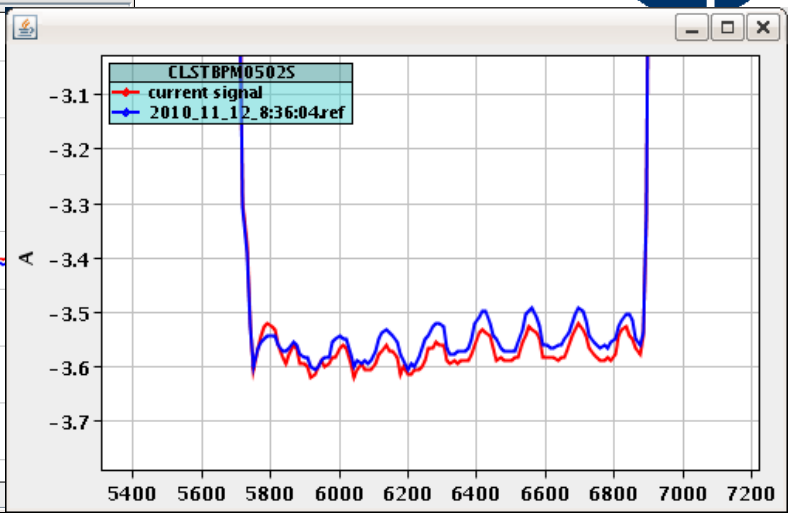
- **TWT3 moved away**

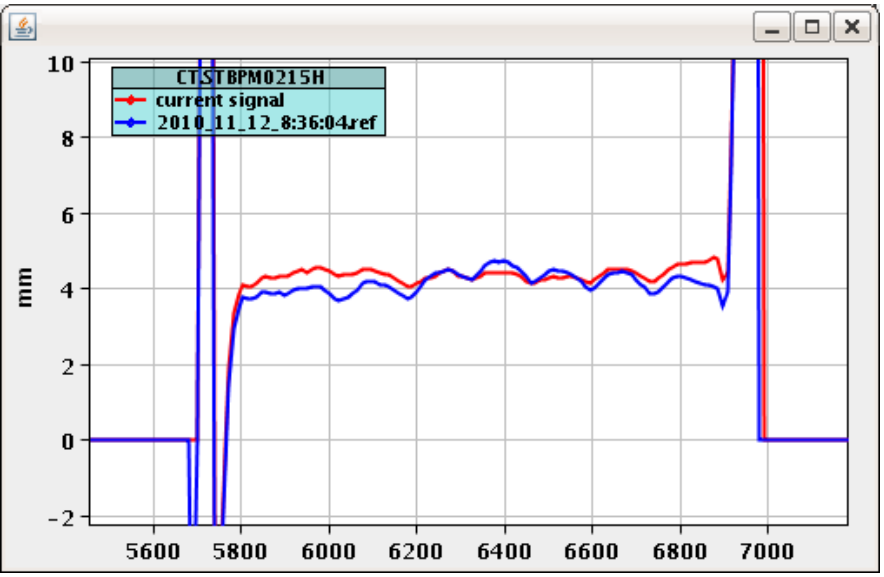


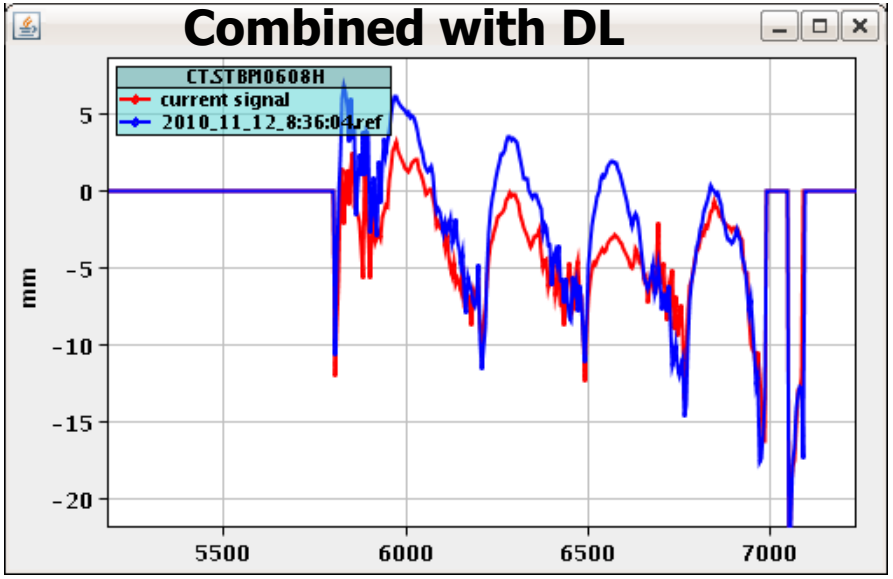
Mon 15-11-10 Production x8 Beam





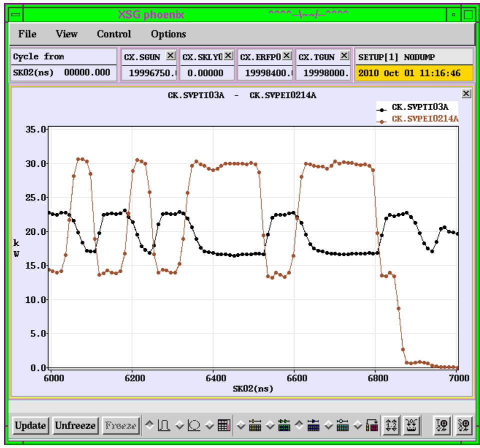


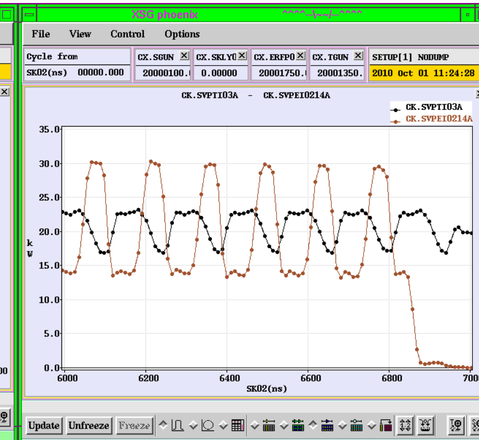


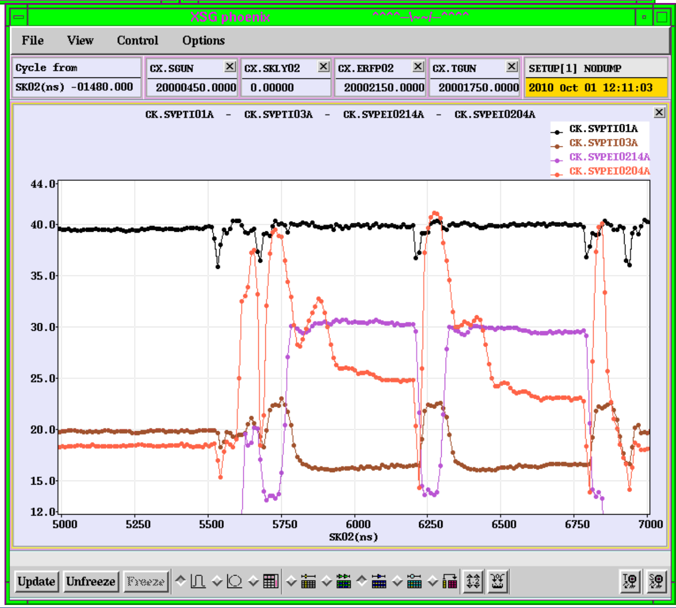


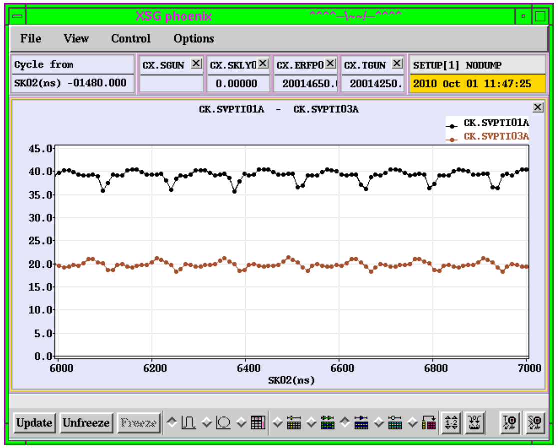
Fri 01-10-10 Streak Camera measurements

- Trying to optimize SHB switch synchronisation.
  Disabled two switches, so there is a switch only every 280ns, so I can see the steady state.
  -1st plot: cable length 2ns to TWT1, 4ns to TWT3
  -2nd: 4+10+16=30ns to TWT3
  -3rd: 2+10+16=28ns to TWT1, 4ns to TWT3
  -4th: 2/4ns as initially with all switches enabled.
  As a conclusion, the 2/4ns configuration looks the best. But there is an apparent amplitude transient of ~50ns on TWT3 which is reflected in a loading transient in SHB03 of the same length.
  TWT1 does not show this effect (see plot #5) (FT)
  Piotr suggested to check without beam: the variation on TWT3 is gone (plot #6).
  Having another look at the loading of SHB02 now: there is a 2-3 step behaviour in the signal after each phase switch. (PSk+FT)

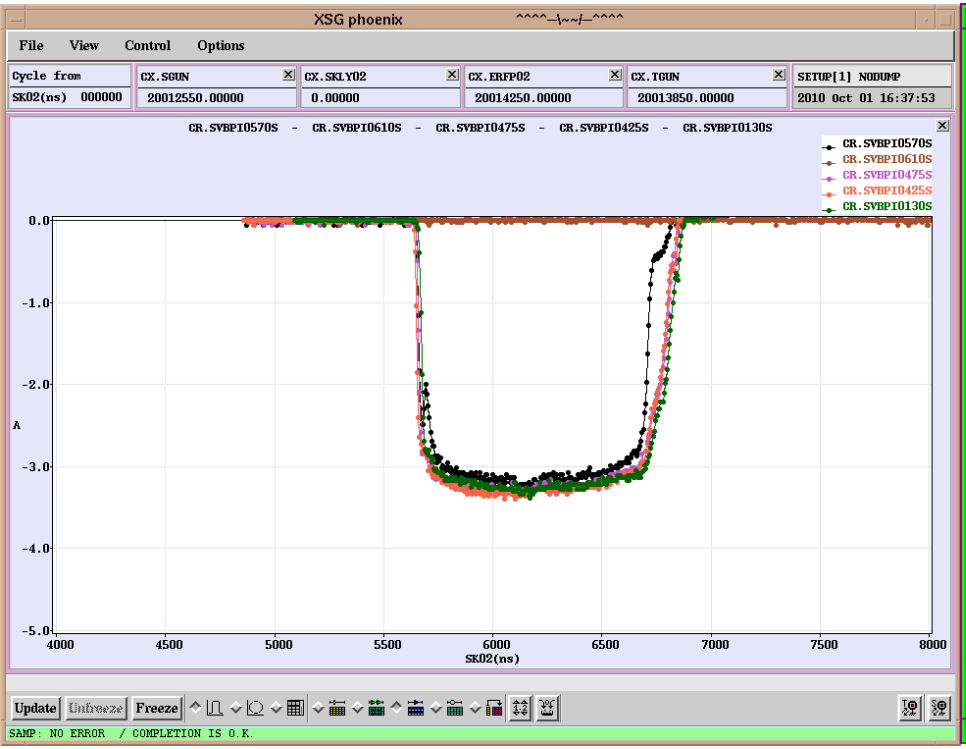


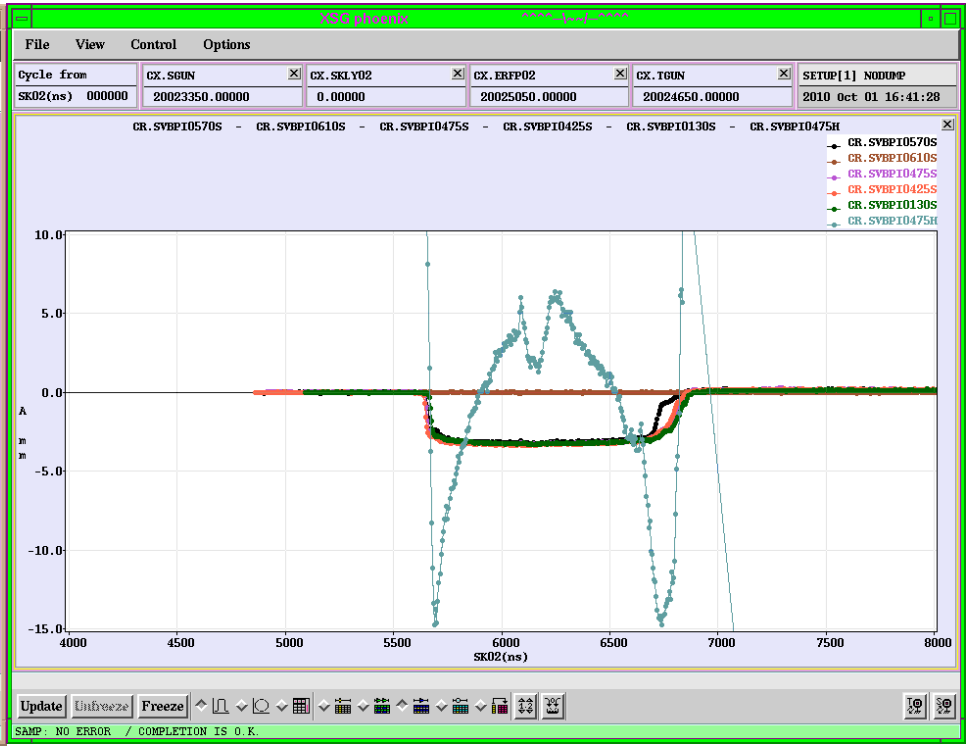






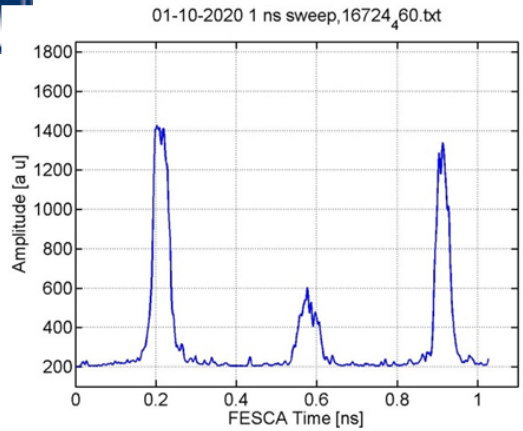
Fri 01-10-10 Streak Camera measurements

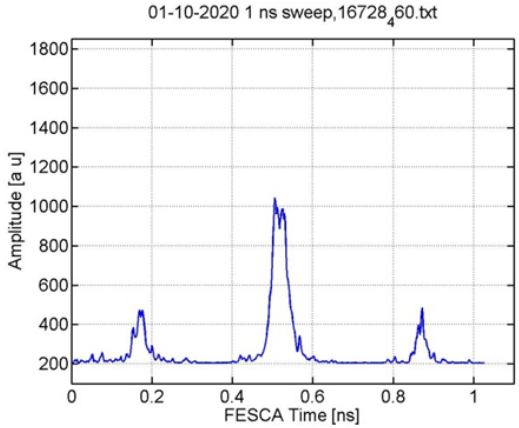


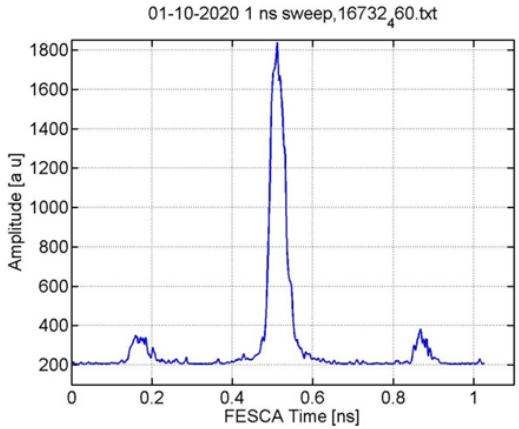


Fri 01-10-10 Streak Camera measurements

Streak camera data under the following link
https://ab-dep-op-elogbook.web.cern.ch/ab-dep-op-elogbook/elogbook/secure/attach.php?attachId=1111118&type=zip&fname=1n.zip





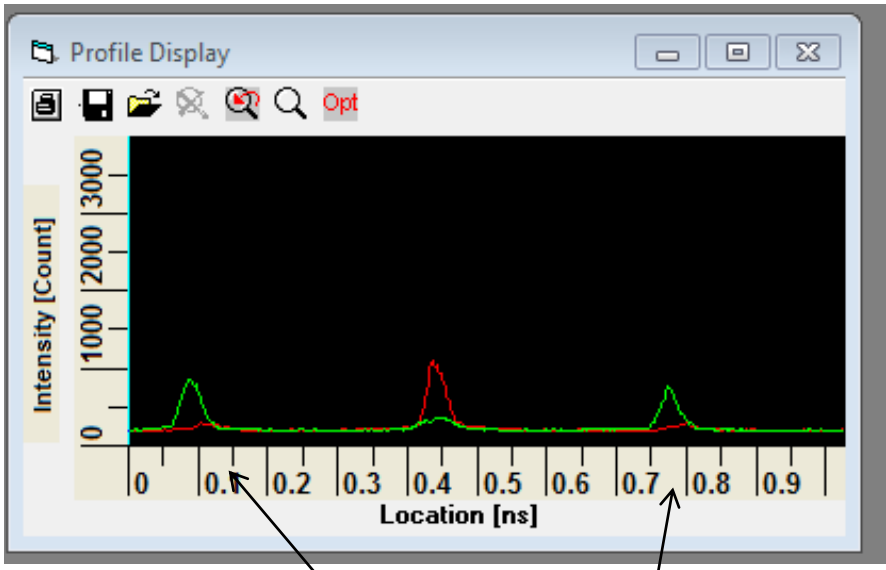


think we found the phase switch
we think that the phase switch occurs over 7/8 ns {to be checked offline}
measured from: 16724 460 to 16742 460

16724 ns

16728 ns

16732 ns



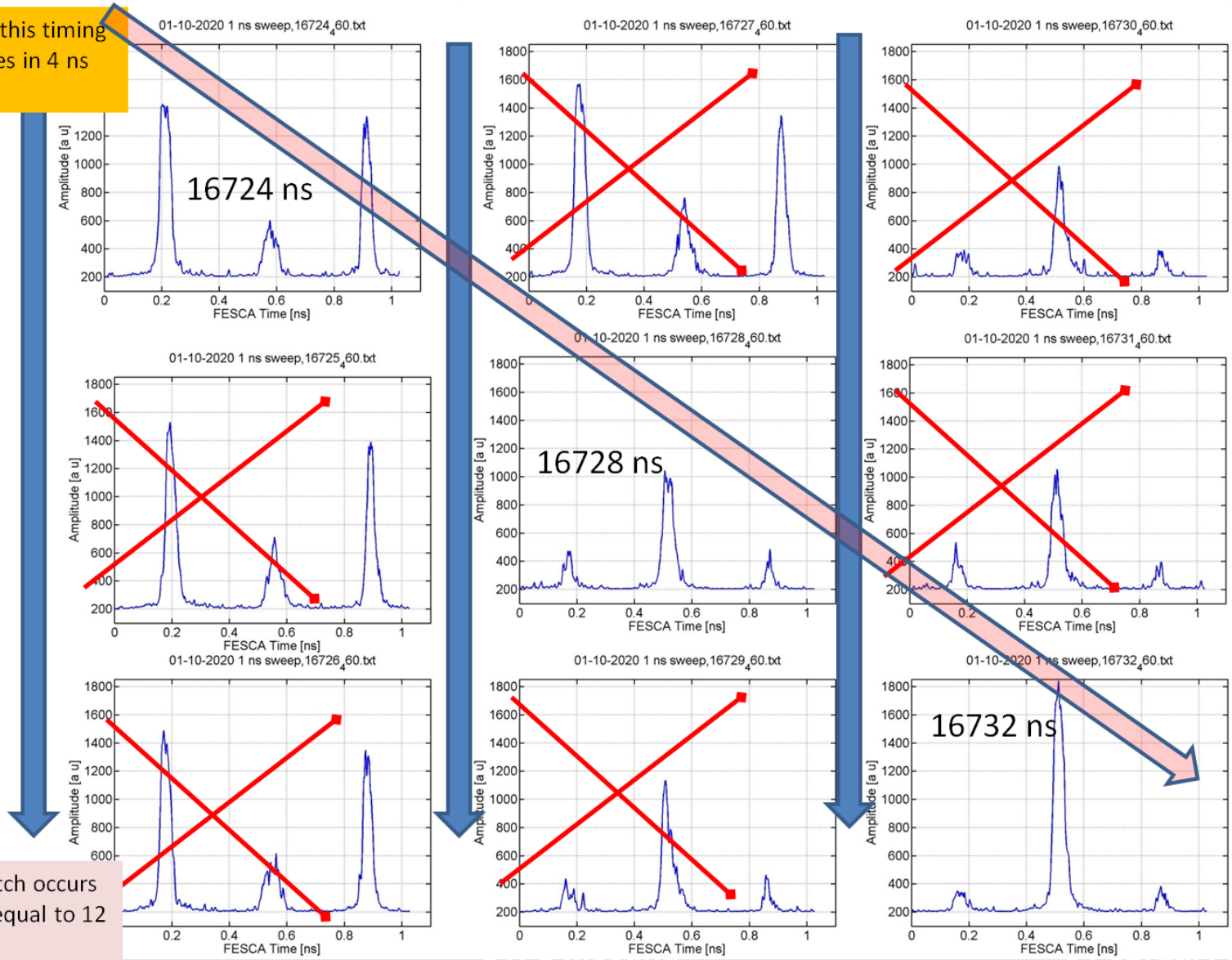
Misplaced?

Fri 01-10-10 Streak Camera measurements

Showing the evolution over 9 ns, moved ~~fast timing~~ slow timing (of the fast timing) in steps of 1 ns.

Work still needs to be done to understand exactly the correspondence between the FESCA time axis and the fine timing

Warning, this timing only moves in 4 ns steps



Phase switch occurs in less or equal to 12 ns