Experimental PLANS:

→ PN Junction

→ N, P, doped

→ GaAs [111] piezo effect

→ Eric's thermal transport measurement

"Nature electronics"

PN PLAN: Refer to Nature Nano. + Science paper

N, P doped: 50ps scan out to 5 ns.

40 s

1 min

5°

GaAs [110]: Refer to Acoustics paper.

↳ fluence dependence measurement. (5~6):

→ 2 day

Eric's thermal transport:

↳ Debye Waller measurement on metals → temperature.

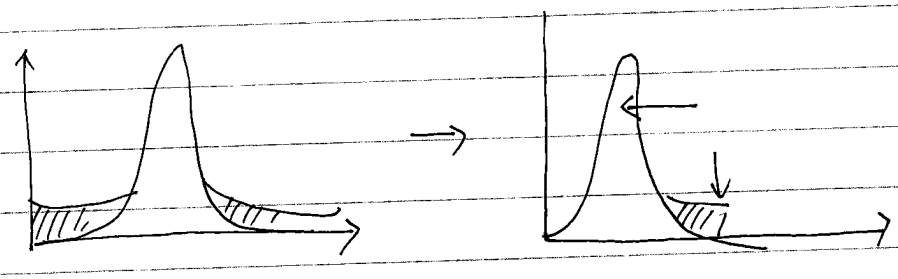
↳ peak shift of GaAs → Thermal transport.

① First fit Low fluence undoped GaAs

② Fit N-doped GaAs to deduce ~~doping density~~ Diffusion Coeff.

③ Deduce delayed Diff. Coeff.

prove momentarily shortened carrier profile ✓ → delayed diffusion.



Tuc, W, Th, Fri, Sa, Suw

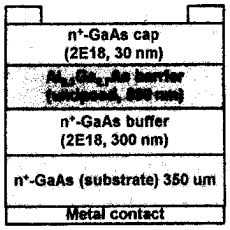
↓ ↓ ↓

P, N, U + GaAs

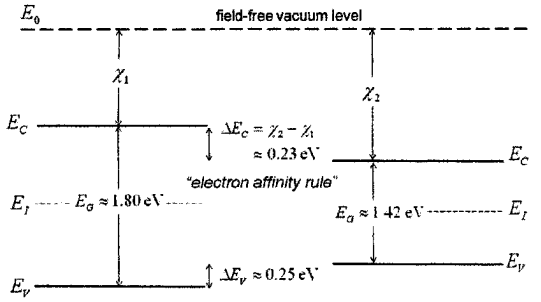
Multi-Layer

i-AlGaAs/n⁺-GaAs Heterojunction Structure

KRISS



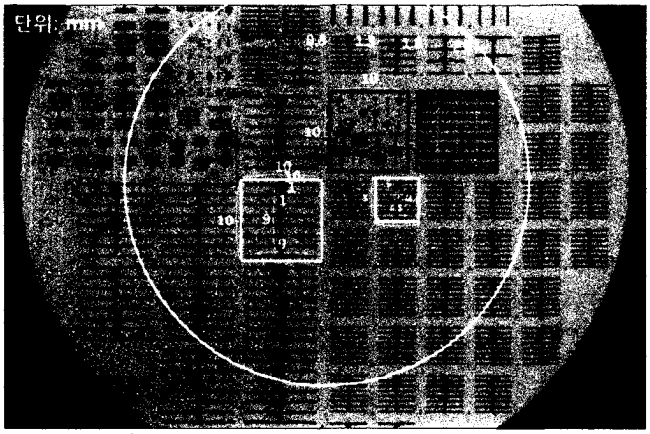
$Al_{0.3}Ga_{0.7}As$: GaAs (Type I HJ)



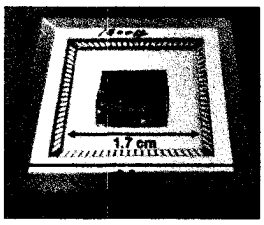
Photomask layout/LCC

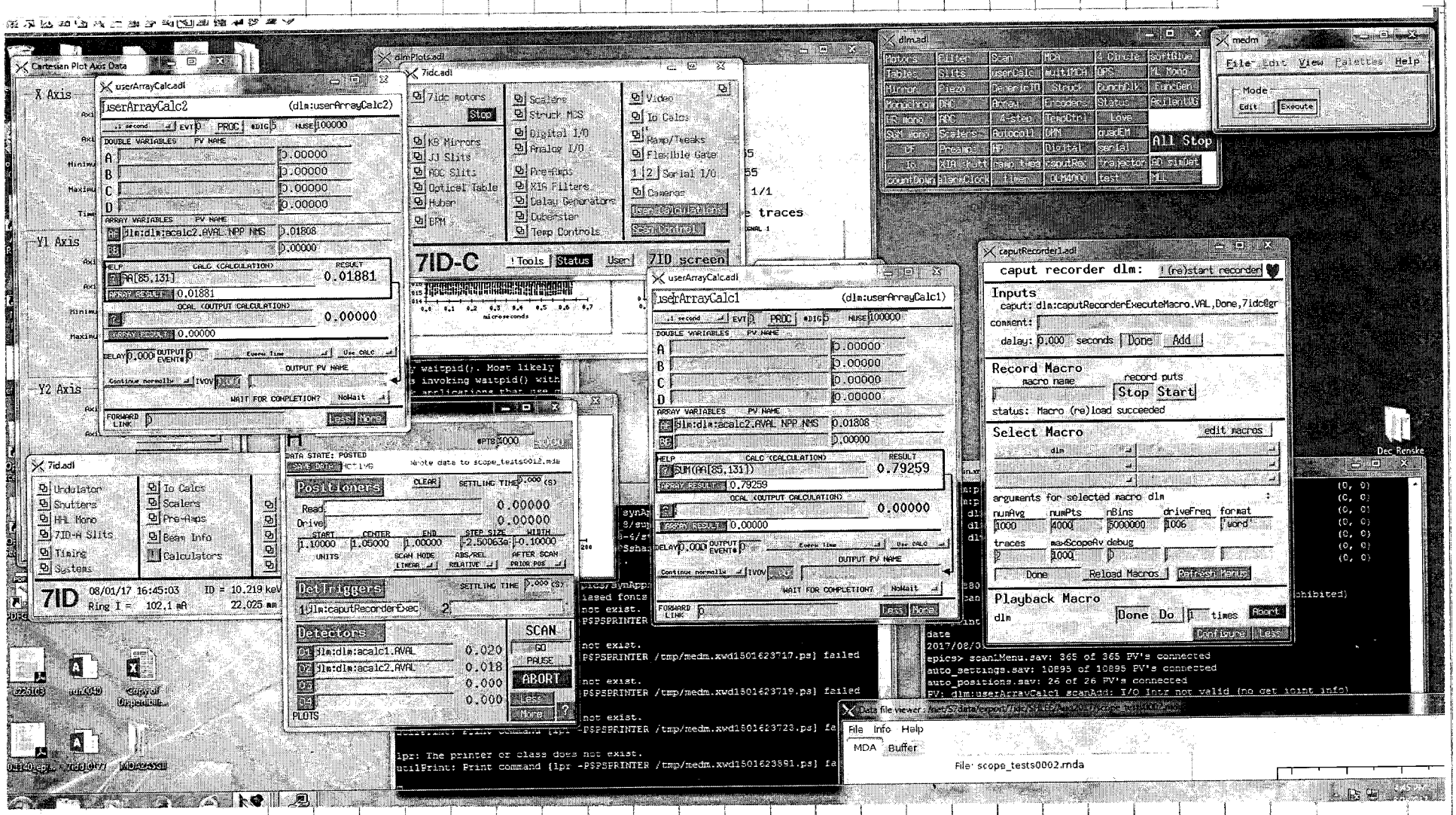
KRISS

Photomask



LCC

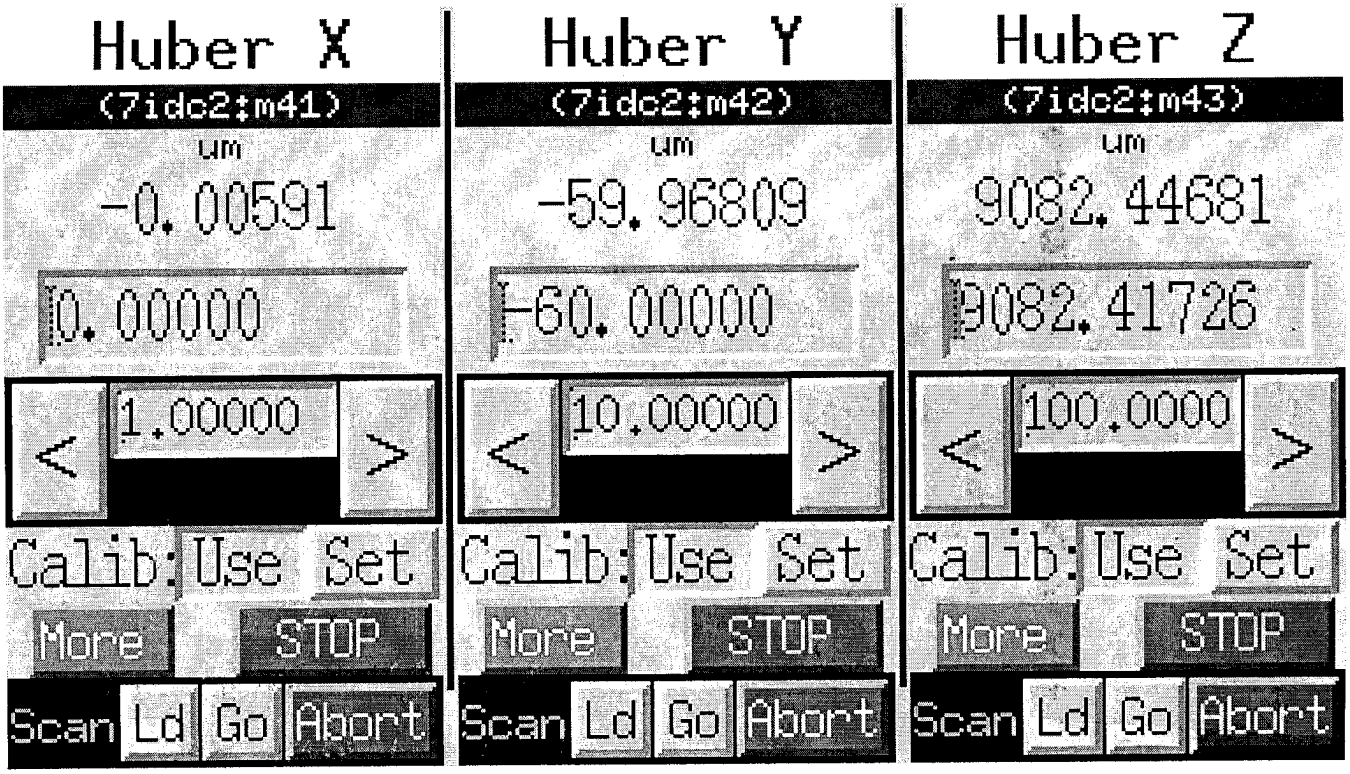




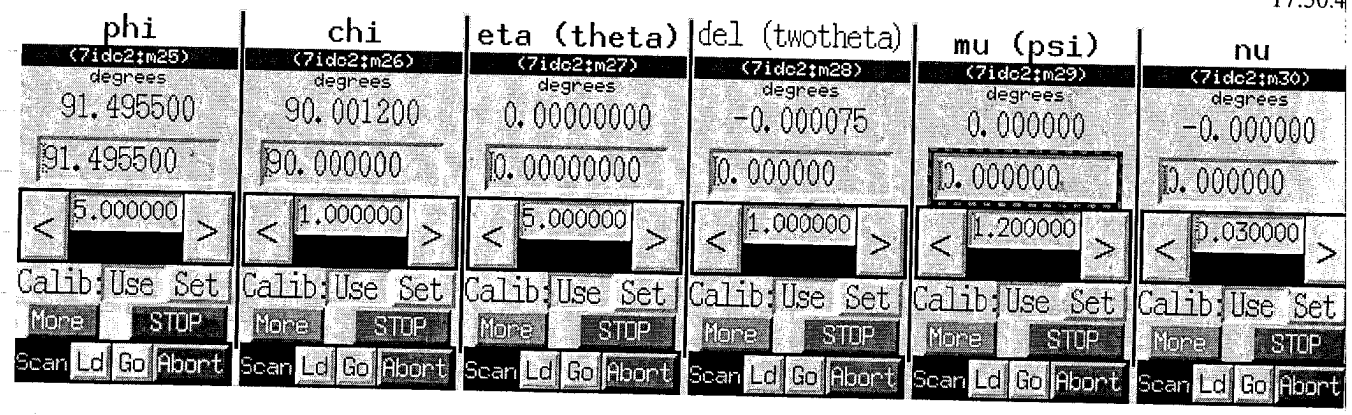
Scope Setting

APD Single photon Counting Mode
10.52V (Bias Control) + 311 V (bias)
APD 'A' DC offset
proportion mode:
7.54V + 211 V , 10mV direct beam.

Aug 1, 2017 motor3x.adl 17:50:49



Aug 1, 2017 motor6x.adl 17:50:4



ID Gap Control

Sector #07 Upstream ID
Undulator_#1_3.3cm

Software Version: 4.21

Avg Current	22.025	10.219
Tpr	-0.001	-0.000
Avg Desired	22.026	10.220
Tpr	0.000	0.000
	Gap (mm)	Energy (keV)

Start Stop

Access Mode : User

User

Harmonic Select (1-7): 1

Gap Deadband (micron): 1

Bl. Comm. Limit (mm): 11.000

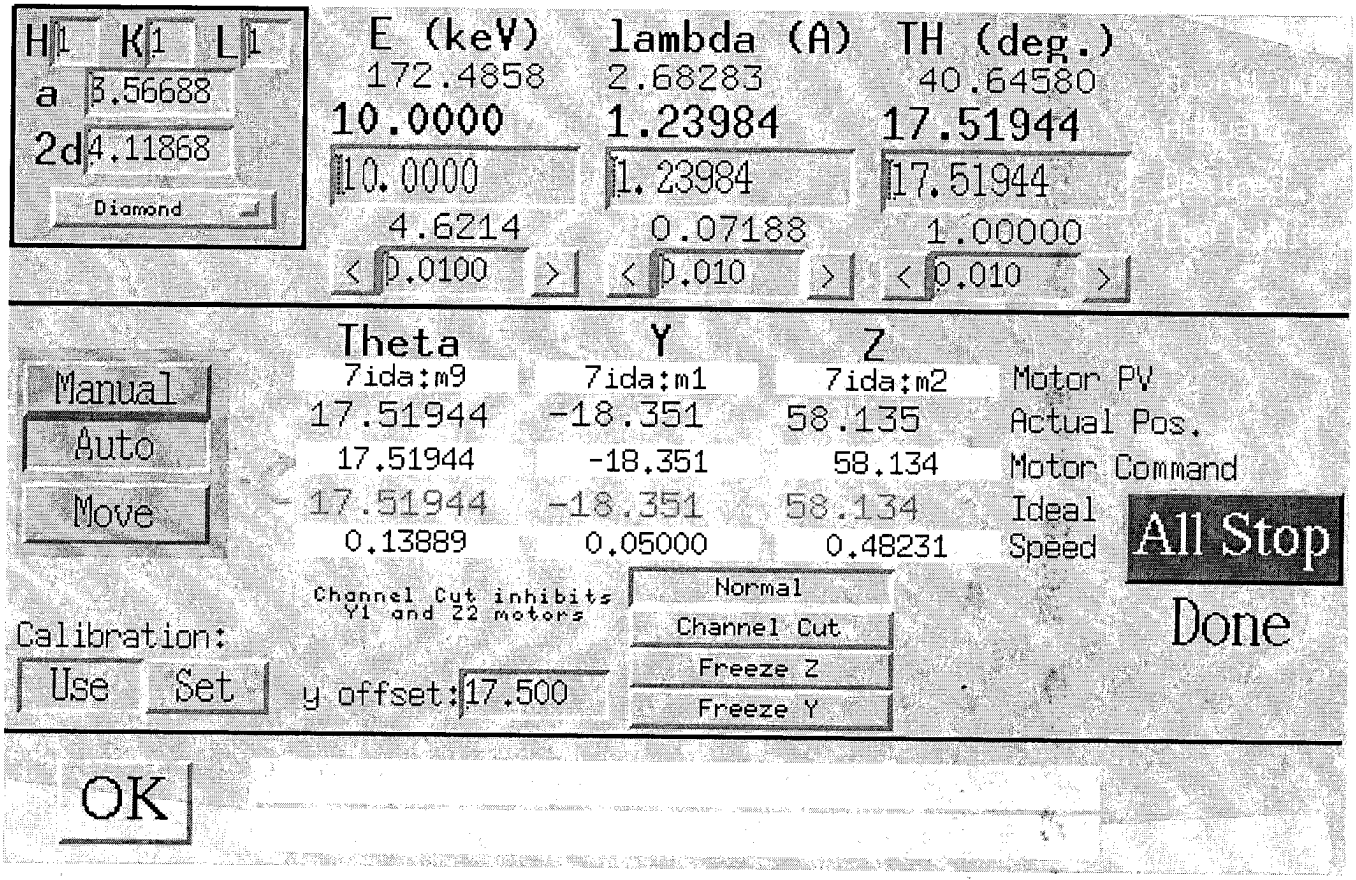
Total Power: 592 W /100ma

Status Messages:

Device At Destination

Time Left: 0 seconds

ID Info: !



GaAs (111) Sample.

$a = 5.65325 Å$

X-ray Energy : 10 keV

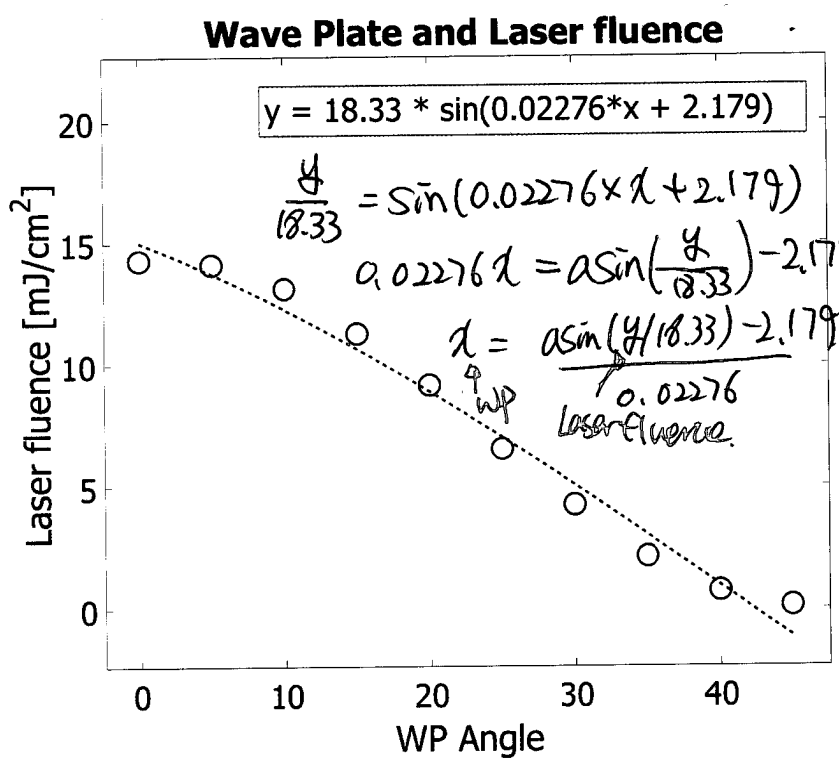
λ (Wave length) : 1.2398 Å

$2\theta_{(111)} : 21.8988.$ $2\theta_{(400)} : 52.0395$

$\theta_{(111)} = 10.9494.$ $\theta_{(400)} : 26.0197.$

WP (deg.)	reference (mW)	mW at sample	fluence mJ/cm^2
0	253		189.834171
5	250		187.583173
10	233		174.8275172
15	200		150.0665384
20	162		121.5538961
25	116		87.03859225
30	75		56.27495189
35	38		28.51264229
40	13		9.754324994
45	2		0.01500665384

laser x (microns)	laser y (microns)	area (microns^2)	a
478	355	133274.2143	



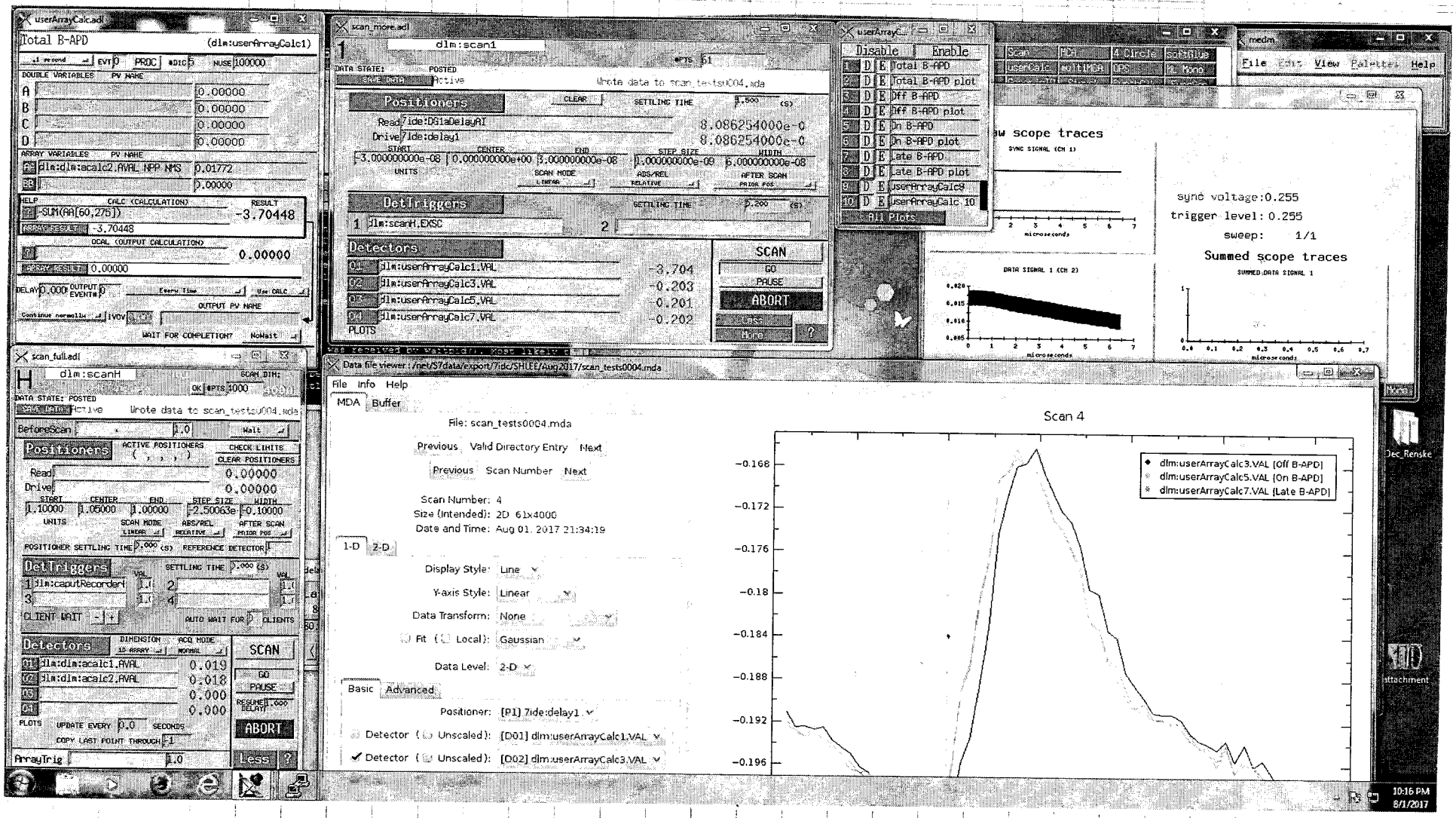
$$\frac{y}{18.33} = \sin(0.02276 \times x + 2.179)$$

$$0.02276\,x = \operatorname{asin}\left(\frac{y}{18.33}\right) - 2.179$$

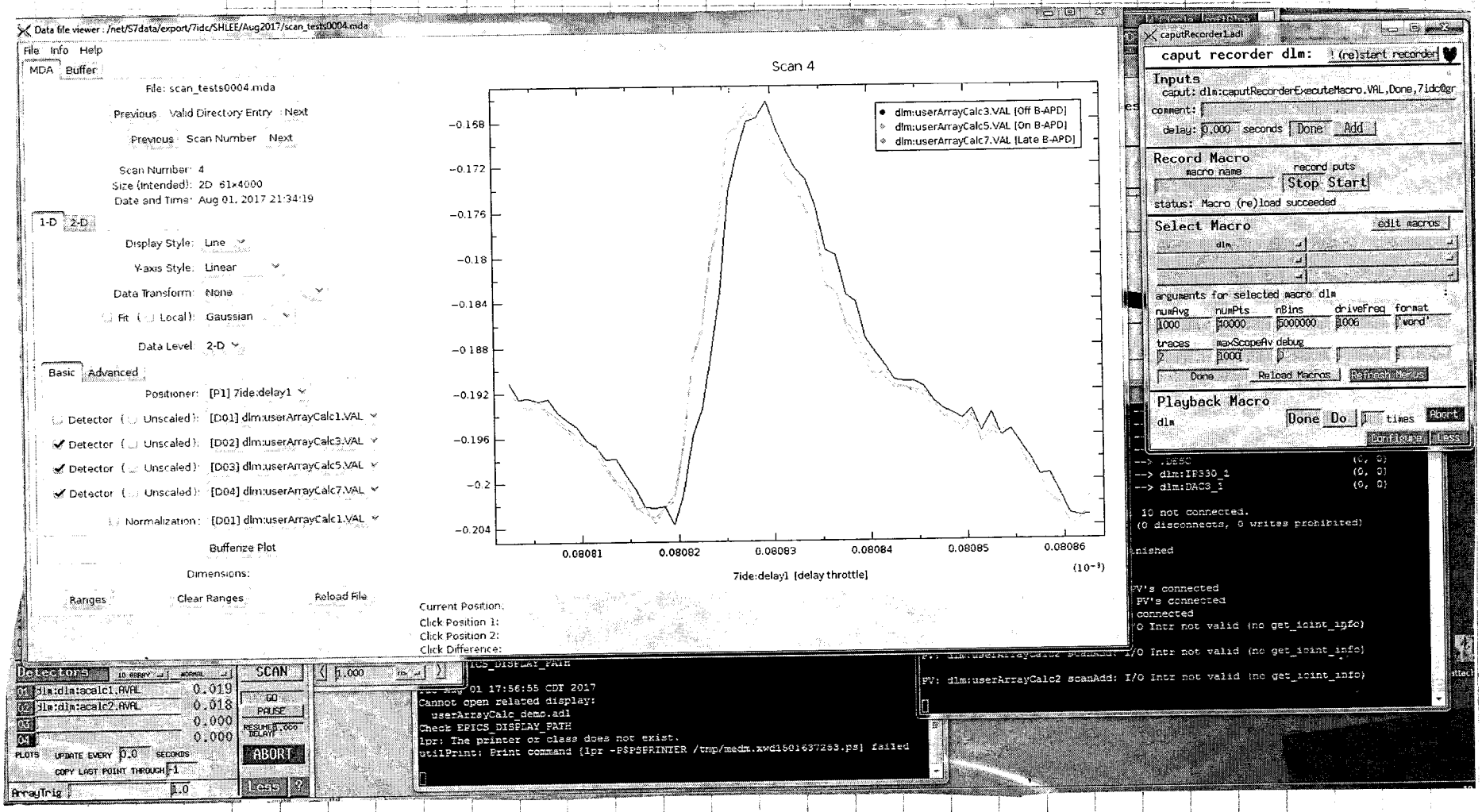
$$x = \frac{\operatorname{asin}(y/18.33) - 2.179}{0.02276}$$

WP

Laser fluence


Total B-APD
(dlm:userArrayCalc1)
scan_more.adl
dlm:scan1
Positioners
DetTriggers
Detectors
SCAN
GO
PAUSE
ABORT
Data file viewer: /net/S7data/export/7idc/SHLEE/Aug2017/scan_tests0004.mda
File Info Help
MDA Buffer
File: scan_tests0004.mda
Scan Number: 4
Size (Intended): 2D 61x4000
Date and Time: Aug 01, 2017 21:34:19
Scan 4
dlm:userArrayCalc3.VAL [Off B-APD]
dlm:userArrayCalc5.VAL [On B-APD]
dlm:userArrayCalc7.VAL [Late B-APD]
sync voltage:0.255
trigger level: 0.255
sweep: 1/1
Summed scope traces
scan_full.adl
dlm:scanH
medm
File Edit View Palettes Help
10:16 PM
8/1/2017

oscilloscope Setting for TRXS Scanning



8/2/17 12:30 AM

Timing problem.

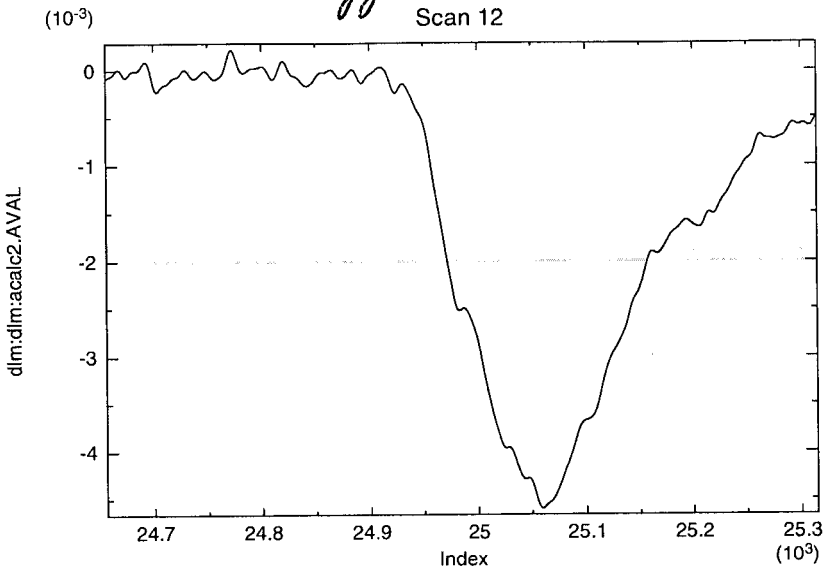
Loose cable controlling delay generator fixed

T0 estimate using photodiode

80.84173 μs

Now time scans properly and repeatably.

Tee-off trigger for Ch. 1 from O-scope in 71DE.



Laser only at T0 on APD-B.

Index 25060

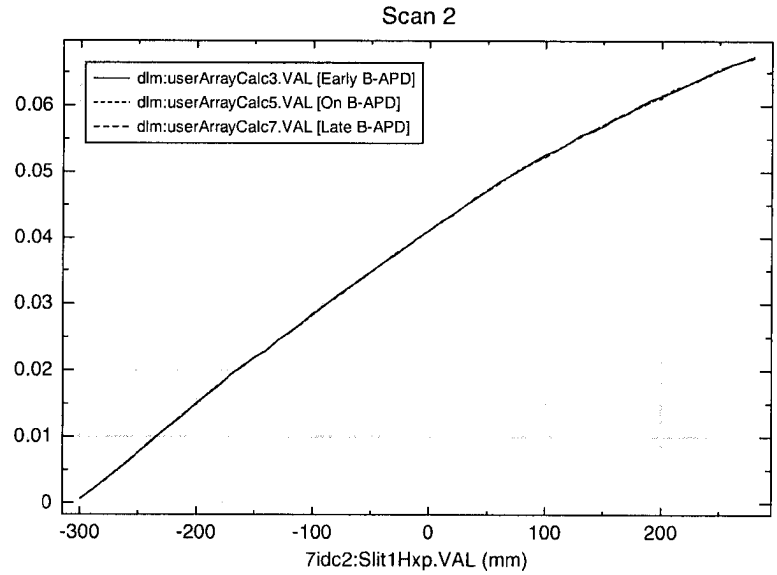
A delay of 1 μs shifts laser to Index 31306

1 μs / (31306 − 25060) = 160 ps / channel.

numAvg = 1000 numPts = ~~5000~~ 10,000 nBins = 5,000,000

driveFreq = 1006, traces = 2 maxScopeAvg = 1000

Need to be careful <u>not</u> to manually adjust scope delay or timebase, or gating will be lost.



A first proportional mode linearity test. y-axis normalized to ion chamber.

Early, On, Late all the same bunch.

4:30 AM 6Z 8/2/17 Change file to Ge 111. Inserted sample

Scan 1 Align sample vertically using Huber Z

2 Align sample in Θ

Whoops, files should be GaAs 111 from here on...

3 Align sample in Θ. Found it fkt at $\Theta = -1.21°$.

111 should be at $2\Theta = 21.898°$ for 10keV

guess $\Theta = 9.75°$.

Found GaAs 111, tweaking up.

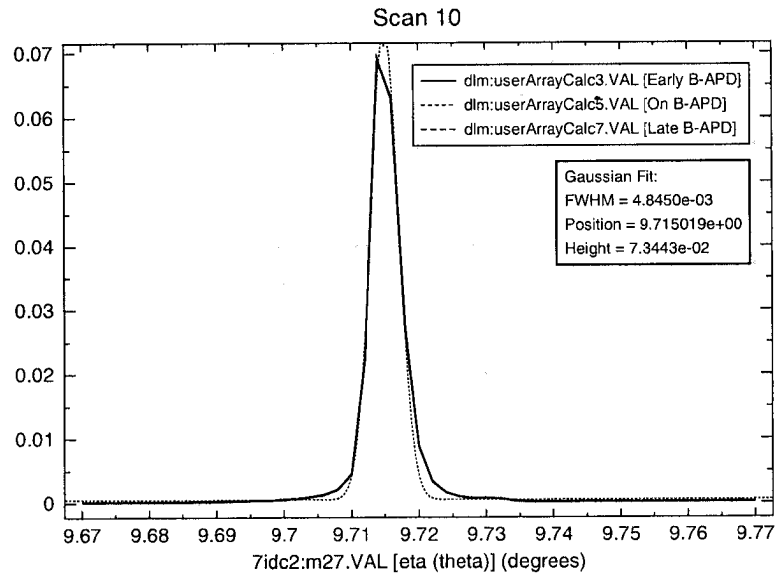
/net/s7data/export/7idc/SHLEE/Aug2017/
GaAs111_0000N.mda

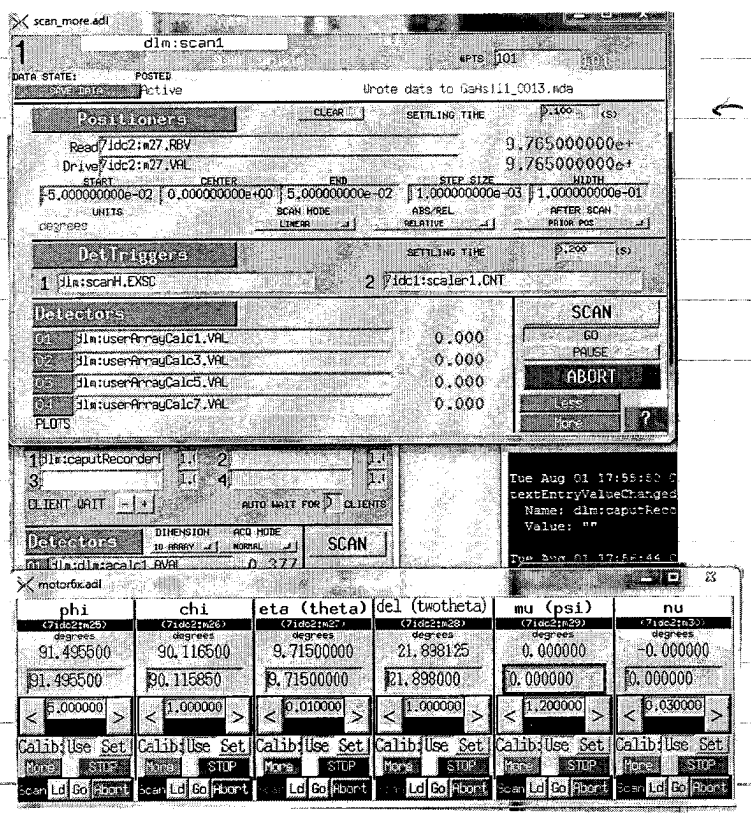
↳ Sample alignment Scans.

C-JJ slits → H: 400 mm
V: 100 mm

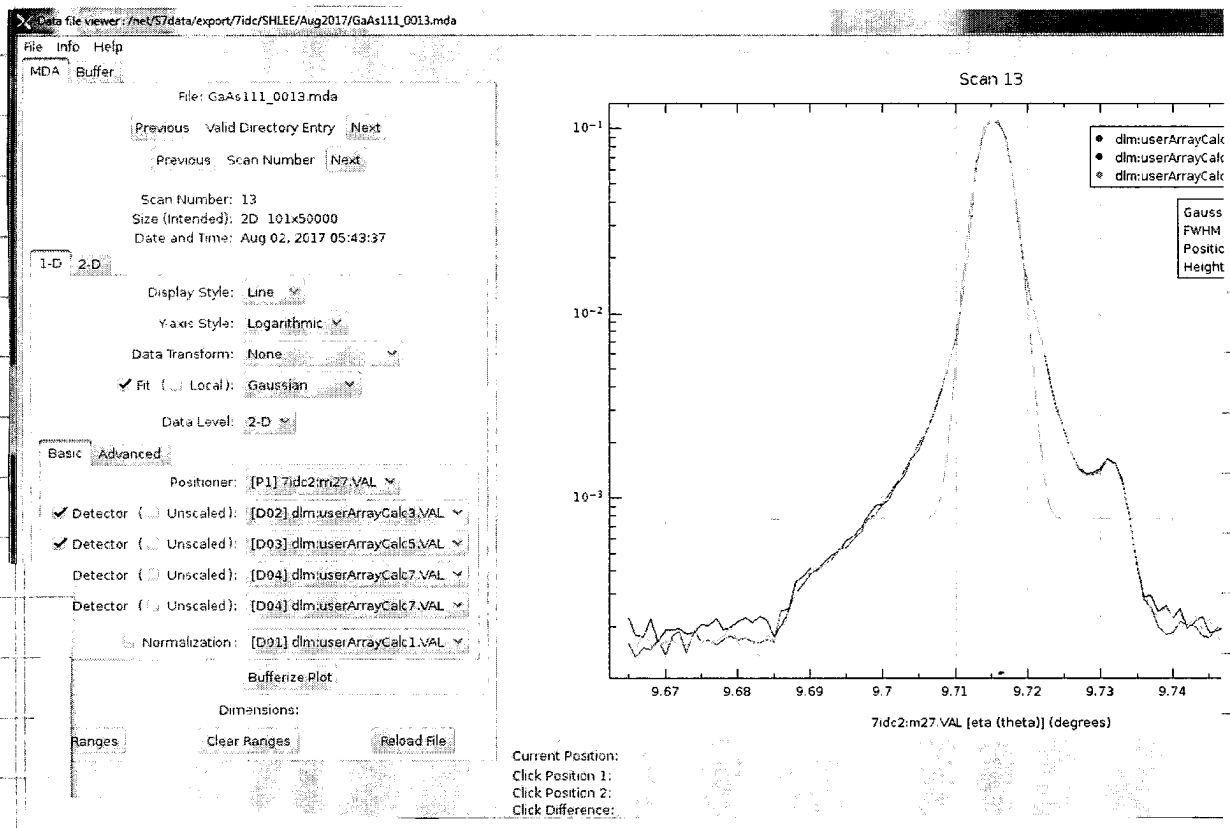
~~# Narrow~~

GaAs111_0004.mda





← Angle Scan Routine

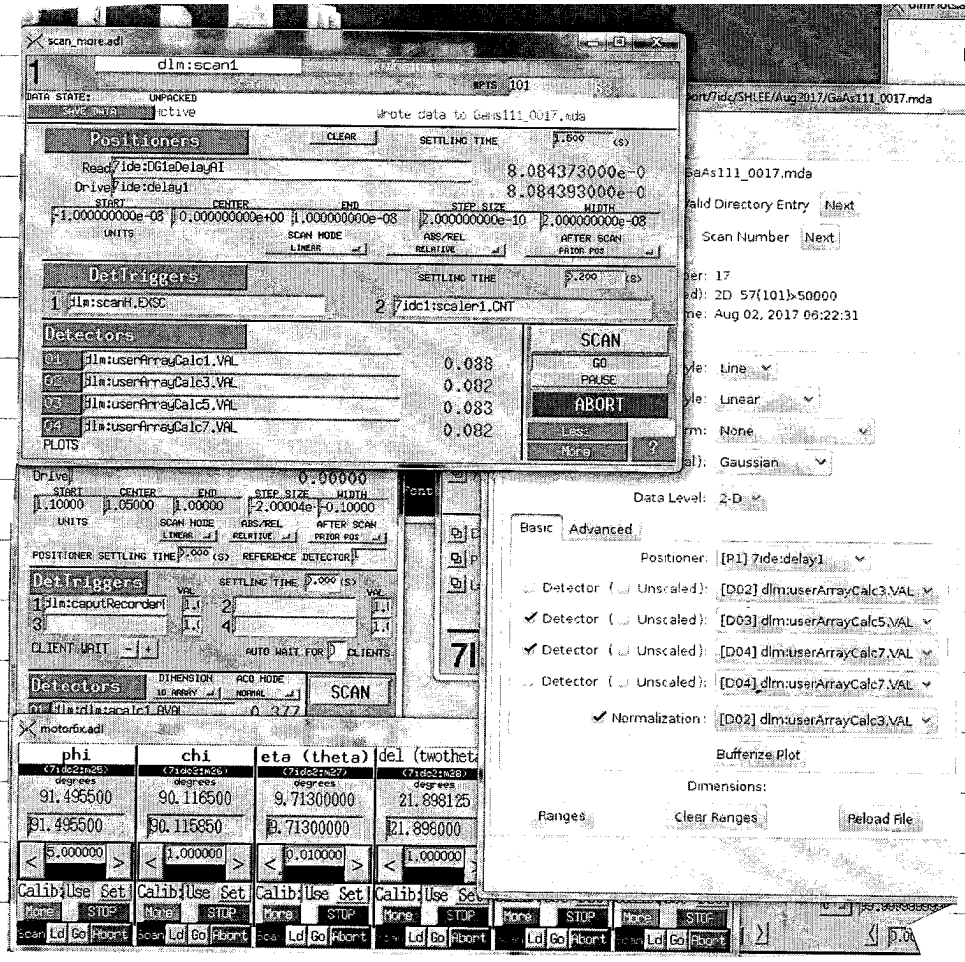


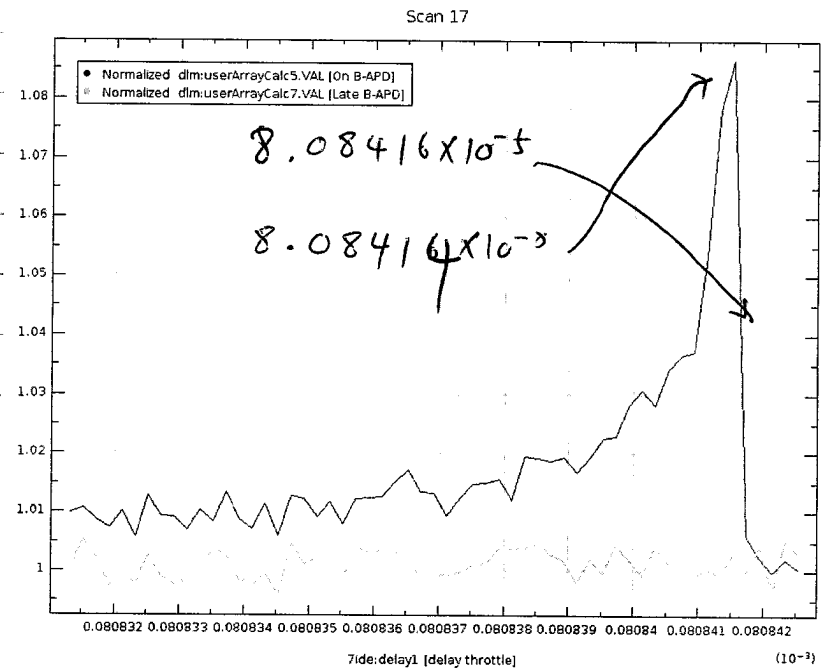
Laser fluence: C-waveplate = 35° { center θ = 9.71558 9

Scan #16: narrower rocking range $\pm 2\times10^{-2}$, 41 steps.
Settling time: 0.1

Scan #17: Time-scan { found
9.7135 = theta

$\pm$ 10 ns, 101 time steps (settling time 1.5)
(settling time 1.5 s)


scan_more.adl
dlm:scan1
Positioners
Drive 7ide:delay1
8.084373000e-0
8.084393000e-0
DetTriggers
Detectors
01 dlm:userArrayCalc1.VAL 0.038
02 dlm:userArrayCalc3.VAL 0.082
03 dlm:userArrayCalc5.VAL 0.083
04 dlm:userArrayCalc7.VAL 0.082
SCAN
GO
PAUSE
ABORT
motorfix.adl
phi
chi
eta (theta)
del (twotheta
91.495500
90.116500
9.71300000
21.898125
Scan Number
Next
Line
Linear
None
Gaussian
Data Level: 2-D
Basic
Advanced
Positioner: [P1] 7ide:delay1
Normalization: [D02] dlm:userArrayCalc3.VAL
Bufferize Plot
Dimensions:
Ranges
Clear Ranges
Reload File


Scan 17
Normalized dlm:userArrayCalc5.VAL [On B-APD]
Normalized dlm:userArrayCalc7.VAL [Late B-APD]
8.08416×10⁻⁵
8.08416×10⁻⁵
1.08
1.07
1.06
1.05
1.04
1.03
1.02
1.01
1
0.080832 0.080833 0.080834 0.080835 0.080836 0.080837 0.080838 0.080839 0.08084 0.080841 0.080842
7ide:delay1 [delay throttle]
(10⁻³)

Scan 18: ~~time scan~~ → Angle Scan

Scan 19: Angle Scan at $t = 8.08414 \times 10^{-5}$ s

Huber X −500 mm
H. Y 1790
H. Z 8792.

± 20 mdegree

−3 ns ~ 7 ns

10 ns

Changed HUBER X = −600 mm
↳ Repeat angle scan # 20

Changed HUBER X = −700 mm
↳ Repeat angle scan # 21

Changed HUBER X = −800 mm
↳ Repeat angle scan # 22
Center : 9.7211

Timescan
th : 9.71912. Side of Rocking curve
−3ns +7ns #23 ← Stop

th : 9.7135
−3ns , +7ns scan # 24 ← No change
~~th : 9.7180.~~
~~−3ns , +7ns~~

th: 9.1100.
delay : -7ns ~ 3ns 51 point. #25
"200ps step"

10ns / 25ps

$\frac{10^{-9}}{25\times10^{-12}} 10^3 \quad \frac{1}{2}\times10^3 = 0.250\times10^3 = 250$

$\frac{10^{-9}}{50\times10^{-12}} = \frac{1}{50}\times10^3$

"Looks Good"

delay scan
-5ns ~ 1ns 121 steps, (50ps) #26.
TO = Delay : 80.8416×10^{-6}

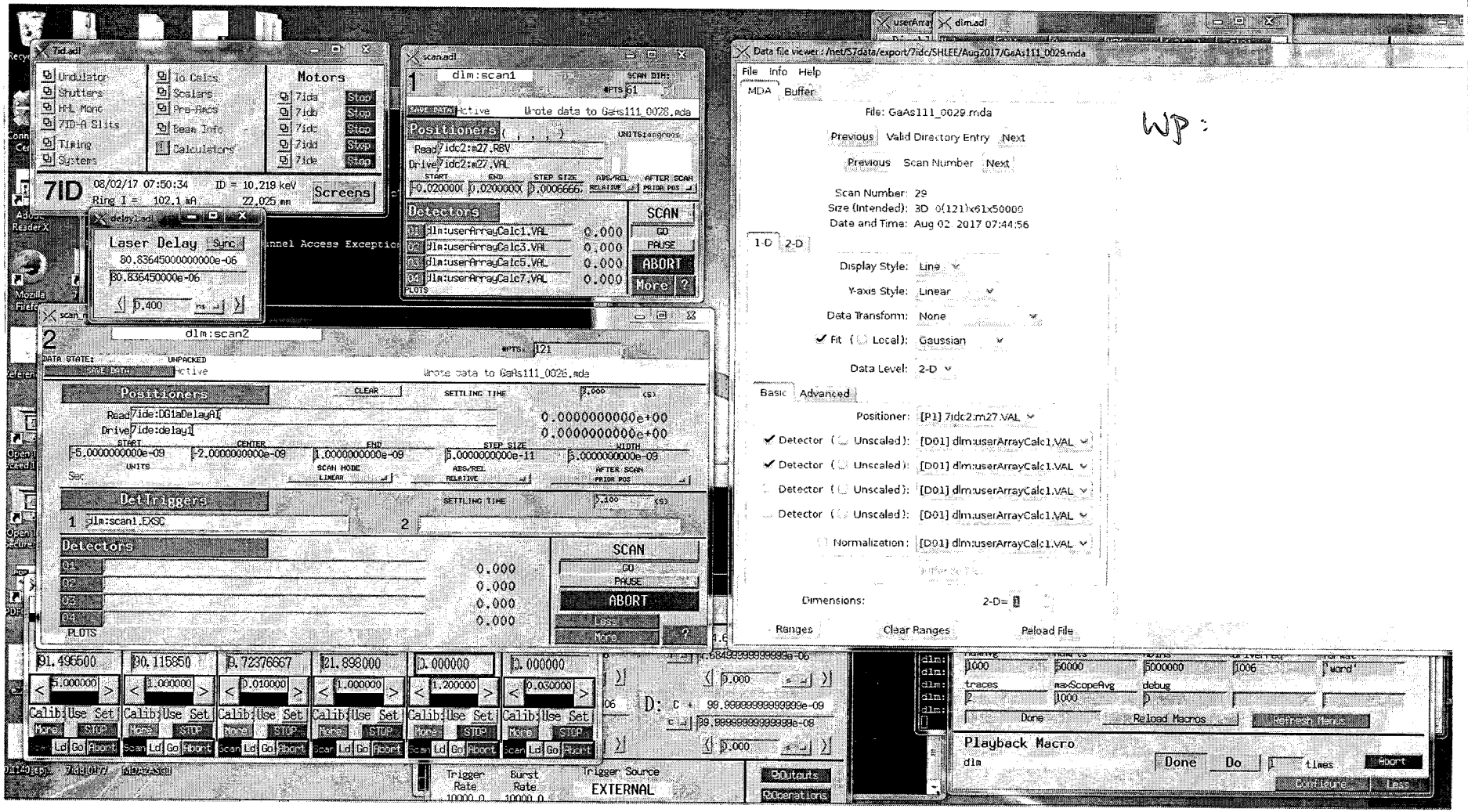
→ 2-D scan
th = 9.7211 "program dump" "wait" 2-08-2017 AM = 7:3
-0.2 , 0.2 , it's getting better.

Test 1-D scan
th = 9.7211
-0.02 0.02 61 points #28.

2-D scan.
th scan : 9.7211
-0.2, +0.2 61 points
delay scan : 80.8416×10^{-6}
-5ns ~ 1ns , 121 steps.

When you stop?
Abort th scan first! ABORT Delay scan Later

2-D SCAN


7id.adl
Undulator
Shutters
H-L Mono
7ID-A Slits
Timing
Systems
To Calcs
Scalers
Pre-Recs
Beam Info
Calculators
Motors
7ida Stop
7idb Stop
7idc Stop
7idd Stop
7ide Stop
7ID 08/02/17 07:50:34 ID = 10.219 keV
Ring I = 102.1 mA 22.025 mm
Screens
delay1.adl
Laser Delay Sync
80.836450000000000e-06
80.836450000e-06
0.400 ns
scan.adl
dlm:scan1
SCAN DIM: 1
NPTS 61
SAVE DATA Active Wrote data to GaAs111_0028.mda
Positioners
Read 7idc2:m27.RBV
Drive 7idc2:m27.VAL
START 0.020000 END 0.020000 STEP SIZE 0.0006667
Detectors
01 dlm:userArrayCalc1.VAL 0.000
02 dlm:userArrayCalc3.VAL 0.000
03 dlm:userArrayCalc5.VAL 0.000
04 dlm:userArrayCalc7.VAL 0.000
SCAN
GO
PAUSE
ABORT
More
dlm:scan2
NPTS 121
DATA STATE: UNPACKED
SAVE DATA Active Wrote data to GaAs111_0026.mda
Positioners
Read 7ide:DG1aDelayA
Drive 7ide:delay1
0.0000000000e+00
0.0000000000e+00
START -5.0000000000e-09 CENTER -2.0000000000e-09 END 1.0000000000e-09 STEP SIZE 5.0000000000e-11 WIDTH 5.0000000000e-09
DetTriggers
1 dlm:scan1.EXSC
Detectors
01 0.000
02 0.000
03 0.000
04 0.000
SCAN
GO
PAUSE
ABORT
Less
More
Data file viewer: /net/S7data/export/7idc/SHLEE/Aug2017/GaAs111_0029.mda
File Info Help
MDA Buffer
File: GaAs111_0029.mda
Previous Valid Directory Entry Next
Previous Scan Number Next
Scan Number: 29
Size (Intended): 3D 0(121)x61x50000
Date and Time: Aug 02 2017 07:44:56
1-D 2-D
Display Style: Line
Y-axis Style: Linear
Data Transform: None
Fit (Local): Gaussian
Data Level: 2-D
Basic Advanced
Positioner: [P1] 7idc2:m27.VAL
Detector (Unscaled): [D01] dlm:userArrayCalc1.VAL
Detector (Unscaled): [D01] dlm:userArrayCalc1.VAL
Detector (Unscaled): [D01] dlm:userArrayCalc1.VAL
Detector (Unscaled): [D01] dlm:userArrayCalc1.VAL
Normalization: [D01] dlm:userArrayCalc1.VAL
Dimensions: 2-D= 1
Ranges Clear Ranges Reload File
Playback Macro
Done Do times Abort
Trigger Rate Burst Rate Trigger Source
EXTERNAL

WP:

again 2-D scan. "xray filter.
fi(0010)(0000)"

th: 9.7211
-0.02 ~ 0.02, 41 steps.
Delay : 80.8416×10^{-6}
-4ns ~ 1ns , 101 steps

"Epics problem, we reboot the program"

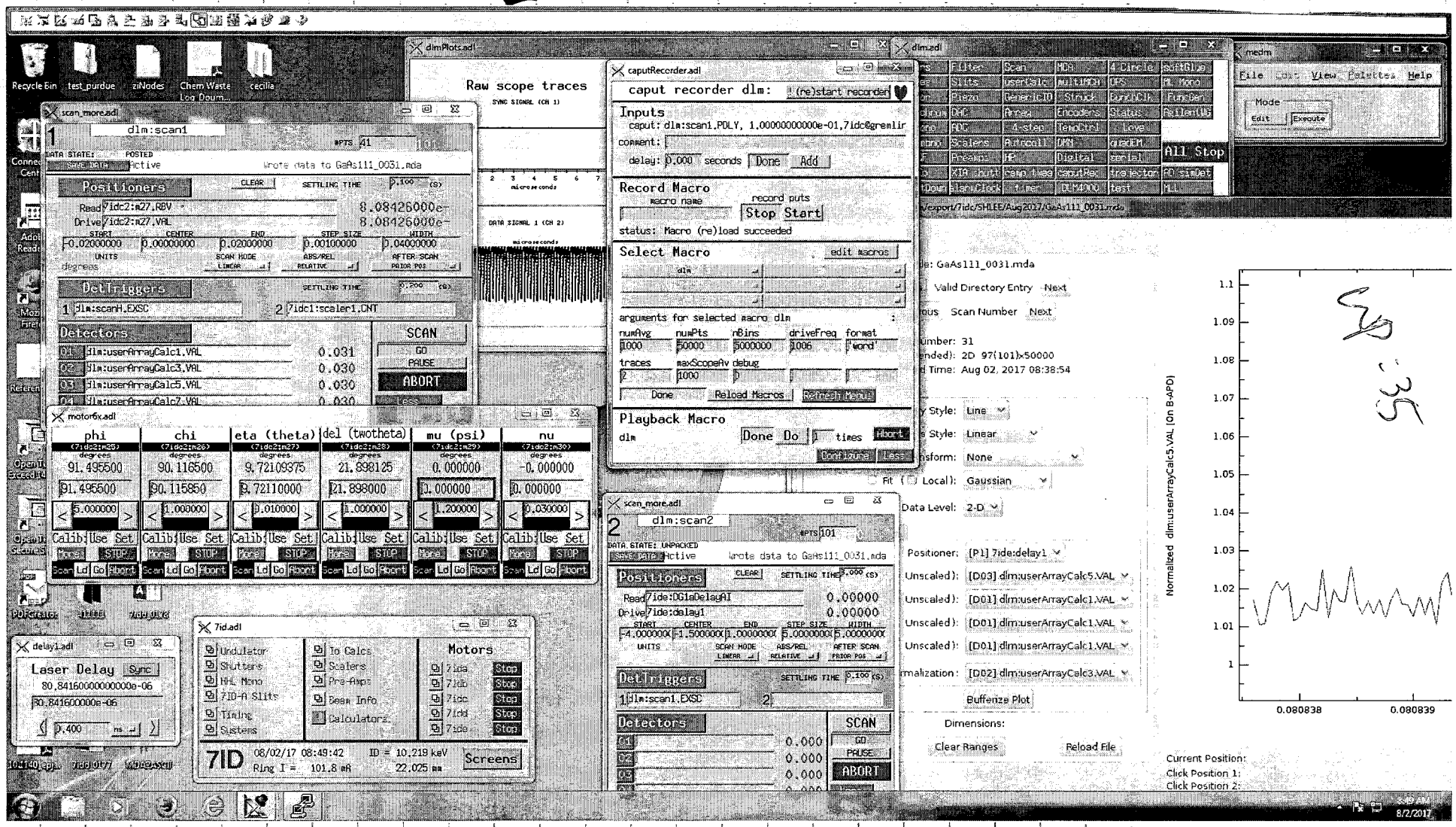
Check time scan. again
Delay : 80.8416×10^{-6} , th : 9.718.
-4ns ~ 1ns , 101 points, 50ps steps.
Scan # 31. "Looks good"

2-D scan start AM 8:50.
Scan # 32
th = 9.7211
-0.02 ~ 0.02 , 41 steps.
Delay : 80.8416×10^{-6}
-4ns ~ 1ns 101 steps (50ps)

"It may take 4 hours"
~ 1 PM.

Waveplate angle 35.

"Next angle 30"



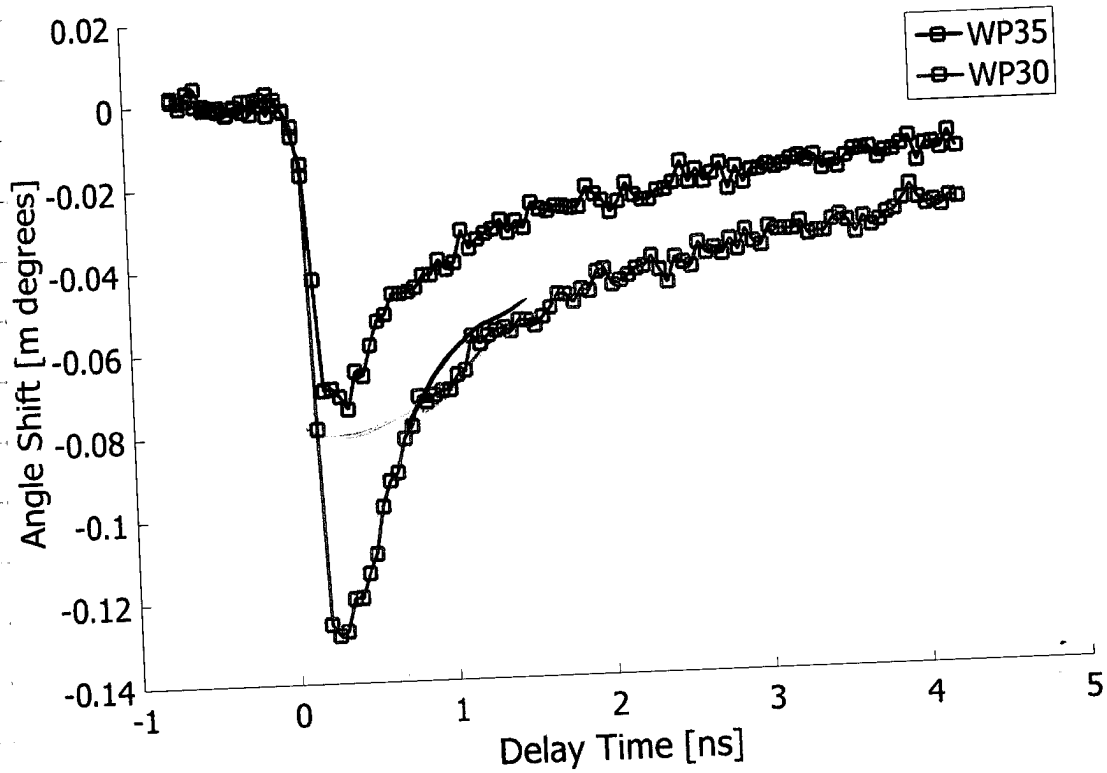
Good Data!

7idc

WP (deg.)	reference (mW)	mW at sample	fluence mJ/cm^2		0	9.491709	sample incident fluenc
0	253	19.02255639	14.27324594	0.713662	5	9.379159	1.739471111
5	250	18.79699248	14.10399797	0.7052	10	8.741376	1.718844972
10	233	17.51879699	13.1449261	0.657246	15	7.503327	1.601963513
15	200	15.03759398	11.28319837	0.56416	20	6.077695	1.375075977
20	162	12.18045113	9.139390682	0.45697	25	4.35193	1.113811542
25	116	8.721804511	6.544255056	0.327213	30	2.813748	0.797544067
30	75	5.639097744	4.23119939	0.21156	35	1.425632	0.515653491
35	38	2.857142857	2.143807691	0.10719	40	0.487716	0.261264436
40	13	0.977443609	0.733407894	0.03667	45	0.075033	0.089379939
45	2	0.15037594	0.112831984	0.005642			0.01375076
	laser x (microns)	laser y (microns)	area (microns^2)	a			
	478	355	133274.2143				
						10	Bragg angle in degrees
			area (mm^2)				
			0.133274214				
			area (cm^2)				
			0.001332742				

28

0.28 ✗



Same Condition with Scan # 32.

"Start at 1PM 2-08-2017"
Finish at 5PM.

#Scan 33. WP=30.
th: 9.7211, -0.02 ~ 0.02, 41 steps. → 22°
delay: 80.8416 X10^{-6}. -4ns ~ 1ns 101 steps. → 8
→ 8.46

#Scan 34 WP:22. Same condition. Start at PM 5:08.

Extinction depth → (111) 10 keV 0.7 μm
(004) 10 keV 1.6 μm

~~Scan~~

Scan #35 wp: 0 Repeat.

Scan #36 wp: 27.64 Repeat

Scan#37

Verifying the ~~time~~ pk shift behavior

$-6\times10^{-10} \rightsquigarrow +4\times10^{-10}$, 21 steps

Waveplate 27.64

Scan #38.

Waveplate 30.

$-6\times10^{-10} \sim 4\times10^{-10}$, 21 steps

Scan #39.

Waveplate 22.

$-10\times10^{-10} \sim 4\times10^{-10}$, 41 steps

Scan #40. → X

Scan Range. $-26\times10^{-10} \sim 4\times10^{-10}$, 61 steps

Remove ND filter

"Waveplate 30"

Scan #41.

Same with #41

Current Motors

phi = 91.4955

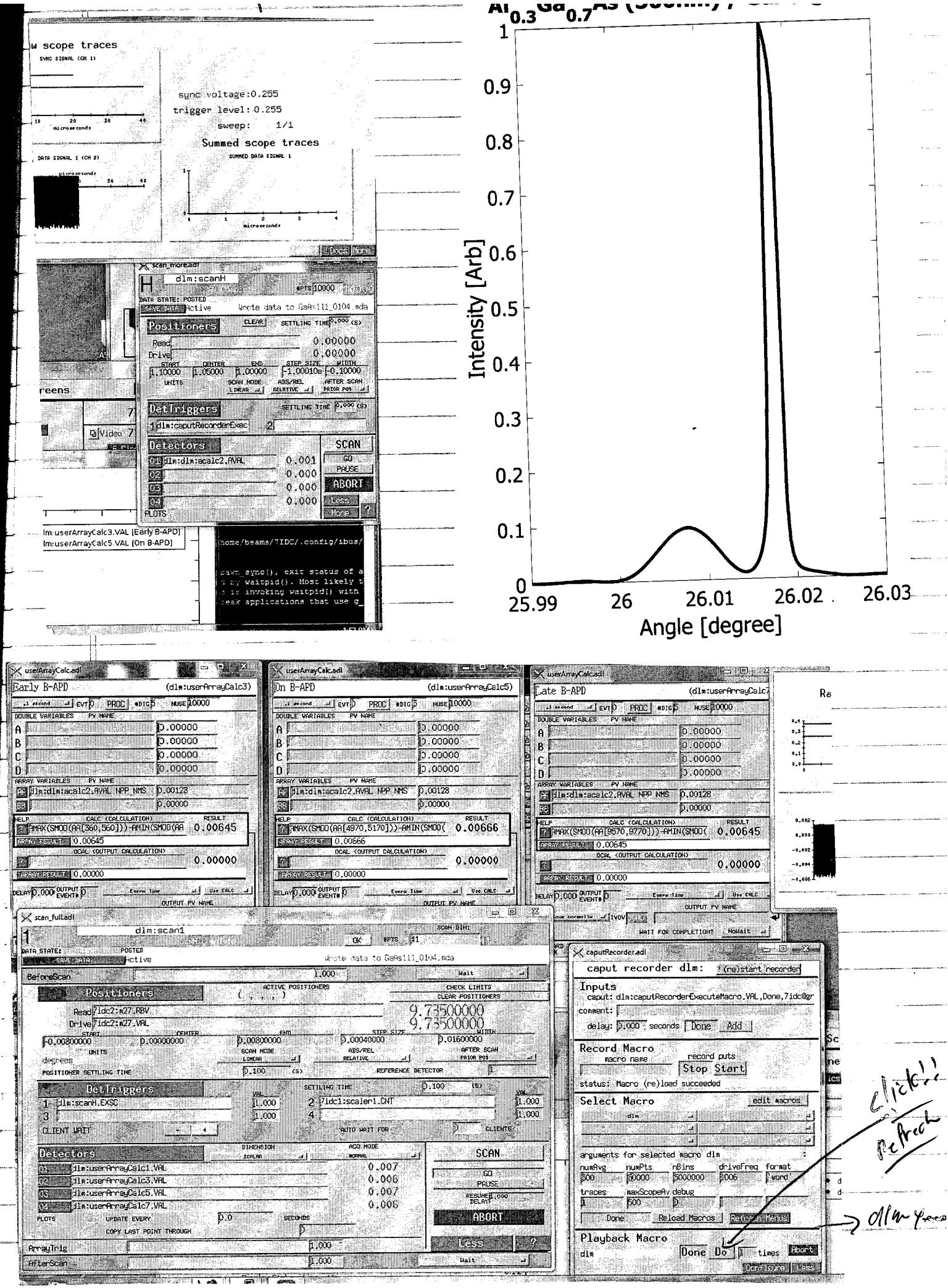
chi = 90.11585

theta = 0

2θ = 21.898

mu = 0

nu = 0


Intensity [Arb]
Angle [degree]
sync voltage:0.255
trigger level:0.255
sweep: 1/1
Summed scope traces
dlm:scanH
Positioners
DetTriggers
Detectors
SCAN
ABORT
Early B-APD
On B-APD
Late B-APD
scan_full.adl
dim:scan1
caput recorder dlm:
Inputs
Record Macro
Select Macro
Playback Macro
Stop Start
Reload Macros
Refresh Menus
Click!! Refresh
dlm

Scan #108 → half cutting Huber Z (7,1,0 : m43)

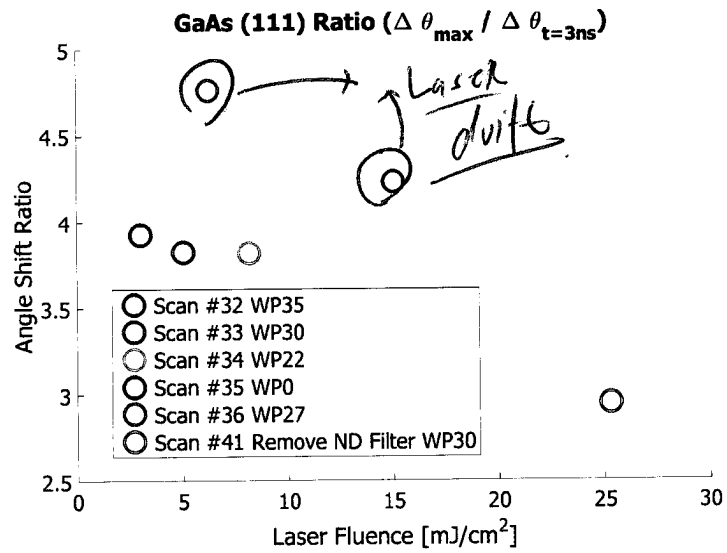
/net/S7data/expert/7,1,0/SHLZ

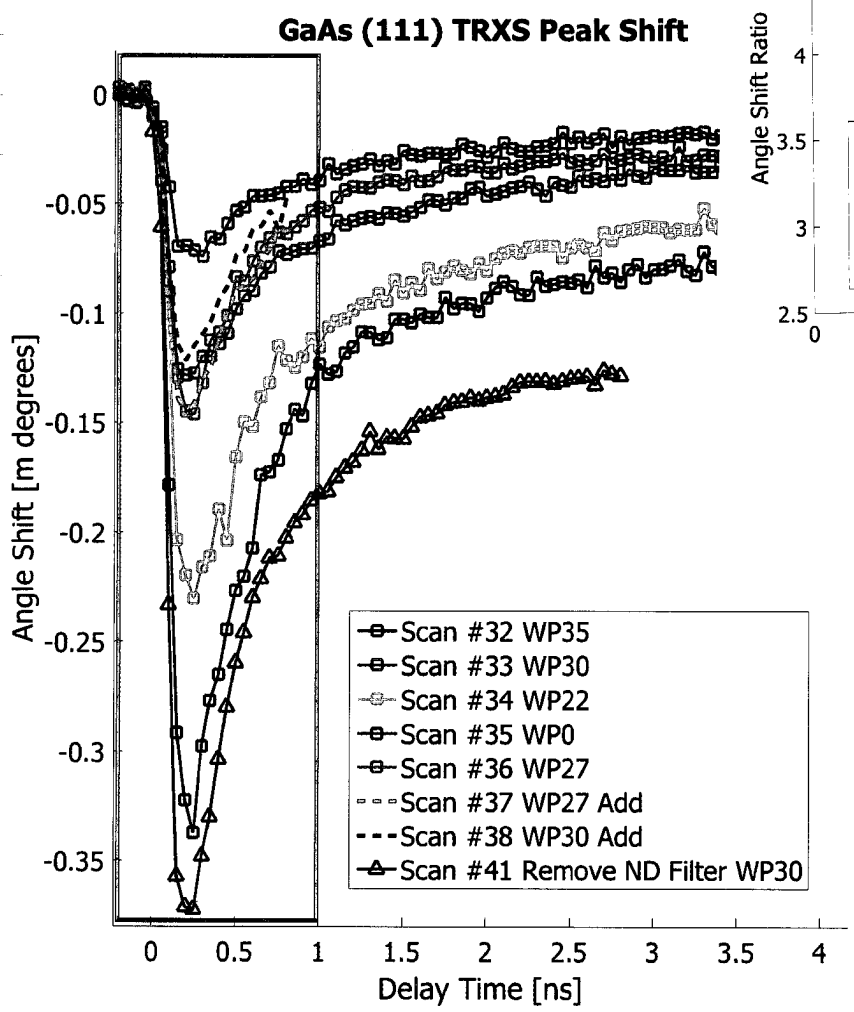
→ 8837 μm HUBER Z (Scan #125)

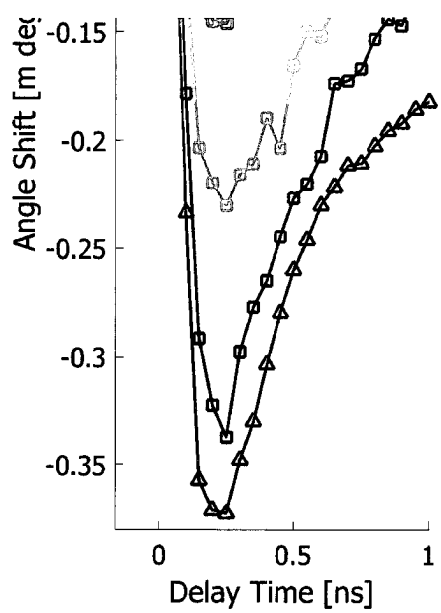
Scan #126 → theta surface scan.

Scan #127 → Repeat above. → -1.257

2θ → 52.0329° expected







Yokogawa Scope

Thursday, October 27, 2016 3:56 PM

To connect gremlin from local PC:
>> ssh -Y 7idc@gremlin.xray.aps.anl.gov

how to run IOC for scope DLM
>> **run**
at location: /net/s7dserv/xorApps/epics/synApps_5_8/ioc/dlm/iocBoot/iocLinux

how to run scope DLM
>> **start_epics_dlm**
at location: /net/s7dserv/xorApps/epics/synApps_5_8/ioc/dlm

>> start_epics ↳ select executer

How to use EPICS interface:

- CaputRec: control interface for camera
  - nmAvg: number of average
  - numPts: number of total data points saved for one scope trace, max 1.25M
  - nBins: desired number of data points in one period
  - Driving Frequency: expected frequency of trigger signal
  - Trace: number of channels recorded
  - maxScope Ave: build-in average for each trace, recommend <8
- DLM4000: display information of recorded scope trace
  - dlmParams.adl: parameters of scope
- ScanH: hardware scan configured to save scope trace

To configure Ethernet control

1. Utility-Remote Control-Network
2. Change IP address
3. Power cycle the scope

7ID IP: 164.54.107.52
Net: 255.255.252.0
Gate: 1.1.1.1

Scan 1
Scan 2
Scan H
↳ scan it first, once.

7idc
Good path!

→ 7idc → Tools!
↳ dvrew

03-08-2017 17:00.

WP (deg.)	reference (mW)	mW at sample	fluence mJ/cm^2			9.491709	sample incident fluence
0	253	30.48192771	22.87158687	1.143579	0	9.379159	10.73755963
5	250	30.12048193	22.60038228	1.130019	5	8.741376	10.61023679
10	233	28.07228916	21.06355629	1.053178	10	7.503327	9.888740688
15	200	24.09638554	18.08030583	0.904015	15	6.077695	8.488189432
20	162	19.51807229	14.64504772	0.732252	20	4.35193	6.87543344
25	116	13.97590361	10.48657738	0.524329	25	2.813748	4.923149871
30	75	9.036144578	6.780114685	0.339006	30	1.425632	3.183071037
35	38	4.578313253	3.435258107	0.171763	35	0.487716	1.612755992
40	13	1.56626506	1.175219879	0.058761	40	0.075033	0.551732313
45	2	0.240963855	0.180803058	0.00904	45		0.084881894
	laser x (microns)	laser y (microns)	area (microns^2)	a			
	478	355	133274.2143				
						25	Bragg angle in degrees
			area (mm^2)				
			0.133274214				
			area (cm^2)				
			0.001332742				

Control: 7-30 V
HV: 230 V

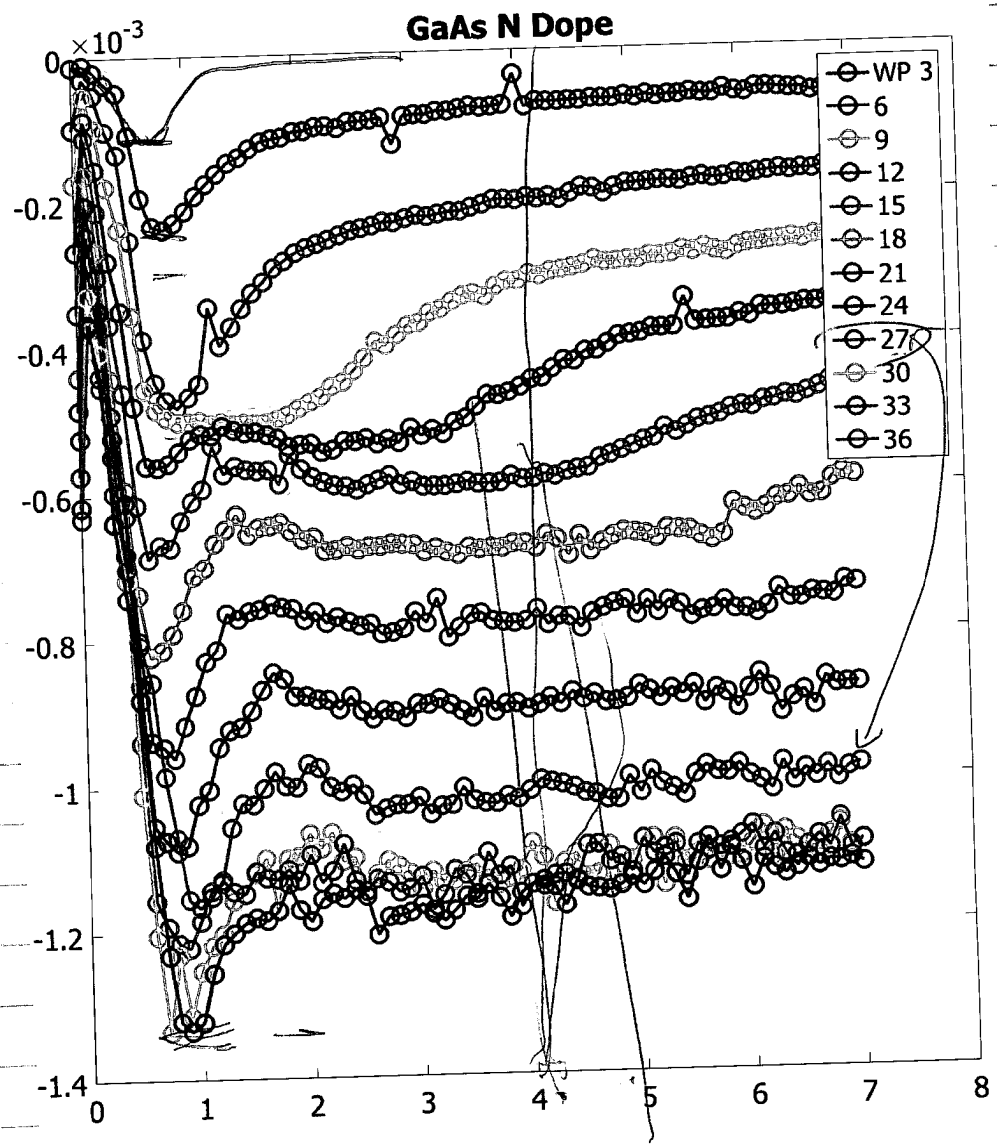
22.8796 J

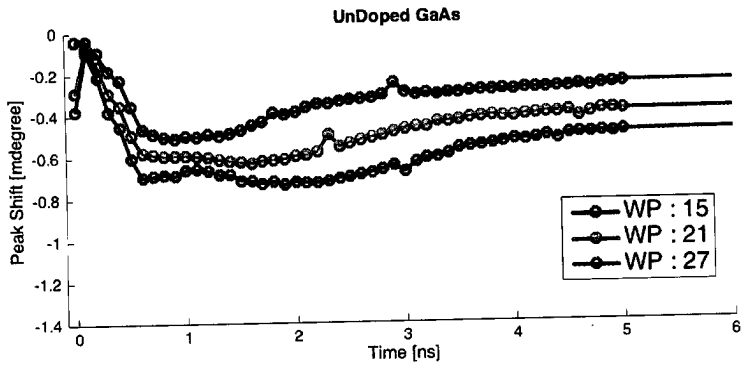
Sep 12

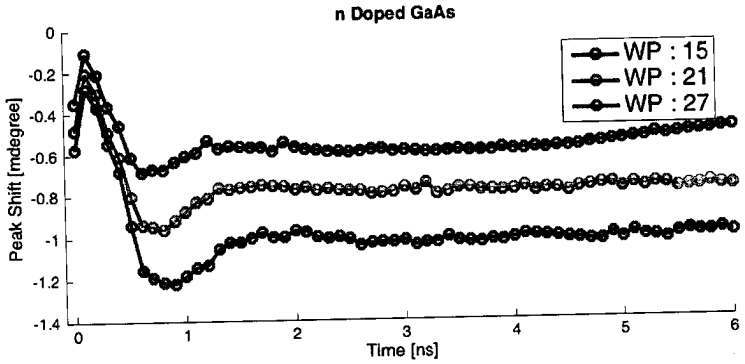
#Scan 145. ~ 148. Check. Laser effect.
↳ Peak width 2.5 mdegree. Delay : 80.8416×10^{-6}

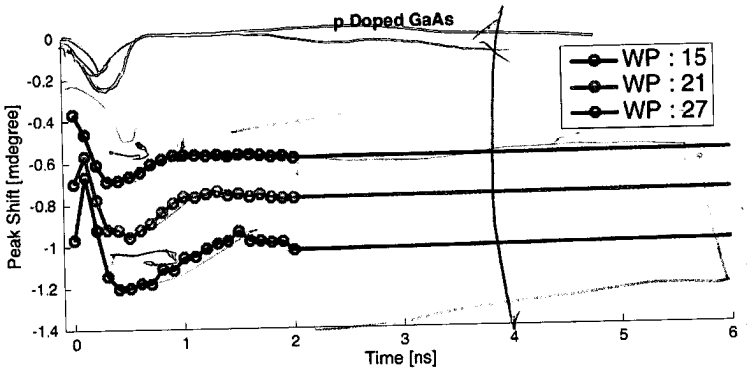
file name change "
GaAs004.mda.

#Scan 1.
Delay : -4ns ~ 1ns 100ps steps. 51 points.
(at) 80.8416×10^{-6}
WP : 40 : 0.5 detector 5 : Laser on
" 3 : Laser off
theta : ~~25.250~~
25.052









plan for WP

34, 31, 28, 25, 2

Scan #2 WP : 37. : 11.6

Scan

"3-D Scan" Start @ 7:50 PM.

GaAs 004-0003.mda

② → delay −6ns ~ −1ns @ 71 points, 100ps step.

↳ 80.8416×10⁻⁶

① → th −0.008 ~ 0.008, 54 points, 0.0003 steps

↳ 25.052.

③ → WP 34 ~ 22, 5 steps.

→ stop scan!?

WP = 34 ; GaAs 004b_0021.mda

54 th steps, 71 delay steps.

WP = 31 ; GaAs 004b_0022.mda 10:50 PM.

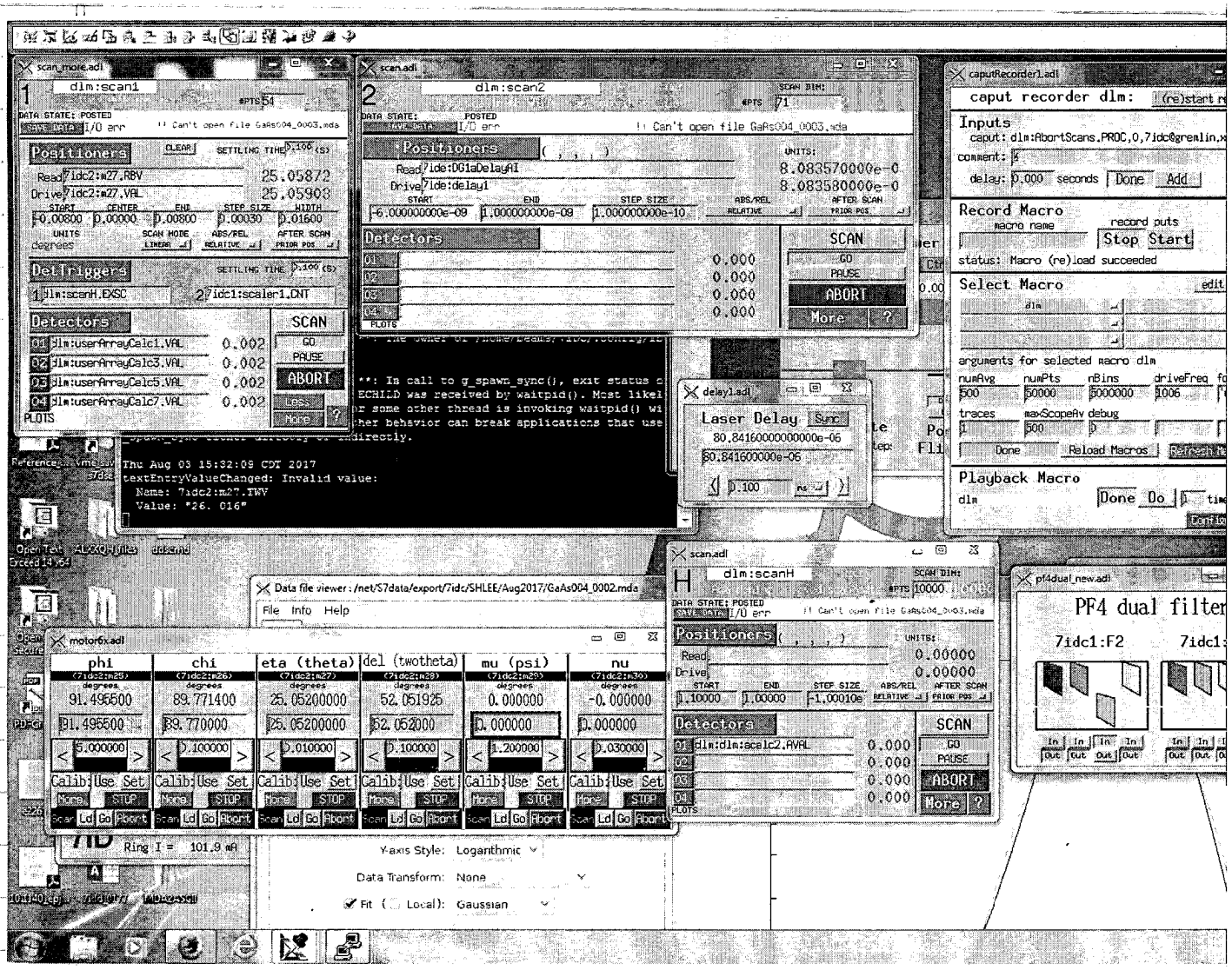
WP = 28 : GaAs 004b_0023.mda. 00:58 AM start.

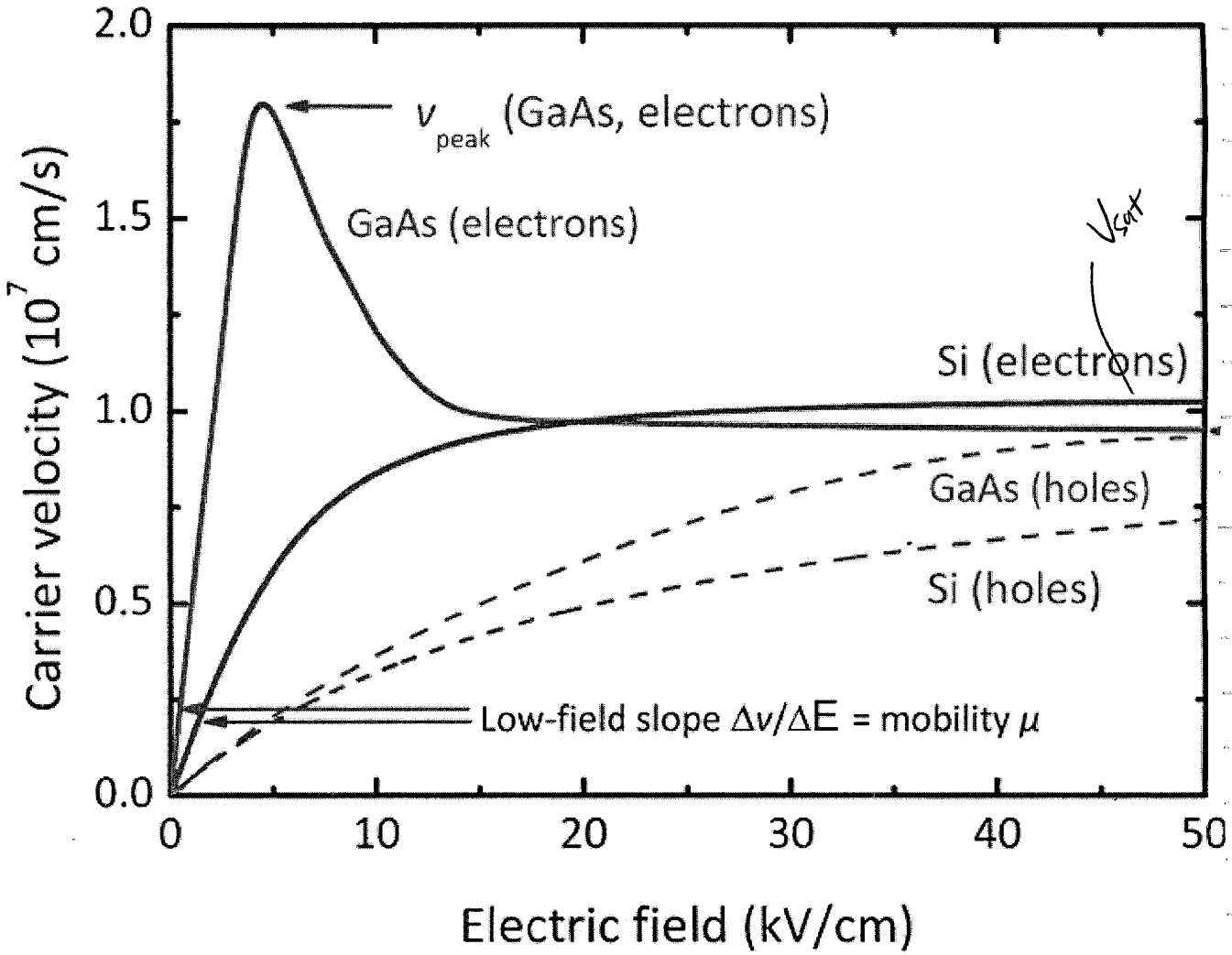
WP = 25 : GaAs 004b_0024.mda 3:06 AM start.

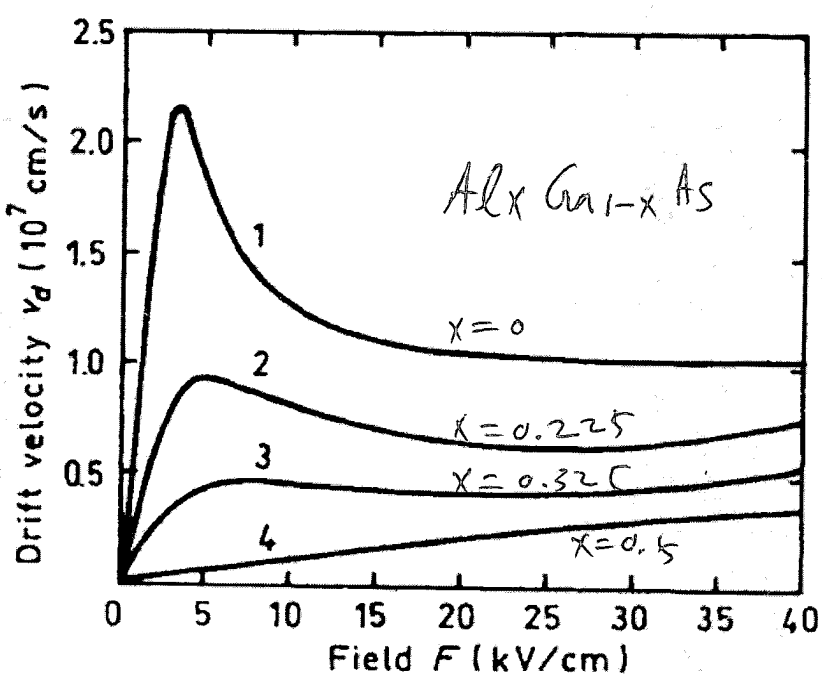
WP = 7.4 : GaAs 004b_0025.mda 5:17 AM start.

Restart Epics!?

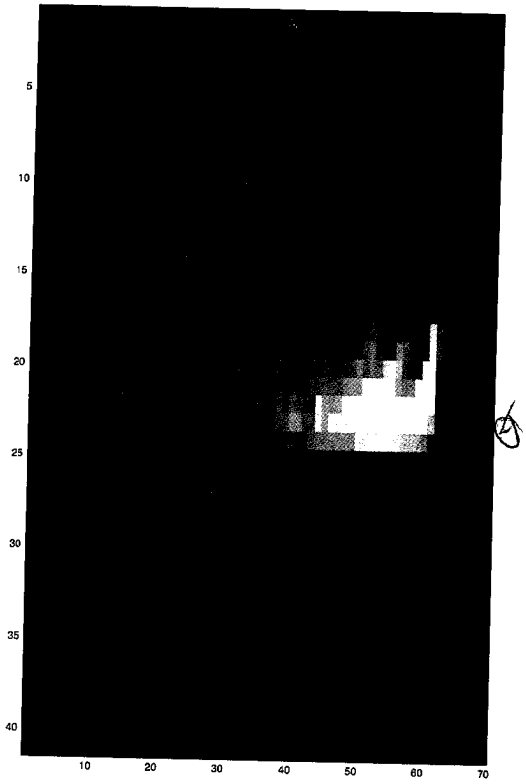
Rocking curve scan.

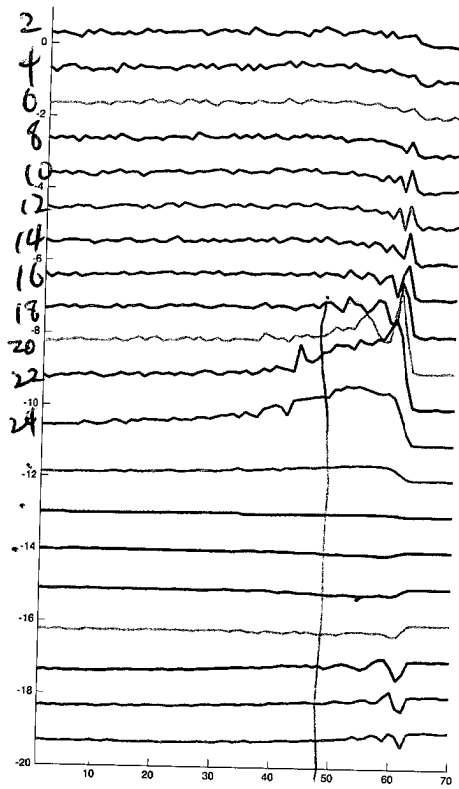

scan_more.adl
dlm:scan1
Positioners
Read 7idc2:m27.RBV 25.05872
Drive 7idc2:m27.VAL 25.05903
DetTriggers
Detectors
SCAN
GO
PAUSE
ABORT
More
scan.adl
dlm:scan2
Positioners
Read 7ide:DG1aDelayA1 8.083570000e-0
Drive 7ide:delay1 8.083580000e-0
Detectors
caputRecorder1.adl
caput recorder dlm:
Inputs
Record Macro
Stop Start
Select Macro
Playback Macro
delay1.adl
Laser Delay
80.841600000000000e-06
80.841600000e-06
Thu Aug 03 15:32:09 CDT 2017
textEntryValueChanged: Invalid value:
Name: 7idc2:m27.TWV
Value: "26. 016"
Data file viewer : /net/S7data/export/7idc/SHLEE/Aug2017/GaAs004_0002.mda
File Info Help
motor6x.adl
phi
chi
eta (theta)
del (twotheta)
mu (psi)
nu
91.495500
89.771400
25.05200000
52.051925
0.000000
-0.000000
scan.adl
dlm:scanH
Positioners
Detectors
pf4dual_new.adl
PF4 dual filter
7idc1:F2
Ring I = 101.9 mA
Y-axis Style: Logarithmic
Data Transform: None
Fit (Local): Gaussian


2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
Carrier velocity (10^7 cm/s)
Electric field (kV/cm)
v_{peak} (GaAs, electrons)
GaAs (electrons)
Si (electrons)
GaAs (holes)
Si (holes)
Low-field slope $\Delta v/\Delta E$ = mobility μ
V_{sat}


2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
35
40
Drift velocity v_d (10^7 cm/s)
Field F (kV/cm)
$Al_x Ga_{1-x} As$
1
2
3
4
x = 0
x = 0.225
x = 0.32
x = 0.5

Scan 23 wp 28. (Watts (400))





Center : 25.05

-7.8mdegree

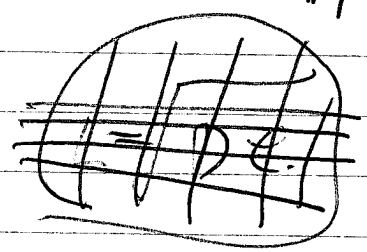
-6.6mdegree - 5.4m degree, -4.2mdegree, - 3mdegree from Center

Delay : 80.8416×10^{-6}

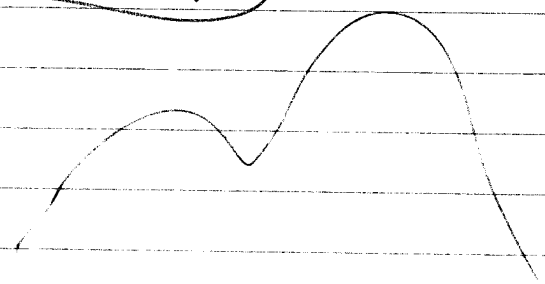
Timedelay Scan.

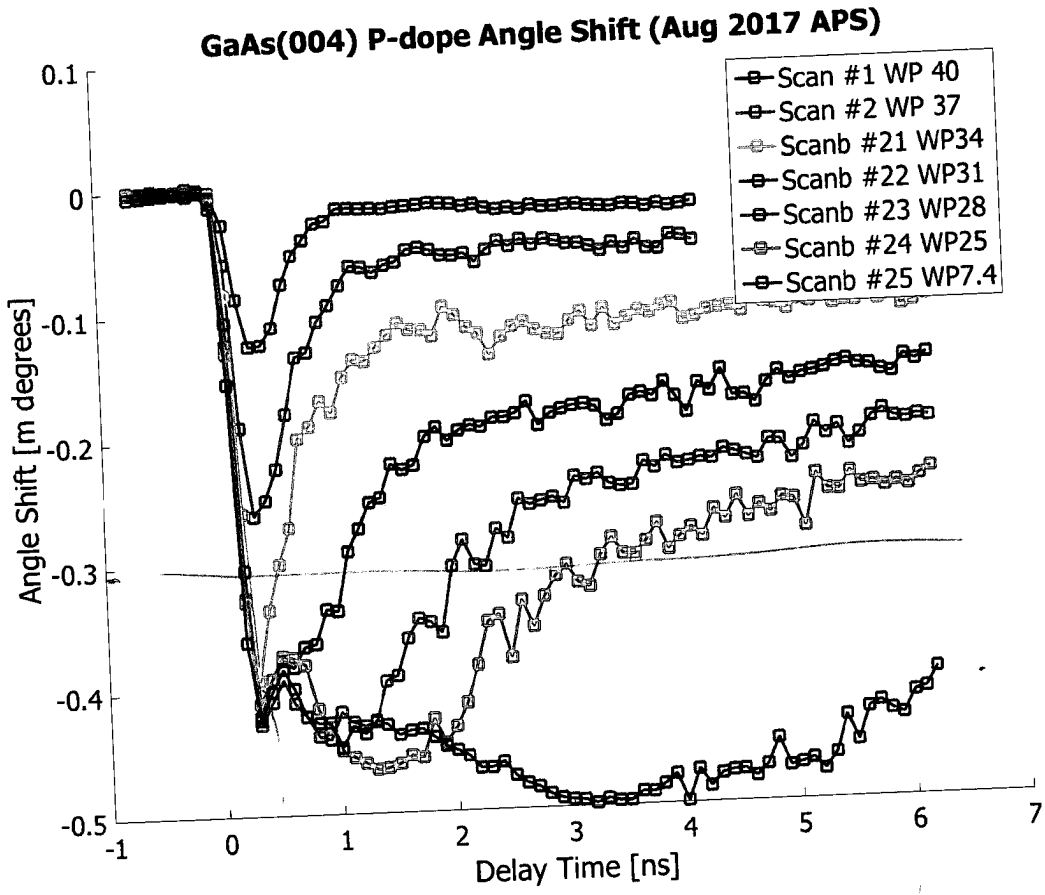
-1.5ns ~ 0.5ns , 25ps Step, 80 points.

wp = 28



① th: 25.0497 #31.
② th: 25.0485 #32.
③ th: 25.0473 #33
④ th: 25.0461 #34
⑤ th: 25.0449 #35





04-08-2017. 8:50 AM
Sample change to GaAs(001) n-doping.

find (400) peak.
GaAs004b_00#.mda
#36. th -0.02 0.02 40.
~~#46~~
#45, #46. Normal Rocking scan.
th: 24.9181,
FWHM: 2.4 mdegree. Laser off

#47: Laser ON (WP 27)