

Experimental PLANS:

- PN junction
- N, P, doped
- GaAs C(111) [Piezo effect]
- Eric's thermal transport measurements

"Nature electronics"

PN PLAN: Refer to Nature Nano. + Science paper

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

GaAs C(110): Refer to Acoustics paper.

↳ fluence dependence measurement. ($5 \sim 6$):

Eric's thermal transport:

↳ Debye Waller measurement on metals \rightarrow temperature.

↳ peak shift of GaAs

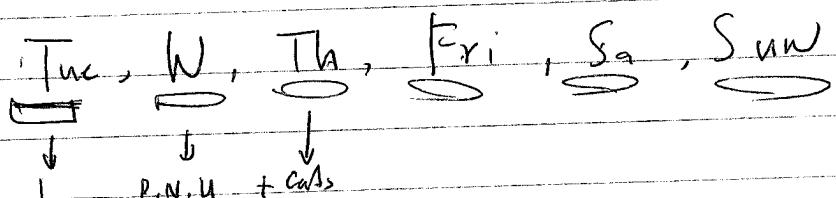
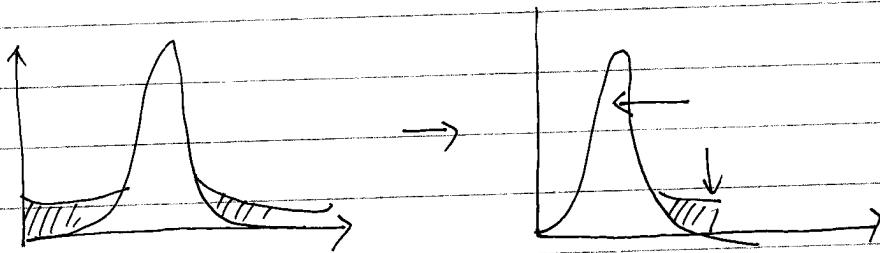
\downarrow Thermal transport.

① First fit Low fluence undoped GaAs

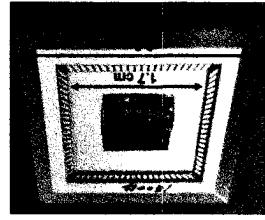
② Fit N-doped GaAs to deduce ~~doping density~~
Diffusion Coeffi.

③ Deduce delayed Diff. Coeff.

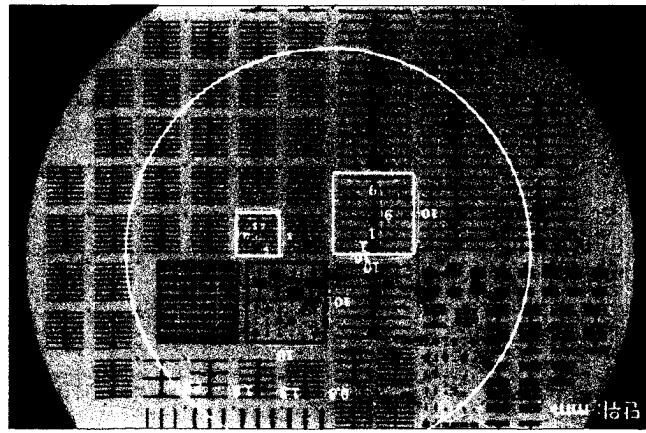
prove momentarily short-chord carrier profile $V \rightarrow$ delayed diffusion.



Multi-Layer



LCC

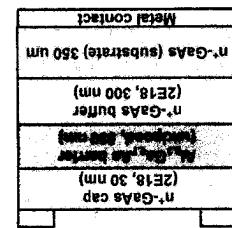
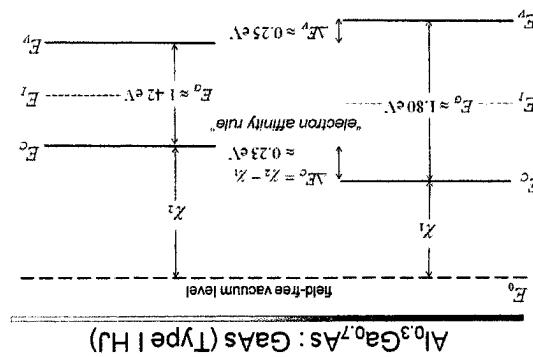


Photomask



KRIS

Photomask layout/LCC



KRIS

i-AlGaN/n+GaN Heterojunction Structure

Scope
Setting

7ID-C

The screenshot displays several windows from the 7ID-C software:

- Main Window (Bottom Left):** Shows a list of double variables and their current values. One variable, "X Axis", has its value set to 0.000000.
- 7ID-Calc (Top Left):** A calculation window with fields for Input, PROC, and Output. The output is labeled "RESULT = 0.1881".
- 7ID-Screen (Center):** A screen showing various parameters and a graph of current vs. voltage.
- 7ID-Data (Bottom Right):** A table showing experimental data with columns for Date, Time, Beam Current, and other parameters.
- 7ID-Plot (Bottom Center):** A plot window showing data points over time.
- 7ID-Calc2 (Top Right):** Another calculation window showing results like 0.000000 and 0.000000.
- 7ID-Calc3 (Bottom Right):** A third calculation window.
- 7ID-Dockable (Bottom Center):** A dockable window showing detector status for To Gafas, Scalers, Pre-Pheos, Beam Info, Calculators, and Soot Sensors.

APD Single photon Counting Mode

10.52V (gas)
central

+ 311 V (bias)

APD 'A' DC offset

proportion made:

7.54 V + 211 V, 50mV direct beam.

Aug 1, 2017

motor3x.adl

17:50:49

The figure displays three identical-looking digital control panels arranged horizontally. Each panel has a title at the top: "Huber X" (left), "Huber Y" (middle), and "Huber Z" (right). Below the title is a status line showing "(7 idle; m41)" for X, "(7 idle; m42)" for Y, and "(7 idle; m43)" for Z. The main area contains a numeric value followed by "um": -0.00591 for X, -59.96809 for Y, and 9082.44681 for Z. Below each value is a large input field with "10.00000" in it. Underneath the input field is a horizontal slider with a central box containing "1.00000". To the left of the slider is a double-left arrow button, and to the right is a double-right arrow button. At the bottom of each panel are several buttons: "Calib", "Use", "Set" (highlighted in gray), "More", "STOP", "Scan", "Ld", "Go", and "Abort".

Aug 1, 2017

motor6x.adl

17·50·4

ID Gap Control

Sector #07 Upstream ID

Undulator_#1_3.3cm

Software Version: 4.21

Avg	22.025	10.219
Current		
Tpr	-0.001	-0.000
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) :

10

B1, Comm. Limit (mm) : 11.000

Total Power: 592 W /100mA

Status Messages:

Device At Destination

Time Left: 0 seconds

ID Info: 0

H1	K1	L1
a	3.56688	
2d	4.11868	
Diamond		

E (keV)	lambda (Å)	TH (deg.)
172.4858	2.68283	40.64580
10.0000	1.23984	17.51944
10.0000	1.23984	17.51944
4.6214	0.07188	1.00000
< 0.0100 >	< 0.010 >	< 0.010 >

Manual

Auto

Move

Theta	Y	Z	
7ida;m9	7ida;m1	7ida;m2	Motor PV
17.51944	-18.351	58.135	Actual Pos.
17.51944	-18.351	58.134	Motor Command
17.51944	-18.351	58.134	Ideal Speed
0.13889	0.05000	0.48231	All Stop

Channel Cut inhibits
Y1 and Z2 motors

Normal
Channel Cut
Freeze Z
Freeze Y

Calibration:

Use Set

y offset: 17.500

Done

OK

GaAs (111). Sample.

$a = 5.65325 \text{ \AA}$

X-ray Energy = 10 keV

λ (Wave length) = 1.2398 \AA

$2\theta_{(111)} = 21.8988$.

$\theta_{(111)} = 10.9494$.

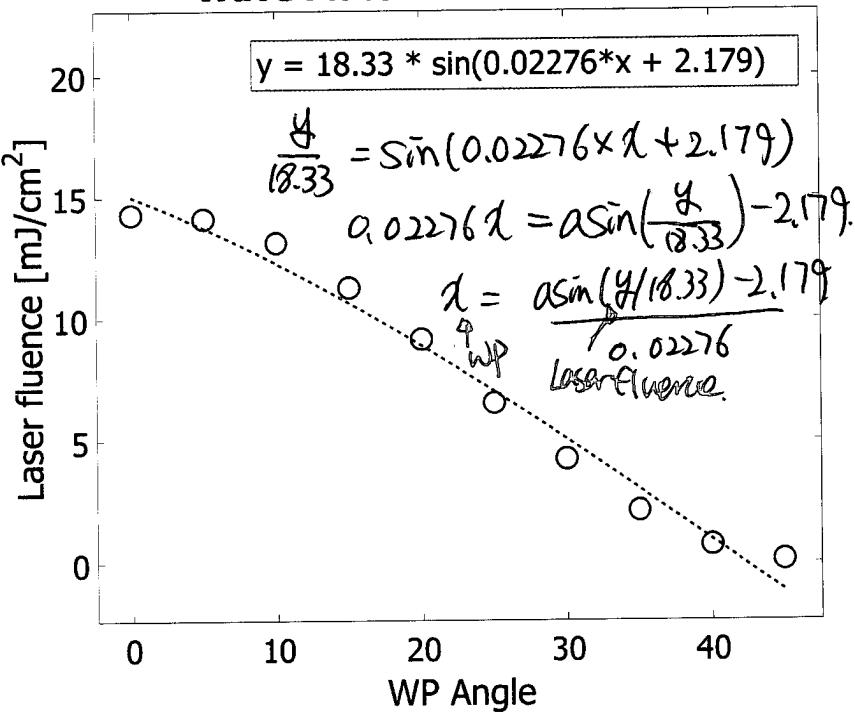
$2\theta_{(400)} = 52.0395$

$\theta_{(400)} = 26.0197$.

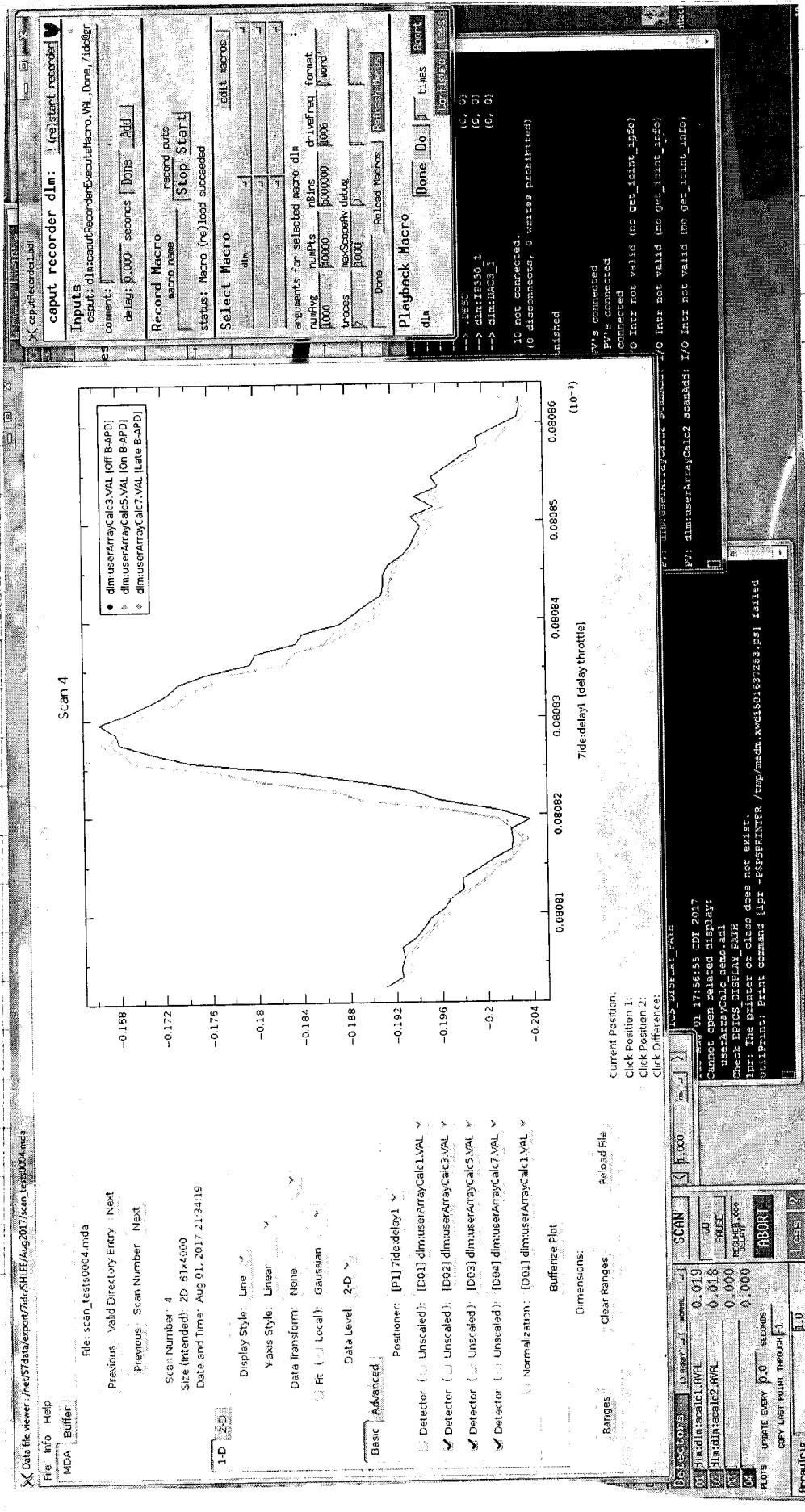
WP (deg.)	reference (mW)	mW at sample	fluence mJ/cm^2
0		253	189.834171
5		250	187.583173
10		233	174.8275172
15		200	150.0665384
20		162	121.5538961
25		116	87.03859225
30		75	56.27495189
35		38	28.51264229
40		13	9.754324994
45			0.01500665384

laser x (microns) laser y (microns) area (microns²) a
 478 355 133274.2143

Wave Plate and Laser fluence



Oscilloscope Setting for TRRS Scanning



8/2/17

12:30 AM

~~In the fit~~ Timing problem.

Loose cable controlling delay generator fixed
T ϕ estimated using photodiode

Q2

80.84173 μ s.

Now time scans properly and reproducibly.

tee-off trigger for Ch. 2 from O-scope in TIDE.

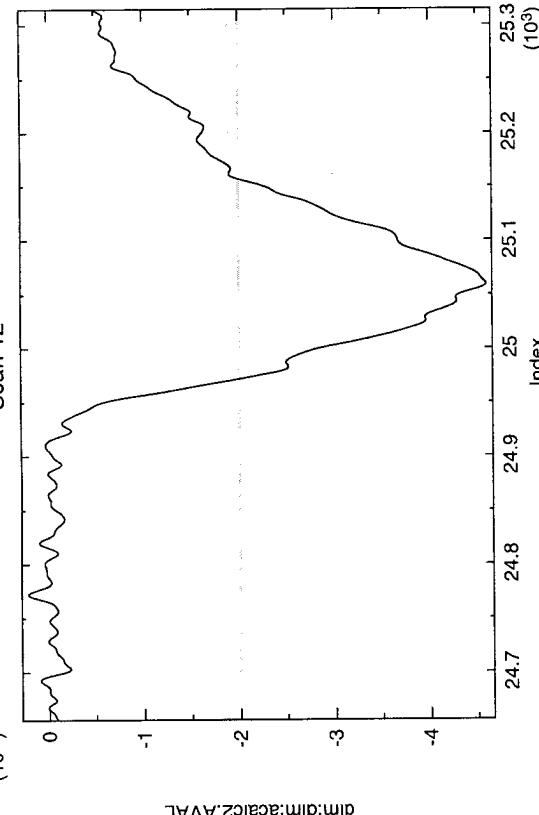
Laser only at T ϕ

on A PD-B.

Index 25060

A delay of 1 μ s shifts

laser to Index 31306



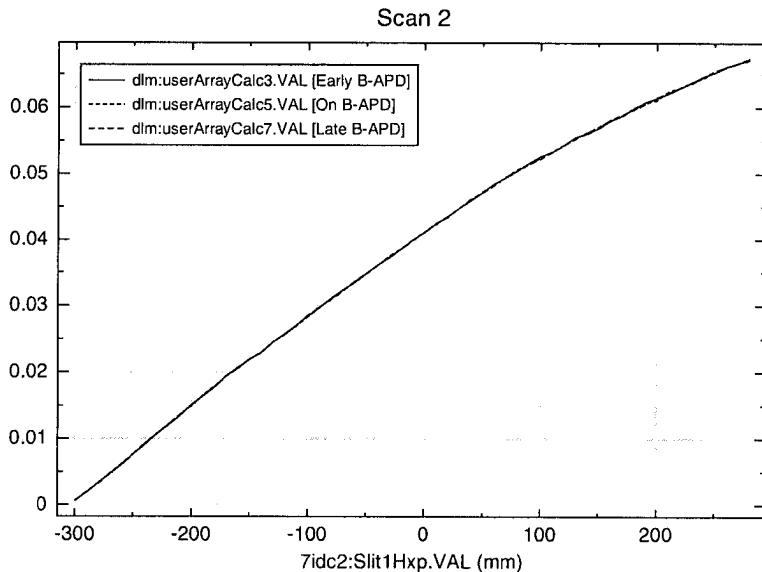
$$1 \mu\text{s} / (31306 - 25060) = 160 \text{ ps/channel}$$

$$\text{num Pts} = 50000 \text{ nBins} = 5,000,000$$

$$\text{drive Freq} = 1006, \text{ traces} = 2, \text{ max Scope Avg} = 1000$$

Need to be careful not 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
62
18/2/17

Change file to Ge III. Inserted sample

Scan 1 Align sample vertically using Huber Z
2 Align sample in Θ

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

3 Align sample in Θ . Found it flat at $\Theta = -121^\circ$.

III should be at $2\Theta = 21.898^\circ$ for 10keV
guess $\Theta = 9.75^\circ$

Found GaAs III, tweaking up.

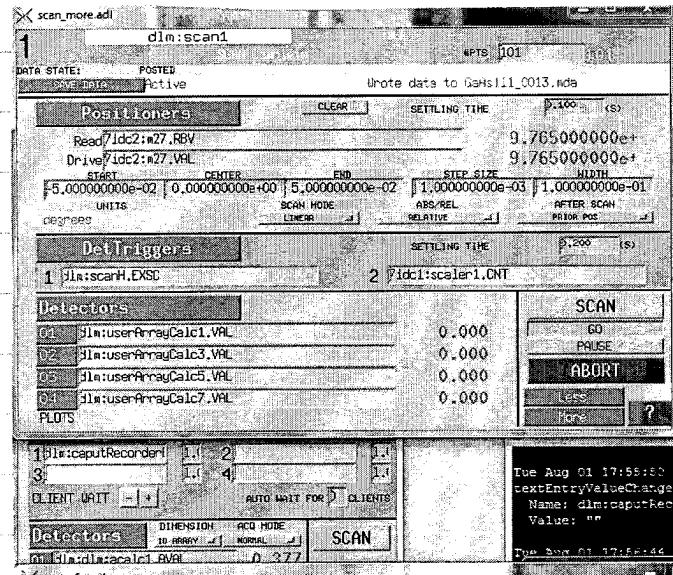
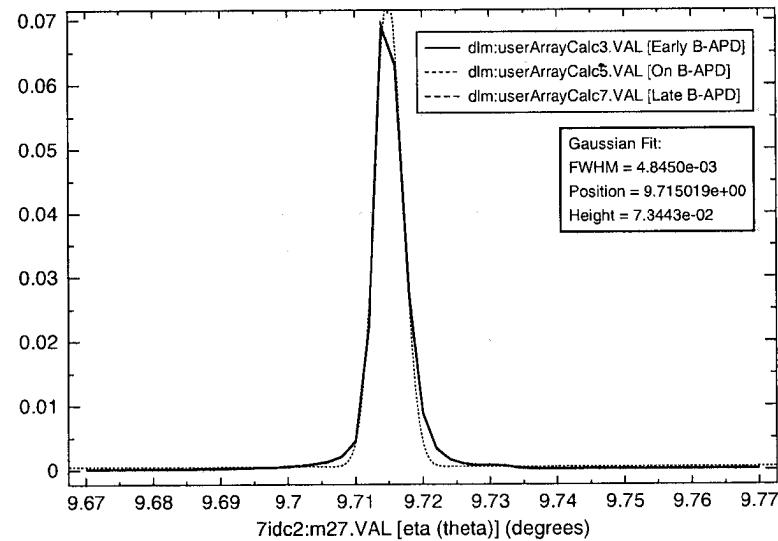
/net/IS7data/export/Tide/SHEC/~~Aug~~ Aug 2017/
Gals 111-000 N. Mda

↳ Sample alignment Scans

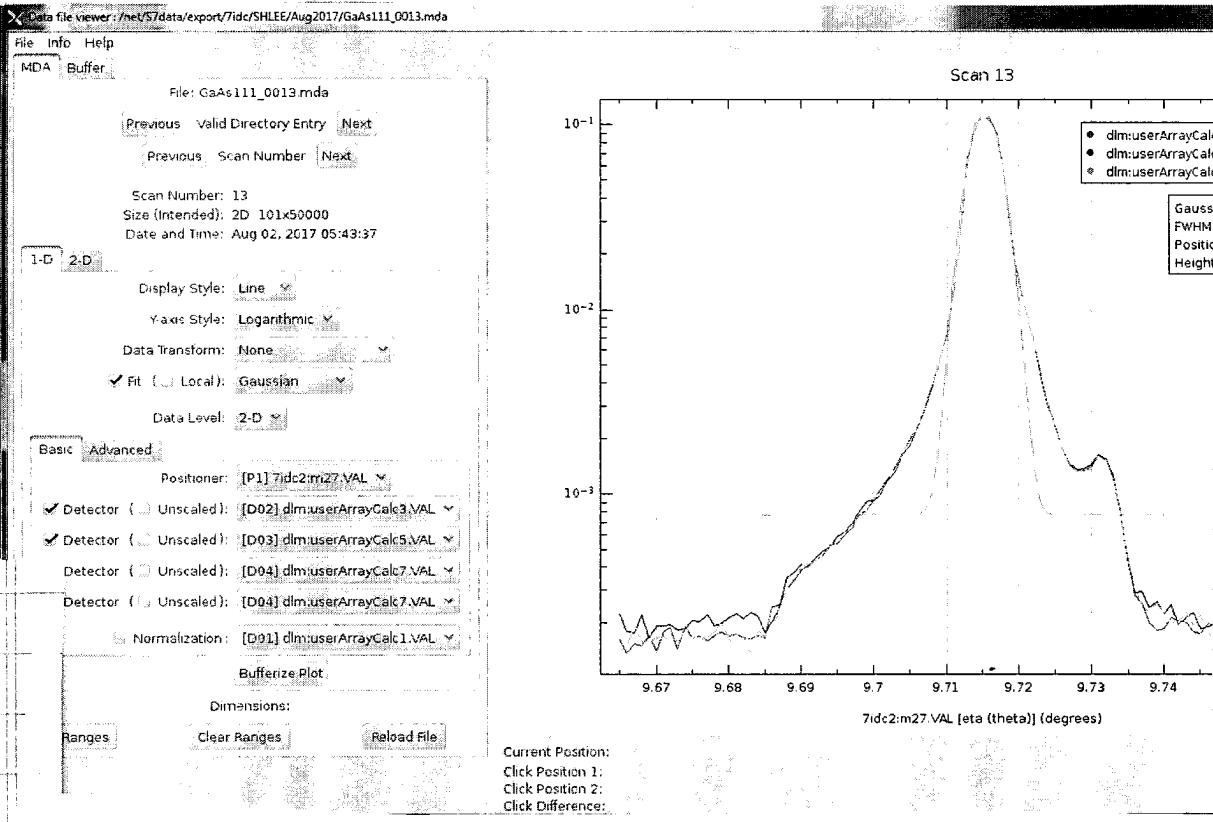
C - JJ slits \rightarrow H: 400 nm
V: 100 nm

~~H. Harrow~~

GaAs III-000ff.mda



← Angle Scan Routine



Laser fluence: C-waveplate = 35° { center $\theta = 9.715589$

Scan #16: narrowed rocking range $\pm 2 \times 10^{-2}$; 41 steps.
Settling time > 0.1

Scan #17: Time-scan { found

$$\underline{9.7135} = \theta$$

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

scan_more.edt

dlm:scan1

DATA STATE: UNPACKED
SAVE DATA: Active Wrote data to GeAs111_0017.mda

Positioners CLEAR SETTLING TIME 5.000 (s)
Read: 7ide:delay1 AI 8.084373000e-0
Drive: 7ide:delay1 8.084393000e-0
START CENTER END STEP SIZE WIDTH
[1.0000000e-03] [0.0000000e+00] [1.0000000e-03] [2.0000000e-10] [2.0000000e-08]
UNITS SCAN MODE ABSREL RELATIVE AFTER SCAN PRIORITY POS
LINEAR ✓

DetTriggers SETTLING TIME 5.000 (s)
1 dlm:scanH.EXC 2 7idc1:scaler1.CNT

Detectors
01 dlm:useArrayCalc1.VAL
02 dlm:useArrayCalc3.VAL
03 dlm:useArrayCalc5.VAL
04 dlm:useArrayCalc7.VAL

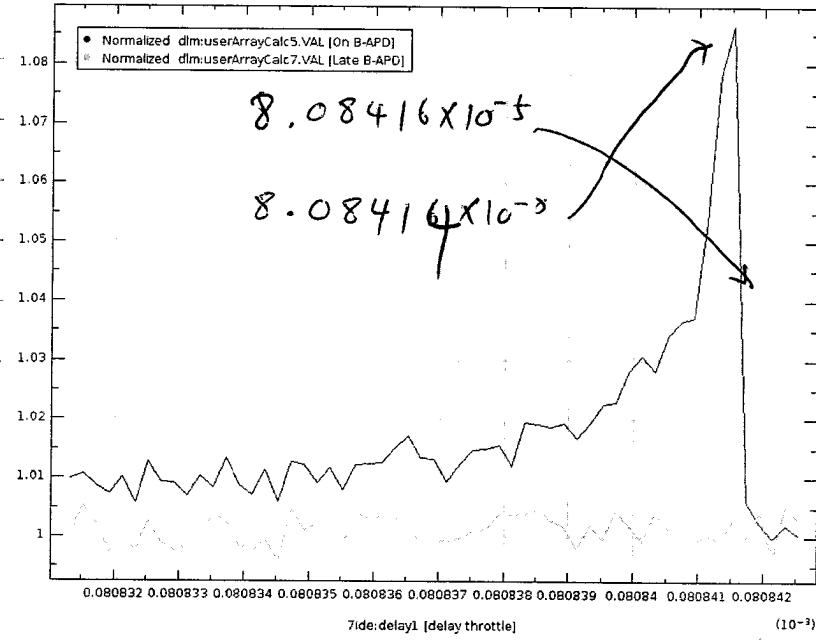
PLOTS SCAN GO PAUSE ABORT
LEAVE HELP ?
Data Level: 2-D
Basic Advanced
Positioner: [P1] 7ide:delay1
✓ Detector (Unscaled): [D02] dlm:useArrayCalc3.VAL
✓ Detector (Unscaled): [D03] dlm:useArrayCalc5.VAL
✓ Detector (Unscaled): [D04] dlm:useArrayCalc7.VAL
✓ Normalization: [D02] dlm:useArrayCalc3.VAL
Bufferize Plot
Ranges Clear Ranges Reload file
Dimensions:
CLIENT_WAIT — AUTO_WAIT_FOR_CLIENTS
Detectors DIMENSION ACC MODE SCAN
01 dlm:scaler1.RVA 0 377

motorfix.edt

phi	chi	eta (theta)	de1 (two theta)
(7ide:delay1)	(7ide:delay1)	(7ide:delay1)	(7ide:delay1)
degrees	degrees	degrees	degrees
91.495500	90.116500	9.7130000	21.898125
91.495500	90.115850	9.7130000	21.898000
< 5.00000 >	< 1.00000 >	< 0.01000 >	< 1.00000 >

Calib Use Set Calib Use Set Calib Use Set Calib Use Set
None STOP None STOP None STOP None STOP
Scan Ld Go Abort Scan Ld Go Abort Scan Ld Go Abort Scan Ld Go Abort
Scan Ld Go Abort Scan Ld Go Abort Scan Ld Go Abort Scan Ld Go Abort

Scan 17



Scan 18: ~~time scan~~ \rightarrow Auger Scan

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

HUBER X -500 nm

H. Y 1790

H. Z 8792. ~~0.65~~

± 20 mdeg/sec

-3 ns ~ 7 ns

Changed HUBER X = -600 nm

10 ns

↳ Repeat angle scan #20

Changed HUBER X = -700 nm

↳ Repeat angle scan #21

Changed HUBER X = -800 nm

↳ Repeat angle scan #22
Center = 9.7211



Timescan side of Rocking curve

th = 9.71912.

-3ns +7ns #23 ← Stop

th = 9.7135

-3ns, +7ns scan #24. ← No chose

~~th = 9.7180.~~

~~-3ns, +7ns~~

TH: 4, 110 v.

delay : -7ns ~ 3ns 51 points. #25

"200ps step."

10ns / 25ps

$$\frac{10}{25 \times 10^{-9}} = 4 \times 10^3$$
$$\frac{1}{2} \times 10^3 = \boxed{250} \times 10^3 = 250$$
$$\frac{10^{-9}}{50 \times 10^{-12}} = \frac{1}{5} \times 10^3$$

"looks good"

delay scan

-5ns ~ 1ns (21 steps, 50ps) #26.

TO = Delay : $80.84 / 6 \times 10^{-6}$

→ 2-D Scan

th = 9.7211 program dump, wait. 2-08-2017 AM: 7:3

-0.2, 0.2, it's getting better.

Test 1D scan

th = 9.7211

-0.2, 0.2 61 points #28.

2-D Scan.

th scan = 9.7211

-0.2, +0.2 61 points

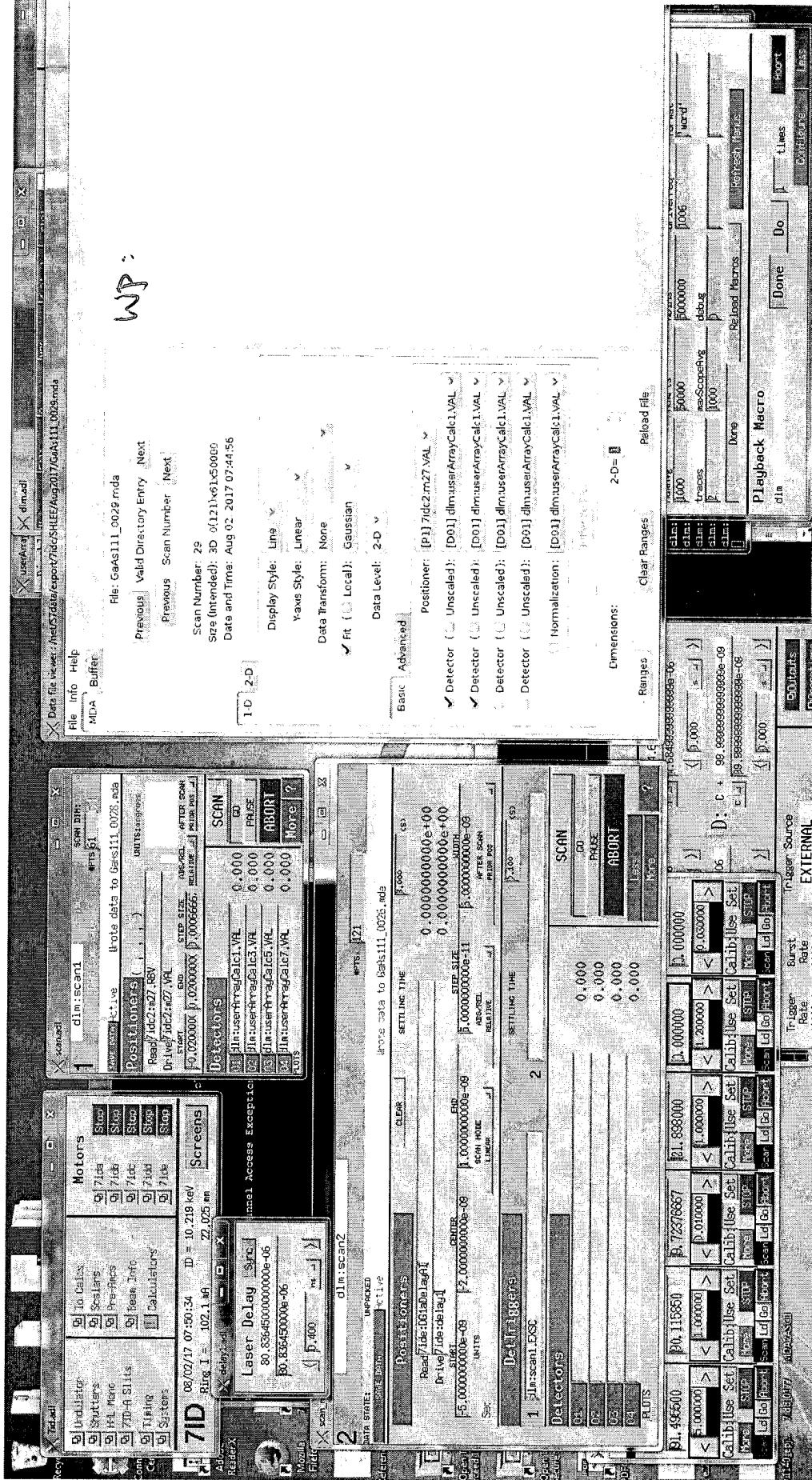
delay scan = $80.84 / 6 \times 10^{-6}$

-5ns ~ 1ns, 21 steps.

When you stop?

Abort th scan first! ABORT Delay scan later.

2-D Scan



again 2-D Scan. "xray filter.
f1(0010)(0000)"

th: 9.7211

-0.02 ~ 0.02, 41 steps.

Delay = 80.8416×10^{-6}

t_{ns} ~ 1ns, 101 steps

"Epics problem, we reboot the program"

Check tTime scan again.

Delay = 80.8416×10^{-6} , th = 9.718.

t_{ns} ~ 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} .

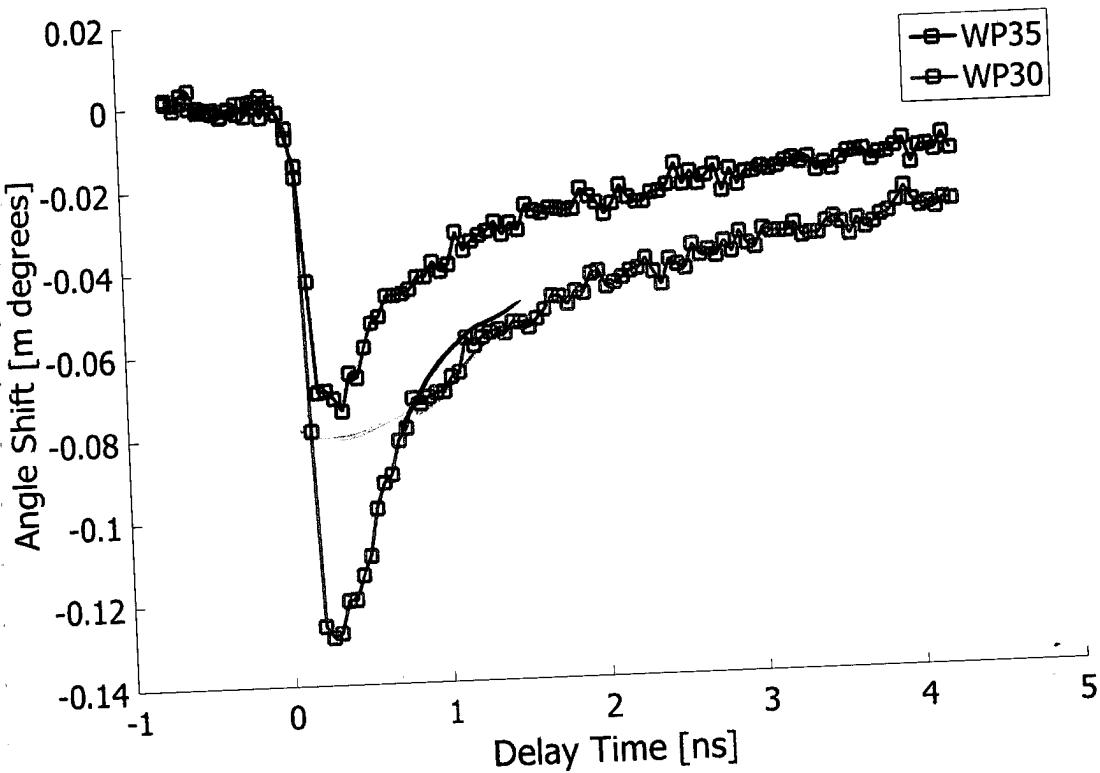
t_{ns} ~ 1ns 101 steps (50ps)

"It may take 4 hours"

~ 1 PM.

Waveplate angle 35°

Next angle 30°



Some Condition with Scan # 32.

#Scan 33. WP = 30.

th: 9.7211, -0.02 ~ 0.02, 41 steps.

delay: 80.8416×10^{-6} . 4ns ~ 1ns 101 steps.

Start at 1PM 2-08-2017⁴

Finish at 5PM.

$\rightarrow 22^\circ$

L8
8.46

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

② Extinction depth \rightarrow (111) 10 keV 0.7 mm

(004) 10 keV 1.6 mm

Scatt

Scan #35 WP: 0 Repeat.

Scan #36 WP: 27.64 Repeat

Scan #37

Verifying the ~~time~~-phi shift behavior

-6×10^{-10} $\sim +4 \times 10^{-10}$, 21 steps
Waveplate 27.64

Scan #38.

Waveplate 30.
 $-6 \times 10^{-10} \sim 4 \times 10^{-10}$, 21 steps

Scan #39.

Waveplate 22.
 $-10 \times 10^{-10} \sim 4 \times 10^{-10}$, 41 steps

Scan #40. $\rightarrow X$

Scan range. $-26 \times 10^{-10} \sim 4 \times 10^{-10}$, 61 steps ~~300~~

Remove ND filter
"Waveplate 30."

Scan #41.

Same with #41

Current Motors $\phi = 91.4955$

$\chi = 90.11585$

$\theta = 0$

$2\theta = 21.898$

$m_1 = 0$

$n_1 = 0$

Scan #108 → half cutting Huber \approx (7.14C : m43)

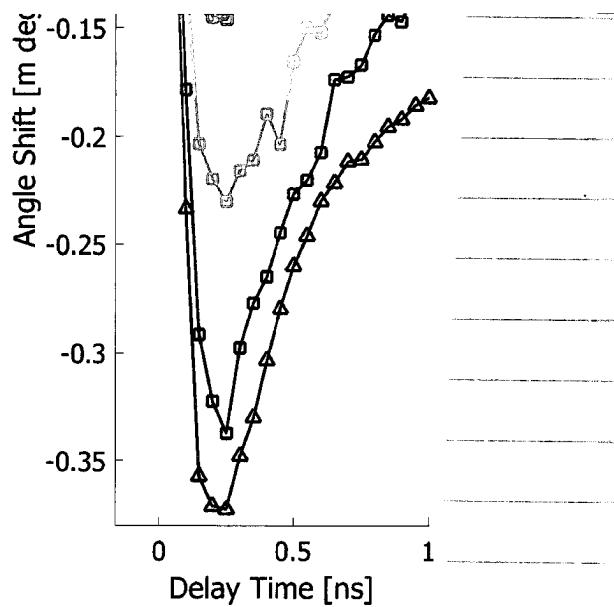
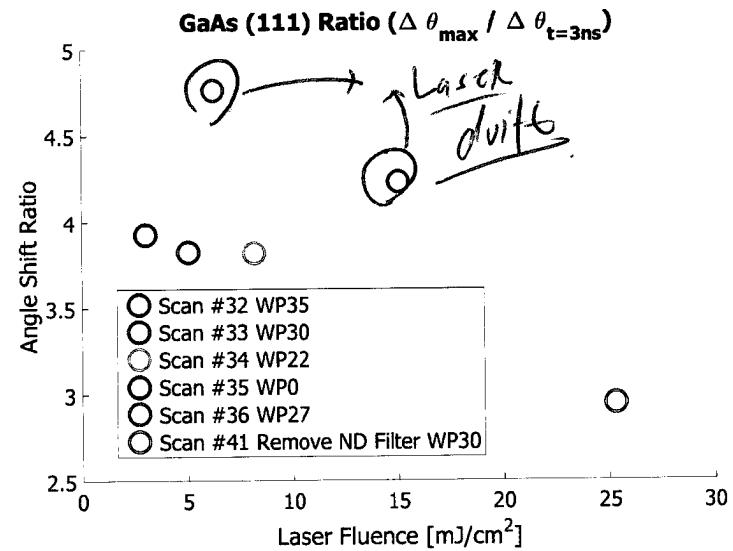
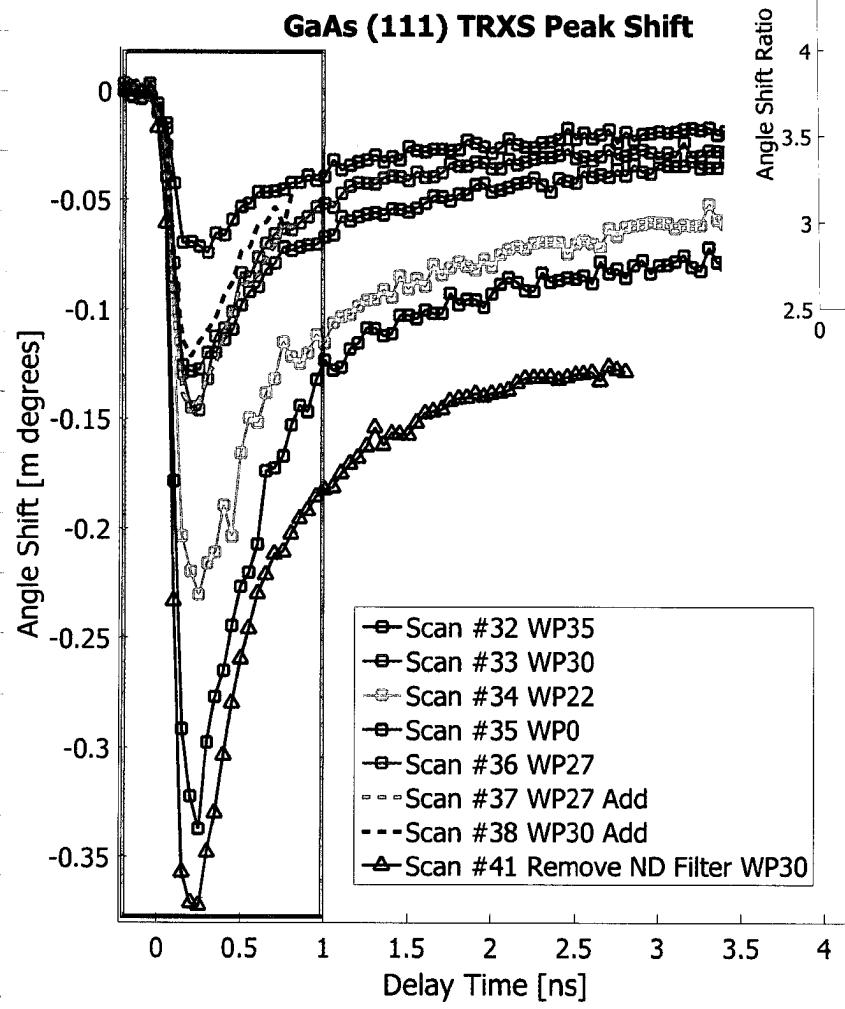
1nd / S7 data / export / 7idc / SMC

→ 8837 μm MUISEZ (Scan #125)

Scan #126 → theta surface scan.

Scan #127 → Repeat above. → - 1.257

$2\theta \rightarrow 52.0329^\circ$ 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*
How to use EPICS interface:

↳ select executor

- 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

→ 7IDC → Tools!
↳ dvew

Scan 1

7IDC

Scan 2

Good data!

Scan 3

scan it first, once.

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

file name chgdc
GaAs004.mda.

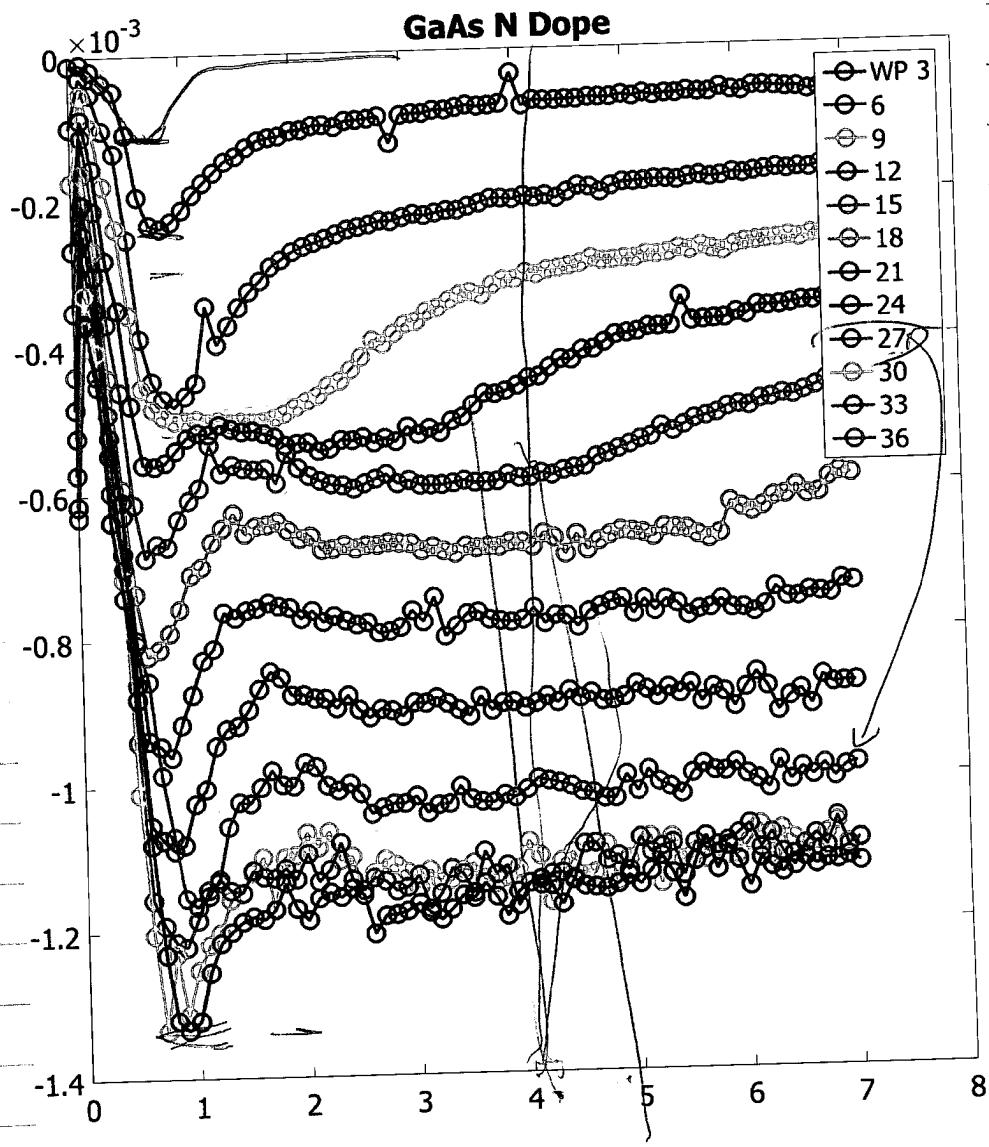
#Scan 1.

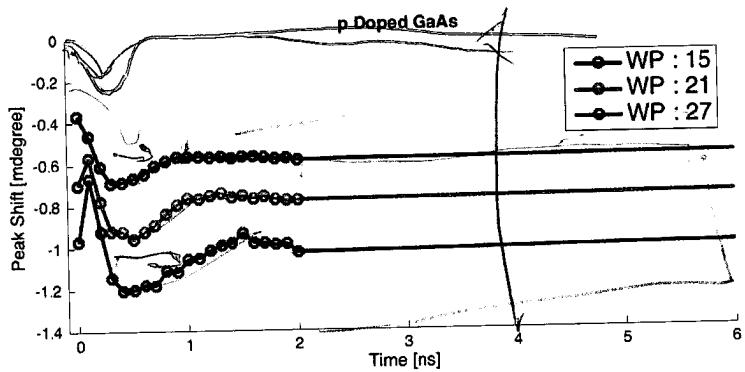
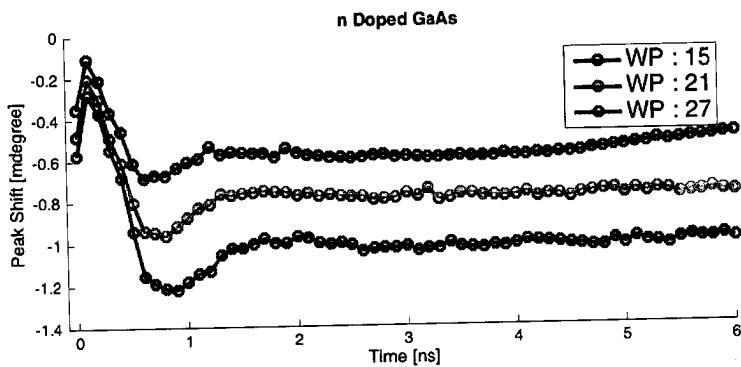
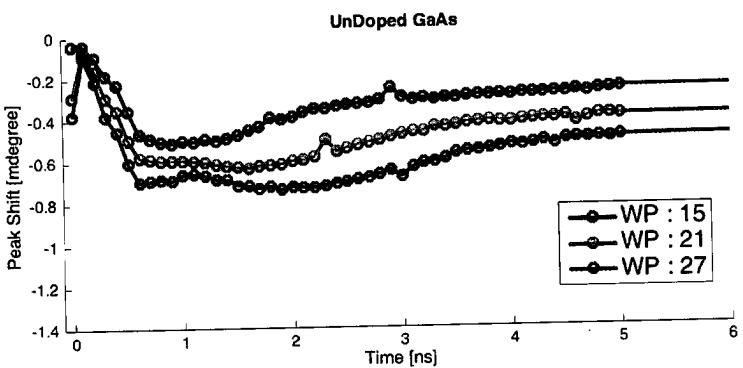
Dely: ~4ns ~ 1ns 100ps steps, 51 points.
(at) 80.8416×10^{-6}

WP: 48 : 0.5

theta: 25.25°
25.05°

detector 5 : laser on
" 3 : laser off





plan for WP

34, 31, 28, 25, 2

Scan #2 WP = 37. : 11, b

Scan

"3-D Scan" Start 7:50 AM

Gats 004-0003.mda

② → delay -6ns ~ -1ns 71 points, 100ps
 $\hookrightarrow 80.846 \times 10^{-6}$ stop

① → th -0.008 ~ 0.008 , 54 points , 0.0003 steps
 $\hookrightarrow 25.052$.

③ → WP 34 ~ 22 , 5 steps.

→ Stop scan?

WP = 34 ; Gats 004b-0021.mda

54 th steps, 71 delay steps.

WP = 31 ; Gats 004b-0022.mda

10:50 PM.

WP = 28 : Gats 004b-0023.mda. 00:58 AM
start.

WP = 25 : Gats 004b-0024.mda 3:06 AM
start.

WP = 7.4 : Gats 004b-0025.mda 5:17 AM
start

Restart Epics !

Ridge wave scan.

scan_mode.adl

1 dim:scan1

DATA STATE: POSTED
SWIVEL DATA: I/O err !! Can't open file GaRs004_0003.adb

Positioners CLEAR SETTLING TIME: 0.106 (s)

Read 7idc2:m27.RBV 25.05872
Drive 7idc2:m27.VRL 25.05903
START CENTER END STEP SIZE WIDTH
0.00800 0.00000 0.00800 0.01500
UNITS degrees SCAN MODE ABS/REL AFTER SCAN PRIORITY POS.
LINEAR +/- RELATIVE +/- PRIOR POS.

Det Triggers SETTLING TIME: 0.100 (s)

1 dim:scanH.DSC 2/7idc1:scaler1.CNT

Detectors SCAN

01 dim:userArrayCalc1.VAL 0.002 GO
02 dim:userArrayCalc3.VAL 0.002 PAUSE
03 dim:userArrayCalc5.VAL 0.002 ABORT
04 dim:userArrayCalc7.VAL 0.002 LOG
PLOTS None

Thu Aug 03 15:32:05 CDT 2017
textEntryValueChanged: Invalid value:
Name: 7idc2:m27.IWV
Value: "#. 016"

scan.adl

2 dim:scan2

DATA STATE: POSTED
SWIVEL DATA: I/O err !! Can't open file GaRs004_0003.adb

Positioners (, ,) UNITS:

Read 7idc1:delay1 8.08357000e-0
Drive 7idc1:delay1 8.08353000e-0

START END STEP SIZE ABS/REL AFTER SCAN PRIORITY POS.

-6.00000000e-09 1.00000000e-09 1.00000000e-10 RELATIVE +/- PRIOR POS.

Detectors SCAN

01 0.000 GO
02 0.000 PAUSE
03 0.000 ABORT
04 0.000 More ?

Delayed Laser Delay Sync
80.8416000000000e-06
80.8416000000e-06
D 1.000

scan.adl

H dim:scanH

DATA STATE: POSTED
SWIVEL DATA: I/O err !! Can't open file GaRs004_0003.adb

Positioners (, ,) UNITS:

Read 0.00000 GO
Drive 0.00000 PAUSE

START END STEP SIZE ABS/REL AFTER SCAN PRIORITY POS.

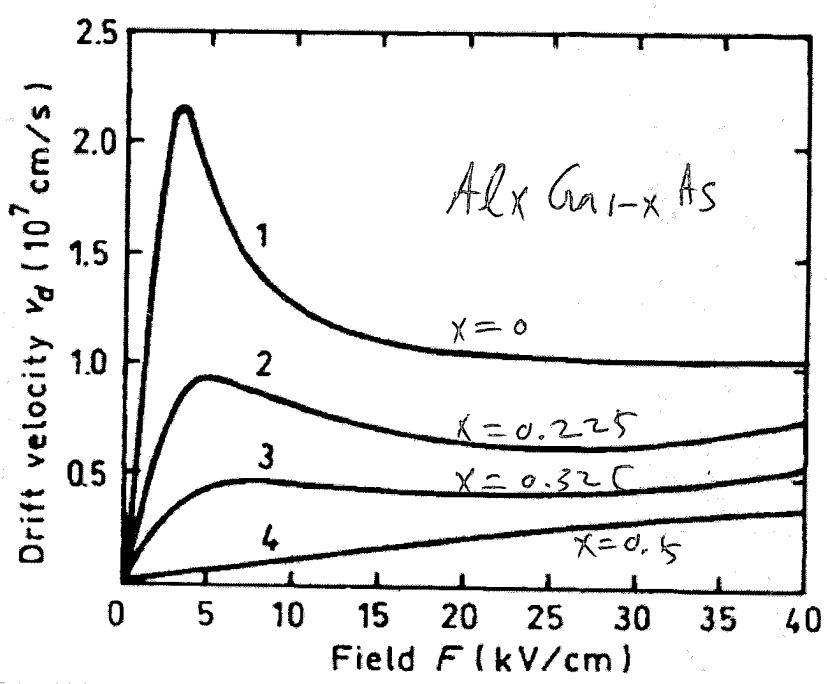
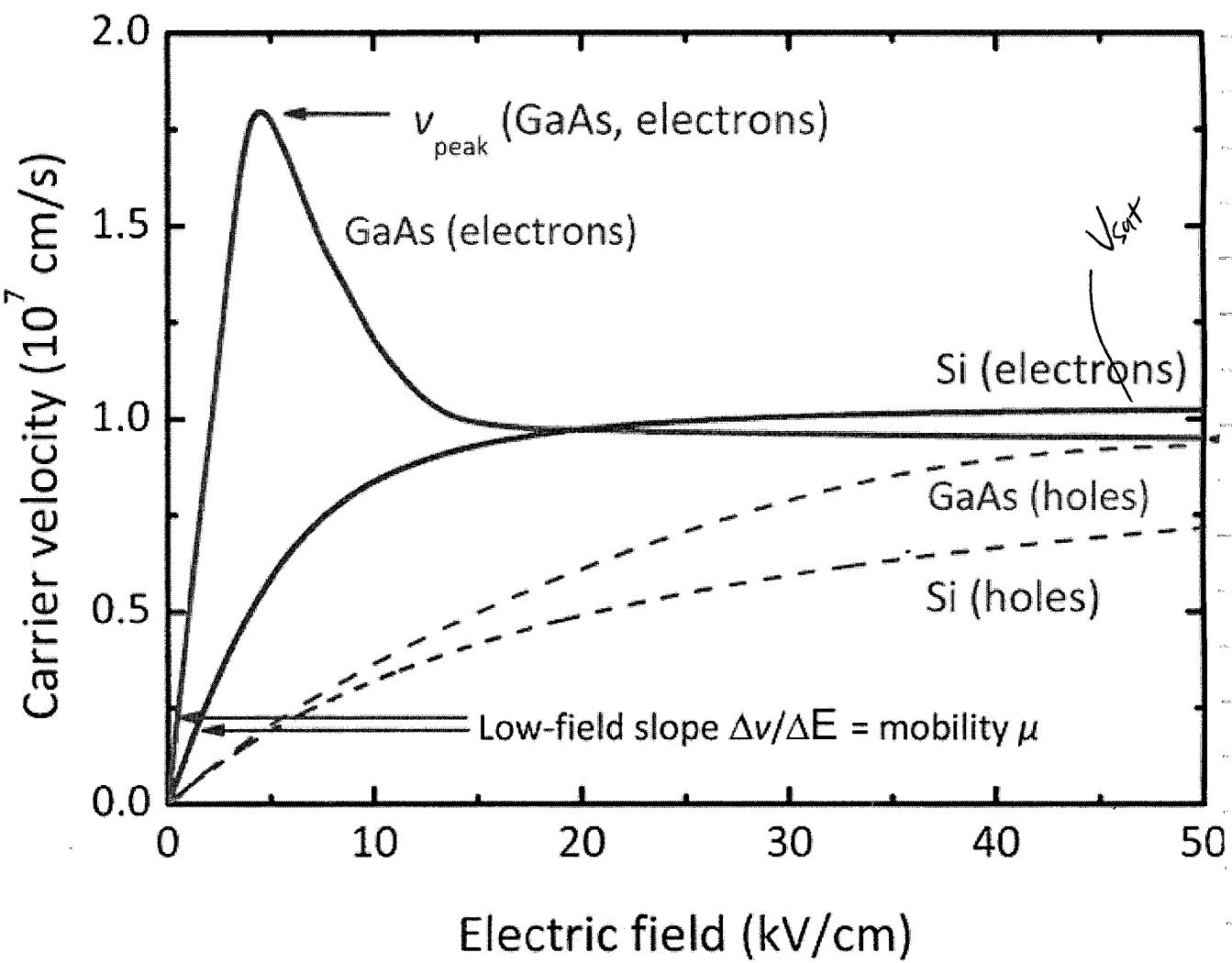
1.10000 0.00000 -1.00010s RELATIVE +/- PRIOR POS.

Detectors SCAN

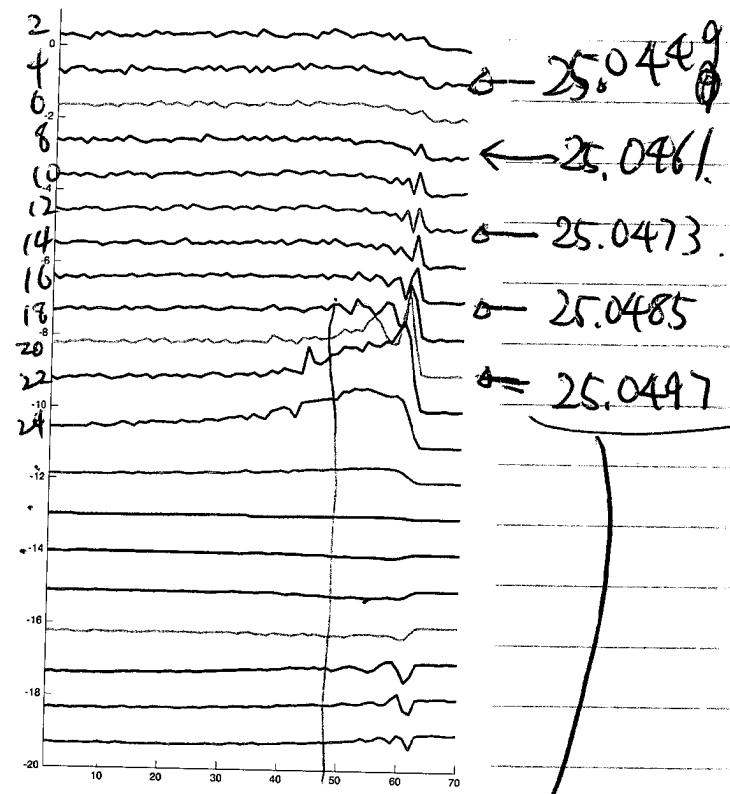
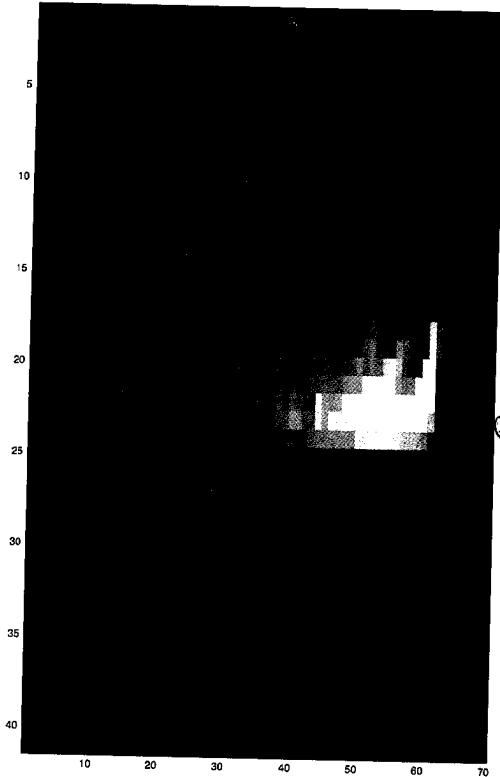
01 dim:die:scal2.RVAL 0.000 GO
02 0.000 PAUSE
03 0.000 ABORT
04 0.000 More ?

PF4 dual filter

7idc1:F2 7idc1:



Scan 23 WP 20. WATTS (40V)



-7.8mdegree

Center = 25.05

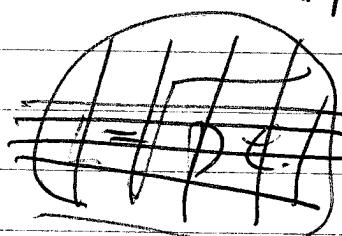
-6.6mdegree - 5.4mdegree, -4.2mdegree, -3mdegree from Center

$$V_{obj} = 80.8416 \times 10^{-6}$$

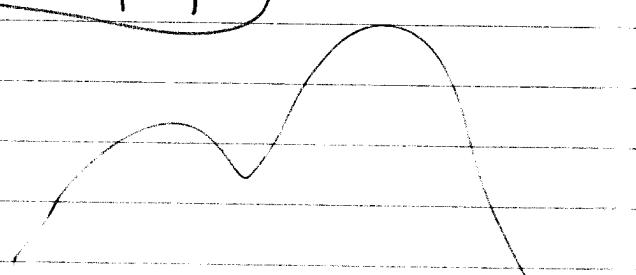
Timedelay Scan.

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

(WP = 26)

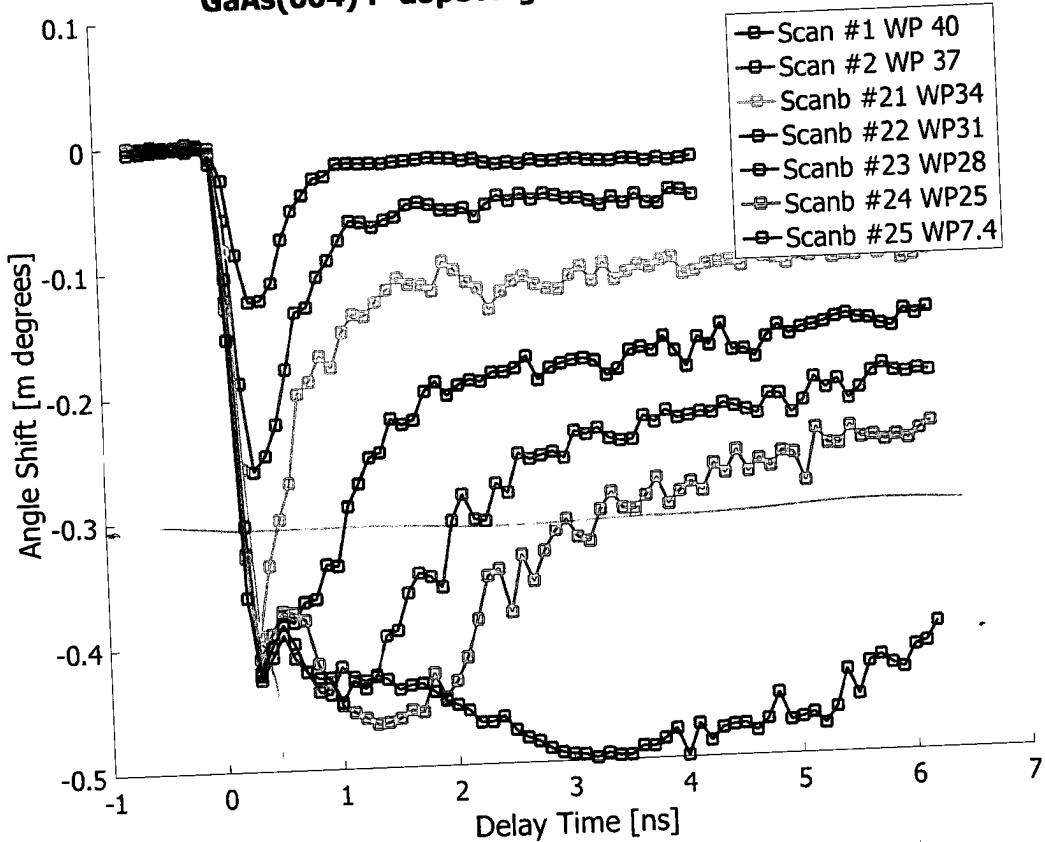


- ① th: 25.0497 # 31.
- ② th: 25.0485 # 32.
- ③ th: 25.0473 # 33
- ④ th: 25.0461 # 34
- ⑤ th: 25.0449 # 35



49

GaAs(004) P-dope Angle Shift (Aug 2017 APS)



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

find (400) peak.

GaAs 004b_00#.mda.
#36. th -0.02 0.02 40.

~~#45~~

#45, #46. Normal Rockey Scan.

th: 24.9181,

FWHM = 2.4 mdegree. Laser off

#47 : Laser ON (WP 27)

