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Prima Metrology Technical Report
COM6 19-28 July 2009

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CHANGE RECORD

Issue	Date	Affected Paragraphs(s)	Reason/Initiation/Remarks
1	21/7/09	All	First issue
2	4/6/10	All	Reformatting and enhanced conclusions are included

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1 INTRODUCTION

This document presents the results obtained during the PRIMET run held between 19/7 and 28/7/2009. Some activities were closely related to the realignment of MARCEL and of the FSUs, which was a prerequisite to proceed with further PRIMET tests as identified during COM4.
Some of these alignment activities are also reported in this report. For detailed information and interpretation of the associated results, the reader shall refer to the FSU documentation.

2 EXECUTIVE SUMMARY

During COM6, the emphasis was put on the verification of PRIMET after the realignment of both Marcel and the FSU ACU following the experience of the previous commissioning.
Unfortunately, only AT3-STS-B was operational. We identified an alignment problem of AT3-STS-A.
In addition, the VCMB of AT4-STS was misaligned and the VCMA piezo cable needed to be repaired (the latter being known before Com6). Finally PRIMET could only be operated in cyclop mode on AT3-STS-B

The main achievement was to successfully operate PRIMET B (cyclop mode only) along the overall stroke of the Delay line, by defining a proper pupil longitudinal offsets for the DL-VCM.

Task list defined for COM6 and associated achievements:

1. **Install and test the repaired fringe tracking board:**

   Status: Done, PRIMETA/B fringe DC, Pk-Pk and visibilities are available on pmacqgui.
   These values can also be recorded in engineering files (lprmacFringe*.txt)

2. **co-alignment of PRIMETA/B FSUA/B**

   Status: done for PRIMET/FSUB; partially done for PRIMET/FSUA (lack of time)
   For PRIMET B on Marcel: the visibility and the flux on IP4 are low (but still OK for calibration). No Ghost , no crosstalk were indentified.
   PRIMET A: The alignment of the FSUA/ACU needs to be optimized prior to a PRIMAT A alignment check. There is a 1-2 mm lateral pupil offset between Marcel and the FSU-BC central patch.

3. **operation of PRIMETA/B through DDL and up to 2 AT-STS**

   Status: done in cyclop mode only, because only AT3-STS-B was operational
   Pupil tracking performed very well with residuals below the specs of std (R)<< 100 μm
   Pupil tracking is not affected if the laser beam crosses the edge of the STS-M10 mirror.

4. **Evaluate the robustness of PRIMET along the overall DL stroke with automatic adjustment of the DL-VCM pressure versus OPL**.

   Status: Done. Tested on AT3-STS-G2-B , DL2,DD4. New P0in defined for DL2 to match optimum pupil re-imaging for PRIMET. PRIMET operated in cyclop mode along the full 60 m stroke of the DL, AT enclosure open. Over the 60m stroke, the PRIMET beam diameter remains within +/- 25 μm.
   We identified a mismatch of about 6 m between the theoretical longitudinal position of the pupil suitable for PRIMET and the calibrated position.

5. **Elaborate and test a procedure to check if the STS_VCM is operating properly if the beam is not retro-reflected from the STS**:

   Status Done. Procedure to be issued

6. **Test PRIMET BTK with the new software version**:

   Status: partially Done.
   Data were collected but are not good enough to characterize the thresholds for PRIMET BTK. Additional data must be taken with a more appropriate modulation amplitude and frequency .(typically fmod=10Hz and Amod=0.01 to 0.05

7. **Operate and check PMCS**

   Status: Not done (lack of time)

8. **Elaborate a procedure for Health check and Day-to-Night**:

   Status: Not done (lack of time)
   (A first version was implemented/tested in Feb'2010)

Additional tasks performed

- Measurement of the straylight originating from the metrology of the DL, DDL and of PRIMET, on the AT-STS TCCD.

  DL/DDL: straylight=spots of about 30 pixels in diameters (~5 arcsec_sky), with ~4000 ADU for DIT=1sec. As of December 2009, this straylight is eliminated by a notch filter installed in the AT-STS. PRIMETB: straylight=diffuse spot superimposed on the DL/DDL straylight. FWHM=25 pixels, with a maximum of 1000ADU for a DIT of 1sec. Impact of the AT-STS notch filter TBC.

- Measurement of the impact of the PRIMET notch filter located in front of IRIS:

  Beam displacement:~ 5 pixels on IRIS (<1 arcsec_sky) along 1 direction. The estimation of the impact of the notch filter on the optical quality was affected by saturation. Measurement to be performed again.

3 SUNDAY 19/7

- Arrival at Paranal
- Verification of the alignment of Marcel on the sighting scopes: MARCEL was misaligned as suspected during COM4 (several PSFs away)
- Tightening of the Marcel roof mirrors
- Alignment of Marcel, IP 2,3,5

(See FSU report)

4 MONDAY 20/7/09

- Check Position of Marcel on IRIS
- Alignment of Marcel, IP 1,4
- Alignment of IFO and IFOA
- Start checking FSUB alignment (HW problem)
- BTK tests on FSUA
  (see FSU report)

FSUA 20/7/09	
enable BTK beam 1 Fiber B	enable BTK beam 2 Fiber B
TTP1 X=-8e-6 Y=11.3e-6	TTP2 X=-437e-6e-6 Y=437e-6
A=5200 (broken fiber)	A=5250 (broken fiber)
B=18300	B=14400
C=12000	C=12600
D=3600	D=3800
Sum (beam 1 only)=39100	Sum (beam 2 only)=36050

5 TUESDAY 21/7/09: CHECK FSUB AND PRIMETB ON MARCEL

Snow at Paranal….access restricted, maintenance/calibration activities have priority.

- Run centroid check on Marcel+IRIS,
- Run BTK test on FSUB
- Verification of the alignment of the ACU
  we look at the footprint of Marcel (red laser) at the output of FSUB
  Ip4, transmitted by FSU_BC: marcel seems **shifted by <1mm** towards AMBER
  Ip2, transmitted by FSU_BC: marcel seems ~OK
- we check metrology fringes on Marcel
  PRIMET B:
  REF B mean 283 mV PP 520 mV Visibility=0.9
  PROBE B mean 336 mV PP 368 mV Visibility=0.55
  Check DC levels (after hiding beam from FSUA to avoid crosstalk)
  DC p pol (IP4) =88 mV → too low, to be checked
  DC s pol (IP2) =198 mV
  Ratio=0.44

No crosstalk ,no ghost are identified

Conclusion: PRIMET B on Marcel. Visibility and flux on IP4 low. Still OK for calibration

- **Alignment of the fibers** of FSUB (lateral position and focus) and **realign slightly ACU** to center TTP2 along Y
- Run BTK on FSU B

FSUB 21/7/09	
enable BTK beam 1 Fiber B TTP1 X=-256e-6 Y=124e-6 A=10600 B=12000 C=9650 D=7650 Sum (beam 1 only)=39900	enable BTK beam 2 Fiber B TTP2 X=-20e-6 Y=224e-6 A=9050 B=8400 C=9950 D=10800 Sum(beam 2 only)=38200

- We verify that after the ACU alignment and BTK, the PRIMET fringes are still ~ as before.

6 WEDNESDAY 22/7/09

6.1 Verification of the Alignment of FSU A

Preparation of FSU A for verification of its alignment

First we do BTK on FSU A

FSUA wed 22/7/09	
enable BTK beam 1 Fiber B TTP1 X=1.3e-6 Y=23.5e-6 A=5300 (broken fiber) B=18100 C=12000 D=3400 Sum (beam 1 only)=38800	enable BTK beam 2 Fiber B TTP2 X=-443e-6 Y=443e-6 A=5200 (broken fiber) B=14500 C=12800 D=3100 Sum (beam 1 only)=35600

we find similar values compared to Mo.22/7

Check the shadow of the central patch of the FSU-BC using Marcel and the red laser

beam 1 (ip3) : OK

beam 2(ip1) : shadow of the central patch of the FSU-BC **too low (1-2 mm)** and towards right **(0.5 -1 mm)** as seen towards the FSU entrance

Check the superimposition of beam 1 and beam 2

beam 2 (ip1) shifted towards AMBER and up compared to beam 1(ip3) by **1-2 mm**

we decide to leave the alignment of the FSUA ACU as it is considering that PRIMETA is not yet used on the AT-STS with the quadcells.

6.2 Finalization of the alignment of the FSUB fibers and of the cold camera

we align the ABCD fibers and. check the cold camera:

The fiber bundle of the cold camera is adjusted to optimize the KW, using halogen lamp at the input of the FSU beam1 (before FSUBC). The focus of the fiber bundle was also adjusted. We use the lamp directly in front of the fibers to eliminate flux variation due to the turbulence in the lab.
We optimize the total flux and then we shift again the bundle to increase the flux on K5 D, which was initially too low.

BTK on the SUM with 2 beams provides a total flux (i.e. with beam 1 and beam 2): **~102 000 ADU**

Check Pivot Points
before we need to run the calibration template.
The results indicate a ~**Phase error of 200nm PP** with BTK amplitude (measured by the FSUB)

6.3 Finalization of the alignment of the FSUA fibers

Alignment of the Fibers ABCD

FSUA wed 22/7/09 (after alignment)	
enable BTK beam 1 Fiber B	enable BTK beam 2 Fiber B
TTP1 X=1e-6 Y=18e-6	TTP2 X=-434e-6 Y=451e-6
A=6300 -> corresponds to broken fiber	A= 4900 -> corresponds to broken fiber
B=18100	B=14450
C=15250	C=13600
D=10600	D=10600
Sum (beam 1 only)=50250	Sum (beam 2 only)=43550
Gain of 30% compared to section 6.1	Gain of 20 % compared to section 6.1

Cold camera alignment using the halogen lamp in front of the FSU fibers
total flux ~ 90000 ADU

7 THURSDAY 23/7

7.1 Checking FSUA and FSUB calibration

- FSUA CALIBRATION is ready and valid
- FSUB CALIBRATION is ready and valid

Linearity tests indicate that FSUB is not as linear as FSUA. The calibrated phases of FSUB are not as good as for FSUA.

7.2 PRIMETB observation in cyclop mode on AT#3-G2

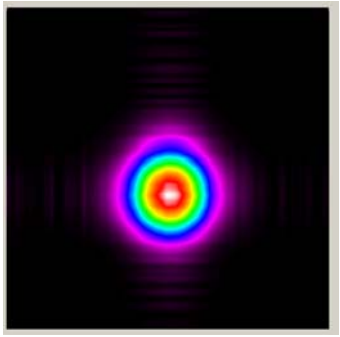
7.2.1 Initial Configuration

Put all systems online including DDL
Use configuration of COM4

Date	Config	DL	DDL	DL-VCM-Curv	STS-VCM Curv
COM4 Mar'09	Ip2-BC-DDL8-DL#2-B-AT#3-G2	30m	?	Theory: 8.888776e-004 mm-1 (ROC= 1125.01mm) Real:20.32e-4 (0.8bars)	Theory: -1.367396e-3 (ROC=-731mm) Real: INF (flat)

Configuration AT#3 on IP2	
AT#3-STS	G2-Beam B
FSMB	12,12
VCMB	21.8 23.8 C= Fixed to FLAT (theoretical value C=-1.367396e-3 or ROC=-731mm)
DL#2	OPL=30m VCM 0.002032 (0.8 bars) instead of ComputeVCMParametersATBC('UT2',2,2,15,0,-1)= 8.88e-004 mm-1
M16	DL#2-2AT (to feed Beam B in ip2)
Switchyard	SW2->BC-DDL (db=230404) and not 230365 which was used in COM4
DDL	DDL2 at OPL~0
Ip	Ip2
Primet Pol	S Quadcell 3

7.2.2 Comparison Ip4 and Ip2 on AT#3-G2-Beam B (by switching the M16)

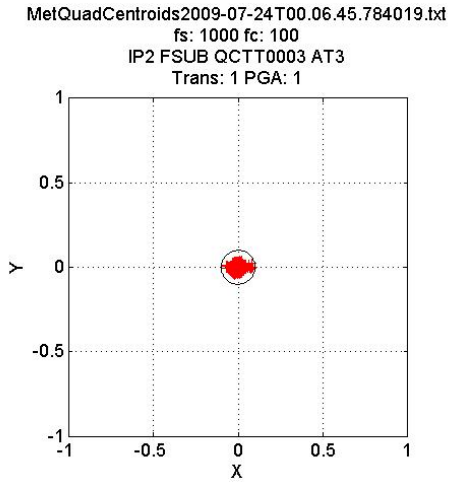
ip4 (M16 DL2->4AT)	**Ip2 (M16 DL2->2AT)**
FSMB 12,12 we guide on VCMB 19.9, 19.5  Power:44 mW Centroid X=-25.2 Y=-335 ϕ~1254 μm; ε=0.93	FSMB 12,12 we recenter the beam with the vcm on 21.8 22.5 we guide on VCM B 21.85 22.30  Power:55 mW Centroid X=-3.5 Y=-414.6 ϕ~1104 μm; ε=0.959

By comparing the position of the returned beam in closed loop as measured on the beam profiler, we can estimate the beam lateral displacement between the 2 quadcell : δ=sqrt((25-3.5)^2+(335-414.6)^2)=**82.45 μm**

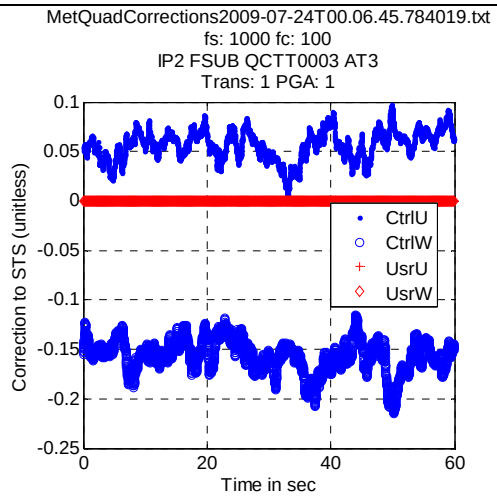
7.2.3 Data recording in cyclop mode: AT#3-G2-B-DL2-DDL2-ip2 and Marcel-Ip4

Enclosure configuration: unkown...
DL2 position: 30m
Pmpsd: closed loop.

MetQuadCentroids2009-07-24T00.06.45.784019.txt
MetQuadCorrections2009-07-24T00.06.45.784019.txt




```
Radial: Pk= 7.936869e-002 p
rms= 7.795765e-003 p p
```




```
IP2 IM Gain A1 A2 B1 B2
    1 0 0 -1 0.015 0 0 -1 0
```

lprmacPhaseMeter2009-07-24T00.06.30.467927.txt
lprmacPhaseMeter2009-07-24T00.07.15.320927.txt
lprmacPhaseMeter2009-07-24T00.07.58.021427.txt (44Mb !)

- ⇨ looks that we forgot to switch off the FSU square modulation ??
- ⇨ ,modulation amplitude ~32 microns PV

files OK
****

Phase Meter Data
==> Filename: lprmacPhaseMeter2009-07-24T00.07.58.021427.txt
Sampling frequency= 8000 Hz
Number of samples= 600000
DeltaL Mean= 2.404211e-006 m
DeltaL PV= 3.195440e-005 m
DeltaL rms= 1.413536e-005 m
Status Not OK: 0

8 FRIDAY 24/7/09

DL calibration was not done in the last 3 days.
The maintenance team is using the DL tunnel until from 12h00

8.1 Test of the fringe board

Modification of the SW of the fringe board (the channels read by pmacq were shifted by 1)

Tests:
Connecting a function generator to the fringe board: the measured DC is 2x larger than the DC of set on function generator. The measured RMS is OK.
In parallel with FSU calibration, we checked that the DC measured by the board and by the phasemeter are the same

RMS oscillo: need to remove the DC to get proper standard deviation measurement
Phase meter connected to oscillo (1MOhm) and fringe board (also 1 Mohm)
Both gives same results for all channels
Also we checked that function generator (50 Ohm) connected to the fringe board (1 MOhm) gives the same results for all channels

➔ The FRINGE BOARD IS OK

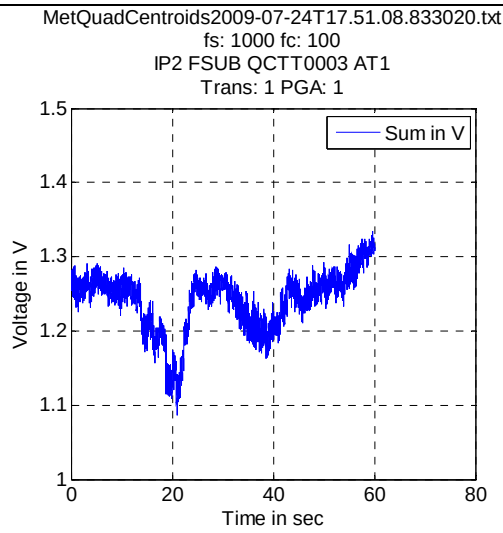
8.2 PRIMET BTK tests on AT#3-G2-B-DL2-DDL2-ip2

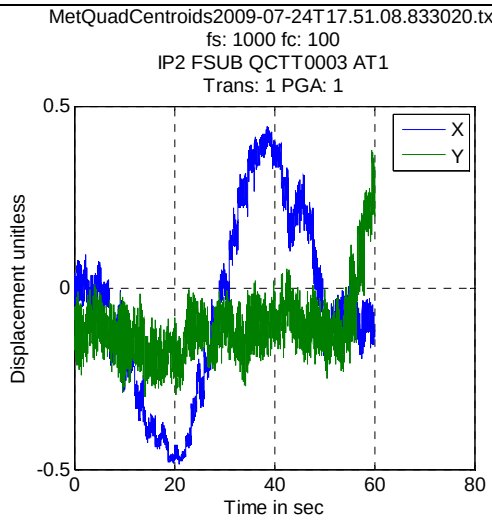
we check again that the pupil tracking is working on AT#3-STS-G2 using IP2 as yesterday.
Initial problem due to wrong operation: AT3 not selected to receive VCM offsets from pmpsd
Operational issue:
After beam search: The values of the vcm are stored in pmpsd and used for the next tracking.
If they are not reset, you may jump to wrong value depending on the history of the manual alignment offsets done on the pspzgui.

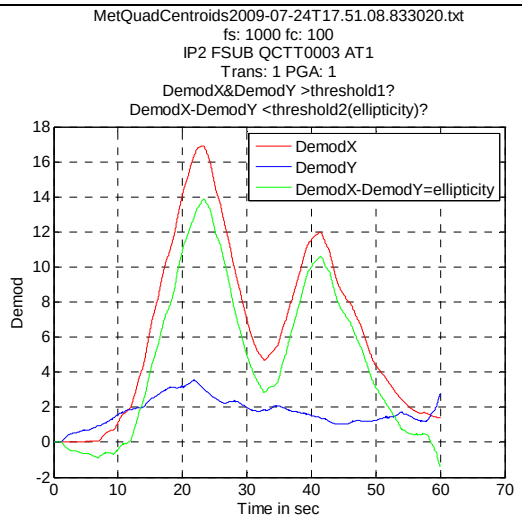
MetQuadCentroids2009-07-24T17.51.08.833020.txt

Closed LOOP but AT1 and AT2 selected !!! so it is equivalent to open loop ?
Circular modulation defined in correction file: circular modulation sent ...to AT1
beamDetAmplitude=0.1
beamdetFrequency= 1Hz
BeamdetFilterTau=??

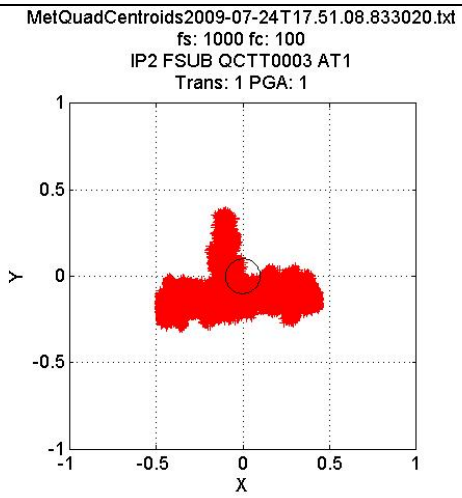
Operational issue: ***No modulation on the centroids but DEMODX and DEMODY are still giving data that could be interpreted as valid ! so it is not sufficient to look at DEMOD and at the correction file to make sure that everything works correctly !***
Demod on the Noise ?





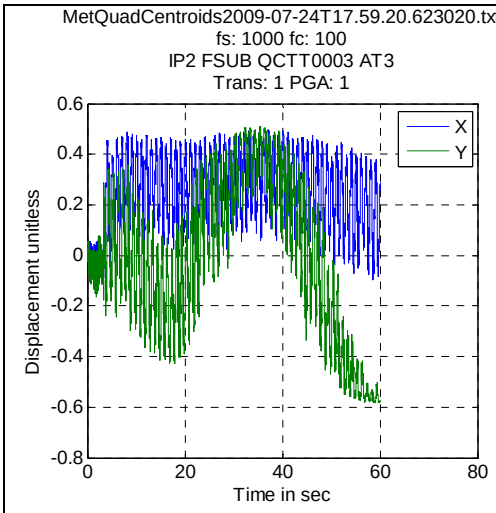


DEMODX and DEMODY giving "valid"data but without modulation! Only manual VCM alignment offsets

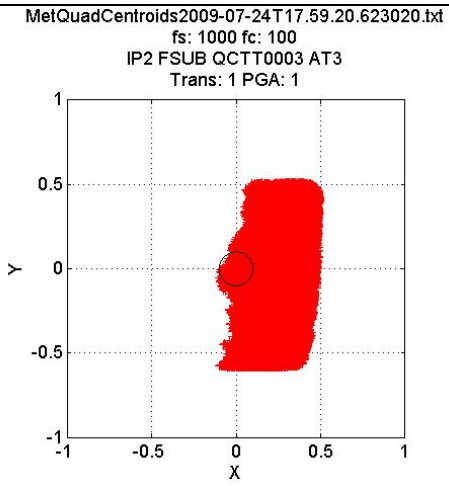


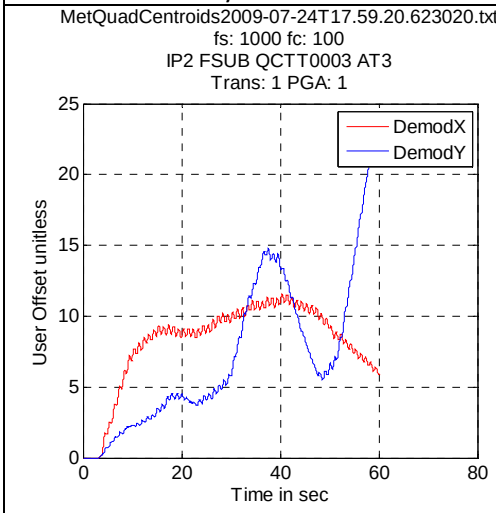
Displacement of the beam using VCM alignment offsets

MetQuadCentroids2009-07-24T17.59.20.623020.txt
CLOSED LOOP using AT3 on IP2
beamDetAmplitude=0.1
beamdetFrequency= 1Hz
BeamdetFilterTau=??
Modulation seen on the centroids



Modulation clearly visible in the centroids





Modulation frequency still visible: TBC if this can be used as a signature that the modulation is really performed ? or is it resulting from the time constant selected for this test.

8.3 Attempt PRIMETB Observation on AT4-STS-J2-B-DL4-DDL4-IP4 : misalignment of AT4-VCMB

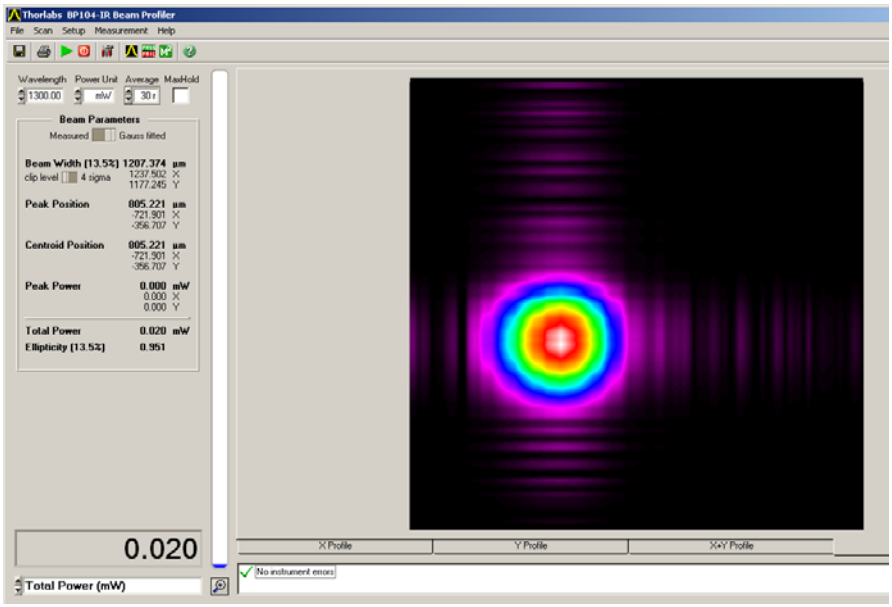
FROM COMM4

Configuration AT#4 on Ip4	
AT#4-STS	J2-Beam B
FSMB	12.9 ; 12.7
VCMB	21.6; 23.6 (off 2.6 4.6) C= 4.7 e-3mm-1 (1.93 bar) (= theoretical value)
DL#4	OPL=14m VCM =ComputeVCMParametersATBC('UT4',4,4,7,0,-1)**= 5.820640e-004 mm-1 (i.e No offset) (theoretical value)**

M16	DL#4-4AT (to feed Beam B in ip4)
Switchyard	SW4->BC-DDL(DB 222002) or encoder value 221818
DDL	DDL7 at OPL~0
Ip	Ip4
Primet Pol	P Quadcell 4

After a lot of effort we finally get the beam using:
FSMB 9.899; 14.397
VCMB 19.6; 1.6 (Close to limits !)

Beacon seen on IRIS-Q3 with derota at zero and M6 at (1.5;-1) in arcsec
instead of centered position (1.5;1) arcsec



We center the beam on the quadcell using VCMB[18.1;0.45]….very closed to the limit.
try to close the loop but it fails…
worked with IM 1000 but failed with IM 100-1 or 1001…..!
also vcm very closed to the limit on Y : (is it still linear ?)

ON AT4-STS:

- VCMB is misaligned
- VCMA piezo cable needs to be repaired (already known before Com6)

AT4-STS cannot be used for PRIMET test.

9 SATURDAY 25/7/09

9.1 Check Marcel after swap of dichroics IFO's

swap on 24/7; we noticed that Q3 had moved. But not corrected on 24/7
25/7: realignment of the IFO IP1 Q3
(all others were OK)

Config FINITO/AMBER
Filter K
IFOA dichroics IFO mirror
Q1beam B IP3= 64.07 64.44
Q2 beam A IP1= 64.54 63.78
Q3 Beam IP5= 63.64 64.31

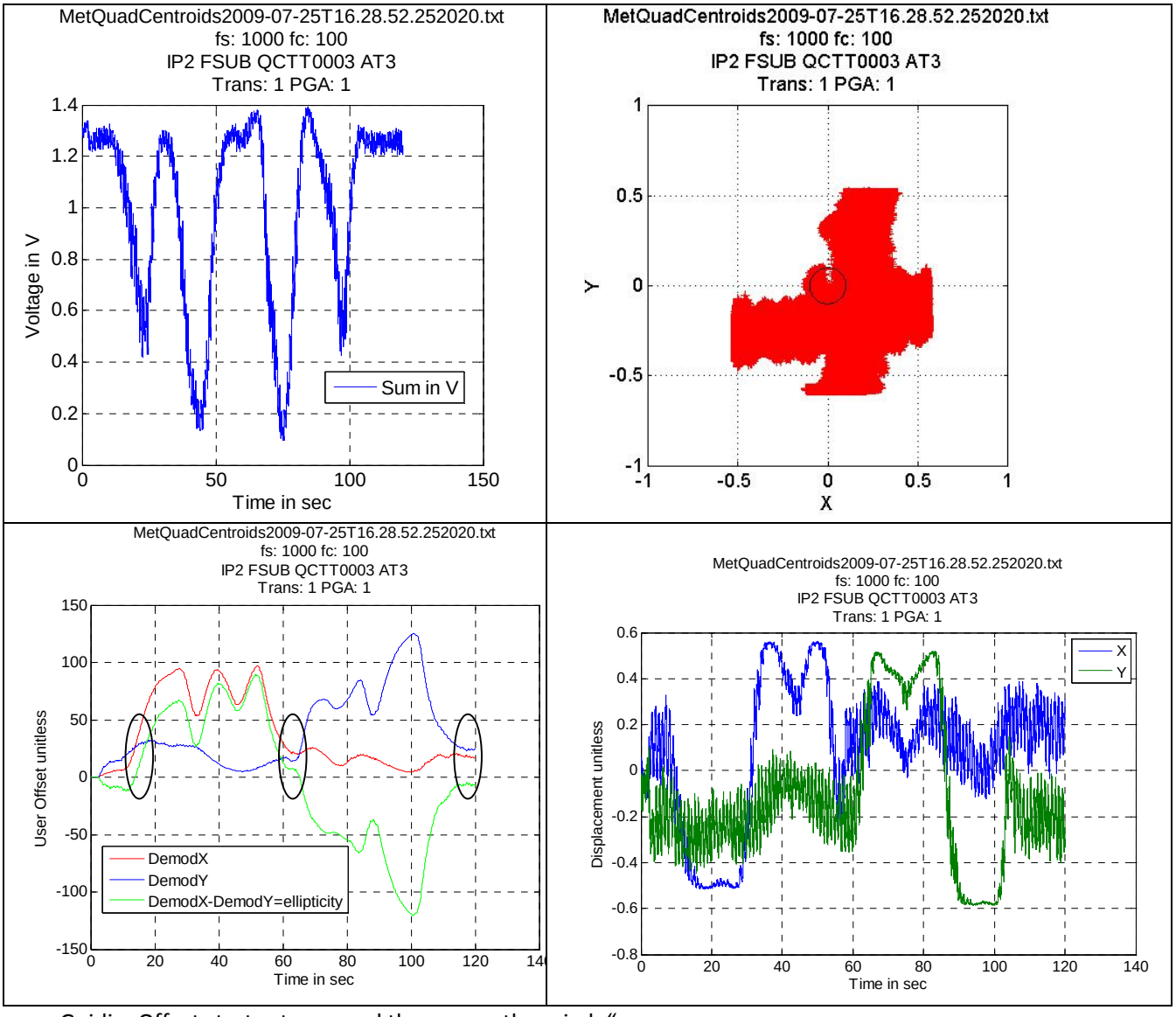
Config PRIMA
Filter H
IFOA mirrors IFO dichroics
Q1beam B IP3= 63.55 63.62
Q2 beam A IP1= 63.94 63.84
Q3 beam F IP4= 63.97 64.35
Q4 beam E IP2= 64.49 64.19

9.2 Test of PRIMET BTK with new parameters: AT3-STS-G2-B-DL2-DDL2-IP2

We use the same configuration as on Thursday 23/7

Configuration AT#3 on IP2	
AT#3-STS	G2-Beam B
FSMB	12,12
VCMB	21.85 22.30 C= Fixed to Flat (theoretical value C=-1.367396e-3 or ROC=-731mm)
DL#2	OPL=30m VCM 0.002032 (0.8 bars) instead of ComputeVCMParametersATBC('UT2',2,2,15,0,-1)= 8.88e-004 mm-1
M16	DL#2-2AT (to feed Beam B in ip2)
Switchyard	SW2->BC-DDL(db=230403)
DDL	DDL8 at OPL~0
Ip	Ip2
Primet Pol	S Quadcell 3

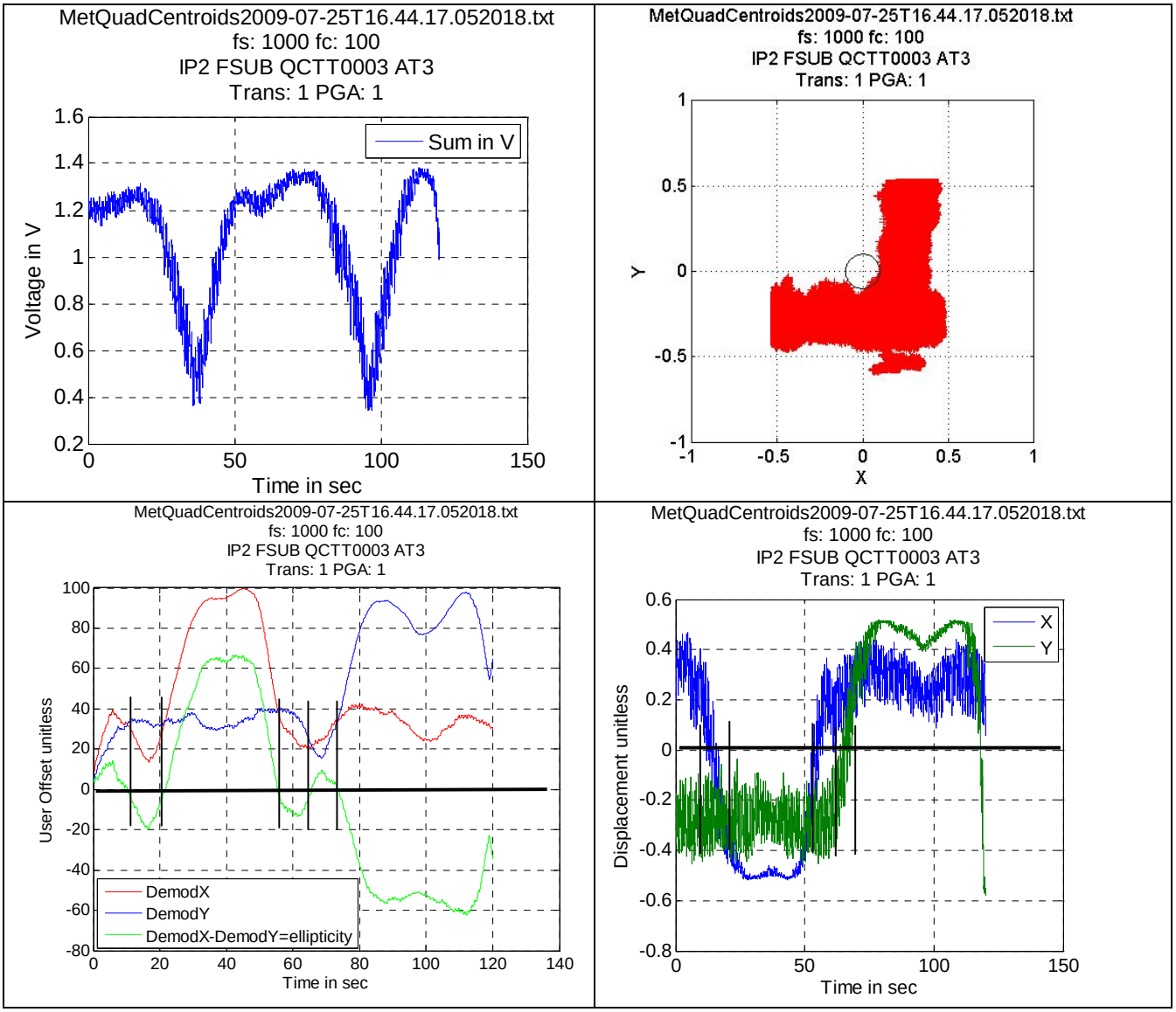
beamDetAmplitude =0.05
beamDetFiltertau=0.5
Modulation frequency: 1 Hz !! only...
MetQuadCentroids2009-07-25T16.28.52.252020.txt



userGuidingOffset starts at zero and then go on the „circle“
->Ellipticity must be closed to zero (abs<10). DemodX and DemodY must be non zero but not too large (<30)

beamDetAmplitude =0.05
beamDetFiltertau=0.25
Modulation frequency: 1 Hz !! only...
MetQuadCentroids2009-07-25T16.44.17.052018.txt

userGuidingOffset starts directly on the circle

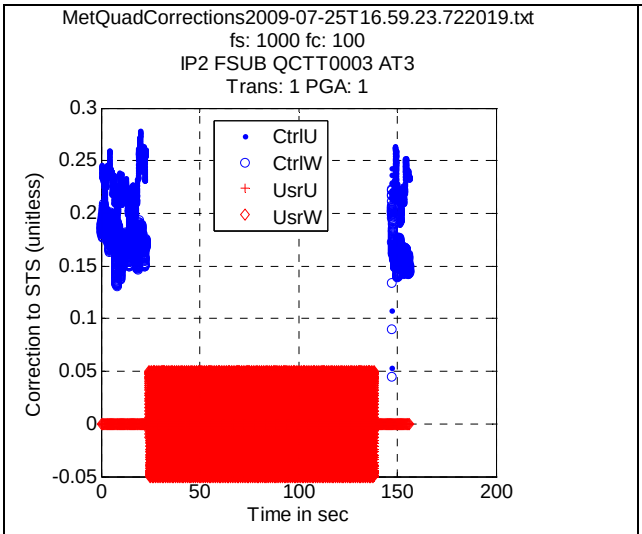


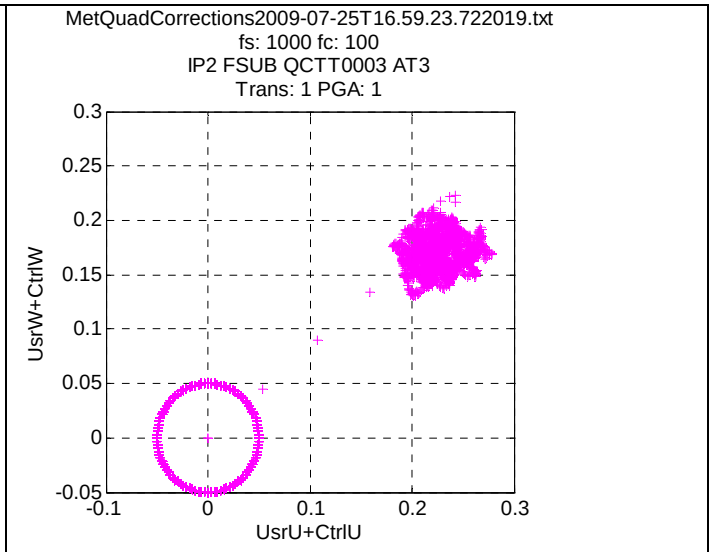
To be investigated: Why demodX is large when there is saturation ((30 to 50 sec)?

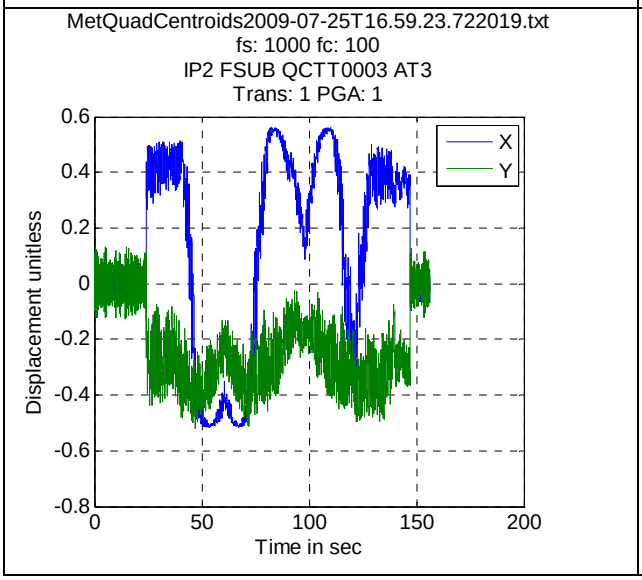
STRTMPO
STARTENG
STOPMPO

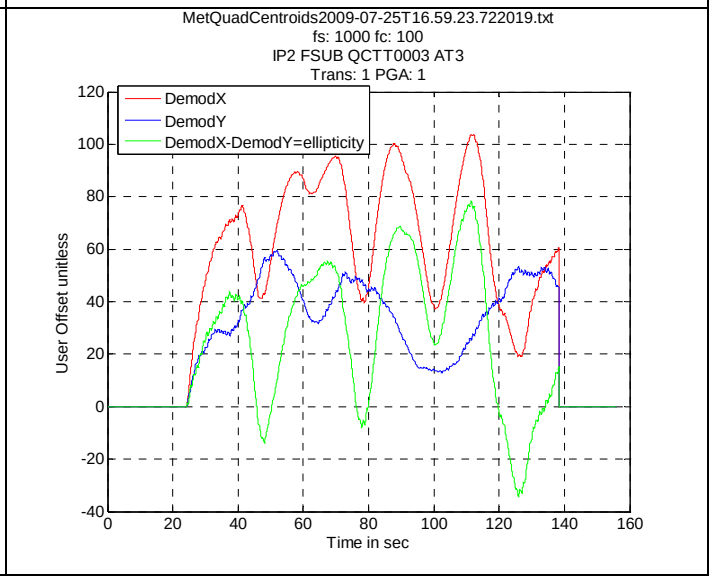
Start Beam search (engineering mode) with 120sec ~modulation at 1 Hz (amplitude 0.05)
During modulation, move manually along X only by sending alignment offsets to the STS-VCM
Stop beam search

STRTMPO
STOPENG
MetQuadCentroids2009-07-25T16.59.23.722019



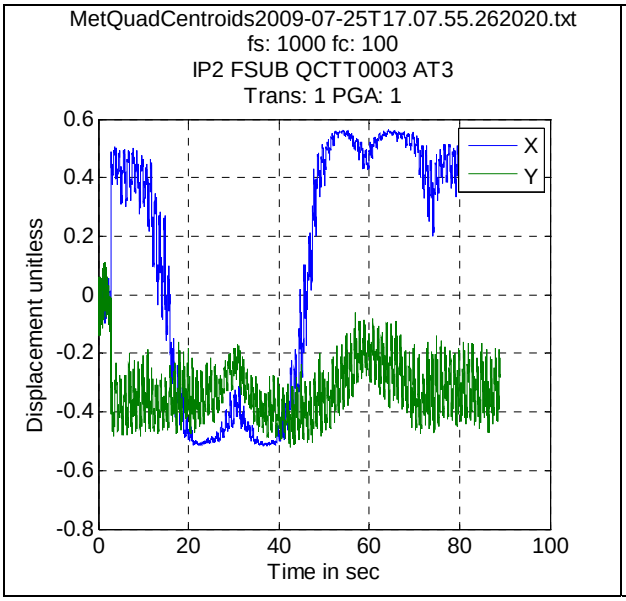


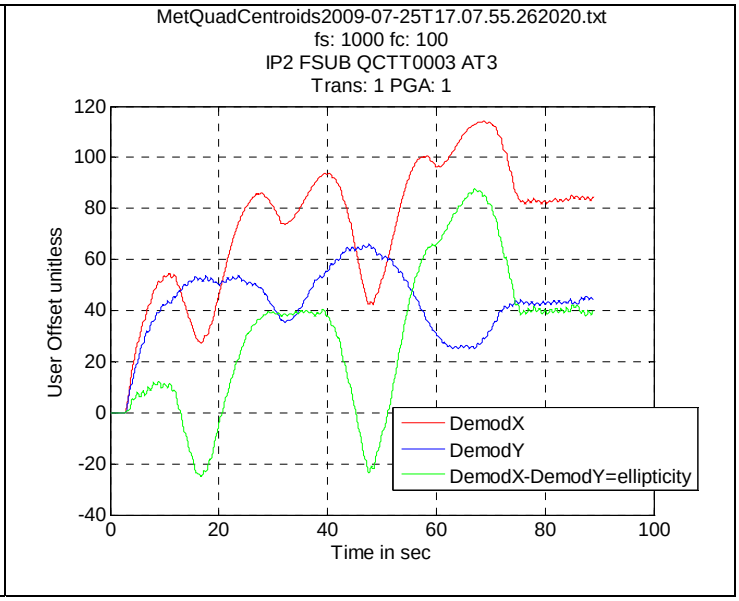




- need to bring to center with alignment offsets because modulation always starts around (0,0)

beamDetAmplitude =0.05
beamDetFiltertau=0.5
Modulation frequency: 1 Hz !! only...
MetQuadCentroids2009-07-25T17.07.55.262020.txt
beam still jumps (in this case to X=0.4 Y=-0.4) when we start modulating





another try
MetQuadCentroids2009-07-25T17.30.55.072019.txt
it's the same.
To be checked

9.3 Conclusion of the BTK tests

BTK Data summary

24/7/09
MetQuadCentroids2009-07-24T17.59.20.623020.txt beamDetAmplitude=0.1 beamdetFrequency= 1Hz
25/7/09
MetQuadCentroids2009-07-25T16.28.52.252020.txt beamDetAmplitude =0.05 beamDetFiltertau=0.5 Modulation frequency: 1 Hz !! only...
MetQuadCentroids2009-07-25T16.44.17.052018.txt beamDetAmplitude =0.05 beamDetFiltertau=0.25 Modulation frequency: 1 Hz !! only...
MetQuadCentroids2009-07-25T16.59.txt Sequence: STRTMPO STARTENG STOPMPO Start Beam search (engineering mode) with 120sec ~modulation at 1 Hz (amplitude 0.05) During modulation, move manually along X only by sending alignment offsets to the STS-VCM Stop beam search STRTMPO STOPENG
MetQuadCentroids2009-07-25T17.07.55.262020.txt beamDetAmplitude =0.05 beamDetFiltertau=0.5 Modulation frequency: 1 Hz !! only...

The data were taken with inappropriate modulation parameters to possibly determine sensible detection thresholds.
When perfectly centered, the beam can move by 750 microns before reaching the edge of the FSU patch (Beam diameter=1000 microns; FSU patch diameter= 2500 microns). This corresponds to a command of 0.55 micron_piezo (using a theoretical sensitivity of 1370micron/micron_piezo).
So the modulation should be at least 10 times lower, i.e. ~0.05 or even lower

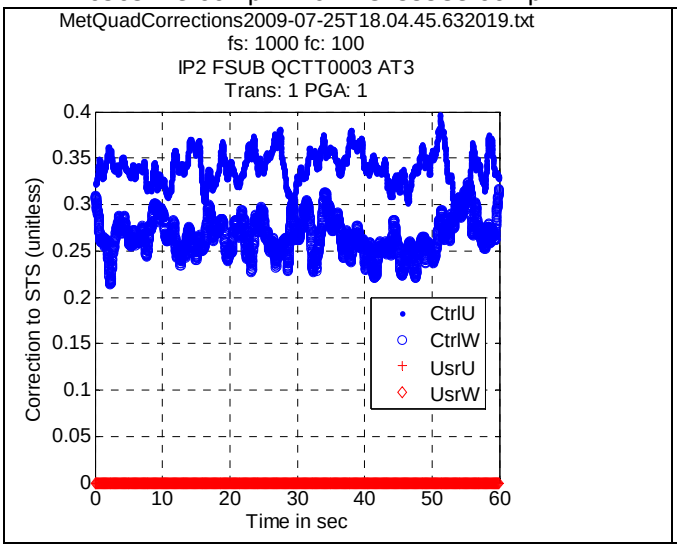
The modulation Frequency shall be larger than 10 Hz (frequency region where turbulence is quieter) and shall be different from any mechanical eigenfrequency of the system. In addition it has to be compatible with the maximum sampling of ~100Hz. So with fmod=10Hz, there will be 10 measurement points per modulation circle

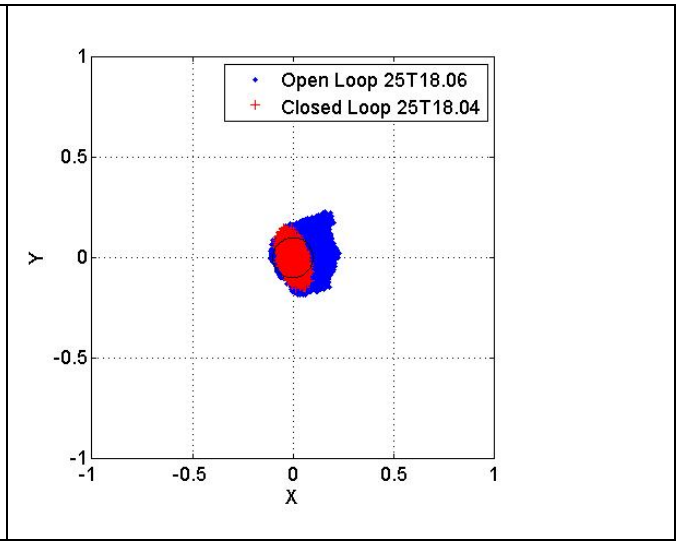
Operational issue:
After beam search: The values of the vcm are stored in pmpsd and used for the next tracking.
If they are not reset, you may jump to wrong value depending on the history of the manual alignment offsets done on the pspzgui.

Operational issue: No on the centroids but DEMODX and DEMODY are still giving data that could be interpreted as valid ! so it is not sufficient to look at DEMOD and at the correction file to make sure that everything works correctly !
Demod on the Noise ?

9.4 Comparison of pupil tracking Open/Closed loop during day-time

Operational Issue:
SWAP in dbcfg is still there
applied for AT3 but not for AT4
X motion on the quadcell , send correction to the Ycontroller of the piezo which was wired to the physical piezo X axis.
Now if the cable swap is not there anymore….we should have to change the interaction matrix ???
(plus in luigi's pspz, the station position north/south is indicated. But he confirms that no sign is applied for PRIMET guiding offsets)
2 files Open loop and closed loop with AT#3 during day-time over 60 sec
(DL2 at 30 m)
Closed loop
MetQuadCentroids2009-07-25T18.04.45.632019.txt
Pk= 1.820822e-001 p rms= 2.359619e-002 p
IM 1 0 0 -1
Gain 0.015
Open Loop
MetQuadCentroids2009-07-6.11.562019.txt
Pk= 2.656314e-001 p rms= 4.825998e-002 p





9.5 Check DL-VCM tracking on AT3-G2-DL2

9.5.1 Definition of the output pupil for AT#3-G2-DL#2 using a flat VCM

Using STS_VCM_Samuel.m: Determine theoretical ROC for the AT-STS VCM for the station G2

Station G2 Delay Line DL#2 STS DATA FDE ********** VCM_STS ********** V-Offset to station center OFS 3.987000e-001 (m) STS VCM ROC is: -7.446345e-001 (m) STS VCM curvature is: -1.342941e-003 (mm-1) Pout is: 3.214870e+001 (m)	Station G2 Delay Line DL#2 STS DATA VLT-SPE-ESO-15736-3186 issue 2.8 april 2007 ********** VCM_STS ********** V-Offset to station center OFS 3.987000e-001 (m) STS VCM ROC is: -7.313170e-001 (m) STS VCM curvature is: -1.367396e-003 (mm-1) Pout is: 3.214870e+001 (m)

Effect of Flat VCM on AT3-STS: The STS reimages the pupil at Pout=8.6664 m.
Origin of the result:
1.Use STS_VCM.m and scan "UTOutPupilu" until ROC converges to infinity.
2. check com 2 report where we found that for AT3-G2: Pout(m)=-17200.VCM_curv(mm-1)+8.6664. For curv=0, Pout=8.6664 !

VCM ROC installed on AT#3-G2 DL#2: Curvature=0 (ROC=Inf).

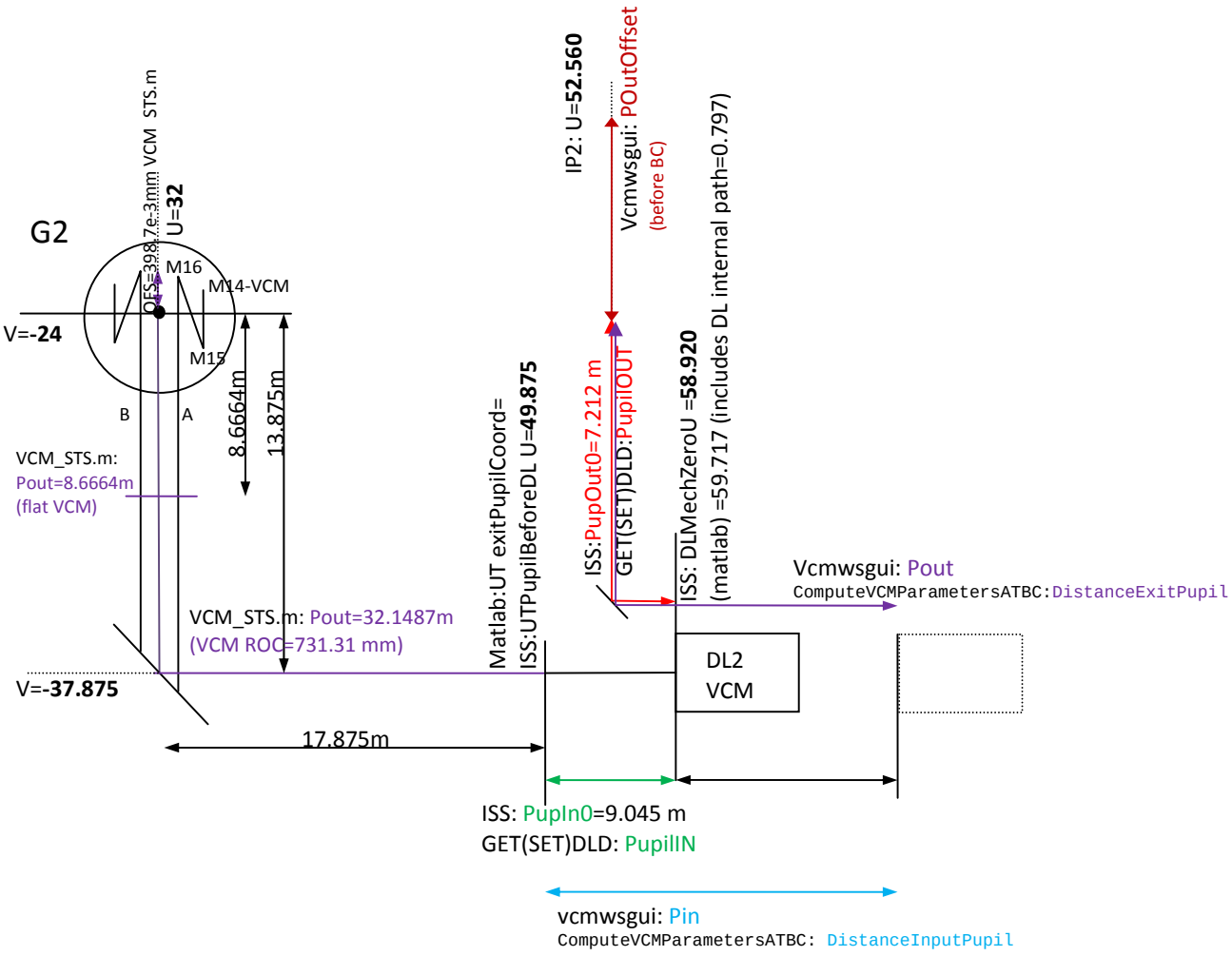
So, with a flat STS-VCM, the DL input pupil position is increased by 32.1487-8.6664= 23.4823m

- PupIn0 becomes [9.045+32.1487-8.6664]=32.5273 m

Equivalent to redefining UTPupilBeforeDL U=**49.875-**32.1487+8.6664= 26.3927
The corresponding DL-VCM adjustment is given by
ComputeVCMParametersATBC('UT2',2,2,0,0,-1) after redefining UTPupilBeforeDL for UT2=26.3927 in the code

- Input pupil distance `DistanceInputPupil` (for DLpos=0) = 33.32430 m= PupIn0(32.5273)+DL internal path(0.797)
- Exit pupil distance required `DistanceExitPupil` (for DLpos=0) = 8.009000 m
- VCM radius required = 1.558980 m

Exit pupil Pout=8.009 including the DL internal path (0.797m)
So we should have ISS:PupOut0=GET(SET)DLD:PupilOUT=8.009-0.797=**7.212 m**



9.5.2 Definition of the Pupil_IN/OUT of DL#2 and verification of the PRIMET pupil on the beam profiler

Theoretical settings:

dlguiStatus

- check that all needed components are ONLINE
- vcmws Online Tracking
- VCMX online Tracking
- other ignored

Define parameters of the delay line

Under wdline

msgSend wdline dlmswControl SETDELD dlmswControl "……."

DLID, TEL ID, STATION ID,STATION POS U, STATION POS V,STATION POS W,
OPL0,InputCHannel,PupilIN,PupilOUt,OPDfilename

- *msgSend wdline dlmswControl* SETDELD dlmswControl "2,X,G2,32,-24,0,0,2, 32.5273, 7.212, SLE_Test"

under vcmwsgui

select setup and then preset

Using the above theoretical settings, we don't get an optimum Metrology pupil, and finally need to use the DL-VCM settings of COM4 (for DLpos=15 m, i.e OPL=30m)

Date	Config	DL	DDL	DL-VCM-Curv	STS-VCM Curv
COM4 Mar'09	Ip2-BC-DDL8-DL#2-B-AT#3-G2	30m	?	Real:20.32e-4 (0.8bars) (ROC=492.13 mm)	Real: INF (flat)

Let's compare the "field" values to the theoretical values, in particular for OPL=30m (15m mechanical),

Theoretical values:

ComputeVCMParametersATBC('UT2',2,2,15,0,-1) after redefining UTPupilBeforeDL for UT2 U= 26.3927 in the code (flat VCM case, as shown above)

- Input pupil distance `DistanceInputPupil` (for DLpos=15) = 48.32430 m=33.32430 m +15m
- Exit pupil distance required `DistanceExitPupil` (for DLpos=15) = 23.009 m=8.009 m +15m
- VCM radius required (with specific DL optical par.) = 1.792204e-003 mm-1
- VCM ROC required (with specific DL optical par.) = **557.97 mm**

Field values

By which amount do I need to shift the input pupil to get an ROC of 492 mm (as observed in practice)?

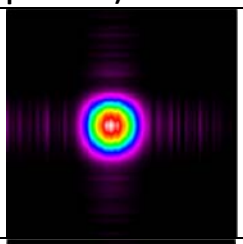
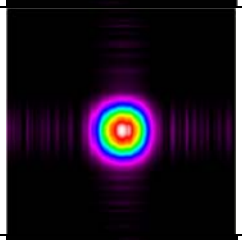
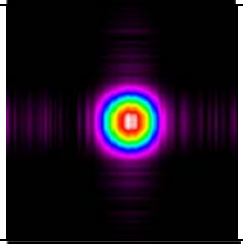
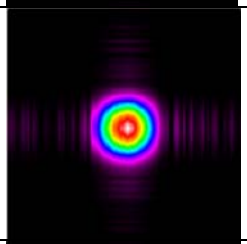
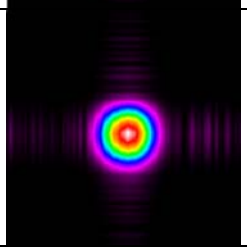
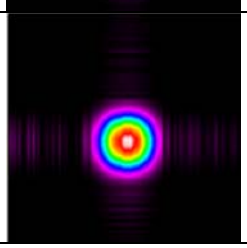
I shift manually the UTPupilBeforeDL in the code until getting ROC close to 492.13mm. Final result is

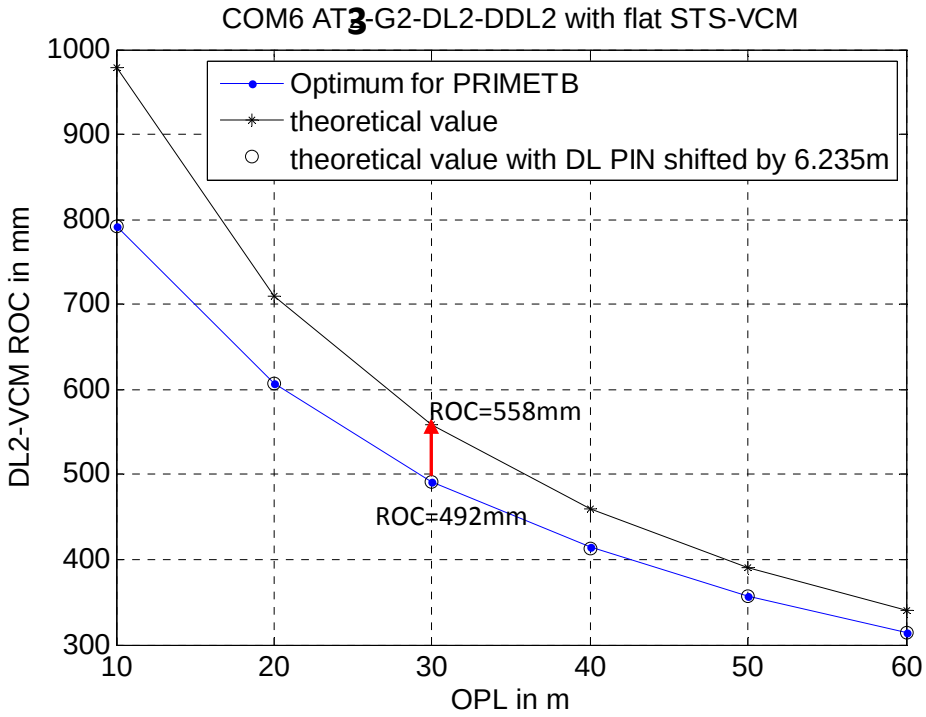
ComputeVCMParametersATBC('UT2',2,2,15,0,-1) after redefining UTPupilBeforeDL for UT2 = 20.1577 in the code

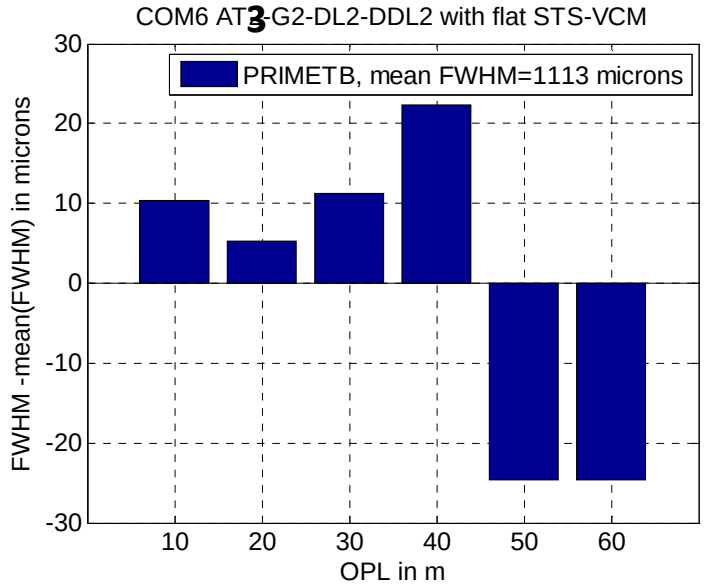
- Input pupil distance `DistanceInputPupil` (for DLpos=15) = 54.55930 m
- Exit pupil distance required `DistanceExitPupil` (for DLpos=15) = 23.009 m=8.009 m +15m
- VCM radius required (with specific DL optical par.) = 2.032054e-003 mm-1
- VCM ROC required (with specific DL optical par.) = **492.11 mm**

The shift of the input pupil is Δ=26.3927-20.1577=**6.235 m,** bringing the STS output pupil to 2.43 m away from the STS instead of 8.6664 m (i.e closer to the STS compared to theoretical values). Δ corresponds to a shift of $\delta = \Delta / 4.44^2 = 0.316$ m in the VLTI lab

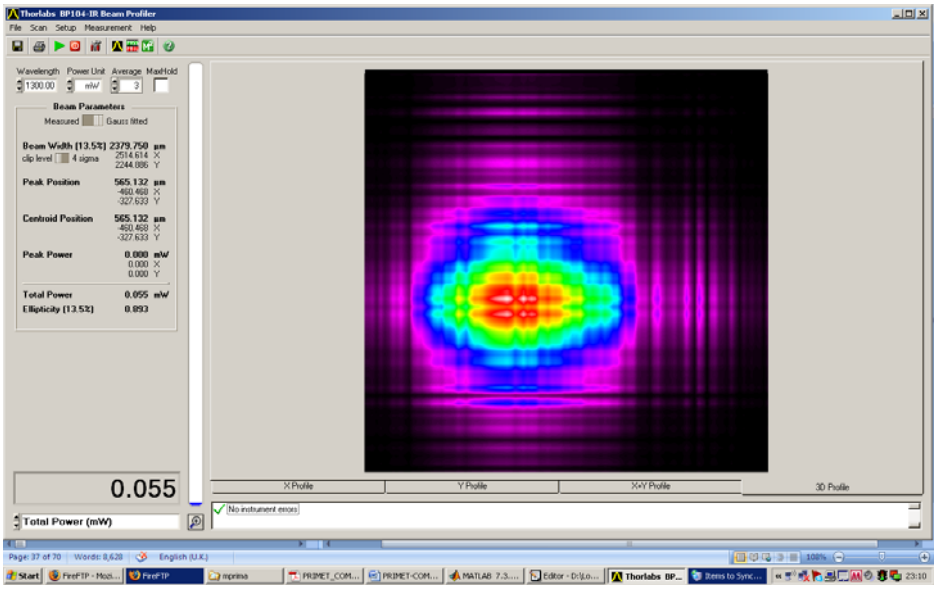
The magnitude and sign of δ (direction of the shift) does **not** corresponds to the separation of the FSU_BC (theoretical pupil position) and the position of the beam profiler (~1.06m).

DL#2 OPL in m	Curv in mm^{-1}	Press in bars	Beam FWHM in µm	Ellipticity	Power in mW	Beam profile after centering with the VCM (increase Beam profiler measurement precision)
60	3.186e-3	1.3294	1089	0.968	57	
50	2.8e-3	1.15	1089	0.95	60	
40	2.416e-3	0.973424	1136	0.989	58	
30	2.032e-3	0.8	1125	0.995	60	
20	1.647e-3	0.62742	1119	0.978	60	
10	1.262e-3	0.4566	1124	0.987	62	





For comparison: Beam from the FSU IP4 retro-reflector
P-Pol



9.5.3 Test impact of DL displacement with VCM curvature tracking.

First files on lprma2 of the 25/7
first from 10m to 60 AT#3 enclosure closed

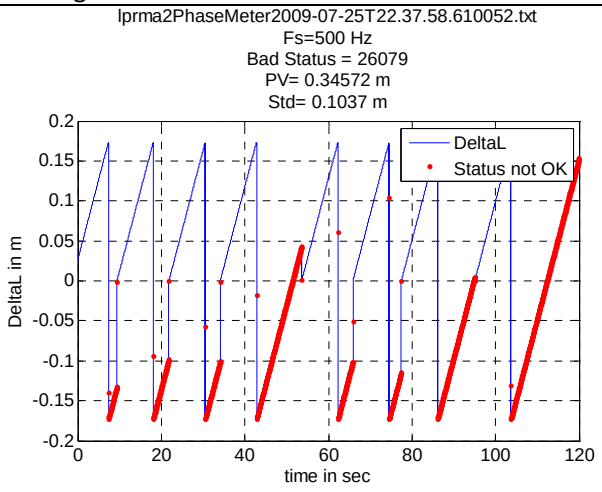
delay lines are moving using : dltestTrack ldlnumber startOPL speed in mm/s
speed ~ 20 mm/sec

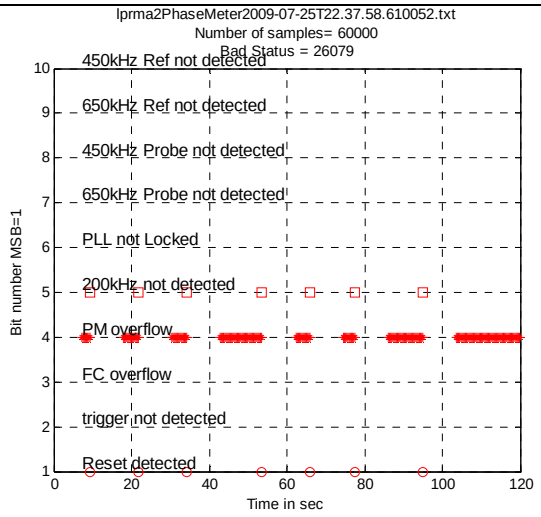
Note: in the following files: known problem of the phase meter overflow which stays toggled even after wrapping of the OPL. To remove the PM overflow flag, the only solution is to reset the phase meter (which toggles the "200kHz not detected" flag. This problem has been solved in October 2009 (Com8).
In the following files, the only relevant verification consists :in checking that :

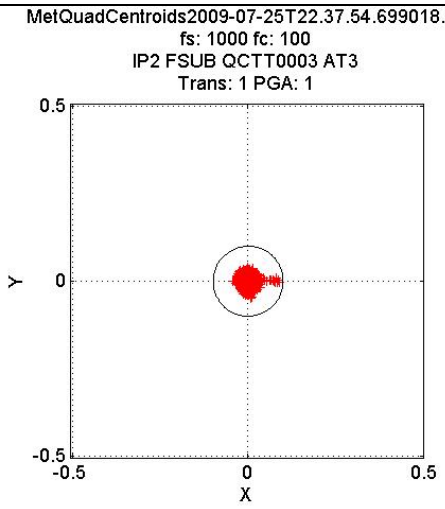
- No other status flag toggles apart from the overflow
- Or when a reset has been performed, that no other status flag toggles between the reset and the next Phase meter overflow.

25T22.37: ; **results OK**

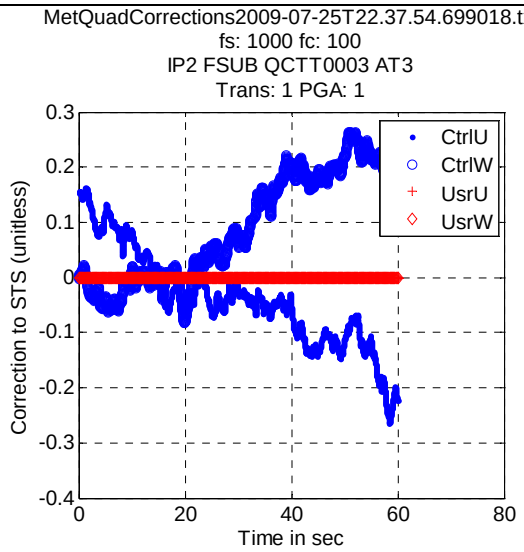
tracking at around 42 m








```
Radial: Pk= 8.035753e-002 p   rms=
7.206207e-003 p
```




```
IP2 IM Gain A1 A2 B1 B2
    1 0 0 -1 0.015 0 0 -1 0
```

25T22.41: **results OK**

tracking at around 44 m

Radial closed loop: Pk= 4.385322e-002 p rms= 5.591628e-003 p

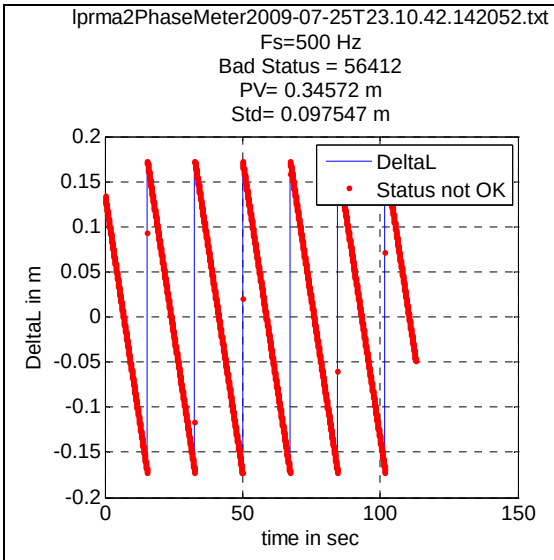
25T22.50: **results OK**
tracking at around 55 m
Radial closed loop :Pk= 6.965947e-002 p rms= 9.267888e-003 p

25T22.55 (no reset performed; PM overflow always toggled): **results OK**
tracking at around 60 m
Radial Closed loop: Pk= 5.259029e-002 p rms= 7.026136e-003 p

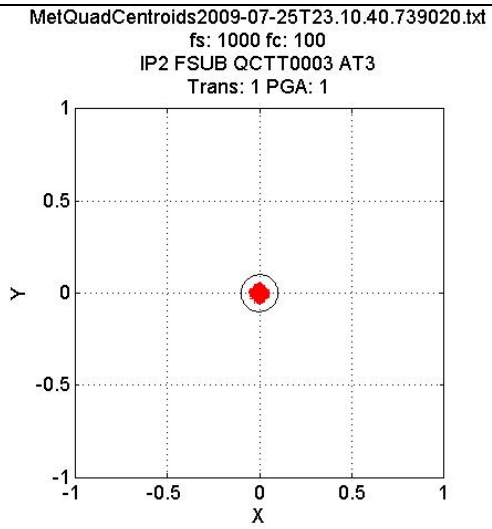
UT23.00: enclosure of AT3 is opened
(AT1 & AT2 already opened since LT 19h00)
we go back from 60 m to 10m: The speed is now dOPL/OPL=-20mm/sec

T23.03
at around 58 meter with AT3 opened: **results OK**
Radial Closed loop: Pk= 4.866434e-002 p rms= 6.319801e-003 p

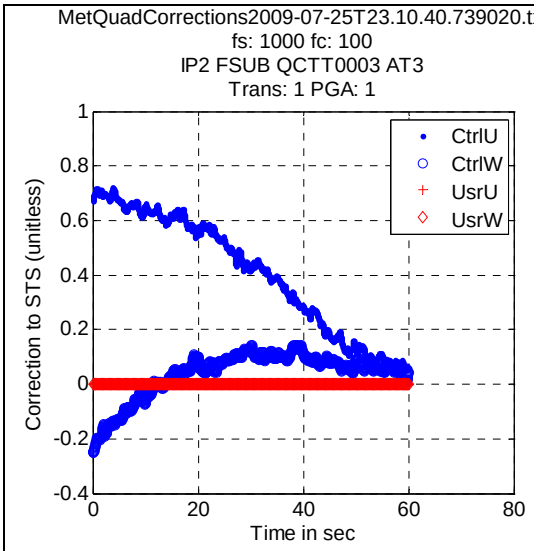
T23.10
at around 50 meters (No reset performed): **results OK**



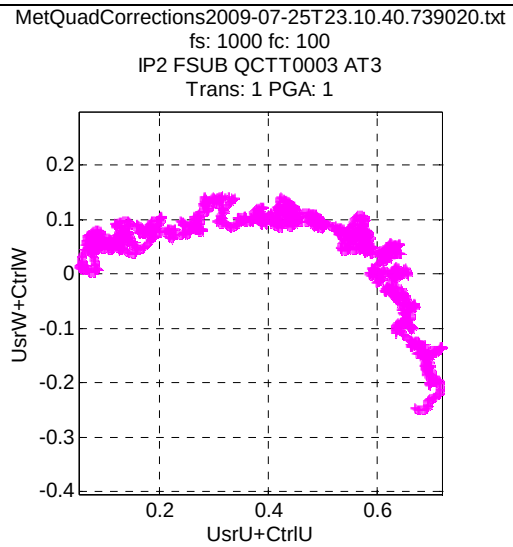
Travelled OPL [@ OPL~50m]: ~6.5 x300mm= 1950mm
Speed~dOPL/OPL=20mm/s



Radial Closed loop: :Pk= 4.802236e-002 p rms= 6.272634e-003 p



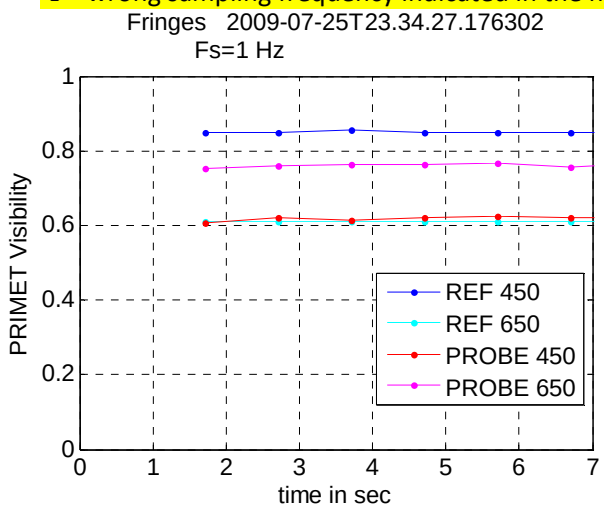
Gives an indication about lateral beam motion introduced by the DL over 1950 mm



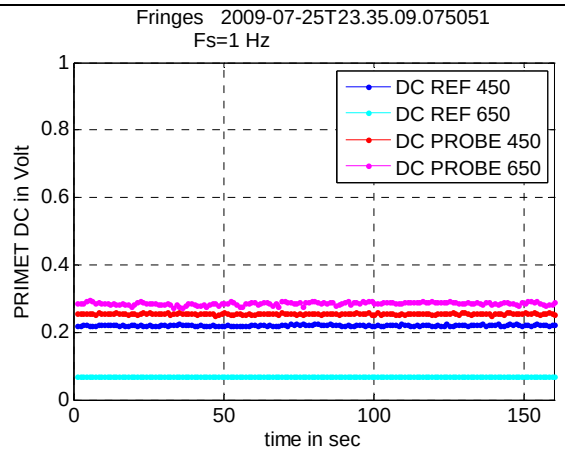
at T23.15, we add bsa and bsb to operate PRIMET A on Marcel simultaneously

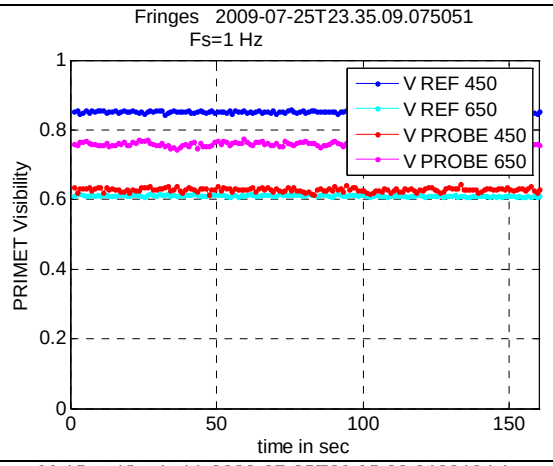
at T23.18 at about 40m
also record on A-B to get fringe visibility
lprmacFringe2009-07-25T23.18-> empty file ??
lprmacFringe2009-07-25T23.34

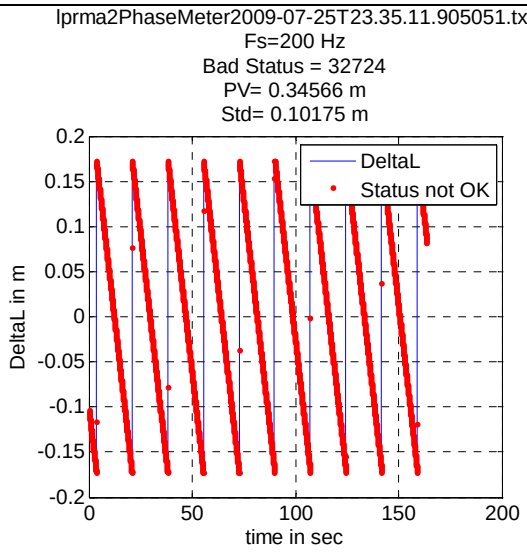
➔ wrong sampling frequency indicated in the header !



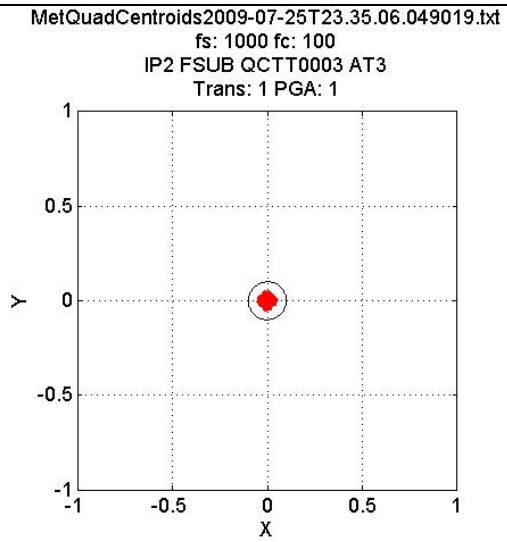
T23.35 around 20 m
lprmacFringe2009-07-25T23.35: **results OK**





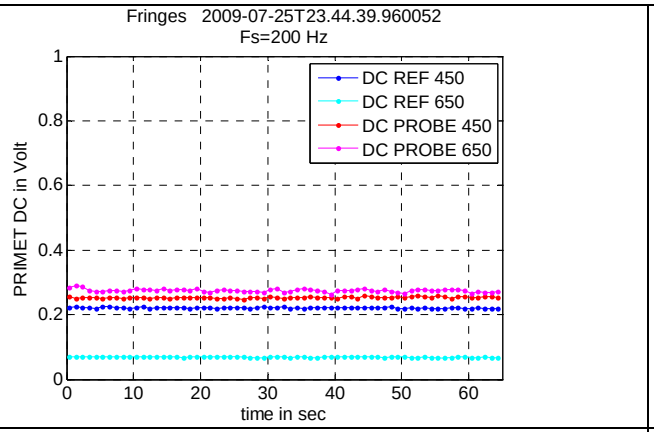


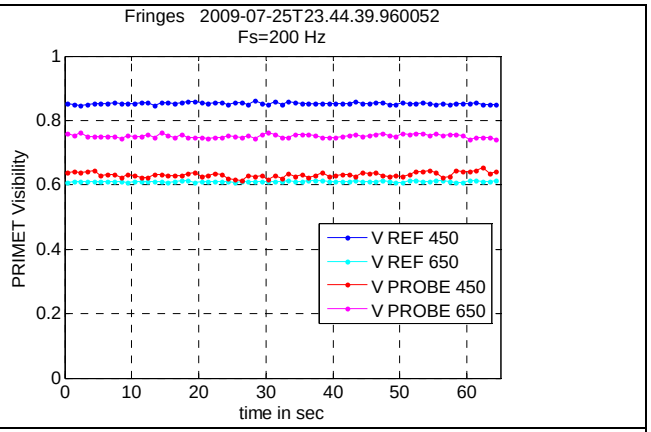
Travelled distance: ~ 9x300mm=2700mm; No phase meter Reset

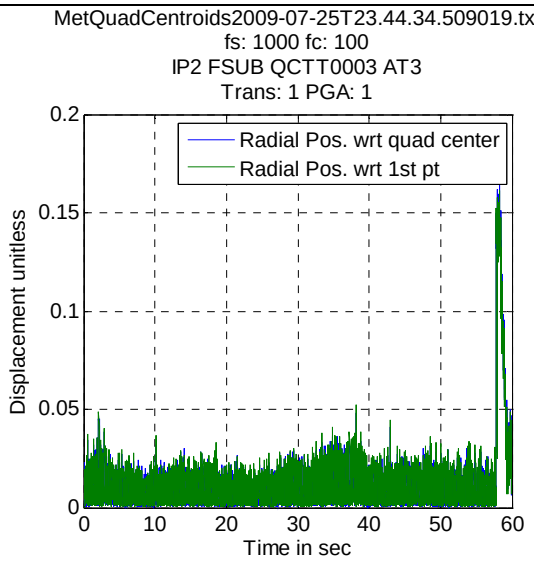


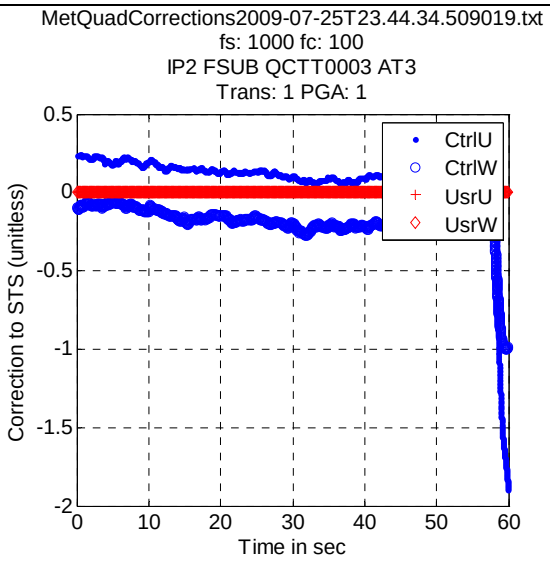
Radial Closed loop: : Pk= 3.681568e-002 p rms= 5.402179e-003 p

T23.44 at around 10 m
lprmacFringe2009-07-25T23.44: **results OK**









Centroids as good as before, except last few seconds. But no effect on phase meter. Origin of the disturbance unknown

Then try different speeds

50 mm/s-> glitch: vcm does not follow

40 mm/sec-> glitch

25 mm/s: -> glitch 200kHz goes error

Practical limit is ~ 20 mm/s

Conclusion: In the configuration (PRIMETB to AT-STS-G2 cyclop and PRIMETA on Marcel), the motion of the DL corresponds to differential OPD between PRIMETA and PRIMETB. Therefore the speed limit is imposed by the phase meter max DDL speed of +/- 23mm/s (see phase meter PAE doc)

9.6 Summary of the pupil tracking performance during COM6

Config: AT#3-G2-B-DL2-DDL2-ip2 **FileName MetQuadCentroids2009**	**Comments**	**Fs(Hz)**	**Tobs(s)**	**Beam radisu. um**	**Radial Peak(rad) w.r.t 1st point**	**Radial rms (rad)**	**Radial Pk um**	**Radial rms um**
07.24T00.06	Closed loop DL2 at 30m Fixed DL/DDL Enclosure state unknown	1kHz	60	552	0.08	7.8e-3	44.16	4.3
07.25T18.04	Closed loop (daytime) DL2 at 30m Fixed DL/DDL Enclosure Closed	1kHz	60	552	0.18	2.36e-2	99.4	13
07.25T18.06	Open loop (daytime) DL2 at 30m Fixed DL/DDL Enclosure Closed	1kHz	60	552	0.265	4.8e-2	146.3	26.5
07.25T22.37	Closed loop DL2 at 42 m moving at 20mm/s . Enclosure Closed	1kHz	60	552	0.08	7.2e-3	44.2	4
07.25T22.41	Closed loop DL2 at 44 m moving at 20mm/s. Enclosure Closed	1kHz	60	552	0.044	5.6e-3	24.3	3.1
07.25T22.50	Closed loop DL2 at 55 m moving at 20mm/s. Enclosure Closed	1kHz	60	552	7e-2	9.3e-3	38.6	5.1
07.25T22.55	Closed loop DL2 at 60 m moving at 20mm/s. Enclosure Closed	1kHz	60	552	5e-2	7e-3	27.6	3.9
07.25T23.03	Closed loop DL2 at 58 m moving at 20mm/s. Enclosure Open	1kHz	60	552	4.8e-2	6.3e-3	26.4	3.5
07.25T23.10	Closed loop DL2 at 50 m moving at 20mm/s. Enclosure Open	1kHz	60	552	4.8e-2	6.3e-3	26.4	3.5
07.25T23.35	Closed loop DL2 at 20 m moving at 20mm/s. Enclosure Open	1kHz	60	552	3.7e-2	5.4e-3	20.4	3

All closed-loop radial displacement are in specs

10 SUNDAY 26/7/09

10.1 Check impact of Marcel BS mirrors on calibrated FSU phase shifts

See FSU report

10.2 Evaluate PRIMET A status

PRIMET A uses Ip1 and IP3 but we only have 1 telescope available (AT3).
Config with M16 DL2-2AT: Ip1-DL2-AT3/G2/A (and Ip2-DL2-AT3/G2/B , not used)

nothing is coming back, although ip1 seems more or less centered on the light duct.

we check on the AT-TCCD: strange spots coming both from the DL and the DDL metrology
image of the TCCD saved:
Moving the fsm allows to find the edge using the DL metrology straylight
note: metrology DDL ip1 not seen on TCCD
mainly metrology of DDL Ip2 (15 pixels and 1000 ADU)

Image beacon switched ON but cannot be seen on IRIS.

Check if ip2/PRIMETB behaves as previous days,
Initially, I fail to detect the returned spot on the quadcell. After a lot of effort and searching around, I finally find out that somebody had left some halogen lamps in front of the IP2 DDL…..:-(
After this, pupil tracking works OK on ip2 beamB again.

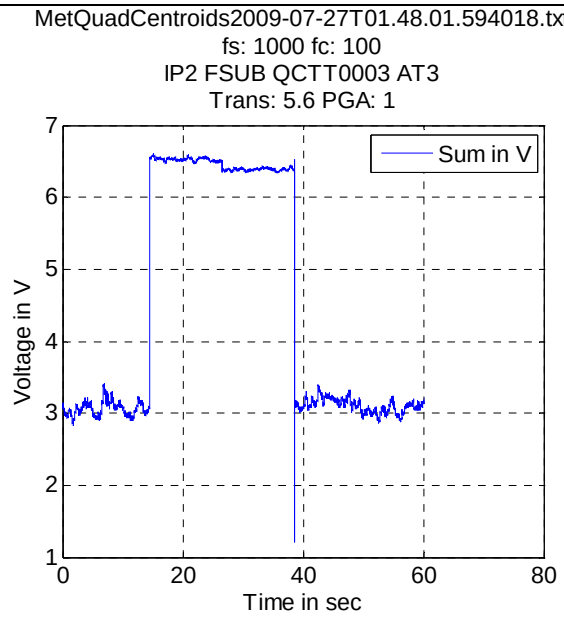
Conclusion: Problem with the alignment of AT3-STS-A
or with the alignment of PRIMAT/ip1 (less plausible because the upcoming PRIMETA beam is centered on the light duct).

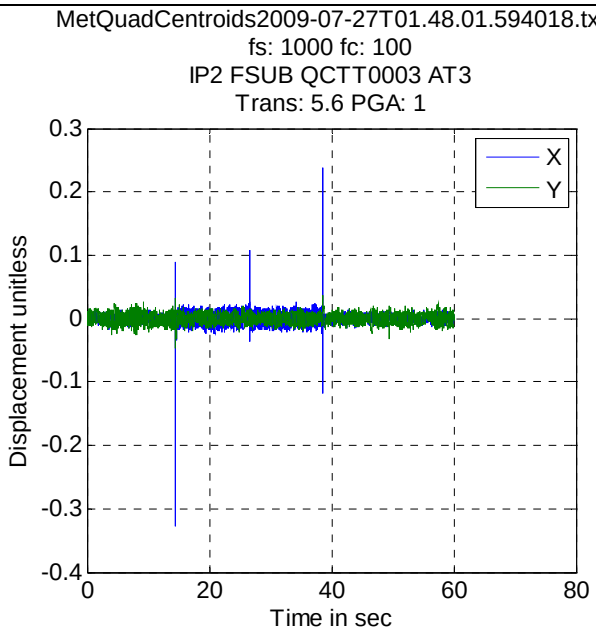
10.3 Check impact of the STS edge position on the pupil tracking loop

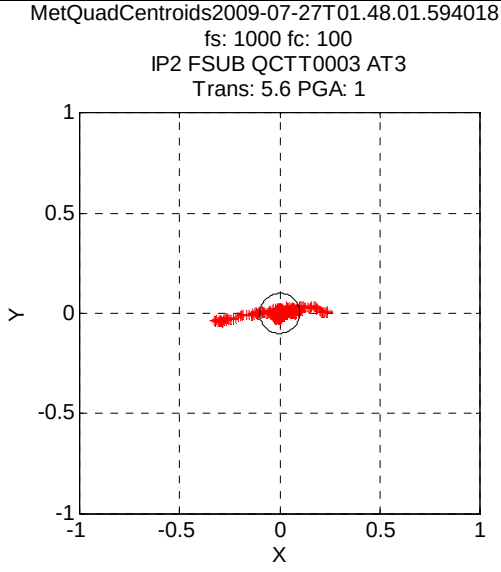
fsm Beam B AT3: db value after init
X_db_fsmB=12 μm_piezo;
Y_db_fsmB=12 μm_piezo
offset in W of 100 gives moves X to 9.90 μm_piezo
offset in U of 100 gives moves Y to 9.98 μm_piezo
The scale factor fsm(μm_piezo) to fsm(U,W) is about 100/(12-10μm_piezo)=50

looking at DL straylight
edge is found for beam B with offset of the fsm of ~ U=40 and W=500 , resulting in
X_edge_fsmB=2.35 μm_piezo
Y_edge_fsmB =11.19 μm_piezo
(instead of theoretical value of 10;10)
pmpsd keeps guiding over this all range

on the edge, pupil tracking still works after flux drops from 1.16 V (gain 1) to 1.10V (gain 2.2)
, i.e 1.16/(1.1*2.2)=53%
startmpo on edge go out of edge to W400 and W300 and then back to edge W=500
Centroids2009-07-27T01.48
Only Ip2-DL2-AT3/G2/B is active







rmsX= 1.040157e-002 p
rmsY= 6.302483e-003 p
rmsR= 9.853042e-003 p

➔ Pupil control not affected by edge

Info related to

fsm Beam A AT3: db value after init

X_db_fsmA=26.4 µm_piezo;
Y_db_fsmA=25.3 µm_piezo
offset in W of 100 gives moves X to 24.3
offset in U of 100 gives moves Y to 23.28

(same scale factor as FSM_B ~ 50)

looking at DDL straylight
edge is found for beam A with offset of the fsm of ~ U=-80 and W=80 , resulting in

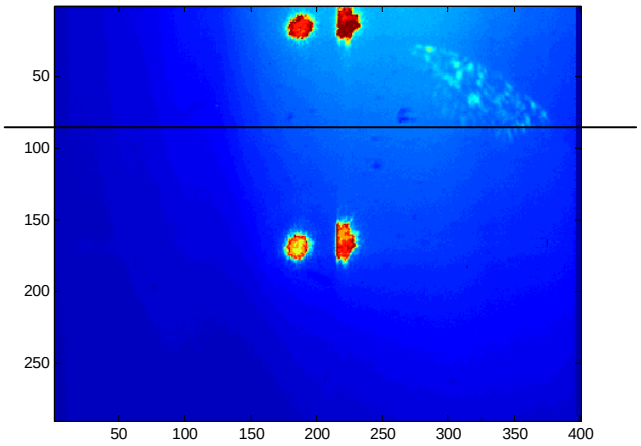
X_edge_fsmA=24.72
Y_edge_fsmA=26.91

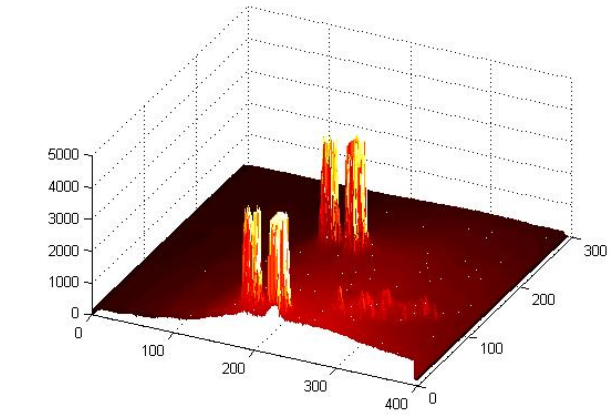
(instead of theoretical value of 28;28)

(vcm Beam A AT3: db value after init X=19;Y=19)

10.4 Evaluate the DL and DDL straylight on the TCCD of AT3-STS

FSMA offset U=-80 W=80 (on edge)
FSMB offset U=40 W=400 (out of edge)
matlab image: need to rotate along axis shown below to match TCCD RTD Display





3D view of left figure (mirrored)

Spots of about 30 pixels in diameters (~5 arcsec_sky), with ~4000 ADU. TCCD Image with DIT=1 sec (TBC) [1]
(file : straylightDl_DDL_DIT100msec.fits)

[1] Initially I wanted to apply DIT=100msec . Finally I probably used DIT=1sec with repeat period of 100msec….which then by default goes to 1 sec because it cannot be lower than the DIT

11 MONDAY 27/7/09

11.1 Alignment of Marcel after exchanging the BS for FSU phase shift tests

E&F mirrors swapped with A&B

After adjustment of the BS on the sighting scopes,

Config PRIMA Filter H IFOA mirrors IFO dichroics Q1beam B IP3= 62.98 63.79 Q2 beam A IP1= 64.24 62.93 Q3 beam F IP4= 64.13 64.24 Q4 beam E IP2= 65.15 63.03

- to be corrected on IFO's
- (does not affect FSU)

11.2 Check M16 positions

M16	DL2	Diffdl2 enc	DL4	Diff dl4enc
1AT	29620	-	34247	-
1UT	77637	48017	82279	48032
2AT	77640	3	82114	-165
2UT	125654	48014	130138	48024
3AT	125640	-14	130281	143
3UT	173610	47970	178329	48048
4AT	173669	59	178200	-129
4UT	170000	36690	226220	48020
5AT	*221639*	*51639*	*226228*	*8*
5UT	*269514*	*47875*	*274240*	*48012*
6AT	*269669*	*155*	*274144*	*-96*
6UT	*250000*	*19669*	*322144*	*48000*

PosX UT=Pos(X+1)AT
Ip5 & 6 not used by PRIMA

encoder scaling 48000enc =240mm or 1 enc=5 µm

Pos UT X feeds IpX to beam A of DL

Pos ATX feeds IPX to beam B of DL

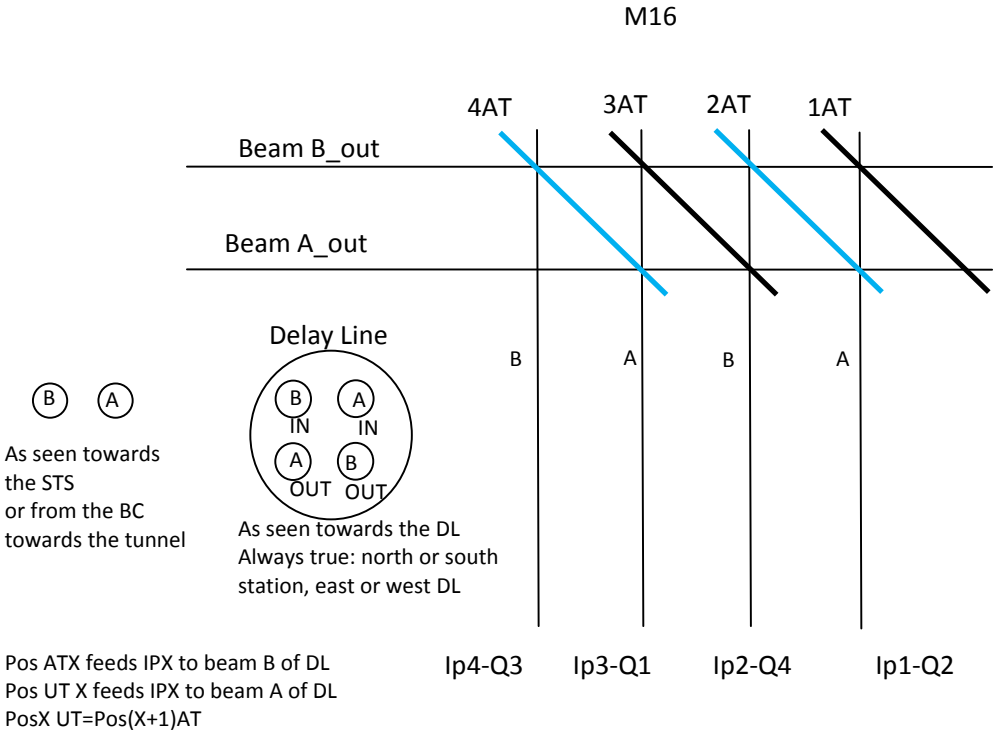


Figure 1: M16 configuration

11.3 Prepare Config

Put derotator to position zero

Image Nasmyth beacon on AT-TCCD
Rotate azimuth from 0 to 180 to find the azimuth axis
adjust M6 to bring the Nasmyth beacon o the azimuth axis:

M6=-0.08; -2 arcsec
pick object: 217.8;136.7
for azimuth =0 and derot=0

to check scale of M6 move M6 by 1 arcsec along X to -1.08;2
pick object: 211.7; 135.5

➔ Scale=6 pixels/arcsec_M6

The azimuth axis has a slight offset towards the right side of the TCDD compared to edge of M10

Adjust FSMA and B to bring the straylight on the azimuth axis and cut the spot in 2 to define the edge position:
FSMB offset U=20 W=80 (on edge) resulting in X=24.72 Y=24.89
FSMA offset U=160 W=515 (on edge) resulting in X=1.2 Y=8.77-→ far away from factory settings !

I put the straylight off edge by
FSMA offset U=20 W=250(off edge by ~) resulting in **X=21.16 Y=24.9**
FSMA offset U=160 W=400 (off edge by ~ 33 pixels horizontally) resulting in **X=3.61 Y=8.765**

take an image of the TCCD:
Beacon_and_straylightDl_DDL_DIT100msec.fits
BCK_ Beacon_and_straylightDl_DDL_DIT100msec.fits (background)

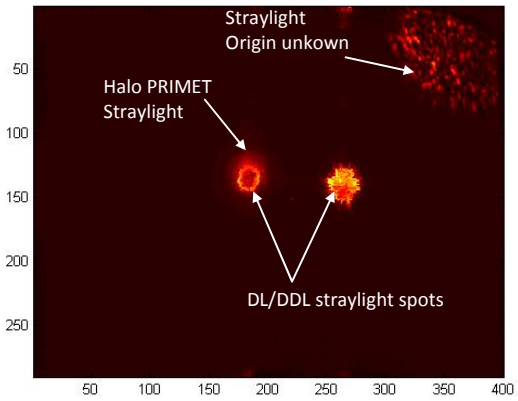
Check the nasmyth beacon on IRIS:
I move the M6 to (X=-6 Y=-2) to bring the beacon on the above straylight spot on beam B
IRIS: filter Open
IFO in mirror
with M16 in DL#2-2AT, beam B is Ip2=Q4.
I effectively see the spot on Q4

I try on beam A (ip1) and find the beam on Q3 (OK)
The spot is very weak, Indicating that the pupil may not be correct.
I check the DL and realized that it was not online
but this does not change the result….beacon is very fat !

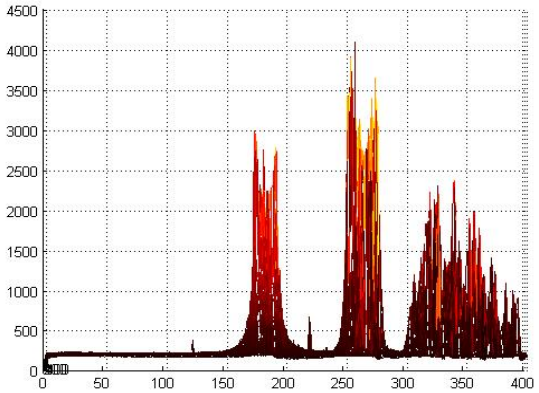
➔ Optical problem with AT3-STS-Beam A confirmed

prepare IP2 using 2AT Beam B
switch on the laser: beam detected on the quadcell
manual offset (-0.2;0.2) to center the beam , then pupil track OK

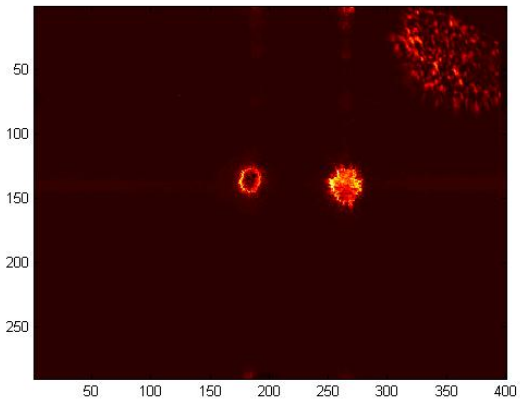
Record TCCD image with and without the laser
laserON_and_straylightDl_DDL_DIT1sec.fits
laserOFF_and_straylightDl_DDL_DIT1sec.fits
should be more precise for the Beam B (left on TCCDdisplay), because AT3-STS-A is misaligned.
The position of the Coude Focus Device is unkown: Mirror or dichroic ? most probably mirror



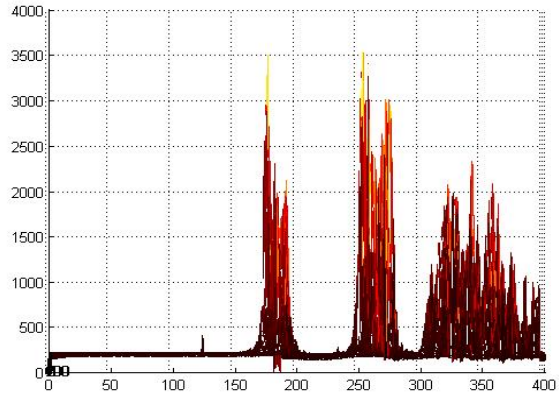
Laser ON



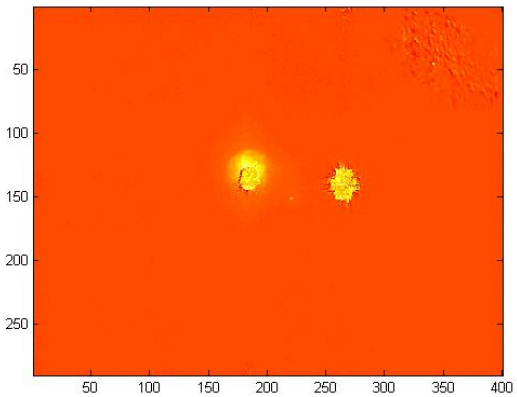
Mesh Laser on, Az=-1;EL=0, ADU vs Pixels;



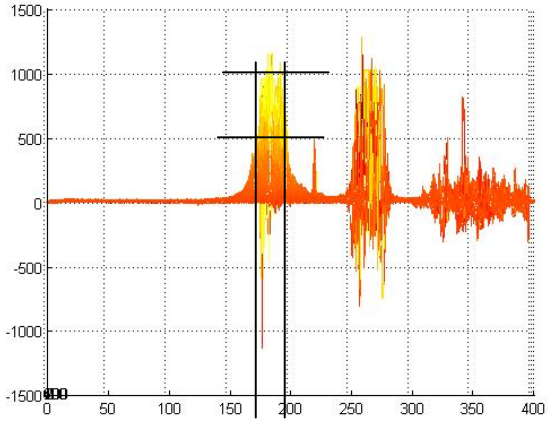
Laser OFF



Background daytime/enclosure closed ~250 ADU with DIT=1sec



Difference (Laser On-Laser OFF)



PRIMET straylight: FWHM~25 pixels, and max~1000 ADU with DIT=1sec

Check the Positions of the Swichyard mirrors for BC_DDL stored in the dB

- SW1=230310
- SW2=230399
- SW3=1132873
- SW4=222000

11.4 Check PRIMET A

ip2(PRIMETB)-> AT#3-beamB Ok: Guiding is working fine

Switch M16 to feed Ip1 to AT3-Beam B
beam is coming back from the STS with the FSM/VCM config working for ip2.
lateral shift of ~25 mm in the tunnel between the incident and the returned beam.
(seen on the alignment plates of the tunnel/lab wall)

➔ This indicates that the alignment of PRIMETA/IP1 is not completely wrong and points to a mis-alignmet problem of AT3-STS-A as discussed in section 10.2.

we see that Ip3 and ip1 are both shifted laterally (too low and left) on the lab/tunnel alignment plate.
This could originate from a tilt error of the injection block.

Switch M16 to feed Ip3 (transmitted by injection block) to AT3-beamB
and try to adjust the injection block.
we cannot superimpose Ip3 and the retro-reflected beam from AT3 at the level of the lab/tunnel alignment plates. We loose the alignment on Marcel: the beams are not centered on the Midi alignment plates.

injection block: only tune the tilt
lateral pos. given by FSUBC
No guaranty that the center of the FSU BC is exactly on the VLTI axis
(we saw a 2-3mm pupil shift between the shadow of the BC central patch and marcel's pupil which leads to about 9-13mm after the BC.

➔ Conclusion: PRIMET A alignment to be checked together with FSUA alignment.

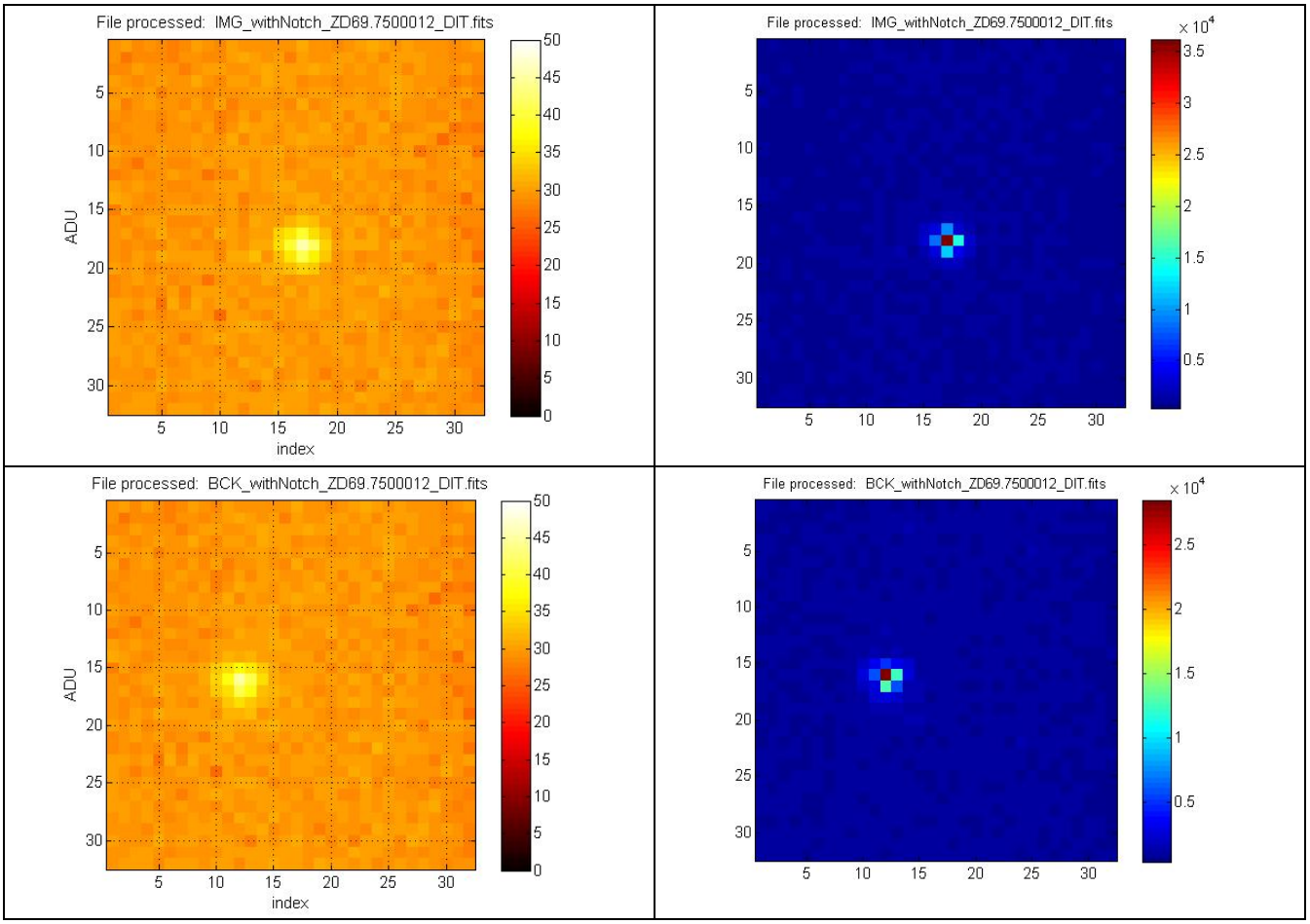
FSUA On pos with which we did PRIMETA alignment on AT3
TTP1 X= 135 Y=-99
TTP2X= -440 Y=441

new BTK on FSUB
TTP1 X= 7 Y= 43
TTP2X= 409 Y=431

11.5 Impact of Notch filter

Use :
./irisMovieShutBGD.sh time_in_sec filename
first do background by moving Notch translation stage with black paper on it
Then takes movies
nb of frame depends on actual DIT and selected time in sec
The black screen or the notch filter are alternatively installed on the translation stage located in front of the cryostat.
Configuration:
IRIS with Filter H ; DIT=0.05 sec (min dit window 32x32)
IFO dichroics
IFOA in Mirror

Measurement with black screen IN and OUT (Without Notch)	BCK_withoutNotch_ZD69.7500012.fits Look at black screen Only	IMG_withoutNotch_ZD69.7500012.fits Look at Marcel only
Measurement with Notch IN and OUT	BCK_withNotch_ZD69.7500012.fits Look at Marcel through notch	IMG_withNotch_ZD69.7500012.fits Look at Marcel only
without marcel ,with notch, with M16 2AT and pupil tracking on IP2 on AT3-G2_beamB	BCK_TestSamuel_ZD90_DIT.fits ?	IMG_TestSamuel_ZD90_DIT.fits ?



Shift of 5 pixels (mainly along 1 direction)
The estimation of the impact of the notch filter on the optical quality is affected by saturation. Measurement to be performed again.

12 TO-DO LIST

Lessons from Com6

- Monitor visibility and flux of PRIMETB
- Improve the alignment of the ACU and BC of FSUA prior to PRIMET A alignment check
- Collect additional PRIMET BTK data with optimized modulation amplitude/frequency. Solve operational issues identified during COM6.
- Check status of swap cable and in dbcfg for AT3-STS-VCM
- Check the possibility to include measurement of X and Y on the quadcell RTD scope.
- Check PRIMETB/FSUB compatibility on sky (incl. Pupil longitudinal position, ACU compatibility etc...)
- Check PRIMET straylight on the AT-TCCD with the notch filter newly installed in the AT-STS, as well as the straylight on IRIS after retro-reflection by the AT-STS.
- Install a Remote control flip mount for the density filter located in front of the PRIMET extraction block
- Extend the osf scripts for PRIMET health checks. Elaborate Day-to-night scripts

More general tasks (to be detailed in a separate document)

Hardware/functionality:

Bring PRIMET A to the same level as PRIMETB (more time consuming due to physical access on the PRIMA table)
Test PRIMETA+B in representative operational conditions (e.g.2xSTS,IRIS guiding, FSU-BTK, dual-feed presets etc…)

Performance:

Quantify performance and robustness: transition from functionality to performance demonstration

Operation:

Test PMCS (PRIMET state machine), Public commands and I/F
Test/update procedures for PRIMET Day-to-night and health check

13 APPENDIX

PRIMET used the following configuration:

AT#3-STS
Station G2-DL#2
fixed curvature VCM both on Beam A and Beam B

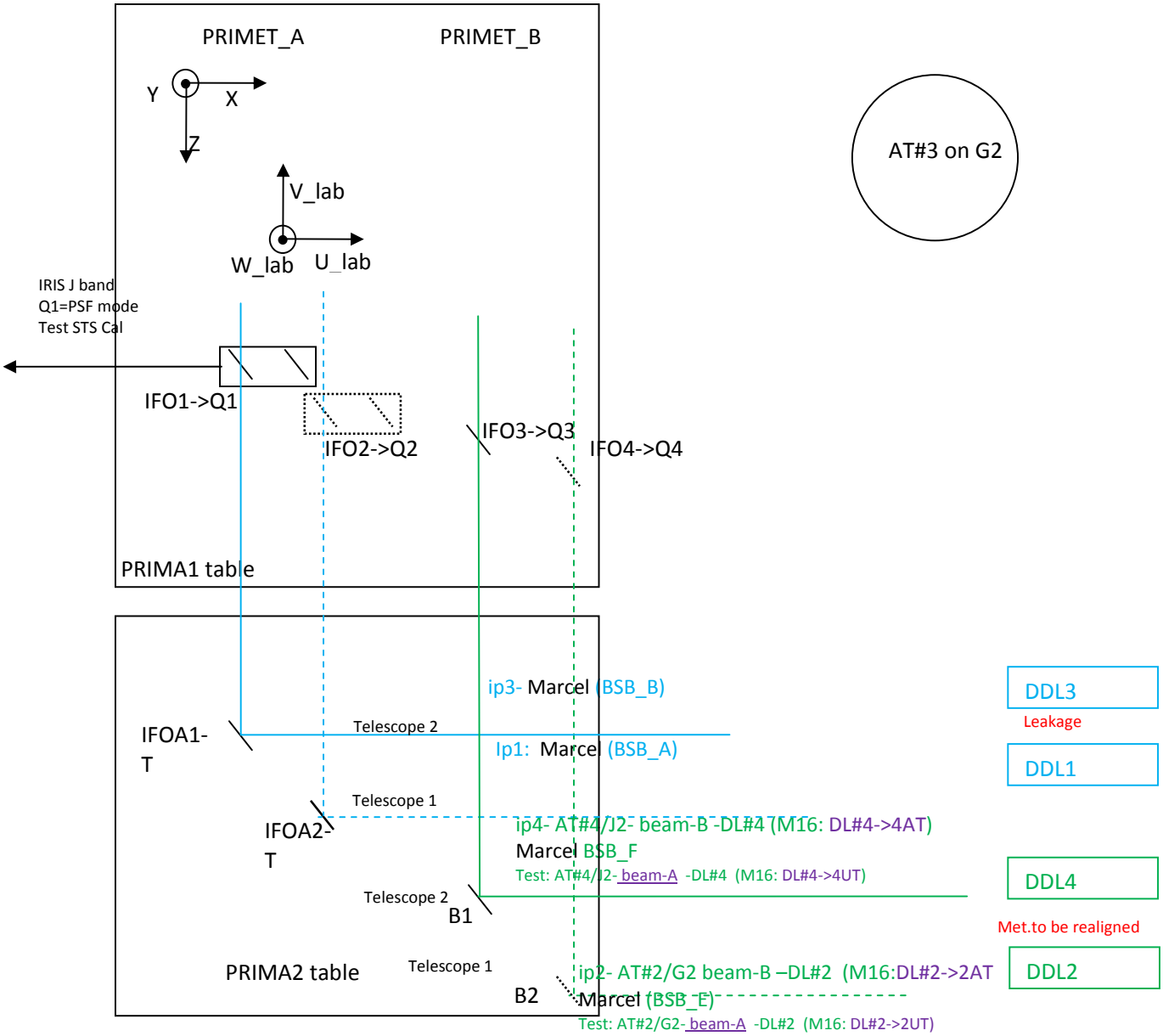


Figure 2: Beam routing.

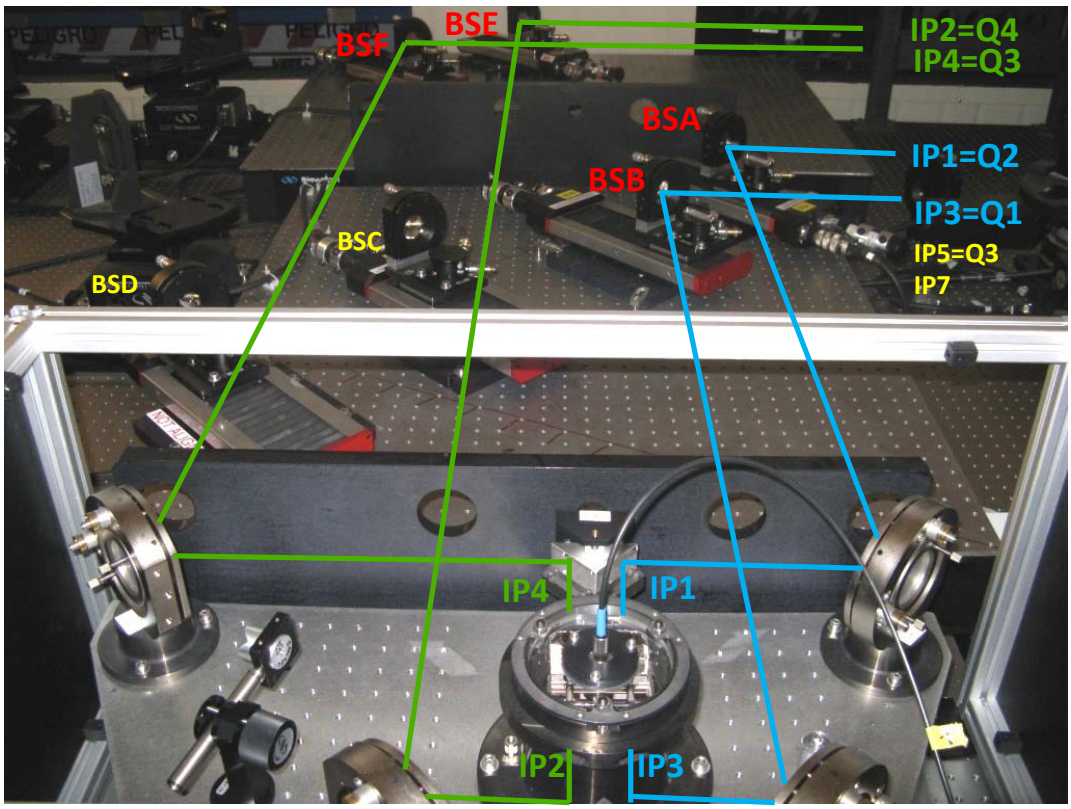


Figure 3: Marcel beam definition

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