E U R O P E A N   S O U T H E R N   O B S E R V A T O R Y
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VERY LARGE TELESCOPE

Prima Metrology COM3 Technical report 28/1 to 6/2 2009

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Issue 1

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CHANGE RECORD

Issue	Date	Affected Paragraphs(s)	Reason/Initiation/Remarks
1		All	First issue

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1 INTRODUCTION

This document presents the results obtained during the PRIMET COM3 period held on Jan 28-Feb 6/2009, with the support of **F.Delplancke, N.DiLieto and C.Schmid.**

PRIMET was in the same configuration as during COM1 (October 2008), which is documented in the report **VLT-TRE-ESO-15730-4653**. PRIMET was operated with the limitation of having 1 STS on J2 equipped with 1 inflatable VCM on Beam B.

The main objectives of COM3 were to operate pupil tracking and gather data for the future implementation of beam tracking for PRIMET, as well as to assess the impact of the DDL on the PRIMET performance.

The laser safety rules defined during the AIV period and defined in memo ***TEL0820*** from 14/8/08 applied during the COM3 run.

2 CONFIGURATION

PRIMET used the following configuration:
AT#4-STS (used as Telescope 2)
Station J2-DL#4
AT#4-STS had the VCM installed on Beam B
AT#4-STS was equipped with its derotator and its TCCD
The Beam A of AT#4-STS not used during COM3

Marcel (used as Telescope 1)
BSB_E (autotest) **ip#2-Beam B**
BSB_A (autotest) **ip#1_Beam A**

The OPL length (ip4, ip3) through DL#4(at OPL=15m) and AT#4-STS-J2 is ~ 150 m (1 way) or ~ 300 m (return way)

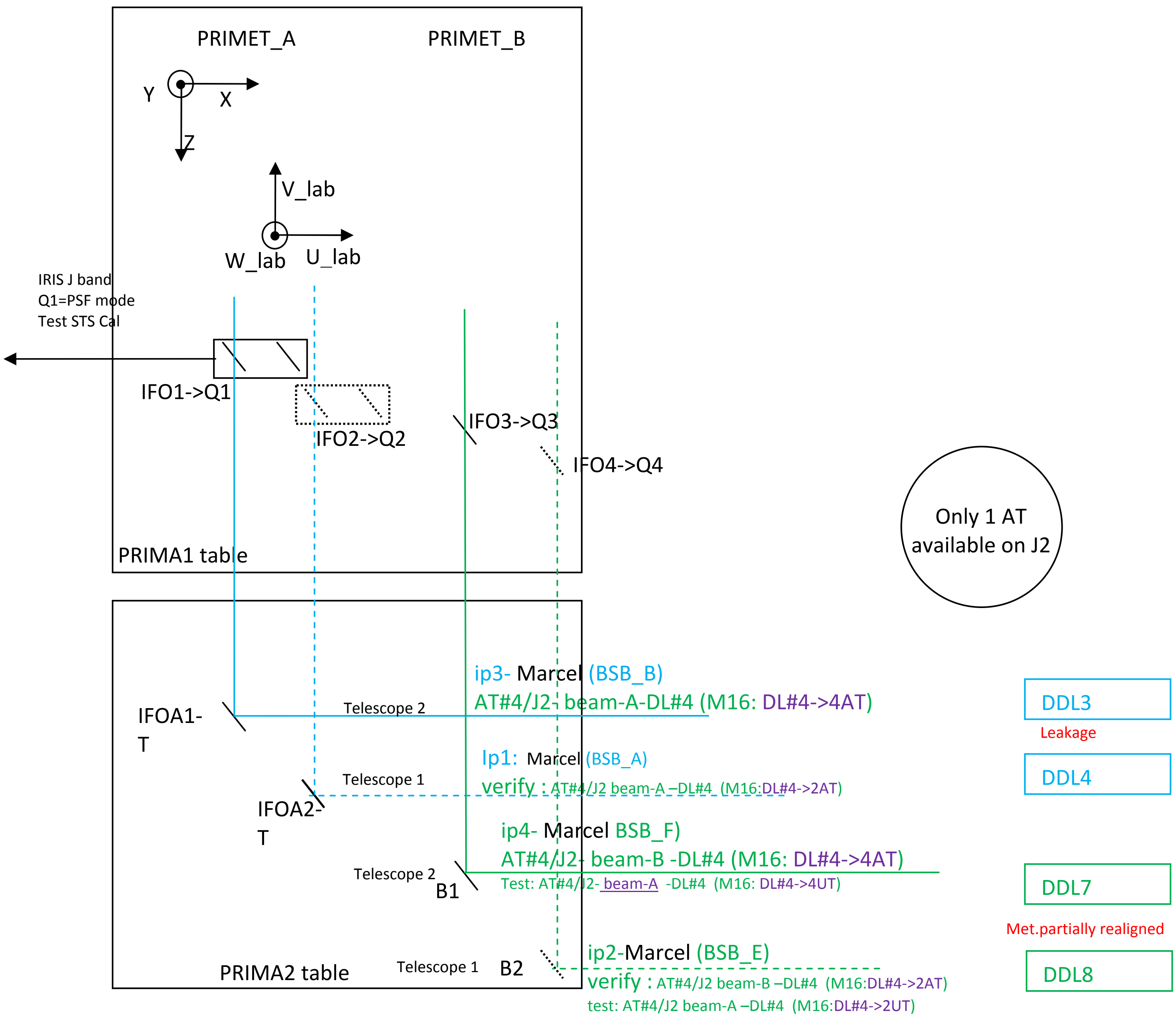


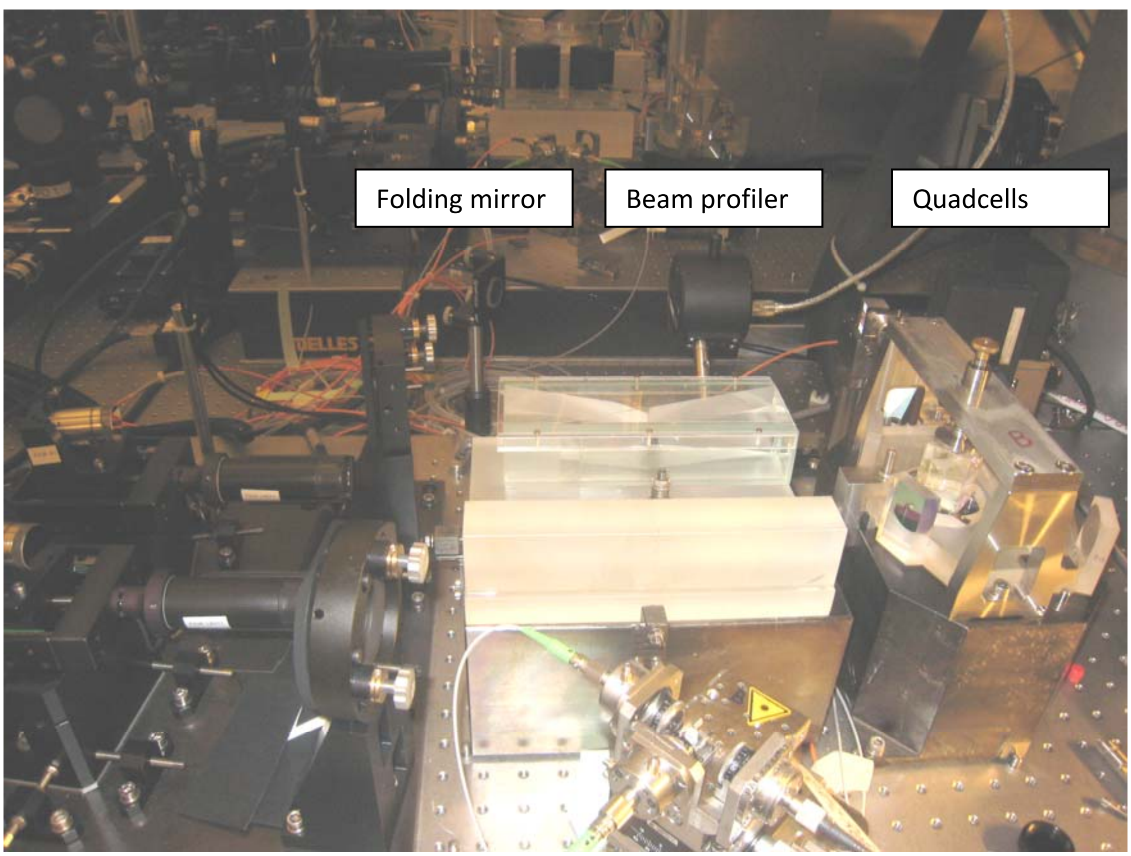
Figure 1: Beam routing for COM3 for PRIMET B ip2/4

3 TUESDAY 3/2/09: STS BEAM B OBSERVED ON IP4 OR IP2 THROUGH THE DDL

Impact of the DDL

Configuration	
AT#4-STS	J2-Beam B
FSMB	Away from edge Position unknown
VCMB	(X,Y): see below C= **-4.743185e-003 (mm-1)** (theoretical value See Com1 report)
DL#4	OPL=14m VCM ComputeVCMParametersATBC(TelescopeStation,DL,IP,DLPOS,pupil Offset,-1) ComputeVCMParametersATBC('UT4',4,4,7,0,-1)**= 5.820640e-004 mm-1**
M16	DL#4-4AT (to feed Beam B in ip4)
Switchyard	SW4->BC-DDL
DDL	DDL7 at OPL=unknown
Ip	Ip4

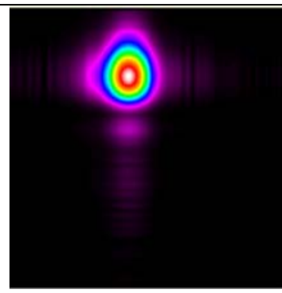
The Beam Profiler is located at 56cm from FSU_BC (between PRIMET new extraction mirror and extraction bloc), i.e after the FSU BC)
No BS in front of FSU optics on ip4



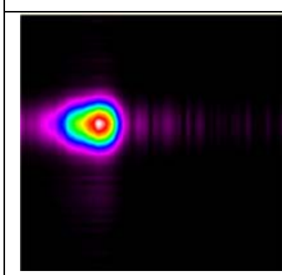
M16 ->DL#4-4AT is selected to feed STS beam B in ip4; SW#4-DDL7

	VCMB U;W	FSMB	BP X	BP Y	Ellipticity	1/e2 diameter	Power
Case 1	26.5;2,7	?	-156	77	0.948	847	0.190 mW
Case 2	27.5;2.7	?	588	-65	0.650	1328.7	0.071 mW
Case 3	25.5;2.7	?	-835	285	0.779	995.7	0.074 mW
Case 4	26.5;3.7	?	-319	989	0.892	1000	0.106 mW
Case 5	26.5;1.7	?	-95	-729	0.937	1571	0.066 mW

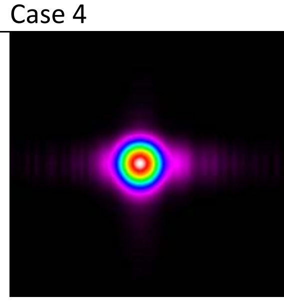
Estimation of the sensitivity: beam Radial displacement /VCM alignment offset in μm/ μm_piezo
(theory: 1370 μm/ μm_piezo)
Case 1 to case 4: ΔW=+1 ΔR=926: **S=926 μm/ μm_piezo**
The size of the vignetting free area is less than +/- 1 μm_piezo
This is comparable to the results obtained during COM2 (limited by beam distortion)



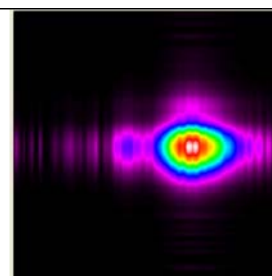
Case 4



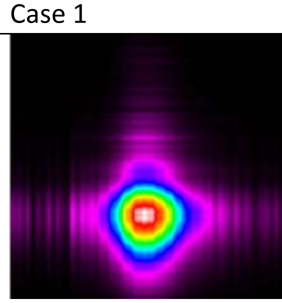
Case 3



Case 1



Case 2

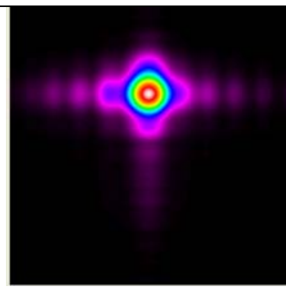


Case 5

Same as before except that
M16 ->DL#4-2AT is selected to feed STS beam B in ip2 SW#2->DDL8
Beam profiler at same position.

	VCMB U	VCMB W	BP X	BP Y	Ellipticity	1/e2 diameter	Power
Case 1	22.6	4.5	-167	110	0.894	1347	0.143
Case 2	23.1	5.7	-68	690	0.875	1122	0.270

The Beam quality is not as good as on ip4
No explanation so far. The pressure of the DL VCM was adjusted to compensate for the differential optical path but the beam quality could not be improved.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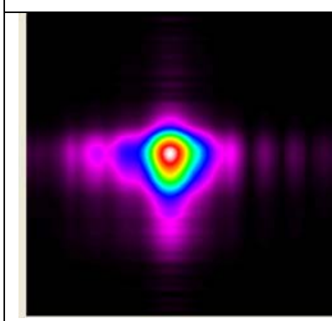
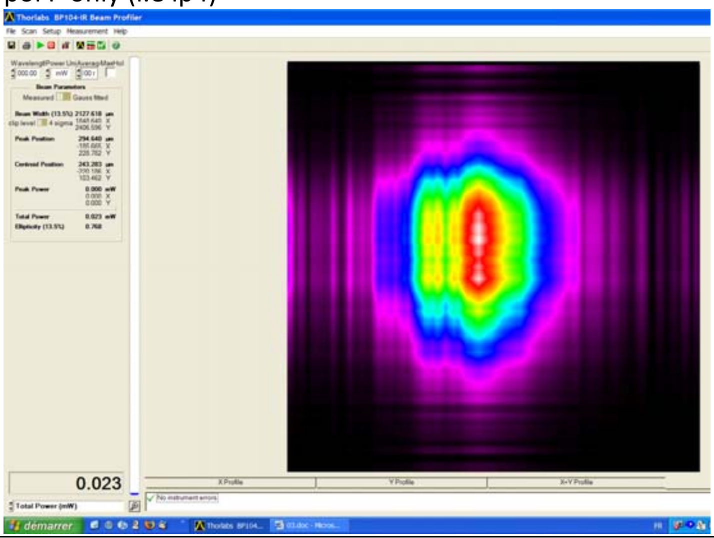

1

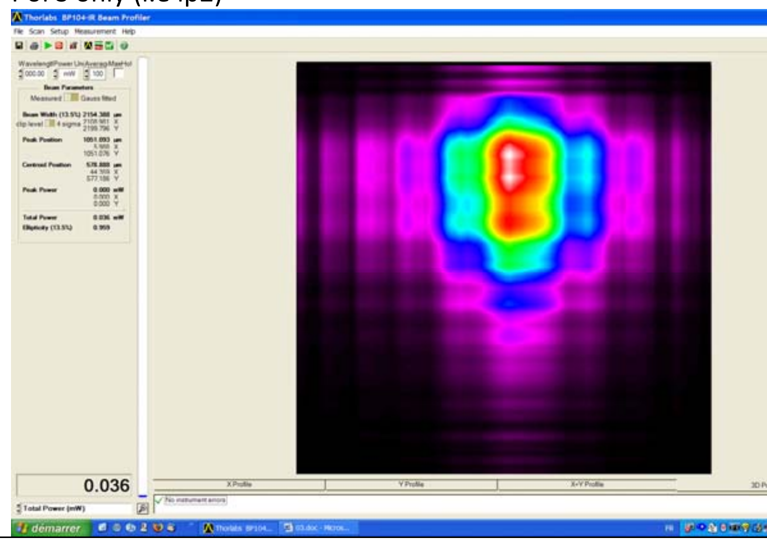
Check the beam retro-reflected by Marcel (i.e NO DDL-DL involved !)

In the last month, the contrast of PRIMET_B on marcel degraded significantly. After some investigations, it seems that the Corner Cube of Marcel corresponding to Ip4 has a problem.
The shape of the beam retroreflected by Marcel (ip2 and Ip4) were observed on the beam profiler (Beam size: limited by FSU-BC aperture). Unfortunately this test could not help to clearly identify a problem on the corner cube of ip4.

pol P only (i.e ip4)

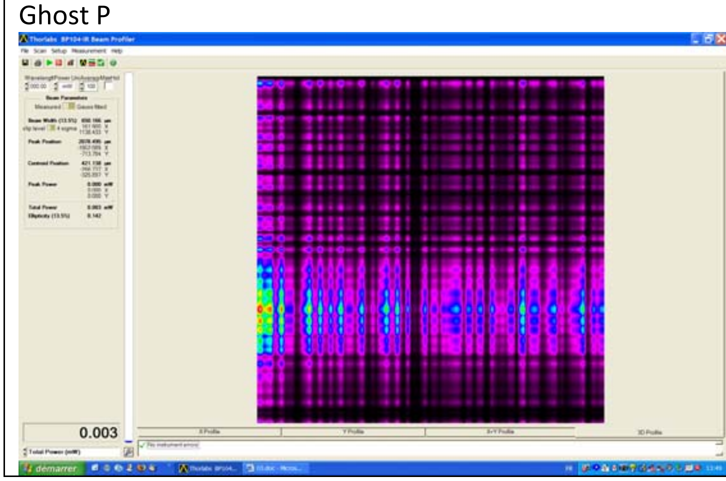


Pol S only (i.e ip2)

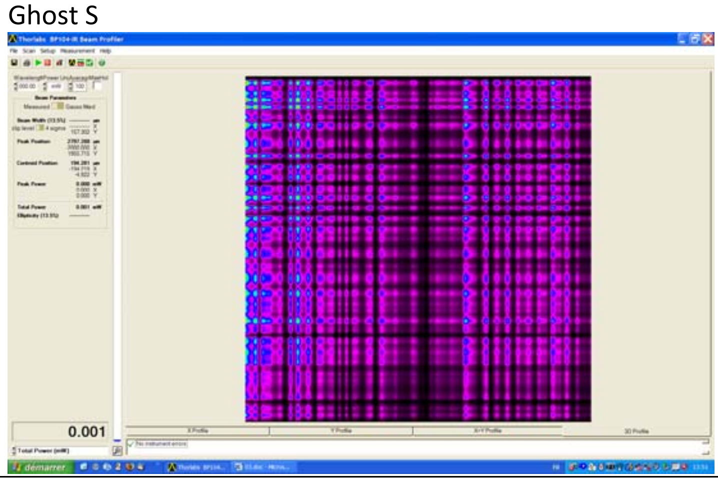


Check if there are ghost images generated by FSU Optics:
Beam retro-reflected from Marcel are interrupted

Ghost P



Ghost S



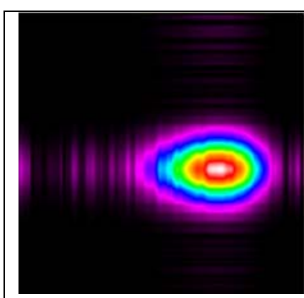
4 WEDNESDAY 4/3/02: STS BEAM B OBSERVED ON IP4 THROUGH THE DDL (NO FSU-BC)

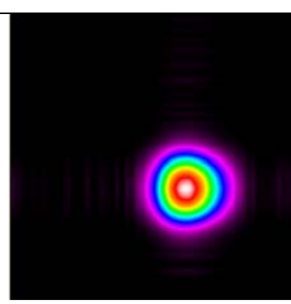
Configuration	
AT#4-STS	J2-Beam B
FSMB	(X,Y) see below
VCMB	(X,Y): see below C= 4.27e-3 mm-1 to minimise the waist in FSU-BC plane (=1.725 bars) (theoretical value com1 :C= -4.743185e-003 mm-1)
DL#4	OPL=14m VCM ComputeVCMParametersATBC(TelescopeStation,DL,IP,DLPOS,pupil Offset,-1) ComputeVCMParametersATBC('UT4',4,4,7,0,-1)= **5.820640e-004 mm-1 (i.e No offset)**
M16	DL#4-4AT (to feed Beam B in ip4)
Switchyard	SW4->BC-DDL
DDL	DDL7 at OPL=??
Ip	Ip4

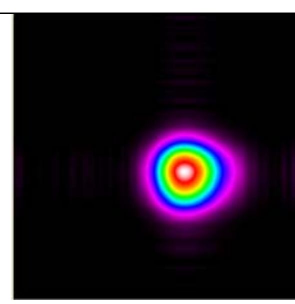
A BS is located in front of the FSU optics. The Beam Profiler profiler placed at distance equivalent to BC Therefore the beam does not go through the FSU_BC optics

	VCMB U W	**FSM B**	**BP X (pk)**	**BP Y (pk)**	**Ellipticity**	**1/e2 diameter**	**Power**
Case 1	26.5; 2.5	13.75; 12.9	313	-234	0.932	1113	0.102
Case 2: **on edge**	26.5; 2.5	12.6; 12.9	582	-204	0.65	1441	0.034
Case 3: **2 arcsec from edge**	26.5; 2.5	12.71;12.9	393	-453	0.957	1130	0.098

Estimation of the sensitivity: beam Radial displacement /FSM alignment offset in µm/ µm_piezo
(theory: 0 µm/ µm_piezo !!)
Case 1 to case 3: ΔX=-1.04 (2arcsec_sky) ΔR=233.15: **S~224 µm/ µm_piezo**
Or S~116 **µm/arcsec_sky**


Case 2: on edge


Case 3: out of edge (2 arcs_sky)


Case 1: out of edge

Conclusion: effect of edge not too dramatic. Impact on transmission T=0.034/0.098 ~ **34 %**
Crosstalk fsm/beam position looks acceptable. TBC when closing both FSM and VCM loops are closed

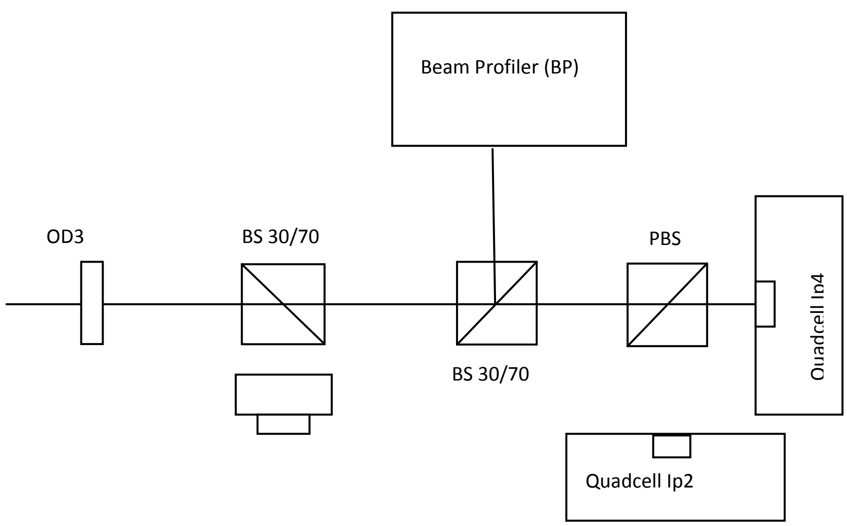
Comparing the flux recorded for case 1 of 3/2 and case 1 of 4/2:
T=102/190=**53 %.**
The optics used in these cases was not the same
3/2/09: FSU BC only
4/2/08: BS(30/70) only
Theoretical ratio: 0.3x0.7/0.5=**42 %**
(looks OK)

5 THURSDAY 5/2/09:

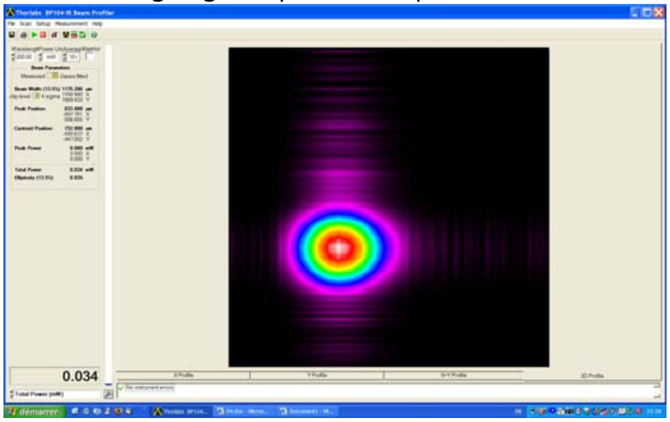
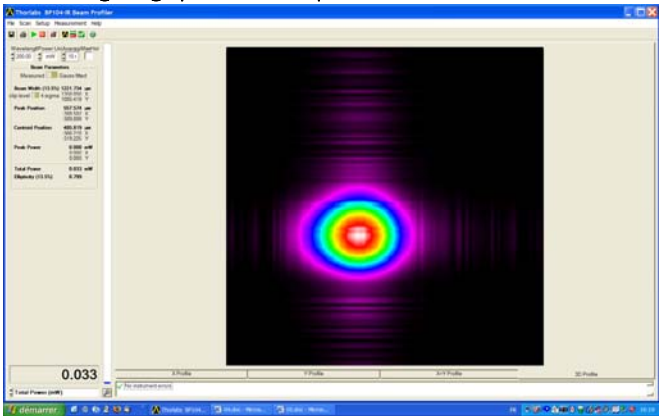
5.1 Impact of the DL and DDL on the pupil motion (open loop)

Configuration	
AT#4-STS	J2-Beam B ENCLOSURE CLOSED, Air Conditioning ON
FSMB	13.6 12.9 (out of edge)
VCMB	26.7 ;2.9 C= 4.27e-3 mm-1 to minimise the waist in FSU-BC plane (=1.725 bars) (theoretical value com1 :C= -4.743185e-003 mm-1)
DL#4	OPL=14m VCM ComputeVCMParametersATBC(TelescopeStation,DL,IP,DLPOS,pupil Offset,-1) ComputeVCMParametersATBC('UT4',4,4,7,0,-1)**= 5.820640e-004 mm-1 (i.e No offset)**
M16	DL#4-4AT (to feed Beam B in ip4)
Switchyard	SW4->BC-DDL
DDL	DDL7
Ip	Ip4

Note: The metrology of DDL7 and DDL8 was re-aligned by B.Chazelas



The Beam Profiler is located at the level of the quadcell
A Neutral Density filter (OD3) is positioned in front of the extraction block. Therefore, the beam intensity is attenuated by factor 1/1000 not to saturate the quadcell. The beam diameter measured by the beam profiler is ~1220 microns.
As the beam was coming back at the centre of the polarizing patch of the FSU_BC, the quadcell was moved to center the beam on it rather than adjusting the STS-VCM.

Before re-aligning the quadcell of ip4	After aligning quadcell of ip4
	

Common Operating conditions: IP4 ; AT4 enclosure closed; Open Loop (no Pupil tracking)
DL#4=14m OPL
DDL

FileName MetQuadCentroids2009-02-	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
	No DL/DDL Motion							
05T15.21.17	NSC in lab Res.freq: 50hz,120Hz PGA=1 TRANS=5.6	1000	60	610	0.478	0.088	291.58	53.68
05T15.31.04	PGA=1 **TRANS=10**	1000	60	610	0.46	0.09	280.6	54.9
05T16.14.16	Dominated by ~5 sec period PGA=1 TRANS=5.6	1000	300	610	0.465	0.083	283.65	50.63
05T16.39.58	15 sec only ! **Dominated by Large beam drift. Reason unknown** Starting position biased (-0.4;0.4) PGA=1 TRANS=5.6	1000	15	610	0.521	0.17	317.81	103.7
05T16.45.53	Dominated by ~5 sec period Starting point : (-0.3 ;0) PGA=1 TRANS=5.6	1000	300	610	0.425	0.073	259.25	44.53
						Average OL no DL/DDL motion	**429**	**61**

FileName **MetQuadCentroids2009-02-**	**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**
With DL/DDL motion								
05T15.32.36	DDL7 home switch High res.freq 67Hz;130Hz Position heavily disturbed PGA=1 **TRANS=10**	1000	60	610	0.76	0.1	463.6	61
05T17.01.15	DL4 tracking @ 5 mms-1 from 14 m (300mm in 60 sec). Dominated by Jitter. Starting point too far (-0.3;0.3) PGA=1 TRANS=5.6	1000	60	610	0.42	0.079	256.2	48.19
05T17.03.06	DL4 tracking @ 5 mms-1 from 14 m.(1.5 m in 300sec)	1000	300	610	0.67 Underestimated Beam offset too large	0.132	408	80
05T17.09. 55	idem, beam recentered before file was taken Again 1.5 m in 300sec	1000	300	610	0.74	0.127	451	77
05T17.19.21	DDL home switch	1000	60	610	0.5	0.07	305	42
05T17.21.10	sending offsets of 10 mm to the DDL	1000	60	610	0.7	0.067	427	41

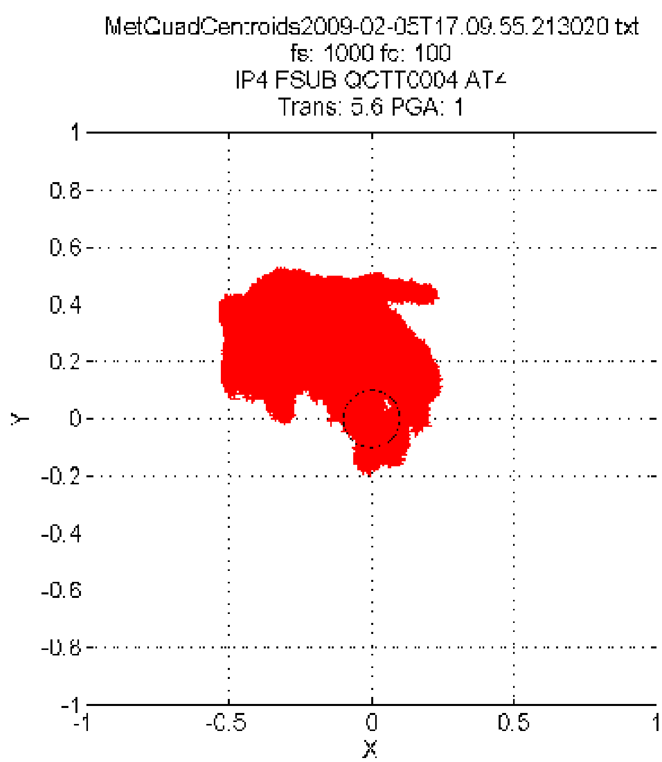


Figure 2: DL4 tracking @ 5 mms-1 from 14 m.(1.5 m in 300sec)

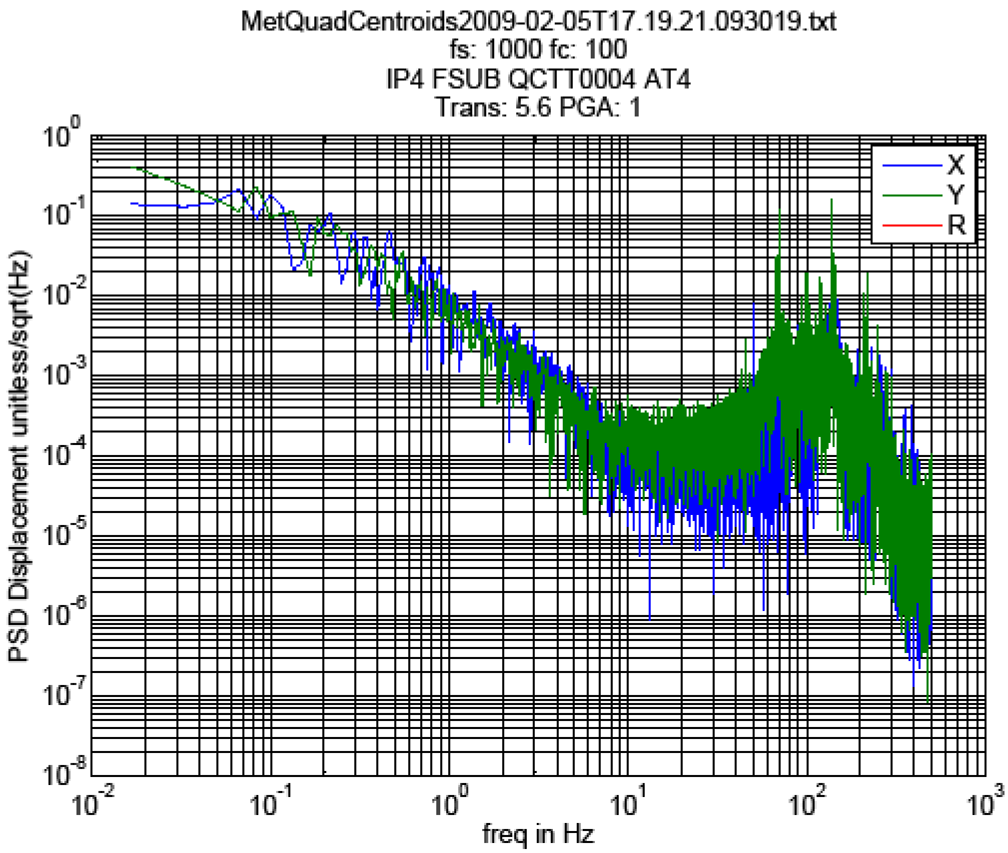


Figure 3: DDL sent to home switch

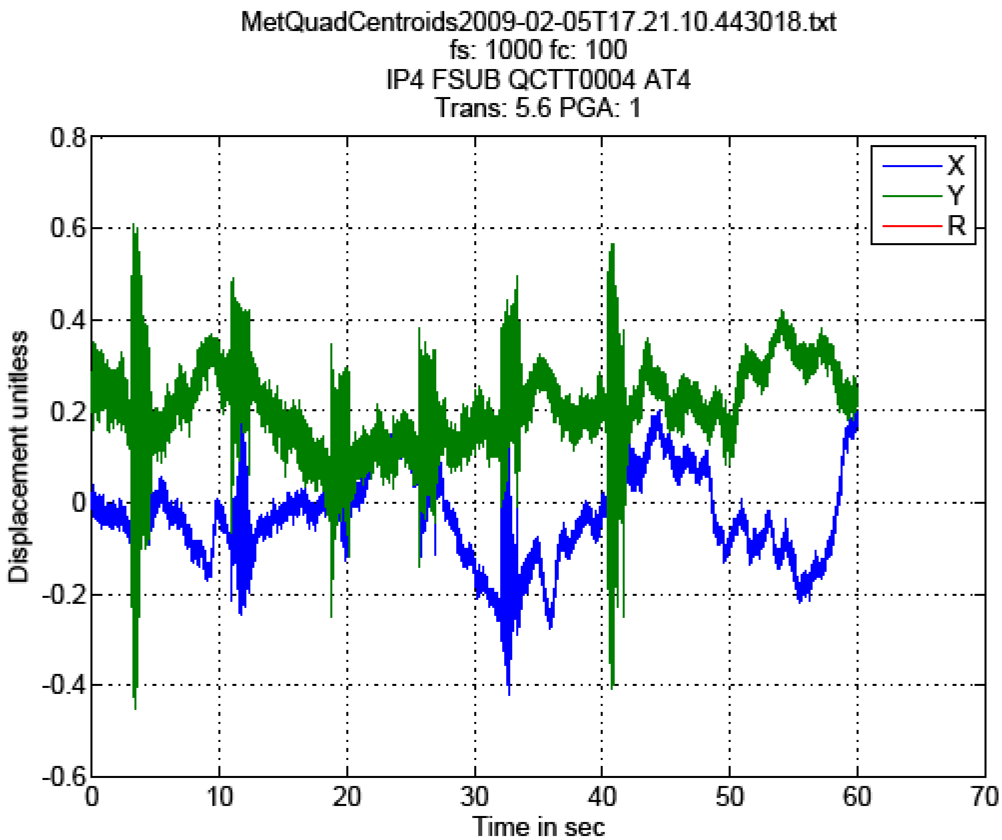


Figure 4: sending offsets of 10 mm to the DDL

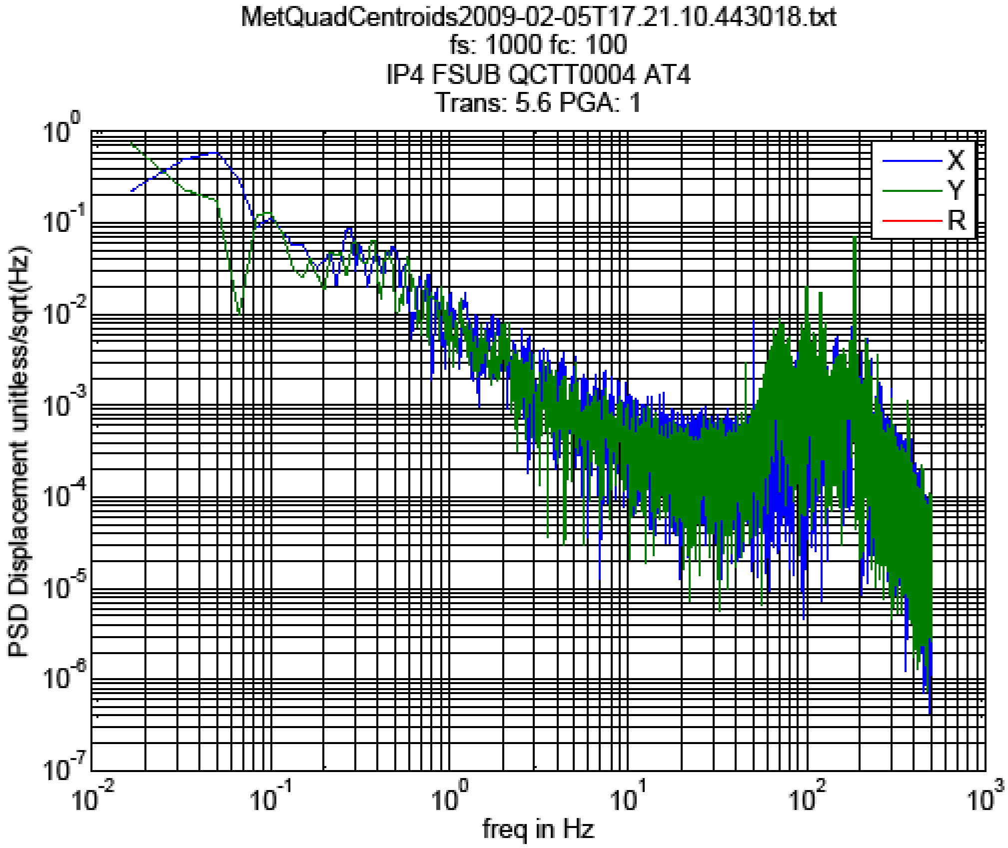


Figure 5: sending offsets of 10 mm to the DDL (PSD)

Conclusion:

1. OL measurement show large displacements dominated by a 5 second period
2. By comparing with COM1 data : AT#4 J2-IP4 no DDL (See VLT-TRE-ESO-15730- 4653)

The Pk and rms were on average significantly smaller. Possible explanations:
- the beam diameter could have been underestimated at COM1
- More turbulence was generated during COM3 for example in the lab where the cryostat intervention as well as some PRIMET alignment took place
- drift introduced by the DDL: to be checked during Com4 (but this is less plausible)

Data from COM1: VLT-TRE-ESO-15730- 4653									
Filename	**Loop**	**Enclosure**	**Wind**	**Beam radius**	**Tobs**	**Pk.Rad**	**Rms Rad**	**Pk µm**	**rms µm**
24T19.53	Opened	Closed	-	750 µm	100s	0.295	0.055	221.25	41.25
25T22.49	Opened	Closed	-	750 µm	300s	0.739	0.171	554.25	128.25
26T02.28	Opened	Opened (3AT)	12m/s	750 µm	300s	0.109	0.022	81.75	16.5
26T02.34	Opened	Opened (3AT)	12m/s	750 µm	300s	0.122	0.020	91.5	15
26T03.25	Opened	Opened (3AT)	14m/s	750 µm	300s	0.163	0.026	122.25	19.5
26T03.32	Opened	Opened (3AT)	14m/s	750 µm	300s	0.126	0.020	94.5	15
26T03.39	Opened	Opened (3AT)	15m/s	750 µm	300s	0.116	0.016	87	12
							Average	**179**	**35**

3. DL tracking at 5mm/s along 300mm (05T17.01.15): no additional effect compared to the contribution of the environment (05T16.45.53).
4. DL4 tracking over 1.5 m (05T17.03.06): as identified in May2008, the pupil drift introduced by the DL over such a stroke is not be compatible with PRIMET and justifies the implementation of the PRIMET pupil tracking.
5. Moving DDL7 to its home switch or by relative steps of 10mm introduces some fast Pupil motion which will not be corrected by the tracking loop (and even amplified in the 5-10Hz region). During PRIMA operation, these actions will most probably require to recalibrate the PRIMET zero OPL.
6. During COM4, the robustness of PRIMET shall be tested during DDL tracking under representative operating conditions (played blind+fringe tracking data).

Test of the Interaction matrix: Alignment offsets are sent directly on the STS_VCM using pspzgui
Filename: 05T16.25.58

ΔU=0	ΔW=0	X~0	Y~=0.2 (starting position biased)
ΔU=0	ΔW=+1	ΔX=+0.2	ΔY=-0.6
ΔU=0	ΔW=-1	ΔX=-0.2	ΔY=+0.6
ΔU=+1	ΔW=0	ΔX=+0.6	ΔY=-0.2
ΔU=-1	ΔW=0	ΔX=-0.3	ΔY=+0.2

Considering that the starting position is biased and that the (U;W) offsets were too large for an accurate measurements, the interaction matrix can be reduced to :

$$\begin{matrix} Y \\ Y \end{matrix} = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \begin{matrix} U \\ W \end{matrix}$$

5.2 BTK preparatory tests

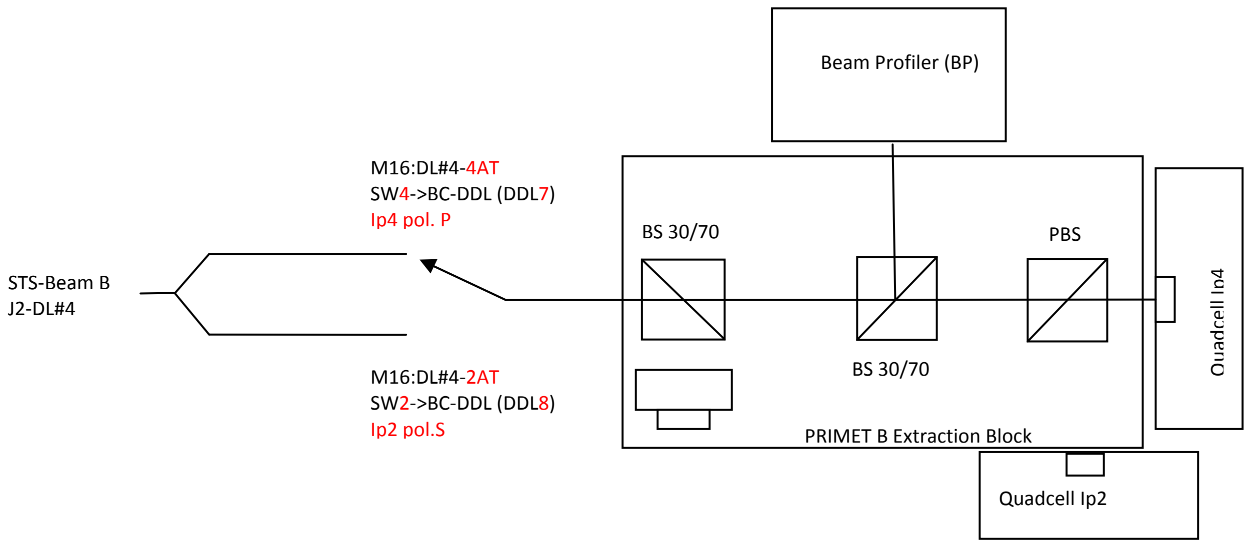
These tests failed because the guiding offsets recorded in the engineering files had the wrong resolution. The origin of the problem needs to be investigated

6 FRIDAY 6/2/09

6.1 Impact of the selection of IP and DDL on the beam position

6.1.1 Configuration

By changing the position of the M16 and the switchyard, it is possible to see on the Beam profiler:
- either the PRIMET P polarization sent to ip4 and reflected by STS-beam B, through SW4 and with/without DDL7
- or the PRIMET S polarization sent to ip2 and reflected by the STS-beam B, through SW2 and with/without DDL8



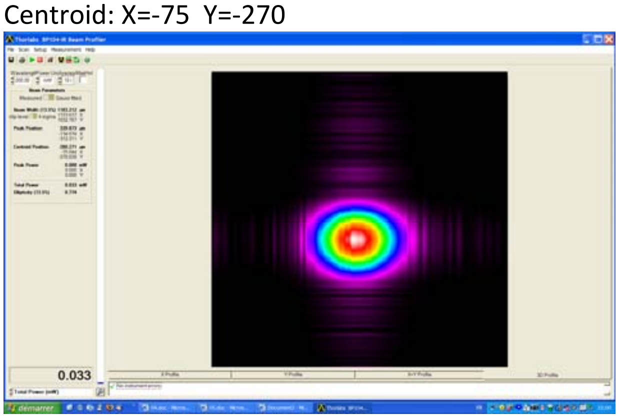
2 quadcells mounted on PRIMET B and both are aligned. However, only the Beam profiler is used throughout the study cases of section6.1.
The following criterium was used for aligning the quadcells: The returning metrology beams are observed on the beam profiler. Once the beams have a nice shape and are simultaneously centered on the polarizing patch of the FSU_BC, then each quadcell is aligned on a its specific beam. In principle, one should also cross-check that the beams are correctly injected in the extraction fiber.

Configuration	
AT#4-STS	J2-Beam B
FSMB	13.5 12.9 (out of edge)
VCMB	(X Y) See below C= 4.74e-3 mm-1 (theoretical pressure)
DL#4	OPL=14m VCM =**5.82e-004 mm-1 (i.e theoretical pressure ;No offset)**
M16	DL#4-4AT (to feed Beam B in ip4) DL#4-2AT (to feed Beam B in ip2)
Switchyard	SW4->BC/BC-DDL or SW2->BC/BC-DDL
DDL	No DDL/DDL7 or No DDL/DDL8
Ip	Ip4 or ip2

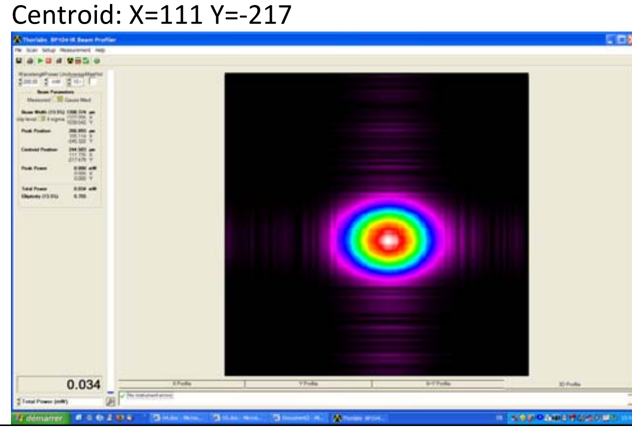
6.1.2 Study cases

M16: DL#4->4AT and SW#4=BC-DDL(7)to observe the P polarization sent to ip4 and reflected by STS-Beam B

<u>Case 1:</u> VCM B 26.8;3.5
Centroid: X=-75 Y=-270

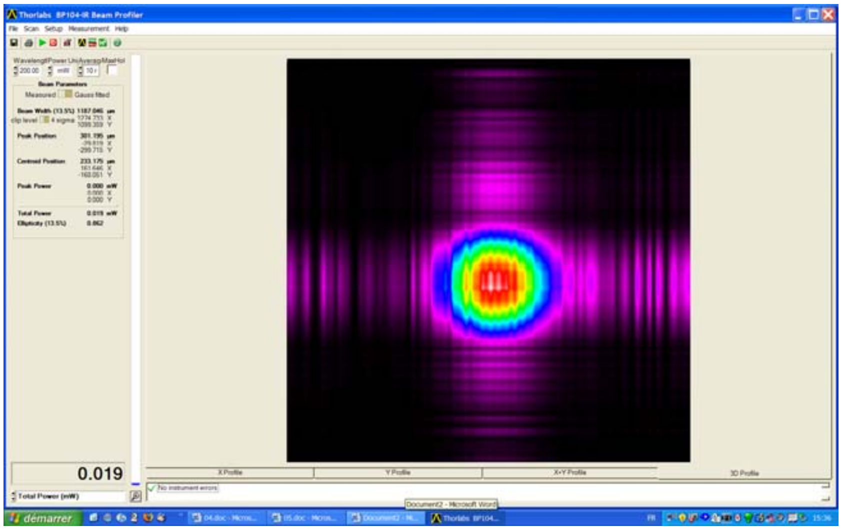


<u>Case 2:</u> VCM B 26.725; 3.2 to center on quad ip4
Centroid: X=111 Y=-217



<u>Case 3</u>: M16: DL#4->2AT and SW#2=BC-DDL(8) to observe the S polarization sent to ip2 and reflected by STS-Beam B

Vcm Optimal pressure identical ; VCMB (X;Y) adjusted to (23.1; 5.7)



<u>Case 3:</u> Centroid: X=161 Y=-168

Assuming that the VCM is adjusted to the same target position from case 2 to case 3:
VCM B (26.725; 3.2) to (23.1; 5.7)
This corresponds to (ΔX=-3.625 ; ΔY=2.5) and ΔR=4.40 μm_piezo
Given the sensitivity of ~1000 μm/ μm_piezo , the VCM adjustment corresponds to a **beam displacement of 4.4 mm while switching the configuration !**
Possible origin:

- PRIMET Ip2 and ip4 are not superimposed while leaving the FSU
- DDL8 and DDL7 are not aligned identically (impact of M3 ?); wedge of entrance window not aligned in the same way for DDL7 and DDL8 ?
- Impact of SW2 and SW4
- Impact of M16 4AT and 2 AT

<u>Impact of the Switchyard position (BC or BC-DDL)</u>

On IP2

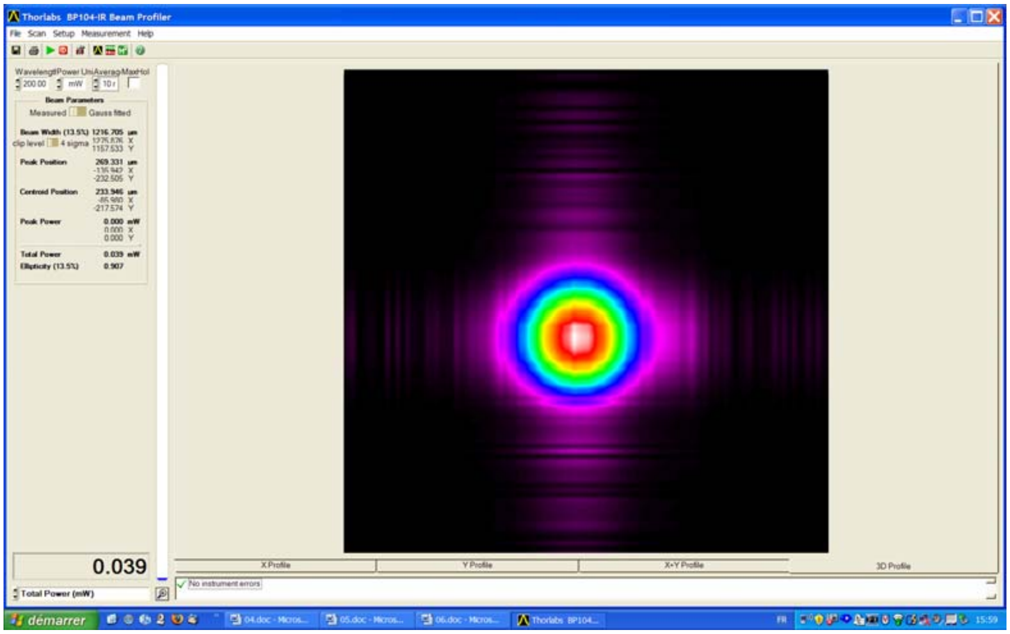
<u>Case 4</u>: M16: DL#4->2AT and <u>SW#2=BC</u> instead of BC-DDL(8)

It is impossible to bring back the beam. It is still 2-3 mm too low when returning back
This cannot be corrected by the vcm which is at the end of its stroke
Possible origin of the problem: After discussing with TPH, he acknowledged he had been playing with the ddl software at this time . It is possible that the ddl m3 was in some weird configuration shifting the pupil at a random position. To be checked again during COM4.

On IP4

<u>Case 5:</u> M16: DL#4->4AT and <u>SW#4=BC</u> instead of BC-DDL(7)

The pressure of DL#4-VCM is set to the theoretical value without DDL
ComputeVCMParametersATBC('UT4',4,4,7,4.5,-1) =3.99e-3 mm-1
The beam is found for VCMB (20.55 ; 3.4)



Case 6:

Back to ip2 with ddl. The beam has not moved on the Beam profiler compared to case 3. The DL-VCM pressure optimization does not improve the beam shape

M16: DL#4->2AT and SW#2=BC-DDL(8)

Case 7:

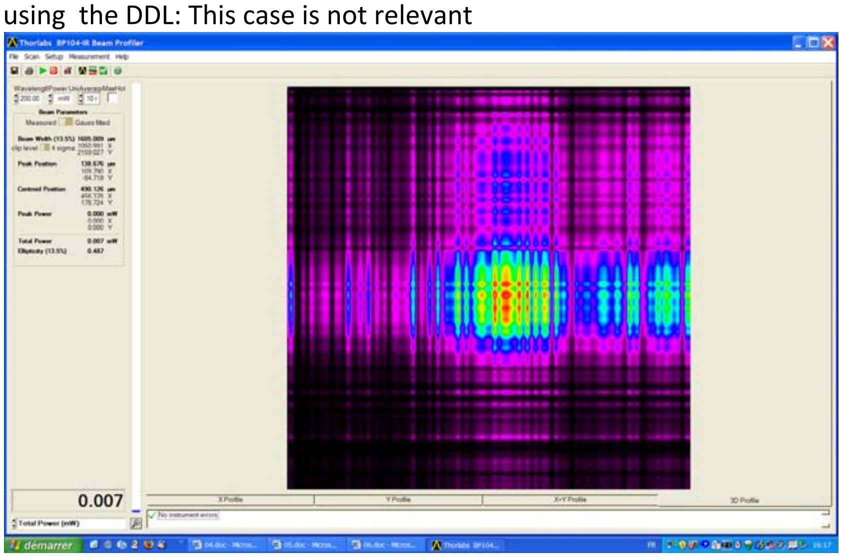
M16: DL#4->2AT and SW#2=BC : The beam cannot be found

Case 8:

M16: DL#4->2AT and SW#2=BC-DDL(8)

Back to ddl, for the same setting the beam is now disgusting…

But TPH was actually using the DDL: This case is not relevant



6.1.3 Summary and conclusion

Study case	Configuration	Comment
2	M16: DL#4->4AT and SW#4=BC-DDL(7)	VCMB (26.725; 3.2)
3	M16: DL#4->2AT and SW#2=BC-DDL(8)	VCMB (23.1; 5.7)
4	M16: DL#4->2AT and SW#2=BC	Beam lost; out of VCM stroke (DL4-VCM pressure ?)
5	M16: DL#4->4AT and SW#4=BC	VCMB (20.55 ; 3.4) (DL4-VCM pressure =theory)
6	M16: DL#4->2AT and SW#2=BC-DDL(8)	Beam OK. No spot motion compared to case 3
7	M16: DL#4->2AT and SW#2=BC	Beam lost
8	M16: DL#4->2AT and SW#2=BC-DDL(8)	Beam Ugly…but the DDL were operated simultaneously by mistake.

Case 2 to Case 3:
A beam displacement is introduced by changing the IP fed to the STS-J2-beamB.
This displacement can be corrected by (ΔX_{VCMB}=-3.625 ; ΔY_{VCMB}=2.5) or ΔR_{VCMB}=4.40 µm_piezo
Given the sensitivity of ~1000 µm/ µm_piezo , the VCM adjustment corresponds to a **beam displacement of 4.4 mm**

Possible origin:

- *PRIMET Ip2 and ip4 are not superimposed while leaving the FSU*
- *DDL8 and DDL7 are not aligned identically (impact of M3 ?); wedge of entrance window not aligned in the same way for DDL7 and DDL8 (I am not sure this has actually has an effect)?*
- *Impact of SW2 and SW4*
- *Impact of M16 4AT and 2 AT*

Case 3 to Case 4: SW#2 BC and BC-DDL(8) are not aligned on the same reference: the beam is lost

Case 2 to Case 5: :

- ➔ Switching from SW#4 BC to BC-DDL(7) introduces a beam offset which can be compensated by ΔX_{VCM_piezo}= -6.175 µm and ΔY_{VCM_piezo}= +0.2 µm. Using a Sensitivity of ~1000 µm/ µm_piezo, **the beam offsets is about 6mm horizontally and 0.2 mm vertically.**
- ➔ the transmission of DDL#7 can be estimated: Case 2:Power with DDL7=0.034 and Case 5:Power without DDL=0.039 , leading to $\mathbf{T_{DDL7\text{-}1319\ nm}}$**=87 %**

6.2 OPL measurement with/without moving DL

Configuration			
IP4		IP2	
AT#4-STS	J2-Beam B	**Corner Cube**	center of tunnel
FSMB	(X Y) unknown (out of edge ?)	**N/A**	-
VCMB	(X Y) unkown C= 4.74e-3 mm-1 (theorical value)	**N/A**	-
DL#4	OPL=14m VCM =**5.82e-4 mm-1 (i.e No offset, optimized on the beam profiler)**	**DL#6**	OPL=14m VCM pressure = Identical to DL4 in fact
M16	DL#4-4AT (to feed Beam B in ip4)	**M16**	DL#6-2AT
Switchyard	SW4->BC-DDL	**Switchyard**	SW2->BC-DDL
DDL	With DDL7 at unkown OPL	**DDL**	With DDL8, OPL=TBC

* Lprma2XXX06T16.10.11 -> internal OPD in configuration described above, 5 min
* MetQuadXXX06T16.11.04 -> pupil in conf as described above
* lprma2XXX06T16.26.54 ->DL4 tracking at 5 mms-1 from 14 m
* lprma2XXX06T16.30.30 ->DL4 tracking at 5 mms-1 from 30 m glitches while presetting
* lprma2XXX06T16.32.53 ->DL4 tracking at 5 mms-1 from 45 m

The above files were accidentaly lost....

6.3 Pupil traking and BTK tests

6.3.1 Estimation of the Transfer function

*MetQuadCentroids2009?-02-06T17.34.12.551015.txt Open loop noise, U-X axis
* MetQuadCentroids2009?-02-06T17.41.31.065015.txt Open loop noise, W-Y axis
* MetQuadCentroids2009?-02-06T18.45.28.891015.txt Closed loop, noise on U, interaction matrix = ???
* MetQuadCentroids2009?-02-06T18.53.06.867015.txt Closed loop, noise on U, reverse sign of cross terms in interaction matrix
* MetQuadCentroids2009?-02-06T19.16.38.835015.txt Open loop, noise on both axes
* MetQuadCentroids2009?-02-06T19.22.58.542015.txt Open loop, noise on U

* MetQuadCentroids2009?-02-06T19.40.06.788015.txt Open loop, noise on W
  Correction frequency 100 Hz but 50 Hz in reality (as recorded in the files).Regular time jumps
* MetQuadCentroids2009?-02-06T19.50.47.691015.txt Open loop, noise on U
  Correction frequency 100 Hz; regular time jumps of 1 msec
* MetQuadCentroids2009?-02-06T19.54.19.007015.txt Closed loop, noise on U, Id interaction matrix, gain -0.015
  Correction frequency 100 Hz; regular time jumps of 1 msec
* MetQuadCentroids2009?-02-06T19.57.43.614015.txt Closed loop, noise on W,Id interaction matrix, gain -0.015
  Correction frequency 100 Hz; regular time jumps of 1 msec

By default, the resolution for centroids data is 1 mV on each Qs and the resolution for correction data (guiding offsets) is 0.001 (microns VCM piezo). NDL changed the resolution to 1.e-6, which is actually not necessary: This corresponds to nanoVolt resolution for centroids and picometer for the VCM piezo.

CONCLUSION:

- Time jump problem needs to be investigated

6.3.2 BTK tests

* MetQuadCentroids2009?-02-06T20.20.07.059018.txt Circular modulation, amp 0.2, freq 10, centered

Time jumps 40 microsec
Modulation clearly seen on centroids X and Y (PSD) and also on Radial motion w.r.t first point. (It should not be seen on radial motion w.r.t mean position)
Beam was initially not well centered

On the correction file: modulation using user guiding offets: amplitude is 0.02 (probably because of divide factor10) and frequency 10Hz (no jitter). 10 points on modulation circle

Analysis with BTK_analysis.m:
Coherence very good at 10Hz: C_{XU}=C_{YW}=1 (also C_{Xw}=C_{YU}=1)and lower at other frequencies

* MetQuadCentroids2009?-02-06T20.22.05.599019.txt Circular modulation, amp 0.2, freq 10, offset VCM by (0.5,0.5)
* MetQuadCentroids2009?-02-06T20.23.57.329019.txt Circular modulation, amp 0.2, freq 10, offset VCM by (1.0,1.0)
* MetQuadCentroids2009?-02-06T20.32.14.022018.txt Circular modulation, amp 0.2, freq 20, centered

5 points on modulation circle
"turn" faster but with less points: is that better ?

Conclusion: the modulation of radius 0.02 can clearly be seen on the centroid and there is good hope that synchronous demodulation can help in detecting the beam. See also section (SAT 7/2)

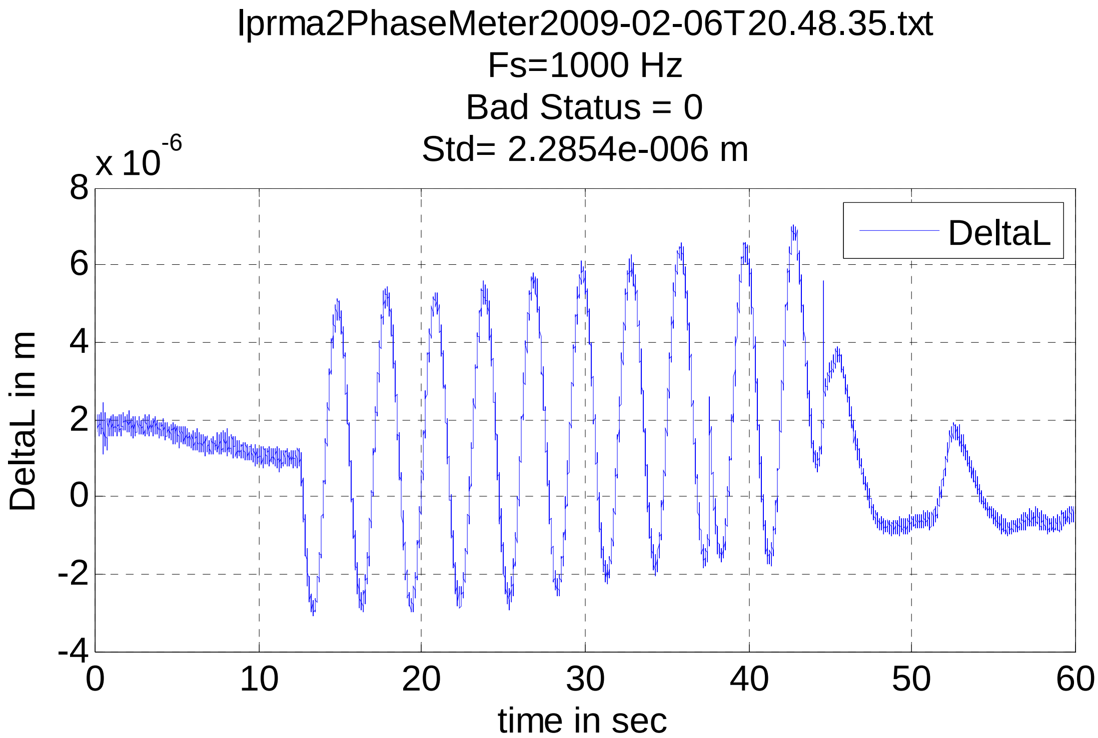
6.4 OPL measurements with moving DDL

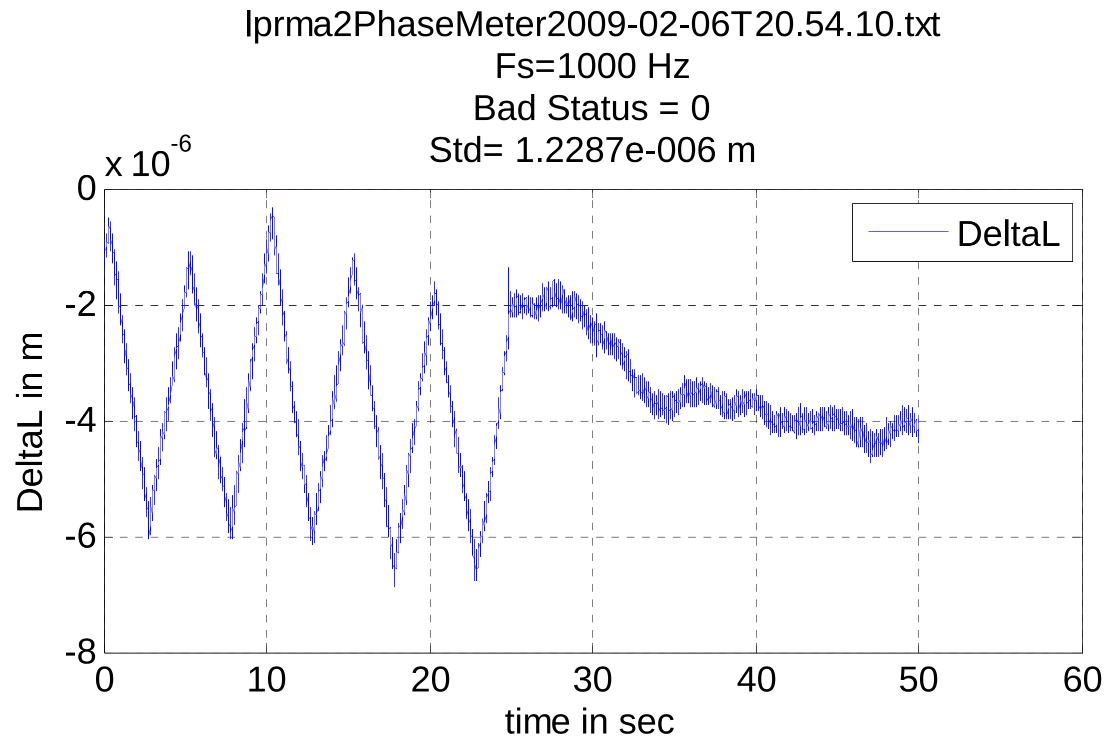
No BTK modulation injected
PRIMET A operates on MARCEL.

lprma2XXX06T20.48 -> ddl follows sin 0.3 Hz with amplitude (0-Pk) 2 um;
OK seen clearly on PRIMETA-B data 0-Pk=4microns, i.e twice as DDL metrology as expected
lprma2XXX06T20.54 -> ddl follows triangle with amplitude 1 um;
Triangle seen on PRIMETA-B data; However the amplitude is ~5 microns

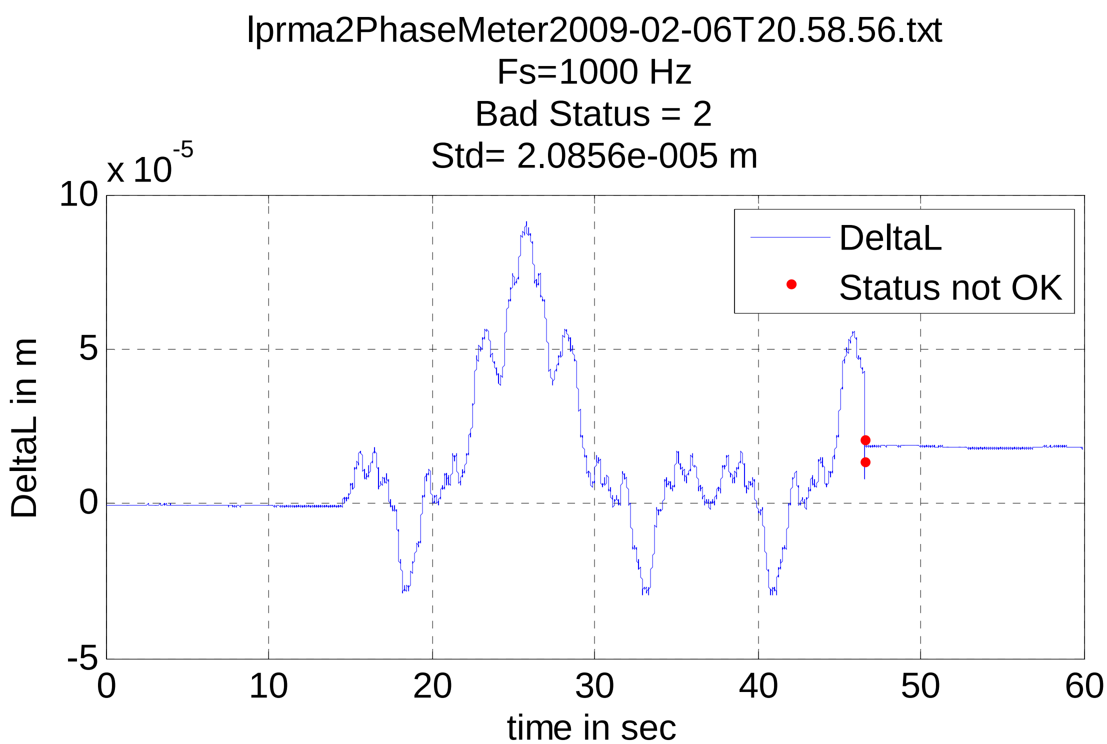
lprma2XXX06T20.58.56 -> Kolmogorov
Peak at ~80 microns measured by PRIMETA-B, i.e similar amplitude for stellar light.
(Amplitude TBC with Bruno Chazelas)
lprma2PhaseMeter2009-02-06T21.00.30.txt -> DDL not moving; but 4 sec only
lprma2PhaseMeter2009-02-06T21.01.21.txt-> DDL not moving,
60 sec. Contribution of Eigenfequency at 300 Hz ; 3% of 94 nm=~ 3nm

CONCLUSION:
At first glance, the motion of the DDL is measured correctly by PRIMET. A more detailed analysis should be performed by comparing the DDL metrology and the PRIMET metrology data.
In the configuration used by PRIMET , it is not possible to identify any particular vibration induced by the DDL. The OPL is dominated by a “forest” of vibrations in the 75 to 130 Hz region, which can be generated by any system along the 300m optical path

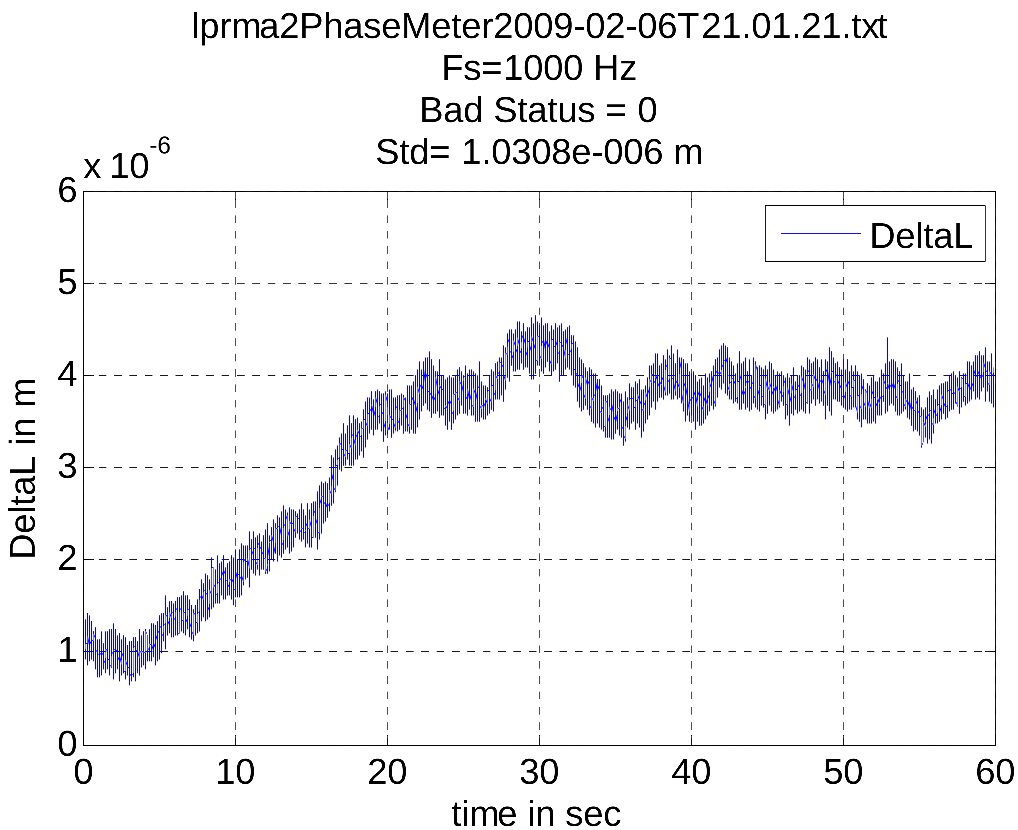


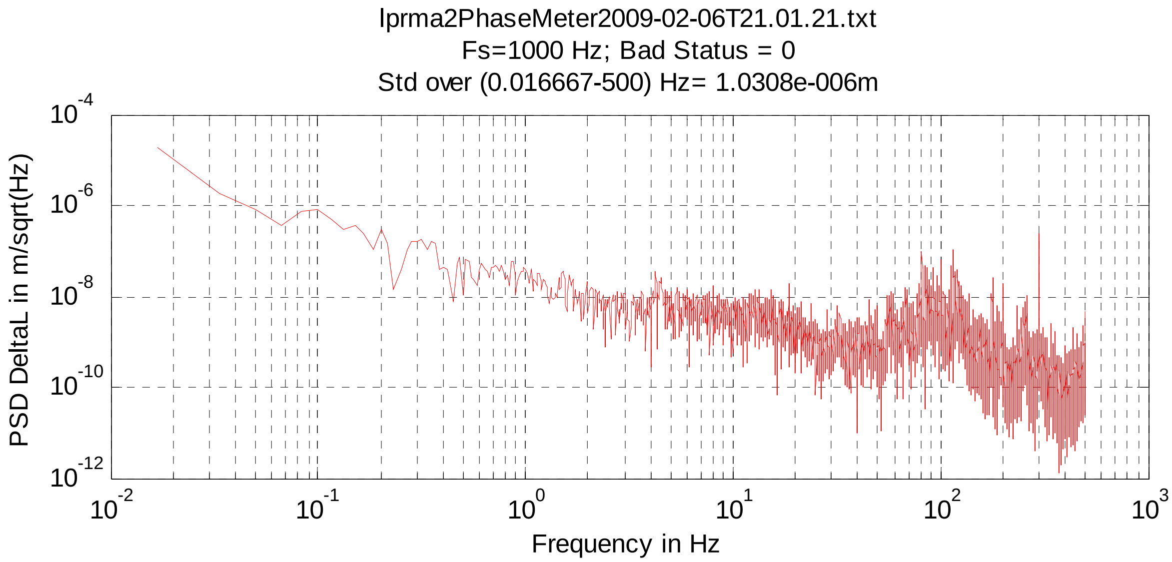


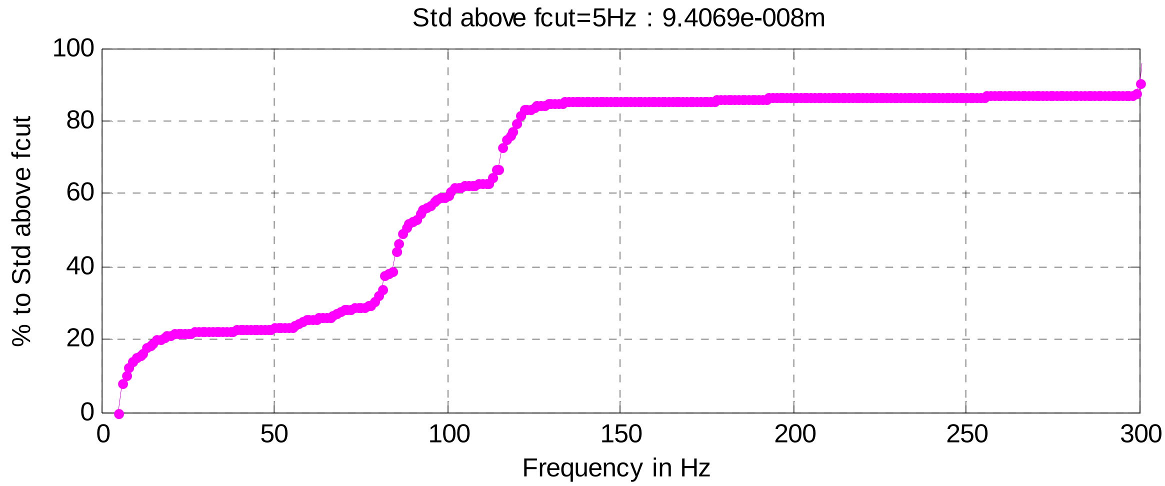
Iprma2PhaseMeter2009-02-06T20.54.10.txt
Fs=1000 Hz
Bad Status = 0
Std= 1.2287e-006 m
x 10^-6
DeltaL in m
time in sec
DeltaL
0
-2
-4
-6
-8
0
10
20
30
40
50
60



Iprma2PhaseMeter2009-02-06T20.58.56.txt
Fs=1000 Hz
Bad Status = 2
Std= 2.0856e-005 m
x 10^-5
DeltaL in m
time in sec
DeltaL
Status not OK
10
5
0
-5
0
10
20
30
40
50
60


lprma2PhaseMeter2009-02-06T21.01.21.txt
Fs=1000 Hz
Bad Status = 0
Std= 1.0308e-006 m
x 10^-6
DeltaL
DeltaL in m
time in sec
0
1
2
3
4
5
6
0
10
20
30
40
50
60





6.5 OPL and Pupil tracking test during DDL motion and STS FSM chopping

Close loop parameters used from there:
Gain = -0.015
IM is identity
Q4pmpsA1 = -1.89…..
Q4pmpsA2 = 0.89215…..
Q4pmpsB1 = -1.999…..
Q4pmpsB2 = 0.999…..

All files from there are <u>with pupil tracking</u>

6.5.1 Opened enclosure, No exitation

opd, opened DOME, no excitation on DL/DDL

==> Filename: lprma2PhaseMeter2009-02-07T01.03.56.txt

Sampling frequency= 1000 Hz

Number of samples= 120000 -> 120 sec

DeltaL Mean= -1.586412e-005 m

DeltaL PV= 1.025636e-004 m

DeltaL rms= 1.754044e-005 m

Status Not OK: 2378 !!!! (450 kHz not detected because the corner cube located inside the tunnel was not aligned correctly (see below)

Dominated by 60 Hz frequency ??? origin ??? corner cube ??

And associated quadcell data:

FileName	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
MetQuadXX07T01.01	Trans=10 ; PGA=1 Closed loop	1000	120	610	0.31	0.038	189	23
MetQuadXX07T01.05	Trans=10 ; PGA=1 Closed loop Significantly better-→	1000	120	610	0.21	0.02	128	12

no modulation of DL/DDL

==> Filename: lprma2PhaseMeter2009-02-07T01.13.09.txt

Sampling frequency= 1000 Hz

Number of samples= 120000

DeltaL Mean= 1.171178e-006 m

DeltaL PV= 2.561000e-006 m

DeltaL rms= 5.184480e-007 m

Status Not OK: 842 !!! (450 kHz not detected)

60 Hz not seen anymore

And associated quadcell data

FileName	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
MetQuadXX07T01.12.56	Trans=10 ; PGA=1 Closed loop	1000	120	610	0.17	0.025	104	15

<u>**Conclusion**</u>: glitches occur when the quadcell is operated in closed loop. Closed loop residuals rather high. The glitch (450kHz not detected) is most probably due to the bad alignment of the corner cube at the center of the tunnel.

6.5.2 Modulation of the DDL OPL

Enclosure Opened

DDL sine modulation 0.3 Hz, amplitude 2 um;

Filename: lprma2PhaseMeter2009-02-07T01.10.18.txt

Sampling frequency= 1000 Hz
Number of samples= 60000 -> 60 sec
DeltaL Mean= 8.171517e-007 m
DeltaL PV= 1.018050e-005 m
DeltaL rms= 2.240538e-006 m
Status Not OK: 1610 !!!

Modulation is nicely seen on OPL data; frequency and amplitude are OK. As before the glitches are attributed to the bad alignment of the corner cube.

Associated file:

FileName	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
MetQuadXX07T01.10.20	Trans=10 ; PGA=1 Closed loop	1000	120	610	0.174	0.026	106	16

➔ quadcell ~in spec (if beam radius confirmed) but gliches on OPL…

no 0.3 Hz contribution neither in the quadcell corrections, nor in the centroids. DDL7 does not introduce lateral motion …over a 2 microns displacement(!!)

then Realignment of corner cube in the tunnel with help of Christian

sine modulation 1 um 40 Hz;

==> Filename: lprma2PhaseMeter2009-02-07T01.32.18.txt

Sampling frequency= 1000 Hz
Number of samples= 120000 -> 120 sec
DeltaL Mean= 1.592198e-006 m
DeltaL PV= 1.278900e-005 m
DeltaL rms= 9.954289e-007 m
Status Not OK: 0 !!!!yes !!

Modulation clearly seen, no problem, measured amplitude and frequency are OK.

Associated file:

FileName	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
MetQuadXX07T01.32.19	Trans=10 ; PGA=1 OPEN loop !!	1000	120	610	0.33	0.055	201	34

➔ No glitch although pupil tracking is open loop. This suggests that the glitches seen before were due to a low signal on Ip2 (corner cube)

triangular modulation;

==> Filename: lprma2PhaseMeter2009-02-07T01.36.09.txt

Sampling frequency= 1000 Hz

Number of samples= 93865 -> 1 min 30
DeltaL Mean= -2.421509e-007 m
DeltaL PV= 1.166840e-005 m
DeltaL rms= 1.423951e-006 m
Status Not OK: 0 !!!!yes !!

Modulation clearly seen: amplitude 5 microns period 0.1 Hz.

Associated file:

FileName	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
MetQuadXX07T01.36.07	Trans=10 ; PGA=1 OPEN loop !!	1000	120	610	0.324	0.056	197	34

->Unfortunately we don't have OPL+pupil CL measurement on 6/2.
See 1 file recorded on 7/2

6.5.3 Chopping of the FSM-STS

The AT Enclosure is Opened

2 arcsec_sky at 0.5 Hz chopping with STS

MetQuadXXXT01.40.53, lprma2XXXT01.40 ->;
==> Filename: lprma2PhaseMeter2009-02-07T01.40.45.txt
Sampling frequency= 1000 Hz
Number of samples= 120000 → 2 minutes
DeltaL Mean= -1.018147e-005 m
DeltaL PV= 7.710200e-006 m
DeltaL rms= 1.110232e-006 m
Status Not OK: 0 : Comptability with FSM motion is here demonstrated

However as seen below it has a clear effect on the OPD ! (at same frequency of 0.5 Hz)

The Scale is 800nm for 2 arcsec, i.e **400nm/arcsec_sky**

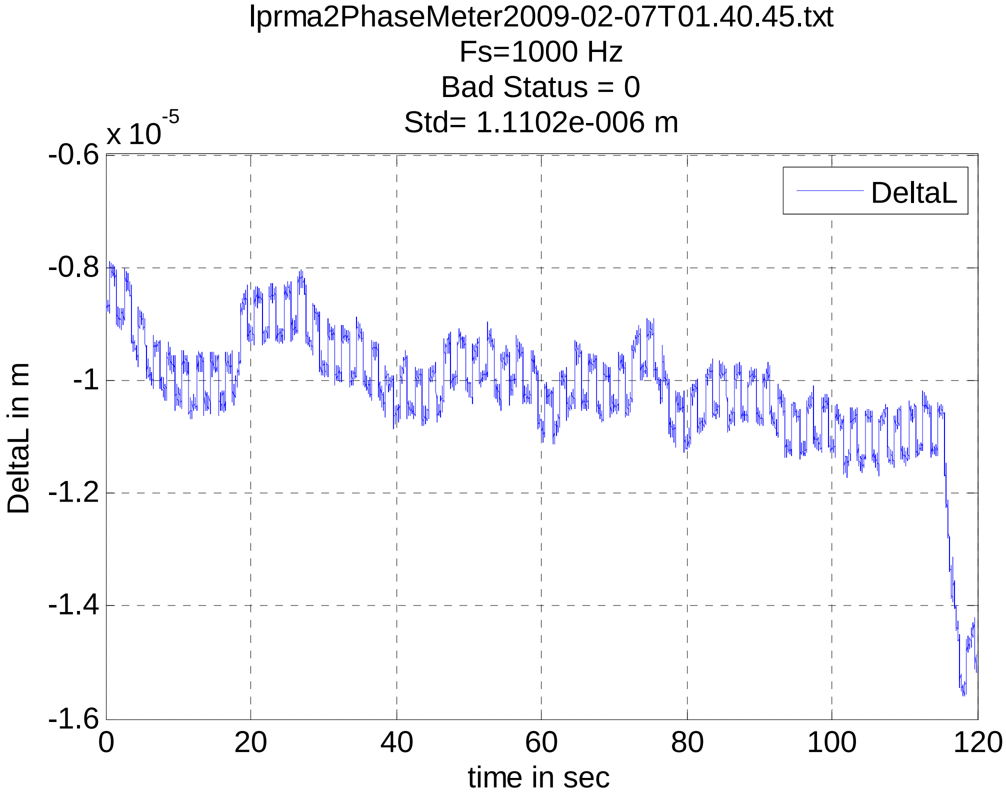
This does not sound good for the IRIS/FSM loop…(unless part of it cancels outs in the differential measurement)

Associated file:

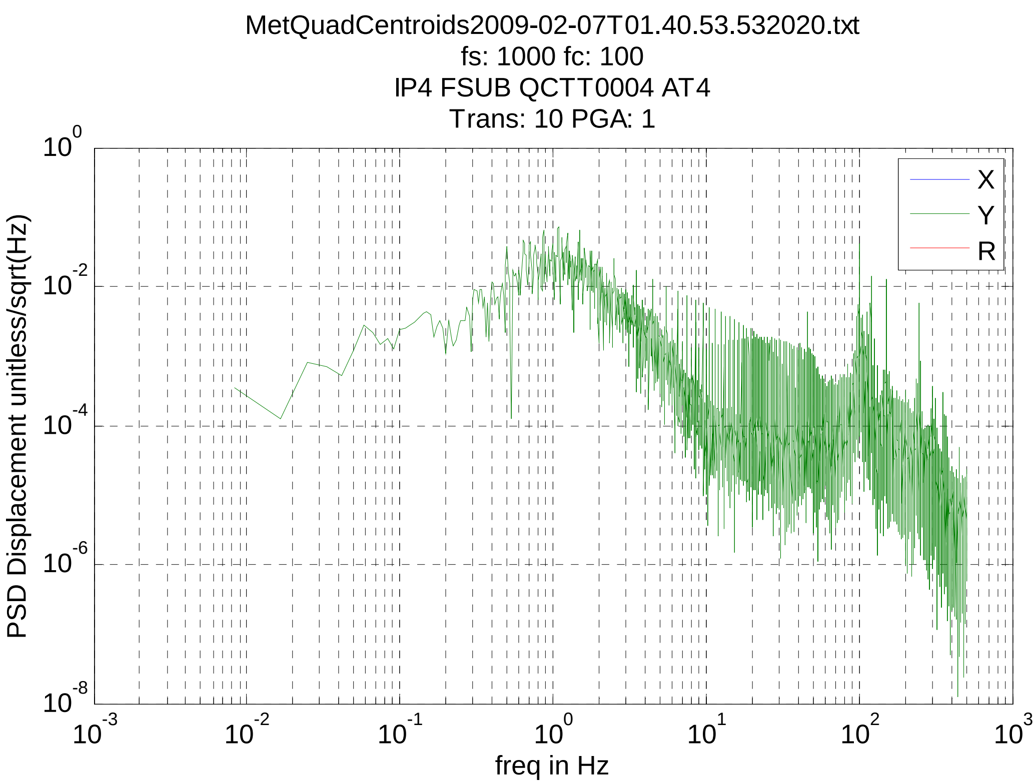
FileName	Comments	Fs(Hz)	Tobs(s)	Beam radisu. um	Radial Peak(rad) w.r.t 1st point	Radial rms (rad)	Radial Pk um	Radial rms um
MetQuadXX07T01.40.53	Trans=10 ; PGA=1 Closed loop	1000	120	610	0.49	0.053	~300	32

FSM modulation leaks into pupil lateral position

from section 4: the estimated crosstalk is 116 microns/arcsec_sky



Iprma2PhaseMeter2009-02-07T01.40.45.txt
Fs=1000 Hz
Bad Status = 0
Std= 1.1102e-006 m
x 10^-5
-0.6
-0.8
-1
-1.2
-1.4
-1.6
DeltaL in m
DeltaL
0
20
40
60
80
100
120
time in sec

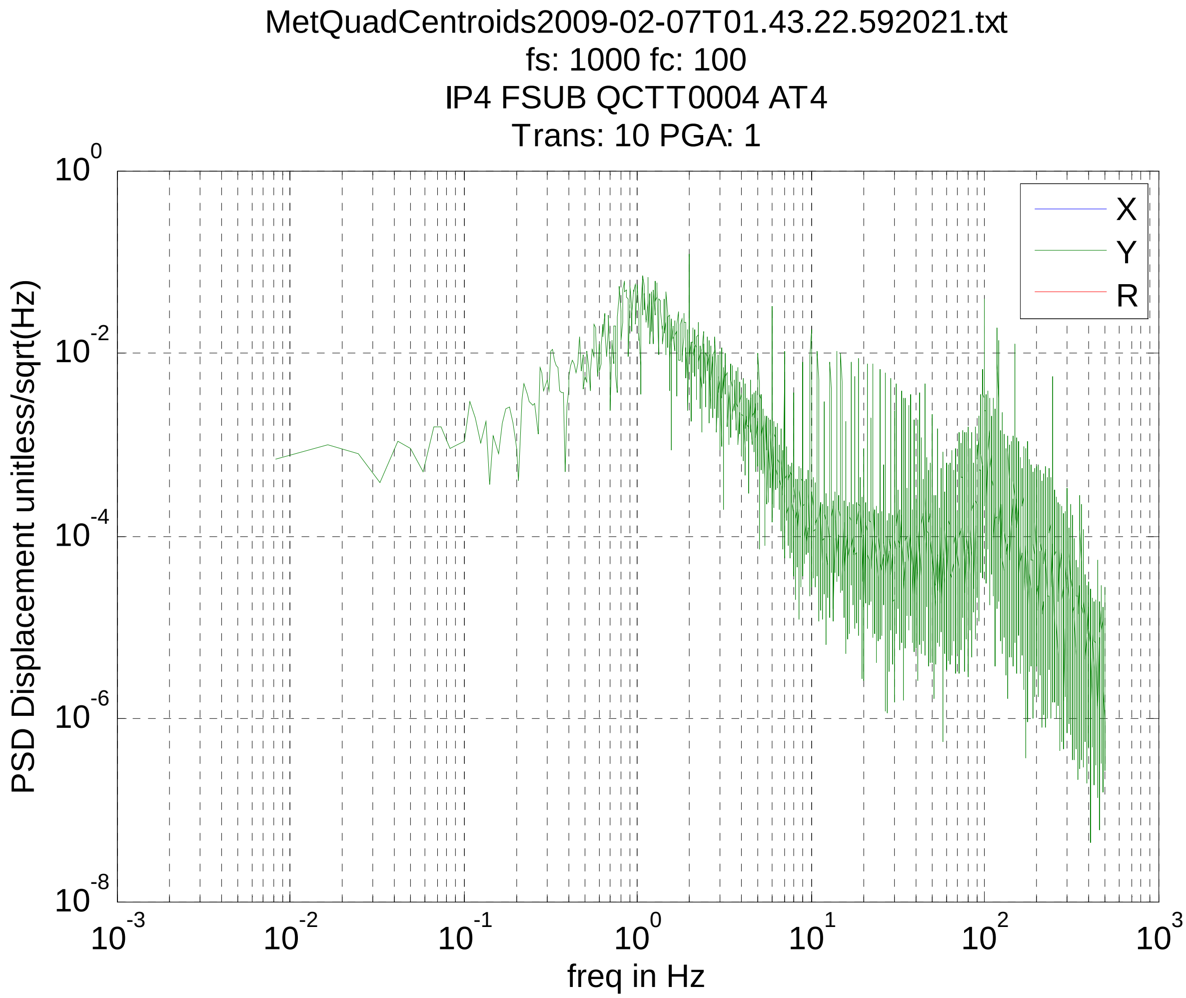


MetQuadCentroids2009-02-07T01.40.53.532020.txt
fs: 1000 fc: 100
IP4 FSUB QCTT0004 AT4
Trans: 10 PGA: 1
10^0
10^-2
10^-4
10^-6
10^-8
PSD Displacement unitless/sqrt(Hz)
X
Y
R
10^-3
10^-2
10^-1
10^0
10^1
10^2
10^3
freq in Hz

2 arcsec at 2 Hz chopping with STS
MetQuadXXXT01.43.22, ->;
Phase Meter Data
==> Filename: lprma2PhaseMeter2009-02-07T01.43.20.txt
Sampling frequency= 1000 Hz
Number of samples= 120000 -> 2 minutes
DeltaL Mean= 4.291373e-007 m
DeltaL PV= 4.111500e-006 m
DeltaL rms= 7.325724e-007 m
Status Not OK: 0
FSM modulation affect the OPL
Crosstalk FSM/OPL is as before ~ 400nm/.arcsec

FileName	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
MetQuadXX07T01.40.53	Trans=10 ; PGA=1 Closed loop	1000	120	610	0.287	0.038	175	23

FSM modulation of 2Hz can be seen on the quadcell residuals . It cannot be compensated by the tracking loop (fc~1 Hz) and it is even amplified !



MetQuadCentroids2009-02-07T01.43.22.592021.txt
fs: 1000 fc: 100
IP4 FSUB QCTT0004 AT4
Trans: 10 PGA: 1
PSD Displacement unitless/sqrt(Hz)
freq in Hz
X
Y
R

7 SATURDAY 7/2/09

Configuration			
IP4		IP2	
AT#4-STS	J2-Beam B	**Corner Cube at center of tunnel**	N/A
FSMB	(X Y) unknown (out of edge)	**N/A**	N/A
VCMB	(X Y) unkown C= 4.27e-3 mm-1 (or theory 4.74)	**N/A**	N/A
DL#4	OPL=14m VCM =**5.82e-4 mm-1 (i.e No offset)**	**DL#6**	OPL 14 m VCM same as DL4
M16	DL#4-4AT (to feed Beam B in ip4)	**M16**	DL#6-2AT
Switchyard	SW4->BC-DDL	**Switchyard**	SW2->BC-DDL ?
DDL	DDL7 at OPL=??	**DDL**	DDL8 at OPL=??

<u>OPD measurements in parallel with CL pupil tracking on ip4</u>
lprma2PhaseMeter2009-02-07T11.23.07.txt
MetQuadC*02-07T11.23.13.txt

Parameters of the loop:
Same as Friday 6/2:

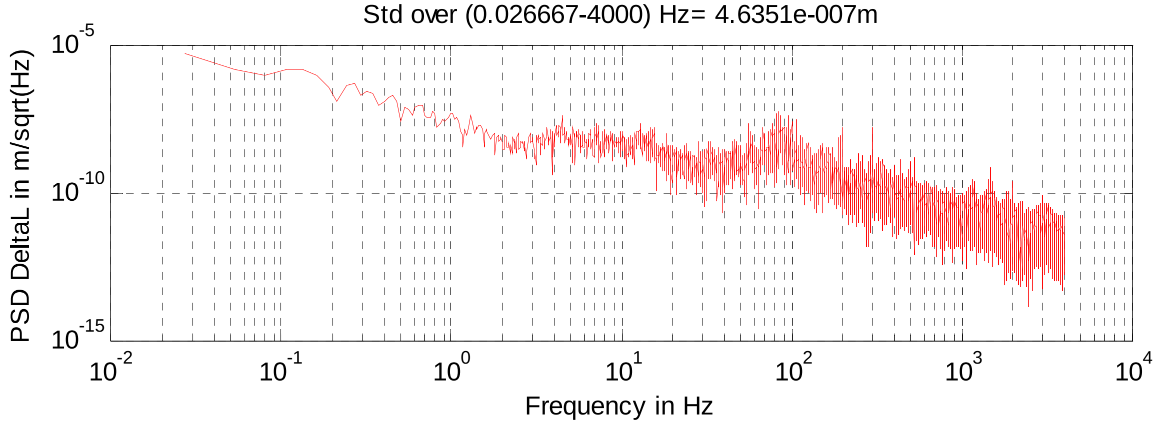
Gain = -0.015
IM is identity
Q4pmpsA1 = -1.89…..
Q4pmpsA2 = 0.89215…..
Q4pmpsB1 = -1.999…..
Q4pmpsB2 = 0.999…..

==> Filename: lprma2PhaseMeter2009-02-07T11.23.07.txt
Sampling frequency= 8000 Hz
Number of samples= 300000 →37.5 sec
DeltaL Mean= 1.217368e-006 m
DeltaL PV= 2.507700e-006 m
DeltaL rms= 4.635063e-007 m
Status Not OK: 0 !!!
Associated file:

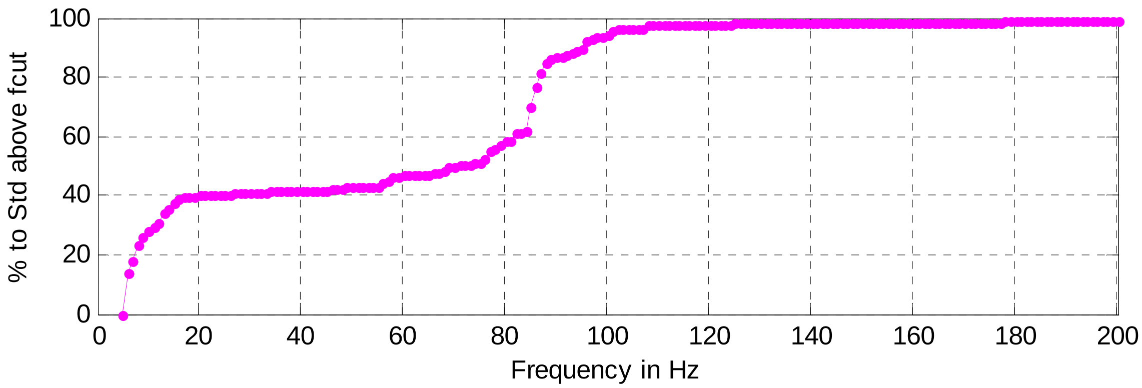
FileName	Comments	Fs(Hz)	Tobs(s)	Beam radisu. um	Radial Peak(rad) w.r.t 1st point	Radial rms (rad)	Radial Pk um	Radial rms um
MetQuadXX07T11.23.07	Trans=10 ; PGA=1 Closed loop	1000	300	610	0.150	0.014	91	8.5

➔ Residuals are good, but the enclosure was closed...
Still this is an encouraging results

lprma2PhaseMeter2009-02-07T11.23.07.txt
Fs=8000 Hz; Bad Status = 0
Std over (0.026667-4000) Hz= 4.6351e-007m



Std above fcut=5.0133Hz : 5.8427e-008m



<u>Try Beam search</u>

opened the loop, kicked the beam by U = -0.5 W = +2, started beam search with a threshold of 0.5, when beam centered sum ~ 3

the beam search was stopped manually: too slow

It is necessary to boot the LCU to update the search file... to be improved for COM4 together with the implementation of BTK.

<u>Circular modulation for BTK design</u>

Modulation circle file for Nicola: circle_0p2_20.txt

offset from quadcell centre= 0.2 beam

07T12.25.15...

offset from quadcell center = 0.1 beam

07T12.31.23...

offset from quadcell centre = 0.4 beam

07T12.33.02...

kicked by 0.3 um more in one axis, flux decerases but the centroid does not move much

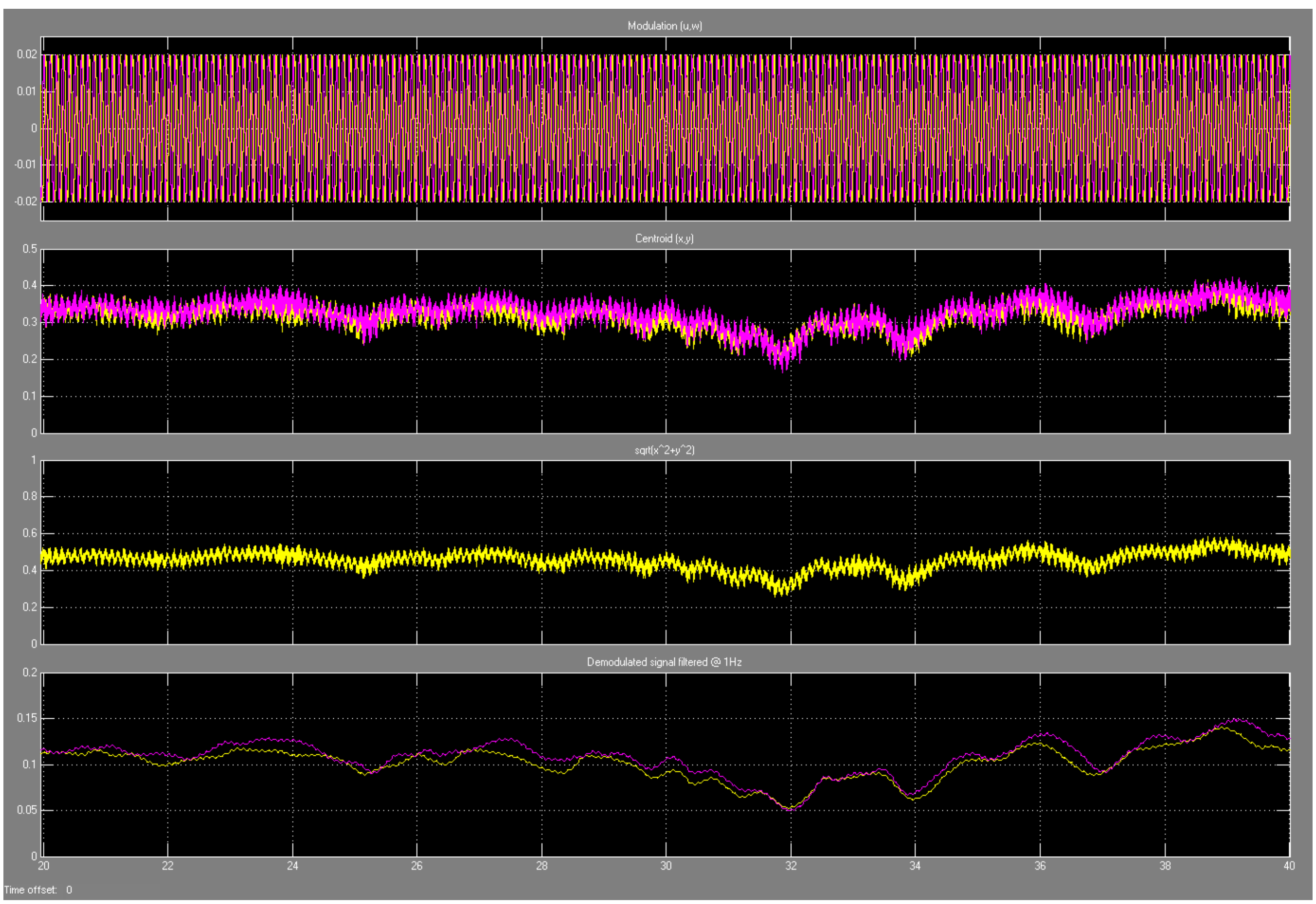
07T12.35.08...

kicked by 0.3 um in the other axis, centroid gets better but sum does not much
07T12.37.31
kicked by 0.3 um in the same axis (u), sum decreases
07T12.41.02

Given the normalized modulation signals $mod_{u,w}$ and the centroid signal $cen_{x,y}$, the big question is how much one needs to filter the demodulated signals $demod_x = cen_x^2 (mod_u^2 + mod_w^2)$ and $demod_y = cen_y^2 (mod_u^2 + mod_w^2)$ to reduce the noise to acceptable levels.

Simulation of the demodulation + filtering on the 10 Hz modulation files shows (figure below) that a first order low pass filter at 1 Hz is enough. This makes the algorithm usable as long as one waits for the demodulated signals to converge for a couple of seconds before sampling them. It is anticipated that the beam detection logic will include a check that both signals are above a threshold and the absolute value of their difference is below a second threshold. The thresholds will have to be determined experimentally.

The demodulation algorithm has been implemented as a C routine to be included in pmpsd for COMM4.



8 CONCLUSION OF COM3 AND PERSPECTIVE FOR COM4

During COM3, PRIMET_B (i.e. Ip2 & Ip4) was operated for the first time using DDL8 and DDL7.
One of the IP propagated to STS-J2-Beam_B while the other propagated either towards Marcel or towards a corner cube installed in the tunnel. PRIMET A was exclusively operated on Marcel.

We derived the following conclusions:

Beam Alignment

Several beam alignment problems were identified and needs further investigations:

- A beam displacement of 4.4 mm is introduced by changing the IP fed to the STS-J2-beamB through the DDL:
  from M16-DL#4->4AT and SW#4=BC-DDL(7) to M16-DL#4->2AT and SW#2=BC-DDL(8)
- Switching the configuration from SW#4-BC to SW#4-BC/DDL(7) introduces a horizontal beam offset of 6mm and a vertical beam offset of 0.2 mm.
- By switching the configuration from SW#2-BC to SW#2-BC/DDL(8) , the beam was lost (vignetted by the DDL) and could not be retrieved because of the limited stoke of the STS-VCMB.

DDL transmission

The measured transmission of DDL#7 is $\mathbf{T_{DDL7\text{-}1319\,nm}=87\,\%}$

Pupil Tracking:

The measured sensitivity of the beam radial displacement versus the STS_VCMB alignment offsets is $\mathbf{S_{VCM}}$**=926 µm/ µm_piezo** (theory: 1370 µm/ µm_piezo). The size of the vignetting free area is less than +/- 1 µm_piezo. These results are comparable those obtained during COM2.

The measured sensitivity of the beam radial displacement versus the STS-FSMB alignment offset is $\mathbf{S_{FSM}}$**~116 µm/arcsec_sky** (theory 0 µm/ arcsec). The impact of this crosstalk on the performance of the pupil tracking remains to be assessed.

The beam quality along the path "*Ip4*-BC-*DDL7*-DL4-AT#4-J2-STSB" was significantly better than the path "*Ip2*-BC-*DDL8*-DL4-AT#4-J2-STSB". The reason is not yet identified but could originate from beam vignetting at the level of the DDL.

Open Loop pupil motions were recorded along "*Ip4*-BC-*DDL7*-*DL4*-AT#4-J2-STSB". The amplitude of the pupil motion (pk &rms) was significantly larger than what was observed during COM1 along "*Ip4*-BC-*DL4*-AT#4-J2-STSB" and was dominated by a disturbance of a ~5 second period. Either the beam diameter was underestimated during COM1 or more probably the level of turbulence was higher during COM4 because of the various activities performed in the VLTI lab.
We assessed the impact of several disturbances on the pupil motion:

- DL4 tracking at 5mm/s along 300mm: no additional effect compared to the contribution of the environment

- DL4 tracking at 5mm/s over 1.5 m :as identified in May2008, the pupil drift introduced by the DL over such a stroke is not be compatible with PRIMET and justify the implementation of the PRIMET pupil tracking.
- Moving DDL7 to its home switch or by relative steps of 10mm introduce some fast Pupil motion which will not be corrected by the tracking loop (and even amplified in the 5-10Hz region). If these kinds of actions are performed during PRIMA operation, and if they lead to a glitch , the PRIMET zero OPL will have to be recalibrated. This may append after a beam swap

During COM4, the robustness of PRIMET shall be tested during a representative DDL tracking conditions (e.g. blind+fringe tracking data played from a file, and beam swap).

We observed that in some cases the pupil tracking corrections which were saved in the engineering file had the wrong resolution or the wrong correction frequency (50 Hz instead of 100Hz). In addition periodical time jumps of 1msec occurred in correction data. The origin of this problem needs to be investigated.

OPL measurements

At first glance, the motion of the DDL is measured correctly by PRIMET. A more detailed analysis should be performed by comparing the DDL and PRIMET metrology data. In the configuration used by PRIMET , it is not possible to identify any particular vibration induced by the DDL. The OPL was dominated by a “forest” of vibrations in the 75 to 130 Hz region, which could have been generated by any system along the 300m optical path (including the corner cube located in the tunnel)

Chopping the STS-FSM with an amplitude of 2 arcsec_sky and a frequency of 2 Hz, does not introduce any glitch but clearly affects the OPL at a level of **400nm/arcsec_sky.**

Due to a lack of time, the OPL could only be recorded once, in parallel with a closed loop pupil tracking on IP4. This test must be performed again during COM4.

PRIMET BTK tests

Data taken during COM3 allowed showing in simulation that modulation at 10 Hz with amplitude 0.02 and synchronous demodulation with low pass filter at 1 Hz can in principle be used for beam detection.

The demodulation algorithm has been implemented in C and will be included in pmpsd for Comm4. The main activities will be validation of its functionality and observation of the demodulated signals in various conditions for the experimental determination of the thresholds.

Perspectives for COM4:

- Replace one of the retro-reflector in Marcel to improve the PRIMET fringe contrast and allow FSU calibration without requiring access to the VLTI lab.
- Assess the impact of the FSM actuation on the performance of the pupil tracking loop
- Investigate the problem of beam alignment with the Switchyard and the DDL, as well as the associated DDL beam vignetting.
- Measure the pupil motion introduced by the DDL during representative blind+fringe tracking (playback of a data file). Operate PRIMET in these conditions (i.e. including pupil tracking) and assess the robustness.
- Implement and test PRIMET BTK

Configuration for COM4

- 2x AT-STS on J2 and G2 with the appropriate fixed curvature mirrors on 3 VCM's (TBC which one)
- Access to all DDLs

Additional tasks:

- Investigate why the gain of the quadcell changes by itself
- Integrate new OD in front of quadcell
- Check co-alignmnet on on FSUB
- Implement BTK and new beam search capability (grid spacing and amplitude as parameter)
- Test Readback of STS

9 APPENDIX

9.1 Beam Tracking

9.1.1 Objective

COM2 has demonstrated that the criterion for beam detection is not sufficient to guaranty that the pupil tracking loop can be closed. When the shape of the beam is distorted due to vignetting, the measured beam displacement are not well correlated with the true displacement and the interaction matrix *[beam displacement vs actuator commands]* becomes non-orthogonal.

A possible improvement consists in implementing a beam tracking algorithm (BTK) similar to what was implemented on the FSU.
During a beam search, the metrology beam is moved along a rectangular grid by sending position offsets to the STS-VCM and at each step, the Sum of the 4 quadrants is monitored. Now, the strategy consists in adding a small circular modulation of the beam position and by synchronous demodulation to check if the measured beam displacement is circular. If , on top of a sufficiently high SUM, the detected motion is circular, there is a good probability that the beam is sufficiently well aligned to initiate the pupil tracking loop.

9.1.2 Preliminary tests

The demodulation algorithm will output a number between L(ow)~0 and H(igh)= XX. It is necessary to verify that under our operating conditions, the ratio H/L is sufficiently large.

The set-up shown in Figure 6 is required with the following components
1. Spare quadcell located along the edge of the PRIMA table
2. Additional Beam splitter to simultaneously observe the beam on the quadcell and on the beam Profiler
3. Diaphragm to introduce beam vignetting and consequently beam distortion as experienced through the FSU-BC

Before connecting/disconnecting any quadcell, its electronic rack must be powered off !

Select the proper beam path: e.g ip4, DL4, AT4 beam B (no DDL), DL at minimum OPL or at the usual 14 m
Configure the FSU ACU to their default values
Pmpsd Online (select the IpXX physically connected to the “spare” quacell and the right telescope ,AT#4)
On lat4vcm: start pspzgui to operate the selected VCM

1. adjust the pressure of the STS-VCM as well as the DL VCM (OPL dependent+ offset of 4.5 m)
2. start pspzgui: set the FSM off the edge

3. Center the beam on the quadcell using VCM alignment offset (eventually modify the default database values)
4. Check the beam quality on the beam profiler and center it (=coalign the beam profiler and the diaphragm on the quadcell)
5. Start the circular modulation (assuming that the algorithm is implemented)
6. Observe the demodulated signal in the following conditions:
    a. Open loop, atmospheric and vibration conditions only
    b. Open loop by changing the beam mean position on the quadcell (VCM alignment offsets)
    c. Open loop by changing the size of the diaphragm
7. Evaluate H/L and adjust the parameters of the algorithm

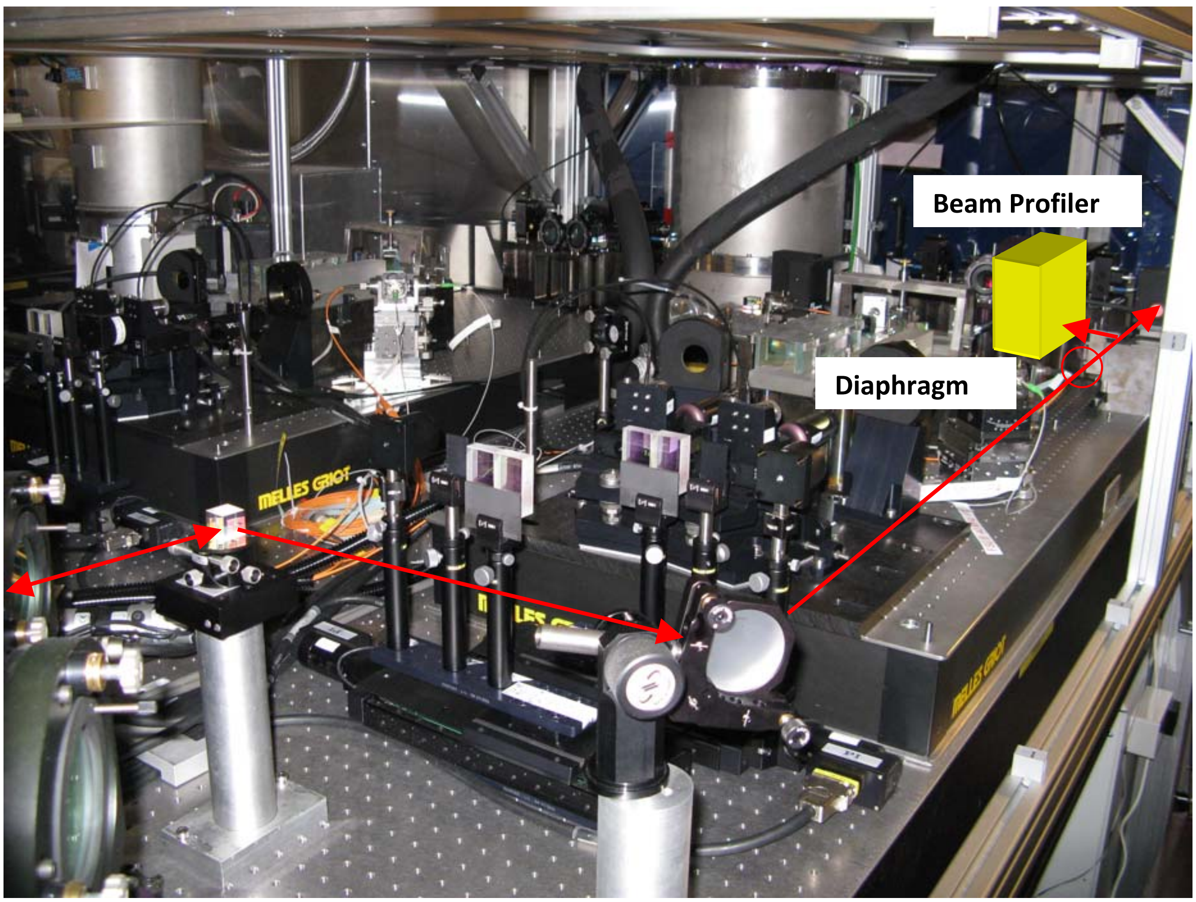


Figure 6: BTK preliminary test set-up

9.2 Configuration of the STS-VCM and DL-VCM

<table>
<tr><th colspan="8">AT#4-STS A&B-J2-DL#4</th></tr>
<tr><td colspan="4">FSM</td><td colspan="4">VCM</td></tr>
<tr><td colspan="2">Mirror 1=Beam A</td><td colspan="2">Mirror 2= Beam B</td><td colspan="2">Mirror 1=Beam A</td><td colspan="2">Mirror 2= Beam B</td></tr>
<tr><td>Xedge=30.5</td><td>Yedge=30.5</td><td>Xedge=12.5</td><td>Yedge=12.5</td><td>Xcenter=19</td><td>Ycenter=19</td><td>Xcenter=26.5</td><td>Ycenter=10.5</td></tr>
<tr><td>X=</td><td>Y=</td><td>X=</td><td>Y=</td><td>X=-</td><td>Y=-</td><td>X=</td><td>Y</td></tr>
<tr><td>U=</td><td>W=</td><td>U=</td><td>W=</td><td>U=-</td><td>W=-</td><td>U=</td><td>W=</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2">Fixed curvature mirror
ROC=infinity ?
(C=0 mm^{-1})</td><td colspan="2">ROC=-210.83 mm,
C= -4.743185e-003 (mm-1)
(theoretical value)
See Com1 report</td></tr>
</table>

DL	OPL	VCM Curvature/pressure
DL#-ip2	N/A	N/A
DL#4-ip4	14	ComputeVCMParametersATBC(TelescopeStation,DL,IP,DLPOS,pupil Offset,-1) ComputeVCMParametersATBC('UT4',4,4,7,4.5,-1) =3.999341e-003 mm-1 ComputeVCMParametersATBC('UT4',4,4,7,0,-1)= 5.820640e-004 mm-1

FSUB ACU	X	Y
TTP1		
TTP2		

FSUB LMOT	Position
LMOT1	
LMOT2	0

9.3 Field orientation on the TCCD

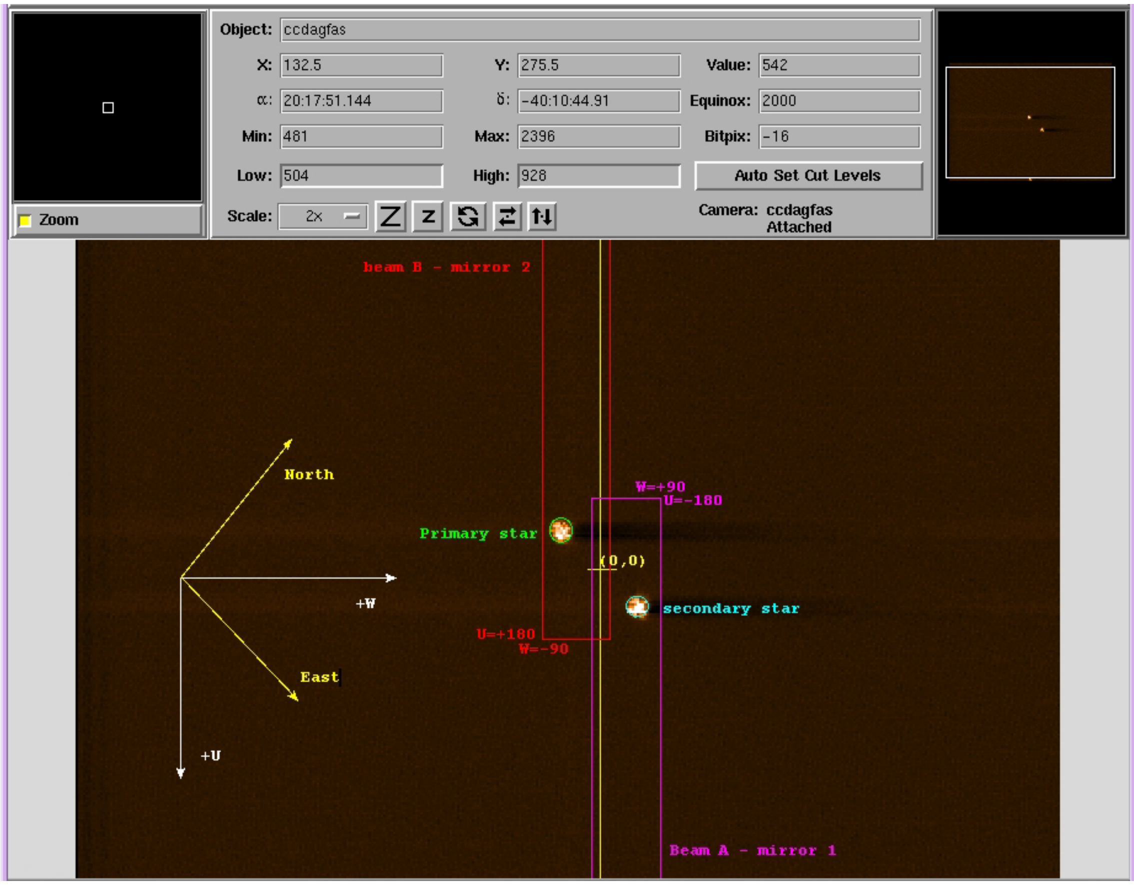


Figure 7: For example only: AT#3-STS (G2) during AIV

9.4 Task definition for COM3

Part 1

Focus on pupil-tracking weakness

- Define a more precise procedure to co-align the extraction fiber and the quadcells on the FSU_BC patch
- Verify if the User Guiding Offsets functionality and in particular the "Beam Search" is still working as in may 2008
- Implement an automatic procedure :
  - to determine the interaction matrix between STS-VCMtip/tilt and the quadcell axes.
  - to measure the VCM displacement sensitivity

- Improve the beam detected condition: Elaborate a strategy to estimate the beam quality after a beam search using only the quadcell signals. (i.e. without the beam profiler which is not available during operation)

Additional tasks:

- Check OPD values measured on Marcel with /without Marcel fiber
- Cross-Check OPL sign for a given LMOT and DL motion
- Measure the equivalent magnitude of the straylight generated by the laser pump diode on the TCCD
- Install and assess impact of λ=1319nm Notch filter on IRIS
- Record data with moving DL
- Daily recording of PRIMET engineering files on Marcel

Part 2

Summary list

PRIMET 1 *PRIMETA/B Start-up: 0.5 day (daytime) Priority High*
PRIMET 3: *Assess the impact of the DDL on the PRIMET performance, 3 days, Priority High*
PRIMET 3: *PRIMET B Fine alignment 1.5 days (daytime) Priority Medium*
PRIMET 4: *Record PRIMET data with moving DL/DDL, 0.5 day, Priority Medium*
PRIMET 5: *Daily recording of PRIMET engineering files on Marcel, Priority low*
PRIMET 6: *Check the compatibility of the PRIMET & FSU pupil re-imaging, 0.5 night, Priority High*
PRIMET 7: TBD

PRIMET 1 *PRIMETA/B Start-up: 0.5 day (daytime) Priority High*

Identification	***PRIMETA/B Start-up***
Priority (high,medium,low)	High
Duration	0.5 day (daytime)
Responsible	N.Schuhler
Description	Functional test of all the PRIMET Hardware & software Operate the laser (safety rules apply!) Operate the frequency stabilization Check that there is no bootscript problem as during COM2 Check Alignment on Marcel (correction if need be) Record PRIMET A/B fringes on Marcel
Prerequisite/Predecessor	PRIMA software operational FSU warm optics aligned (ACU positions calibrated and saved into dbcfg), i.e after cryostat intervention
Input	-
Output	-
Criteria for Completion	PRIMET ready for FSU calibration on Marcel.
Successor	FSU calibration
Manpower Required	-
Facility /Tooling Required	Access to IC102, VLTI lab

	Access to the FSU warm optics
Sequence /procedure(incl. ref doc)	-

PRIMET 2: *Assess the impact of the DDL on the PRIMET performance, 3 days, Priority High*

Identification	***Assess the impact of the DDL on the PRIMET performance***
Priority(high,medium,low)	High
Duration	3 days
Responsible	N.Schuhler
Description	This includes the measurement of the DDL transmission, beam lateral displacement & tilt (with/without M3 LUTcompensation), pupil re-imaging, tracking/preset compatibility with PRIMET, Ghosts, vibrations, glitch or signal jumps
Prerequisite/Predecessor	*PRIMET Start-up completed* *FSU ACU position calibrated and saved in dbcfg* *DDL operational (at least 3&4)* *Switchyard of DDL aligned for position DDL-BC* *AT#4-STS operational on station J2 (TBC)*
Input	-
Output	
Criteria for Completion	Check list completed
Successor	
Manpower Required	
Facility /Tooling Required	
Sequence /procedure(incl. ref doc)	Measurement of performance using “free” quadcell, i.e not going through the FSU-BC. Transmission: lens +Beam profiler

PRIMET 3: *PRIMET B Fine alignment 1.5 days (daytime) Priority Medium*

Identification	***PRIMET B Fine Beam alignment***
Priority(high,medium,low)	Medium
Duration	1.5 days (daytime)
Responsible	N.Schuhler
Description	Fine alignment including co-alignment procedure defined/tested during COM2B
Prerequisite/Predecessor	*PRIMET Start-up completed* *FSU ACU position calibrated and saved in dbcfg* *DDL 7&8 operational* *Switchyard of DDL aligned for position DDL-BC* *AT#4-STS operational on station J2 (TBC)*
Input	-
Output	PRIMET pmacq and pmpsd data files
Criteria for Completion	
Successor	-
Manpower Required	

Facility /Tooling Required	VLTI lab during day-time Access to the FSU warm optics Sighting scope on ip2 or ip4 on DDL side (TBC) AT#4-STS ready on J2 station (TBC)
Sequence /procedure(incl. ref doc)	-

PRIMET 4: *Record PRIMET data with moving DL/DDL, 0.5 day, Priority Medium*

Identification	***Record PRIMET data with moving DL/DDL***
Priority(high,medium,low)	Medium
Duration	0.5 day
Responsible	N.Schuhler
Description	
Prerequisite/Predecessor	*PRIMET Start-up completed* *FSU ACU position calibrated and saved in dbcfg* *DDL 7&8 operational* *Switchyard of DDL aligned for position DDL-BC* *AT#4-STS operational on station J2 (TBC*
Input	-
Output	
Criteria for Completion	
Successor	
Manpower Required	
Facility /Tooling Required	
Sequence /procedure(incl. ref doc)	-

PRIMET 5: *Daily recording of PRIMET engineering files on Marcel, Priority low*

Identification	***Daily recording of PRIMET engineering files on Marcel***
Priority(high,medium,low)	Low
Duration	1 hour daily
Responsible	N.Schuhler
Description	
Prerequisite/Predecessor	
Input	-
Output	
Criteria for Completion	
Successor	
Manpower Required	
Facility /Tooling Required	
Sequence /procedure(incl. ref doc)	-

PRIMET 6: *Check the compatibility of the PRIMET & FSU pupil re-imaging, 0.5 night, Priority High*

Identification	***Check the compatibility of the PRIMET & FSU pupil re-imaging***

Priority(high,medium,low)	High
Duration	0.5 (night)
Responsible	N.Schuhler
Description	Check if longitudinal pupil offsets of more than 1 m are acceptable during FSU operation
Prerequisite/Predecessor	
Input	-
Output	
Criteria for Completion	
Successor	
Manpower Required	
Facility /Tooling Required	
Sequence /procedure(incl. ref doc)	-

PRIMET 7: TBD

Identification	
Priority(high,medium,low)	
Duration	
Responsible	
Description	
Prerequisite/Predecessor	
Input	
Output	
Criteria for Completion	
Successor	
Manpower Required	
Facility /Tooling Required	
Sequence /procedure(incl. ref doc)	-

9.5 Tasks Postponed to COM4

- Test the PRIMET new State Machine and PRIMET OSF script:
- Check new Phase meter overflow conditions
- Address the non compatibility of the full laser power with quadcell operation (saturation with G=1)

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