Fokker Space

NEVEC-TNO Workshop

VLTi DELAY LINES

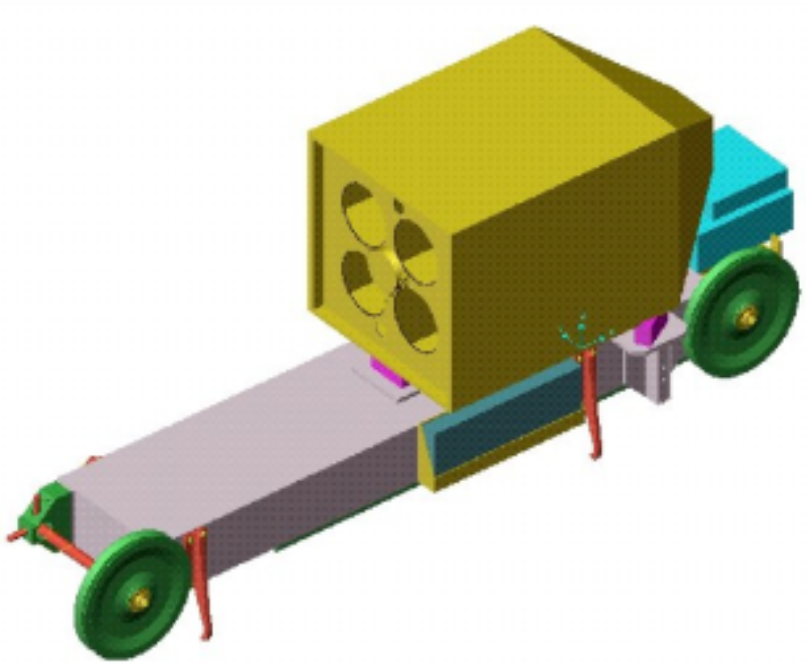
11-october-2001

Harm Hogenhuis

Fokker Space

VLTi DELAY LINES

- Contents of presentation:
  - Short introduction
  - Acceptance data
  - On site performance
  - Future improvements



VLTi DELAY LINES
short introduction

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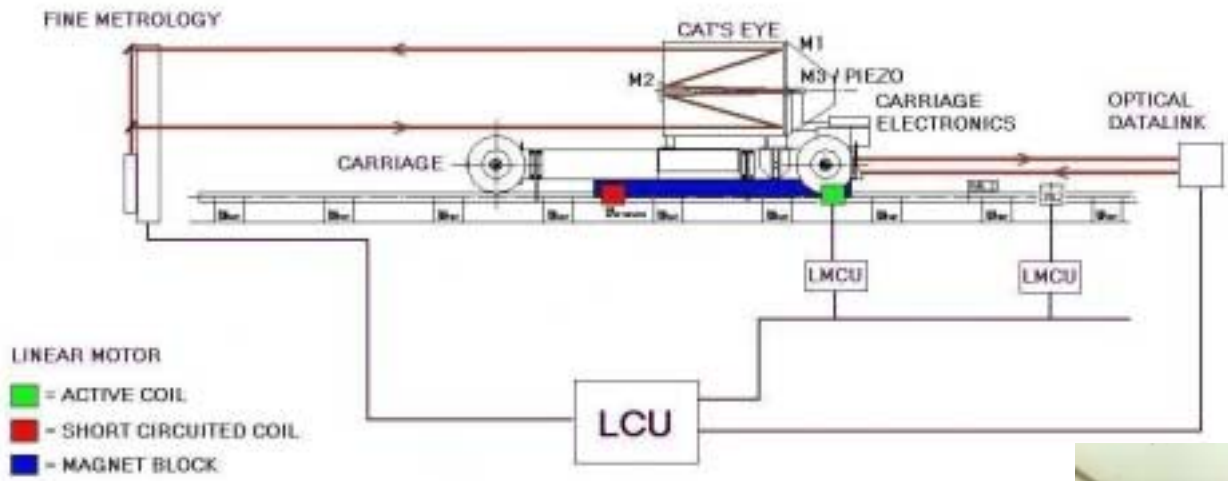

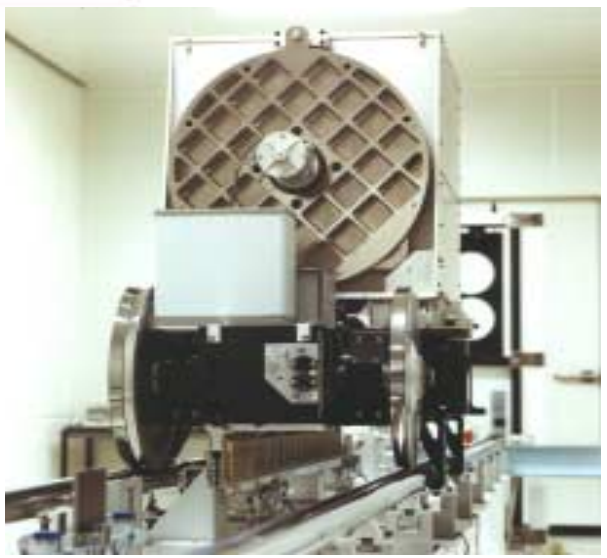

VLTi DELAY LINES short introduction (2)

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- Key requirements:
  - OPD jitter performance: (| V | < 5 mm/sec)
    - Vissible : 14 nm RMS over 10 msec
    - NIR : 50 nm RMS over 50 msec
    - TIR :225 nm RMS over 300 msec
  - Pupil displ. over 66m: 2 mm (eq. to max tilt of 2.6 arcsec)
  - WFE Cat's Eye: 40 nm RMS over 80 mm dia on/off axis
  - Optical tilt error: $|\alpha_{out}-\alpha_{in}| < 1.5$ arcsec
  - Differential tilt error: $|(\alpha_{out}-\alpha_{i})-(\alpha_{in}-\alpha_{i})| < 0.75$ arcsec
  - Heat dissipation: 15 Watt in tunnel

VLTi DELAY LINES short introduction (3)

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- customer: ESO
- team: Fokker Space / TNO-TPD
- team size : 8 (FS), 3 (TPD)
- design and verification:
  2.5 years for 1st model
- delivered and in operation: 3
(C.Huygens, J.C.Kapteyn, W. de Sitter)
- on order: 3, delivery mid 2003

The VLTI Delay Line Integration Team

ESO PR Photo 26e/00 (11 October 2000) © European Southern Observatory

VLTi DELAY LINES acceptance data

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OPD jitter	DL #1 (C Huygens)	DL #2 (JC Kapteyn)	DL #3 (W de Sitter)	Requirement
Visible (RMS over 10 msec)				14 nm RMS
0 µm/sec	9.6	6.1	11.4	
40 µm/sec	30.4	15.5	32.5	
1000 µm/sec	12.4	13.0	12.1	
5000 µm/sec	22.9	12.0	17.4	
NIR (RMS over 50 msec)				50 nm RMS
0 µm/sec	10.7	6.9	13.3	
40 µm/sec	32.7	17.8	34.0	
1000 µm/sec	17.2	17.3	17.8	
5000 µm/sec	33.3	17.0	20.6	
TIR (RMS over 300 msec)				225 nm RMS
0 µm/sec	12.8	12.2	14.6	
40 µm/sec	34.4	21.5	35.7	
1000 µm/sec	20.5	21.1	20.6	
5000 µm/sec	47.3	23.6	26.5	
Software version	1.9	1.14	2.9	

- Remarks:
  - software developments ongoing
  - poor environmental conditions
  - 70 sec testruns

VLTi DELAY LINES acceptance data (2)

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- Max. tilt reflector: 1.8 arcsec (req. 2.6 arcsec) roundness wheels within 3 micron, adjustment supports within 10 micron
- WFE RMS: 30-36 nm (req. 40 nm) after lots of iterations; 1 Cat's Eye within design limit of 25 nm
- Optical tilt: 0.5 ±0.28 arcsec (req.1.5 arcsec) at 15.5 ºC
- Differential tilt within FoV: 0.2 ±0.2 arcsec (req. 0.75 arcsec)
- Heat dissipation 15 Watt (req. 15 Watt). Cooling laser and non-functional LM controllers inactive

VLTi DELAY LINES
on site performance

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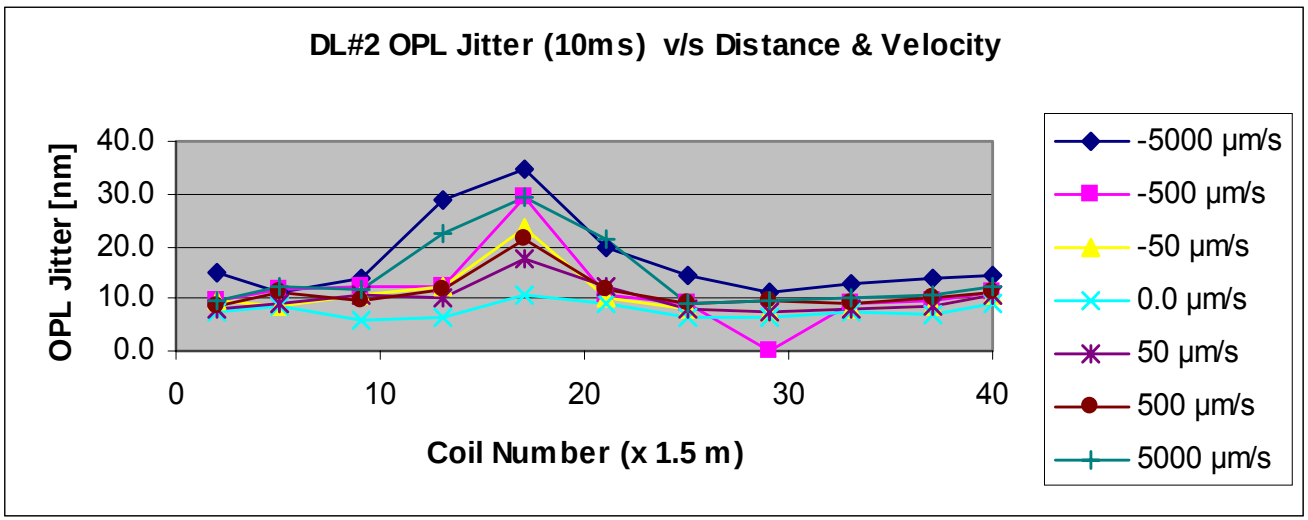
Run of 76 sec, average measured on 60 sec								
strart at coil 2								
OPL MEASUREMENTS								
For 10 ms		SPEC 14 nm						
Coil/Vel	-5000	-500	-50	0	50	500	5000	µm/s
2	15.0	9.6	9.6	7.7	7.9	8.4	9.6	
5	11.4	11.5	8.7	8.4	9.3	11.4	12.4	
9	14.1	12.5	10.5	5.7	10.7	9.7	12.0	
13	28.7	12.1	12.1	6.5	10.2	11.7	22.2	
17	34.7	29.3	23.4	10.8	17.8	21.4	29.3	
21	19.9	10.7	10.3	9.1	12.3	12.0	21.1	
25	14.3	9.3	7.9	6.3	7.8	9.1	9.0	
29	11.3		7.5	6.4	7.6	9.5	9.5	
33	12.7	9.0	7.9	7.3	7.8	9.2	10.2	
37	13.7	9.5	8.6	7.2	8.5	10.1	10.6	
40	14.4	11.2	10.5	9.1	10.5	11.1	12.5	
	17.3	12.5	10.6	7.7	10.0	11.2	14.4	12.0



VLTi DELAY LINES
on site performance (2)

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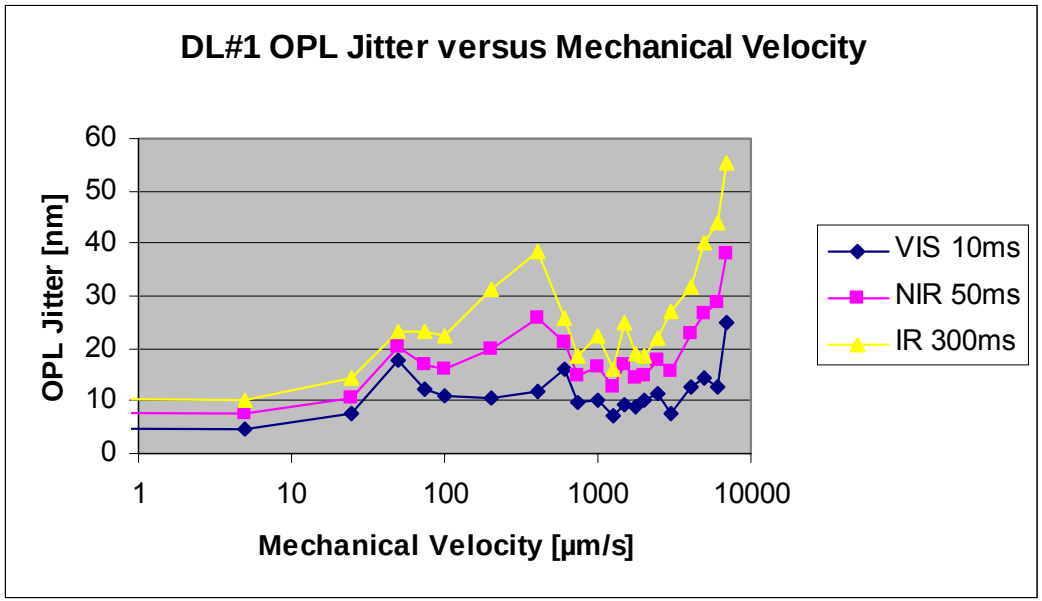
@LMCU20	10ms	50ms	300ms
0.001	5	8.2	10.8
5	4.8	7.4	10.3
25	7.8	10.5	14.3
50	17.7	20.1	23.2
75	12.2	16.9	23.3
100	11	16.1	22.5
200	10.7	19.8	31.1
400	11.8	25.9	38.4
600	16.2	21.1	25.9
750	9.7	14.9	18.4
1000	10	16.4	22.5
1250	7.1	12.5	15.9
1500	9.4	16.9	25.1
1750	8.9	14.2	19
2000	10.1	14.8	18.6
2500	11.6	17.9	22.1
3000	7.8	15.5	27
4000	12.6	22.7	31.8
5000	14.4	26.5	40.1
6000	12.6	28.6	43.8
7000	25.1	38.2	55.2



VLTi DELAY LINES
on site performance (3)

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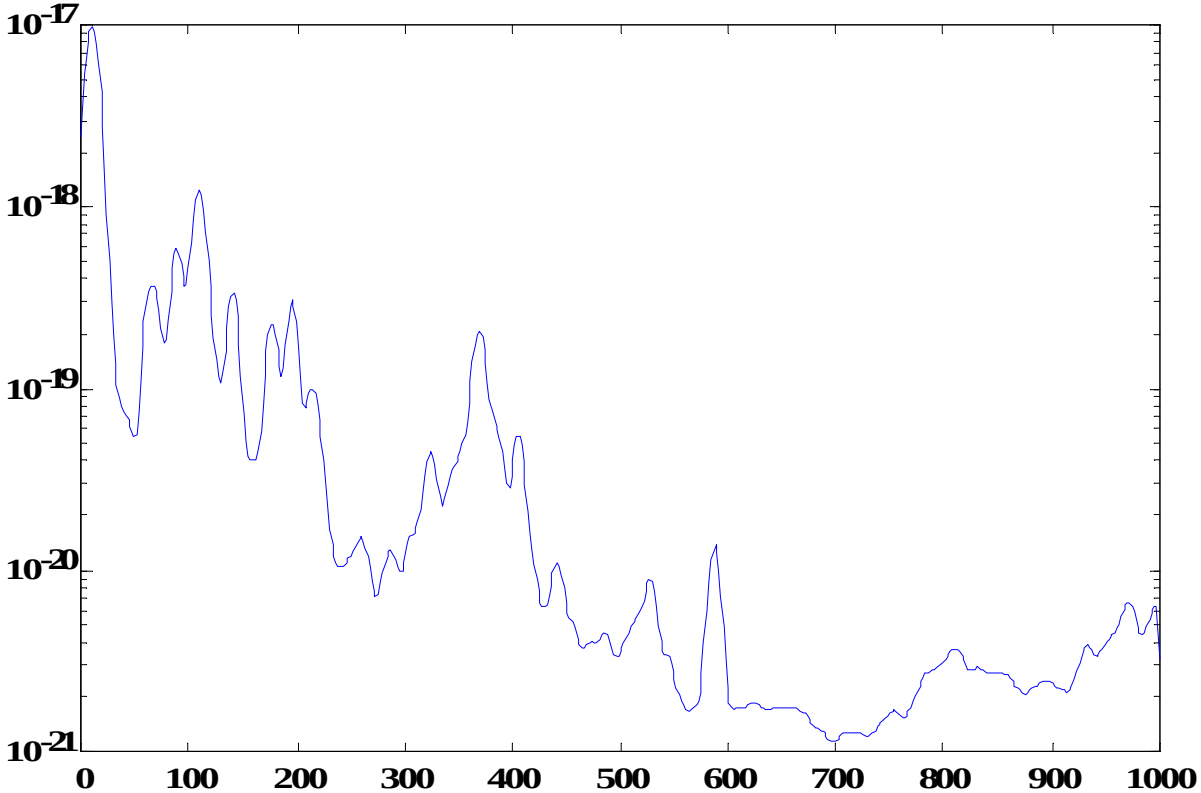

- Velocity 5 µm/sec (DL #1 Huygens)
- OPD jitter RMS over 10 msec : 7.3 nm

VLTi DELAY LINES on site performance (4)

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- Parameters of influence on DL OPD performance

  - Stiffness of the system (rolling assy and sensor mount)
  - Friction level and variations
  - Environmental disturbances (micro vibrations, seeing tunnel, other)
  - Control loop delays, bandwidth, errors in estimators
  - jitter in timing
  - Linear motor performance: force ripple, force resolution, back EMF
  - Piezo bandwidth, position resolution
  - OPL measurement resolution

VLTi DELAY LINES
on site performance (5)

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- Latest reports:

- Delay Lines operate in Fringe tracking mode (closed loop with feedback from VINCI instrument)

- Fringe tracking can be maintained even in severe conditions: during earthquake of 4 (scale of Richter) fringe tracking could be maintained with only minor disturbance

VLTi DELAY LINES
future improvements

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- Improvement structural stiffness of sensor supports
  - lowest eigen frequencies above 80 Hz
- Investigation into control bandpass
  - control loop at 4-8 kHz
  - decrease delays to LM- and piezo controller
  - use of PowerPC
- improvement of LM resolution

VLTi DELAY LINES
‘Huygens’ at Paranal

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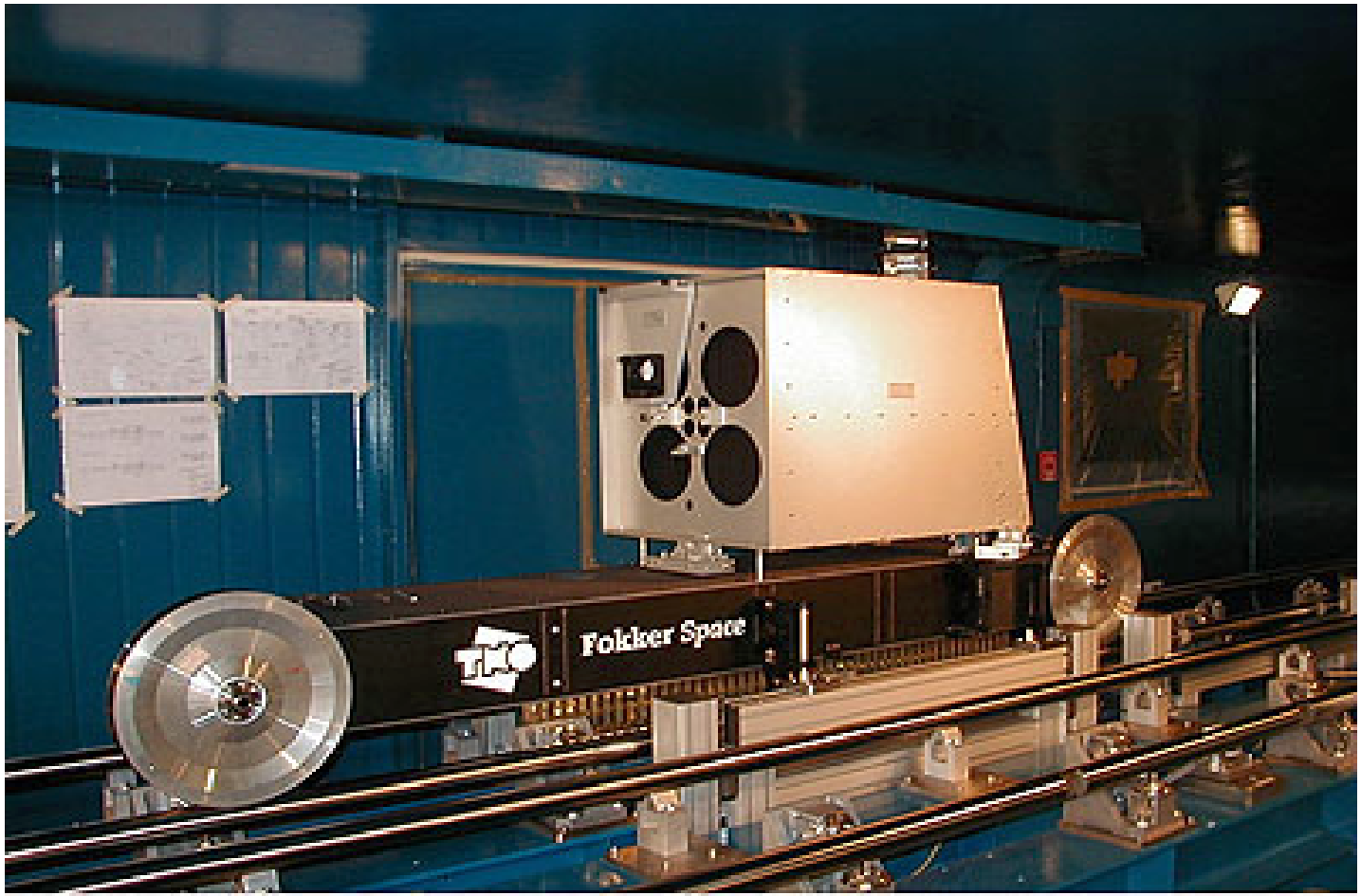

VLTI Delay Line Retroreflector Carriage

ESO PR Photo 26d/00 (11 October 2000)

VLTi DELAY LINES

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- WHO's NEXT???
  - DL #4 F Zernike
  - DL #5 JH Oort
  - DL #6 GP Kuiper