A control loop closure system for the Sardinia Radio Telescope active surface

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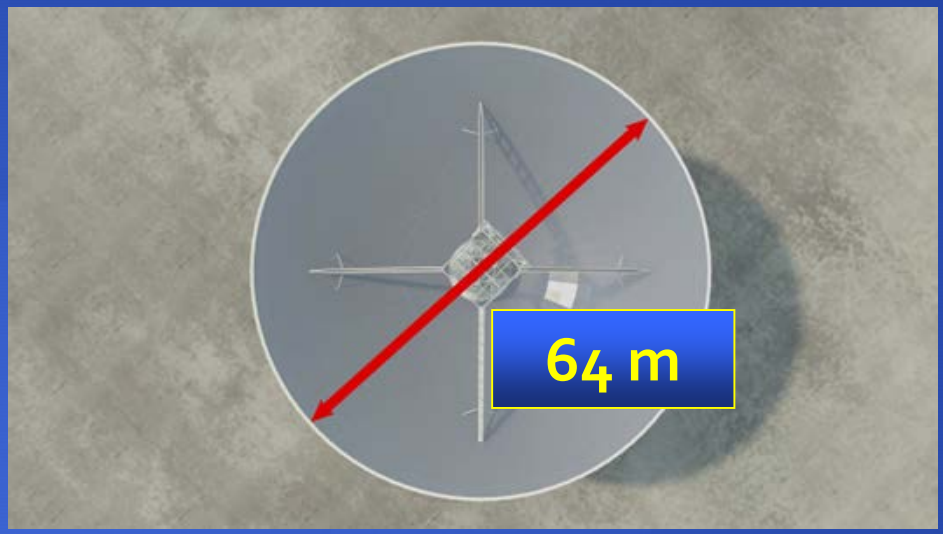
C. Barbieri, CMOS camera
P. Bolli, mw holography
F. Buffa, photogrammetry
T. Pisanu, FEM, temperature sensor
S. Poppi, pointing, star tracker
G. Serra, mw holography
M. Morsiani, mounts & test
J. Roda, mechanics
G. Zacchiroli, mechanics
C. Nocita, test
M. Paternò test

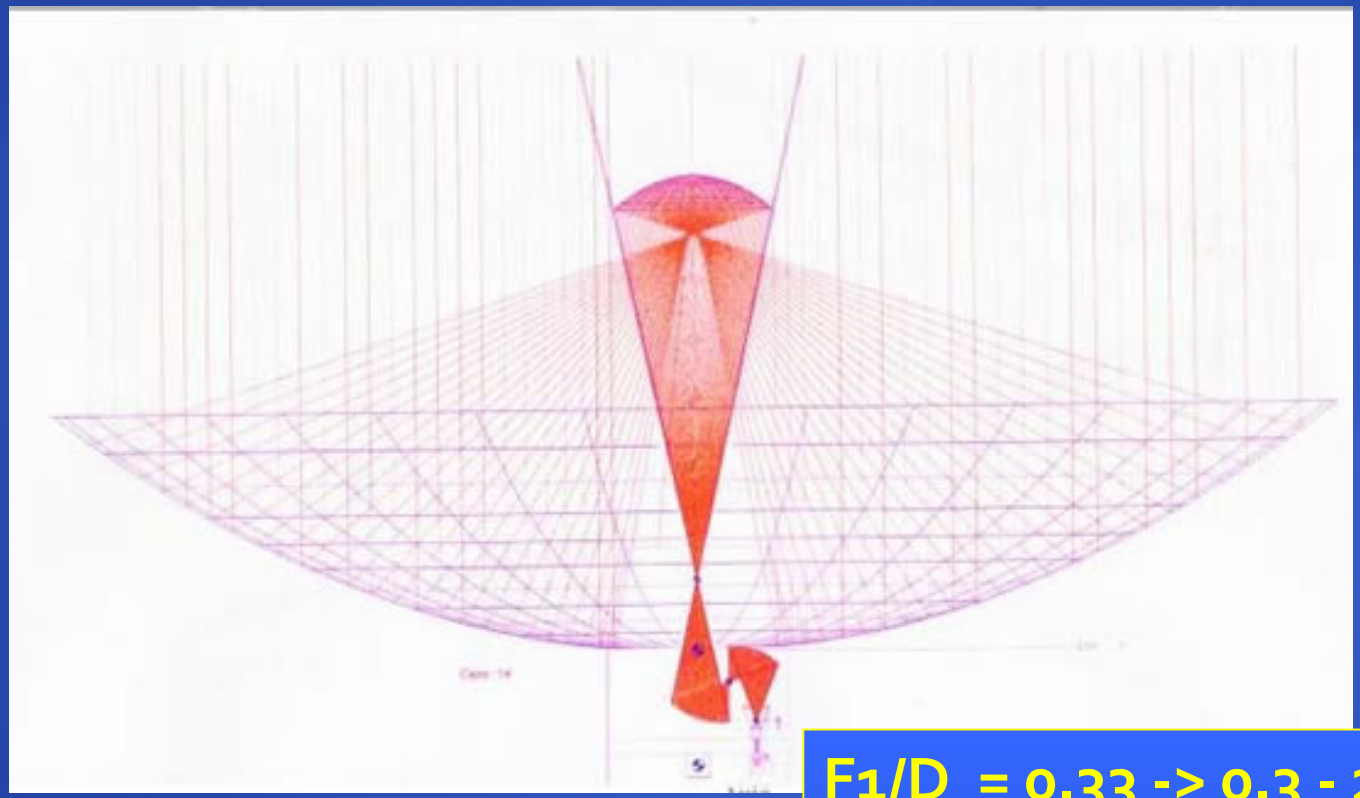
INAF Astronomical Observatory of Cagliari &
National Institute for radioastronomy

Sept, 27th 2016

General parameters

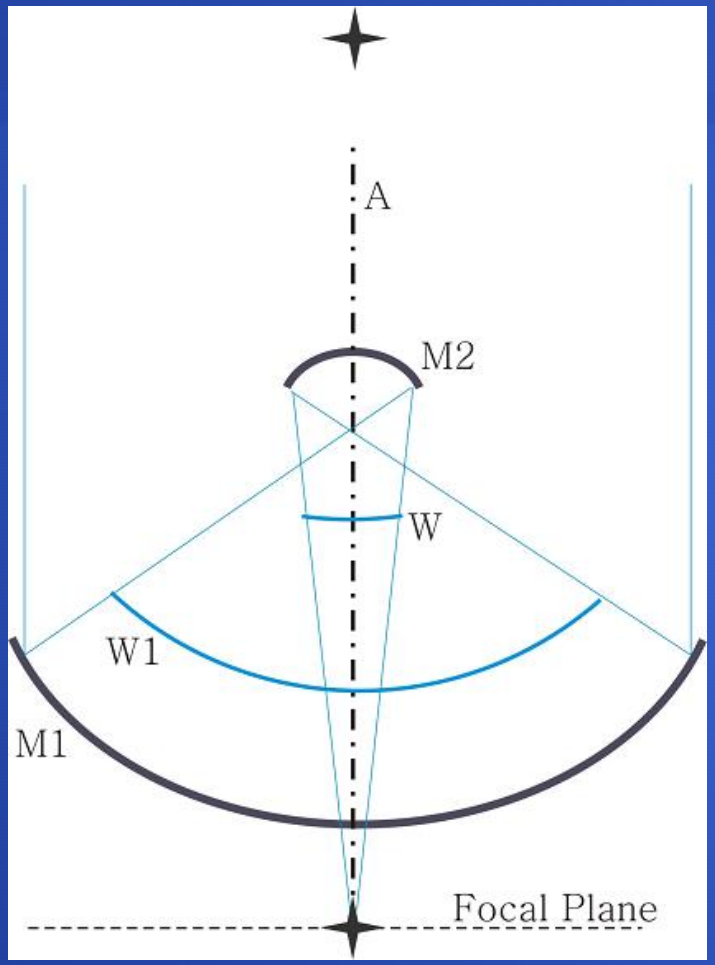


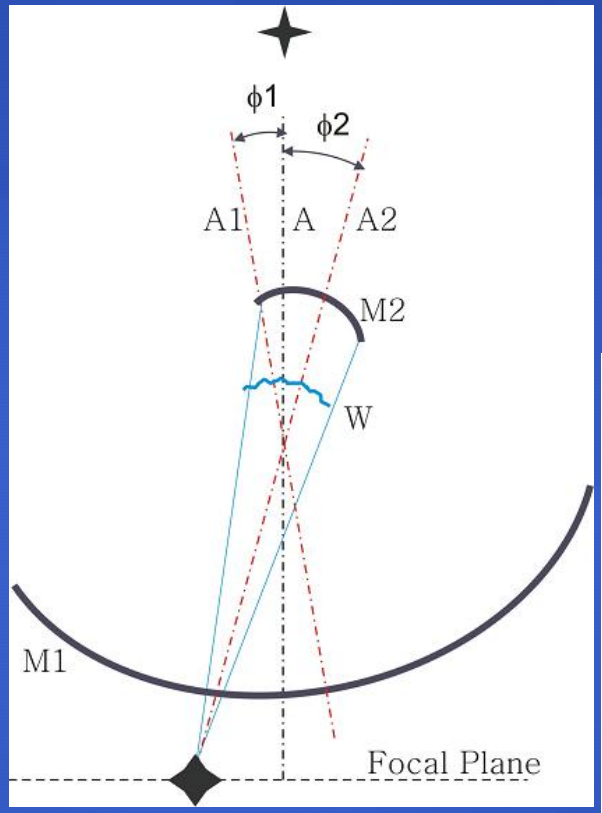
Gregorian Optical Configuration

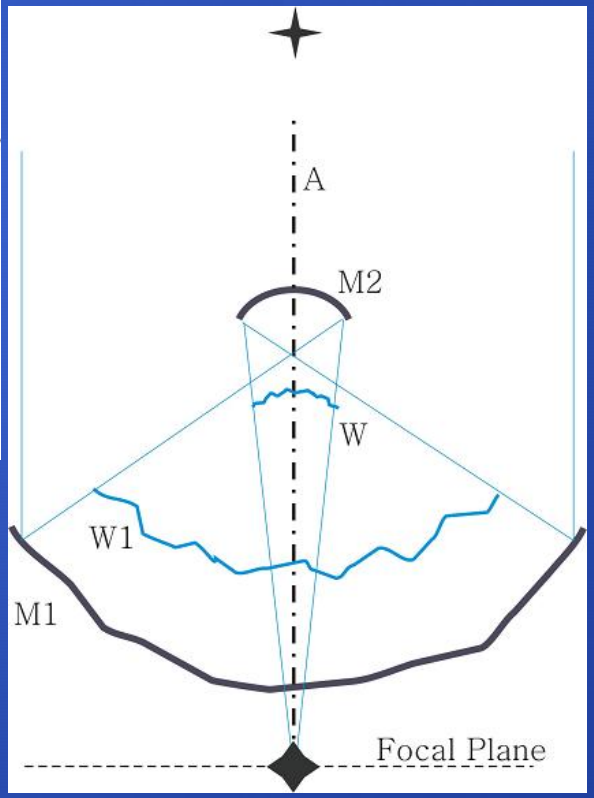


F1/D = 0.33 -> 0.3 - 22 GHz
FG/D = 2.34 -> 7.5 - 100 GHz
F3/D = 1.38 -> 4.3 - 32 GHz
F4/D = 2.81 -> 4.3 - 32 GHz

Metrology Tasks







Metrology Tasks

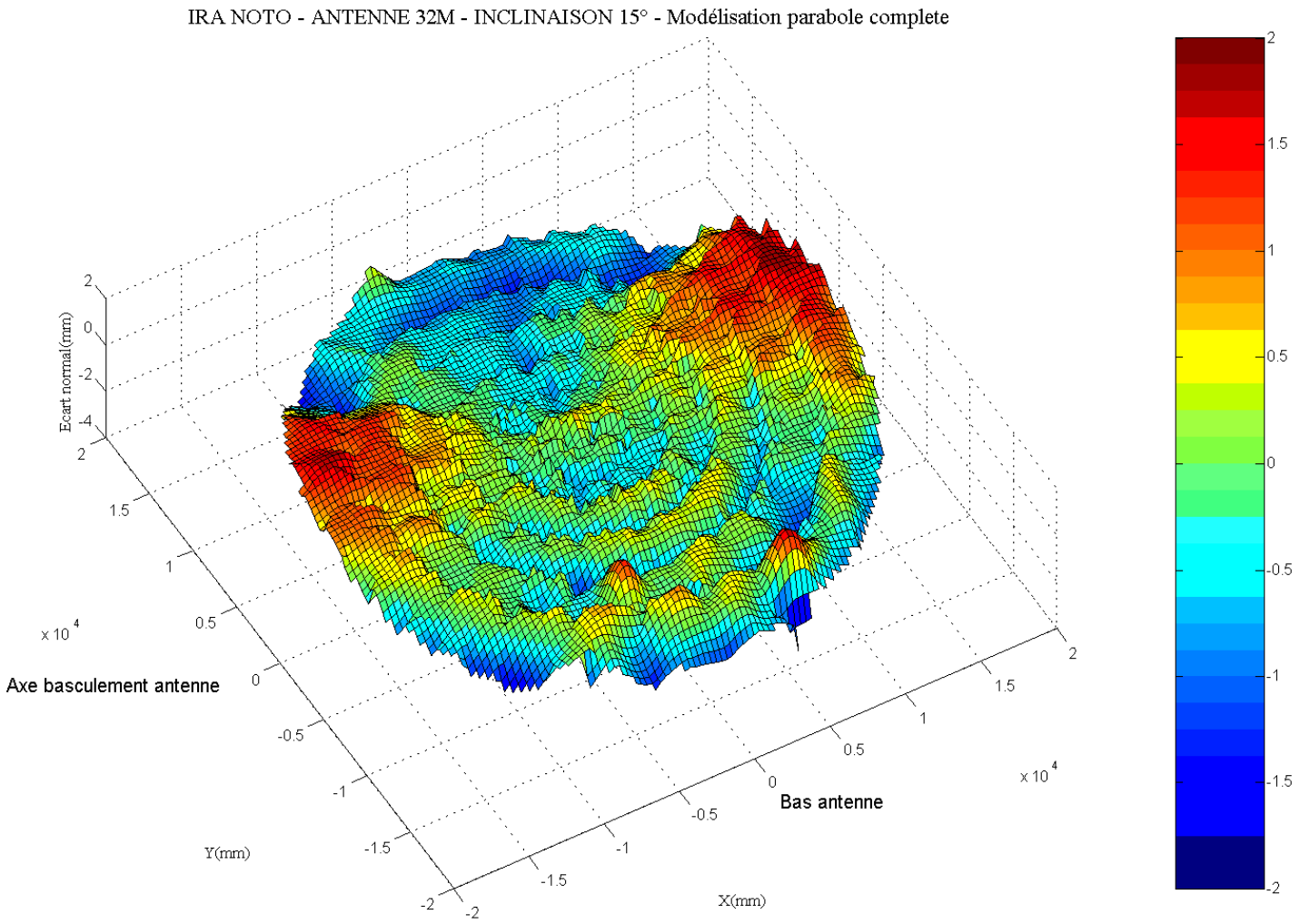
PSD + rangefinder (5 axes)

Star tracker (Poppi et al., (SPIE 7733, 2010)

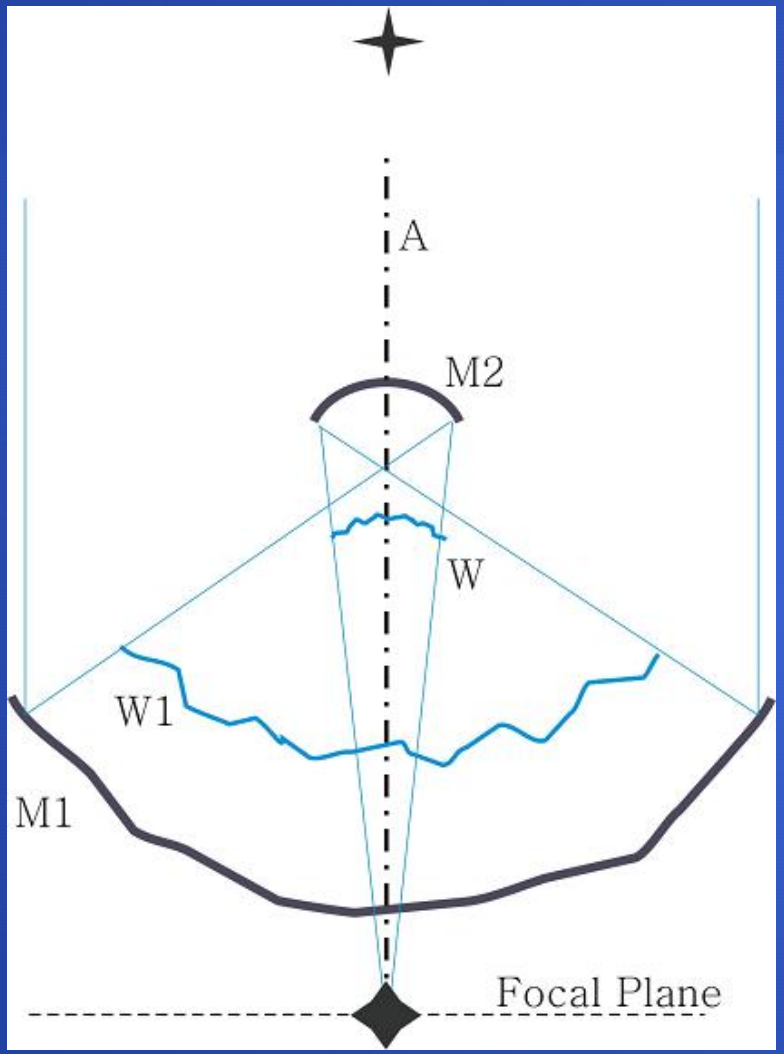
FEM + temp sensors (Pisanu et al., SPIE 7739, 2010)

Optical methods (reflector's shape)

Photogrammetry results @ Noto station

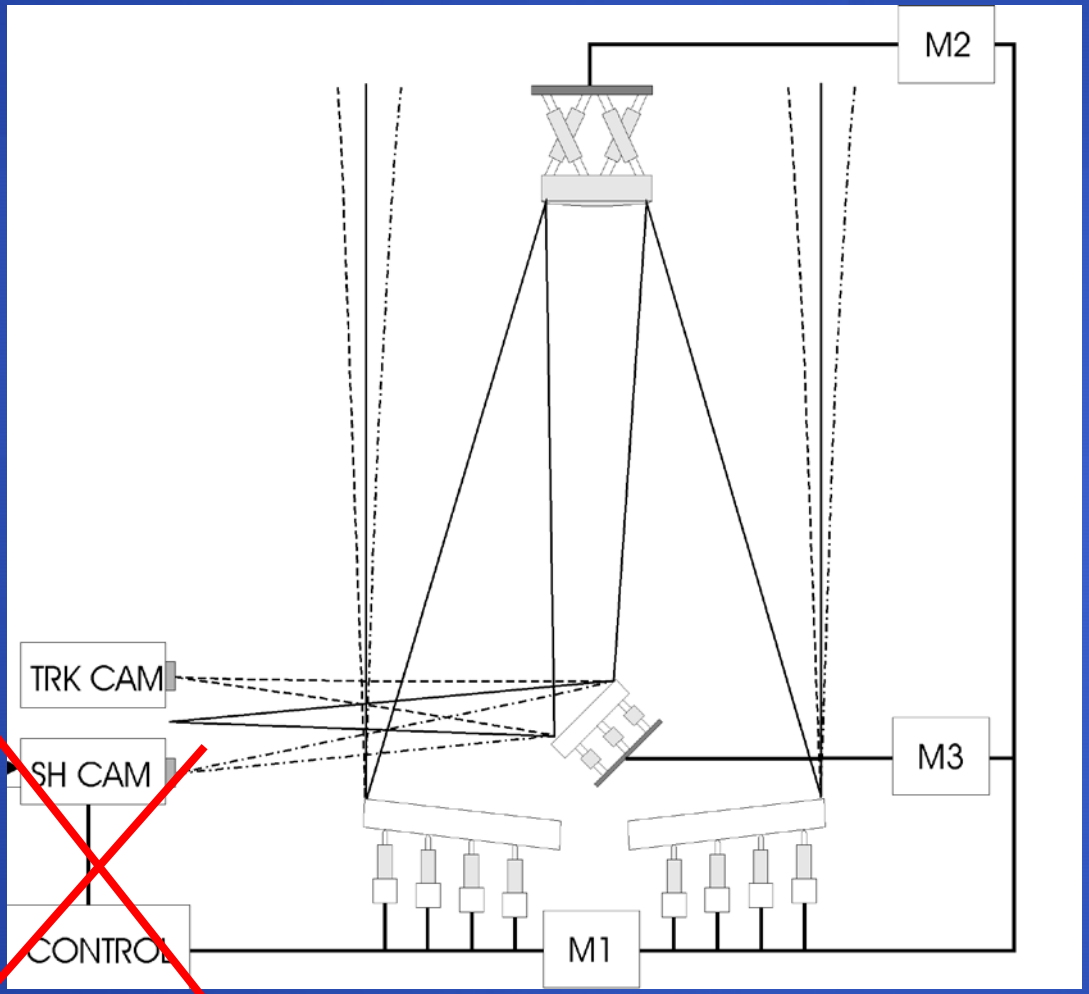


Operation @ 100 GHz



Surface shape < 0.15 mm (λ/20)

Radio vs Visible Active Optics



Visible Range

Closed loop control

Radio Range

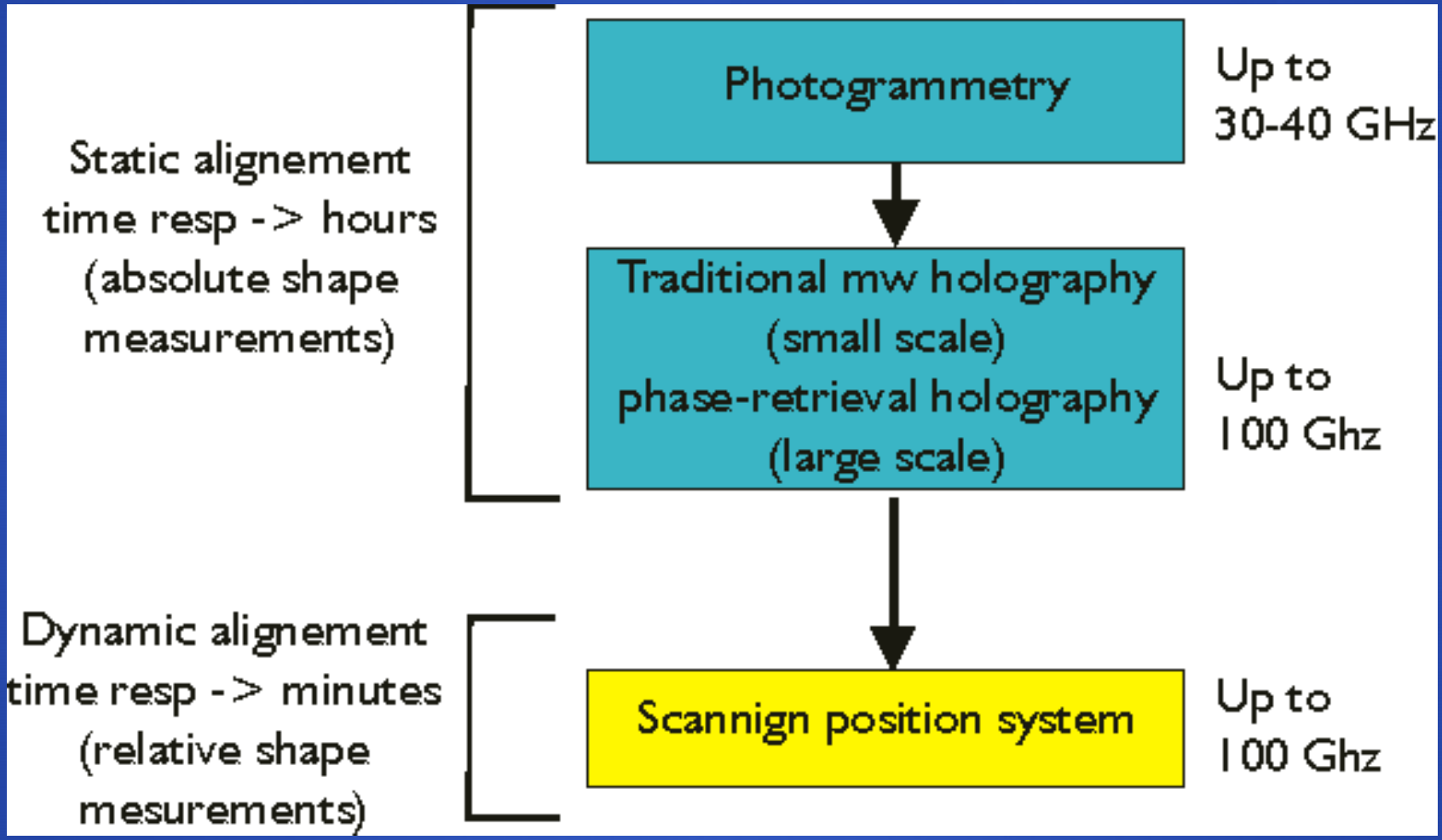
Open loop only

Primary's shape measuring methods

Shape's main reflector typical measurements systems

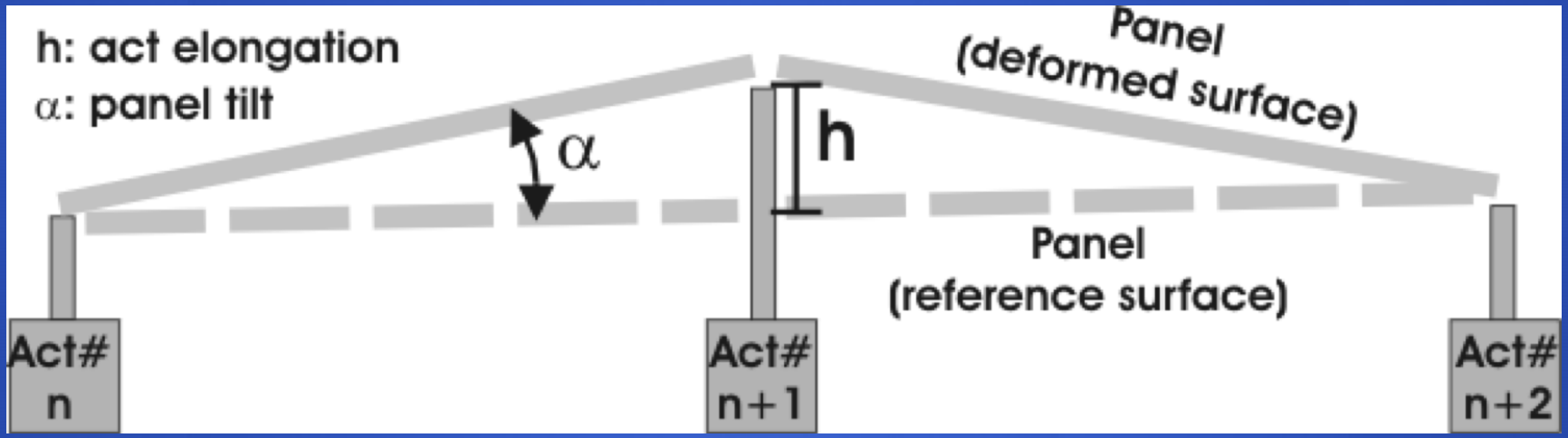
	Time response	Accuracy	Meas. type	EL Angle
Laser Scanner	Hours/day	0.7 mm	Absolute	Any
Photogrammetry	day(s)	0.4 mm	Absolute	Any
Microwave Holography	Hours	0.15 mm	Absolute	<45 for SRT
SRT optical meas. systems	Few minutes	0.15 mm	Relative	Any

SRT actuators closing loop strategy

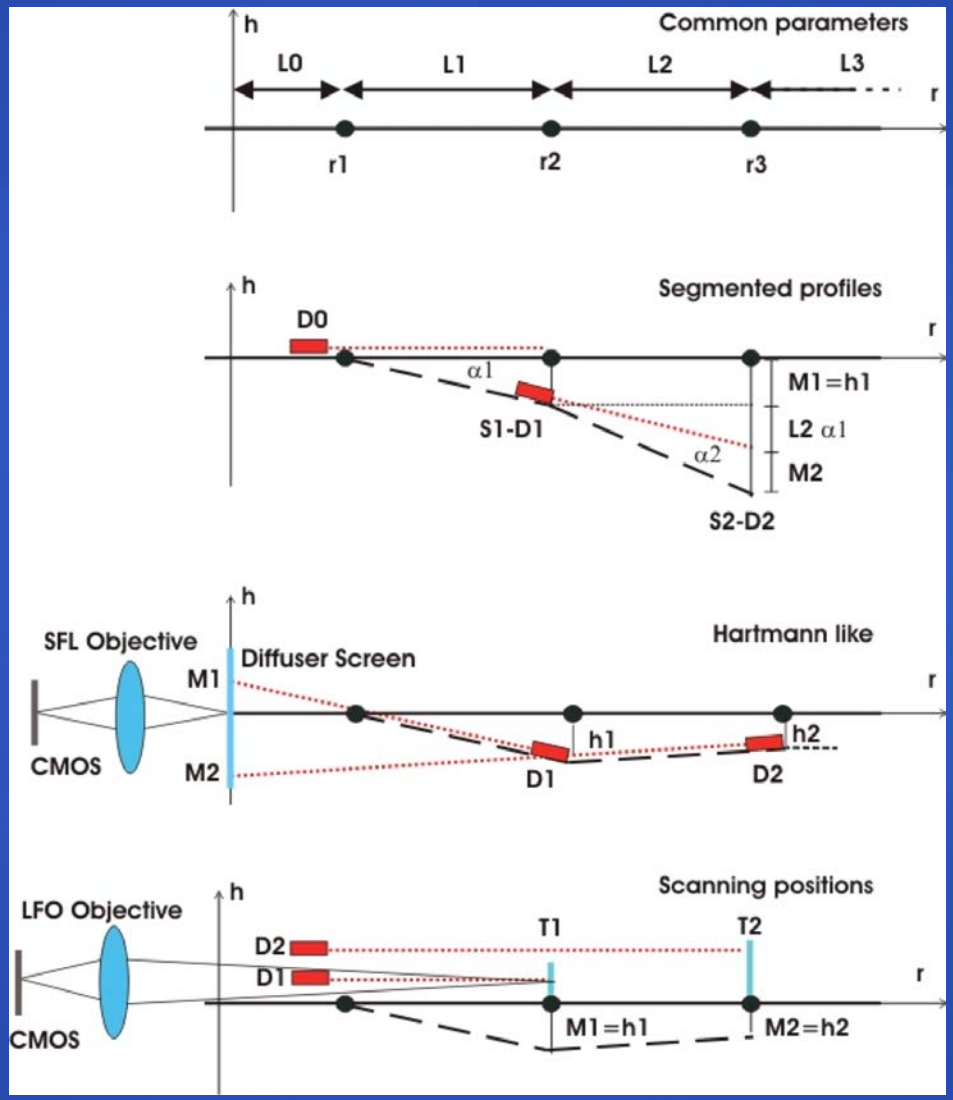


OOF Holography planned in collaboration with GBT (R. Prestage)

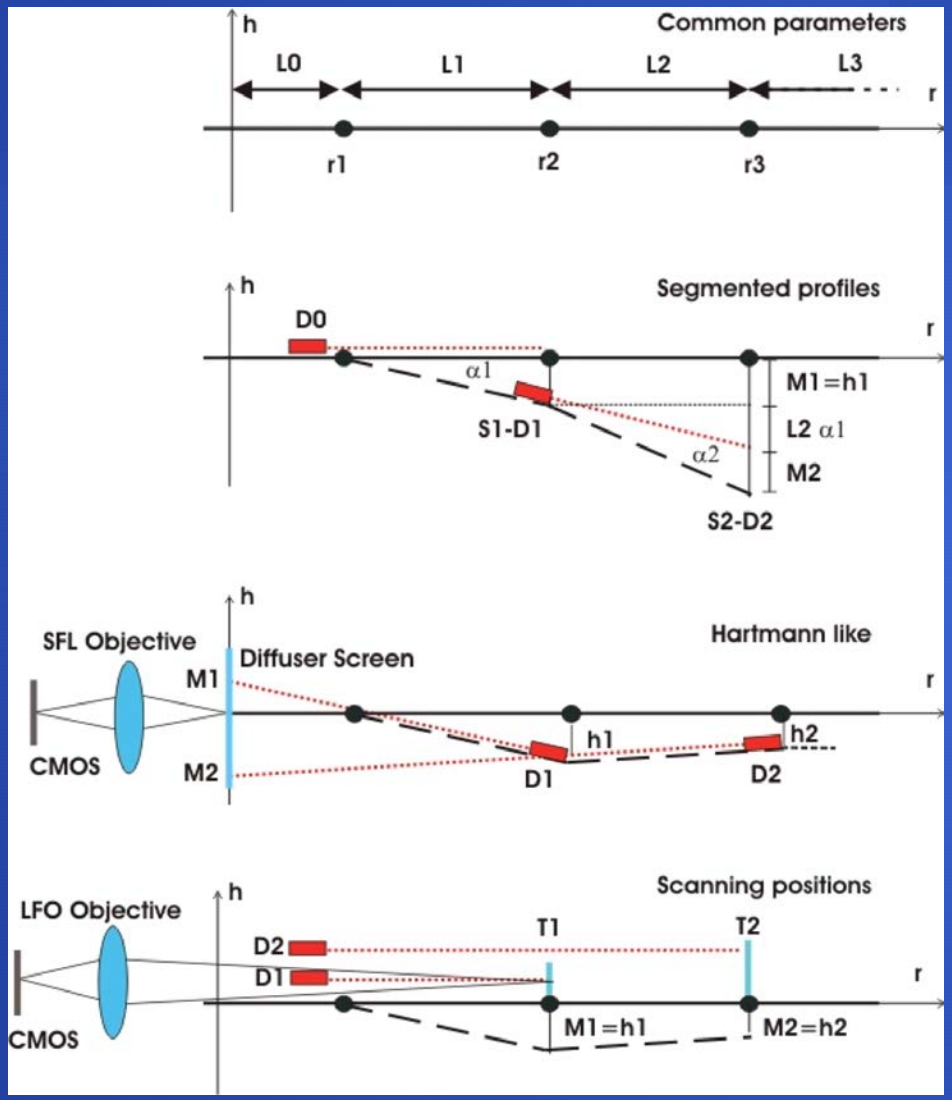
General considerations



The three tested systems



General considerations



$$\alpha_i = \alpha_{i-1} + \frac{M_i}{L_{i1}}$$

$$h_i = h_{i-1} + L_i \alpha_i$$

$$h_0 = 0$$

$$\alpha_0 = 0$$

$$\frac{Mi}{\sum_{i-1} L_j} = \frac{h_i - h_{i-1}}{\Delta M} + \frac{|M_i|}{L_{i1}} + \frac{|M_i|}{L^2_{i1}} \Delta L$$

$$\Delta\alpha_i = \Delta\alpha_{i-1} + \frac{\Delta M}{L_i} + \frac{|M_i|}{L^2_{i1}} \Delta L$$

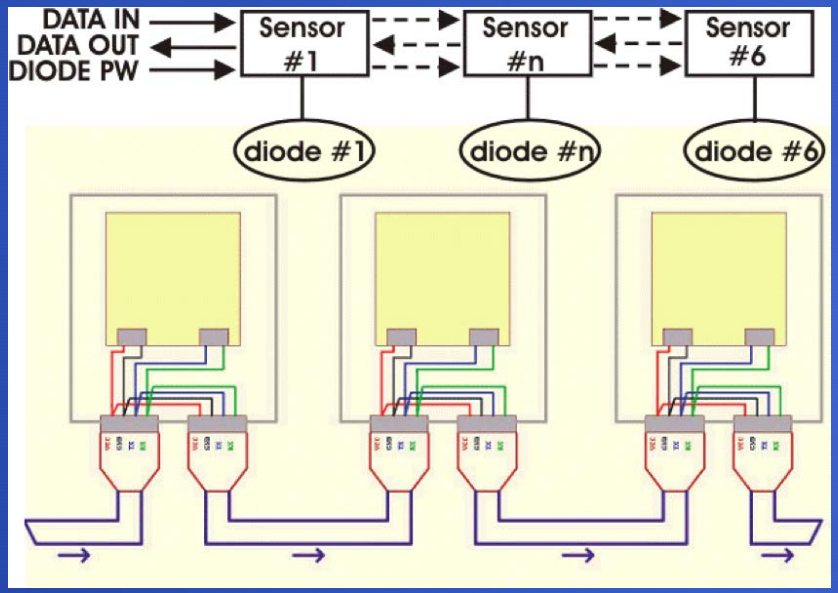
$$\Delta h_i = \Delta h_{i-1} + |\alpha_i| \Delta L + L_i \Delta\alpha_i$$

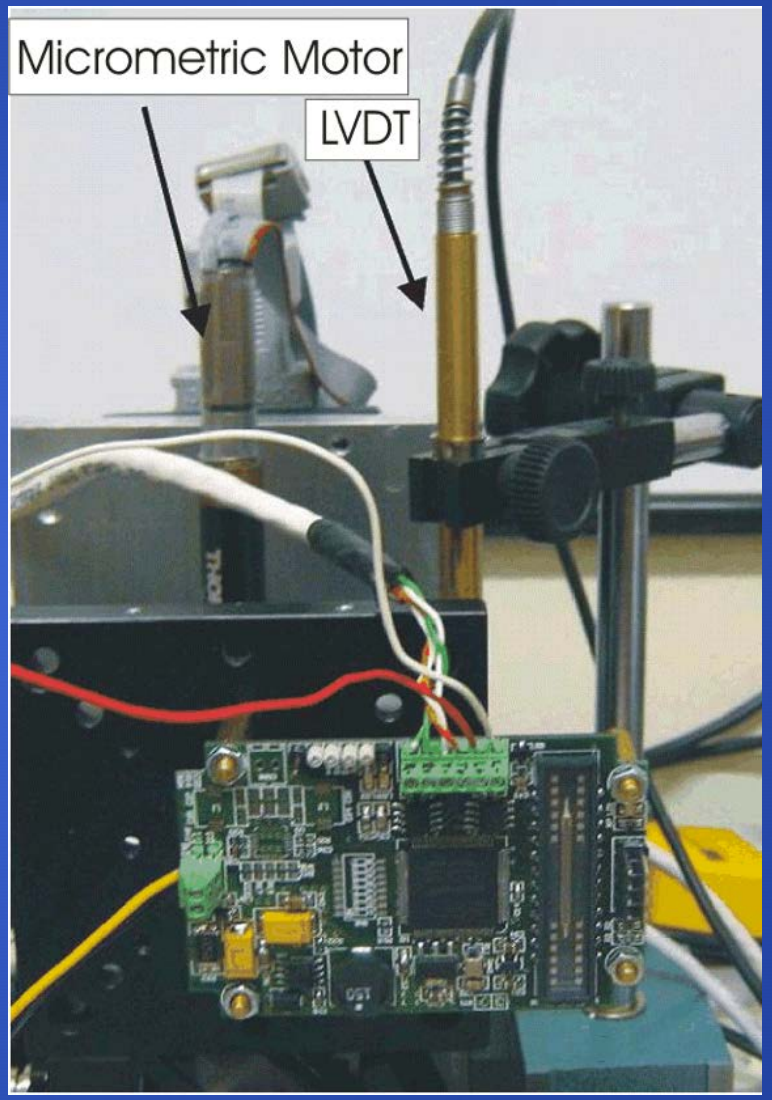
$$\Delta\alpha_0 = 0$$

$$\Delta h_i = \frac{1}{2} M_i \Delta L + \frac{1}{i} \Delta M + \Delta h_{i-1}$$

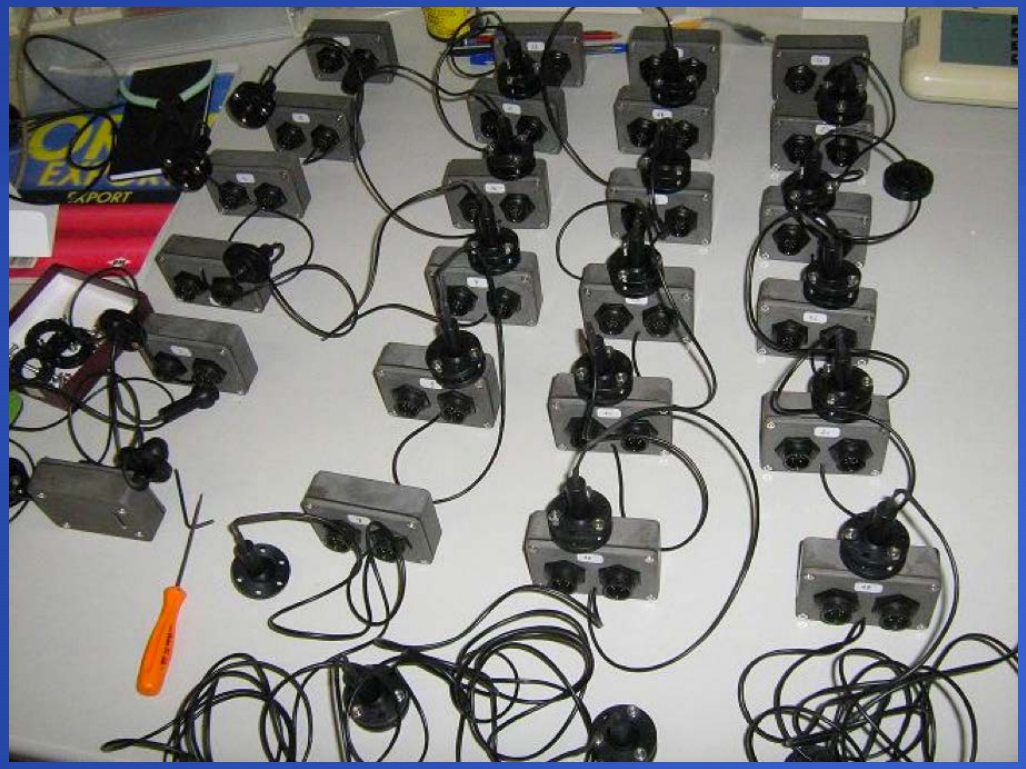
$$\Delta h_0 = 0$$

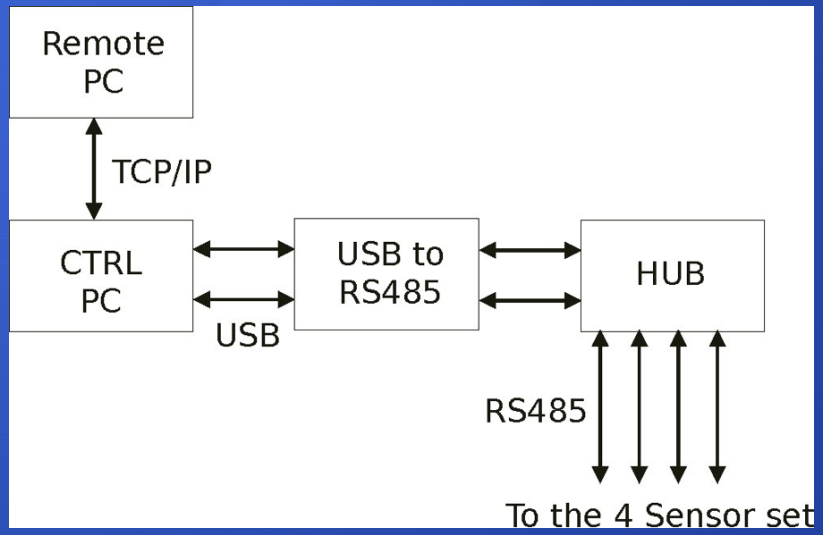
Segmented Profiles





Segmented Profiles





Segmented Profiles

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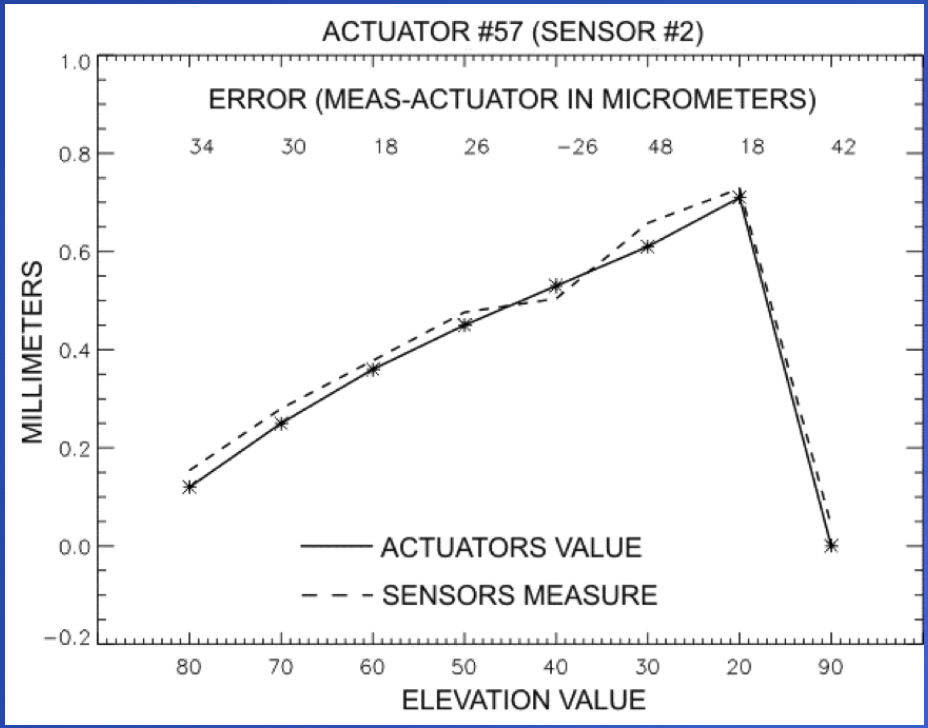
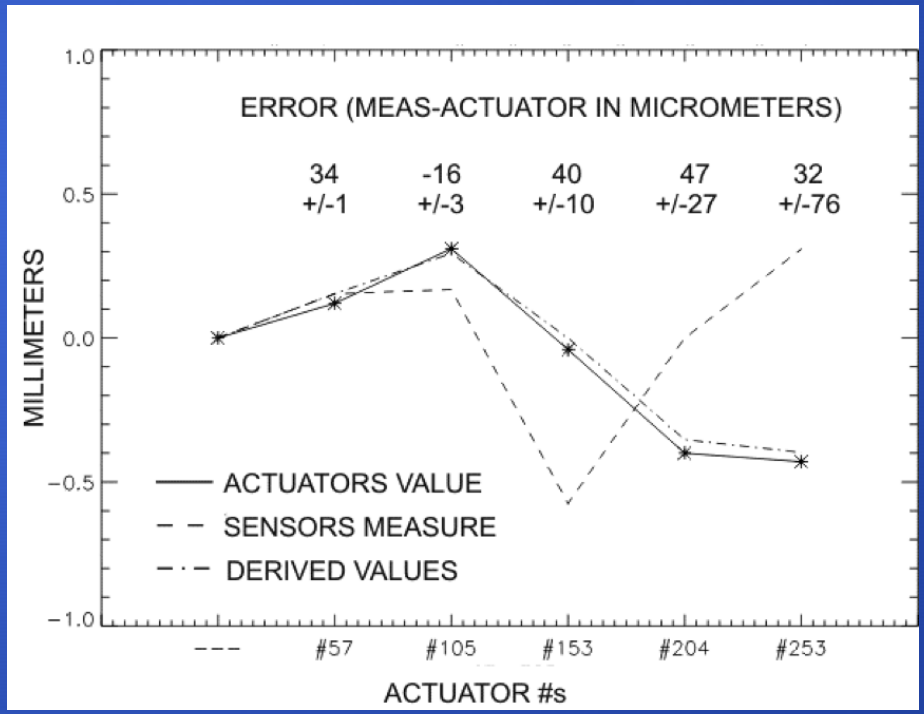
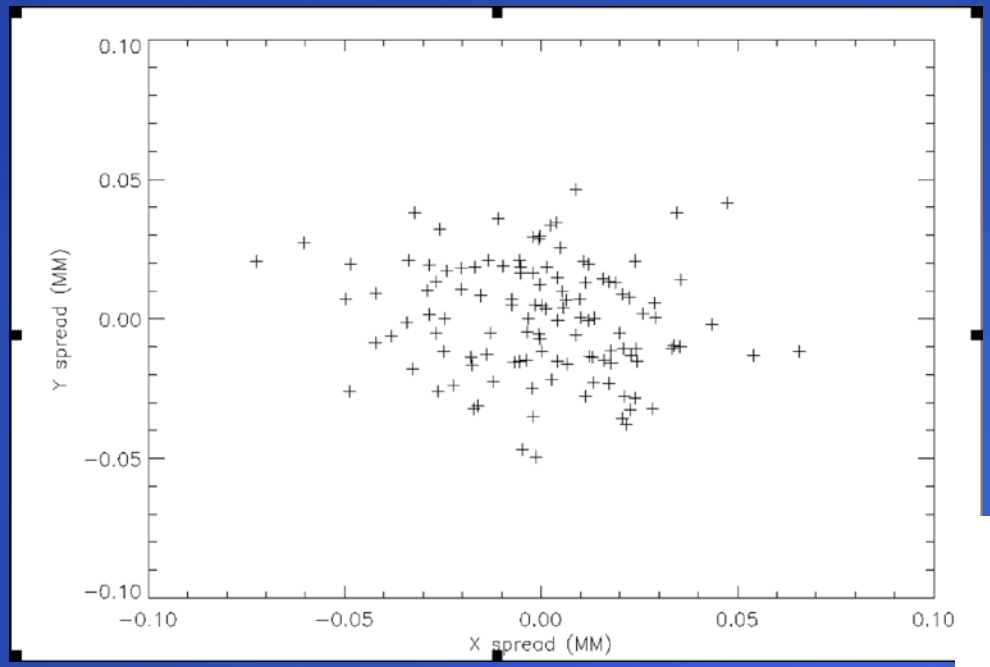
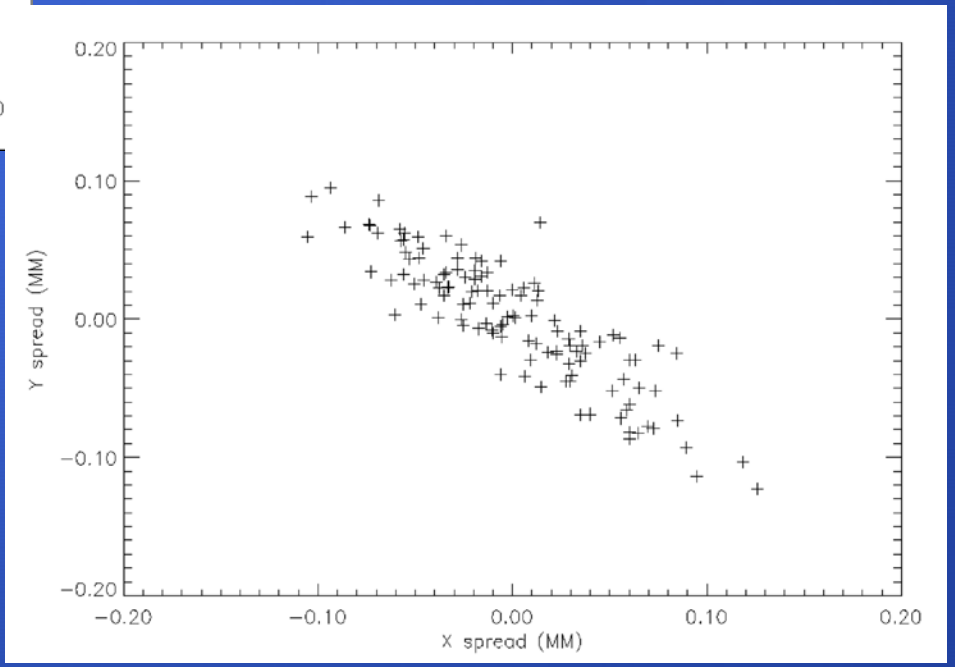




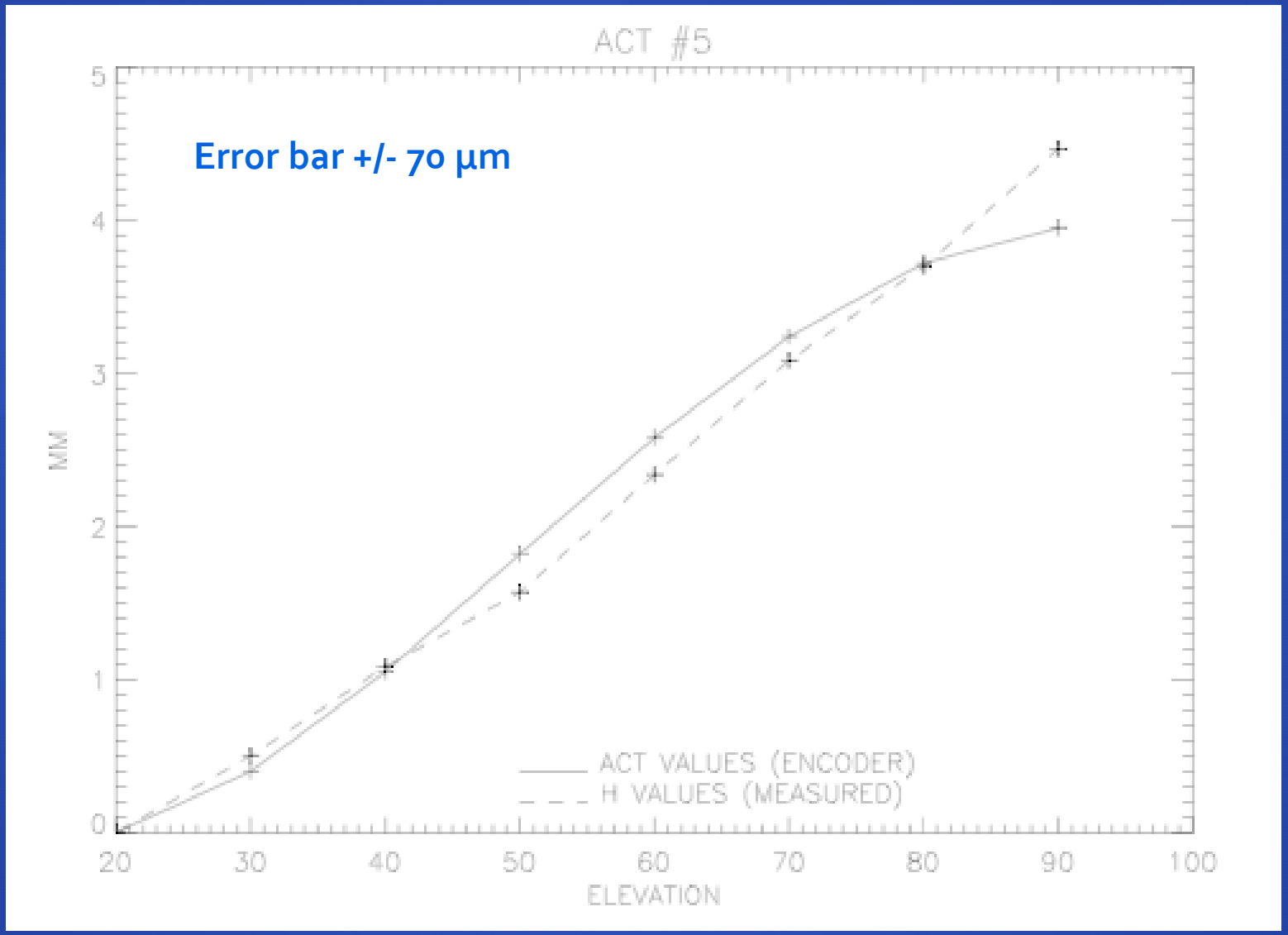
Hartmann like

Hartmann like

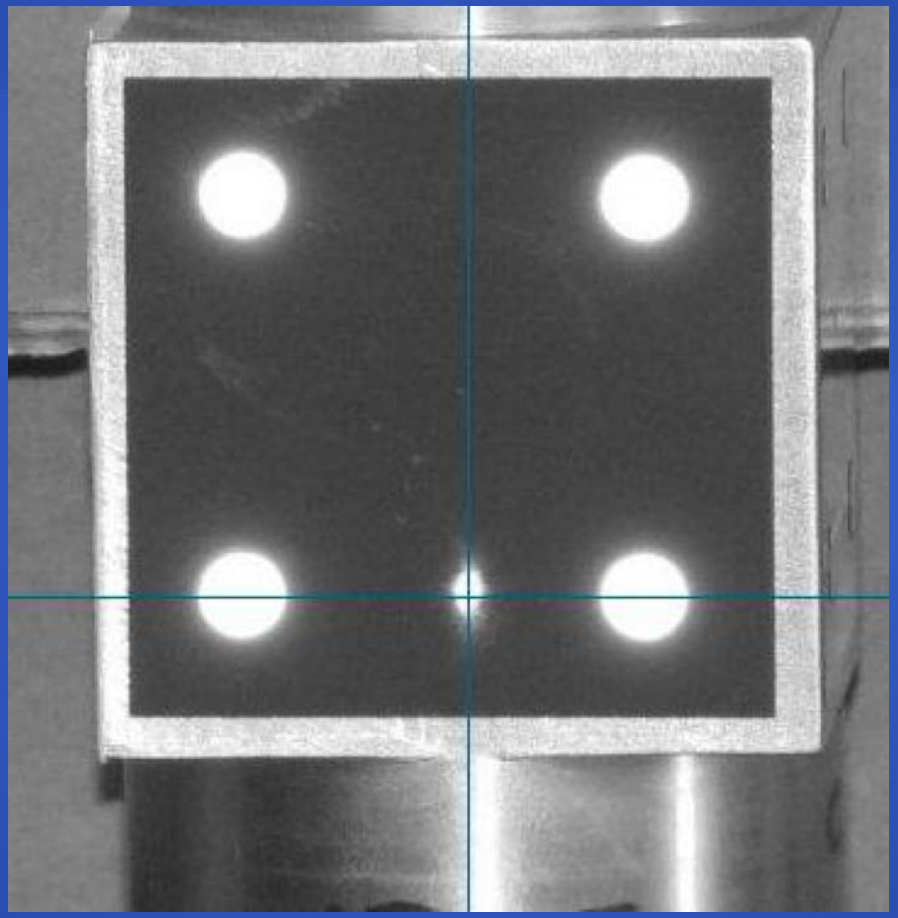




Hartmann like



Scanning Position System



Comparison among the three systems & Conclusions

	Segmented profile	Hartmann-like	Scanning position
Accuracy	+/-3 : +/- 70 μm	+/- 40 μm	+/- 75 μm
Sensitivity against panel deformations	medium	very hight	very low
Hardware cost	$$$	$$	$
Cabling complexity	high	high	low
Mounting cost	$$$	$$	$
Maintainement cost	$$	$$	$
Failure probability	very high	high	low