FIVE TARGET SYSTEM CALIBRATION

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“The man who has ONE ground target knows what his System Delay is.

The man who has TWO is never quite sure.”

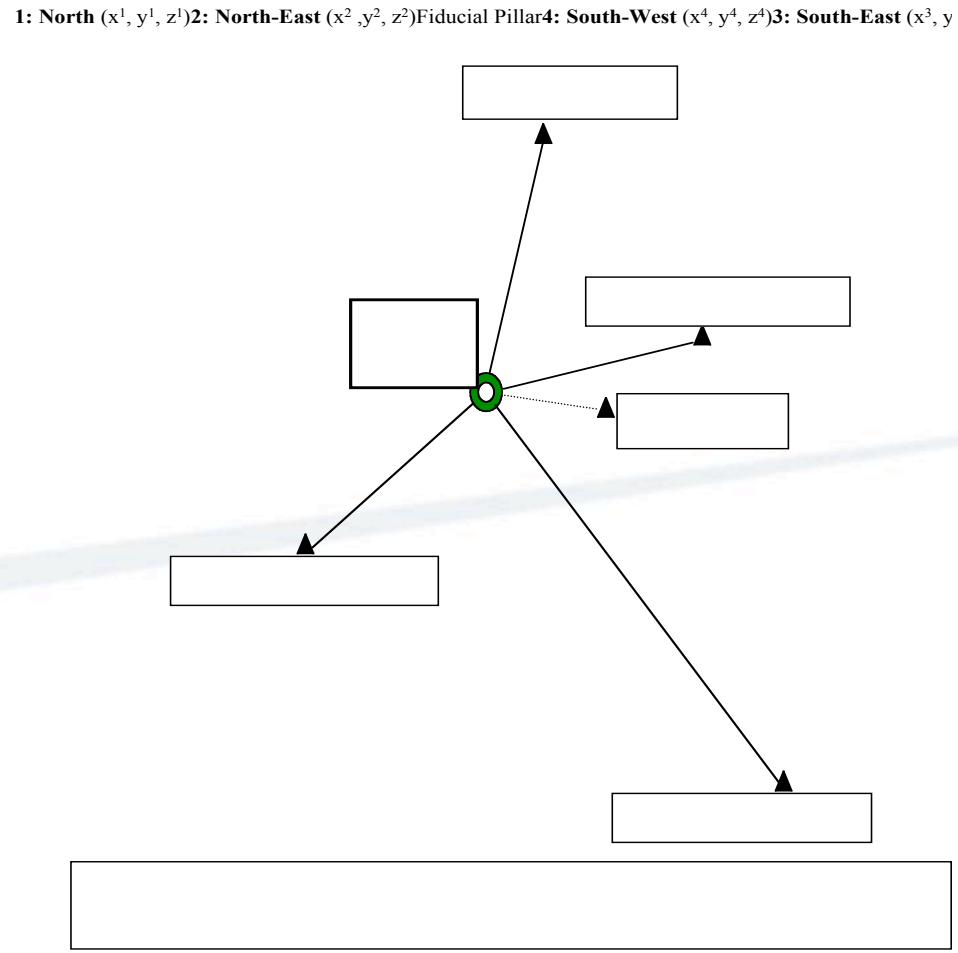
EOS Space Research Centre on Mount Stromlo, Canberra, Australia May, 2004

27 May 2004

View from DIMM Tower over roof of SLR Building. Note NE Cal Pillar, “Oddie” remnant, DORIS & Mets

27 May 2004

The Four Ground Target Locations at Stromlo SLR. The Fifth Target is 1.4 metres from IVP, on “Spider”.



MINICO TARGET LOCATIONS, STROMLO

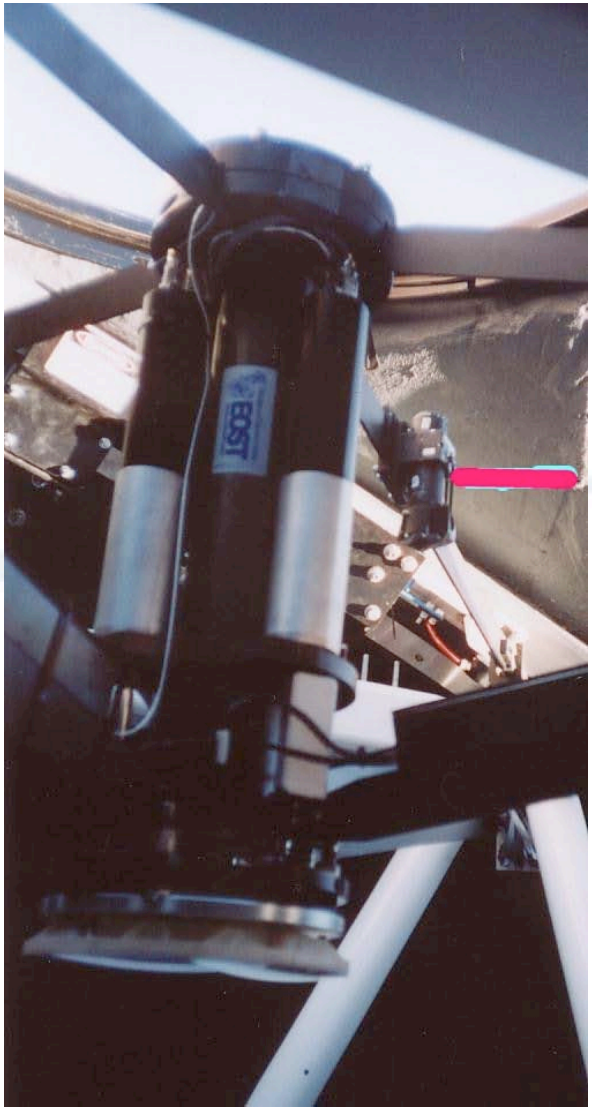
27 May 2004

Very Close Collocation on North Calibration Pillar: GPS Antenna, Target Retro, Official Survey Plate

(photo from 2000)

27 May 2004

Spider Retro: Internal Calibration Target mounted on a Vane holding the Secondary Mirror



Observation Equations for Various Combinations of Ground Target and Spider Retro Ranging

All variables converted to common units, either mm or ns.

i, corrected for atmosphere, window glass, …

i.

g Distance from System Reference Point (SRP) to Spider Retro.

SD System Delay

i

Using all 4 Ground Targets plus Spider Retro

Using all 4 Ground Targets plus Spider Retro , & Subtracting to eliminate *SD*

Common Case: Using 1 Ground Target only

Using Spider Retro only , in real time

Solve for SD continuously assuming g is known.

Using Spider Retro in real time, calibrated from 1 Ground Target

Solve for g pre- and post-pass; then

Solve for SD continuously.

Solution from a typical 5-target MINICO session, in 2001

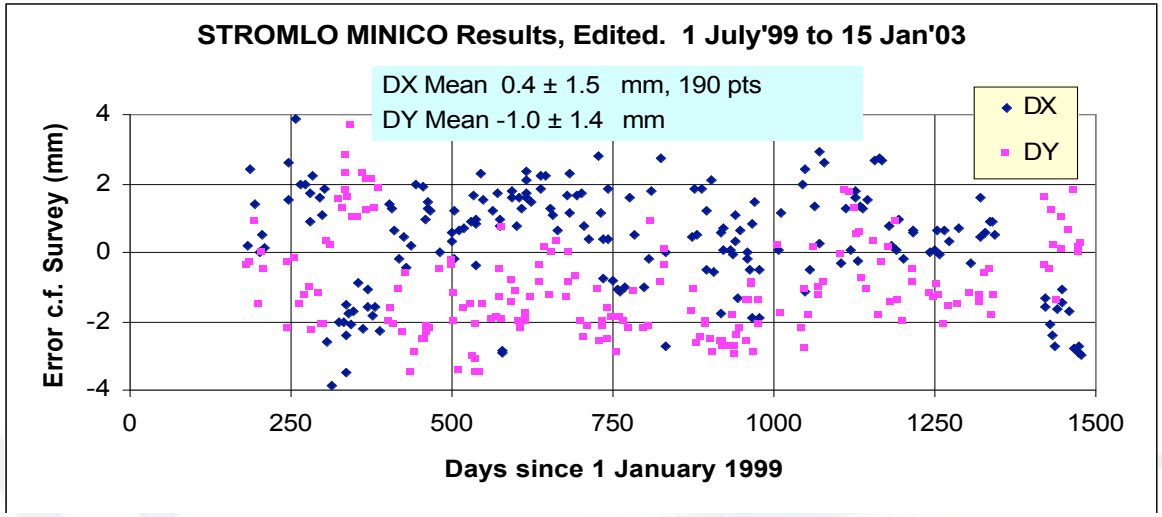
Sol'n	Error w.r.t. Survey				RMS	RMS of Solutions			
Equ'n	DX (mm)	DY (mm)	DG (mm)	SD (ps)		x_0 (mm)	y_0 (mm)	g (mm)	SD (ps)
(4)	1.2	-1.9	-	442	1.9	1.5	1.4	-	6.9
(6)	0.0	-1.5	1.9	-	1.2	1.0	0.9	0.7	-
(4), (5)	1.2	-1.9	1.6	442	1.3	1.0	0.9	0.9	4.6

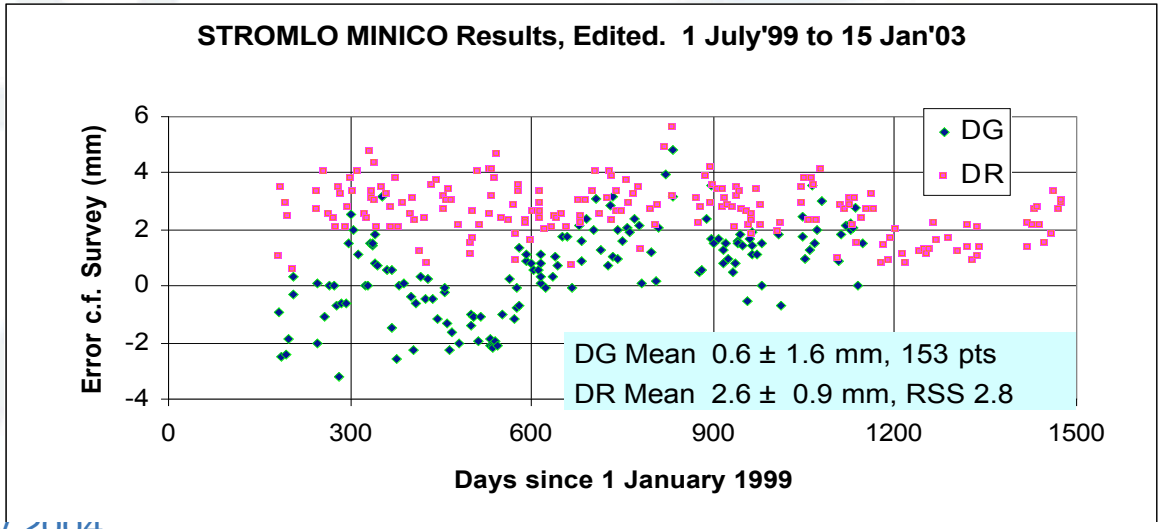
Correlation Coefficients

(x0,y0) -0.29	(x0,g) -0.28	(x0,SD) 0.38
	(y0,g) 0.09	(y0,SD) -0.12
		(g,SD) -0.73

Stromlo-1 MINICO Results, 1999-2003

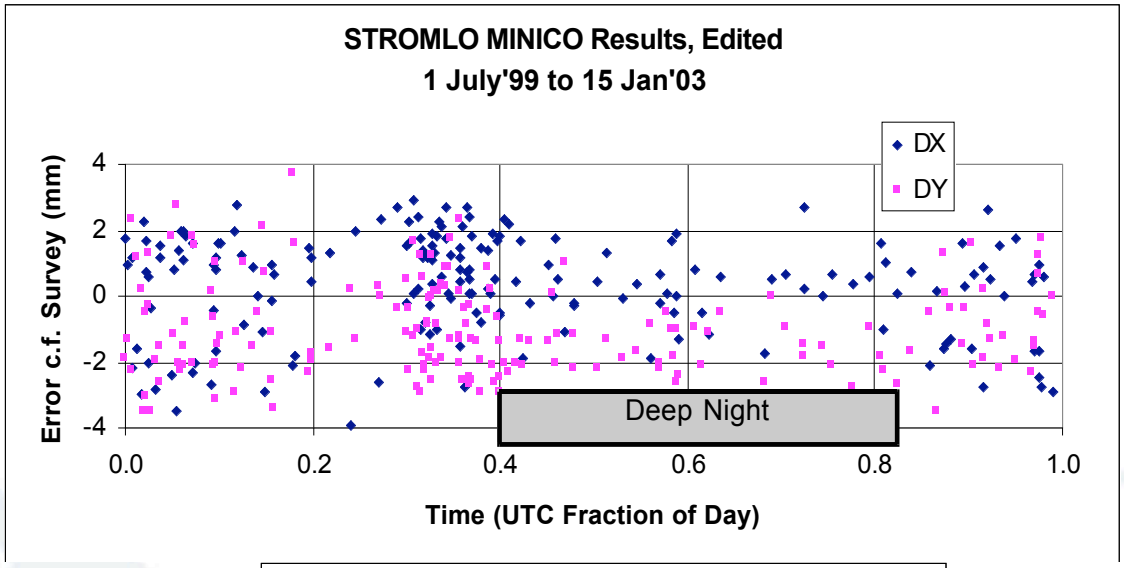
DX, DY are [Solution – Survey] for SRP East & North coordinates
DG is [Solution – Measured] distance SRP to Spider Retro
DR is magnitude of DX, DY, DG combined

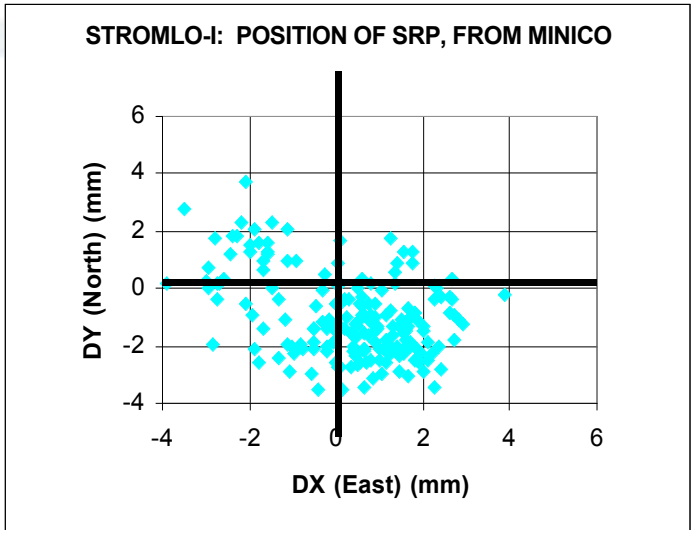




STROMLO-1 MINICO Results, 1999-2003

Solutions for SRP Horizontal Coordinates w.r.t. Survey Values
(a) As function of time of day/night; (b) Map





STOP PRESS

First successful MINICO results with Stromlo-III
31 May 2004

- X_0 -1.0 mm, RMS 1.6 mm (w.r.t. survey)
- Y_0 -0.1 mm, RMS 1.5 mm (w.r.t. survey)
- G -13.3 mm, RMS 1.5 mm (from initial guess)
- SD -98.2 ps, RMS 7.2 ps (from initial guess)

CONCLUSIONS

- Using 5 Target MINICO, calibration **accuracy** was assured to **1.5 mm** on Stromlo-1 from mid-1999 to January 2003
- Hence System Delay calibration accuracy was no worse than **17 ps**
- Calibration distances have been constant at this level over 3_ years
- GA Survey in December 2003 claims 0.5 mm formal RMS in calibration distances. First results from Stromlo-III suggest they might be right!

ACKNOWLEDGEMENTS

- Geoscience Australia (GA), especially Jim Steed, for providing the files of historical MINICO data.
- GA again, for performing several local tie surveys since 1998, including collocation of SLR with GPS, GLONASS and DORIS antennae, fundamental monument, gravity meters, calibration targets and other local marks with flair and skill.
- John Dawson of GA for developing a method of determining the coordinates of the IVP (see his poster at this Workshop, "*The Mount Stromlo SLR System Local Tie Connections* . . .".

“The man who has ONE ground target only THINKS he knows his System Delay.

The man who has FIVE can be pretty sure.”