Statistical Studies of the Calibration of the Helwan-SLR Station

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Acknowledgement

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Aim of Research

Studies on Calibration of the Helwan-SLR Station from 1991 to 2008.

i. **Description of the calibration technique at Helwan-SLR.**

ii. **Analysis of the calibration results from 1991 to 2008.**

iii. **Studies of the results of analysis during two periods using two different photomultipliers.**

iv. **Computation of the calibration constant,**

1) **At 2000, after using the new PMT**

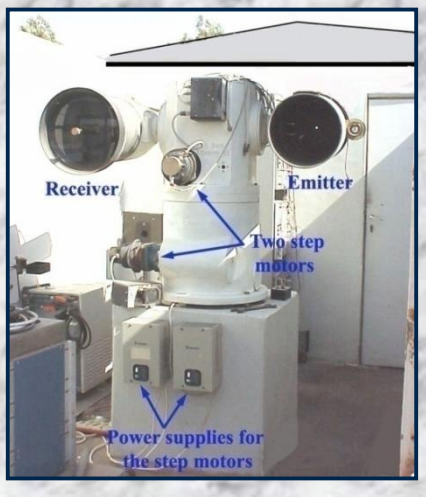
2) **At 1996, using the old PMT.**

Introduction

Helwan –SLR Station

Equipments of Helwan-SLR Station

Mount

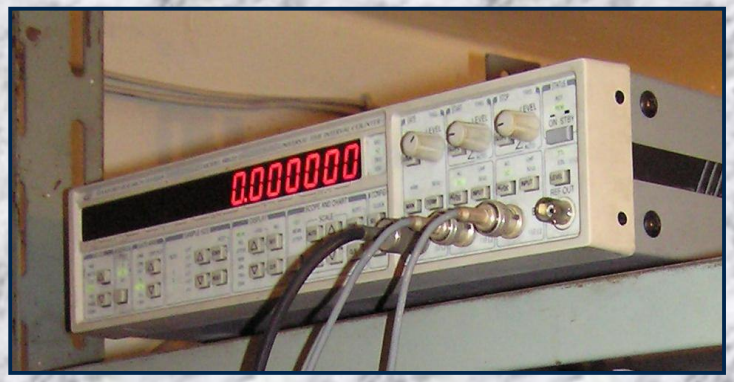


Laser Generator

HP-58503B, It is provide the 1pps with accuracy better than 110 ns

Stanford SR620,

4 ps of precision

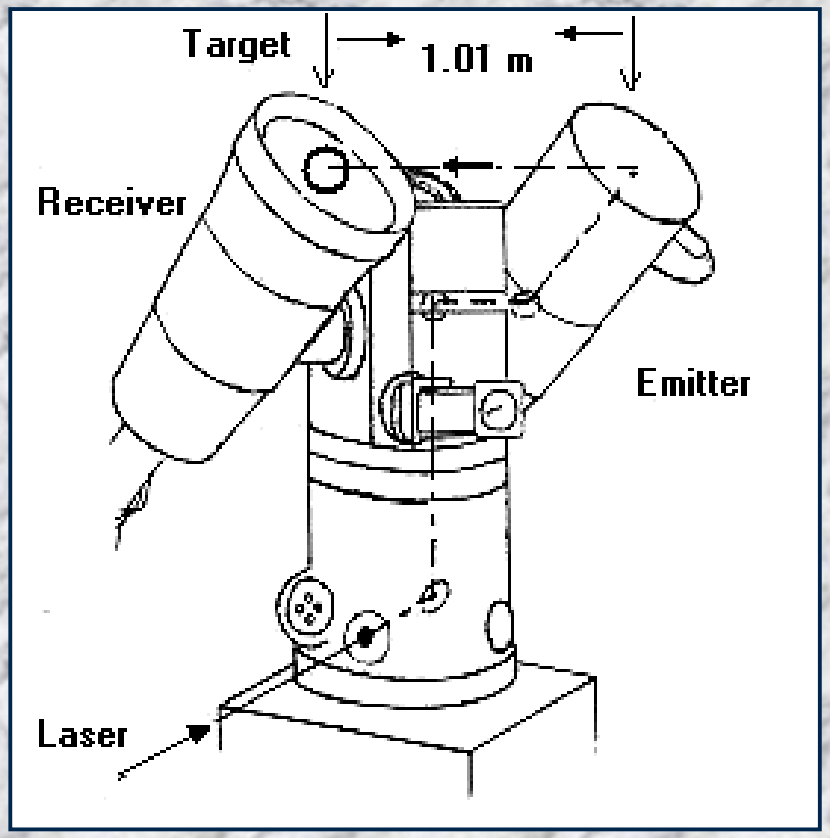


The Geometry of the Calibration Setup

- The Geometry of the calibration is shown in fig.
- Both the emitter and receiver are covered .

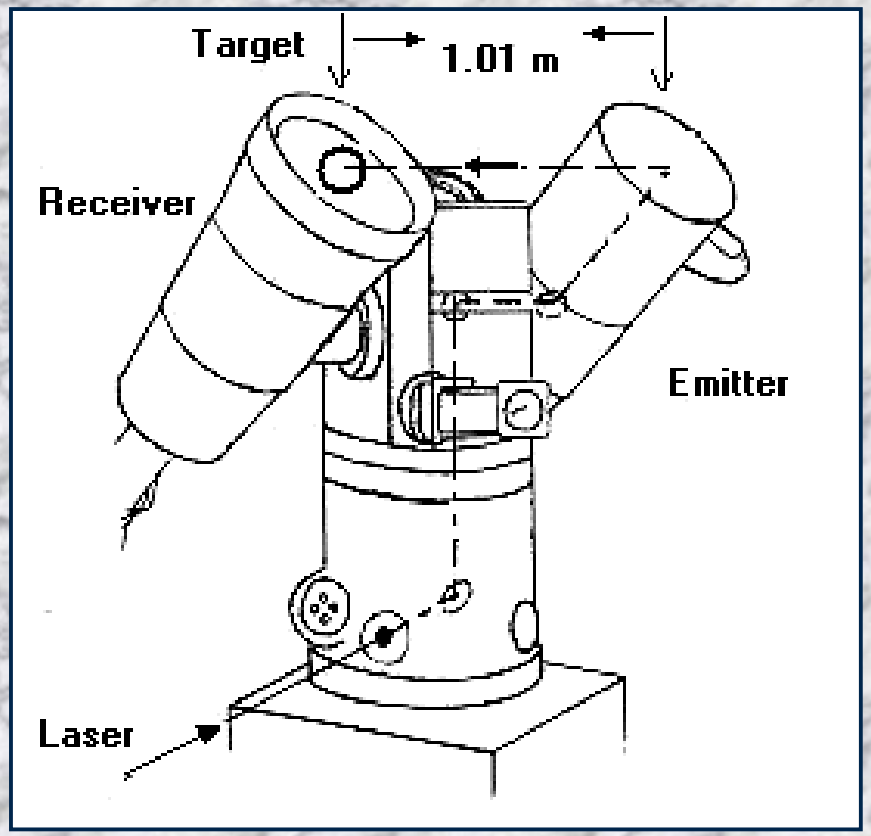
- The cover of the emitter has a hole followed by mirror to reflect the beam to the target .
- The computation of the calibration constant is the average of 100 returns (echoes).

- For the calibration, the signal strength is adjusted using a neutral density filters in order to receive the signal strength with a known range L/E.

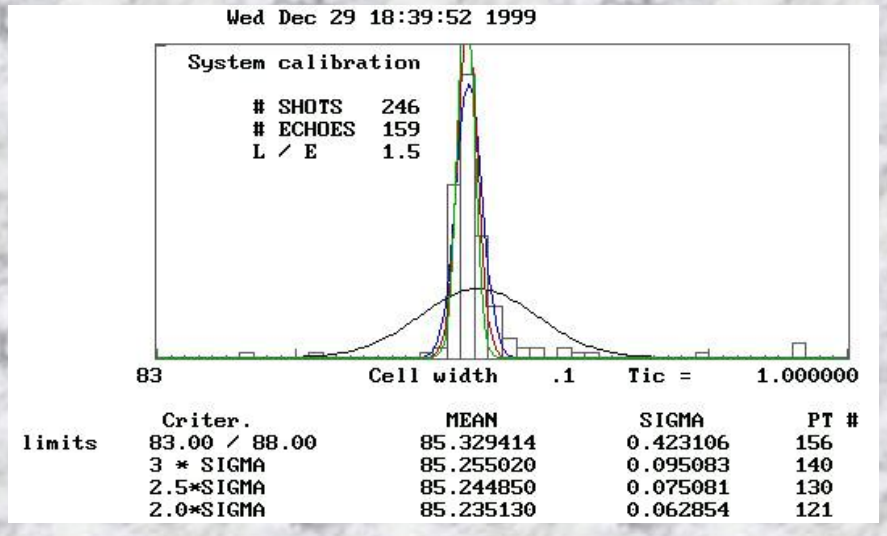


Calibration of the Helwan-SLR Station

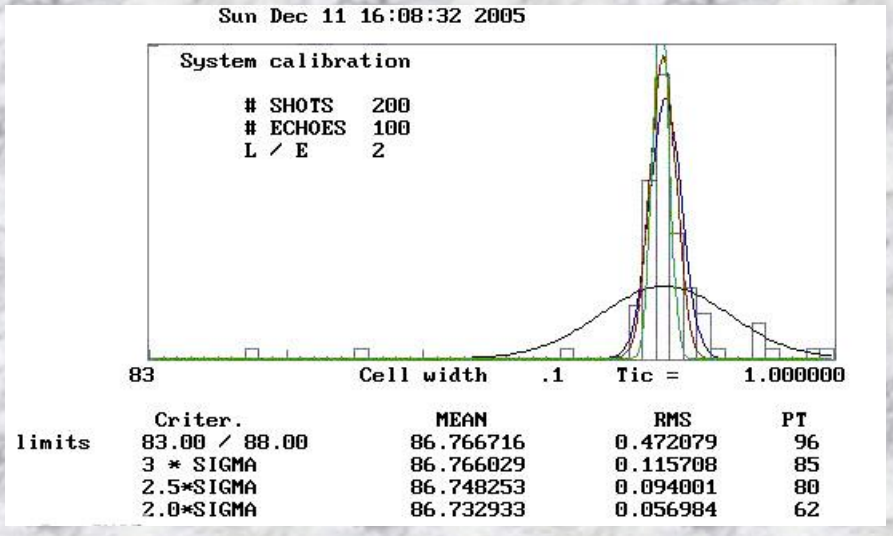
- This study concerns on the results of the calibration, which is applied to the Helwan SLR-station in two periods.
- The first period is from Aug. 1991 to Sept. 1997.
  The PMT of type RCA 31034A has been used.
- The second period is from 1998 to 2008 . The PMT Hamamatsu H6533 is in use.



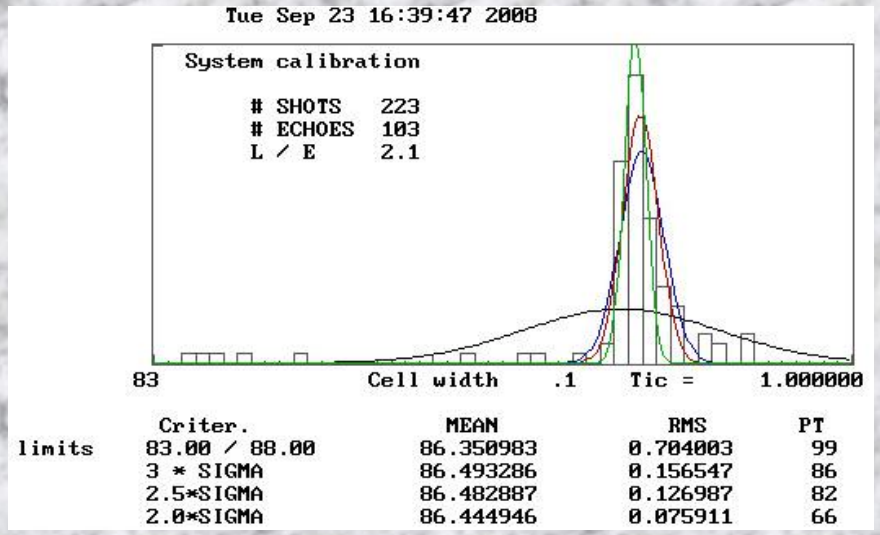
Results of the Calibration



	Criter.	MEAN	SIGMA	PT #
limits	83.00 / 88.00	85.329414	0.423106	156
	3 * SIGMA	85.255020	0.095083	140
	2.5*SIGMA	85.244850	0.075081	130
	2.0*SIGMA	85.235130	0.062854	121



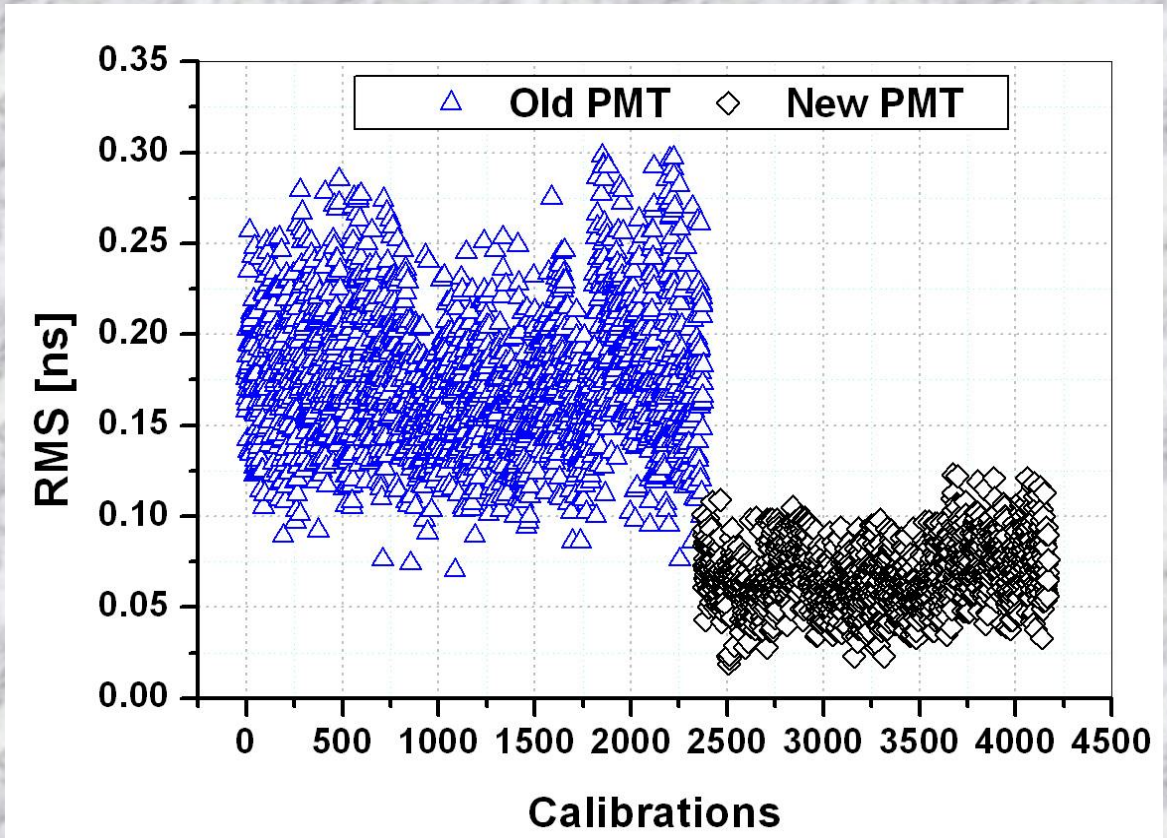
	Criter.	MEAN	RMS	PT
limits	83.00 / 88.00	86.766716	0.472079	96
	3 * SIGMA	86.766029	0.115708	85
	2.5*SIGMA	86.748253	0.094001	80
	2.0*SIGMA	86.732933	0.056984	62



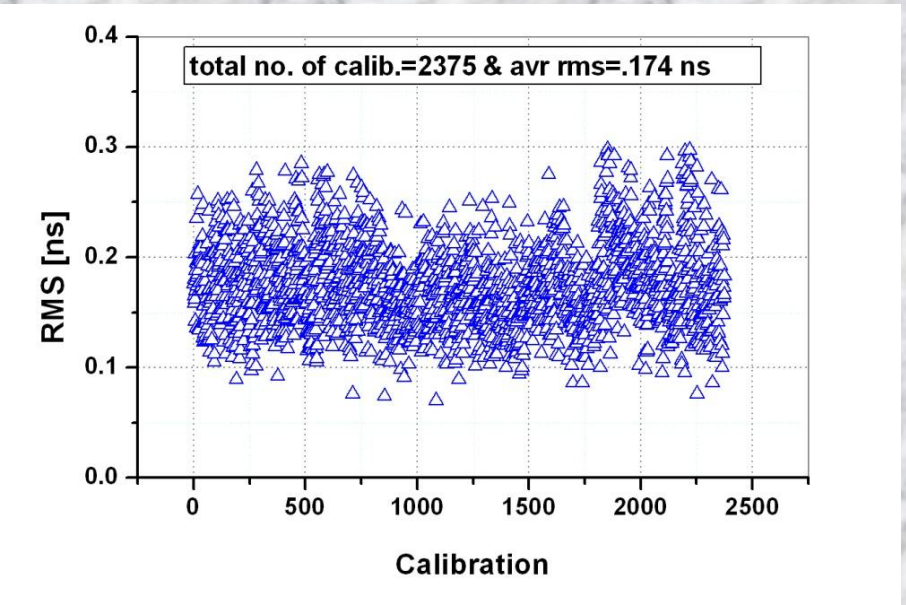
	Criter.	MEAN	RMS	PT
limits	83.00 / 88.00	86.350983	0.704003	99
	3 * SIGMA	86.493286	0.156547	86
	2.5*SIGMA	86.482887	0.126987	82
	2.0*SIGMA	86.444946	0.075911	66

Typical histogram of the internal calibration of the system .

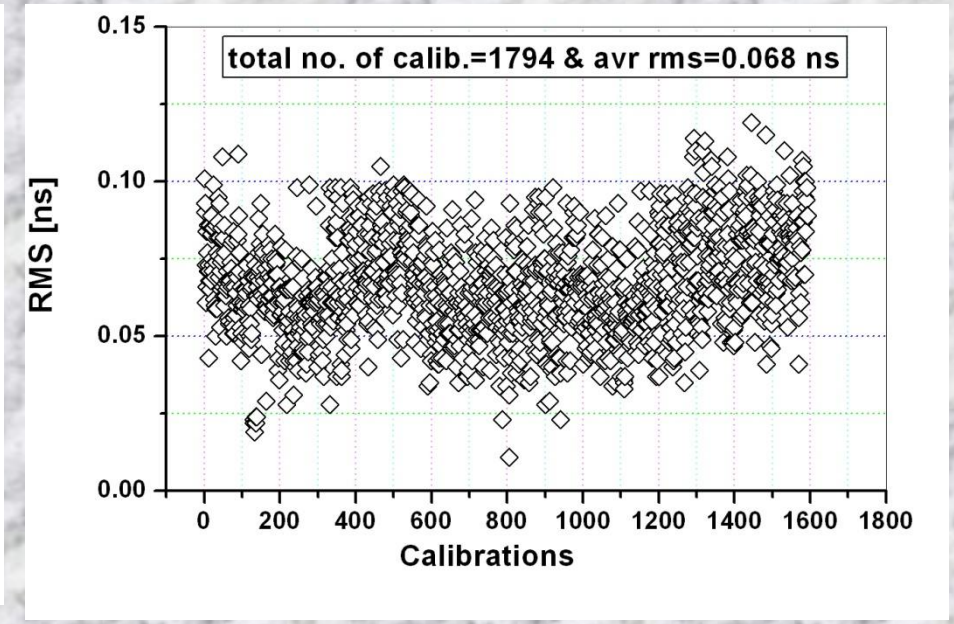
The Calibrations for all the data (4169) carried out at the period from 1991 to 2008



Calibration using old and new PMT



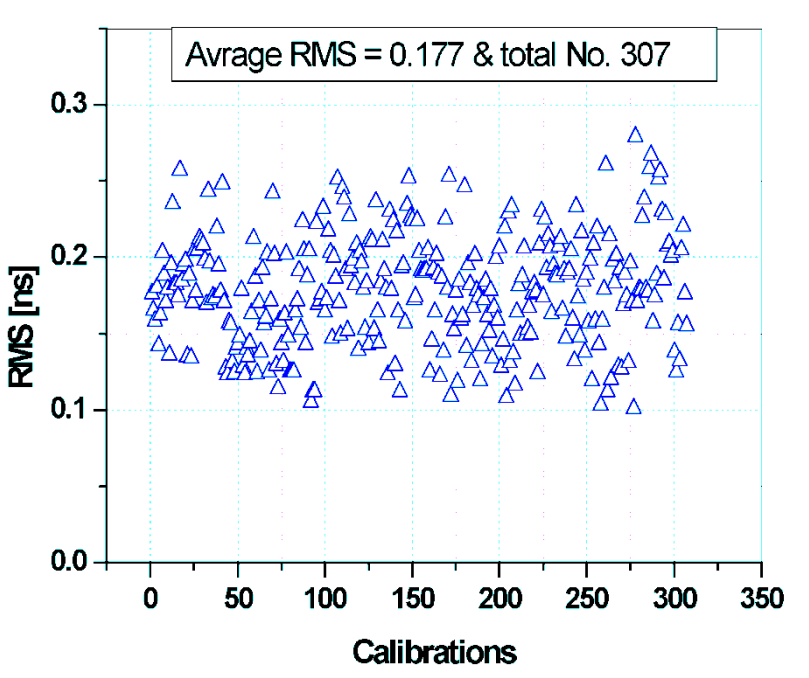
(a)



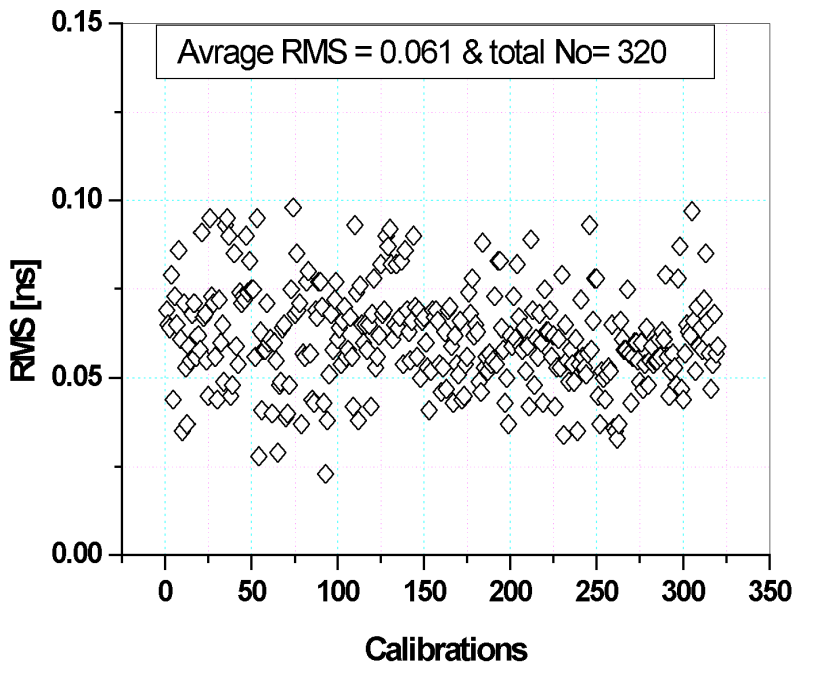
(b)

The calibrations versus the RMS values for all the calibrations carried out by the old PMT in (a) and by the new PMT in (b)

Calibration of the Helwan-SLR Station



(a)



(b)

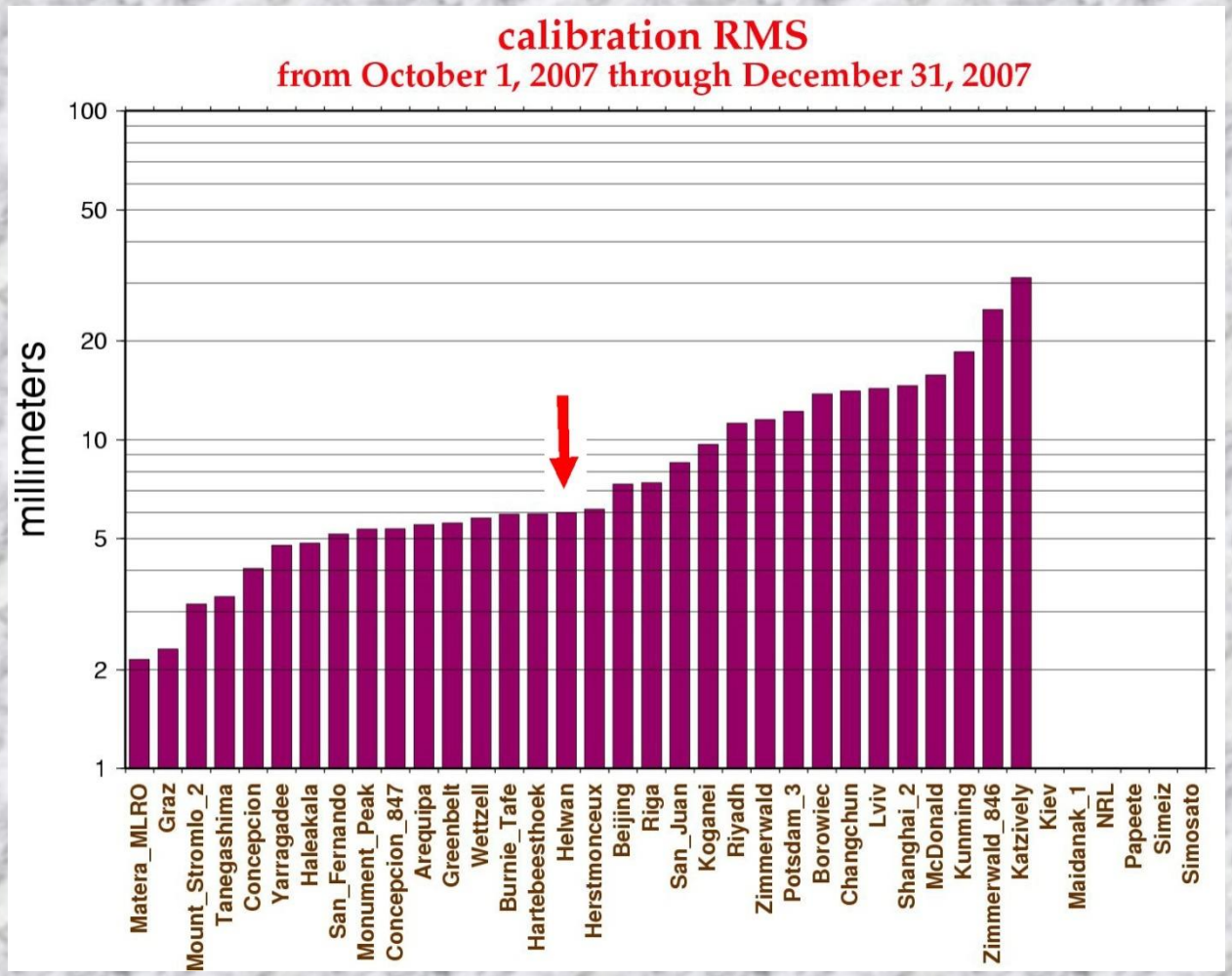
The calibrations versus its RMS value for the calibrations carried out at the years 1991 in (a) and 2000 in (b).

Calibrations for each year

Year	Start Date	End Date	Nr of calib.	Avr. RMS
1991	3 - Aug	1 - Dec	307	0.177
1992	17 - Feb	8 - Dec	401	0.181
1993	28 - May	29 - Sep	453	0.168
1994	31 - May	24 - Sep	389	0.160
1995	6 - Jan	11- Sep	282	0.171
1996	20 - Jun	18 - Aug	214	0.198
1997	16 - May	22 - Sep	329	0.175
1998	13 - May	31 - Dec	428	0.064
1999	2 - Jan	29 - Dec	418	0.066
2000	4 - Jan	8 - Nov	320	0.061
2001	13 - Jan	10 Nov	119	0.068
2002	- - -	- - -	- - -	- - -
2003	- - -	- - -	- - -	- - -
2004	6 - April	28- Dec	120	0.075
2005	1-Jan	26- Nov	226	0.077
2006	30 - Jan	25- Dec	55	0.079
2007	14 - April	30 - Dec	77	0.077
2008	27 - Jan	23 - Sep	31	0.074

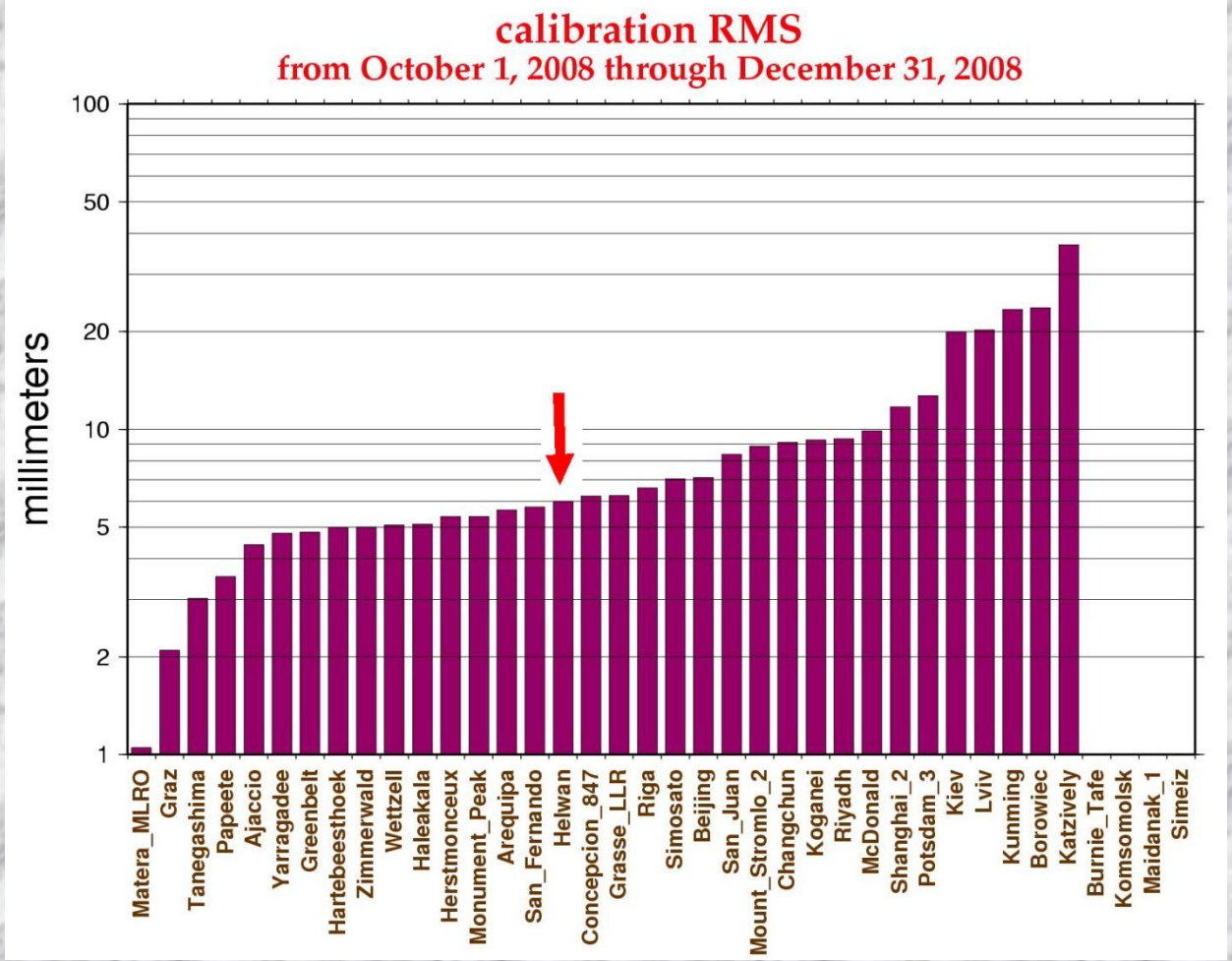
Tab.1. The calibrations applied to the station during the period from 1991 to 2008.

Calibrations of all the SLR Stations, 2007



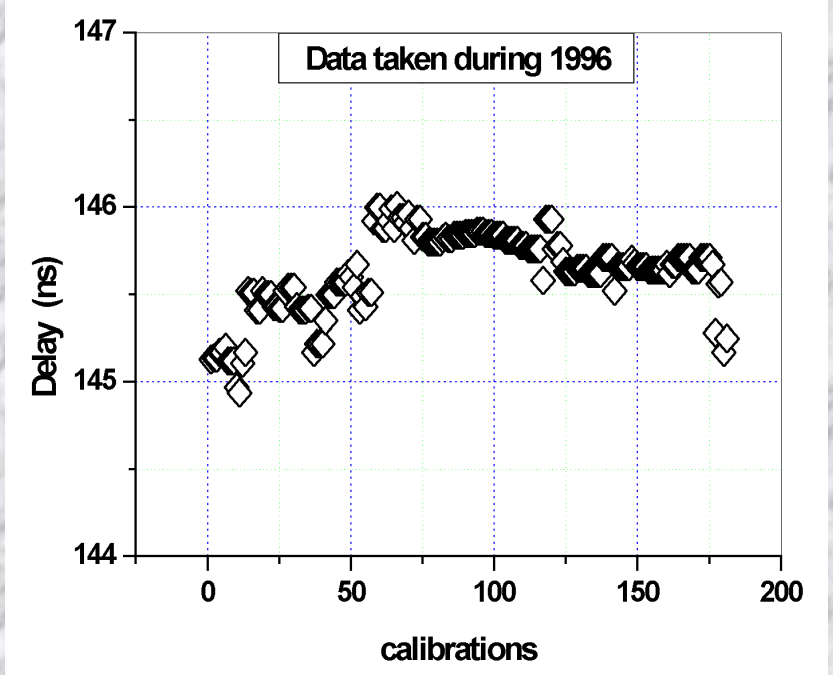
The deduced precession of the average single-shot calibration RMS, in millimeters, during the last quarter of 2007.

Calibration of the all SLR Station, 2008

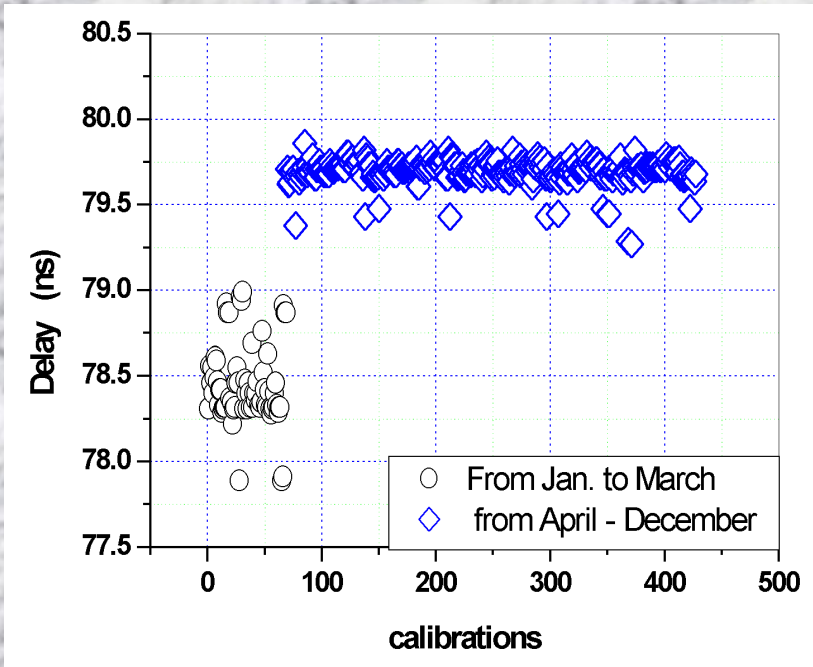


The deduced precession of the average single-shot calibration RMS, in millimeters, during the last quarter of 2008.

System Internal Delay



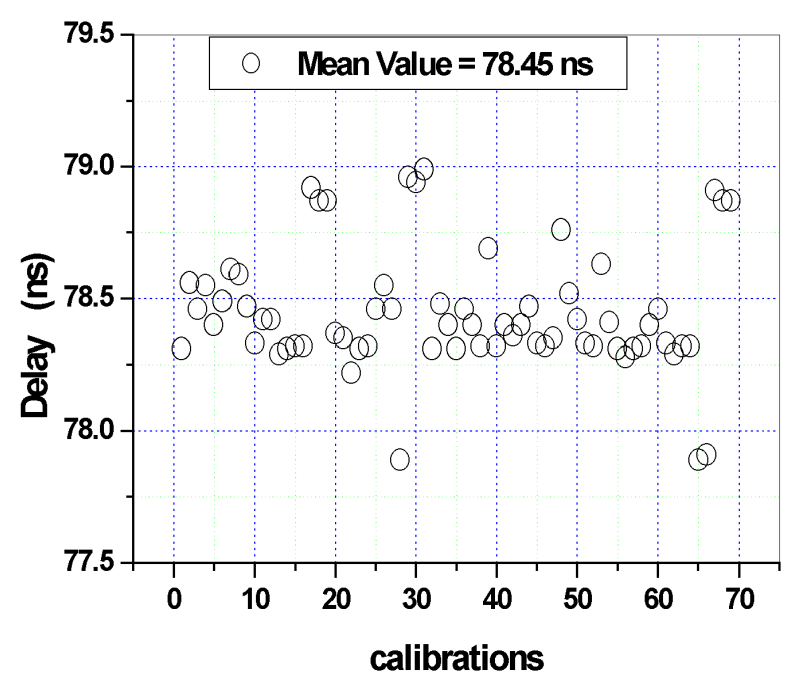
(a)



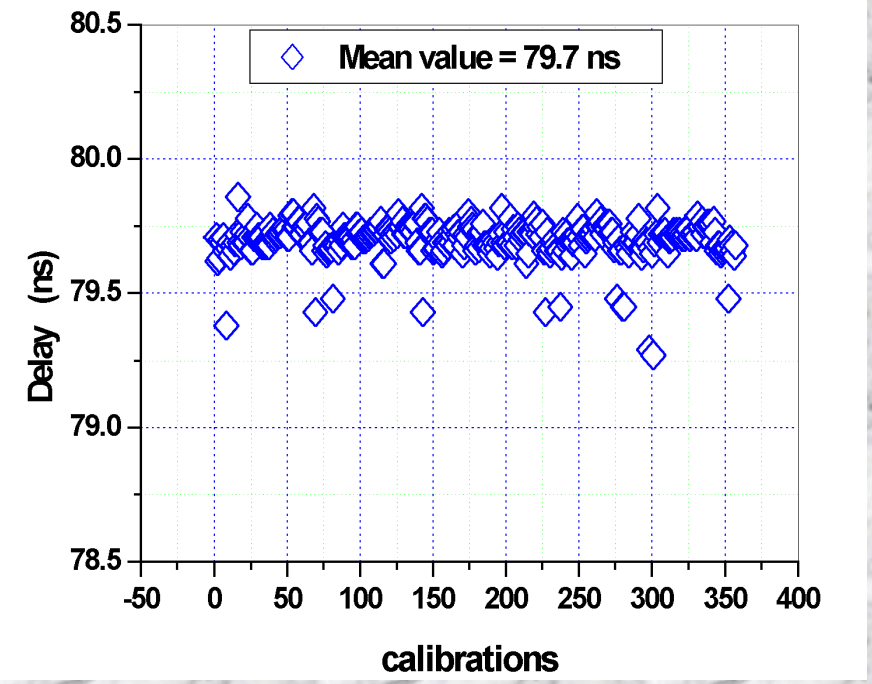
(b)

The system internal delay obtained by calibrating the system during the year 1996 in (a) and 2000 in (b).

System Internal Delay during 2000



(a)



(b)

The internal delays carried out by calibrating the system during the year 2000 using the time interval of type HP5370B in (a) and of type SR620 in (b).

Conclusion

Statistical studies of the calibration of Helwan-SLR station

1) The first period, using the old PMT from 1991 to 1997.

2) The second, using the new PMT from 1998 till 2008.

- **The average RMS value using the old PMT is found to be 0.174 nsec, while using the new PMT is 0.068 nsec.**
- **That is, the calibrations produced using the new PMT package are nearly 2.6 times better.**
- **The average RMS of the years from 1998 to the year 2002 is below 0.07 nsec, while it is higher than 0.07 nsec from the year 2005 till 2008.**
- **From the measurements of the system delay, it is found that the data obtained during 2000 is more stable than the data obtained in 1996.**
- **Also, the stability of the system delay obtained using the new time interval is better than the data produced by the old counter.**


Thank you

PMT Modification

- In May, 1998 the PMT RCA 31034 was replaced by the PMT Hamamatsu H6533 box with PMT tube 4998.
- It consists of a PMT tube and high voltage with precise divider. The Tennelec TC 952A high voltage power supply with stable 2500 volts is used as a source for the PMT, to obtain standard parameters.
- The old pre-amplifiers HP8447A (400 MHz) and HP8447D (1.3 MHz) have been replaced by EG & G Ortec 1 GHz pre-amplifier Model 9306.
- It is a four-stage preamplifier based on Hewlett Packard MMIC chips. The constant fraction discriminator Ortec 646 were replaced by the Quad Tenellec discriminator TC454.
- The first channel is used for processing the signal from the start detector; the second channel is used for discriminating pulses from the PMT. The time delays of both, i.e. the start and stop channel, were adjusted to the lowest time jitter. The first results shows the mean value of the system calibration is about 58 nsec and time jitter is 50 psec, where the counter HP5370B is used as a ranging counter