Space Debris Tracking in Changchun Observatory

DONG Xue, Han Xingwei, Fan Cunbo, SONG Qingli

DongX@cho.ac.cn

Changchun Observatory, National Astronomical Observatories, Chinese Academy of Sciences

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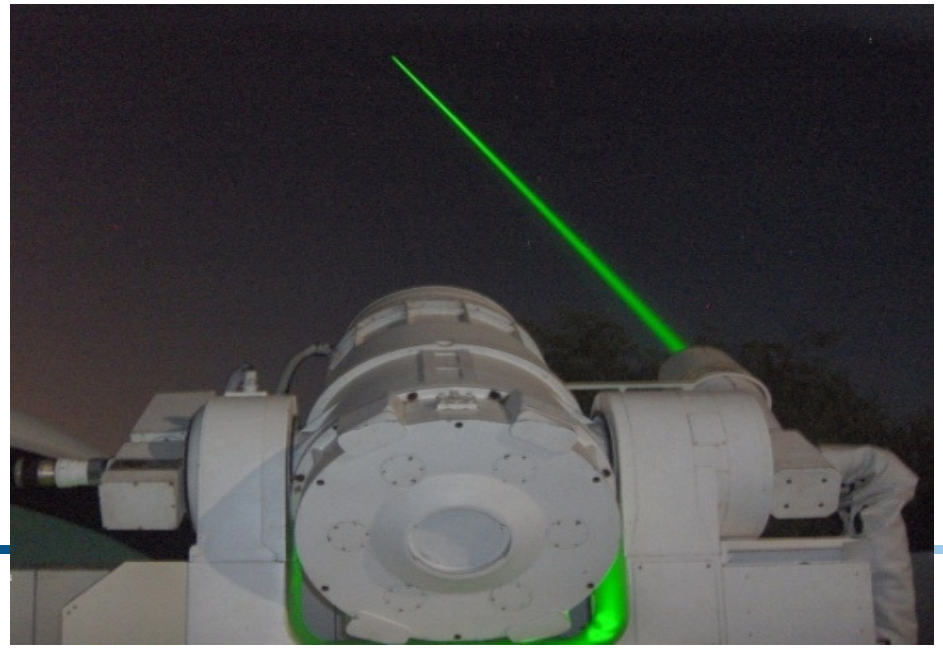
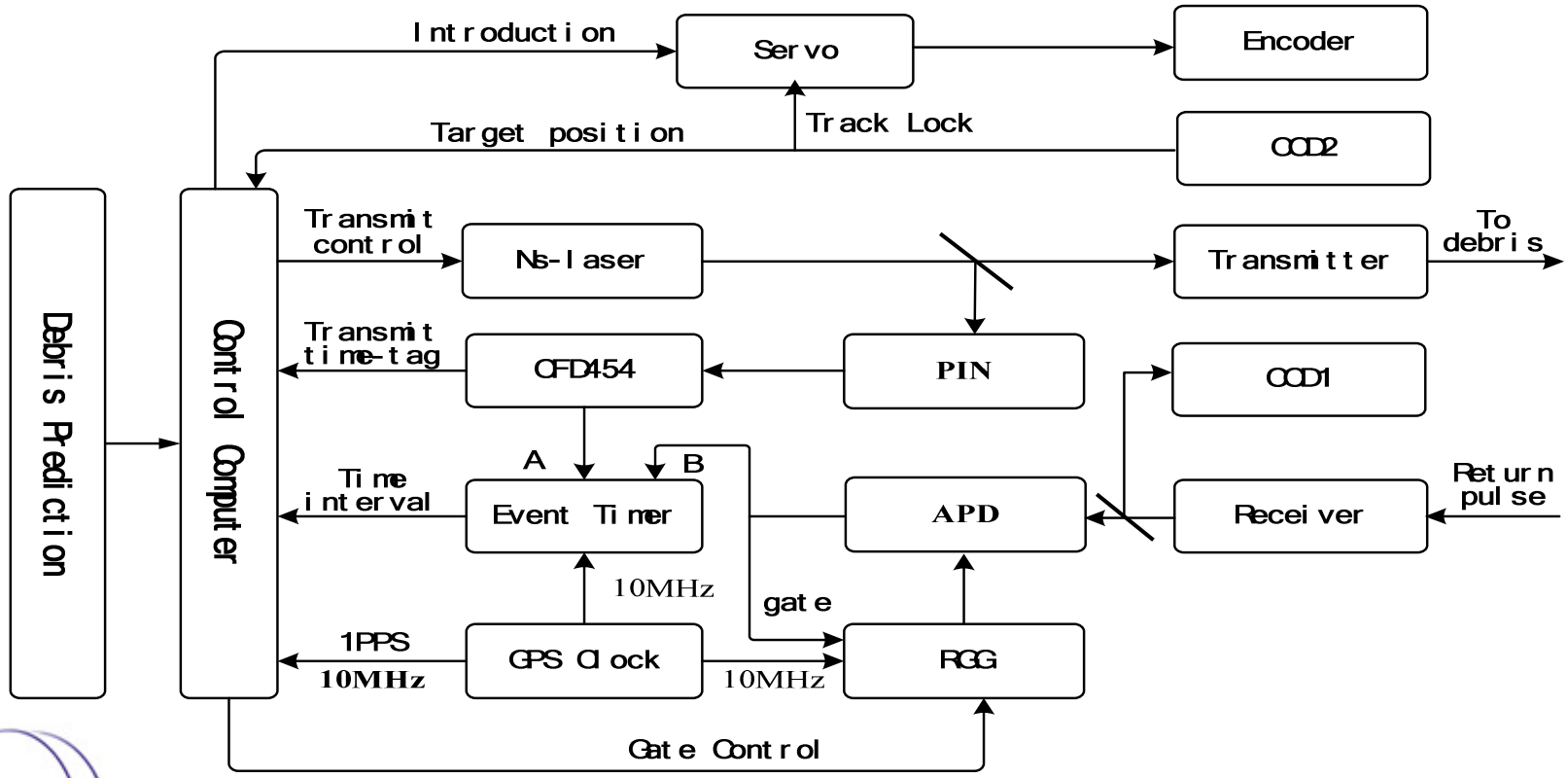
Overview

- Changchun Space Debris Laser Ranging
- Tracking Technologies
- Observation Results
- Plan



Changchun Space Debris Laser Ranging

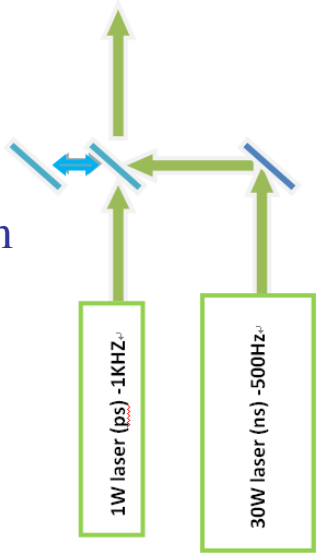
Till May 2014, Changchun established Space Debris Laser Ranging (SDLR) system.



Assembly of SDLR System

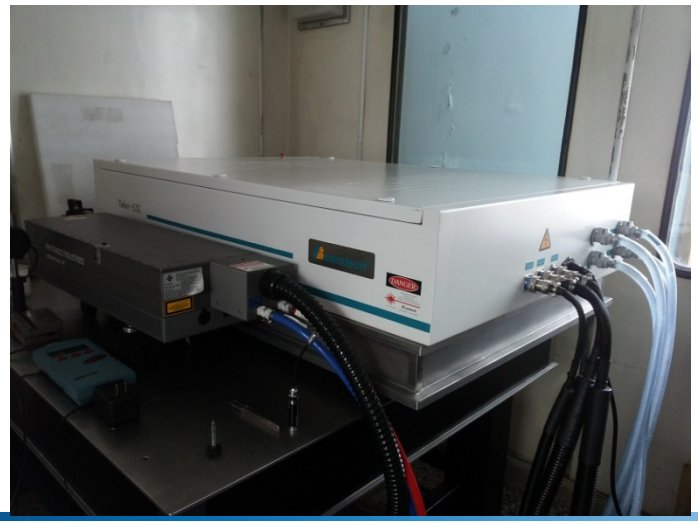
◆ Dual System

Two lasers placed parallel in laser room



A movable 45° mirror make the two lasers turn-around fast□so that different light source can be lead to Coudé path.

SLR
1kHz
0.8 mJ /50ps@532 nm



Laser for Space Debris objects
0.5kHz
60mJ/10ns@ 532 nm

◆ Laser

Table of Tolar performances

Performances	Ns-laser
Working Mode	LD pump
Wavelength	532nm
Repetition Rate	1-500Hz
Pulse Energy	60mJ/500Hz
M^2 Factor	≤1.5
Pulse Width	9-10ns
Beam Divergence	0.4mrad

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Tracking Technologies

◆Upgrade Tracking Control Program

- NORAD ID for the tracking file.
- Real-time index calculation testability.
- Target Closed-loop with CCD image.
- Laser beam Recognition and automatic adjustment.
- Data Recognition □Noise filtering and echo signals in real time to identify.
- Automatic TB and RB correction.

◆Space Debris Database

Target assistant software

- TLE Automatic Updates downloads
- Select the target □
  - ✓Target Type
  - ✓ RCS
  - ✓ Orbital max. Elevation
  - ✓ Easily observed index

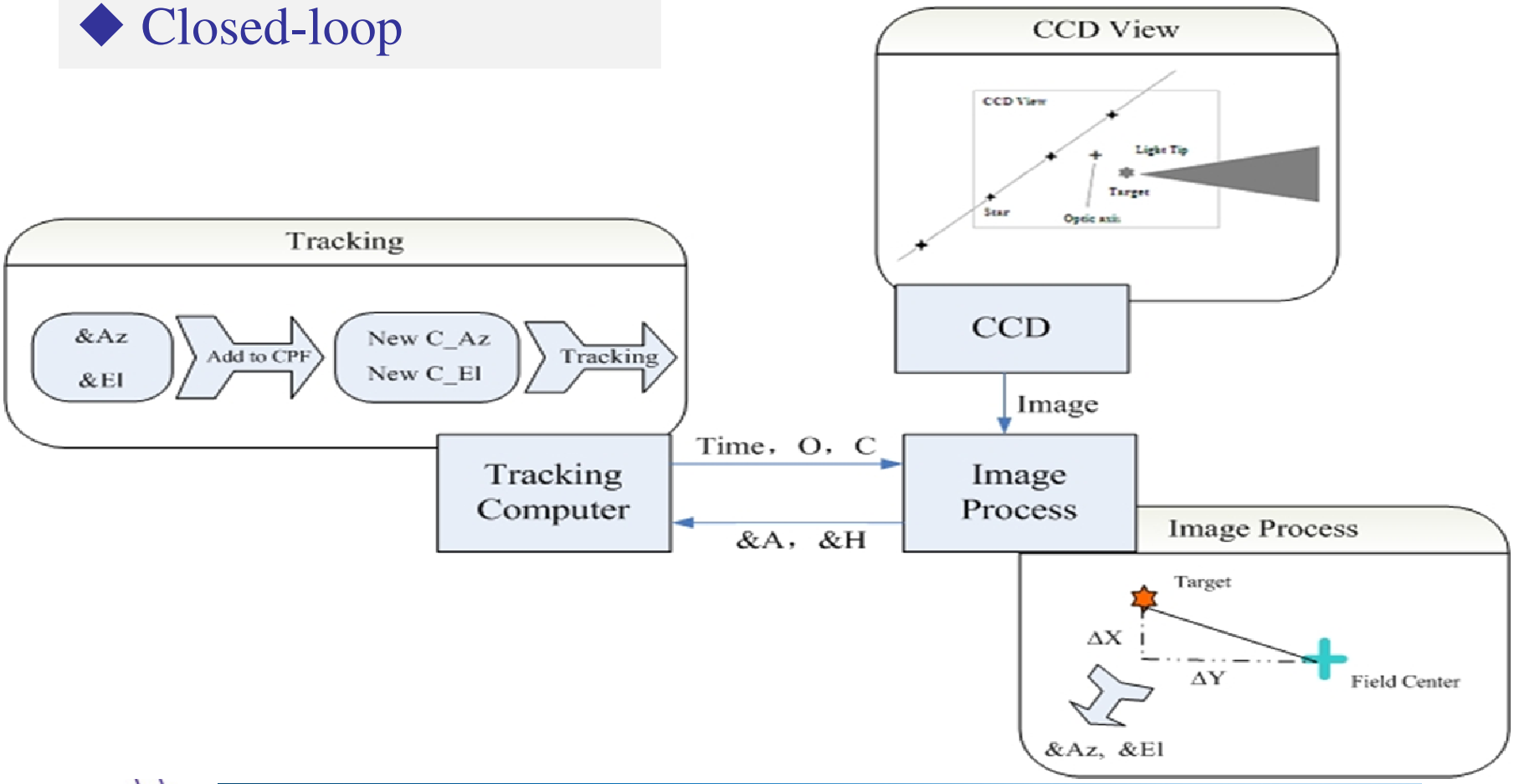
TLE=>CPF=>SLR=>tracking

日期 Date	开始时刻 Begin	结束时刻 End	最大仰角 Max ELV	回波指数	NORAD ID	file	rcs	name	轨道高度
2014/05/13	00:00	00:07	86 deg	12.1	20855	file	7.3 m2	CZ-4 DEB	864 km
2014/05/13	00:00	00:11	63 deg	7.3	8520	file	6.5 m2	SL-3 R/B	863 km
2014/05/13	00:01	00:09	69 deg	5.7	8546	file	0.7 m2	SL-12 R/B(AUX MOTOR)	10463 km
2014/05/13	00:01	00:10	56 deg	13.1	19211	file	4.1 m2	SL-14 R/B	621 km
2014/05/13	00:02	00:12	57 deg	9.6	16953	file	6.5 m2	SL-8 R/B	768 km
2014/05/13	00:02	00:13	76 deg	21.0	19120	file	10.5 m2	SL-16 R/B	828 km
2014/05/13	00:02	00:11	67 deg	18.8	15370	file	4.2 m2	SL-14 R/B	620 km
2014/05/13	00:03	00:11	75 deg	86.6	28813	file	9.9 m2	SL-24 DEB	554 km
2014/05/13	00:07	00:13	28	11.6	11849	file	5.4	SL-3 R/B	434

Space debris Database

Tracking Technologies

◆ Closed-loop

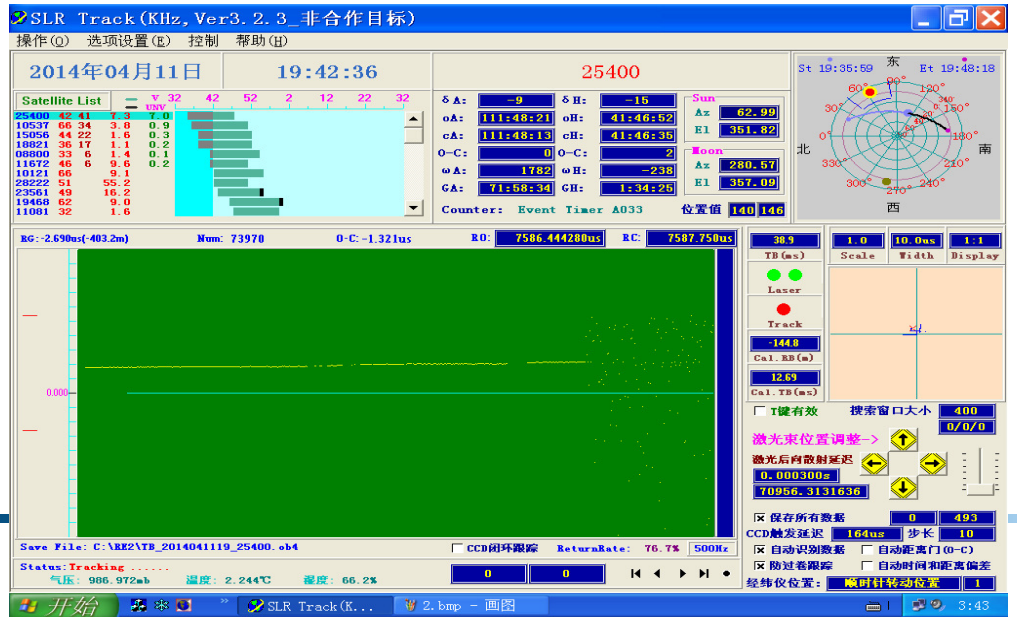


Closed-loop with CCD image

Tracking Technologies

◆Target Quick Search

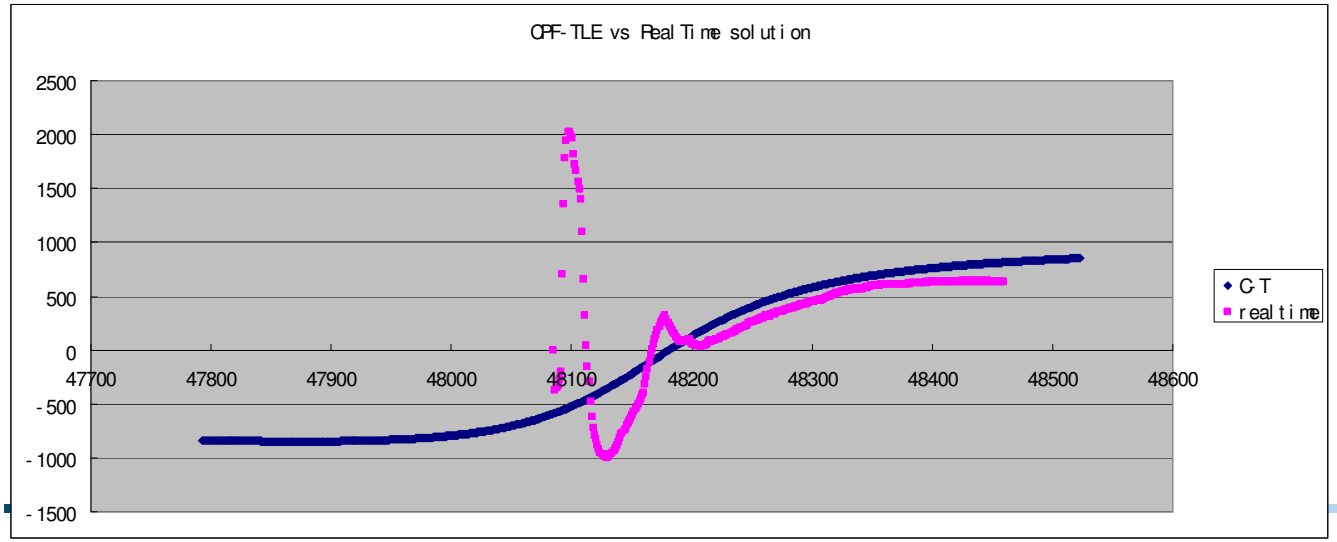
- **Space debris target running too fast, prediction accuracy is poor □**
- **Ranging control software specially added a time and ranging gate bias correction Auto-adjustment function;**



Tracking Technologies

◆ Range Bias Improved

- As the accuracy of TLE prediction is low (a few hundred meters), it is necessary to improve the predicted orbit accuracy.
- We developed a method to calculate the RB bias according to real-time visual position bias, which could improve the prediction accuracy to less than 100m in a few minutes.

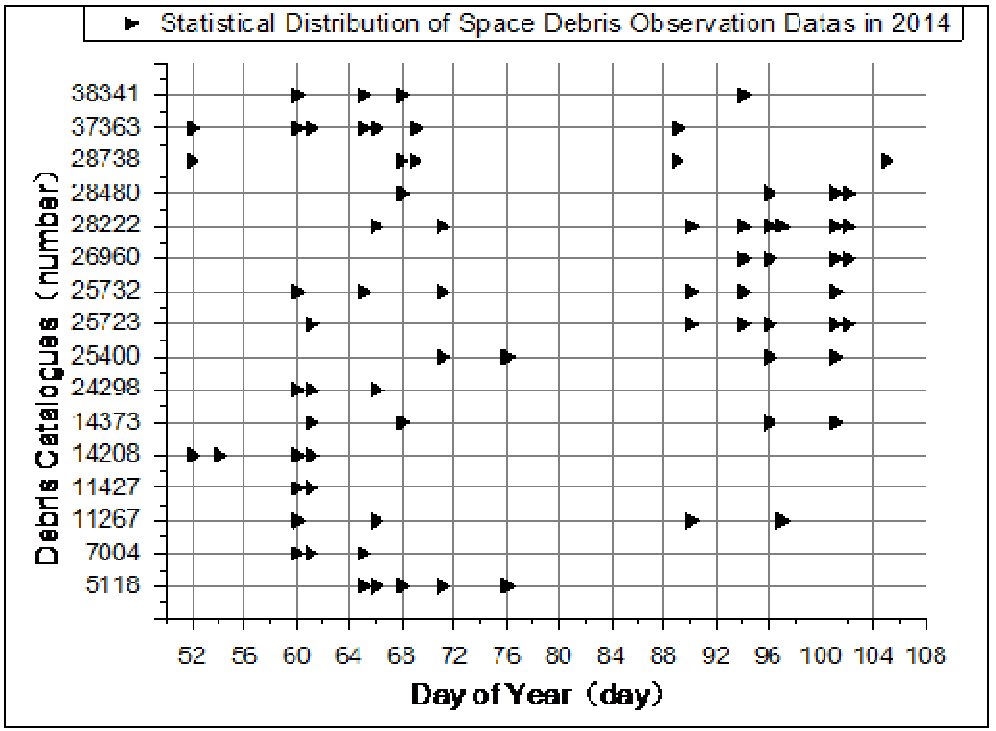


Range bias improved by position bias

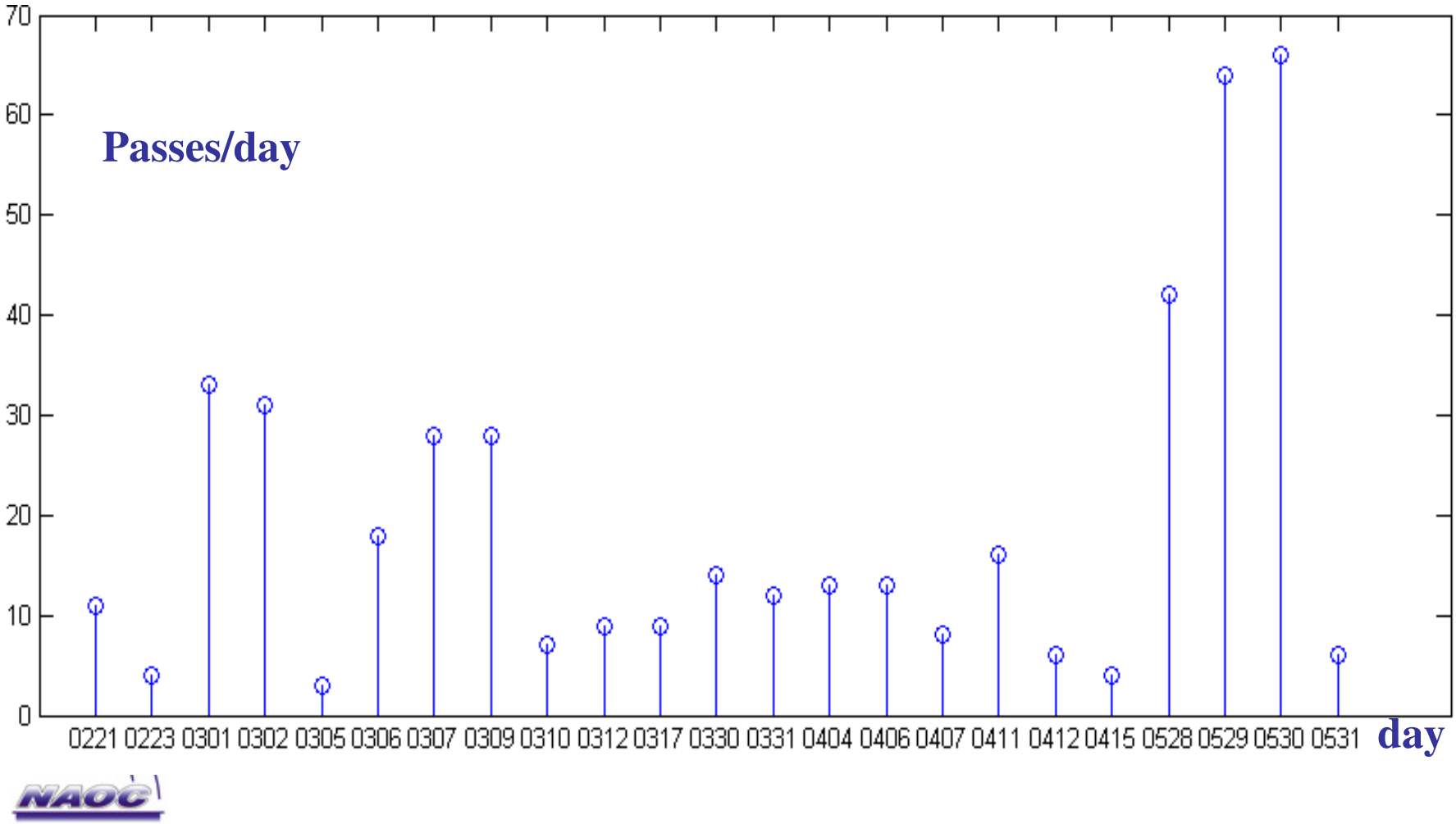
Observation Results

◆ Data Statistics

- ✓ 466 passes for 233 targets in 26 observe days
- ✓ 26 passes in twilight
- ✓ Elevation from 19° to 87°
- ✓ Observe time□2 hours/day (night or morning)
- ✓ **Acquire 34 passes in one day**
- ✓ Precision: ≈ 1.0 m RMS□mostly□
- ✓ Height from 400 km to 2000 km
- ✓ RCS From > 15 to < 1.0 m^2



Observation Results



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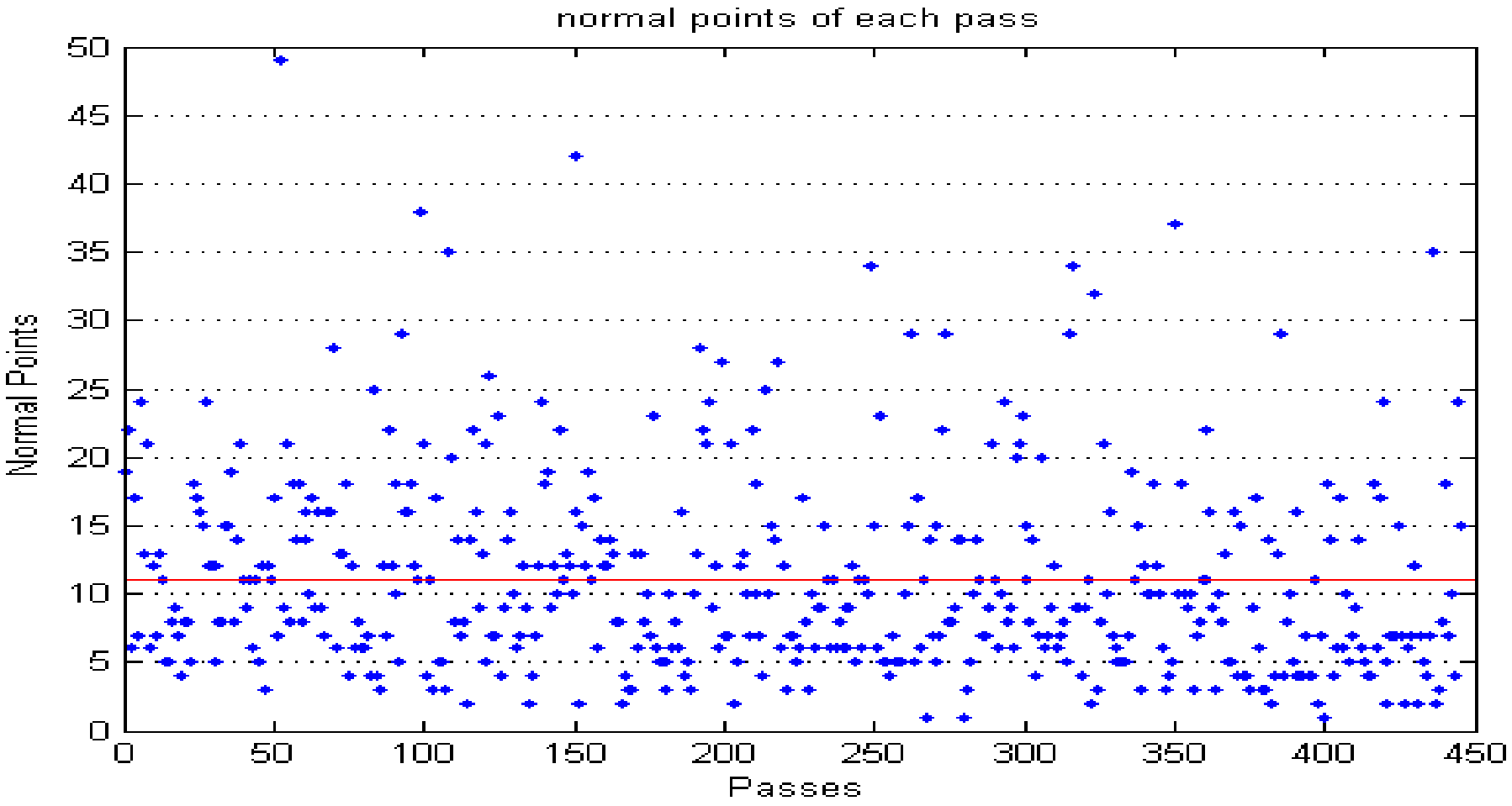
Observation Results



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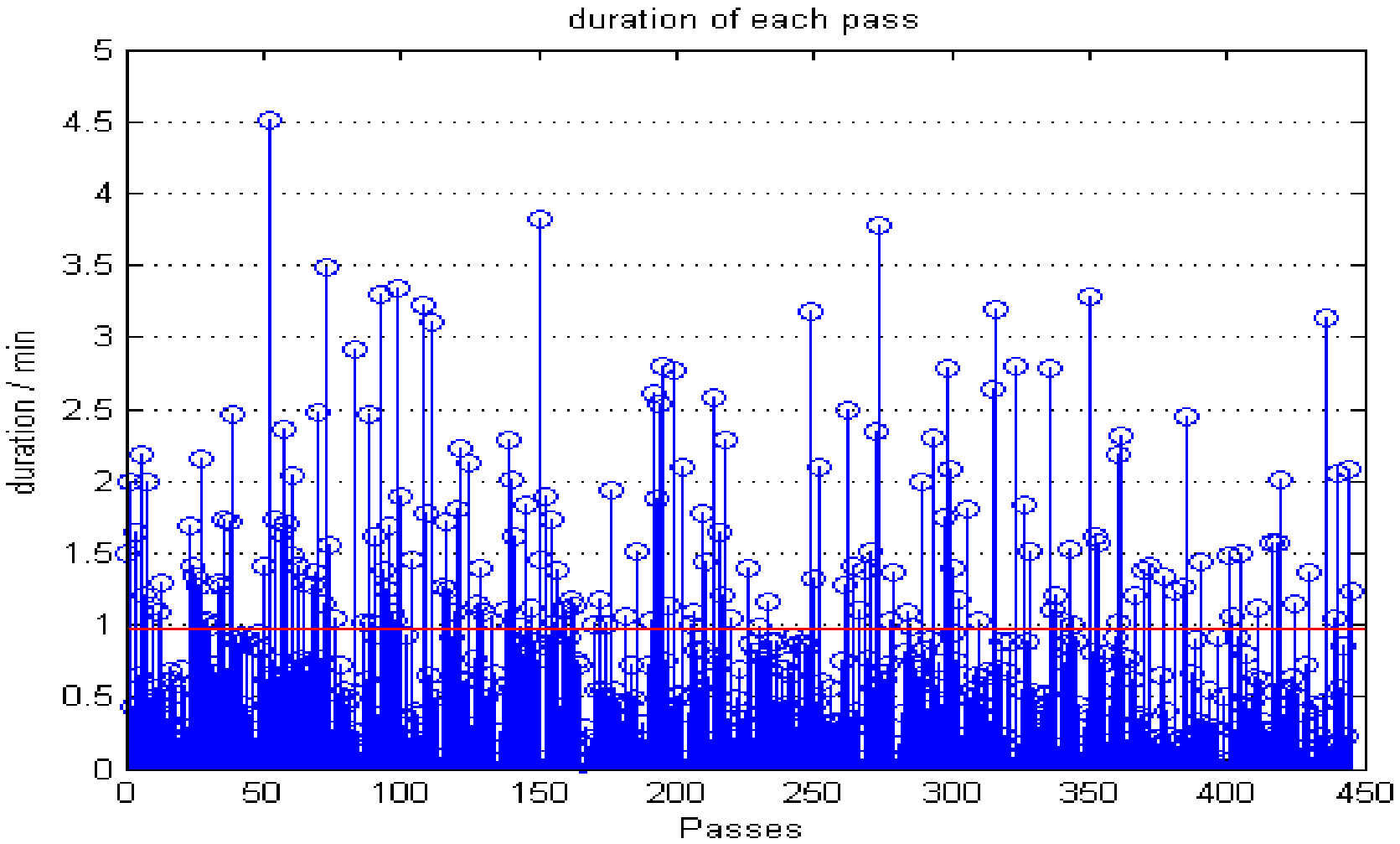

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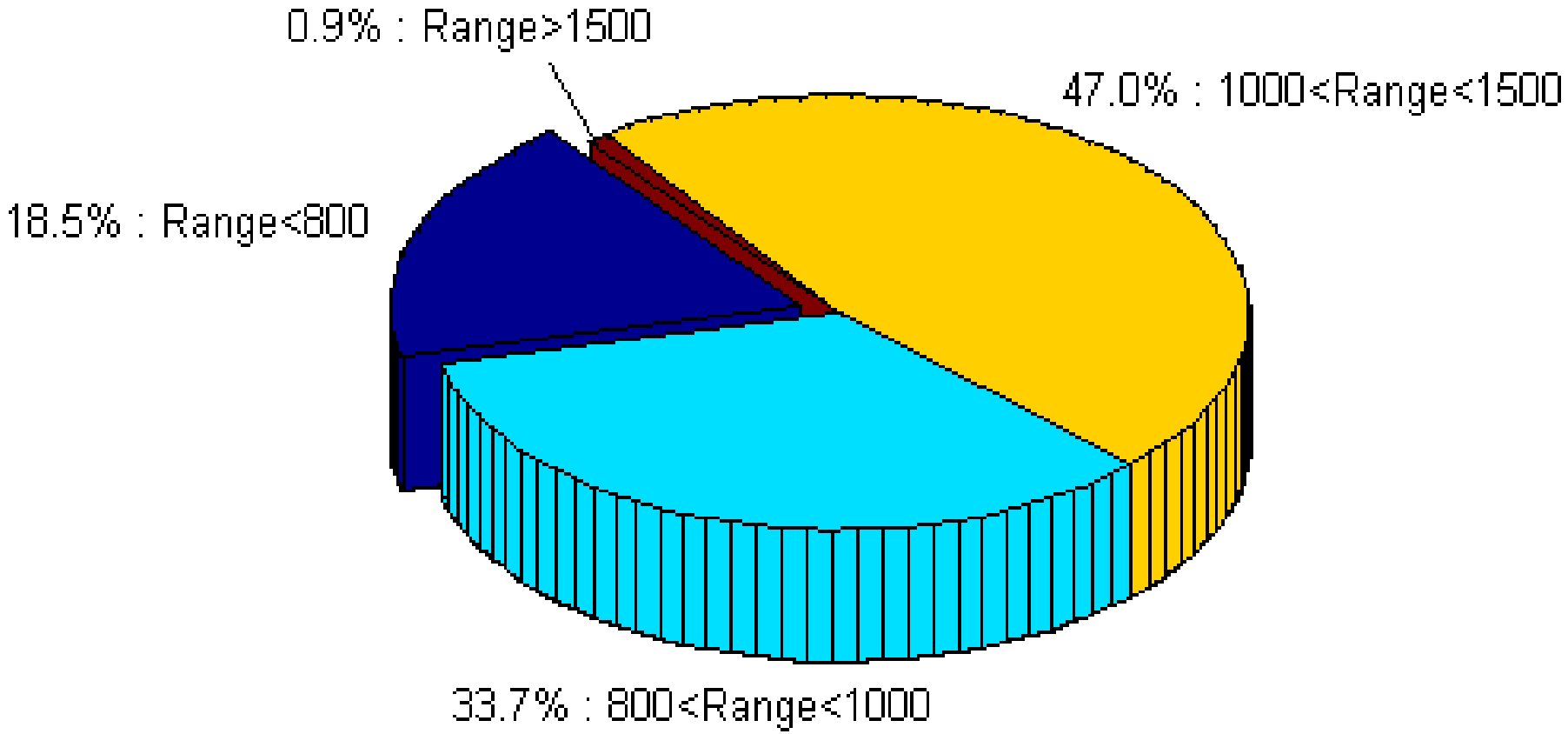

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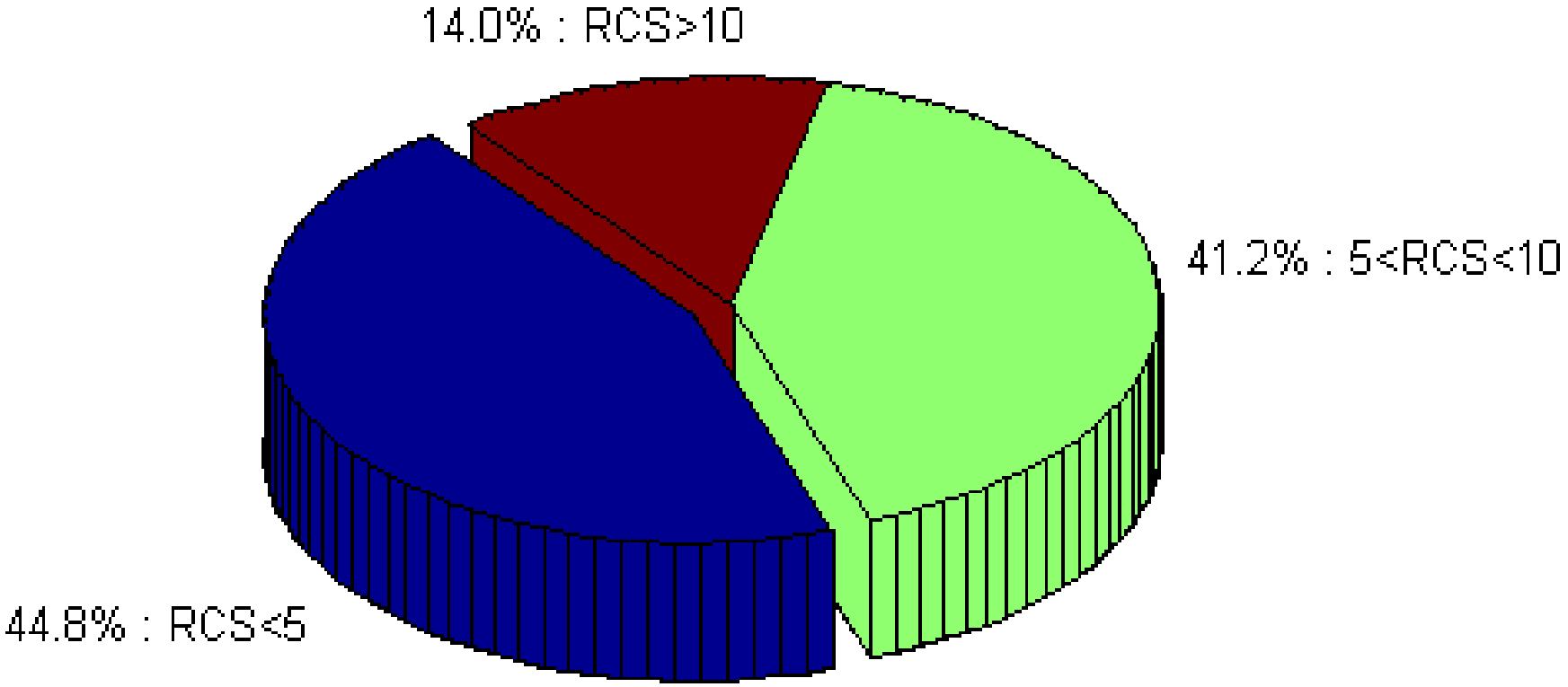

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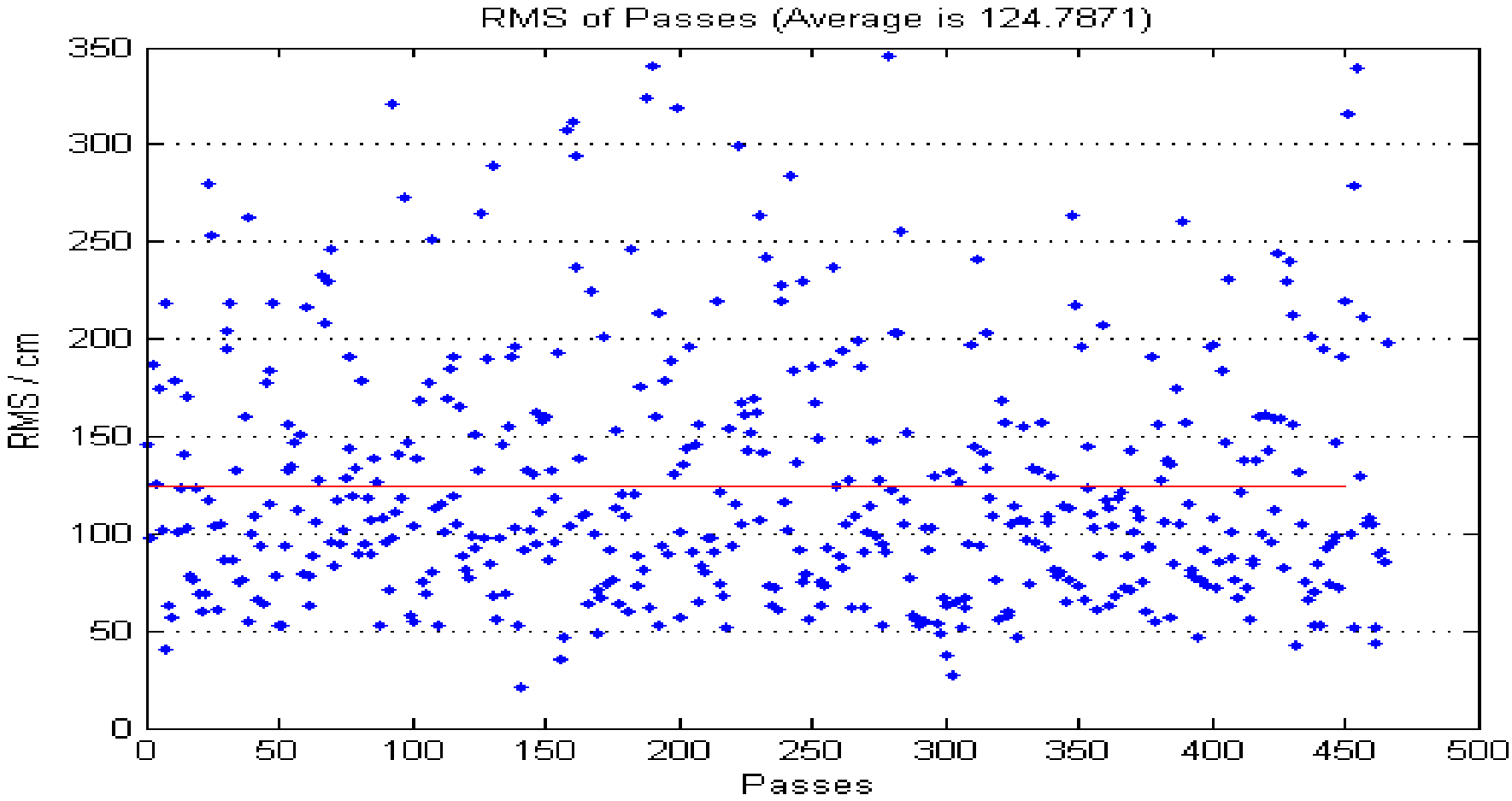
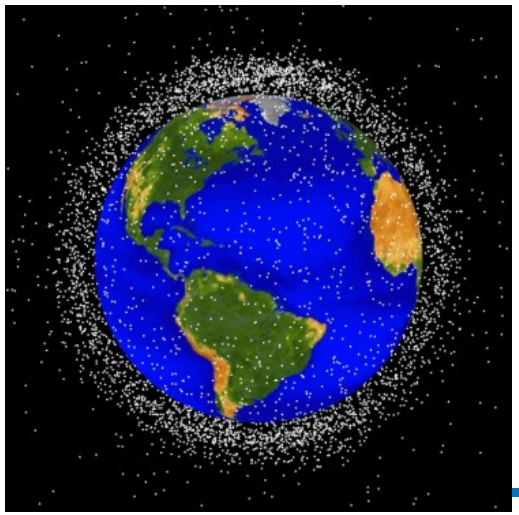
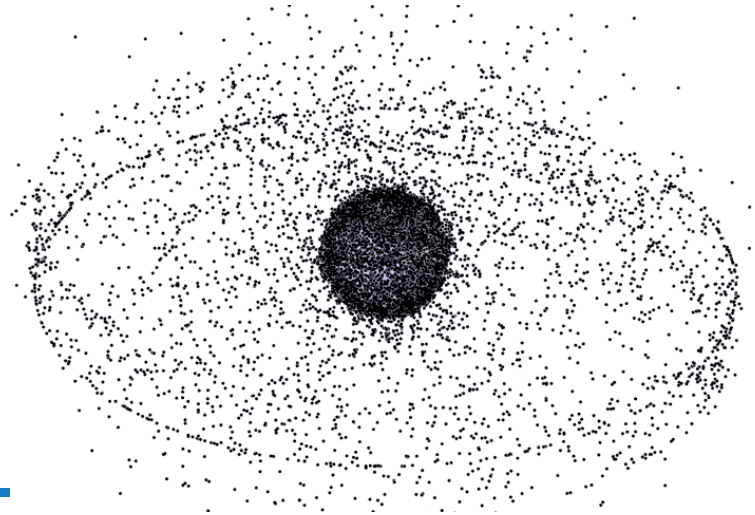


The Plan of Space Debris Laser Ranging

- We plan to implement the space debris laser ranging for smaller RCS(<1m^2).
- Combined with Optical Observation
- The orbit update





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