Orbit determination of CZ-2C rocket bodies with SLR
--- A Late Story

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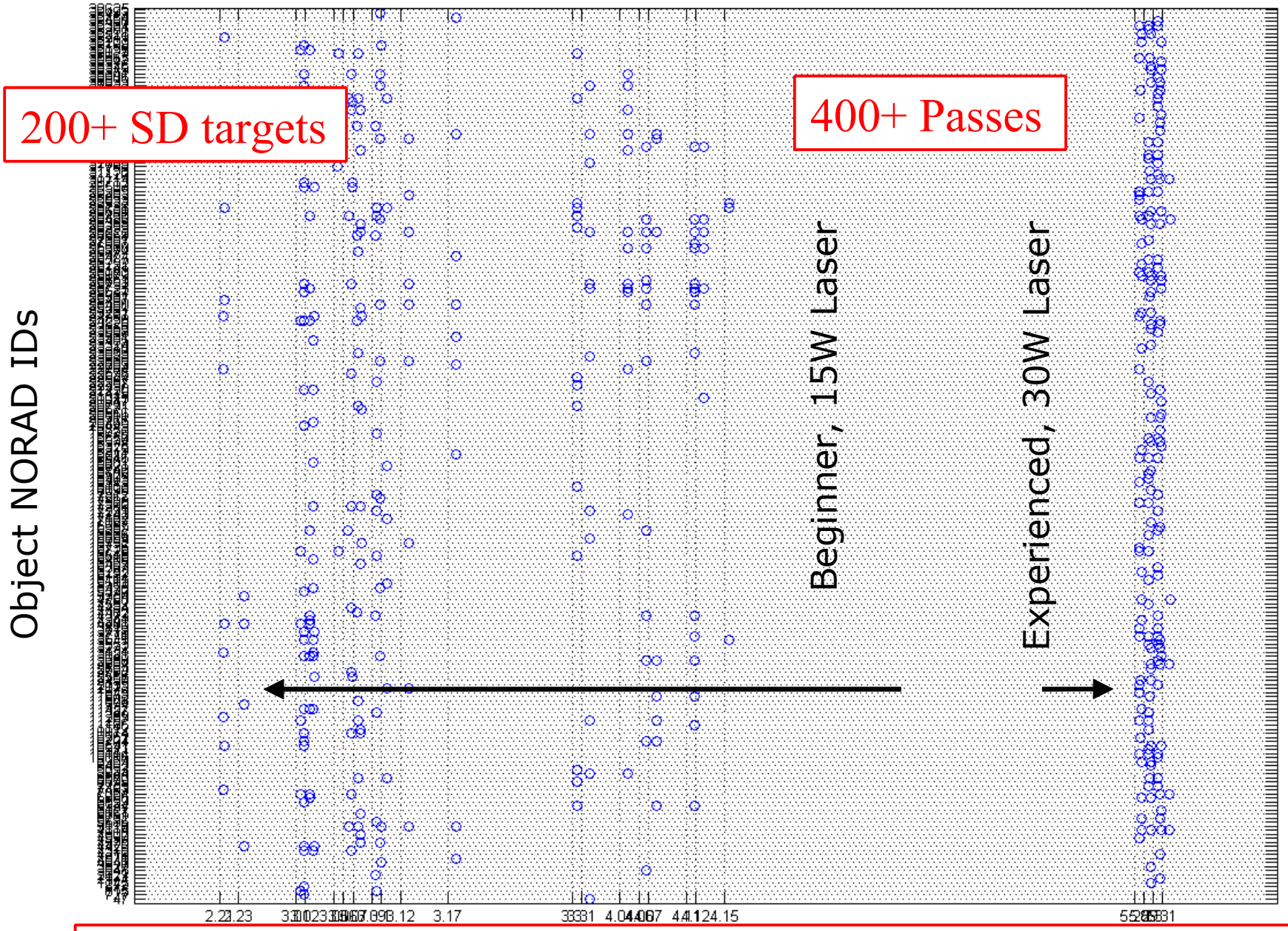
Changchun SDLRS

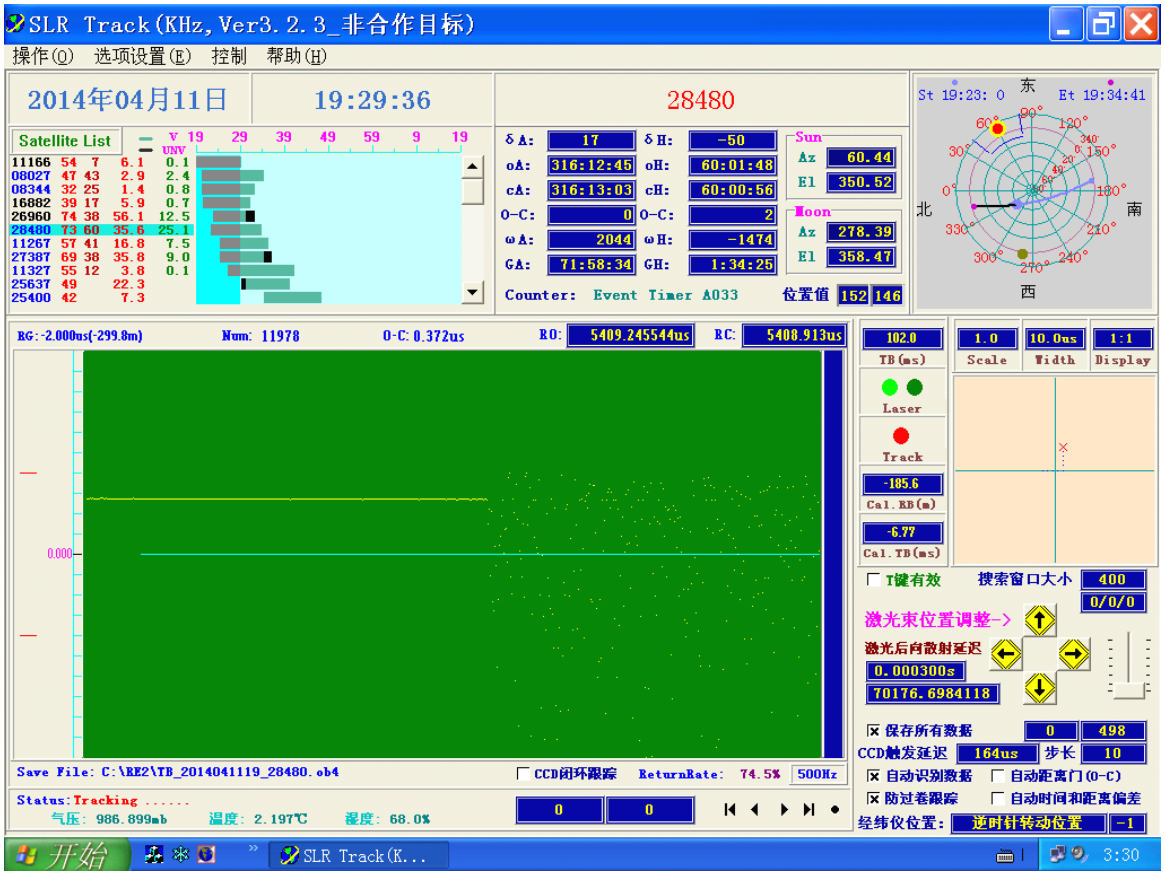
Space Debris Laser Ranging System

- Pulse Energy: 60mJ @532nm
- Repetition Rate: 1-500Hz
- Pulse Width: 9-10 ns
- Beam Divergence: 0.4 mrad
- $M^2 \leq 1.5$

Data Passes Date Distribution

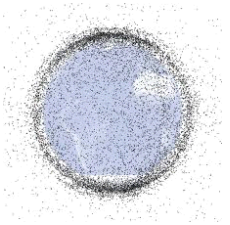


Something Interesting…

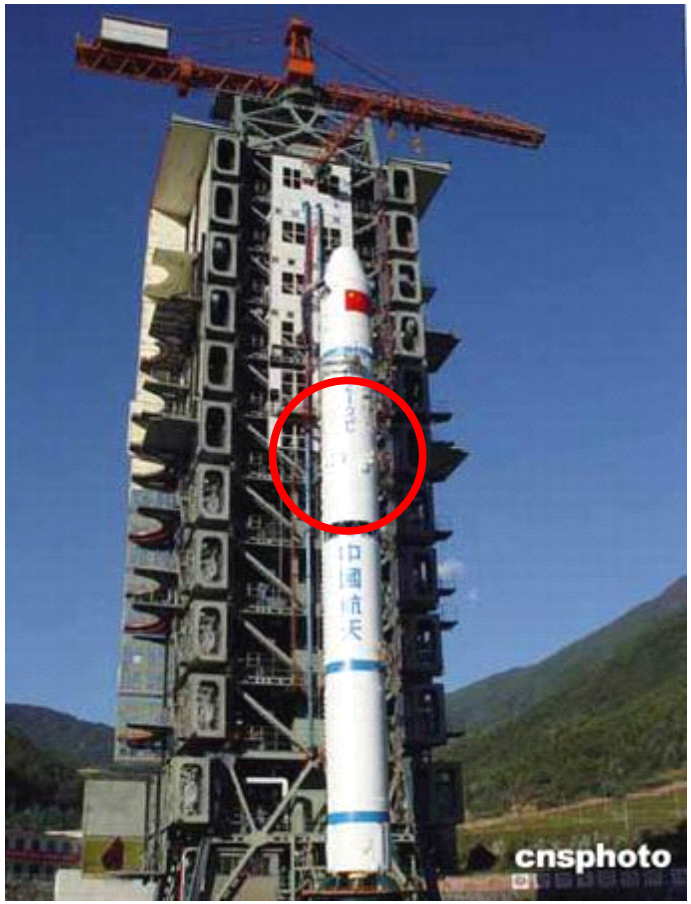


- NORAD #: 28480
- Type: CZ-2C R/B
- RCS: 10.8 m^2
- Pass Min Range: 773km
- Pass Max Range: 1199km
- Pass duration: 4 min
- Echo points: > 60000

- …High Reflectivity!
- Comparable to regular missions



What is it?



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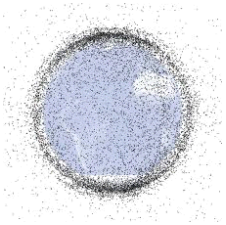
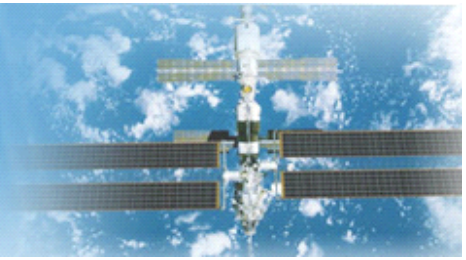
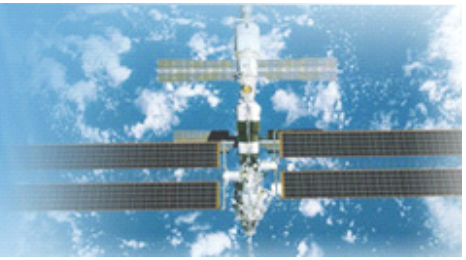




What is it?

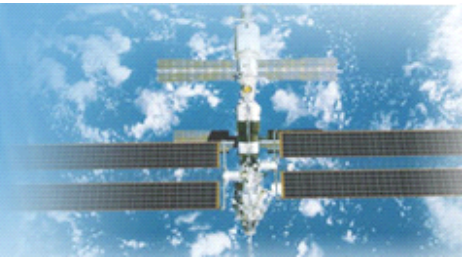
- We still don't know…
- But since the high reflectivity it has
- We tracked it in September 2015
- With normal SLR instruments



This is what we did

- We generated prediction with TLE.
- Its range error was about 0.3 km (RMS)

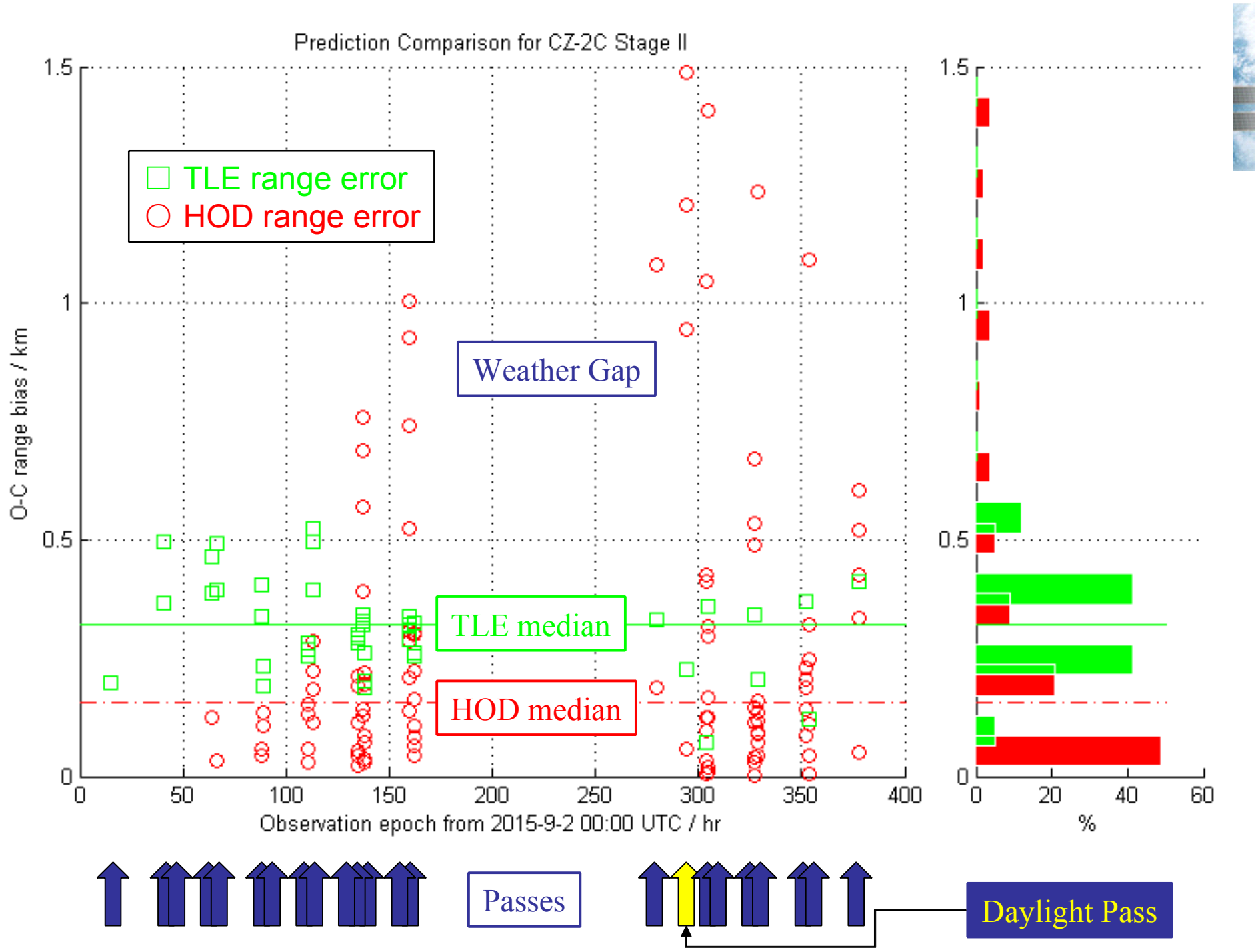
- Then we acquired range data
- And we did orbit determination: HOW?

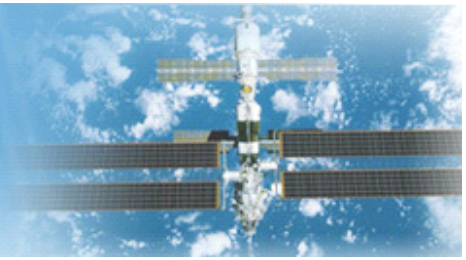


Method of OD

- Hybrid Orbit Determination(*)
  - Step 1: Use TLE as initial orbit
  - Step 2: Simulate network data by TLE
  - Step 3: Assign weight to real data and simulated data
- OD on mixture of real and sim data, thus named 'Hybrid'
- Real data is from single station/pass

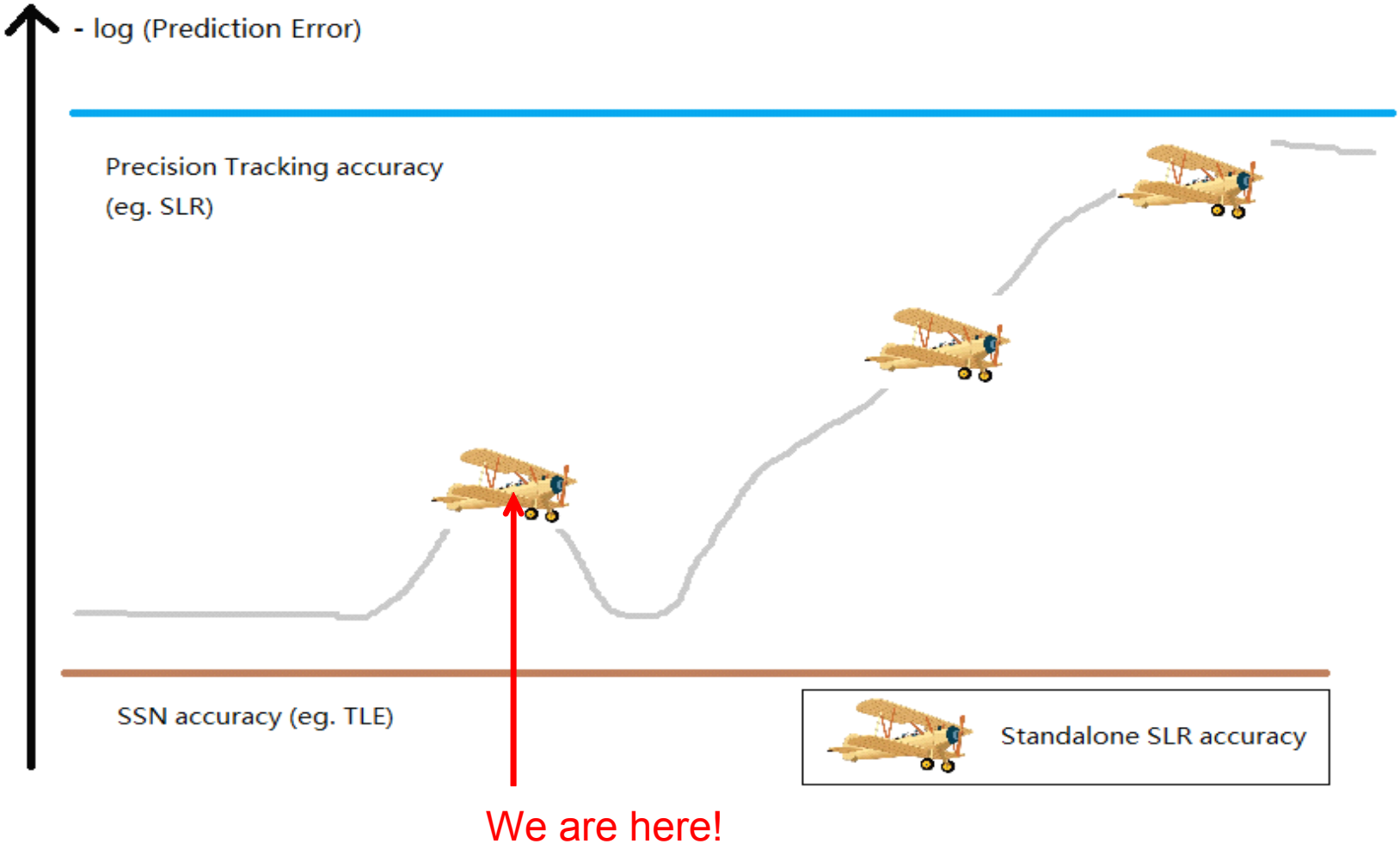
(*) LIANG Zhi-peng, LIU Cheng-zhi, FAN Cun-bo, SUN Ming-guo, TLE-Aided Orbit Determination Using Single-station SLR Data, Chinese Astronomy and Astrophysics 36 (2012) pp. 417-425

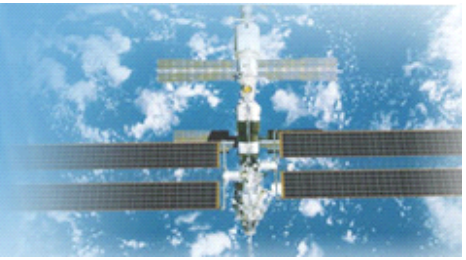

Prediction Comparison for CZ-2C Stage II
TLE range error
HOD range error
Weather Gap
TLE median
HOD median
O-C range bias / km
Observation epoch from 2015-9-2 00:00 UTC / hr
%
Passes
Daylight Pass



This is what we get

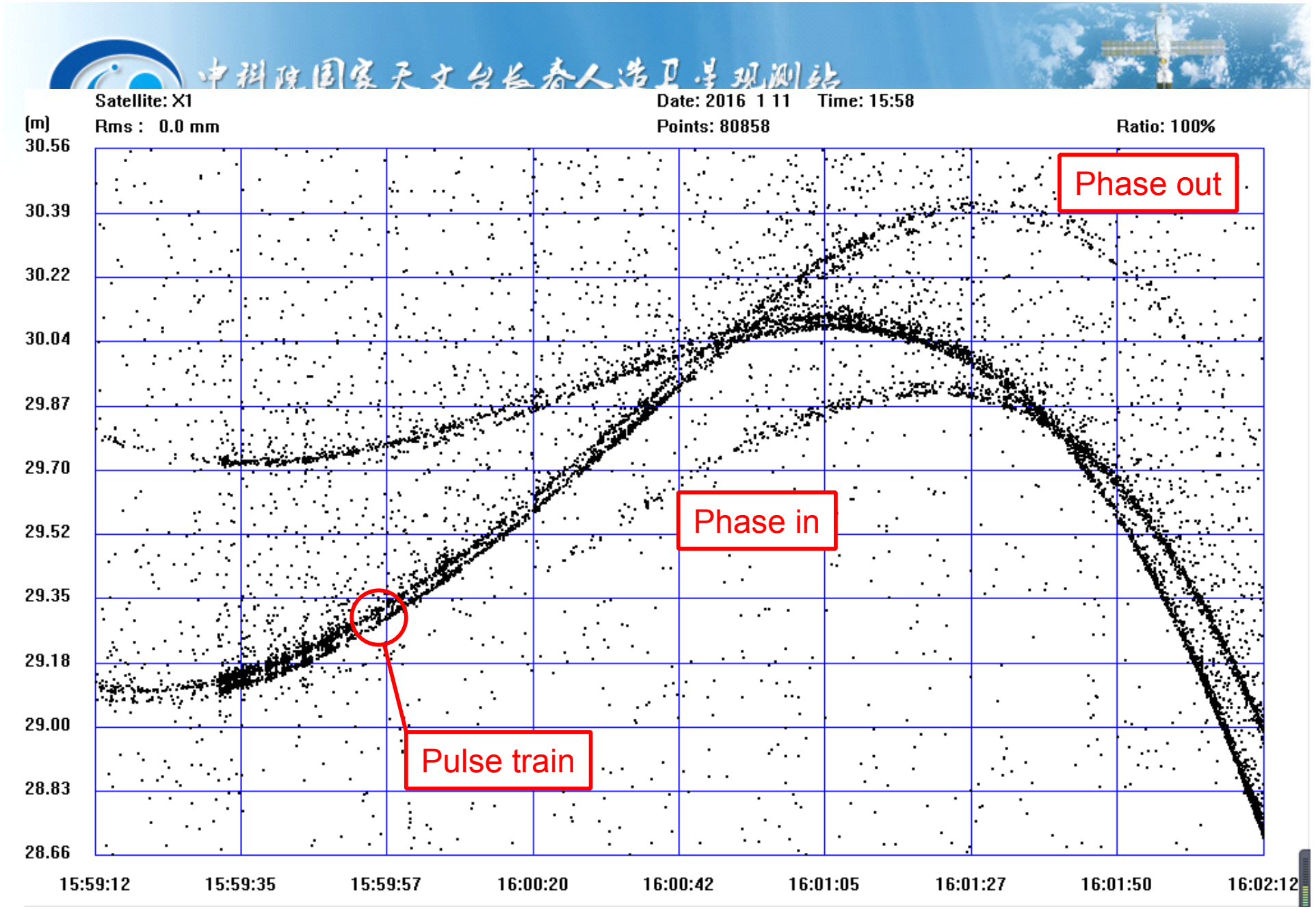
- Improved orbit predictions produce similar average error, but different median.
- The HOD method works, but reliability still needs improvement
- Standalone tracking (with initial TLE) may be possible

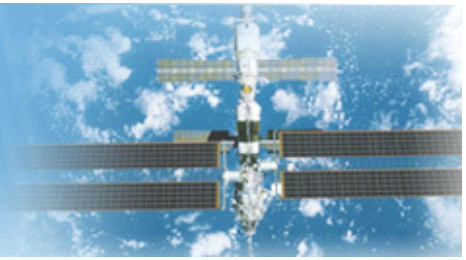

- log (Prediction Error)
Precision Tracking accuracy
(eg. SLR)
SSN accuracy (eg. TLE)
Standalone SLR accuracy
We are here!



What is it?

- We still don’t know…
- But with the KHz data…


中科院国家天文台长春人造卫星观测站
Satellite: X1
Date: 2016 1 11 Time: 15:58
(m)
Rms : 0.0 mm
Points: 80858
Ratio: 100%
30.56
30.39
30.22
30.04
29.87
29.70
29.52
29.35
29.18
29.00
28.83
28.66
Phase out
Phase in
Pulse train
15:59:12
15:59:35
15:59:57
16:00:20
16:00:42
16:01:05
16:01:27
16:01:50
16:02:12

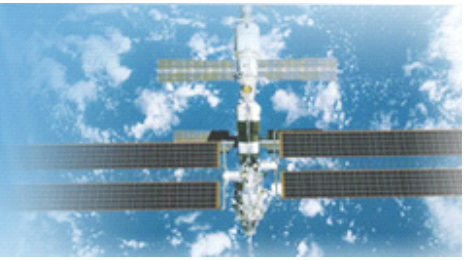


What is it?

- At least 3 reflectors, not in line
- Spinning
- We still don’t know…
- But we guess…

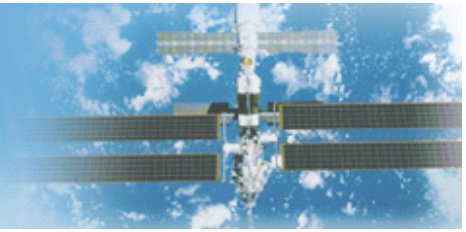
Our guess

- It has something to do with rocket testing
- And is NOT dedicated for orbital laser ranging



We hope…

- To scan the list of launched CZ-2C R/Bs
- To analyze the attitude spin with KHz data
- Anyone interested to join



谢谢

Merci

Thank you

Danke