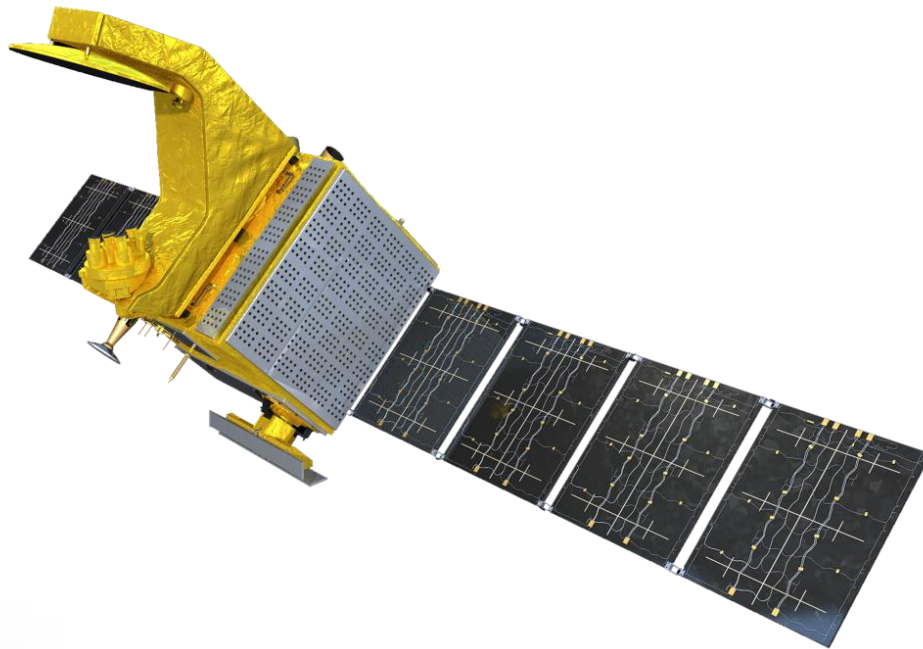




CFOSAT Orbit Status and Platform In-orbit Performance Introduction



**Sep. 2022
ZOOM**



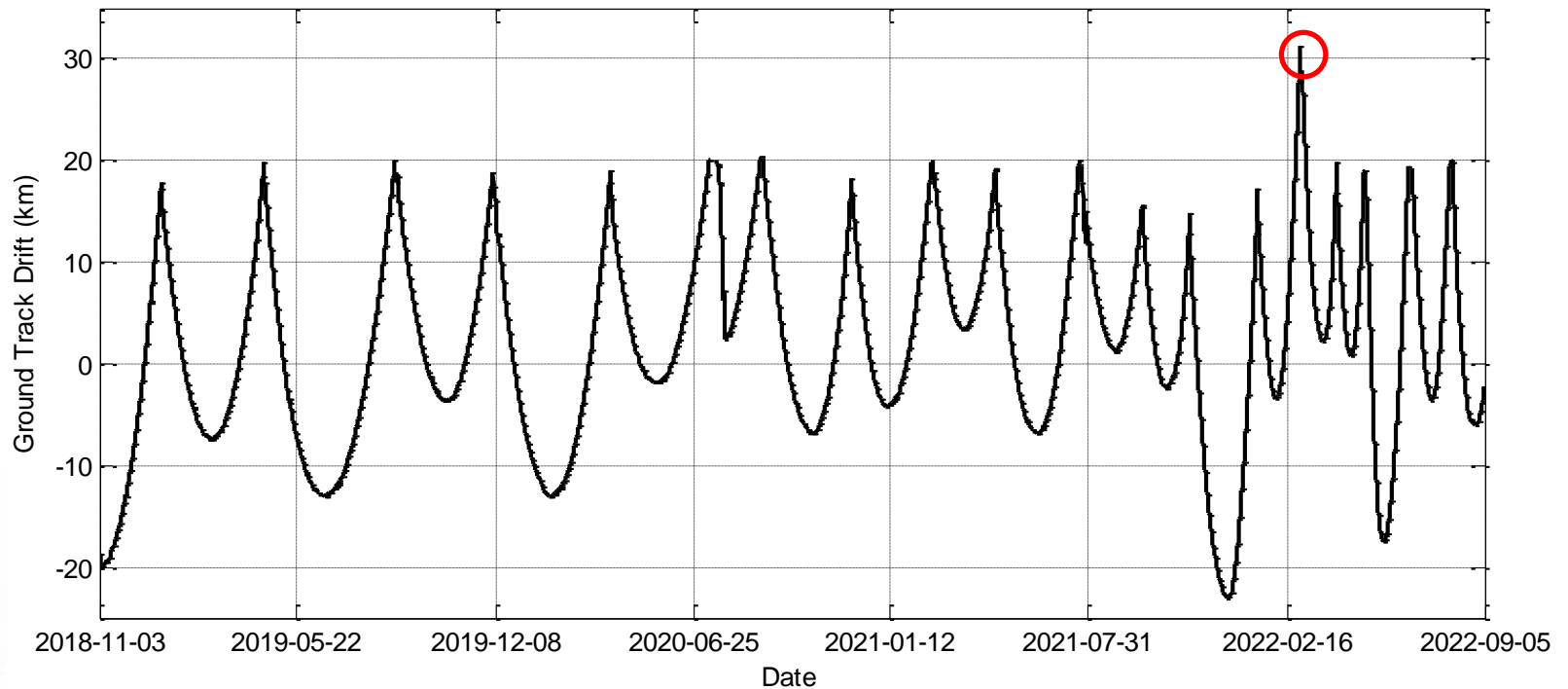
Orbit Basic Situation

- Since launch till 2022.9.5, CFOSAT made the following routine orbit maneuver to maintain the ground track within a range of $\pm 20\text{km}$, on the following dates :
 - 2019, **01.04, 04.18, 08.29, 12.06,**
 - 2020, **04.02, 07.17, 09.03, 12.03,**
 - 2021, **02.23, 04.27, 07.22, 09.23, 11.10,**
 - 2022, **01.18, 03.03, 04.08, 05.07, 06.21, 08.02**
- The maneuver frequency in 2022 is higher than previous years, mainly due to year 2022 is the **peak point** of solar activity under the 11 years cycle period. Space air density is now at the **highest** level.
- The fuel cost for orbit ground track keeping each time is **less than 0.1kg**. And the fuel left onboard right now is around **17.668kg**.





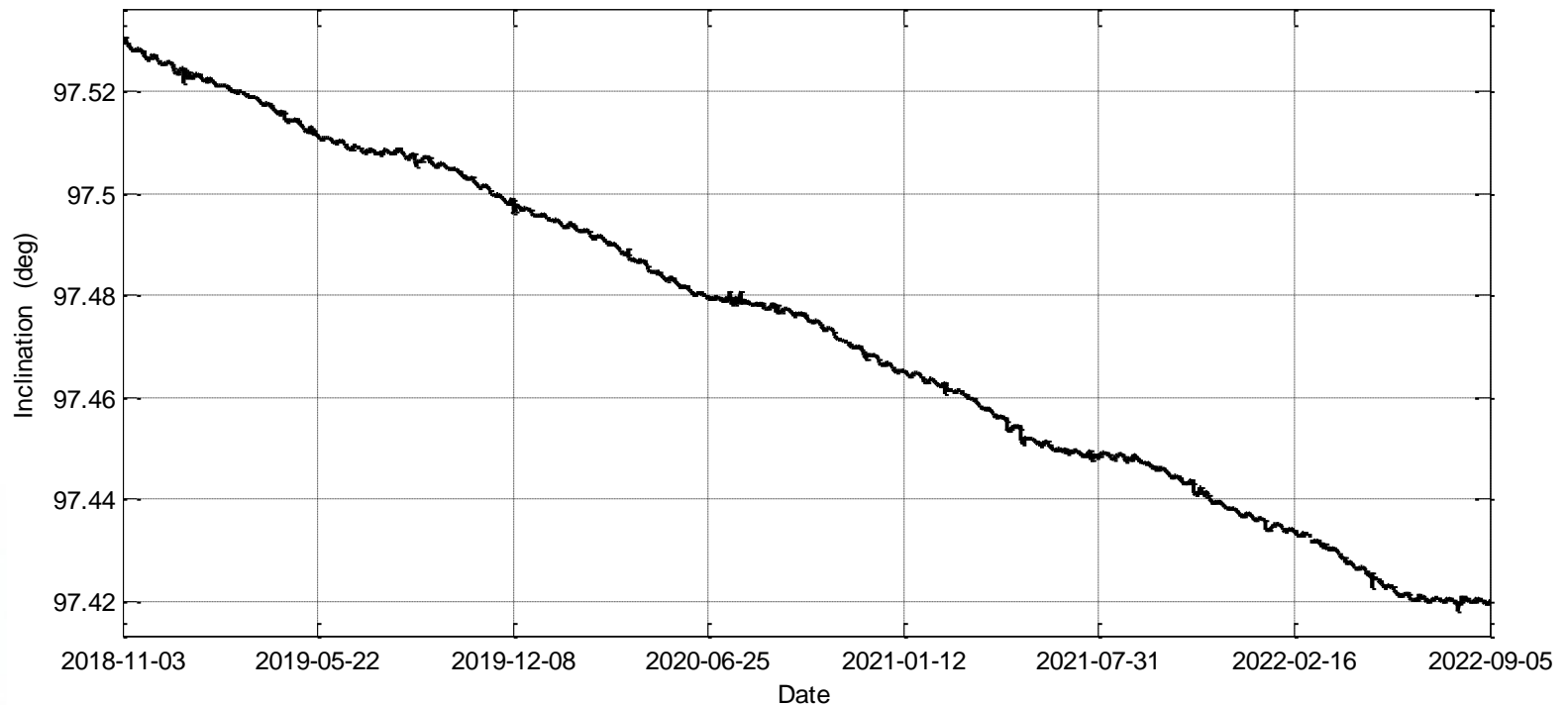
Ground Track Keeping



- The **ground track** was kept within the range of $\pm 22\text{km}$.
- It means that the ground strips of adjacent orbits have **enough overlap margin** to **prevent** remote sensing observation **gap**.
- The maneuver on 2022.03.03 (**red circle**) was postponed by about 1 week, due to avoiding space debris collision risk, and caused ground track exceed +20km border



Orbit Inclination

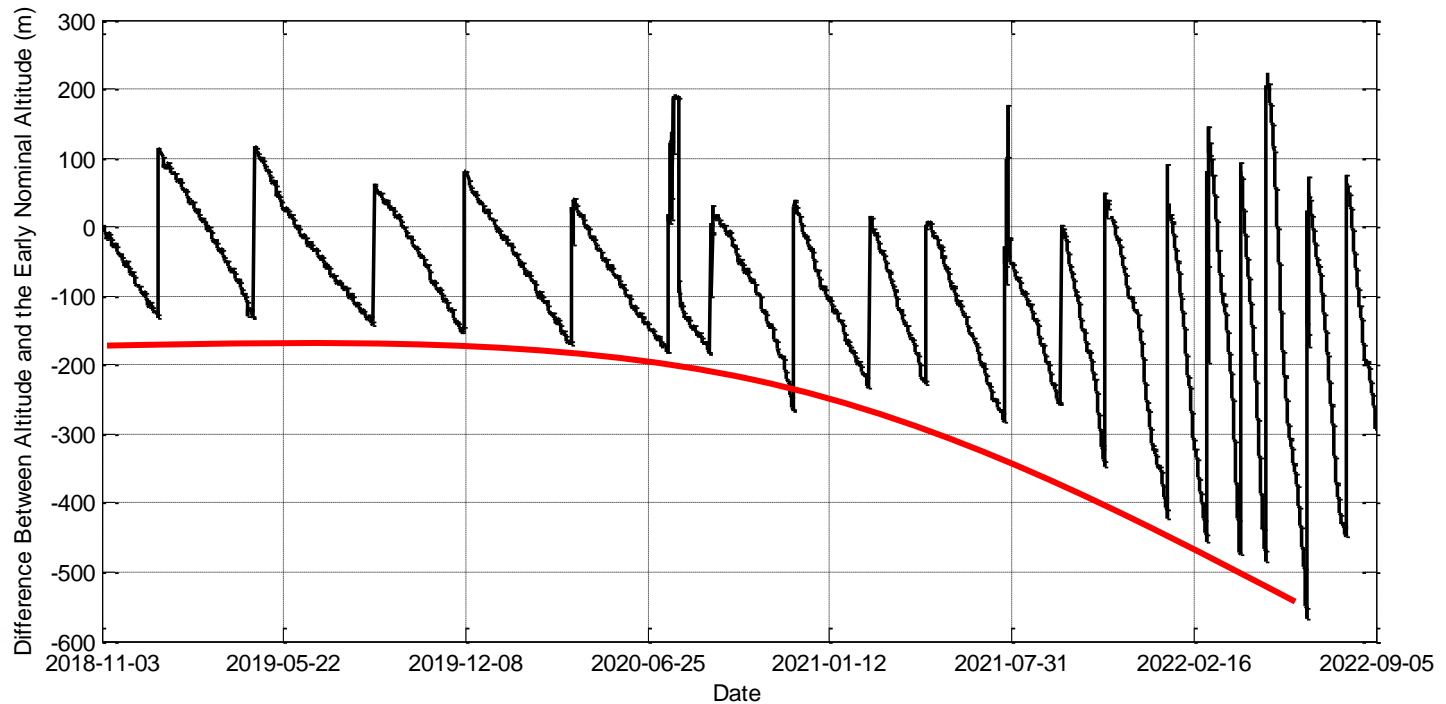


- Orbit inclination keeps **decreasing** in the last 4 years. It's normal drift for orbit characteristics.

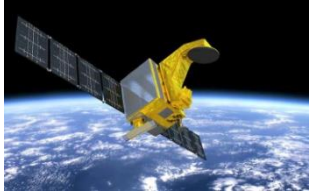




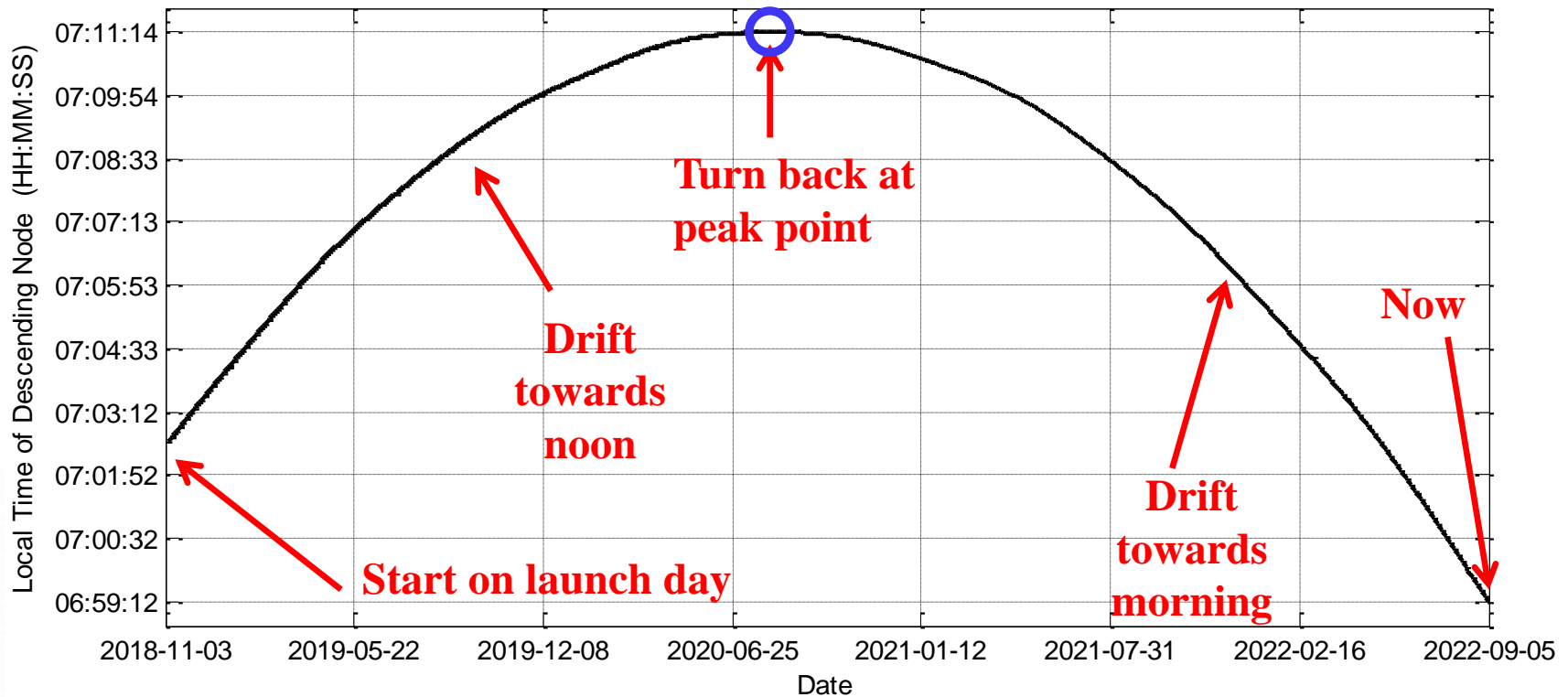
Orbit Altitude Changing



- The orbit **altitude** was kept near the normal value through orbit maneuver for ground track keeping.
- It is clearly to see, the altitude trend is **dropping (red line)** slowly.
- This trend is compliant with Inclination change in the last slide. As the inclination **decreases**, the satellite altitude need to be adjusted **negatively** to maintain orbit sun synchronization.



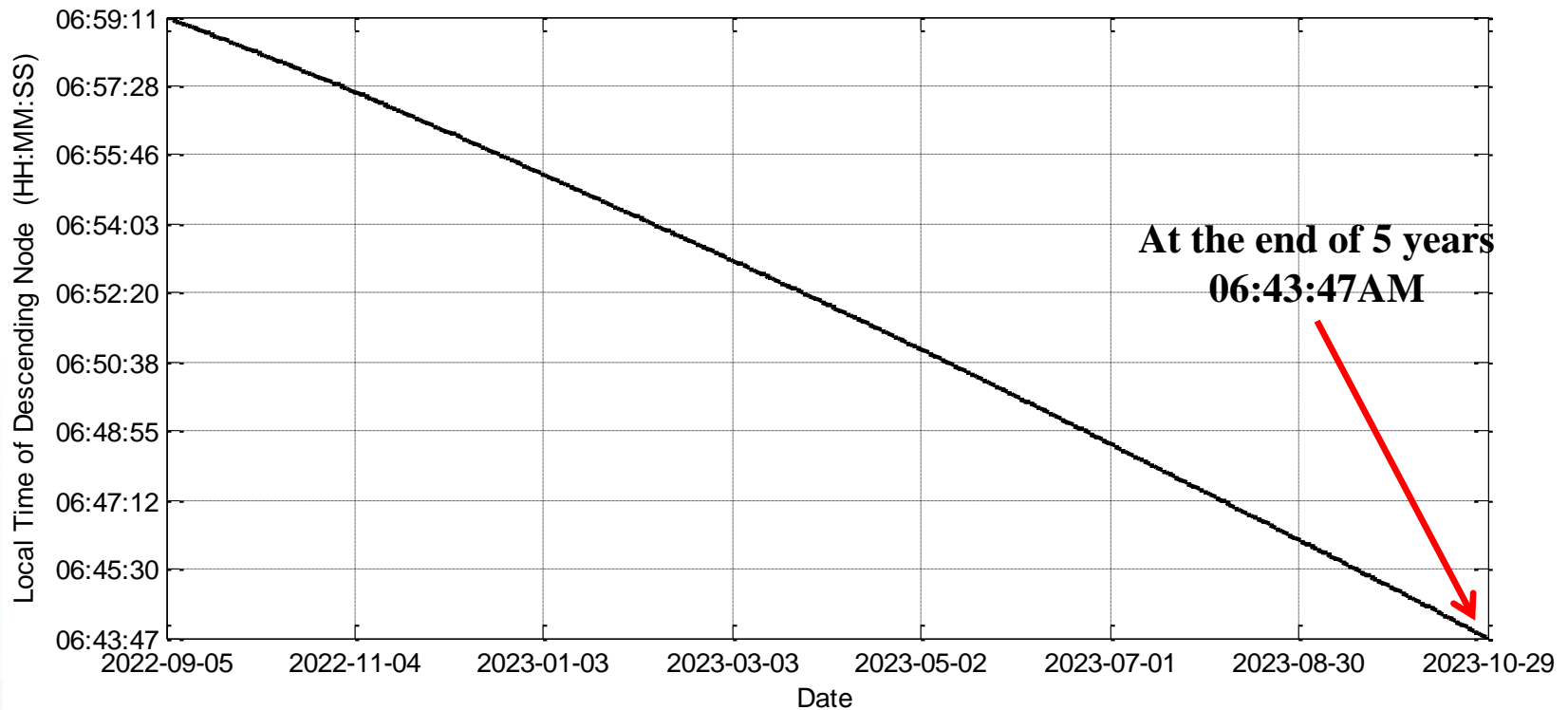
LTDN drifting



- The **LTDN** (Local Time Descending Node) is drifting.
- It started from **07:02:25AM** on 2018.10.29 (the launch day), kept drifting towards noon; then after reaching the peak point, it turned back towards morning. It reached **07:10:48AM** peak (blue circle) in mid 2020.
- Right now LTDN is at **06:59:12AM**, earlier than launch day, and still drifting towards morning.



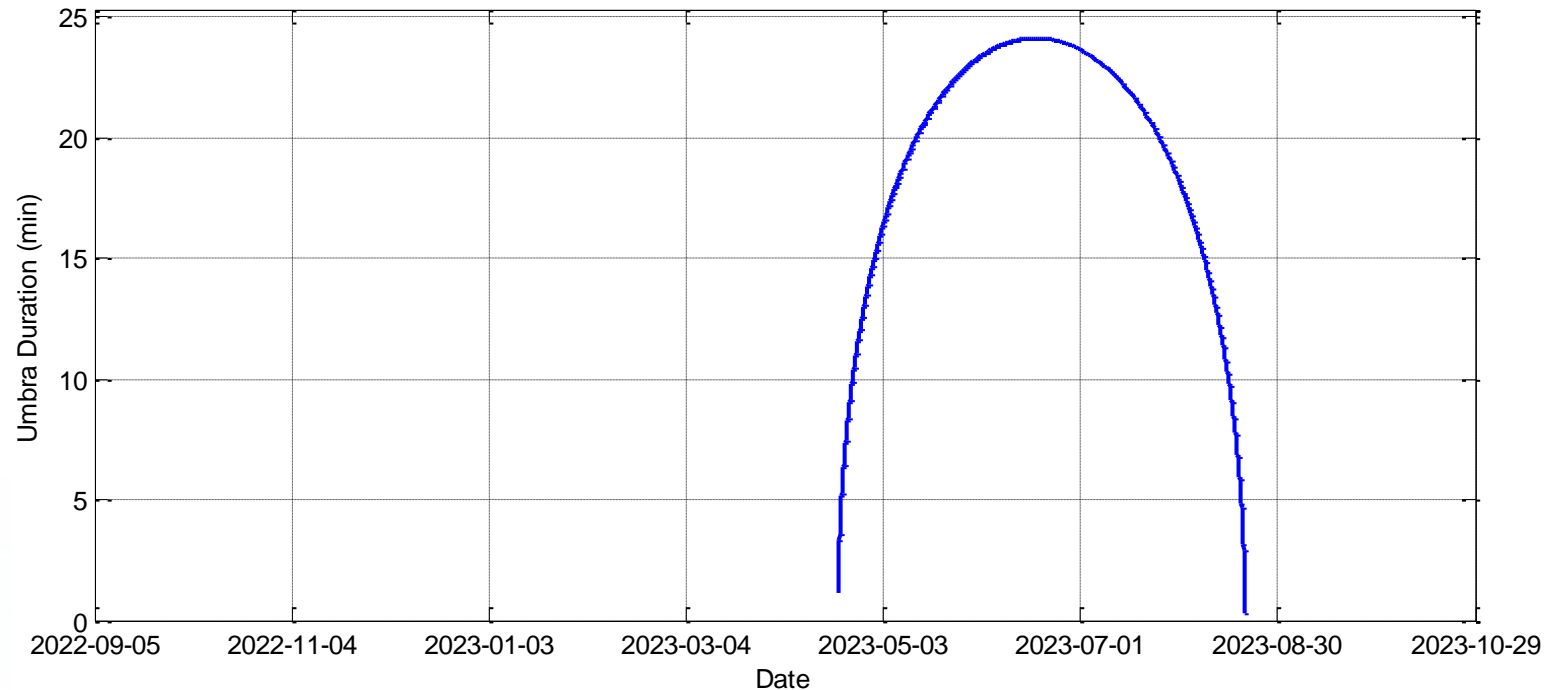
LTDN Estimation



- At the end of 5 years (2023.10.29), LTDN is estimated to reach 06:43:47AM.



Umbra Duration Estimation

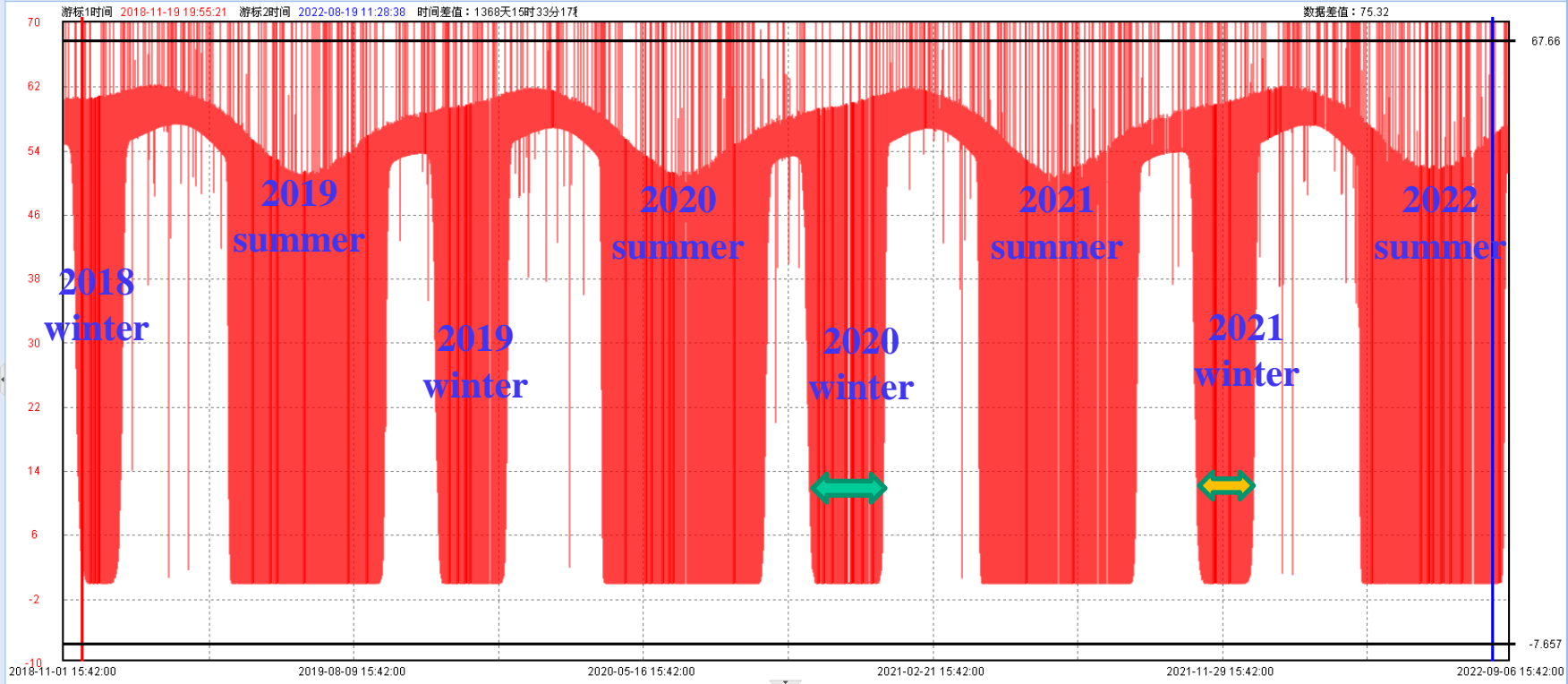


- In the future, comparing to the previous years, due to the drift of LTDN, there will be **no winter umbra** phase since 2022, only summer umbra phase left.
- The umbra period will get shorter and shorter in the future. (E.g: 25 mins per orbit in 2022 summer, 24.5 mins per orbit in 2023 summer)
- It means the onboard temperature will **rising** gradually year by year.



Power Supply – Solar array current(1)

Solar array current (A)

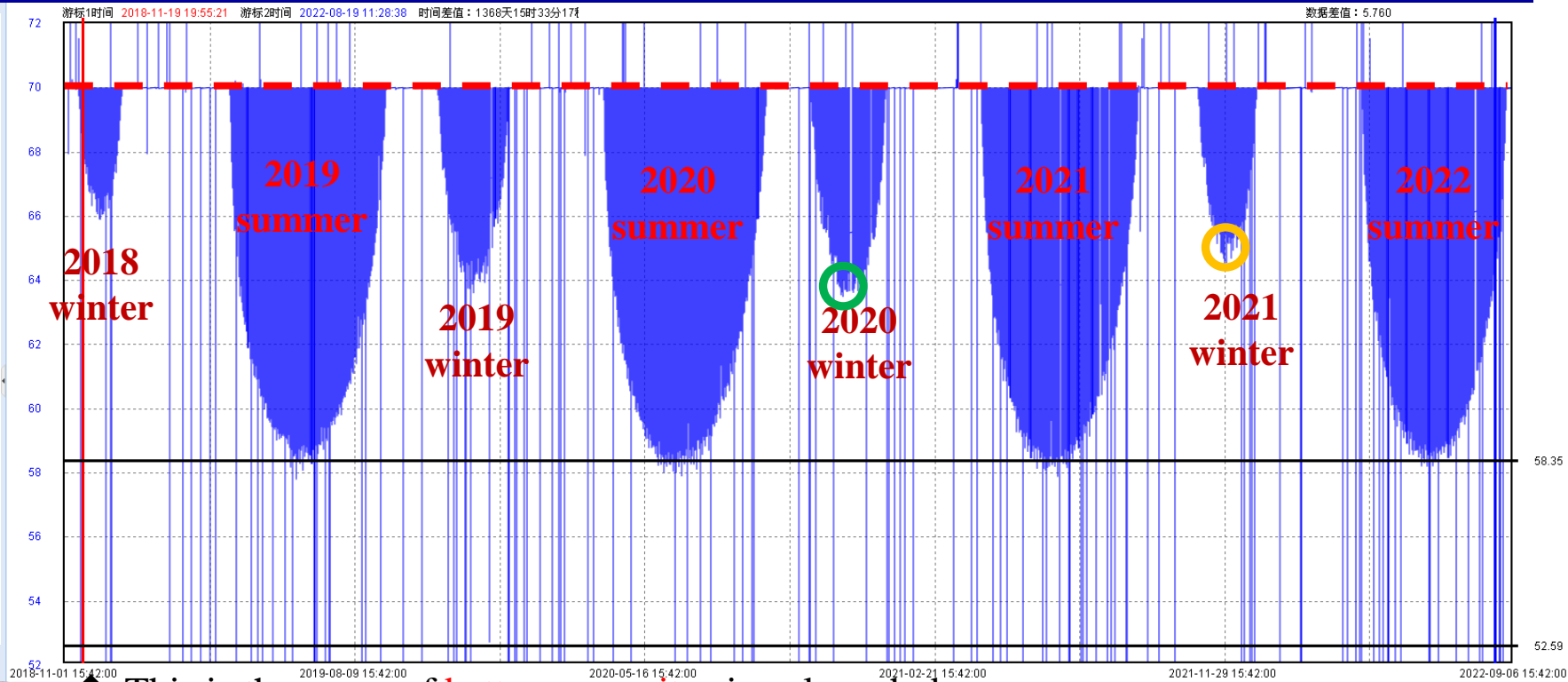


- ◆ This is the curve of **solar array current** since launch day.
- ◆ The current value keeps **stable** in the last 4 years. Satellite power supply is guaranteed **without** degeneration.
- ◆ Also we can see, 2021 winter (**yellow dual-arrow line**) is shorter than 2020 winter (**green dual-arrow line**). This trend is compliant with LTDN drift.



Power Supply – Battery capacity

Battery Capacity (Ah)

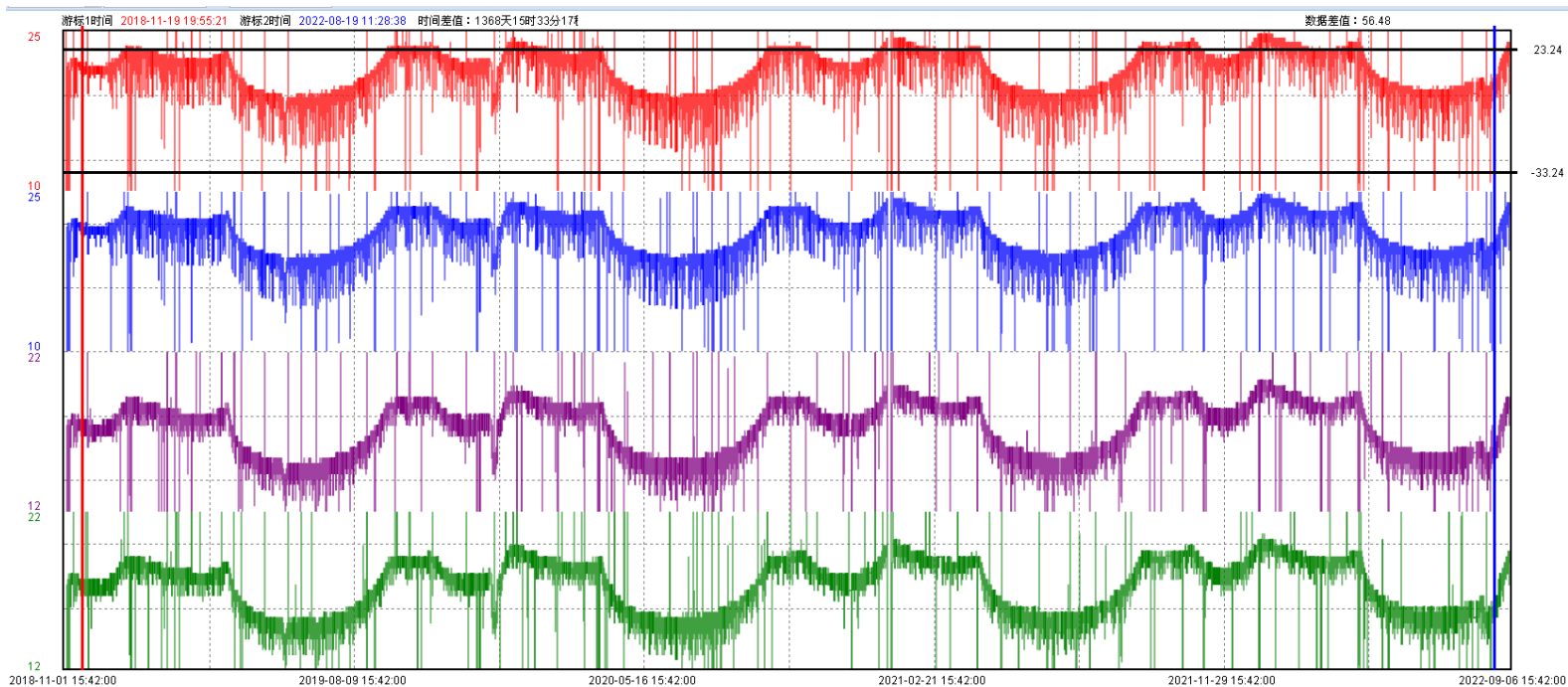


- ◆ This is the curve of **battery capacity** since launch day.
- ◆ The lowest capacity in 2021 is about **58.35Ah**. This value is almost the same as the one in 2020 (58.2Ah) and 2021(58.3Ah), indicating that there is **no** degeneration in battery.
- ◆ The DOD in winter in 2021 (**yellow circle**) is lower than the one in 2020 (**green circle**), the duration is shorter. This phenomenon complies with the LTDN drift.
- ◆ It is estimated that, there will be **no winter umbra** on CFOSAT orbit since 2022.



Onboard Temperature: SWIM

SWIM Temperature(°C)



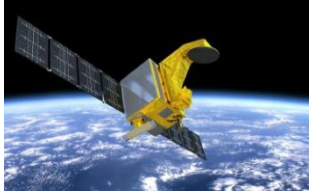
SWIM TWT
temp 1

SWIM TWT
temp 2

SWIM EPC
temp 1

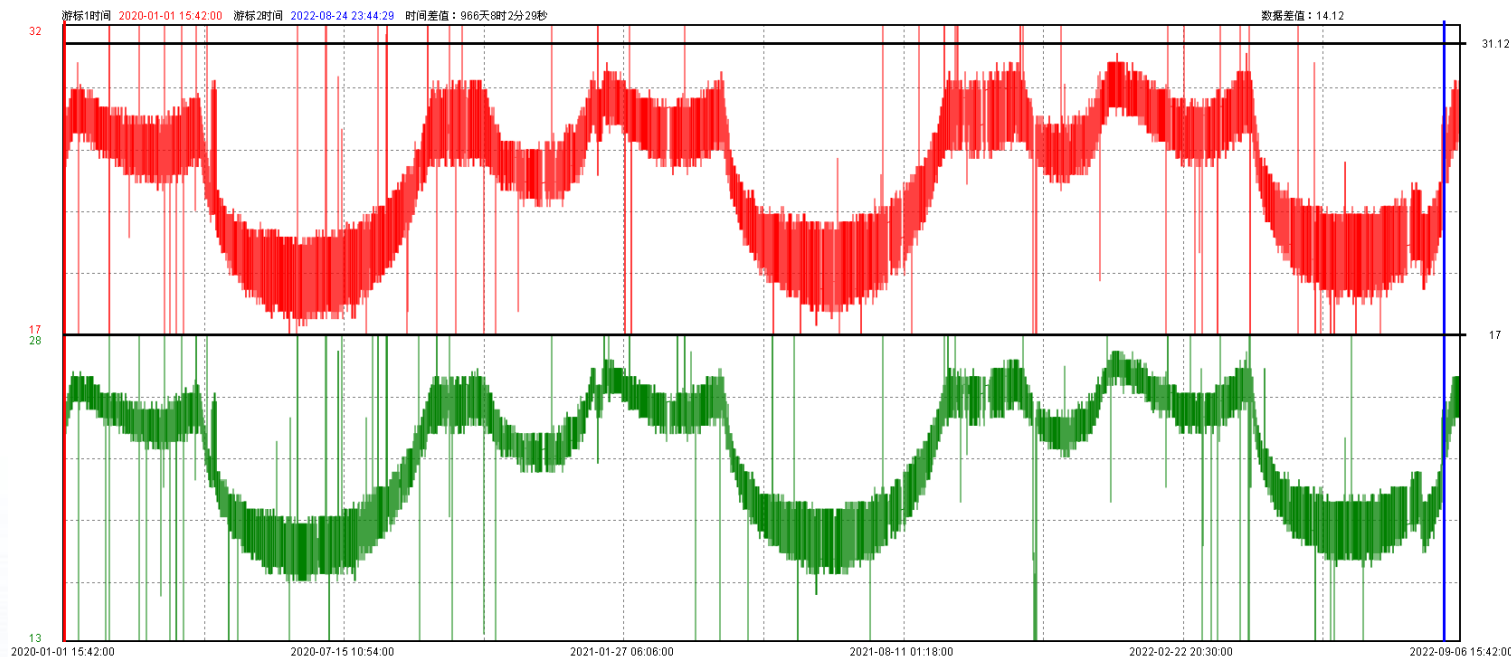
SWIM EPC
temp 2

- ◆ This is the curve of **SWIM TWT & EPC onboard temperature** since launch day.
 - ✓ TWT temperature varies between 10°C and 25°C;
 - ✓ EPC temperature varies between 12°C and 22°C;
- ◆ All the temperatures are within normal range.



Onboard Temperature: SCAT

SCAT Temperature(°C)



SCAT
redundant
TWT temp

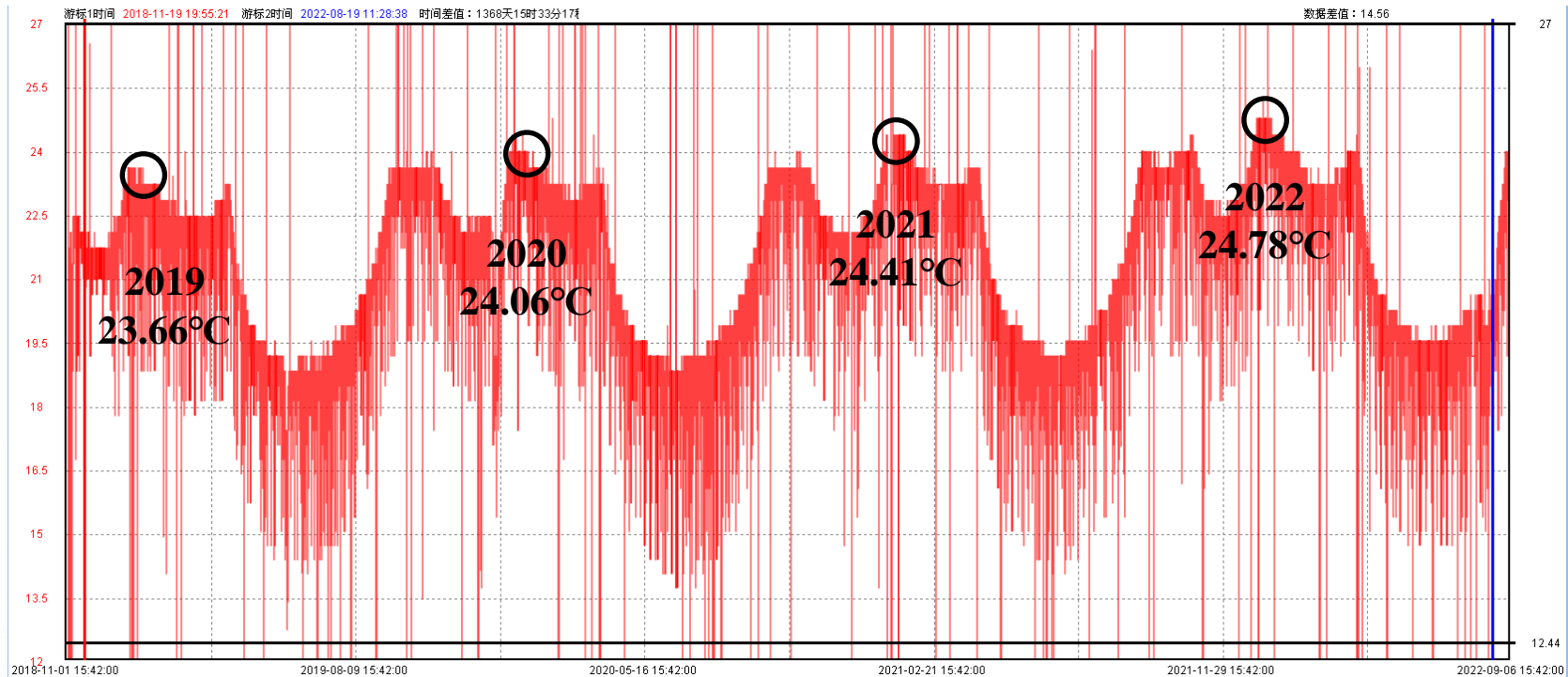
SCAT
redundant
EPC temp

- ◆ SCAT was switched from nominal part to redundant part on 2019.12.30. So SCAT curve was plotted starting since 2020.01.01.
- ◆ This is the curve of **SCAT TWT & EPC onboard temperature** since then.
 - ✓ TWT temperature varies between 17°C and 32°C;
 - ✓ EPC temperature varies between 16°C and 28°C;
- ◆ All the temperatures are within normal range.



Onboard Temperature: Higher and Higher

SWIM TWT
Temperature1(°C)

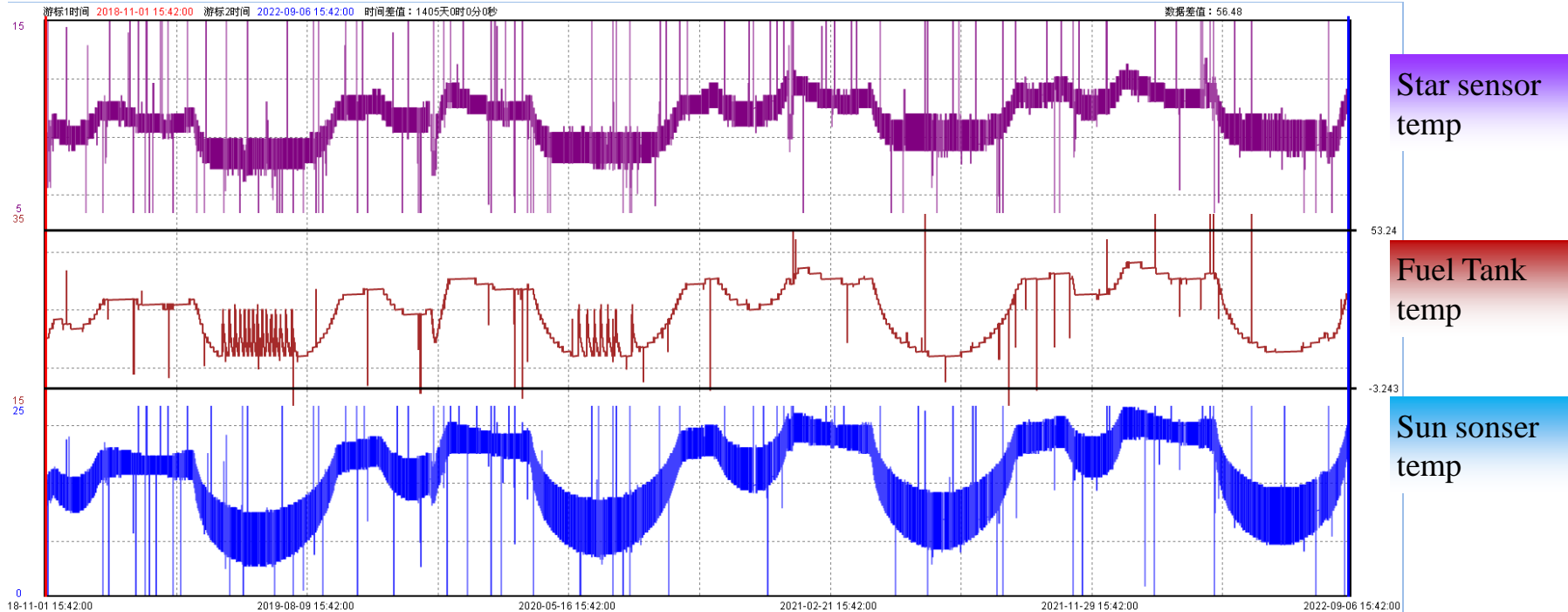


- ◆ If we enlarge the temperature curve to check more detail, e.g. SWIM TWT temp1, we will see that, the peak temperature (black circles) is getting **higher and higher**, year by year, increased by more than 1°C from 2019 to 2022.



Onboard Temperature: Higher and Higher

Onboard Temperature(°C)

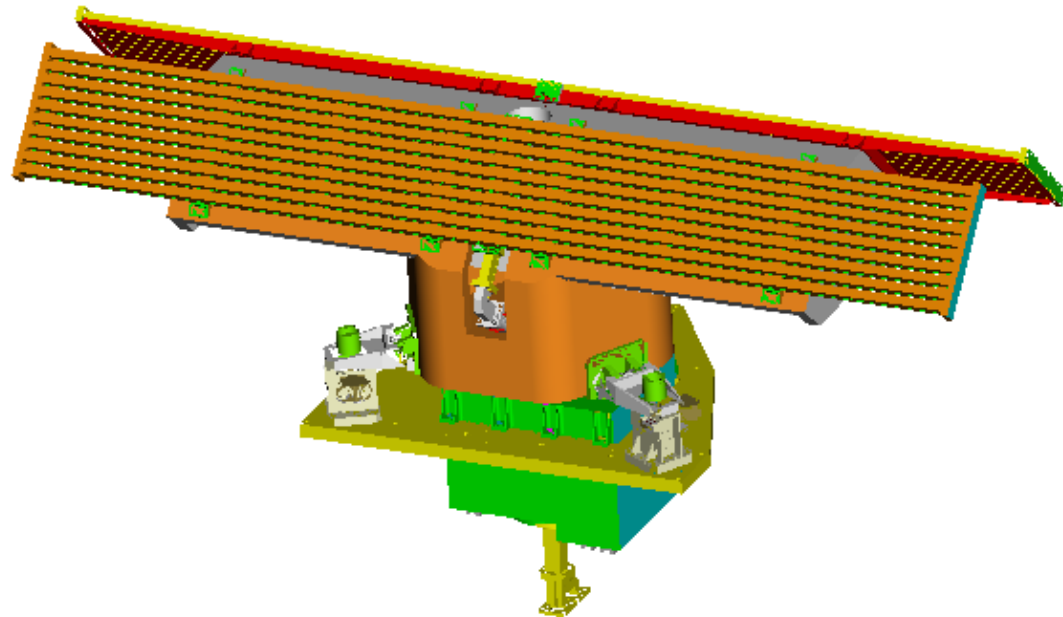


- ◆ For some other onboard equipment, the temperature increased by higher value than SWIM TWT in the last 4 years in similar way, e.g. star sensor (purple) from 10.86°C to 12.42°C, fuel tank (brown) from 26.16°C to 30.02°C, sun sensor (blue) from 19.62°C to 24.82°C.
- ◆ This phenomenon complies with the orbit LTDN drift trend.
- ◆ As we mentioned, there will be no winter umbra since 2022. So the temperatures onboard is estimated to be **much higher** than the values in previous years.
- ◆ However, there is still **enough margin** (>10°C) to the equipment upper temperature threshold. So satellite right now is **still safe** under thermal control.



SCAT antenna abnormal recently

- 2022.08.07, SCAT antenna stopped rotation;
- 2022.08.25, after trying several times, SCAT antenna retrieved to normal status;
- 2022.09.07, unfortunately, SCAT antenna stopped rotation again.
- Right now, it is still under retrieval process by Chinese team.

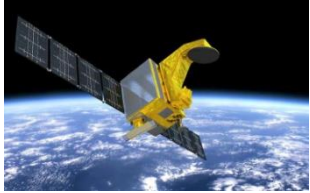




Conclusion

- In the last 46.5 months after launch, CFOSAT **orbit** meets requirement. Orbit ground track keeping maneuver was performed successfully. There are enough onboard fuel margin;
- The **battery DOD** and temperature are maintained within normal range, which benefit a lot for long life time;
- The onboard equipment **temperature** are maintained within normal range with enough margin, which means onboard thermal control function works well without big degeneration.
- The temperatures onboard is estimated to be **much higher** since 2022, but there is still enough thermal **margin**.
- The satellite platform is under **health and safe** condition till now.
- SCAT is facing antenna stuck problem. It's still under retrieval process.





谢谢
MERCI

