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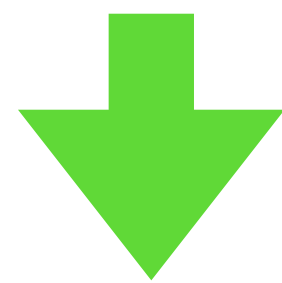
Langmuir Waves Associated with Magnetic Holes

**Jordi Boldu, Daniel Graham, Michiko Morooka, Tomas Karlsson,
Yuri Khotyaintsev, Mats Andre, RPW team, MAG team**

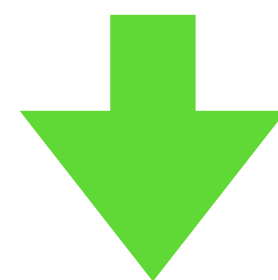


Do Magnetic holes have any relation with the presence of Langmuir waves in the solar wind?

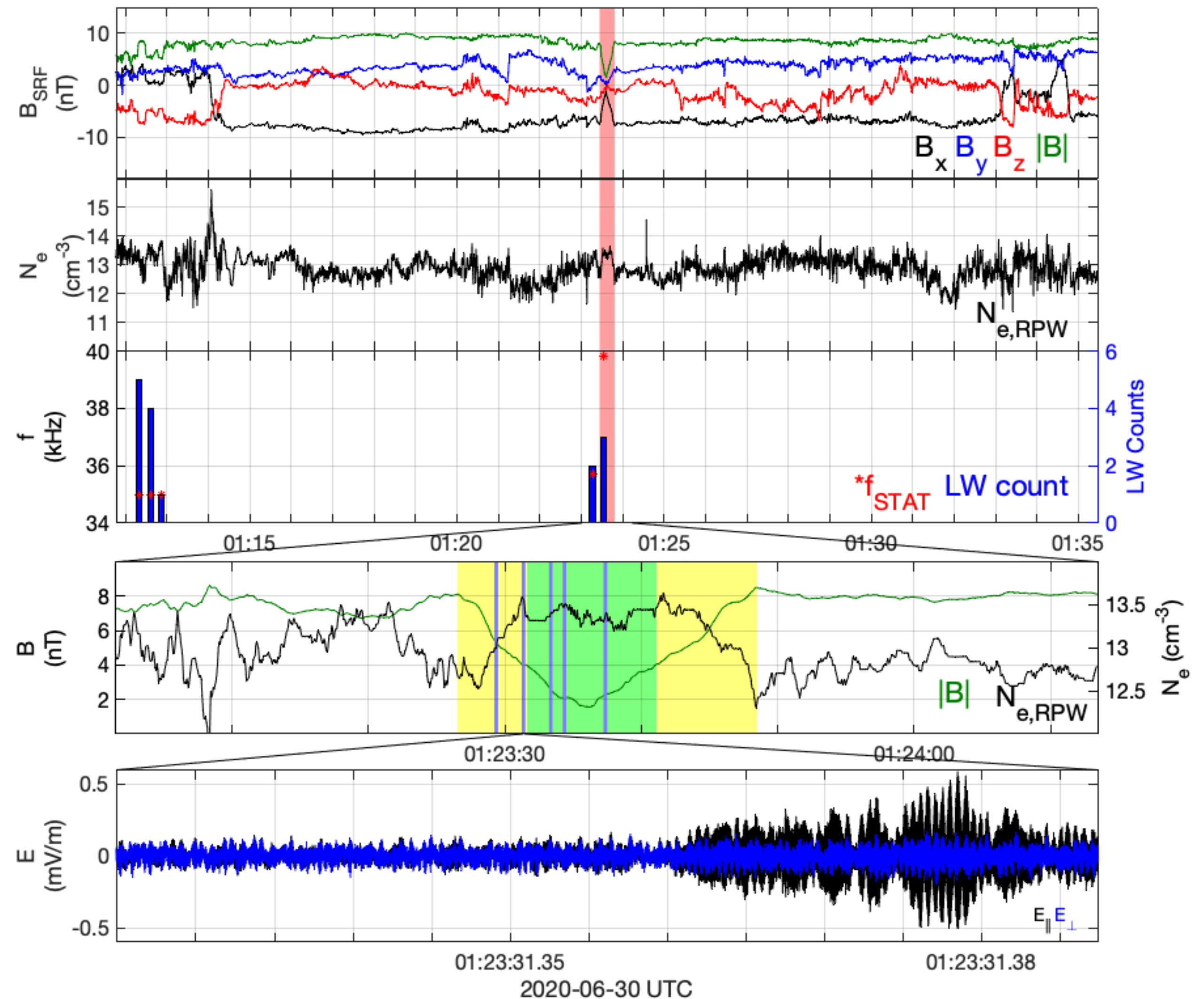
- Wave-particle interactions dominate the evolution of the solar wind.



- Langmuir waves (LW) are strong candidates for shaping the electron distributions in the solar wind.

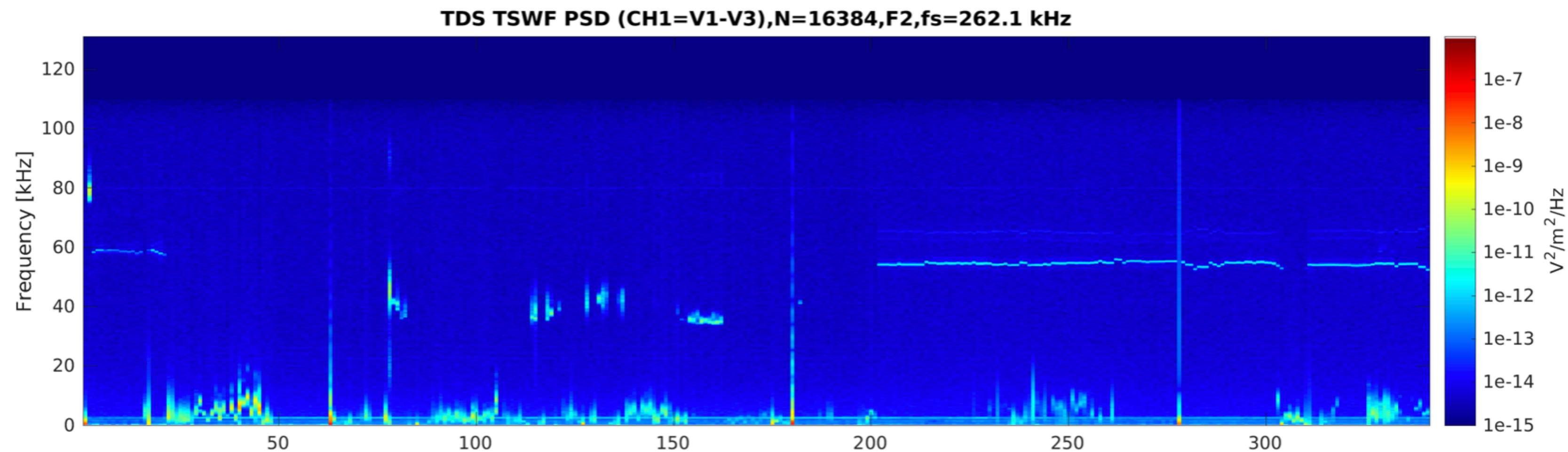
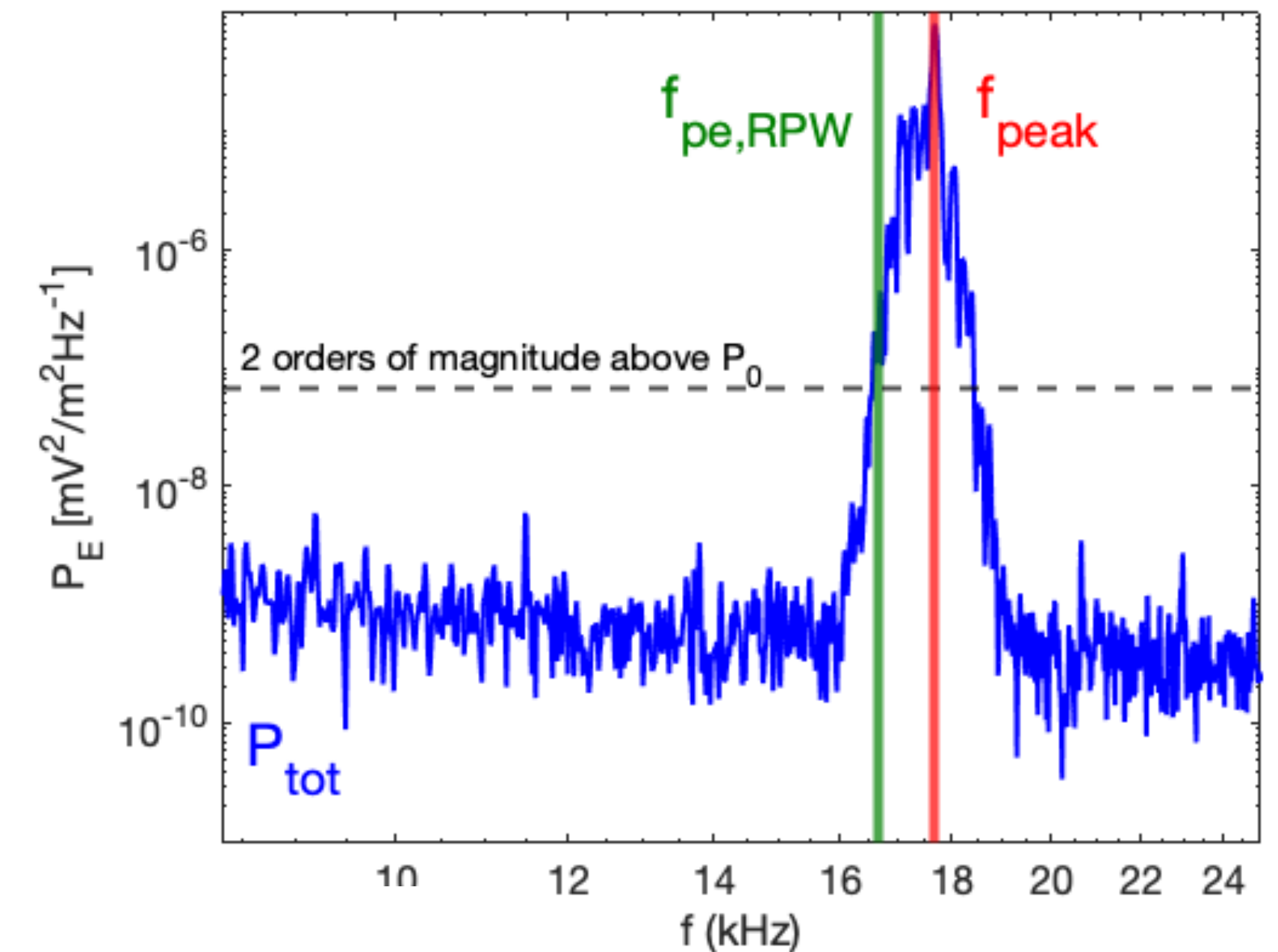


- LWs have often been observed in magnetic holes (MH)



Langmuir Wave detection with TDS

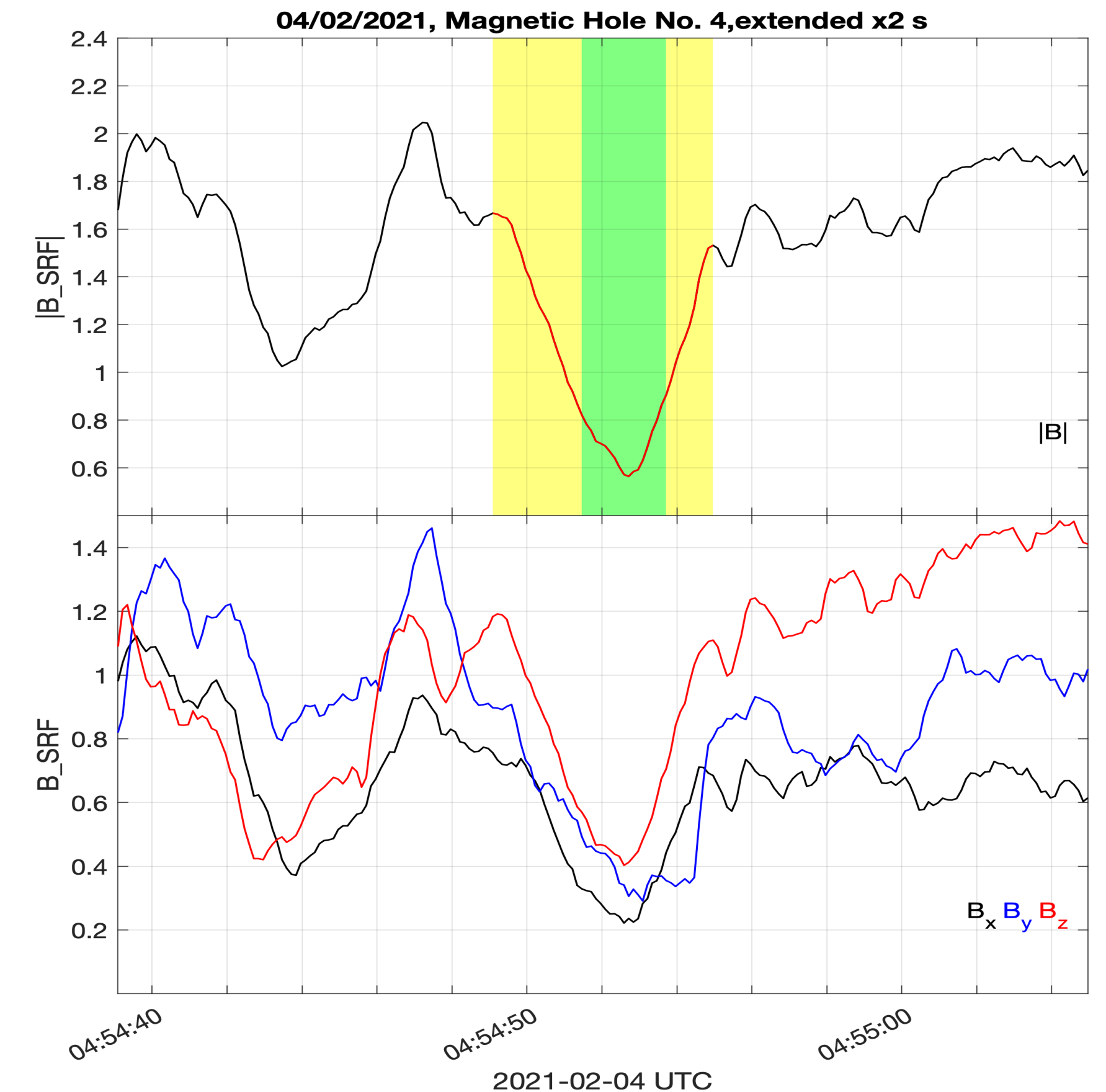
1. Rotate Efield from triggered TDS snapshots to Bfield-aligned coordinates.
2. Perform FFT on the rotated Efield.
3. Look for peaks in PSD between 0.5 and 1.5 F_{pe} (from S/C potential) and two orders of magnitude above the background power.
4. Remove snapshots with interference



Magnetic Hole detection with MAG

Karlsson et al. 2021.

1. Determine B-field strength (B_0) with a 300 s sliding window.
2. Calculate relative relation
$$\Delta B/B_0 = \text{mean}\left(\frac{|B| - B_0}{B_0}\right) |_{1s}$$
3. If $\Delta B/B_0 < -50\%$ and no other hole candidate within 120s \rightarrow identify it as MH with start and end times corresponding to the first and last point fulfilling the criterion.



Total time SolO is inside MH: <0.1% (2020-2021)

Triggered vs. STAT

During 2020-2021:

- Triggered

3476 LW detected

↳ ~74% non-related to Type II/III radio bursts.

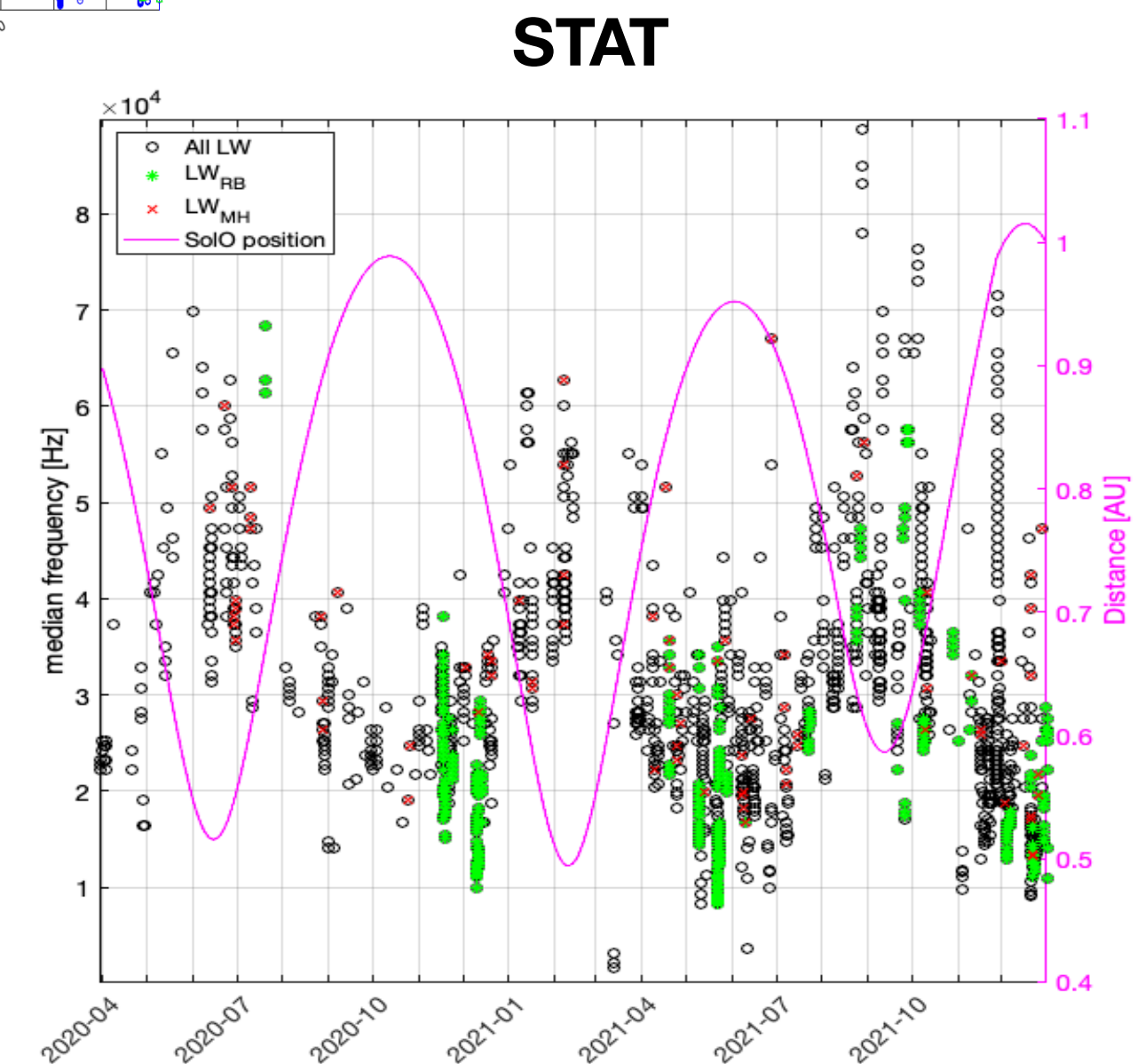
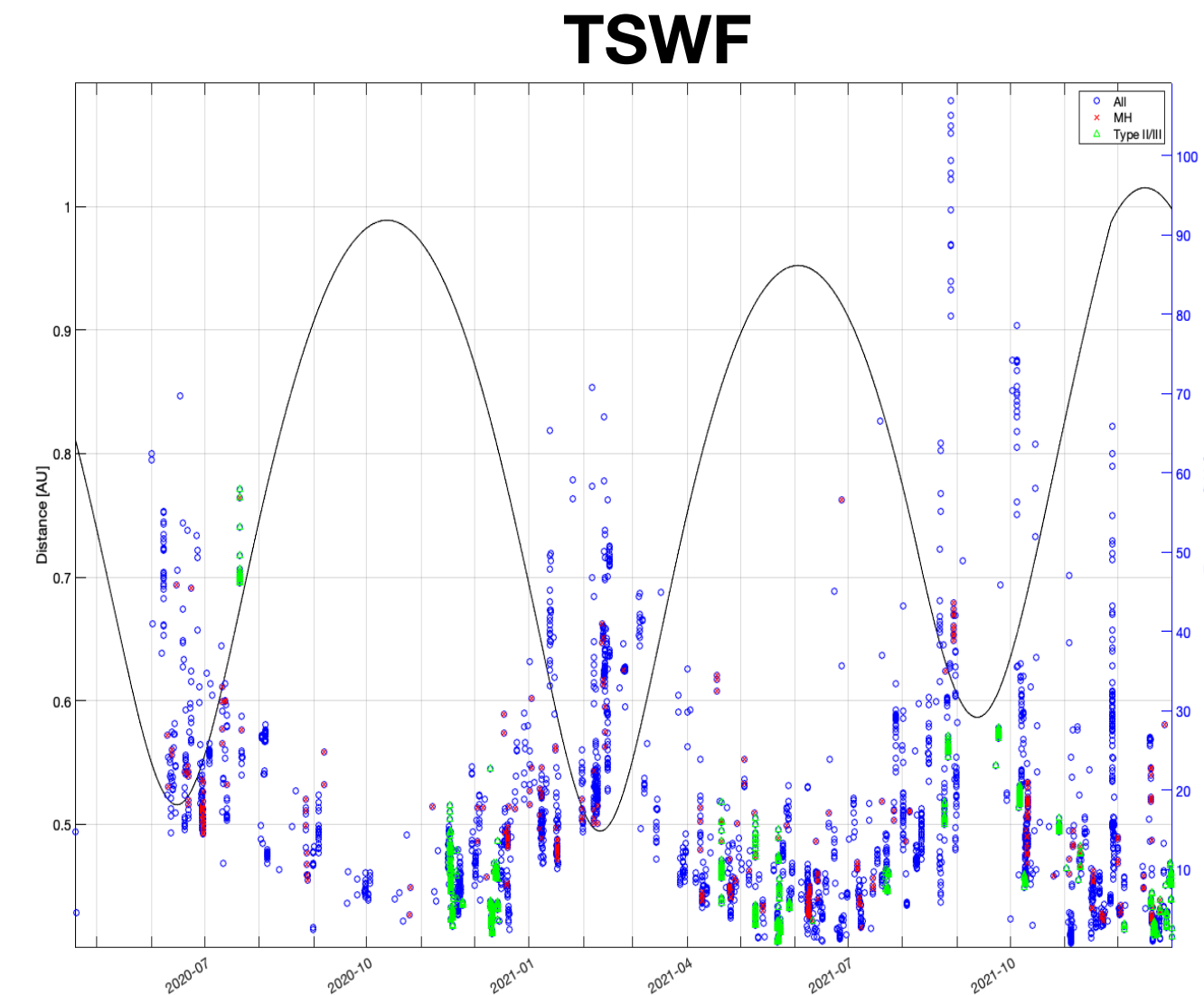
↳ ~7% inside MH.

- STAT

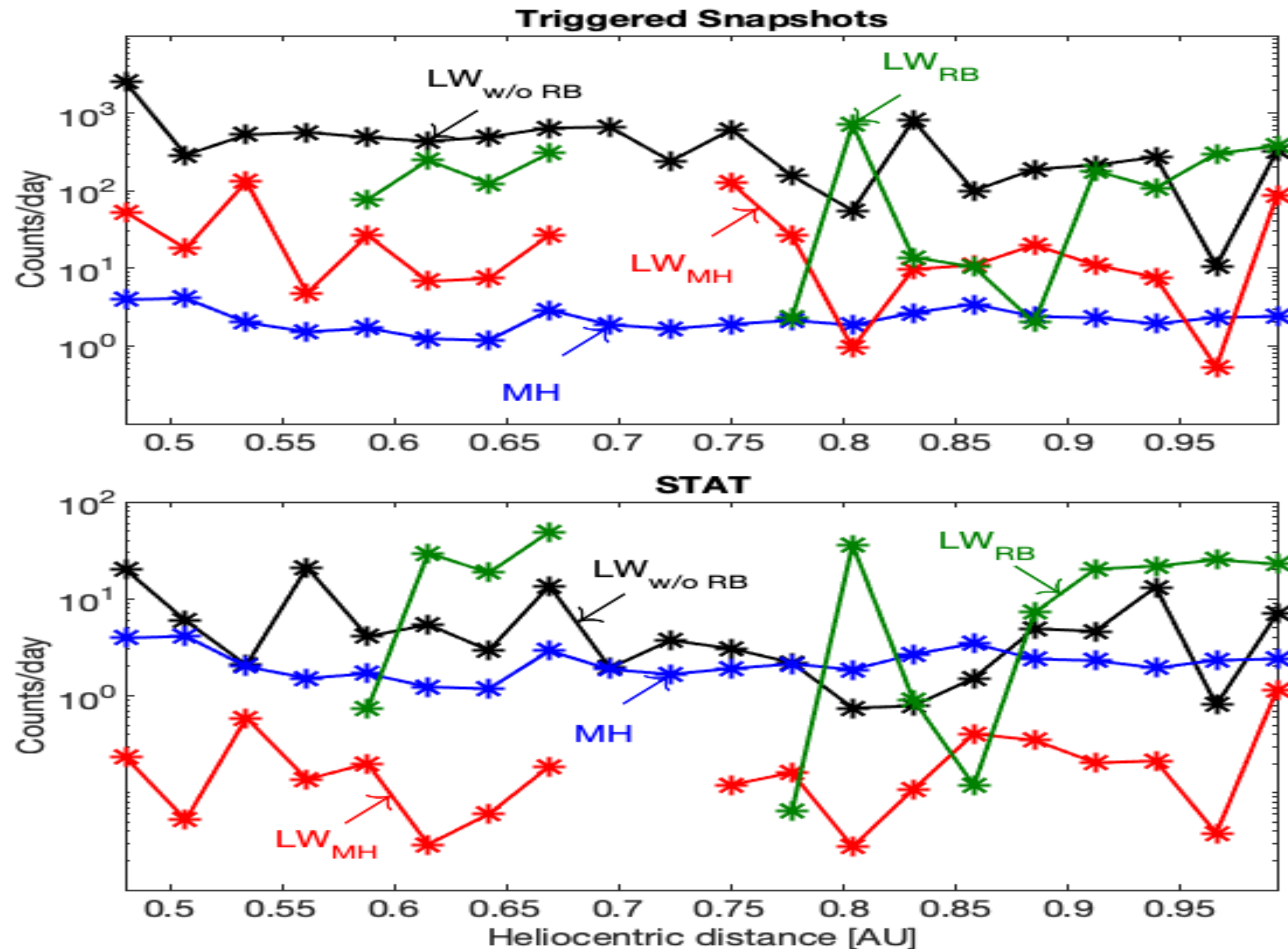
13346 LW detected

↳ ~40% non-related to Type II/III radio bursts.

↳ ~4% inside MH.



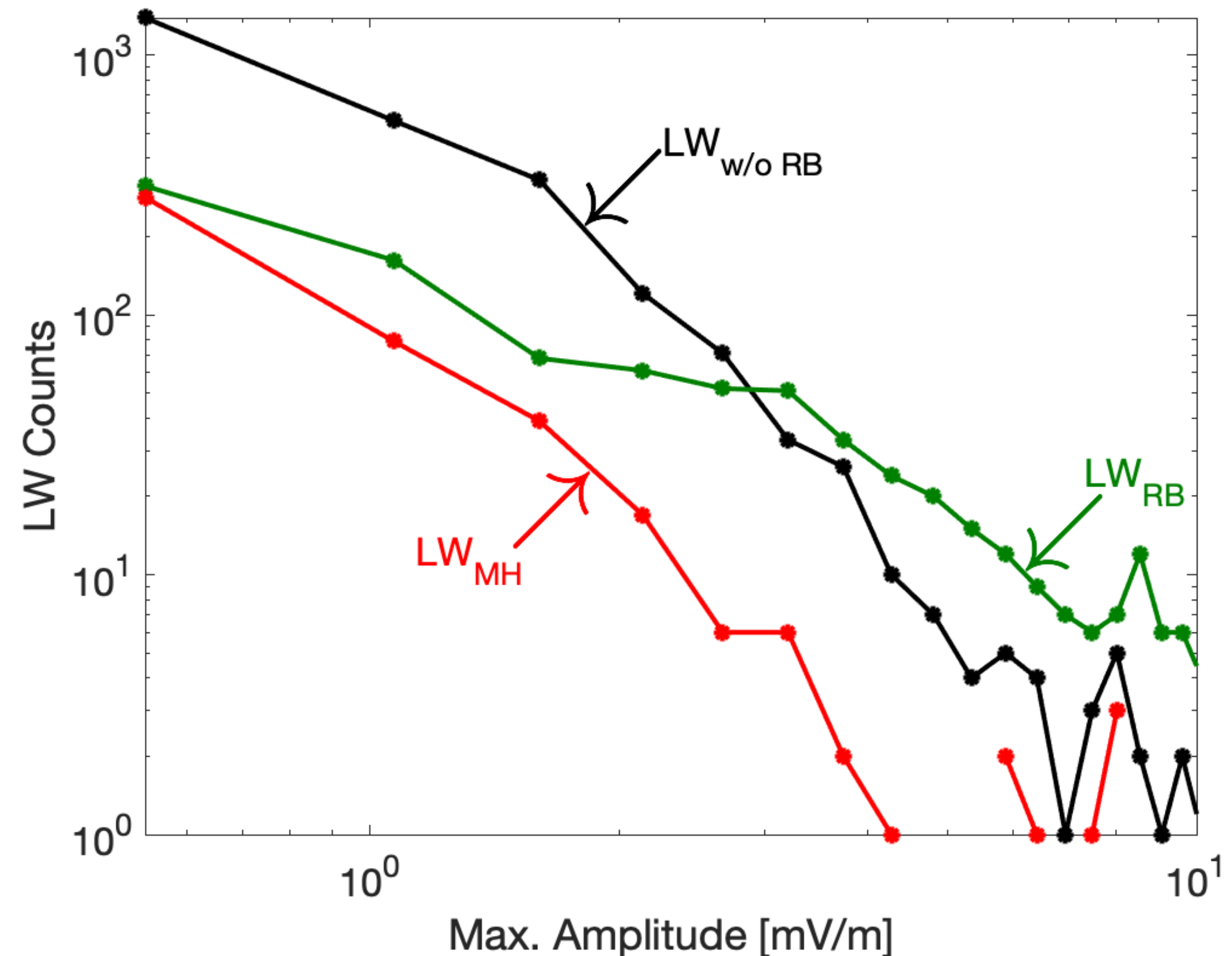
Langmuir waves at different distances



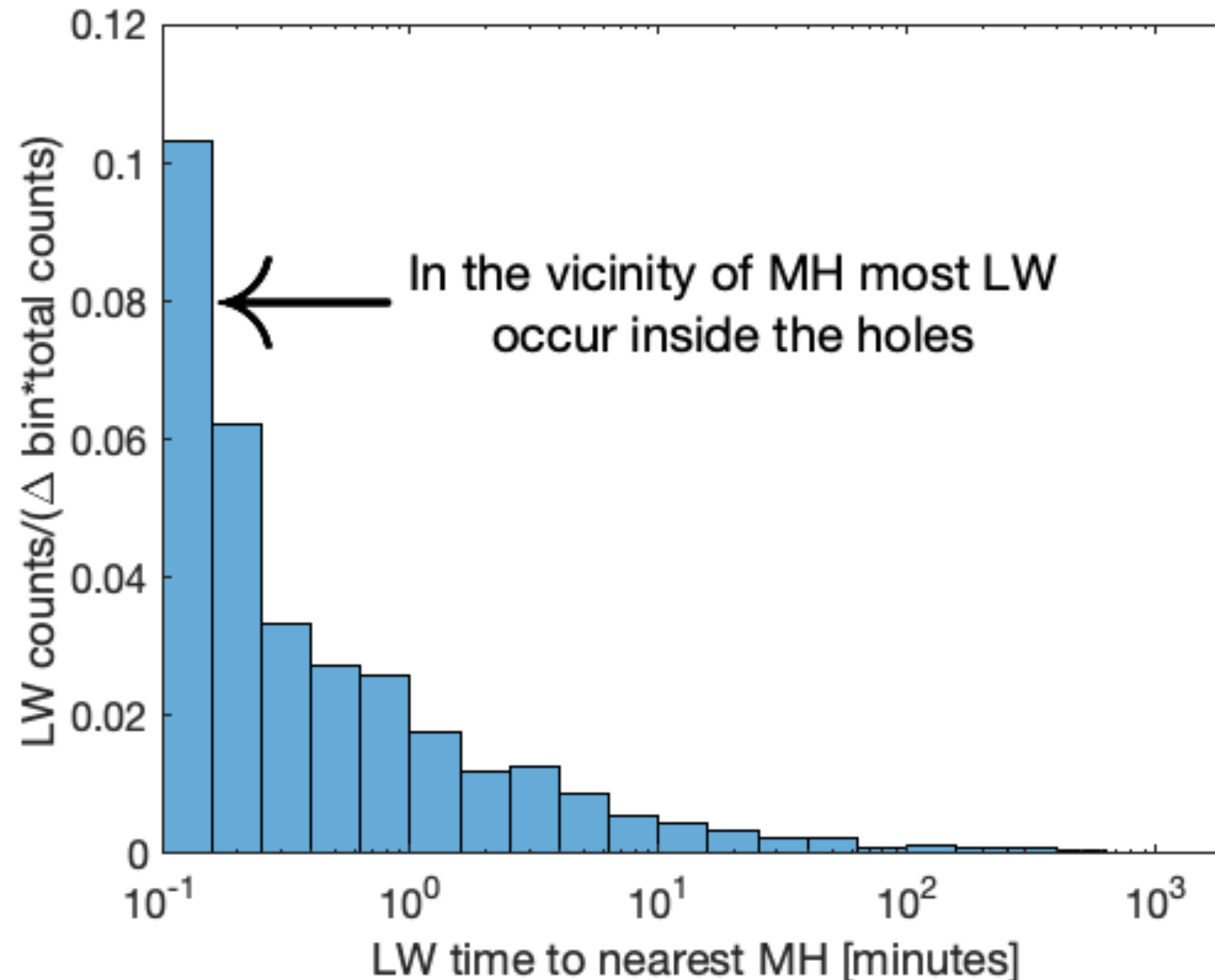
- Sometimes we can observe a relation between LW activity and MH.
- However, many MH do not show LW activity.
- MH are not enough for LW excitation. Other mechanisms must be involved, such as a strahl population (Briand et al. 2010)

Amplitudes of observed Langmuir waves

- Around 3 mV/m the dominance of LWs shifts from pristine solar wind waves to radio bursts LWs
- Typically, LWs associated with MH are of low amplitude.



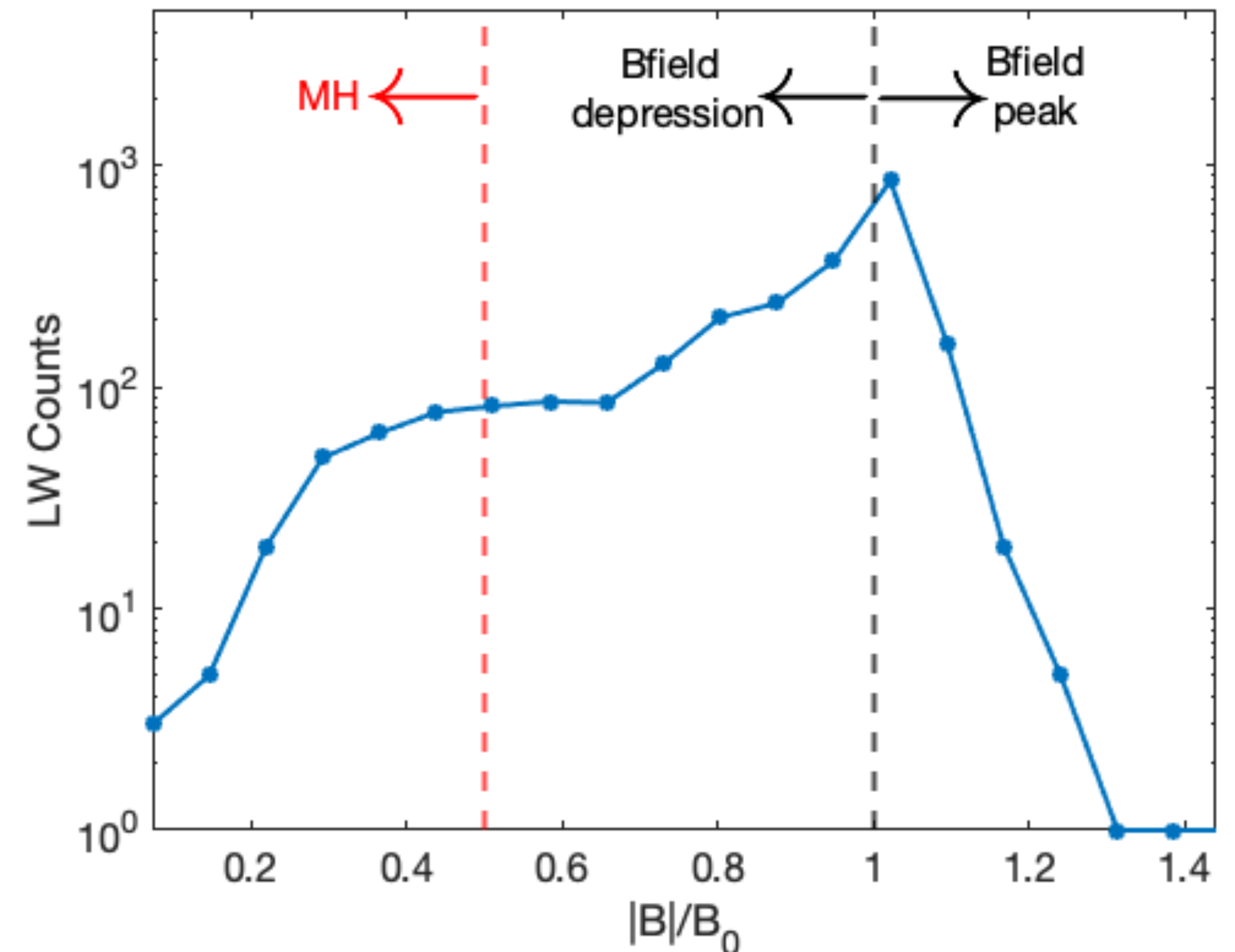
How far from MH the LW are found?



Evidence pointing that LWs are formed inside magnetic holes as previously observed at 1AU.

Conditions near LW in the pristine solar wind

- Bfield magnitude $|B|$ at LW times divided by the background level B_0 .
- LW tend to occur when the local B field is lower than the background level.



Summary

- LW may play an important role in the wave-particle interaction that shapes the electron distribution in the solar wind.
- Low amplitude waves have often been observed inside MH. There is strong evidence of their formation inside the holes.
- Around 7% of the LWs in the quiet solar wind occur in <0.1% of the time.
- LWs often occur inside MH. However, the presence of holes is not sufficient for the excitation of LW. Some other mechanisms must be in play -> Strahl.
- LWs in the pristine solar wind are more common in B-field depressions.

**More to discuss at
Poster #56**