Decametric and hectometric Solar Type III bursts at Saturn's orbit observed by RPWS/Cassini experiment

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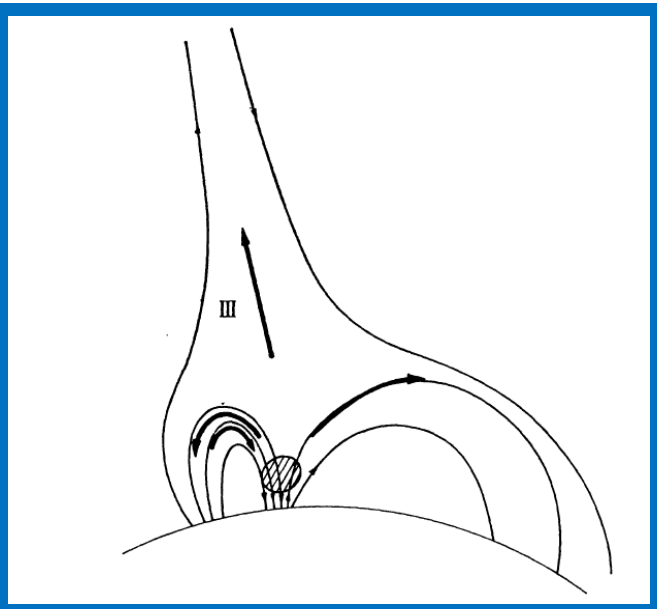
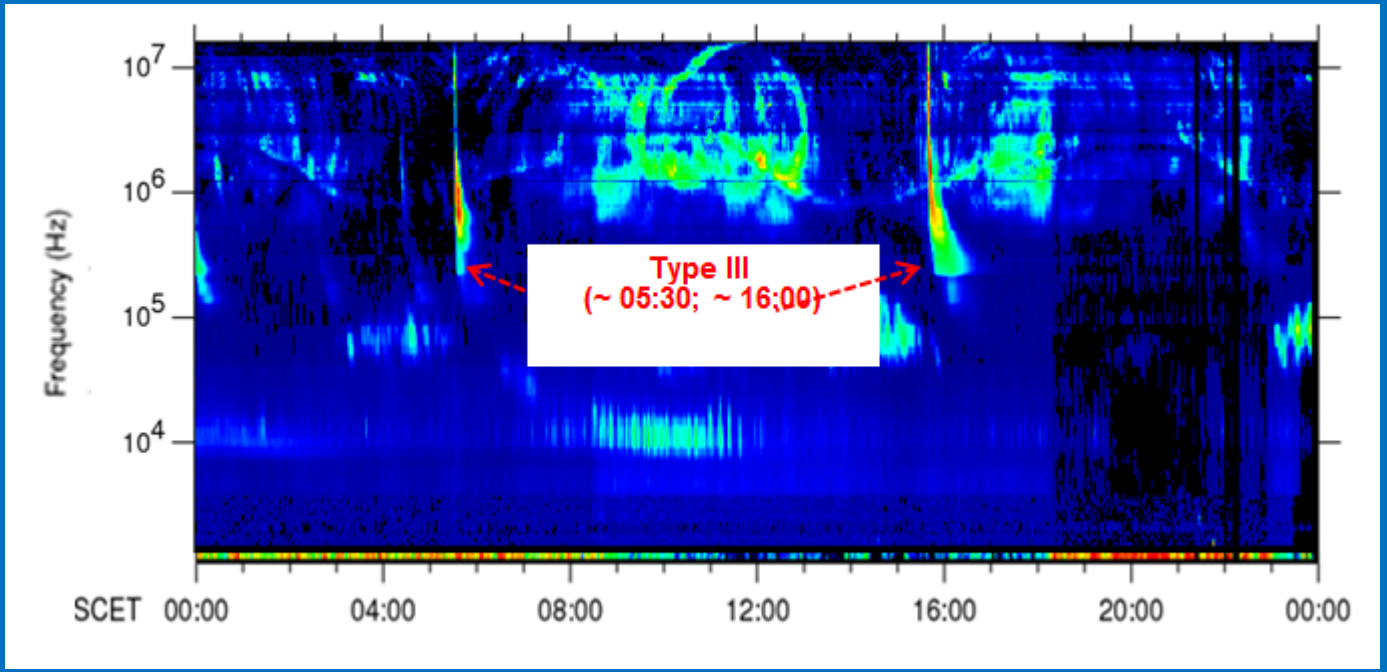
- **Solar Type III radio bursts**

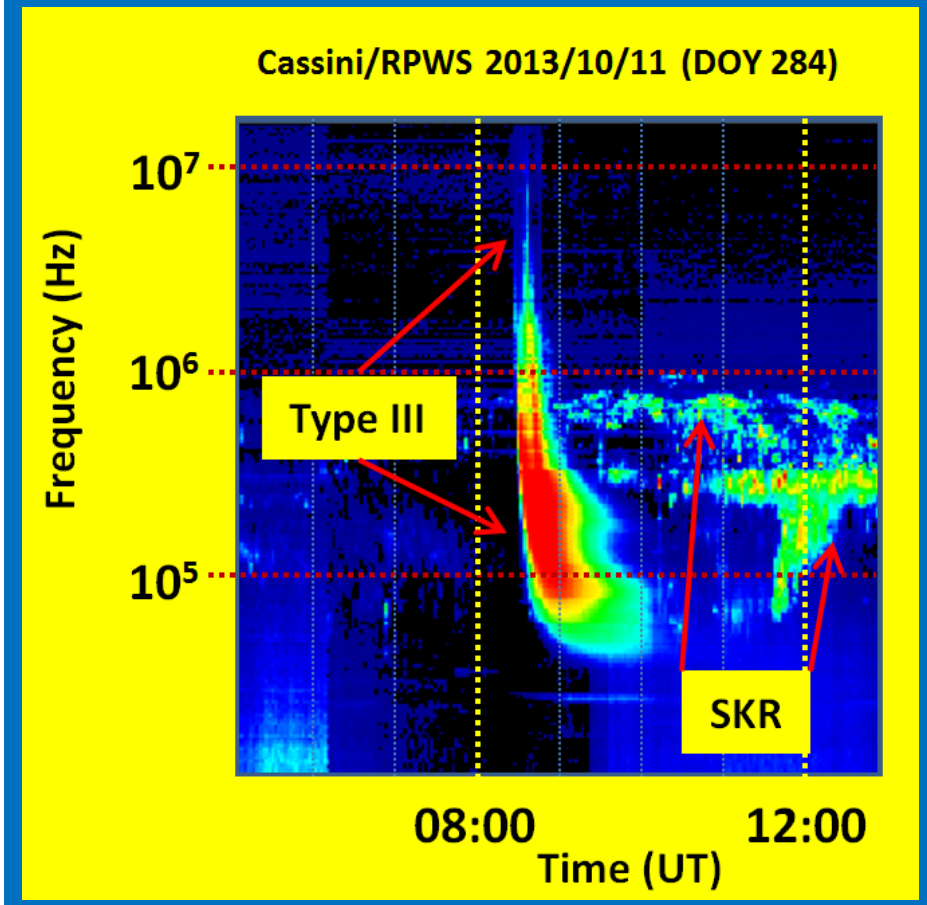


- Type III bursts result from streams of electrons travelling out from active regions along open magnetic field lines (Wild, 1950)
- Electrons generate at each height Langmuir waves whose frequency is nearly the local plasma frequency fp (MHz) = 9.10^{-3}.$ne^{1/2}$ (cm^{-3}) where *ne* is the local electron density (Mann et al., 1998)
- Some of the energy in the Langmuir waves is converted into electromagnetic waves (Ginzburg and Zheleznyakov, 1958)
- In the interplanetary space, both the electrons (Lin, 1974) and the waves (Gurnett and Franck, 1975) have been observed directly

Dynamic spectrum of solar Type III radio bursts recorded at Jupiter's orbit (15 Oct. 2000)



Observational spectral features of Type III bursts recorded at Saturn in 2013



- Observation day (Year, Month, Day)
- Occurrence time in UT (hour, minute)
- Day Of the Year (DOY) since Jan. 2004
- Type III frequency (in kHz)
- Intensity level (in dB).
- Distance between the Sun and the spacecraft (expressed in AU)
- Longitude and latitude heliographic coordinates of Cassini

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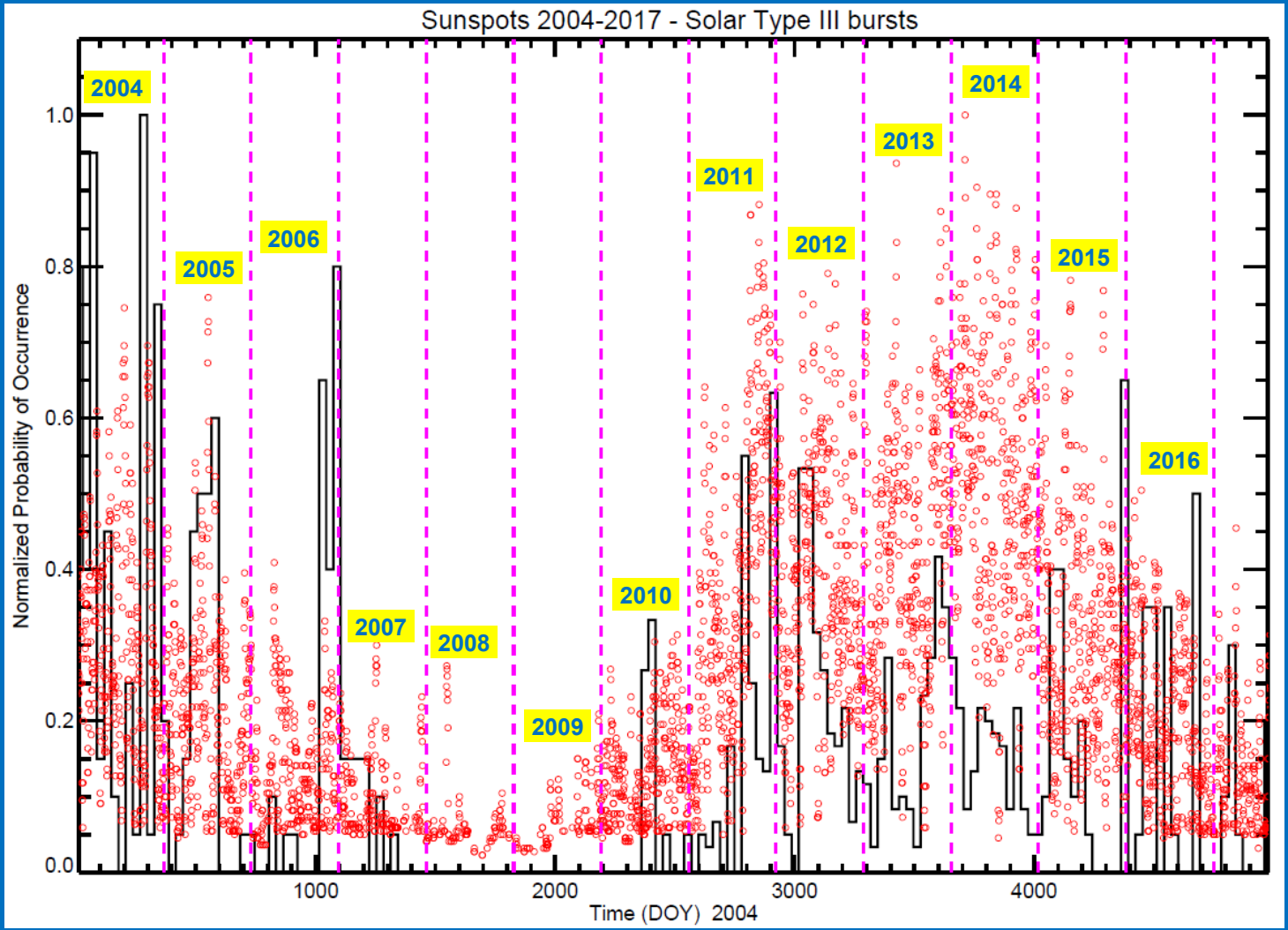
Occurrence of Solar Type III radio bursts versus Sunspots



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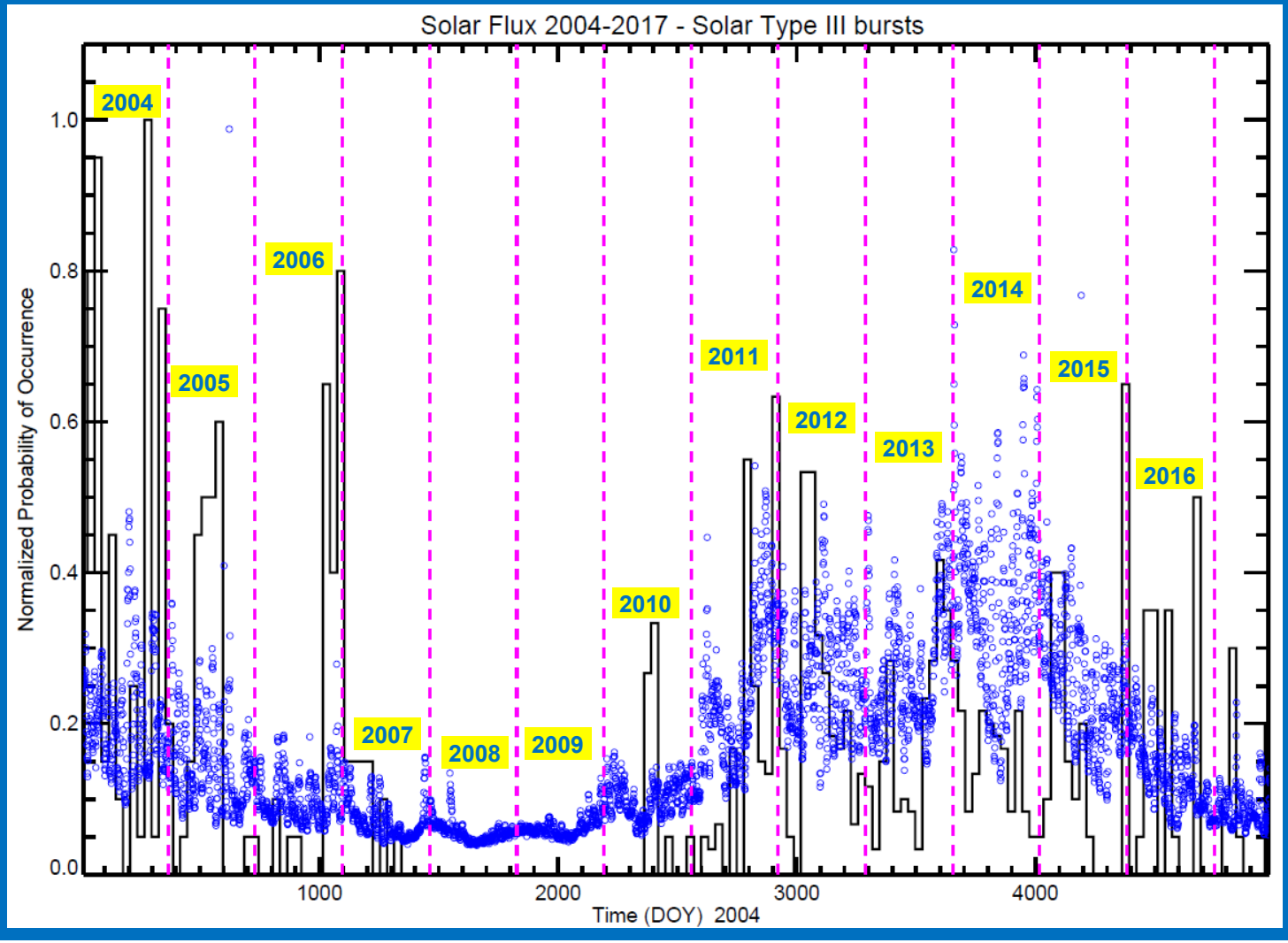
Occurrence of Solar Type III radio bursts versus Solar radio flux 10.7 cm



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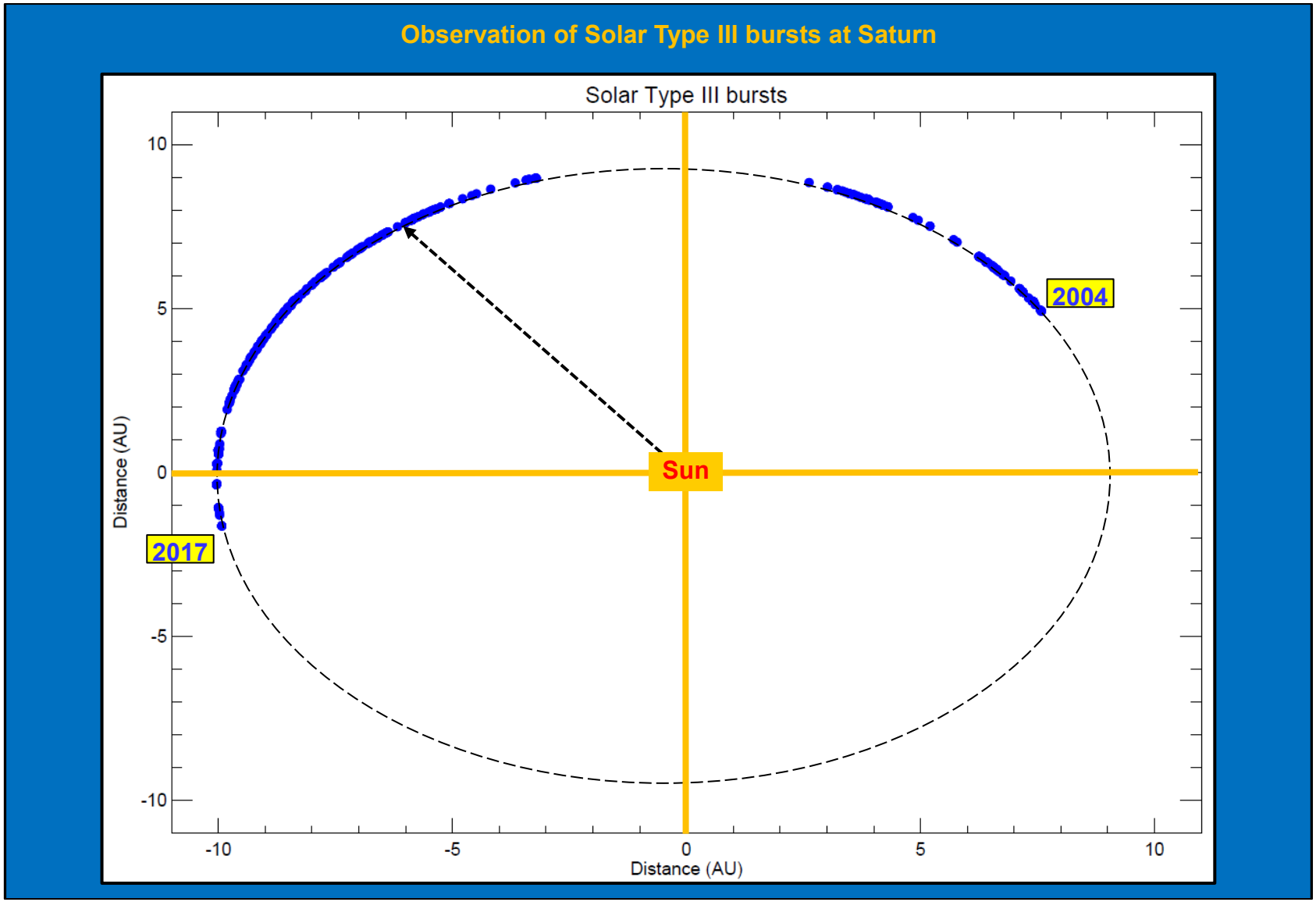

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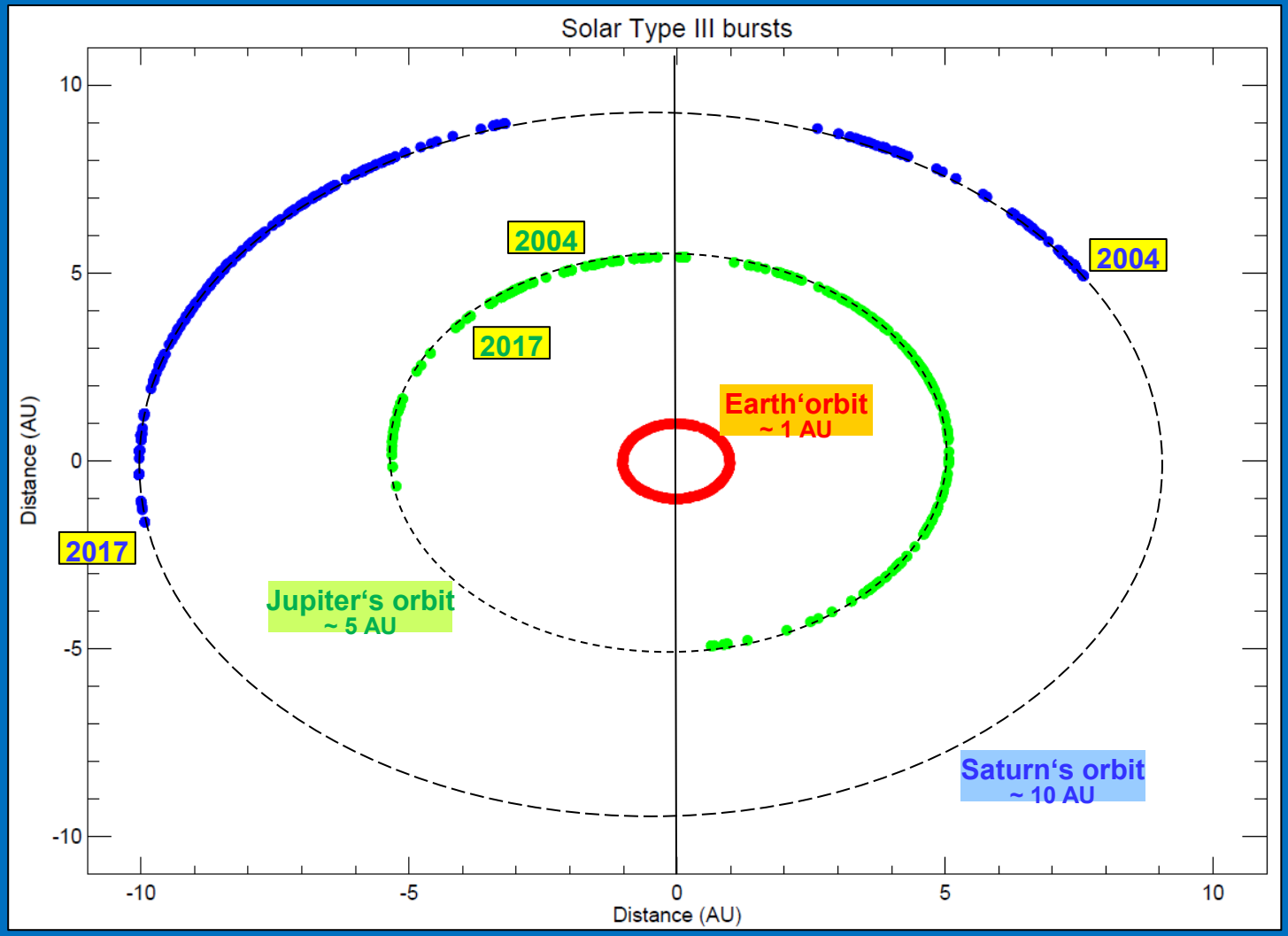
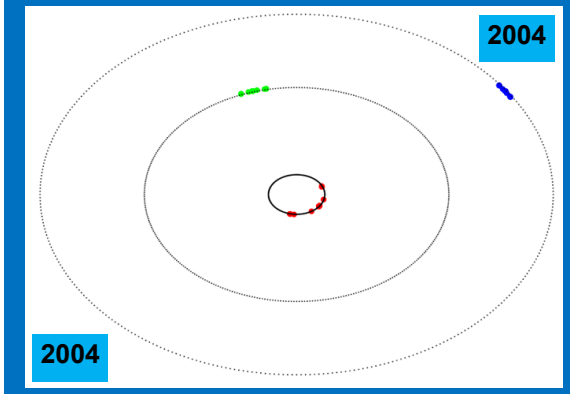
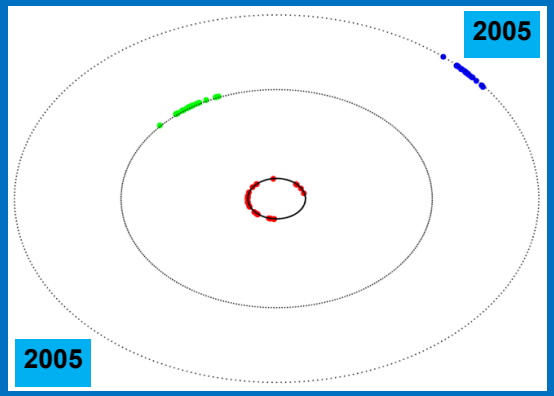
Observation of Solar Type III bursts at Saturn and corresponding locations at Jupiter and at the Earth

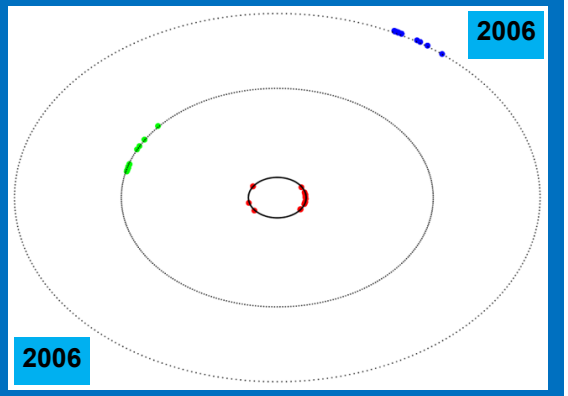


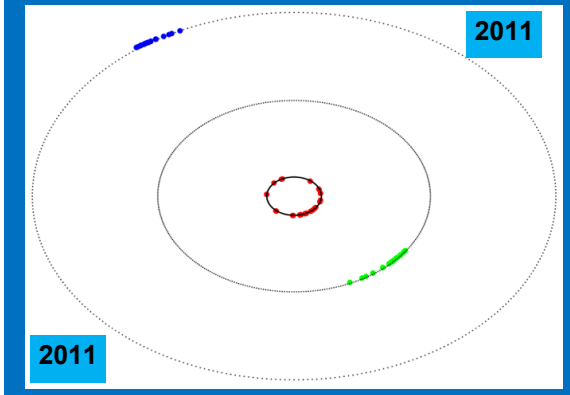
Decametric and hectometric Solar Type III bursts at Saturn's orbit observed by RPWS/Cassini experiment

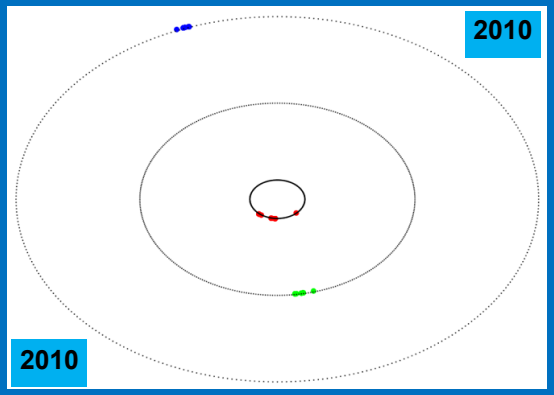
Evolutions of Solar Type III bursts at Saturn with corresponding positions at Jupiter and the Earth from 2004 to 2011

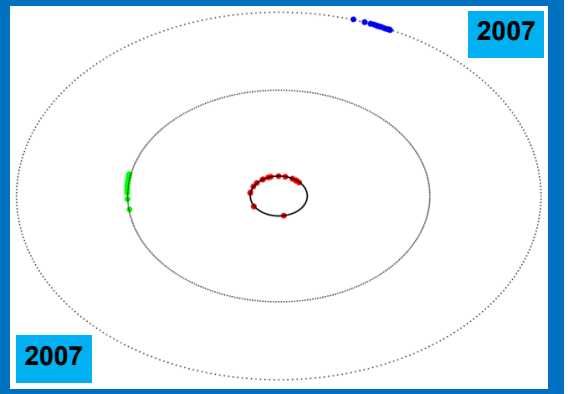






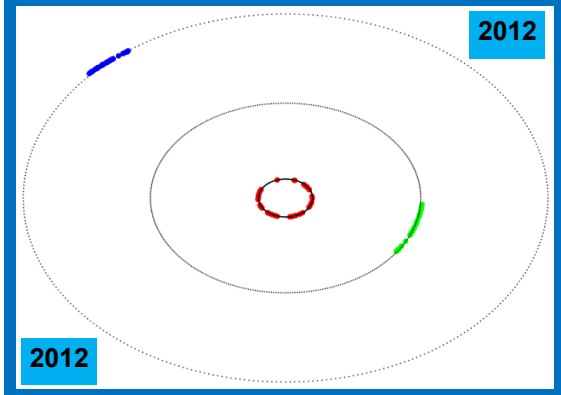


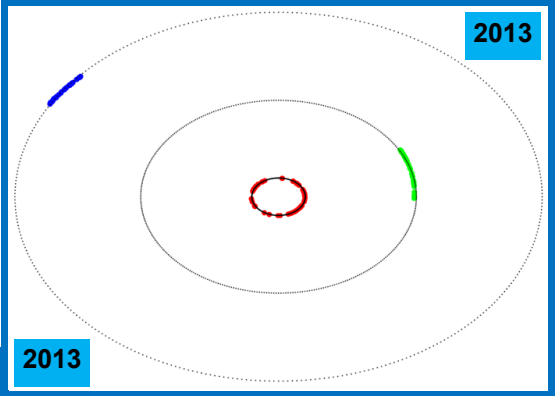


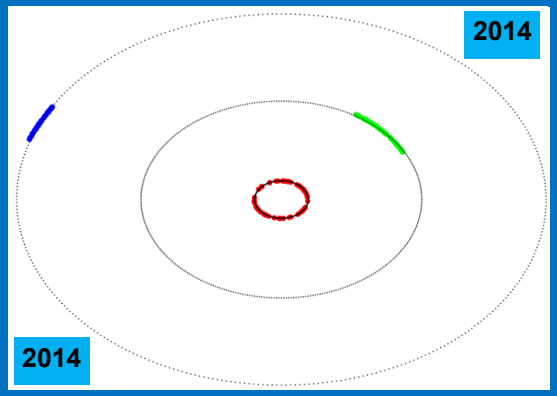


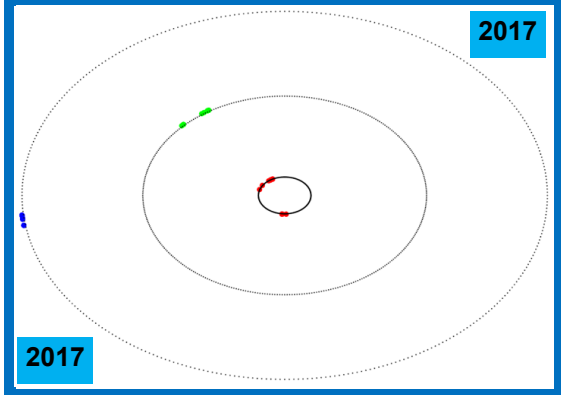
Decametric and hectometric Solar Type III bursts at Saturn's orbit observed by RPWS/Cassini experiment

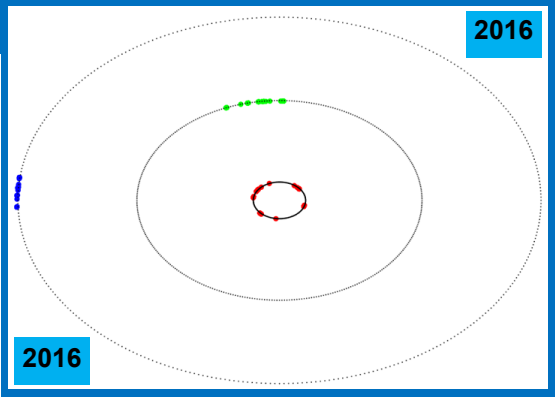
Evolutions of Solar Type III bursts at Saturn with corresponding positions at Jupiter and the Earth from 2012 to 2017

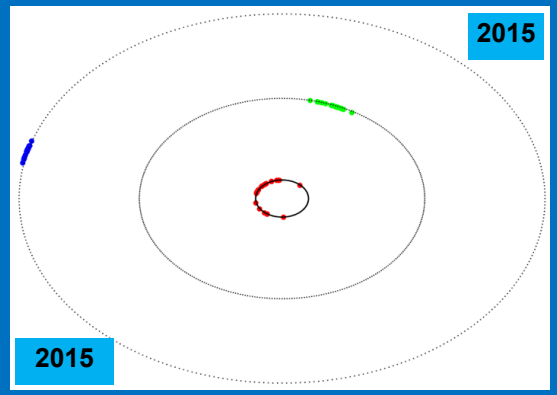












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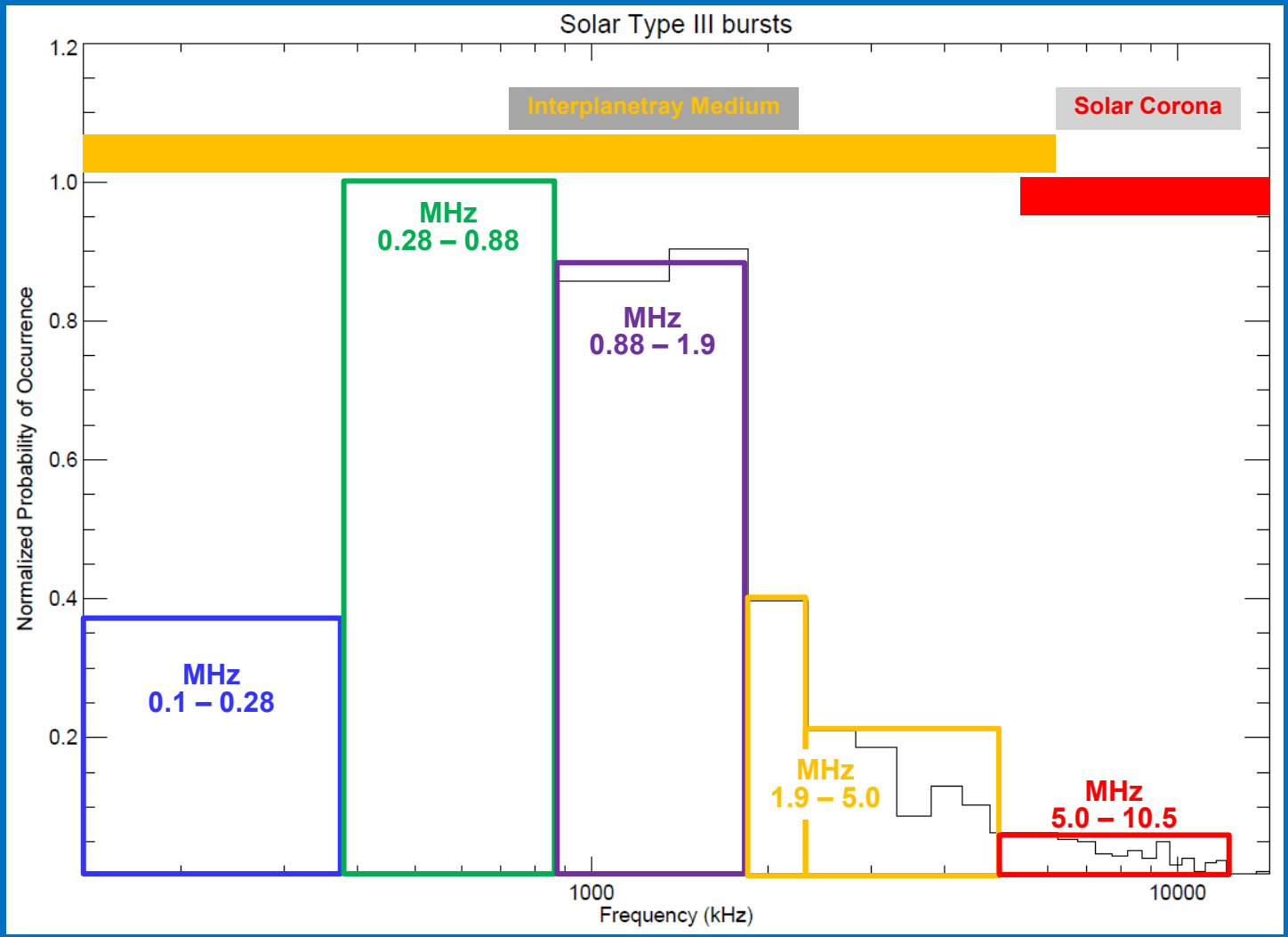
Occurrence of Solar Type III radio burst frequencies



Decametric and hectometric Solar Type III bursts at Saturn's orbit observed by RPWS/Cassini experiment

- We consider that the electrons at the origin of the Solar Type III bursts follow the interplanetary magnetic field
- The trajectory is an Archimedean spiral contained in the ecliptic plane. The equation is:

$$\phi = \frac{\Omega}{V_{SW}} \frac{r}{215}$$

where, Ω, V_{SW}, and r are, respectively, the solar angular rotation (in rad.s^{-1}), solar wind speed in km.s^{-1}) and the distance to the Sun in solar radii (in km).

- Frequency associated to Solar Type III radio bursts:
  - Decametric wavelengths [9.8,9.6,9.4,9.1,8.8,8.6,8.4,8.1] MHz
  - Hectometric wavelengths [580,540,510,460,430,390,370,320,310,250,210,190,180,140,100] kHz
  - Kilometric wavelengths [80,60,40,10]

- Empirical formula derived by Bougeret et al. (1984) leads to estimate the distance at which occurs the observed frequency

$$f_p = 22.5\, r^{-1.05}$$

where f_p is the local plasma frequency and r is the heliocentric distance expressed in AU

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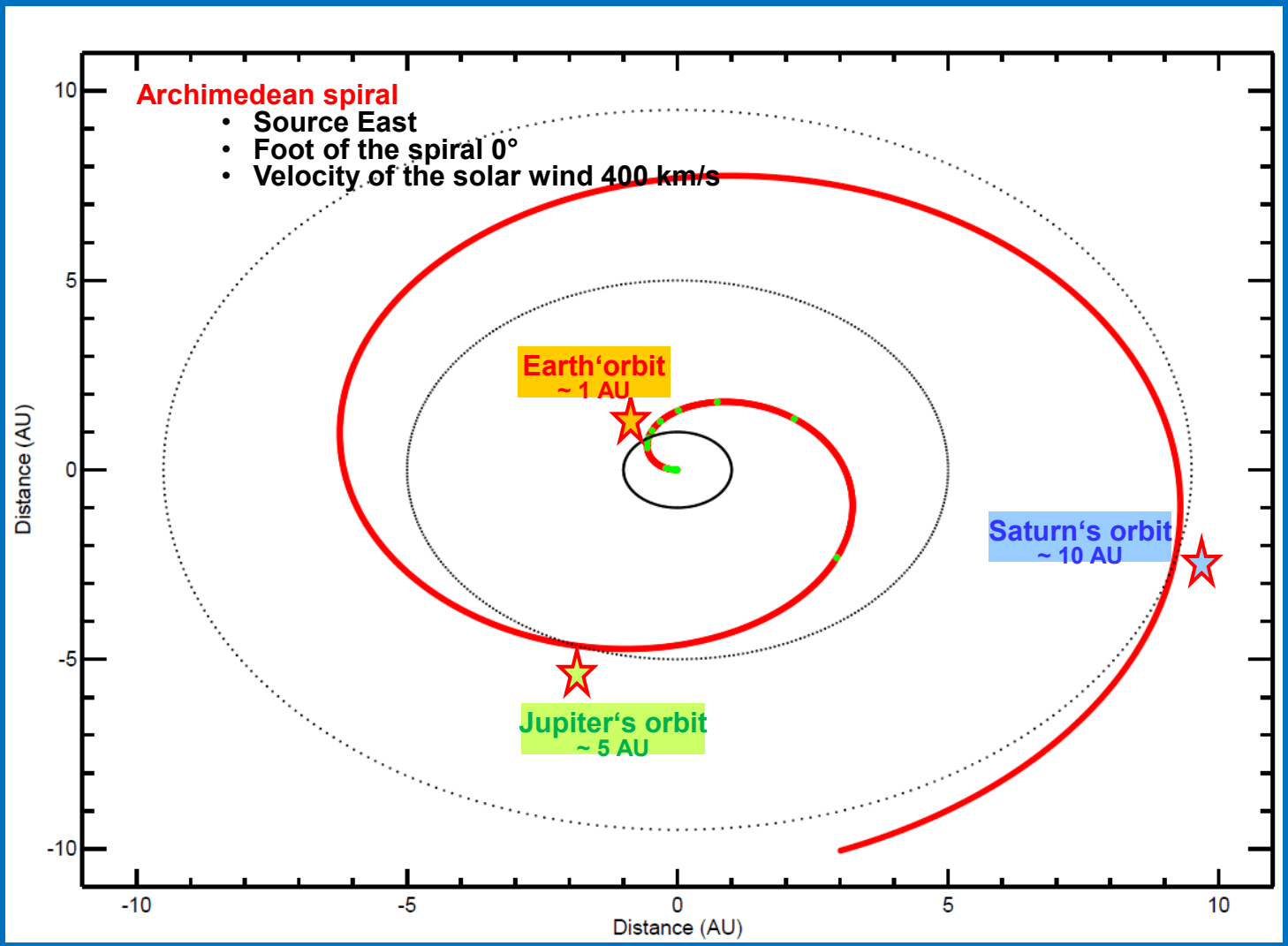

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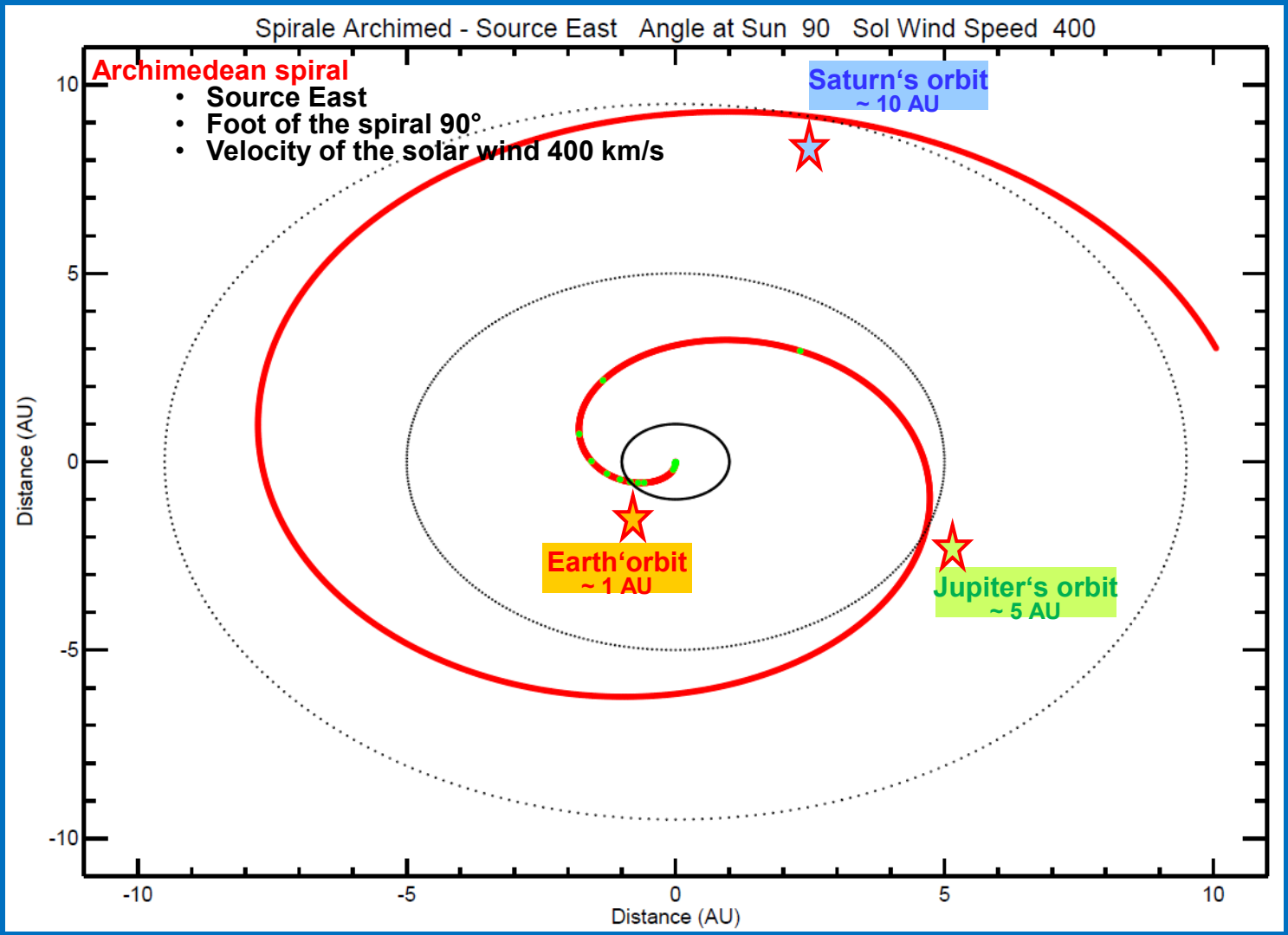

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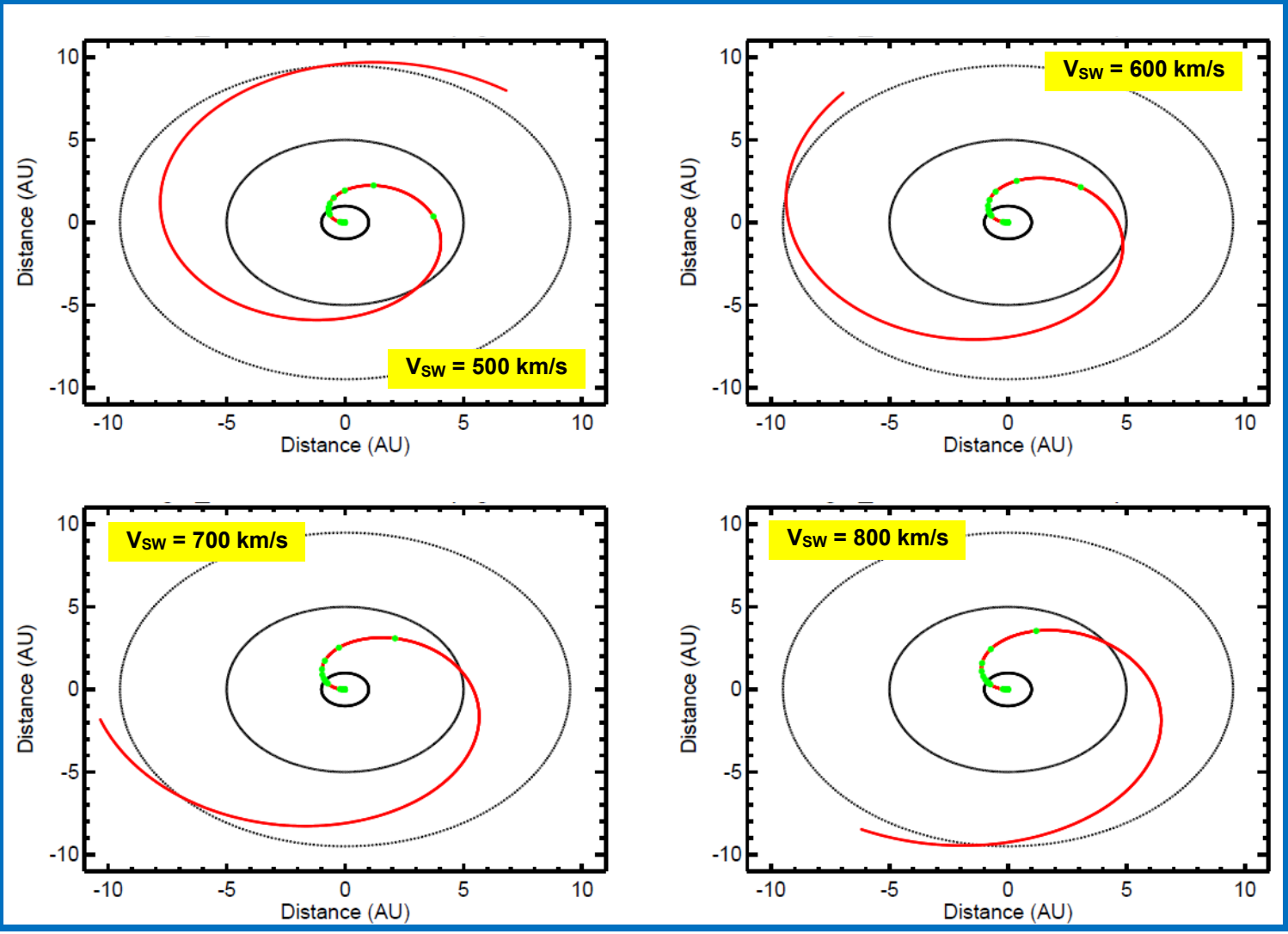
Source East – Foot of spiral 0°



Summary

- More than 1000 bursts were detected by this instrument in the period from 2004 to 2017
- The occurrence is found to be correlated to sunspot and solar radio flux at 10.7 cm
- The main Type III radio bursts are generated in the interplanetary medium
- We have used the Archimedean spiral and the empirical model of Bougeret et al. to derive the evolution of the spiral from the Sun and up to the Saturn orbit
- The source seems to be located on both sides (Easter and Wester sides)
- The velocity of the solar wind is important, around 700 km/s, close to the maximum of solar activity