

**Type III radio bursts
observations
on 20th August 2017
and 9th September 2017
with LOFAR Bałdy
telescope**

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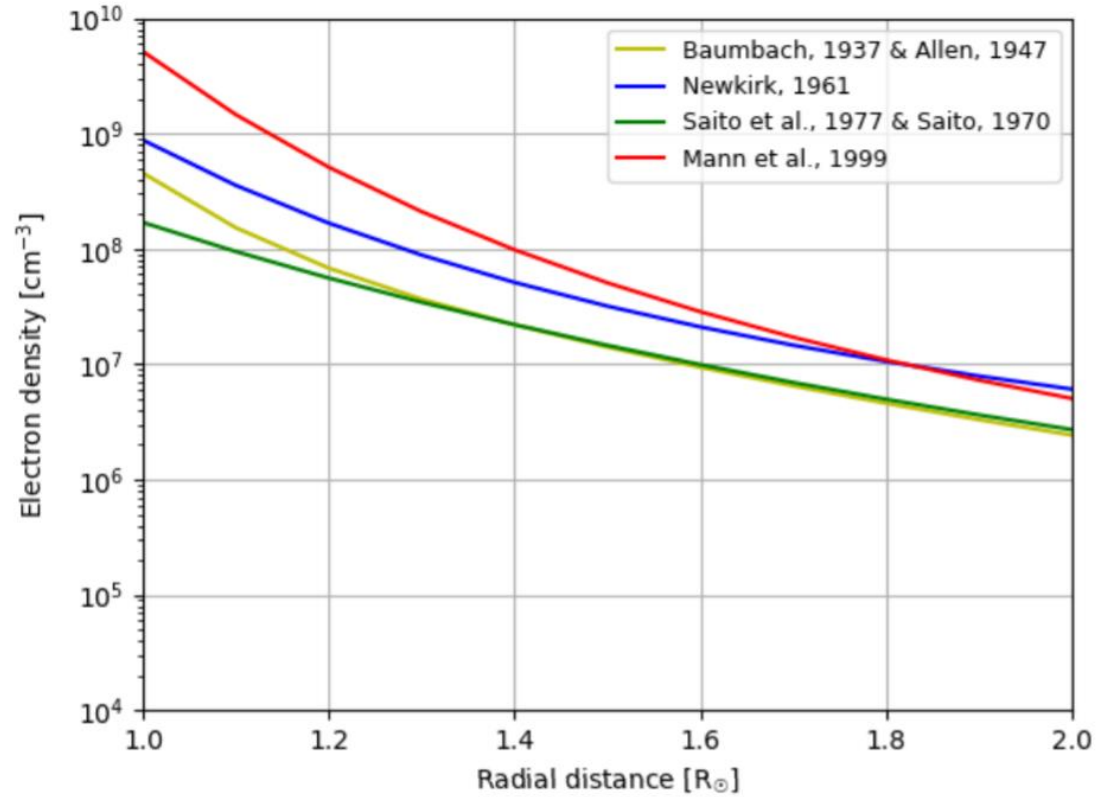
Introduction

- Observations of two type III solar radio events in single mode – LOFAR Baldy station (PL612),
- 20th August 2017 and 9th September 2017,
- Study of relationship between different wavelengths,
- Complementary observations: GOES, IRIS, SDO.

Main goals:

- determination of parameters of the type III radio bursts (drift rate, radial velocities, energy of the electrons),
- comparing them with the results obtained by other authors,
- adding more detail to already established knowledge on type III radio bursts.

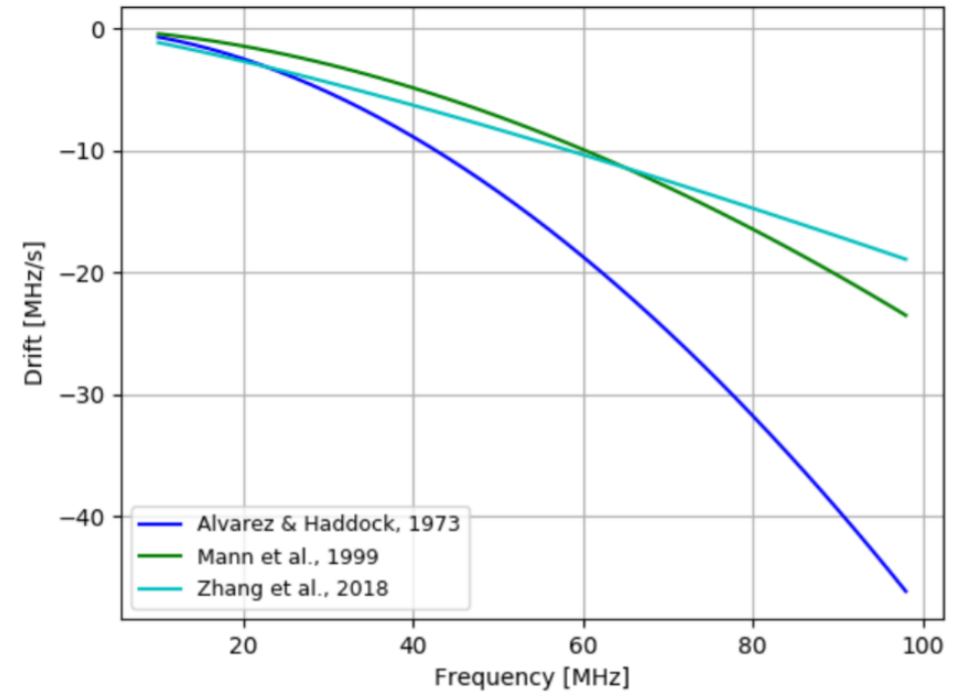
Electron density models in the solar corona



Radial velocities:

- Mann et al. (1999)
- Newkirk (1961)

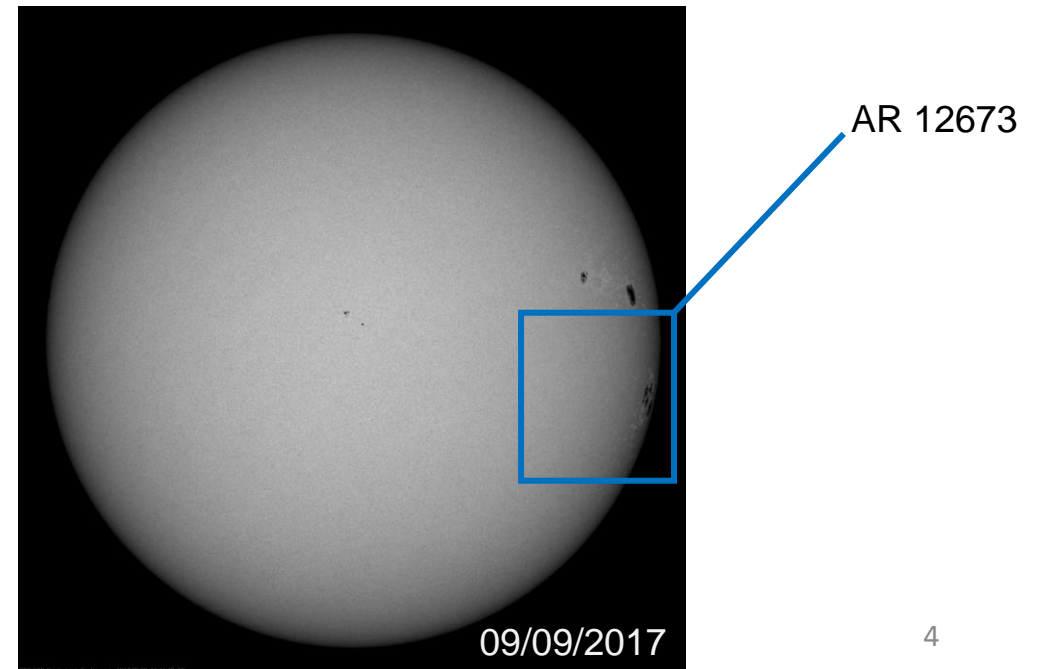
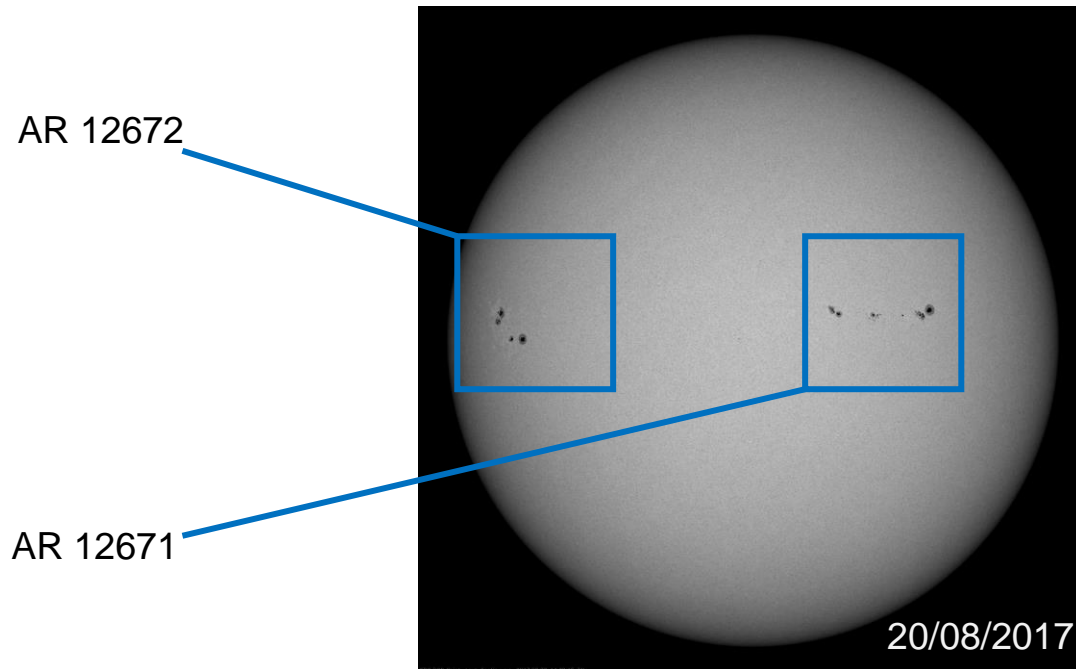
Drift rates



Drift D_f [MHz/s]	Frequency Range [MHz]	Reference
$-0.01 f^{1.84}$	0.075 – 550	Alvarez & Haddock 1973
$-0.007354 f^{1.76}$	0.04 – 85	Mann et al. 1999
$-0.0672 f^{1.23}$	10 – 80	Zhang et al. 2018

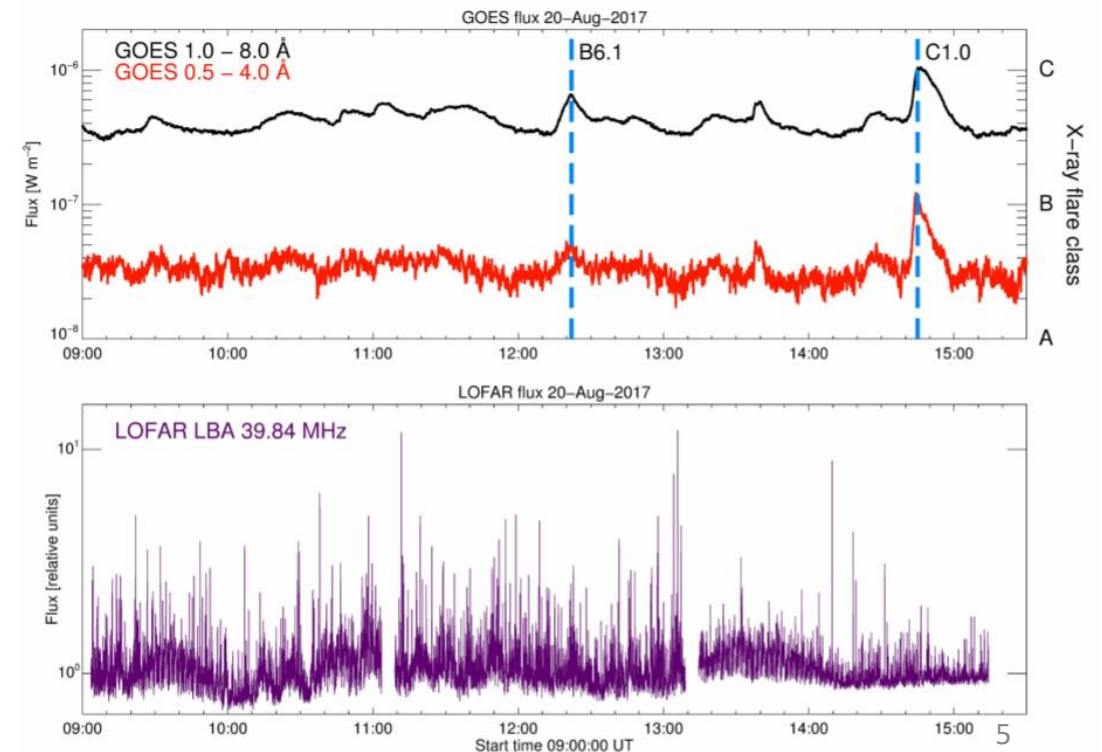
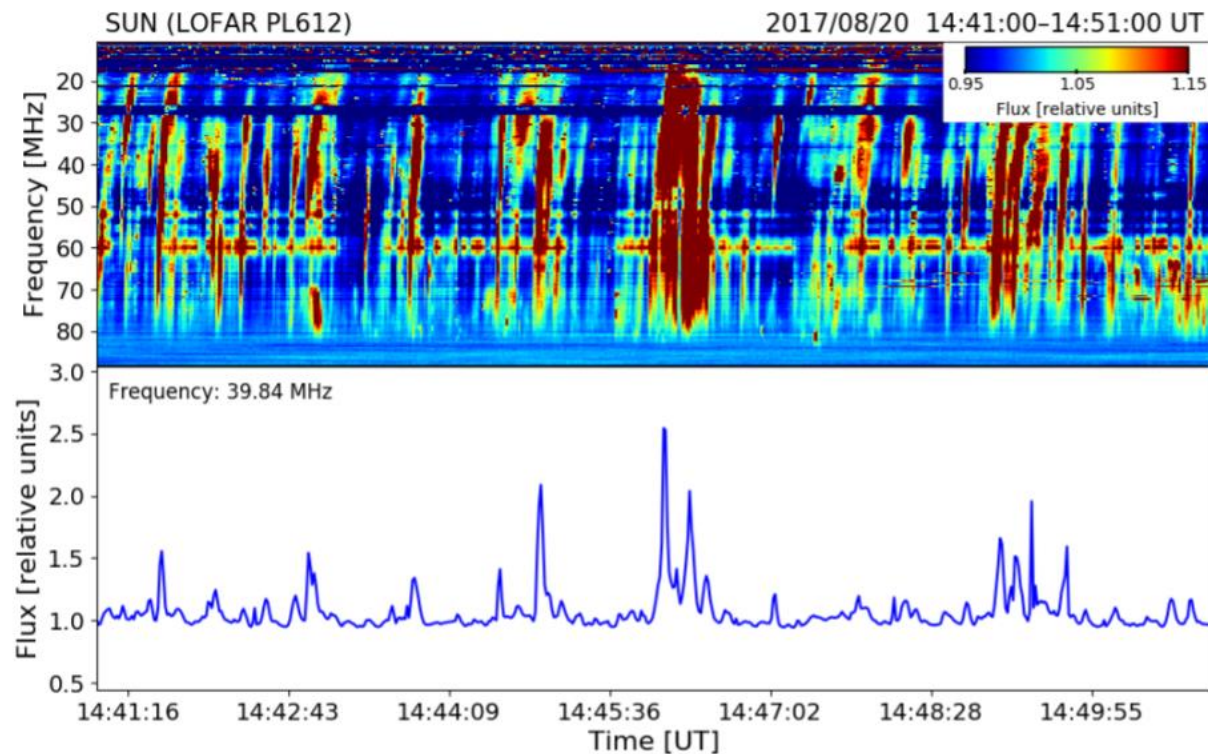
The type III radio events and GOES flares

Type III events	Flare class	Time (Start – Max – End)	NOAA AR	Location
2017-08-20 09:03:32 – 15:14:36 UT	B6.1	12:16 12:21 12:26 UT	12671	34°N 144°W
2017-08-20 09:03:32 – 15:14:36 UT	C1.0	14:40 14:45 14:52 UT	12672	75°N 945°E
2017-09-09 10:03:32 – 14:09:08 UT	M3.7	10:50 11:04 11:42 UT	12673	187°S 883°W

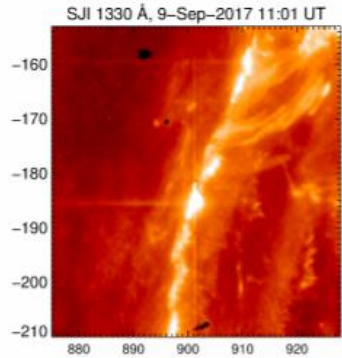


The type III radio bursts 20th August 2017

- Frequency range: 10 – 90 MHz
- Observations: LOFAR and GOES
- Flux from LOFAR at 39.84 MHz frequency has been selected as it corresponds to the middle of our frequency band

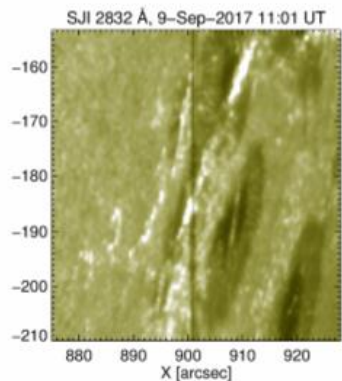
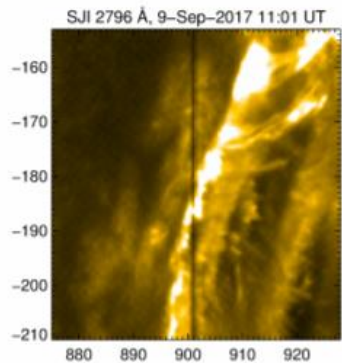


IRIS and SDO observations on 9th September 2017



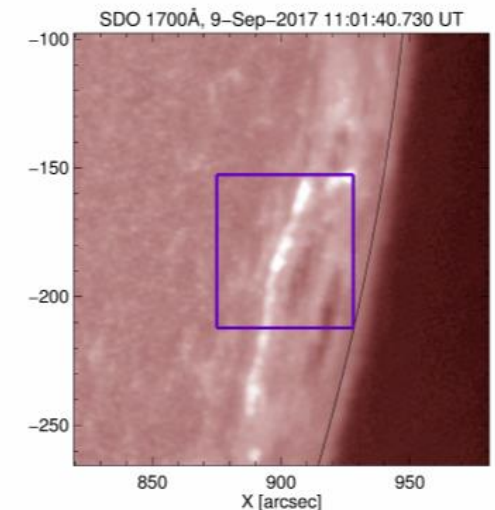
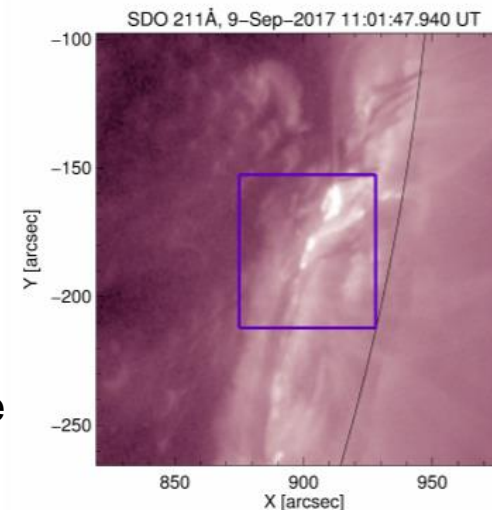
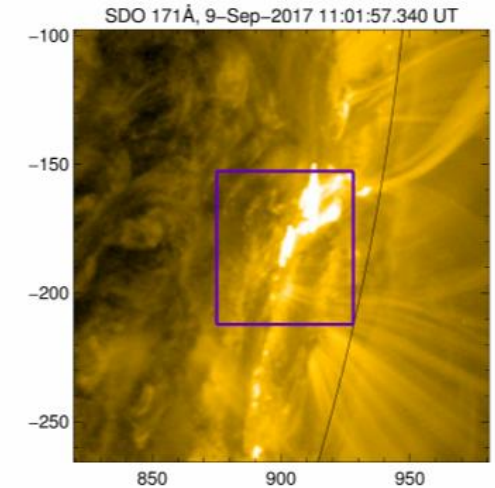
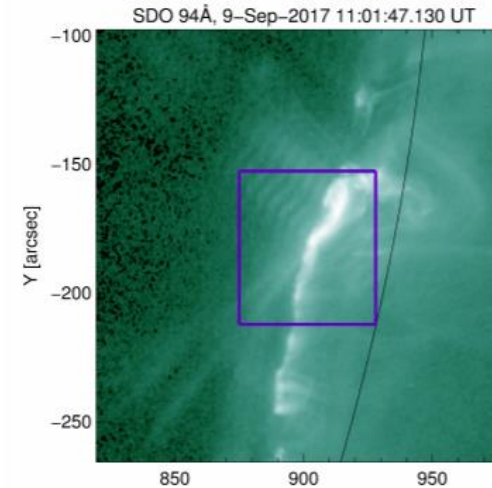
UV Slit-Jaw Images at wavelengths:

- 1330 Å (transition region),
- 2796 Å (chromosphere),
- 2832 Å (photosphere).



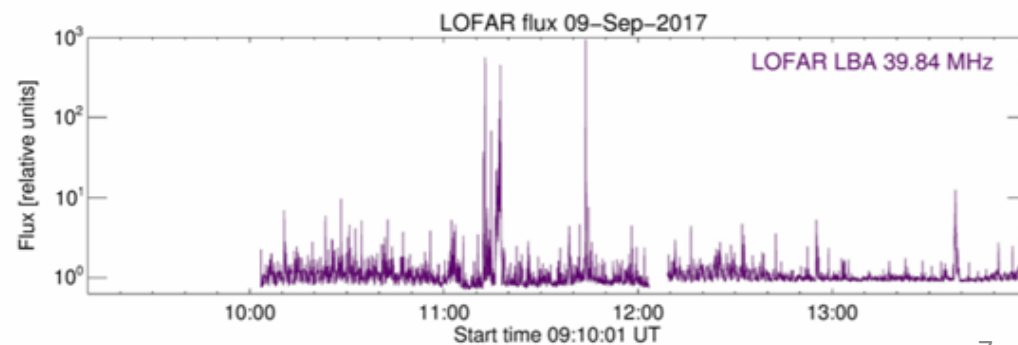
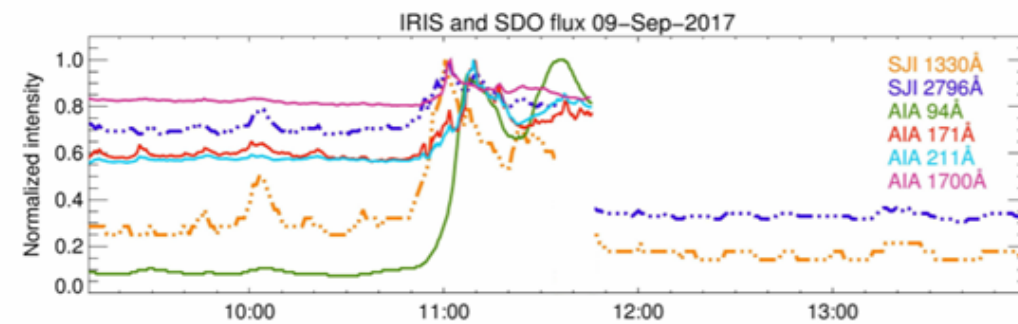
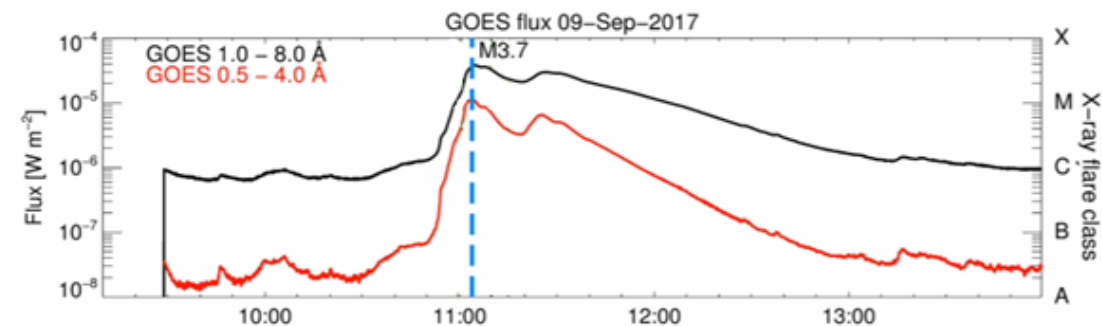
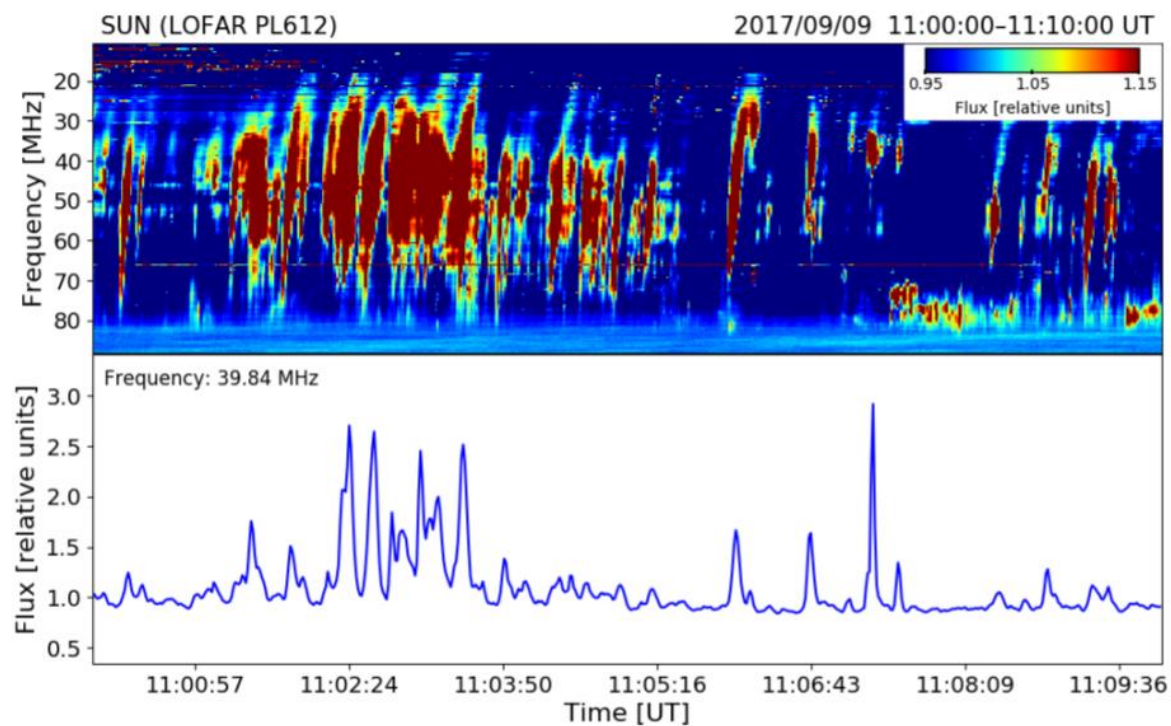
EUV images of the active region:

- 94 Å – flaring regions of the solar corona,
- 171 Å – upper transition region,
- 211 Å – active regions of the corona,
- 1700 Å – photosphere/temperature minimum region.



The type III radio bursts 9th September 2017

- Frequency range: 10 – 90 MHz
- Observations: LOFAR, GOES, IRIS and SDO



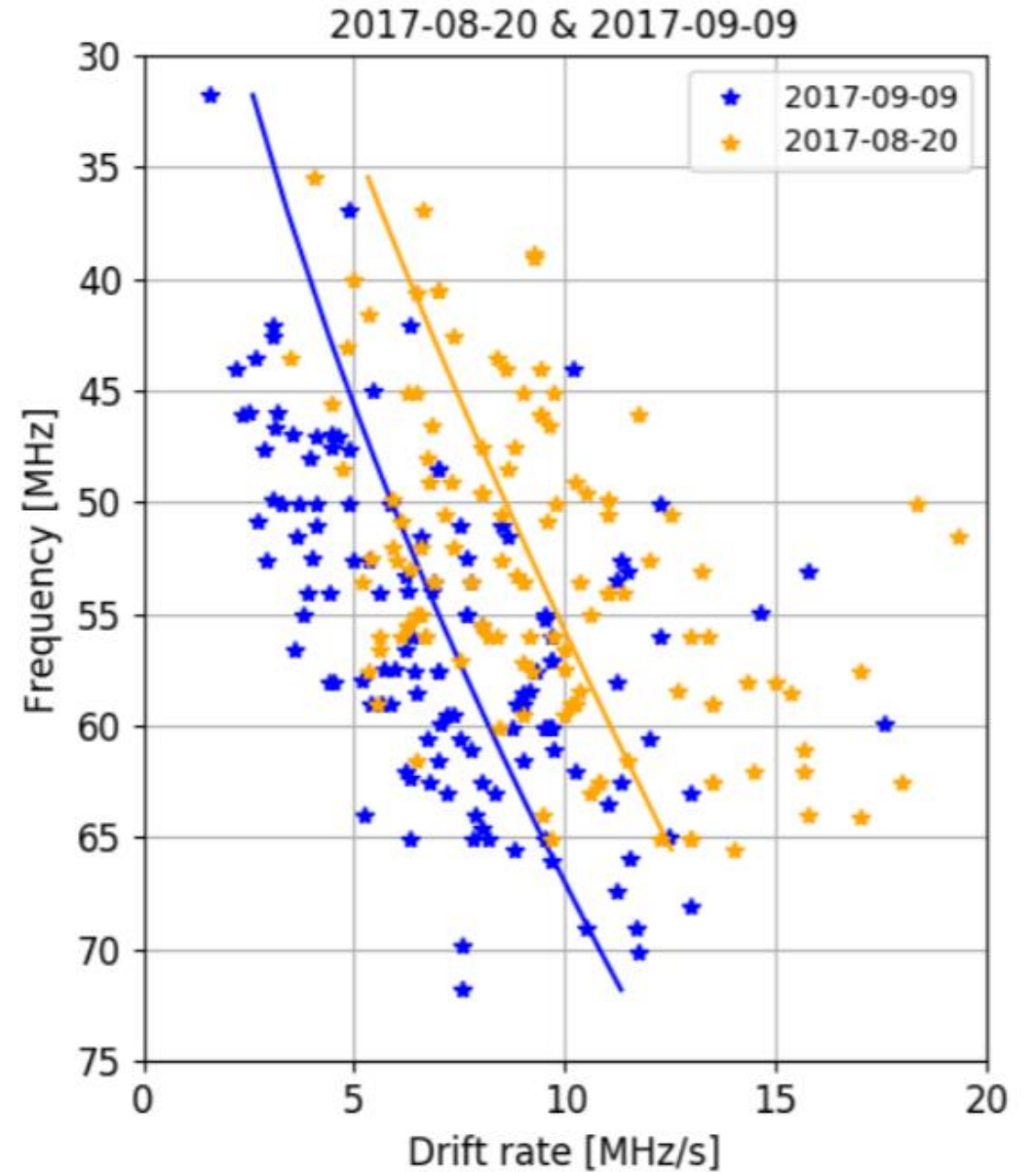
Results – drift rates

Event	Number of type III bursts	Drift (D_f) [MHz/s]	Central frequency (f) [MHz]
2017-08-20	124	-9.4	53.3
2017-09-09	131	-7.3	56.0

Obtained drift rates as a function of frequency:

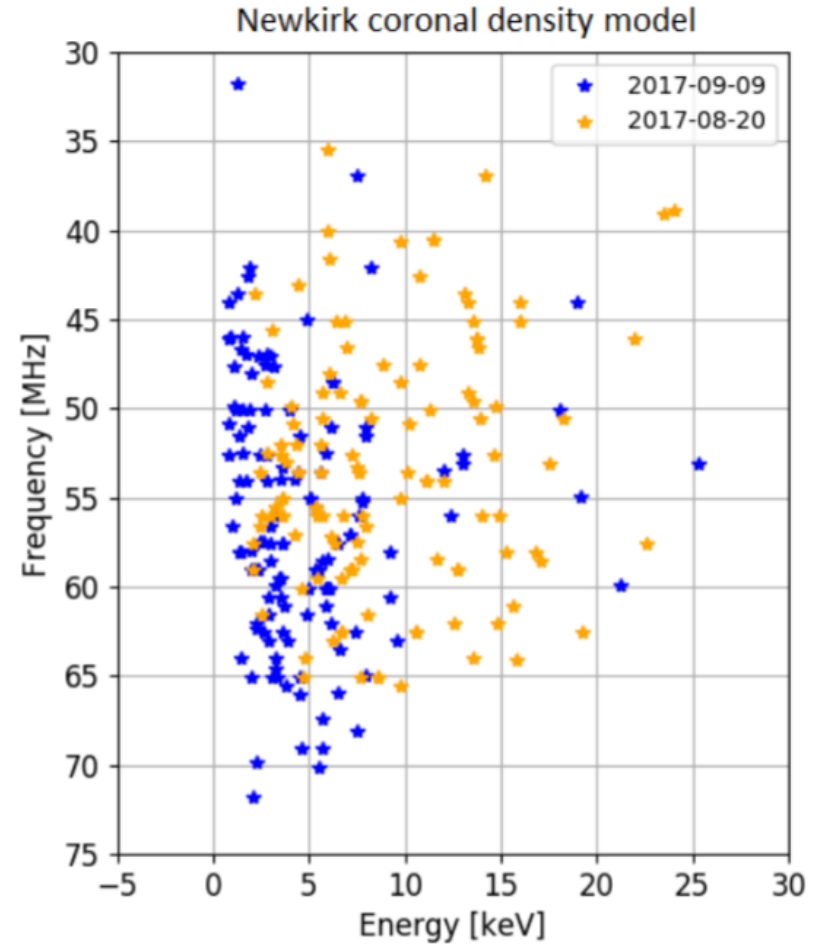
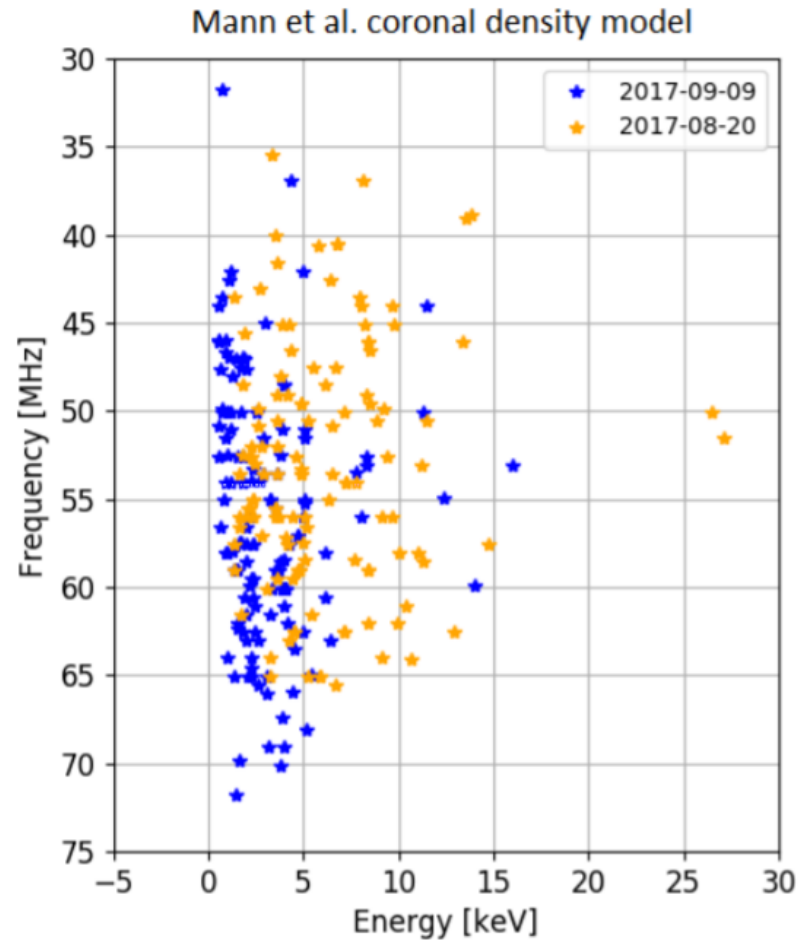
$$D_f = -0.04f^{1.39} \quad \text{for 20th August 2017}$$

$$D_f = -0.01f^{1.81} \quad \text{for 9th September 2017}$$

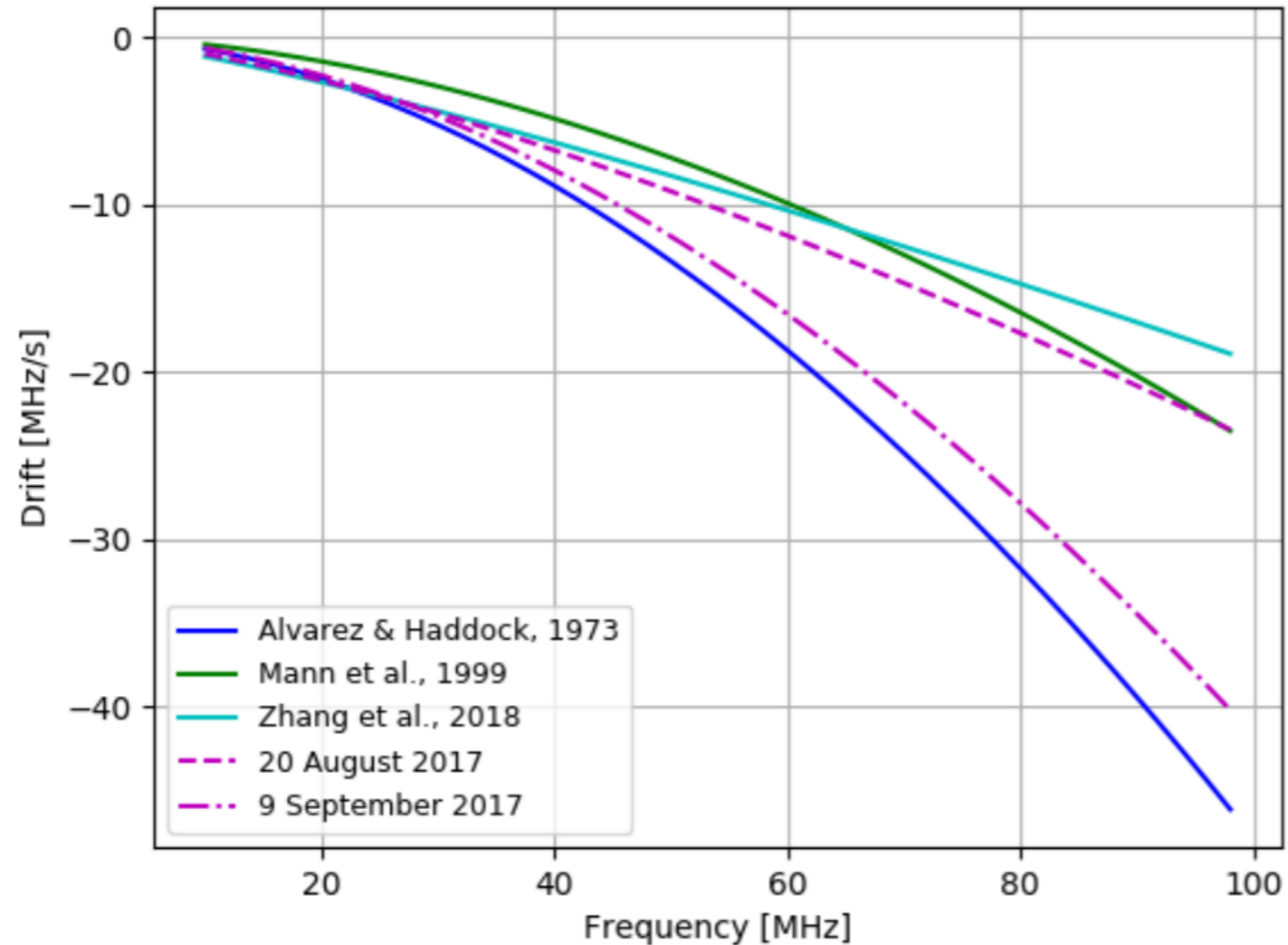


Results – energy of the electrons

Mann et al. model		Newkirk model	
V_r [km/s]	Energy [keV]	V_r [km/s]	Energy [keV]
43704 (0.15c)	6.09	54287 (0.18c)	9.55
30960 (0.10c)	3.19	38119 (0.13c)	4.83



Comparison of drift rates vs frequency by different authors



Conclusions

- Two solar radio events of type III radio bursts observed by Bałdy LOFAR station in the frequency range 10 – 90 MHz,
- Complementary observations: GOES, IRIS and SDO,
- The frequency drift rate the type III radio bursts can be described by $D_f = -0.04f^{1.39}$ (20th August 2017) and $D_f = -0.01f^{1.81}$ (9th September 2017),
- Electron beams propagate through the plasma with different density, temperature, velocity and the geometric configuration of magnetic field,
- No increase in the number of individual radio bursts was observed during the M3.7 solar flare (9th September 2017),
- Comparison of radio fluxes the X-ray and UV fluxes,
- There were not any correlation for event 20th August 2017.

Funding

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