

e-CALLISTO Solar Radio Spectrometer Network
Solar Radio Burst Catalog
Burst Images Provided by Christian Monstein

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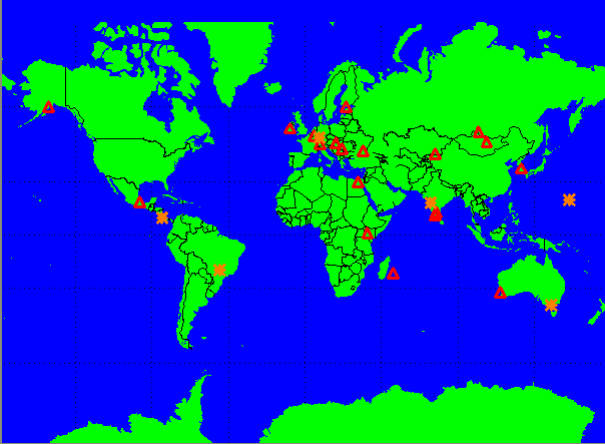
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e-CALLISTO

- e-CALLISTO Solar Spectrometer Network:
 - extended-Compound Astronomical Low-cost Low-frequency Instrument for Spectroscopy and Transportable Observatory

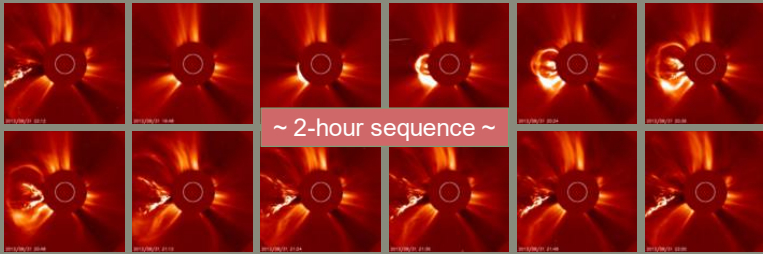


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Solar Radio Bursts

- Solar radio emissions have three distinct components
 - ☼ Quiet Sun
 - ☼ Bright regions
 - ☼ Transient disturbances usually related to flares



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Solar Radio Bursts

- **Transient disturbances = Radio bursts**
 - ☀ Radio bursts originate from all levels of the solar atmosphere
 - Between the lower chromosphere and outer corona to heights of several solar radii
 - ☀ Descriptions of the chromosphere and corona:
 - <http://en.wikipedia.org/wiki/Chromosphere>
 - <http://en.wikipedia.org/wiki/Corona>

Solar Radio Bursts

- **Solar Bursts Classification**
 - ☀ Classified on basis of frequency and time characteristics
 - ☀ Seven types: Type I through Type VII
 - Types I through Type V are basic types
 - Types VI and VII are extensions of Type III and Type V
- **References**
 - <http://www.jps.gov.au/Category/World%20Data%20Centre/Data%20Display%20and%20Download/Spectrograph/Solar%20Radio%20Burst%20Classifications.pdf>
 - <http://www.swpc.noaa.gov/ftpdir/indices/events/README>

Solar Radio Bursts

• Solar Bursts Classification

Type	Characteristics	Duration	Frequency Range (MHz)	Associated Phenomena
I	Short, intense, narrow-bandwidth bursts. Usually occur in large numbers with underlying low-intensity continuum	Single: ~1 s Storm: hours–days	30 – 400	Active regions, flares, eruptive prominences

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Solar Radio Bursts

• Solar Bursts Classification

Type	Characteristics	Duration	Frequency Range (MHz)	Associated Phenomena
II	Slow frequency drift bursts. Usually accompanied by a second harmonic	3 – 30 min	Fundamental: 20 – 150	Flares, proton emission, magneto-hydrodynamic shockwaves

Type II bursts have drift rates of about 250 kHz/s

Resulting from shockwaves moving through solar plasma

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Solar Radio Bursts

• Solar Bursts Classification

Type	Characteristics	Duration	Frequency Range (MHz)	Associated Phenomena
III	Fast frequency drift bursts. Can occur singularly, in groups, or storms often with underlying continuum. Can be accompanied by a second harmonic	Single: 1 – 3 s Group: 1 – 5 min Storm: minutes – hours	0.01 – 1000	Active regions, flares

Type III bursts are most common type and have sweep or drift rates in the HF range of 1 ~ 10 MHz per second and in VHF and UHF range of 75 ~ 700 MHz per second

Resulting from electron beams in flare region

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Solar Radio Bursts

• Solar Bursts Classification

Type	Characteristics	Duration	Frequency Range (MHz)	Associated Phenomena
IV	Stationary Type IV: Broadband continuum with fine structure	Hours – days	20 – 2000	Flares, proton emission
	Moving Type IV: Broadband, slow frequency drift, smooth continuum	0.5 – 2 hours	20 – 400	Eruptive prominences, magneto-hydrodynamic shockwaves
	Flare Continua: Broadband, smooth continuum	3 – 45 min	10 – 200	Flares, proton emission

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Solar Radio Bursts

• Solar Bursts Classification

Type	Characteristics	Duration	Frequency Range (MHz)	Associated Phenomena
V	Smooth, short-lived continuum. Follows some type III bursts. Never occurs in isolation	1 – 3 min	10 – 200	Same as type III bursts

Solar Radio Bursts

• Solar Bursts Classification

Type	Characteristics	Duration	Frequency Range (MHz)	Associated Phenomena
VI	Series of Type III bursts over a period of 10 minutes or more, with no period longer than 30 minutes without activity	> 10 min	See Type III	See Type III

Solar Radio Bursts

• Solar Bursts Classification

Type	Characteristics	Duration	Frequency Range (MHz)	Associated Phenomena
VII	Series of Type III and Type V bursts over a period of 10 minutes or more, with no period longer than 30 minutes without activity	> 10 min	See Type III and Type V	See Type III and Type V

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Solar Radio Bursts

• Type I

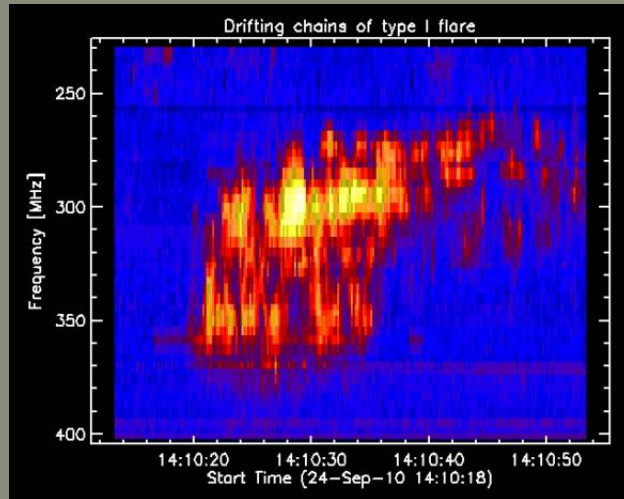
Type	Characteristics	Duration	Frequency Range (MHz)	Associated Phenomena
I	Short, intense, narrow-bandwidth bursts. Usually occur in large numbers with underlying low-intensity continuum	Single: ~1 s Storm: hours–days	30 – 400	Active regions, flares, eruptive prominences

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Solar Radio Bursts

- Type I
 - ☀ Bleien, Switzerland
 - ☀ 7 m dish antenna



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Solar Radio Bursts

- Type II

Type	Characteristics	Duration	Frequency Range (MHz)	Associated Phenomena
II	Slow frequency drift bursts. Usually accompanied by a second harmonic	3 – 30 min	Fundamental: 20 – 150	Flares, proton emission, magneto-hydrodynamic shockwaves

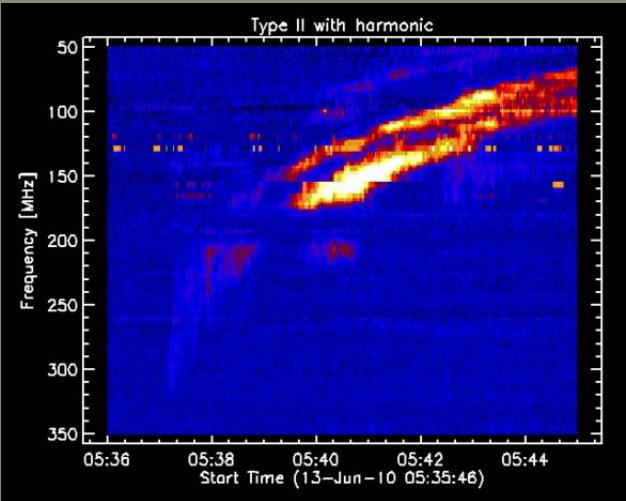
Type II bursts have drift rates of about 250 kHz/s

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Solar Radio Bursts

- Type II
 - ☀ Ooty Observatory, India
 - ☀ Log periodic dipole array

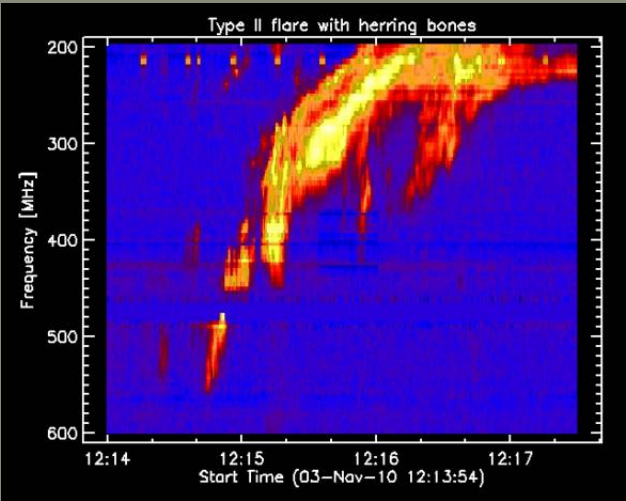


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Solar Radio Bursts

- Type II
 - ☀ Harmonics & herring-bone structures
 - ☀ Bleien, Switzerland
 - ☀ 7 m dish antenna



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Solar Radio Bursts

Type III

Type	Characteristics	Duration	Frequency Range (MHz)	Associated Phenomena
III	Fast frequency drift bursts. Can occur singularly, in groups, or storms often with underlying continuum. Can be accompanied by a second harmonic	Single: 1 – 3 s Group: 1 – 5 min Storm: minutes – hours	0.01 – 1000	Active regions, flares

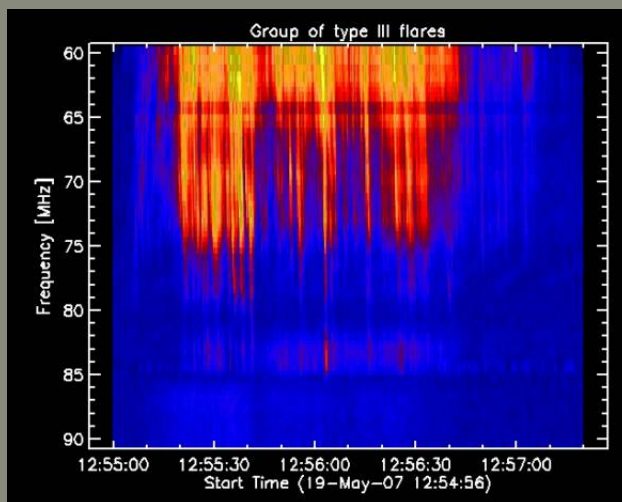
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Type III bursts are most common type and have sweep or drift rates in the HF range of 1 ~ 10 MHz per second and in VHF and UHF range of 75 ~ 700 MHz per second

Solar Radio Bursts

Type III

- ☀ Bleien, Switzerland
- ☀ 7 m dish antenna

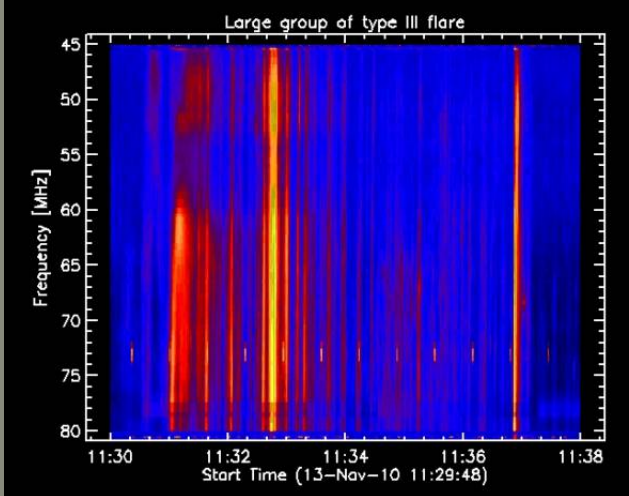


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Solar Radio Bursts

- Type III
 - ☀ Humain Observatory, Belgium
 - ☀ Log periodic dipole array

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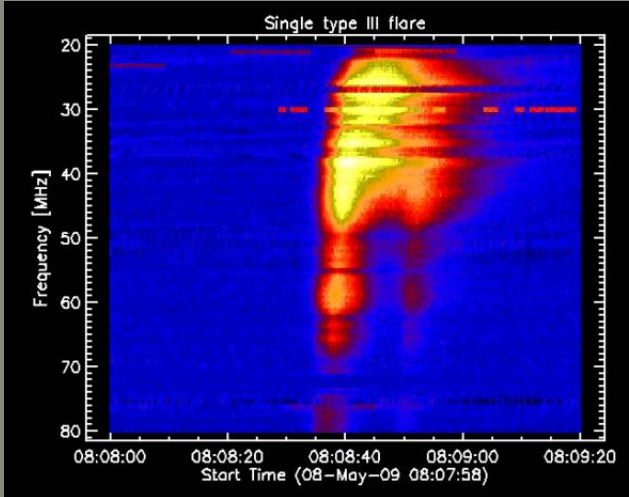


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Solar Radio Bursts

- Type III
 - ☀ Bleien, Switzerland
 - ☀ Log periodic dipole array

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Solar Radio Bursts

Type IV

Type	Characteristics	Duration	Frequency Range (MHz)	Associated Phenomena
IV	Stationary Type IV: Broadband continuum with fine structure	Hours – days	20 – 2000	Flares, proton emission
	Moving Type IV: Broadband, slow frequency drift, smooth continuum	0.5 – 2 hours	20 – 400	Eruptive prominences, magneto-hydrodynamic shockwaves
	Flare Continua: Broadband, smooth continuum	3 – 45 min	10 – 200	Flares, proton emission

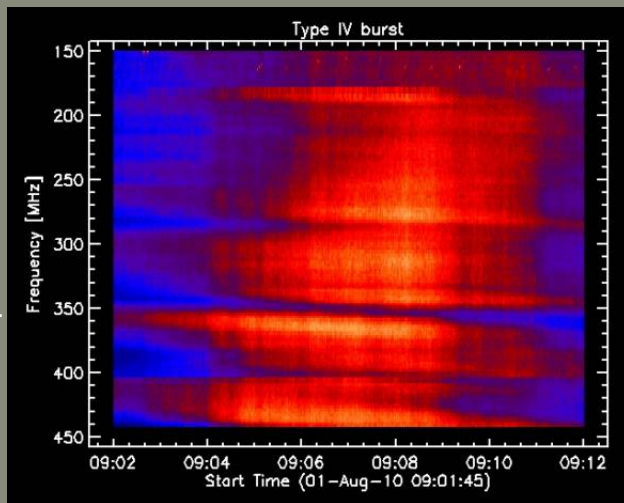
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Solar Radio Bursts

Type IV

- ☀ Badary Observatory Irkutsk, Russian Federation
- ☀ Log periodic dipole array



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Solar Radio Bursts

Type V

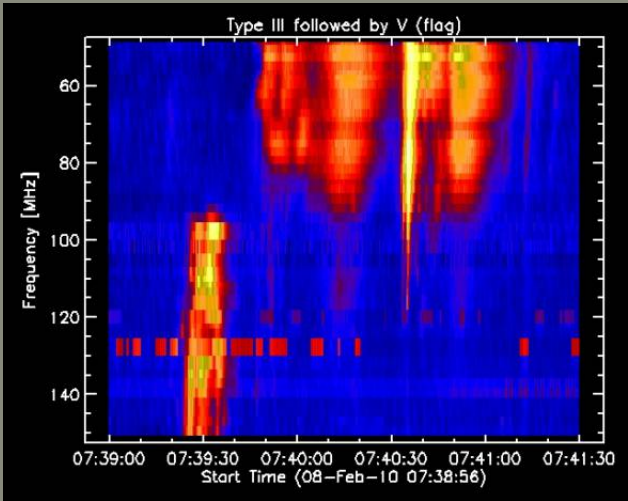
Type	Characteristics	Duration	Frequency Range (MHz)	Associated Phenomena
V	Smooth, short-lived continuum. Follows some type III bursts. Never occurs in isolation	1 – 3 min	10 – 200	Same as type III bursts

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Solar Radio Bursts

Type V

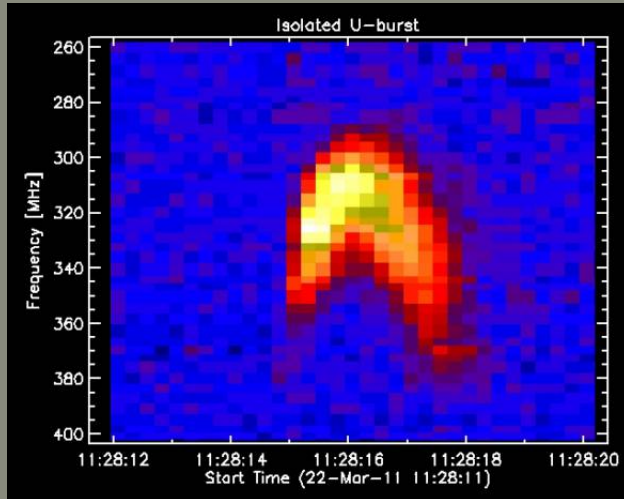
- ☀️ Ooty Observatory, India
- ☀️ Log periodic dipole array



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Solar Radio ~ Other

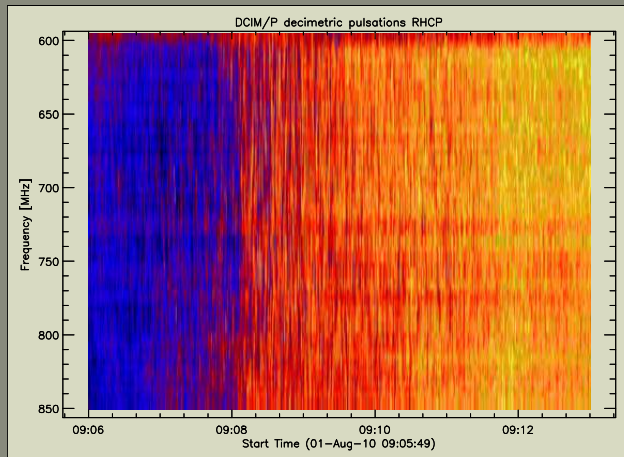
- Type U
 - ☀ Bleien, Switzerland
 - ☀ 7 m dish antenna



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Solar Radio ~ Other

- Deci-metric
 - ☀ Bleien, Switzerland
 - ☀ Log periodic dipole array

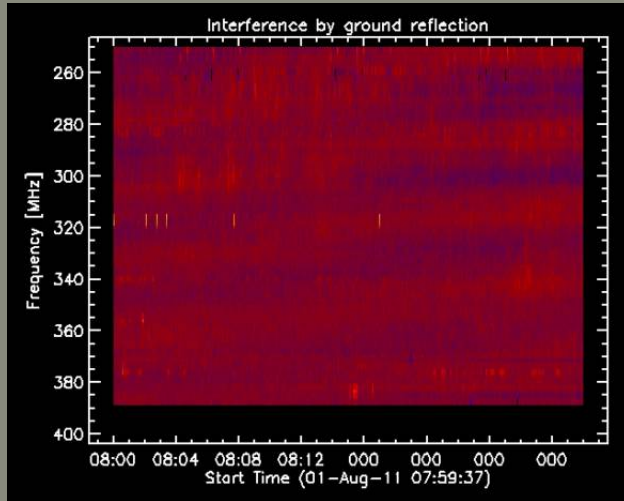


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Solar Radio ~ Other

- Ground reflection at sunrise
 - ☀️ Human Observatory, Belgium
 - ☀️ Log periodic dipole array

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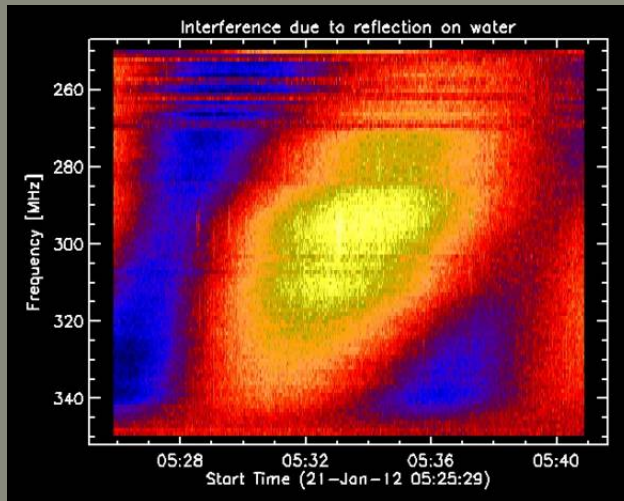


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Solar Radio ~ Other

- Ocean reflection
 - ☀️ Crimea Island, Ukraine
 - ☀️ 4x4 Yagi Array

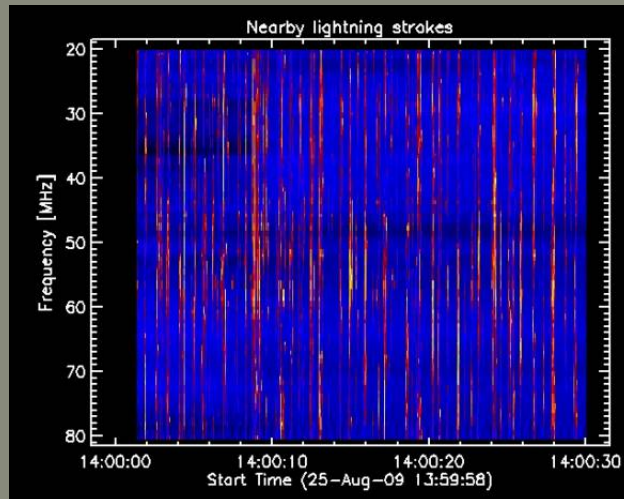
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Natural Radio

- Lightning
 - ☀ Bleien, Switzerland
 - ☀ Up-Converter
 - ☀ Log periodic dipole Array



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Conclusions

- e-CALLISTO consists of
 - ☀ Worldwide network of CALLISTO Receivers, antenna systems and data collection PCs
- Seven solar radio burst classifications
 - ☀ Type I through Type V are basic types
 - ☀ Type VI and VII are extensions of Type II and Type V
- Some bursts defy classification



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