

Observations of solar radio bursts using a high-resolution spectro-polarimeter

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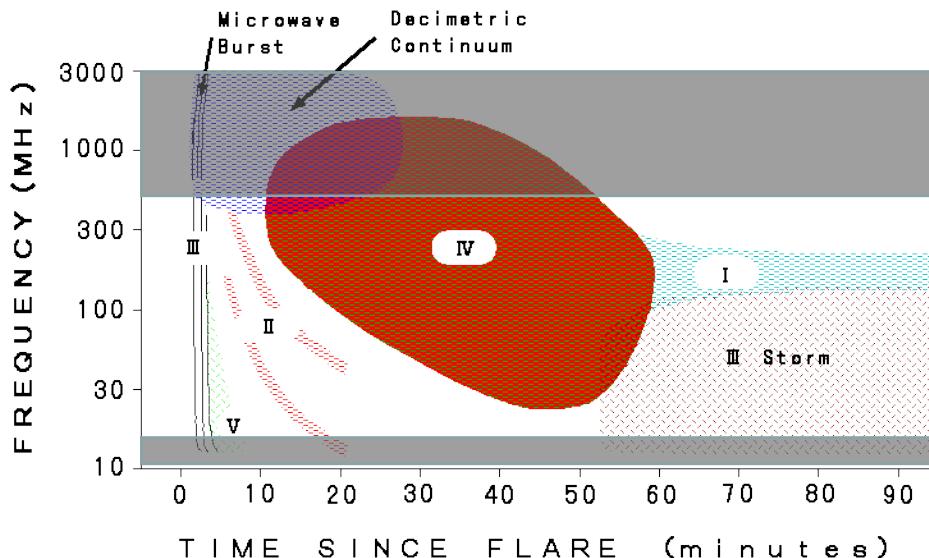
1) Planetary Plasma & Atmospheric Res. Cent., Tohoku Univ., Japan

2) Nobeyama Solar Radio Obs., Nat'l Astron. Obs., Japan

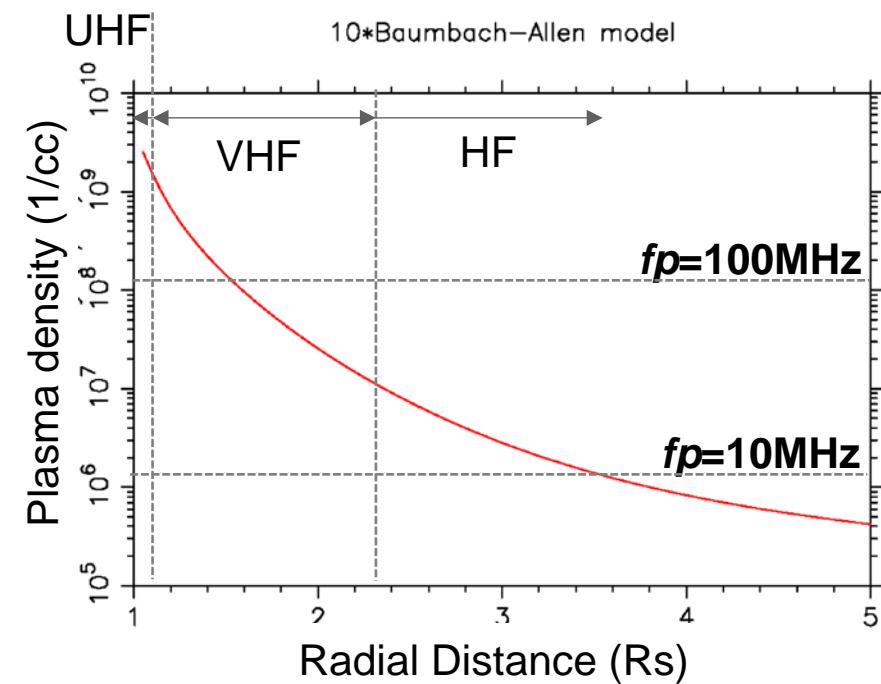
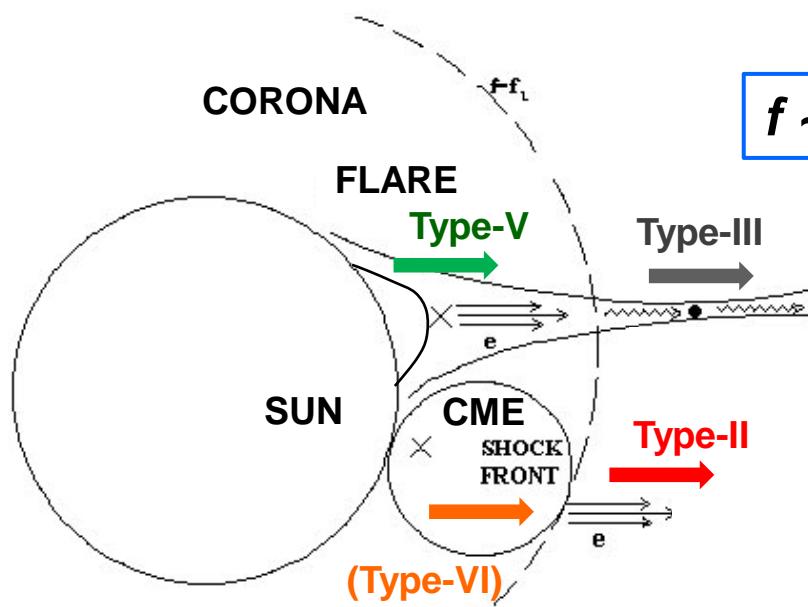
3) Graduate School of Science, Tohoku Univ.

4) Accenture Japan Ltd

Solar Radio Bursts in HF – low UHF band



(<http://sunbase.nict.go.jp/solar/denpa/hiras/gif/typefignew.gif>)



(adapted from http://alexeynik.com/images/solar_flare.jpg)

[Want / Aim] Our interest ex. SEP & Solar Radio Bursts (Type-II)

Table. Relations between SEP & solar Type-II bursts (1994-2007)
(after Gopalswamy+, 2008)

Type II	All	No SEP	HiB	<1 pfu	≥ 1 pfu	SEP Rate ^c
yY Events	165	53	30	7	75	61% (56%)
nY Events	69	25	17	5	22	52% (42%)
yN Events	26	16	3	4	3	30% (13%)
nN Events ^a	193	144	35	5	9	9% (6%)

Metric Type-II

Deca~Hectometric Type-II

Wide band Type-II bursts correlate more closely with SEP.



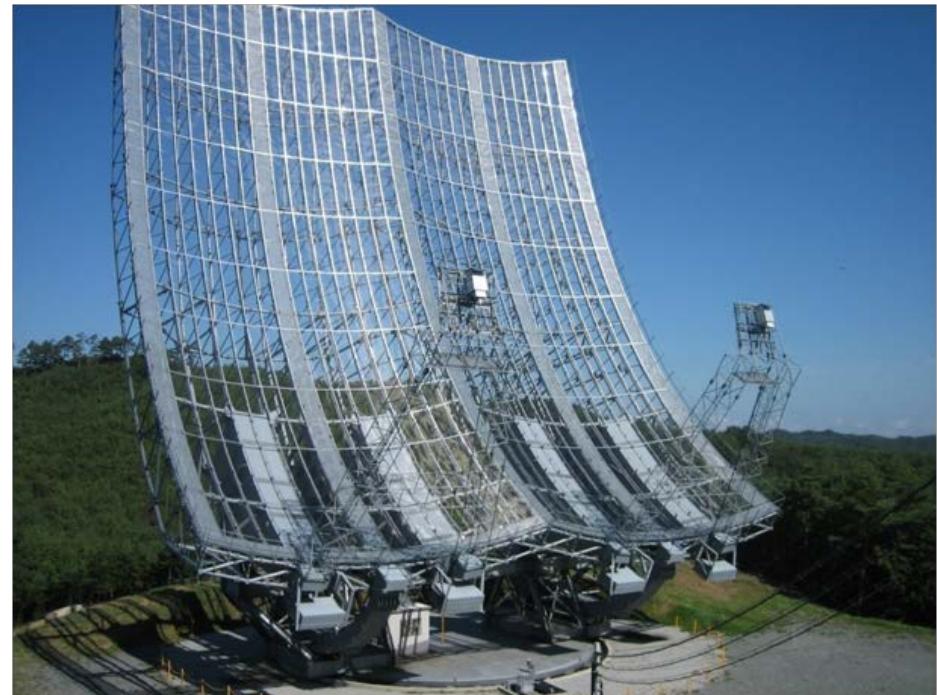
Fast identification of wide band Type II bursts is effective for early warning for SEP events.



Importance of wide band radio receiving system → [Seed]

[Seed] Solar Radio Obs. in Tohoku U.

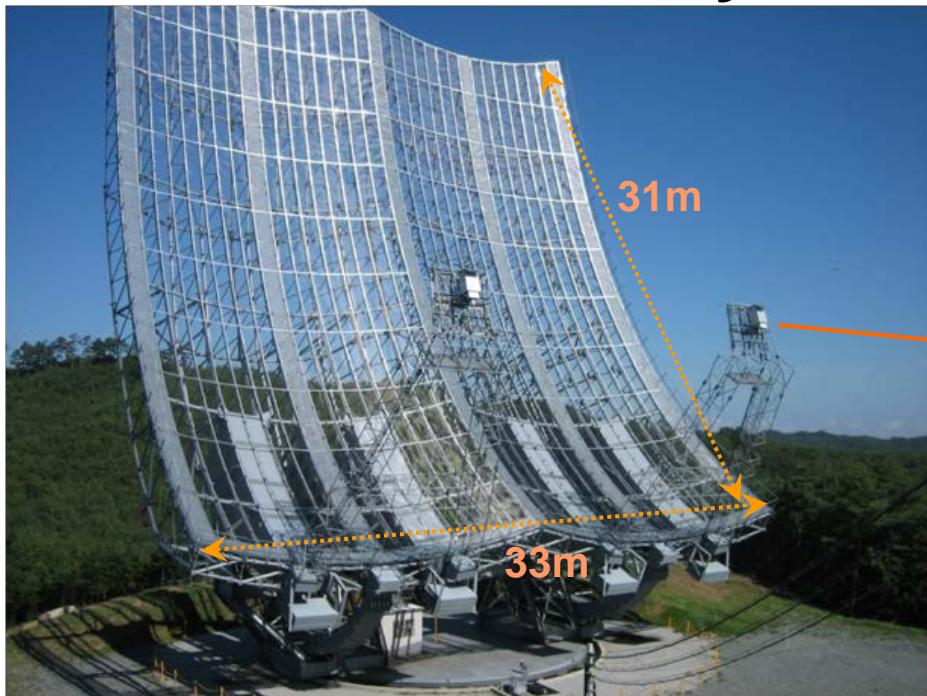
- July, 2001 Establishment of UHF band 1000m² radio telescope (IPRT: Iitate Planet. Radio Telescope) in Fukushima, Japan



- Oct. 2010~ : Start of VHF~UHF band observation of solar radio spectra using a new system named “AMATERAS” @150~500MHz
- Mar., 2011 : Occurrence of the Great East Japan Earthquake → Survived.
- Sept., 2014~ : Start of test observation of HF~VHF band observation of solar radio spectra @(15)~150MHz in Miyagi

[Seed-1] IPRT/AMATERAS

• IPRT (Iitate Planetary Radio Telescope)



- Feeder: Crossed dipoles with a flat reflector

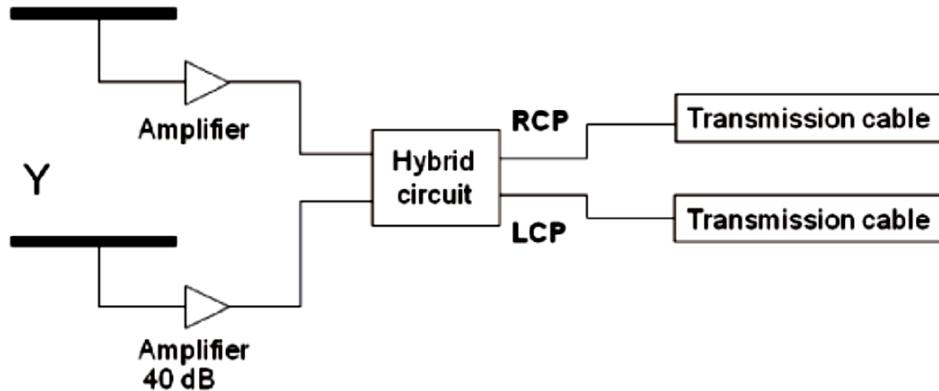


Antenna type	Offset square parabolas
Phys. aperture	1023 m²
Mount	Alt. - Az.
Directional accuracy	<0.1°
Reflector	20mm mesh (freq. < L-band)

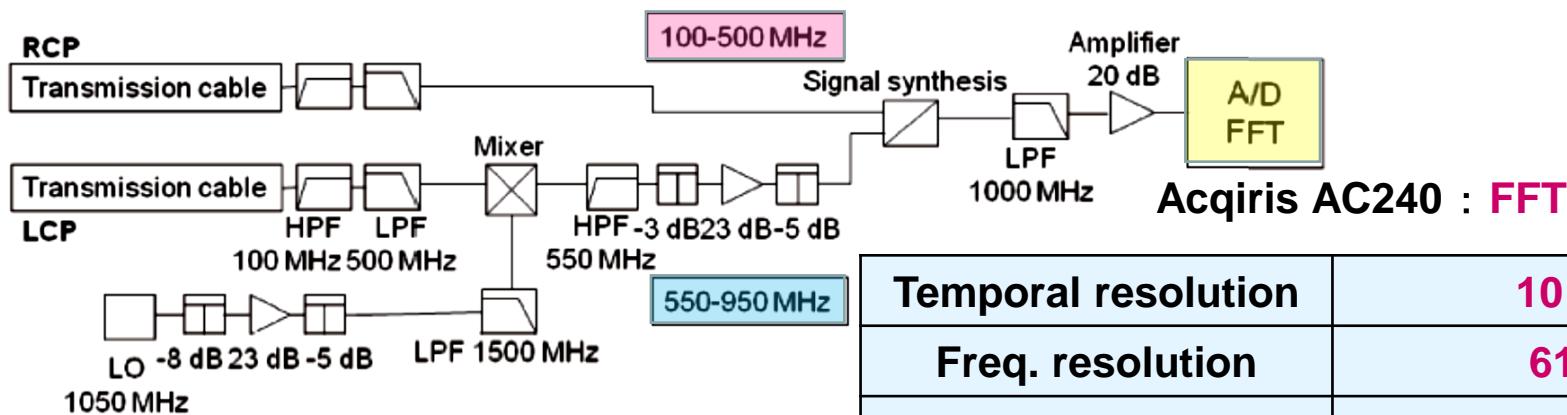
[Seed-1] IPRT/AMATERAS (VHF~UHF band) ⁶

▪ AMATERAS (the Assembly of Metric-band Aperture TElescope and Real-time Analysis System)

X



Y



(after Iwai et al., 2012)

Temporal resolution	10 msec
Freq. resolution	61 KHz
Freq. band	150~500 MHz ($\sim 0.4R_s$)
Polarization	RH & LH (simultaneous)
Min. detectable flux	<0.7 SFU

[Seed-1] IPRT/AMATERAS: Data base

IPRT DATA CENTER - Windows Internet Explorer

<http://pparc.gp.tohoku.ac.jp/data/iprt/>

Welcome to the IPRT DATA CENTER

What is IPRT and AMATERAS ?

IPRT is a ground-based radio telescope developed by Tohoku observatory in Fukushima prefecture Japan since 2000. Its wide-band dynamic range is enough to observe solar radio bursts in the frequency range between 100 MHz and 500 MHz. The flux in this frequency range is less than 0.7 SFU with 10 ms resolution. Simultaneous observations for both RCP and LCP are possible.

Observation data (time and frequency resolutions are redacted) are available from links below.

[Data availability & Daily FITS files](#)

Daily quick look: [10dB range] / [22.5dB range]

High-res quick look (access restricted)

Data search (IUGONET Web page)

#See also IUGONET
 → Meta data search
 → IPRT
 → Solar radio data in VHF

IPRT wide-band dynamic spectrum QL plot - Windows Internet Explorer

http://iprt.gp.tohoku.ac.jp/sun ql/ql_iprt_sun.php

IPRT Wideband Dynamic Spectrum QL Form

Date 2011/09/07 Incr. non Execute Back to Home

IPRT/AMATERAS LCP Solar Radio Spectra 2011/09/07

TIME UT

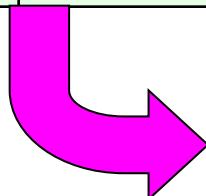
IPRT/AMATERAS RCP Solar Radio Spectra 2011/09/07

TIME UT

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[Seed-1] IPRT/AMATERAS: Data base

Data name	Low resolution	High resolution
Temporal resolution	1 sec	10 msec
Frequency resolution	1 MHz	61 kHz
Dynamic range	8 bit (log)	8 or 16bit (log)
Data size	1.5 MB/h	4.6 or 9.2 GB/h
Data format	FITS	Binary (→ FITS)
Availability	Download from the web	Contact to Tohoku U.



Welcome to the IPRT DATA CENTER

What is IPRT and AMATERAS ?

IPRT is a ground-based radio telescope developed by Tohoku University. IPRT has been developed at the Iitate observatory in Fukushima prefecture Japan since 2000. Its wideband metric radio spectro-polarimeter, **AMATERAS** (the Assembly of Metric-band Aperture TElescope and Real-time Analysis System), performs well enough to observe solar radio bursts in the frequency range between 150 and 500 MHz. The minimum detectable flux in this frequency range is less than 0.7 SFU with 10 ms accumulation time and 61 kHz bandwidth. Simultaneous observations for both RCP and LCP are possible.

Observation data (time and frequency resolutions are redacted to 1 sec and 1 MHz) and quick look plot are available from links below.

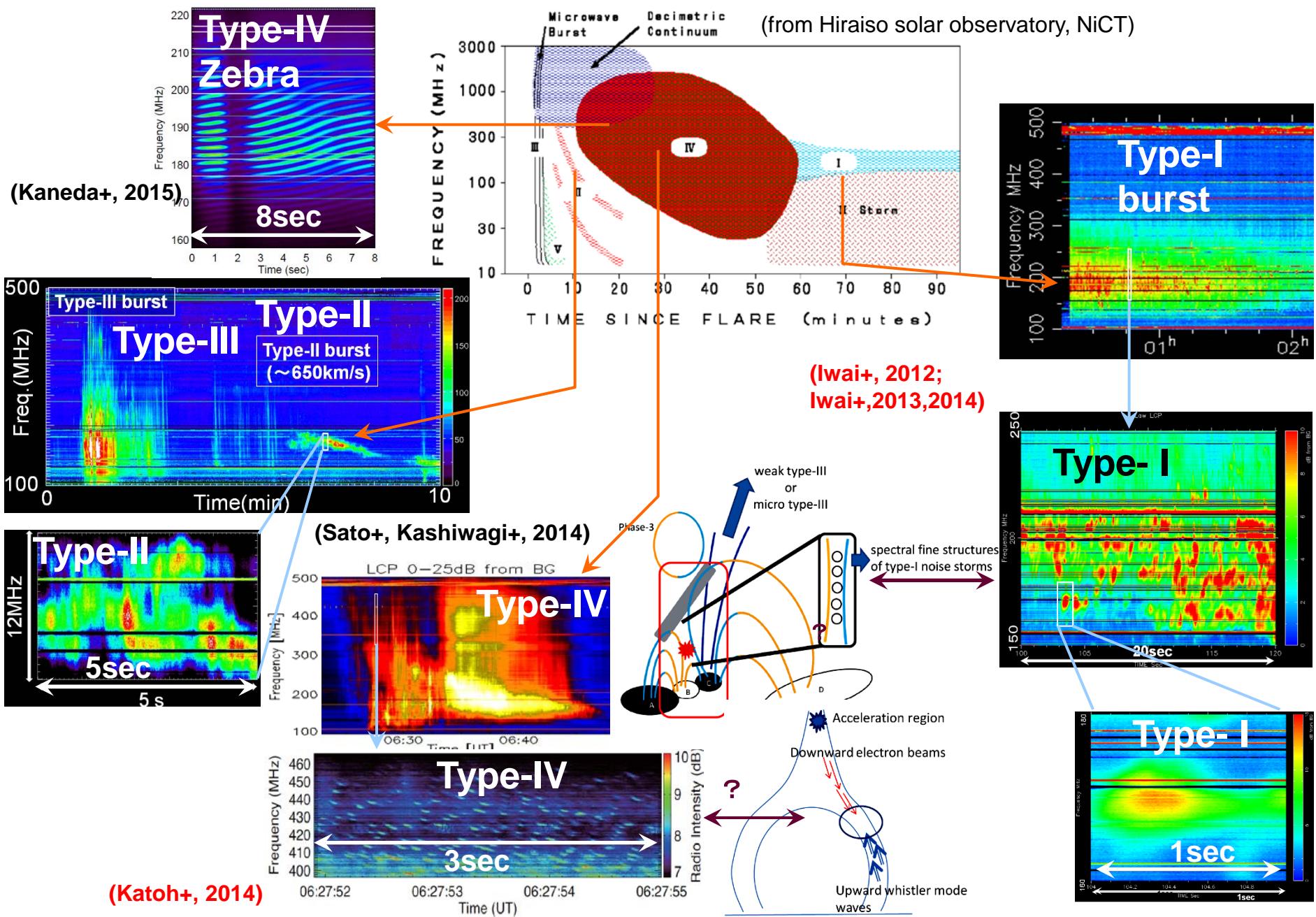
[Data availability & Daily FITS files](#)

Daily quick look:[10dB range]/[22.5dB range]

[High-res quick look](#) (access restricted)

[Data search \(IUGONET Web page\)](#)

[Seed-1] IPRT/AMATERAS: Obs. results



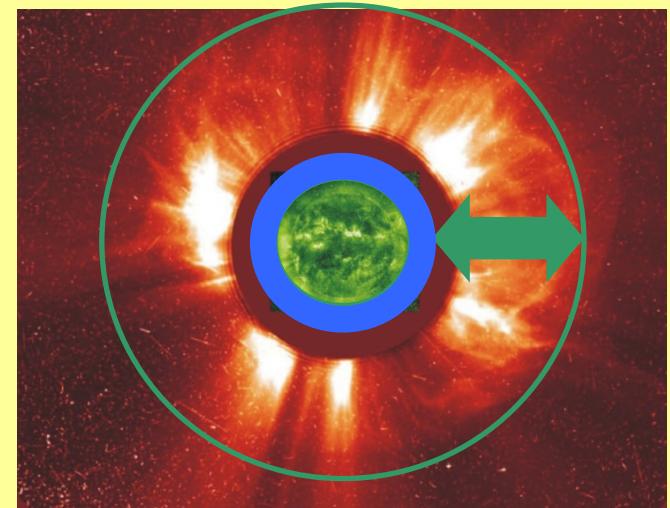
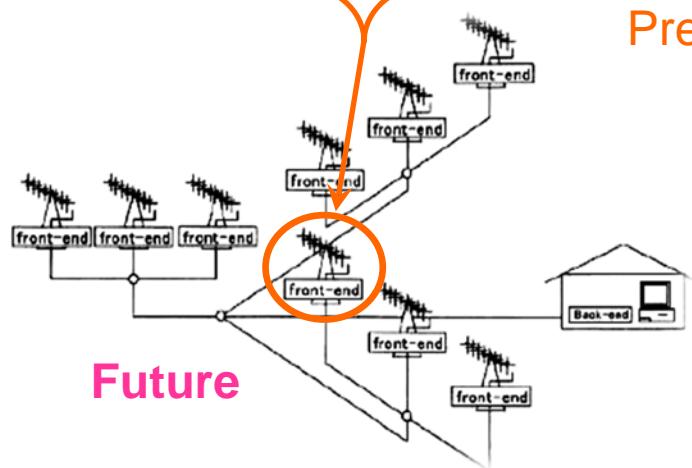
[Seed-2] new HF~VHF obs. system

•(15)~150MHz obs. by log-peri. antenna (\rightarrow future “Array”)



2014.9.8

Present

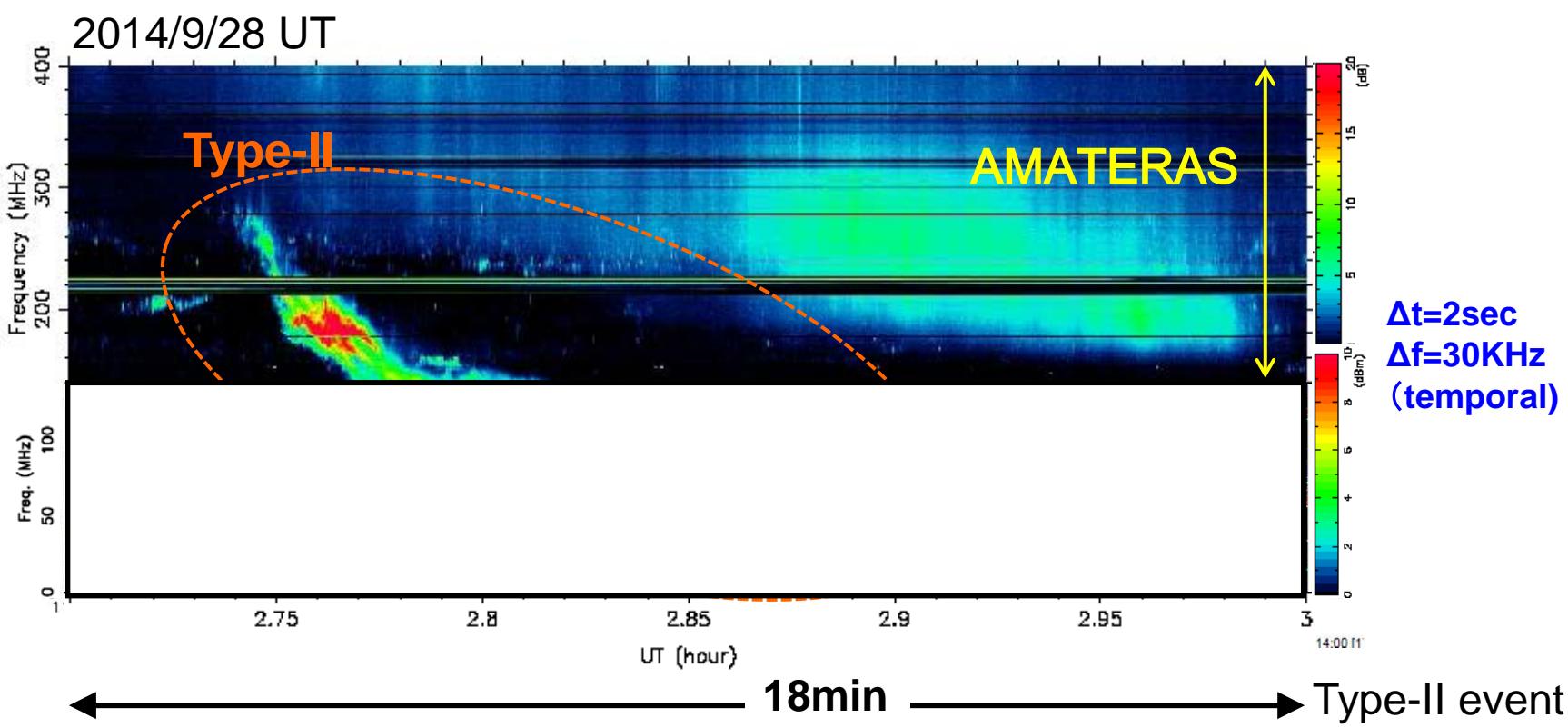
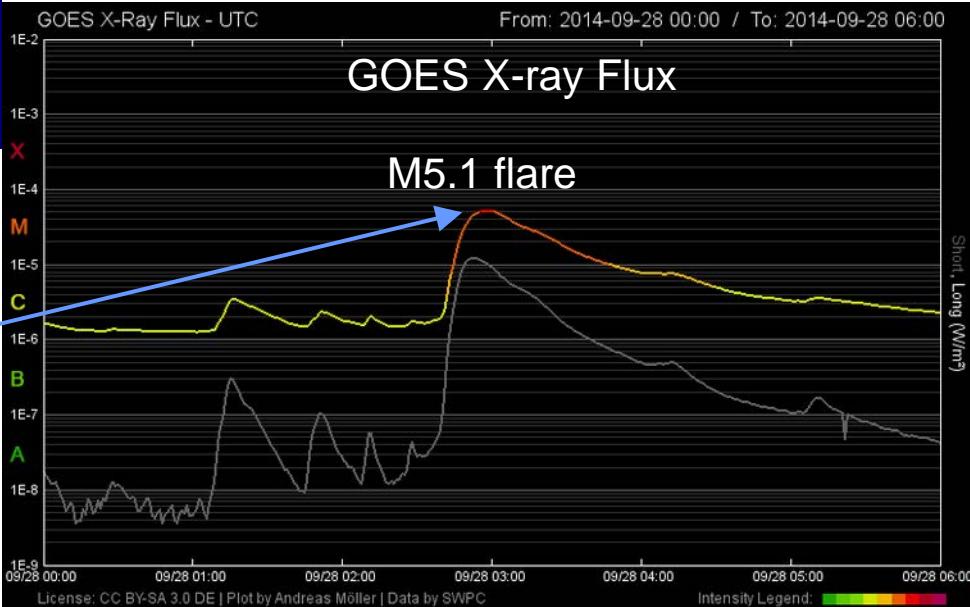
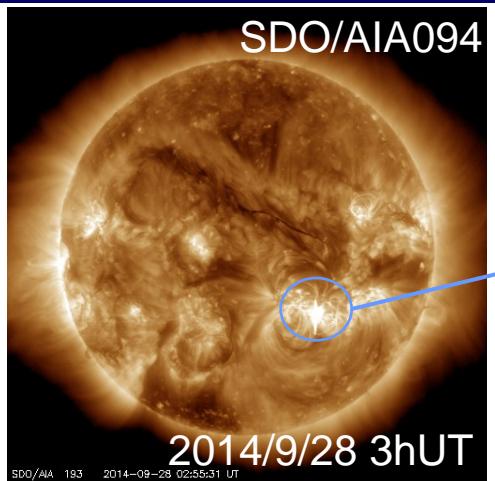


Observation area: AMATERAS & New
(~0.4Rs) (~4Rs)
(※Assuming $f_{OBS} \sim f_P$)

Purposes

1. Understandings of fundamental plasma physics ... particle accel., W-P(W) interact.
2. Understandings of phys. of flare, CME(·SEP) ...
generation/propagation env. ~ space weather / space disaster sci.

2014/9/28 ~12hJST M5.1 flare related Type-II burst (linear pol.)



Summary

[Seed]

At present:

VHF~UHF band system for solar radio bursts : **AMATERAS** with the resolutions of 10msec & 61KHz (max).

#Data are open and updated everyday.

Near future:

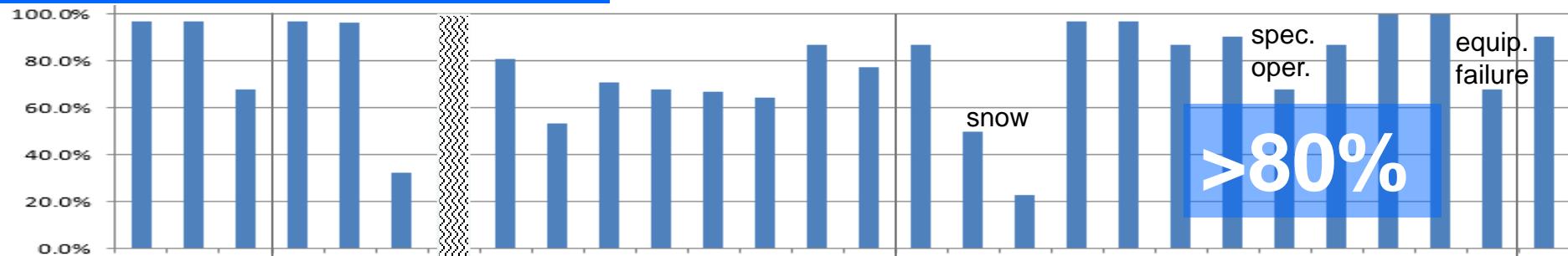
Addition of a new HF~VHF band system (similar resolutions).

[Want (Purpose) & Need]

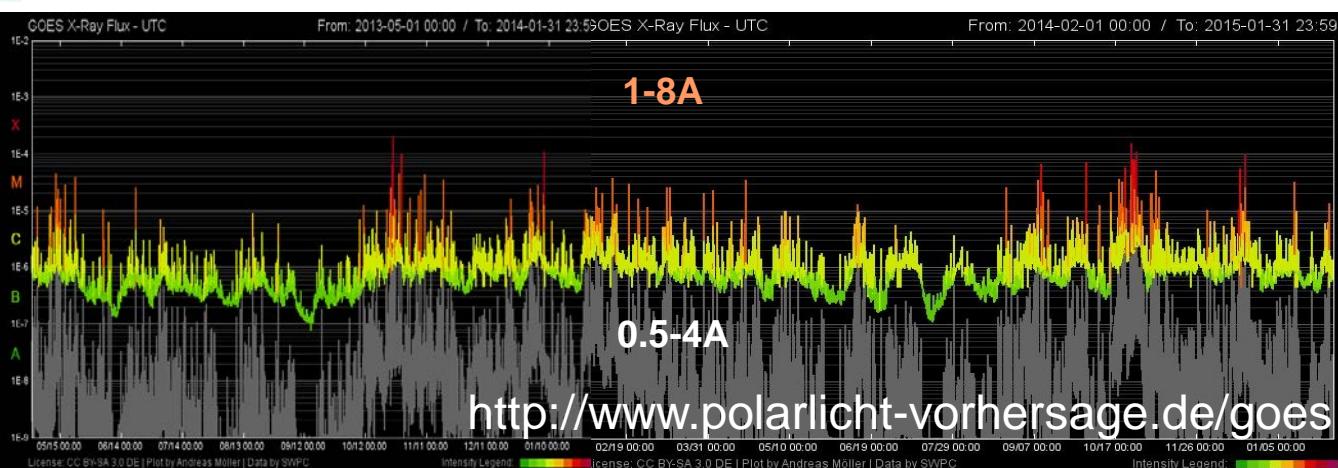
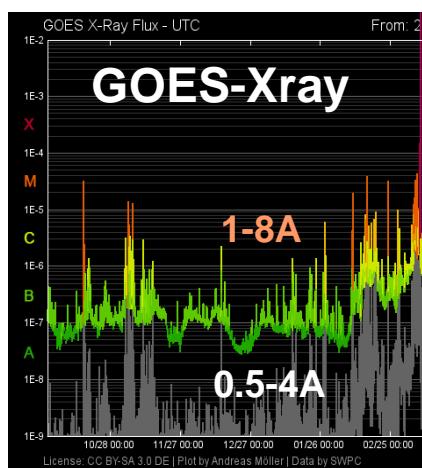
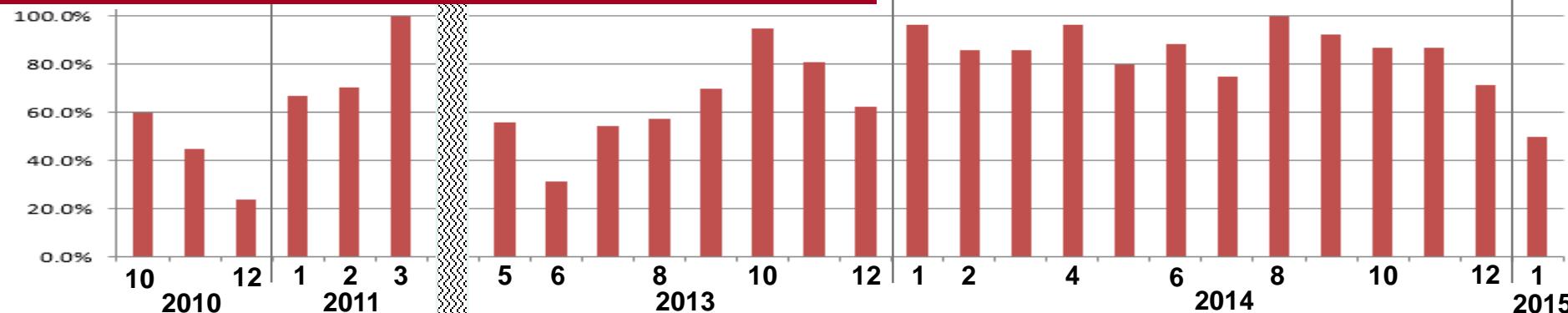
- ✓ Fast & automatic identification of solar radio bursts and evaluation of occurrence of possible hazard (~ SEP) from their spectral feature (drift rate, frequency range)
- ✓ Collaborative study with modeling / theoretical researches to investigate source regions & fundamental physical processes of such hazardous events

[Seed-1] IPRT/AMATERAS: Observation stats¹⁴

Monthly effective obs. rate (%)



Monthly obvious solar bursts occur. rate (%)



<http://www.polarlicht-vorhersage.de/goes>

SEP : Observer's positional dependence

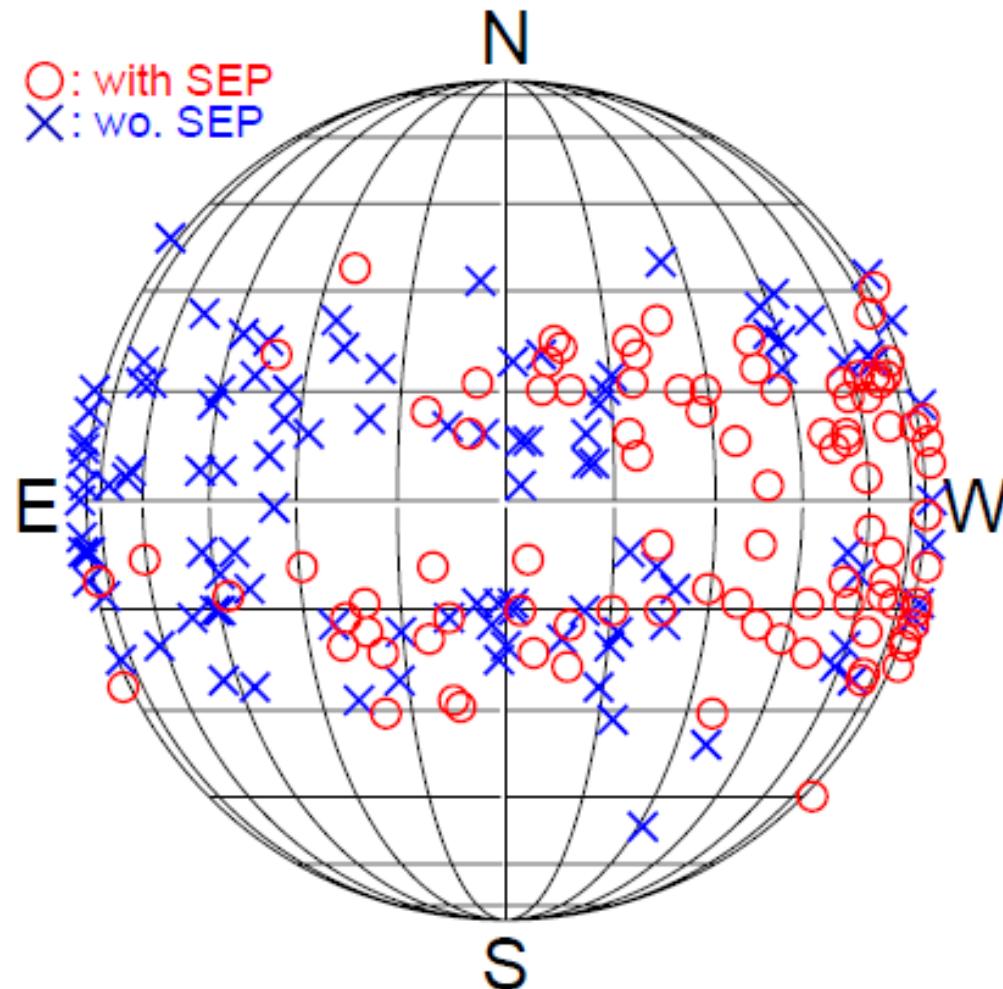


Fig. Heliographic coordinates of CMEs accompanied by Deca-Hectometer type II bursts and the relation with SEP ($>1\text{ pfu}$) in 1994-2007. (Gopalswamy+, 2008)

Sensitivity of the new system

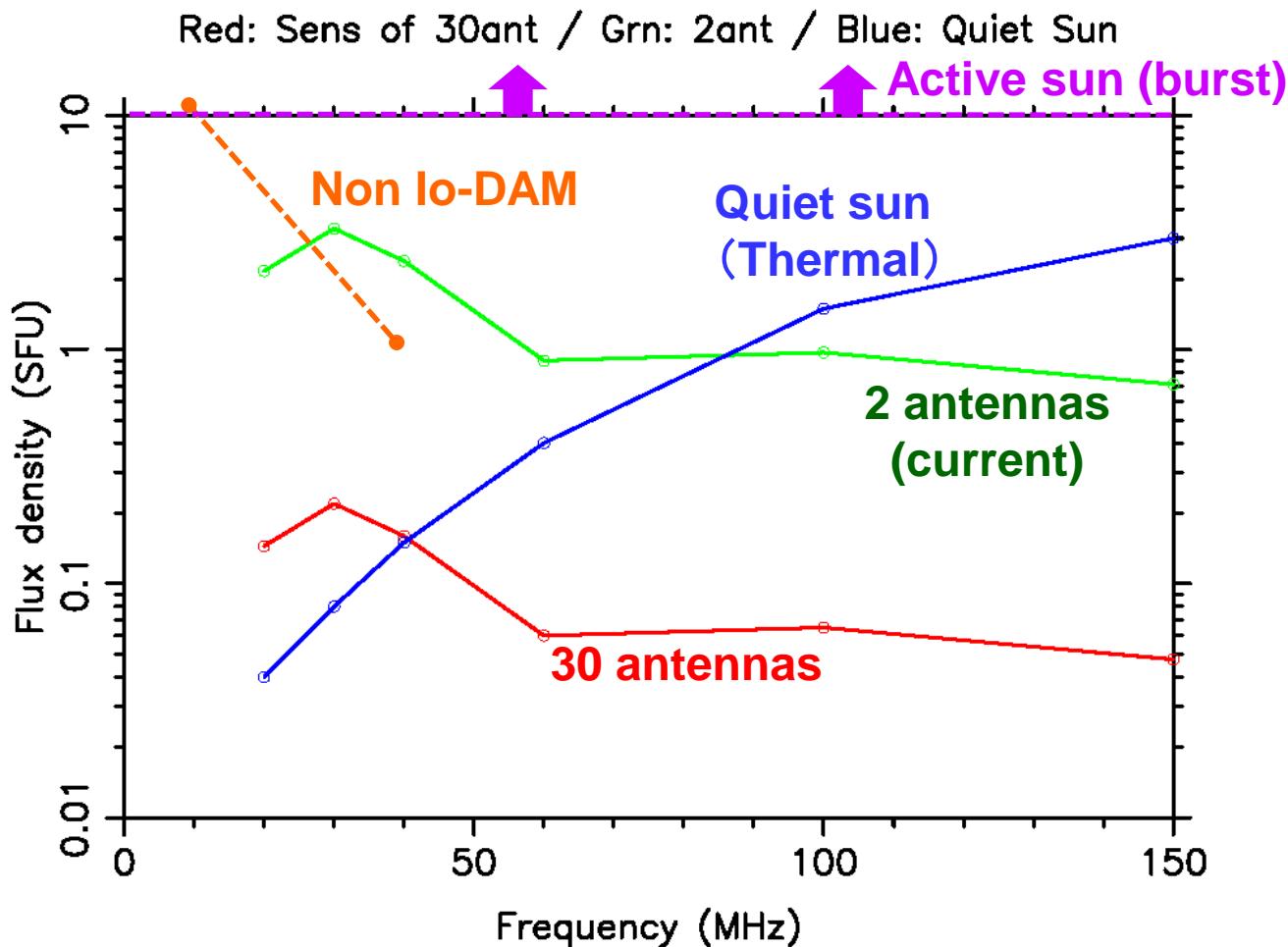
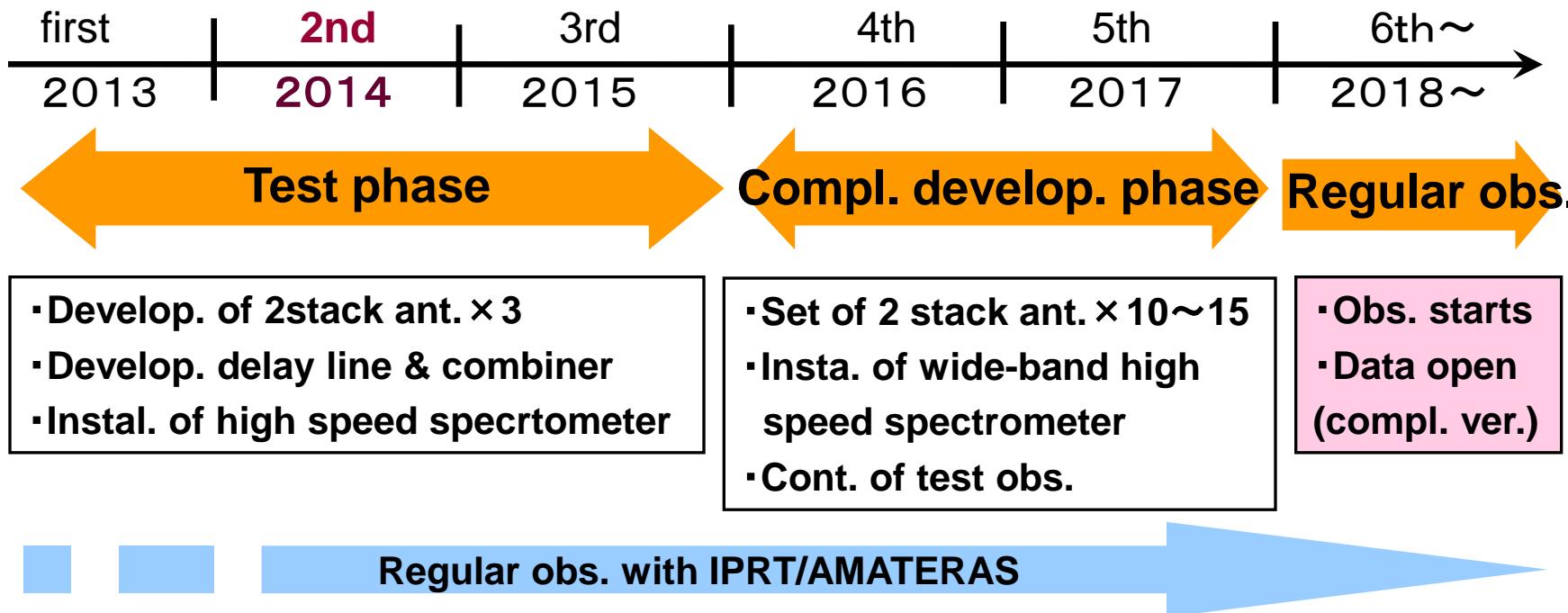


Fig. Sensitivity the new system with the relation of natural radio emissions.

Summary & Schedule

● Time line



● Current status(Mar. 2015) :

- 1st antenna, temporal receiver & spectrometer have been installed.
Solar & Jovian radio bursts have been tried to be received.
- Under preparation of 2nd & 3rd antennas & high speed spectrometer