VLBI with NOEMA
(**NO**rthern **E**xtended **M**illimeter **A**rray)

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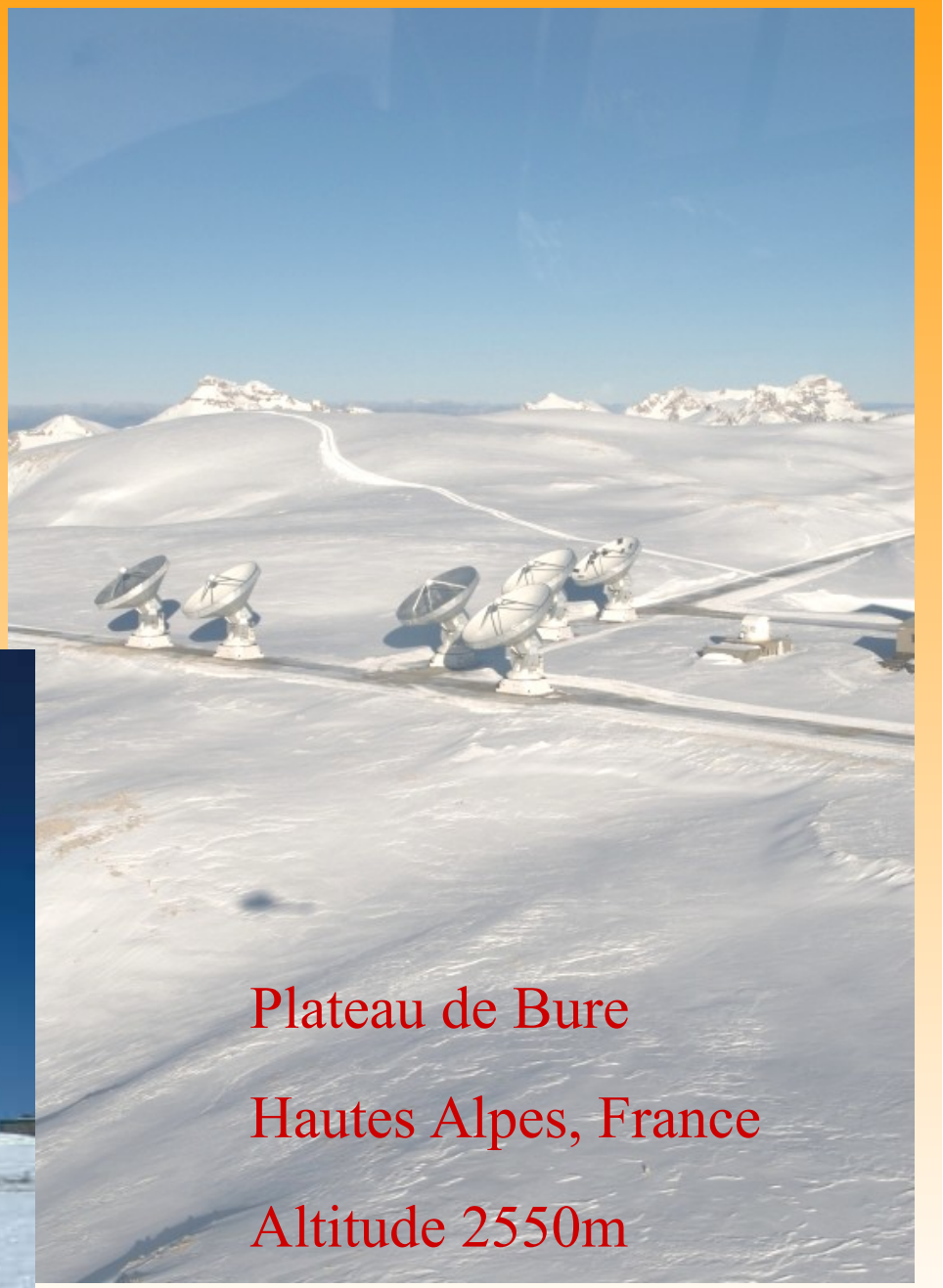
- The NOEMA extension – current status and future plans

Geographical Overview

IRAM supports two mm/sub-mm instruments in central Europe, connecting baseline length: 1146 km

NOEMA: 15-m aperture dishes on railway tracks

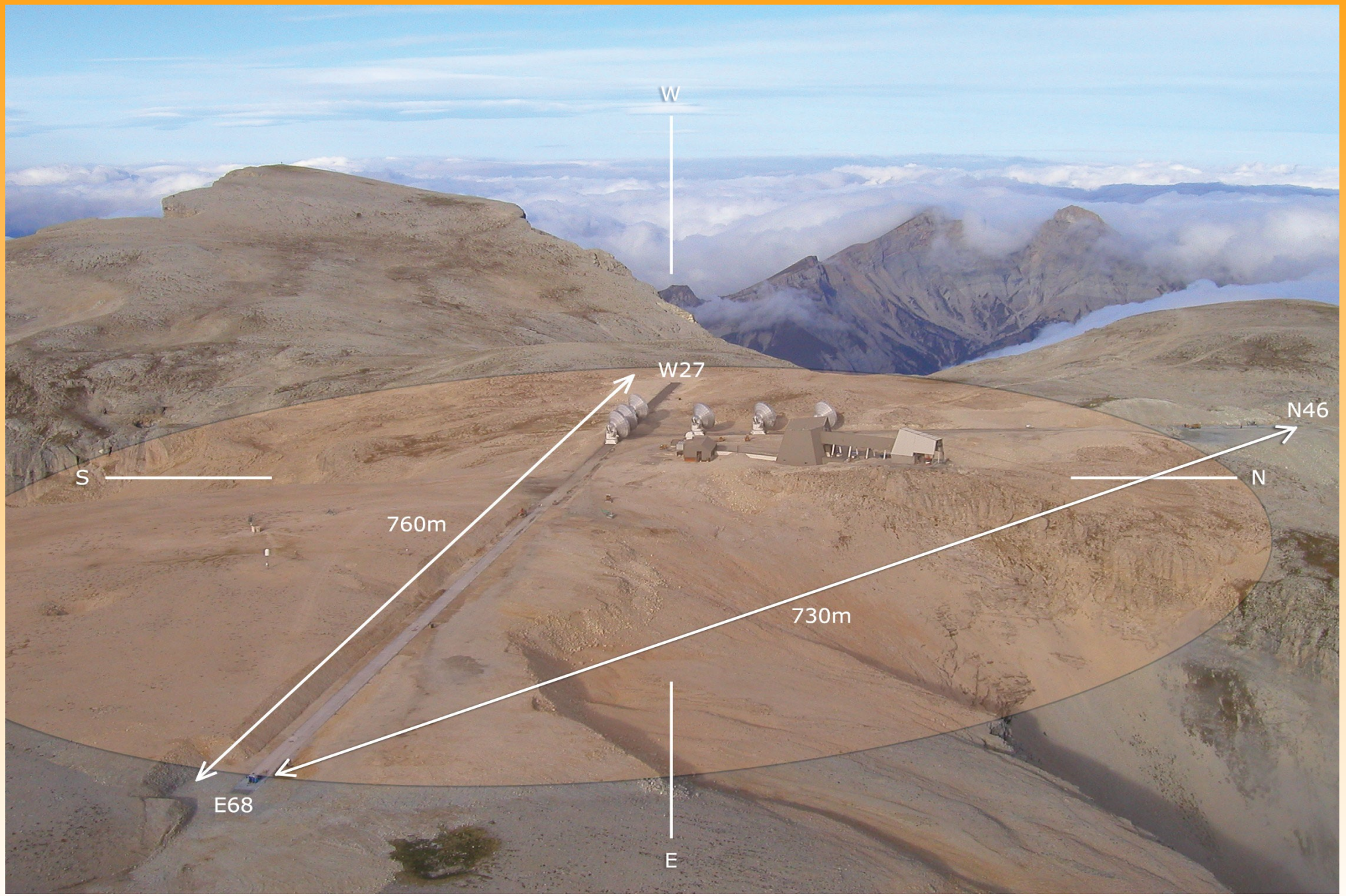


Plateau de Bure

Hautes Alpes, France

Altitude 2550m

NOEMA: synthesis array with two tracks (E-W,N-S)



NOEMA 2016: SSB receiver tuning ranges

	Band 1	Band 2	Band 3	Band 4
RF range*/[GHz]	80–116	129–174	201–267	277–371
T_{rec}/[K] LSB	40–55	30–50	40–60	30–50
T_{rec}/[K] USB	40–55	40–80	50–70	30–50
G_{im}/[dB]	-10	-12 ... -10	-12 ... -8	-20
RF LSB/[GHz]	80–104	129–165	201–264	277-359
RF USB/[GHz]	104–116	164–174	264–267	289-371

* center of the 4.2-7.8 GHz IF band;

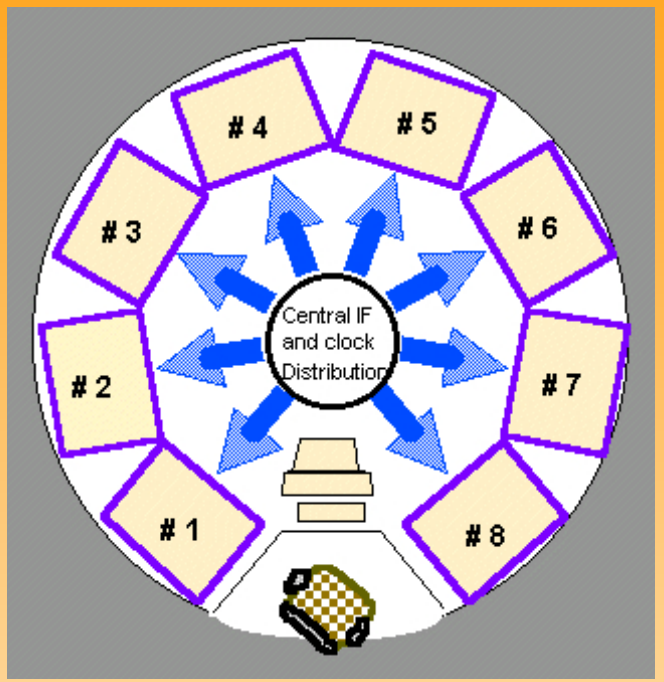
All bands are in dual polarization, Single-Sideband, 3.6 GHz/polarization

Filter wheels: Currently we have lambda/4 plates installed for band 1 and band 3

Present NOEMA VLBI equipment

Swiss EFOS-38 maser (built in 2006), with low phase noise quartz

Mark4 Formatter + Mark5A recorder



Narrow-band correlator (In operation since 2000)

Rohde & Schwarz SMA100 B22 frequency generator

Only the Narrow-band correlator is VLBI capable, not the more recent continuum WIDEX backend.

The phased array operation is currently limited to 1 Gbit/sec data rates , VLBI correlation at MPIfR in zoom mode.

That looks already nice. Why do we want to upgrade the Interferometer further?

The main reason is ALMA (Chajnantor, Chile).

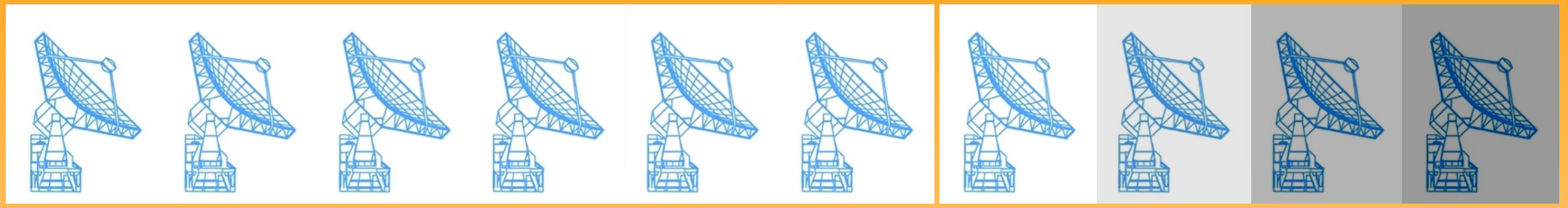
The idea is to have a Northern instrument that is not too far behind ALMA, and that is a bit easier to get access to.

Also, part of the Northern sky is not accessible for ALMA.

Take the old six-antenna Plateau de Bure array and add:

- More collecting area, more simultaneous baselines
- More receiver bandwidth
- Longer baselines

NOEMA extension progress: February 2016



6-antenna PdBI (since 16-Dec-2001)

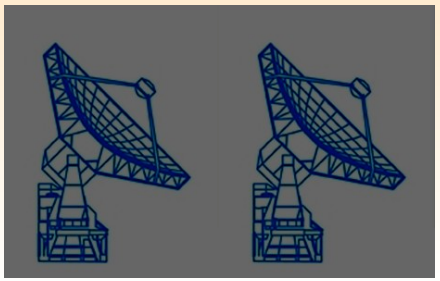
NOEMA antenna 7 (inaugurated 2014)

NOEMA antenna 8 (near completion)

NOEMA antenna 9 (construction started)

NOEMA antenna 10 (funded)

NOEMA antennas 11+12 (with more partners?)



NOEMA extension progress: February 2016

Receivers:
Progressive conversion from SSB (2x4 GHz) to 2SB (4x8 GHz) receivers,
3 of 7 antennas are today equipped but those 3 are bandpass-filtered to stay compatible with the others *(observing continues during upgrade)*.
→ 8 antennas, each with 2SB receivers, foreseen for end of 2016

Backend:
Polyfix correlator installation is planned to start in late 2016

Baselines:
Track construction will start in 2016: additional service tracks first,
extension of the main E-W track in 2017

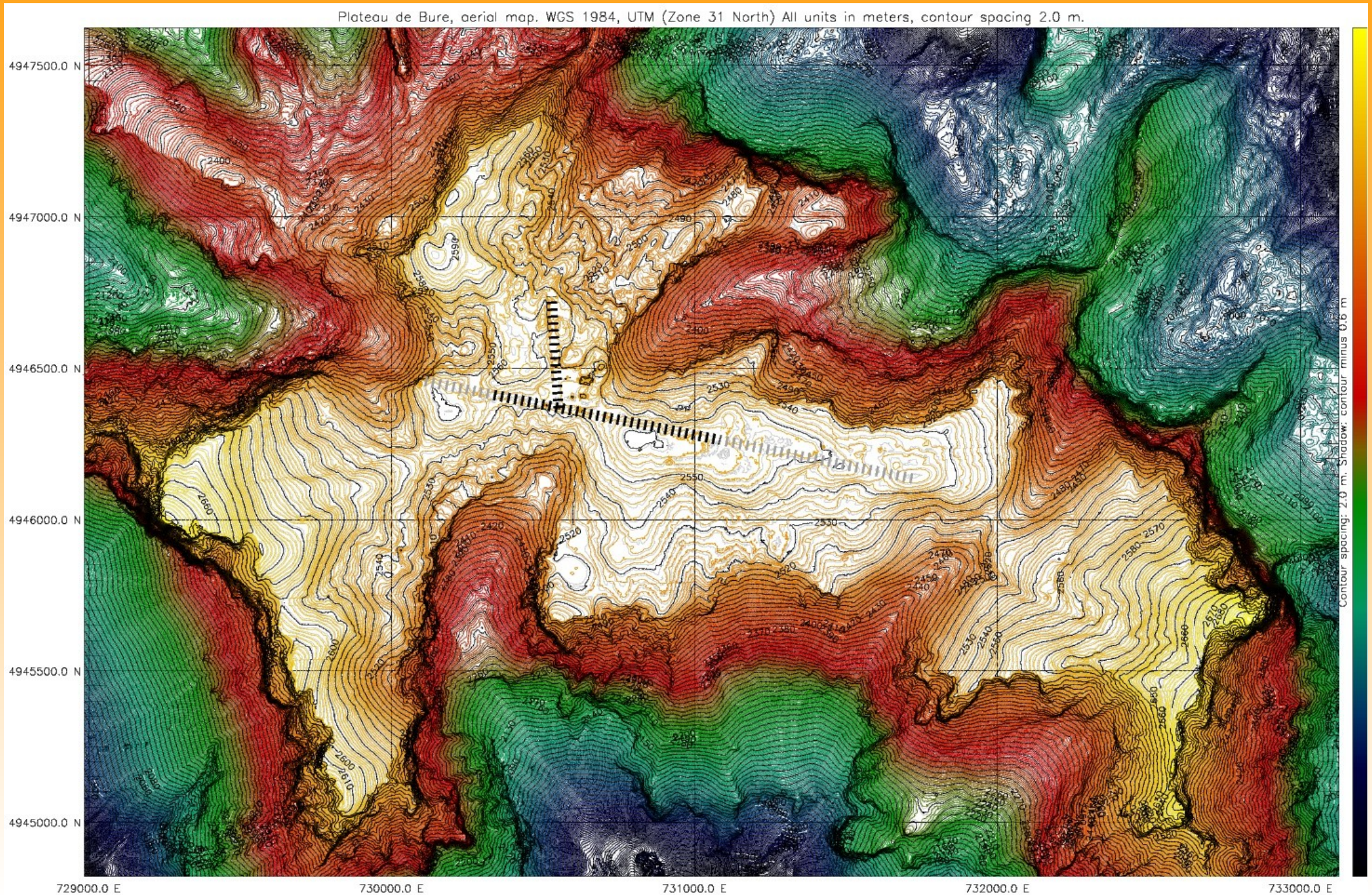
NOEMA

Northern **E**xtended **M**illimeter **A**rray:

	PdBI	NOEMA now	NOEMA
antennas	6	7	10 (12 ?)
baselines	15	21	45 (66 ?)
bandwidth	2 x 3.6 GHz	2 x 3.6 GHz	2 x 16 GHz
max. baseline	760 m	760 m	1600 m

Why 12 antennas and 1600 m baselines and not more ?

Well, that is all the space we have …



End 2016: The 5th generation correlator on Bure

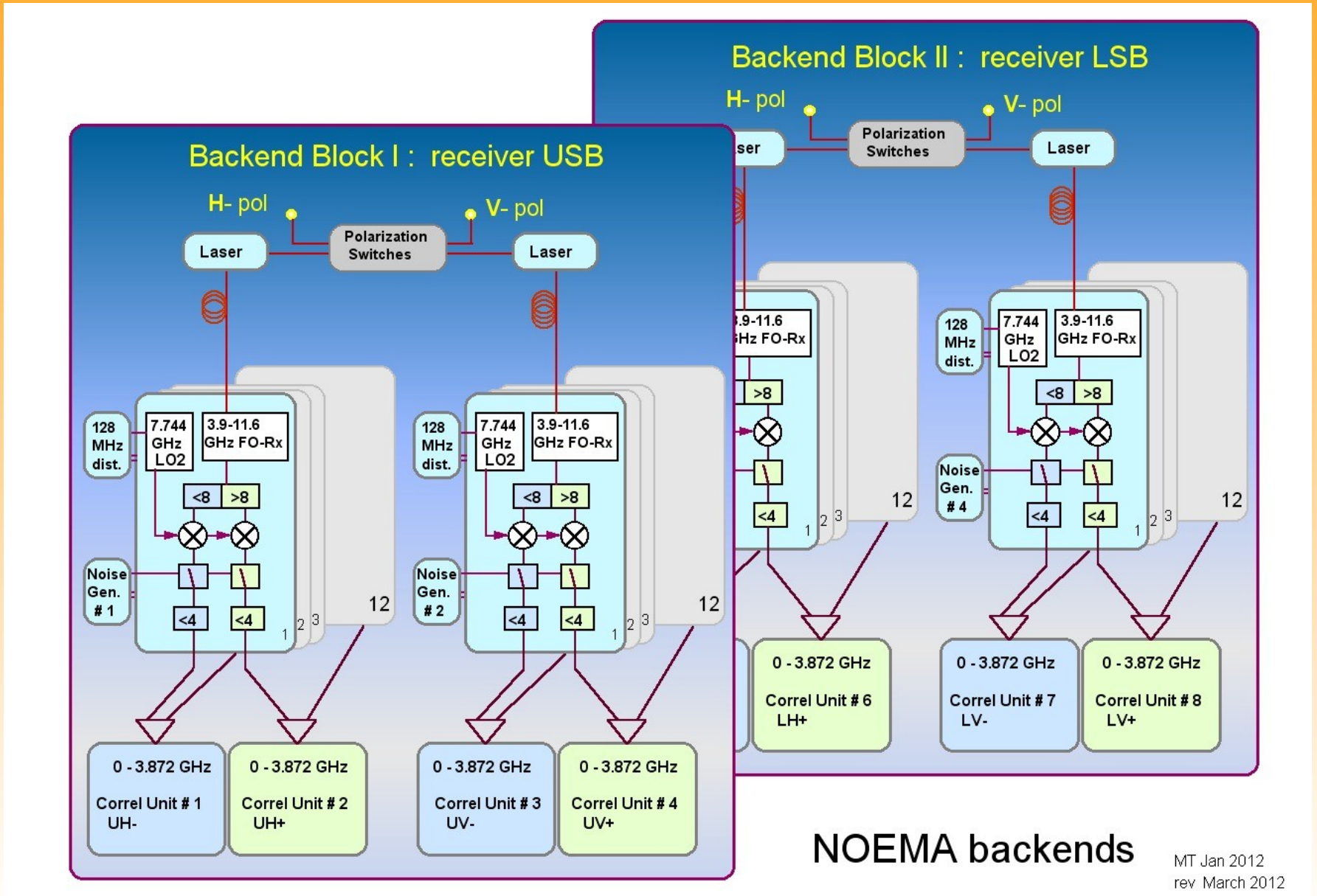
(first phase – extension to VLBI capabilities later)

The updated NOEMA receivers will deliver 8-GHz wide sidebands in 2SB mode, dual polarization. The new correlator is based on FPGAs (Altera), highly flexible.

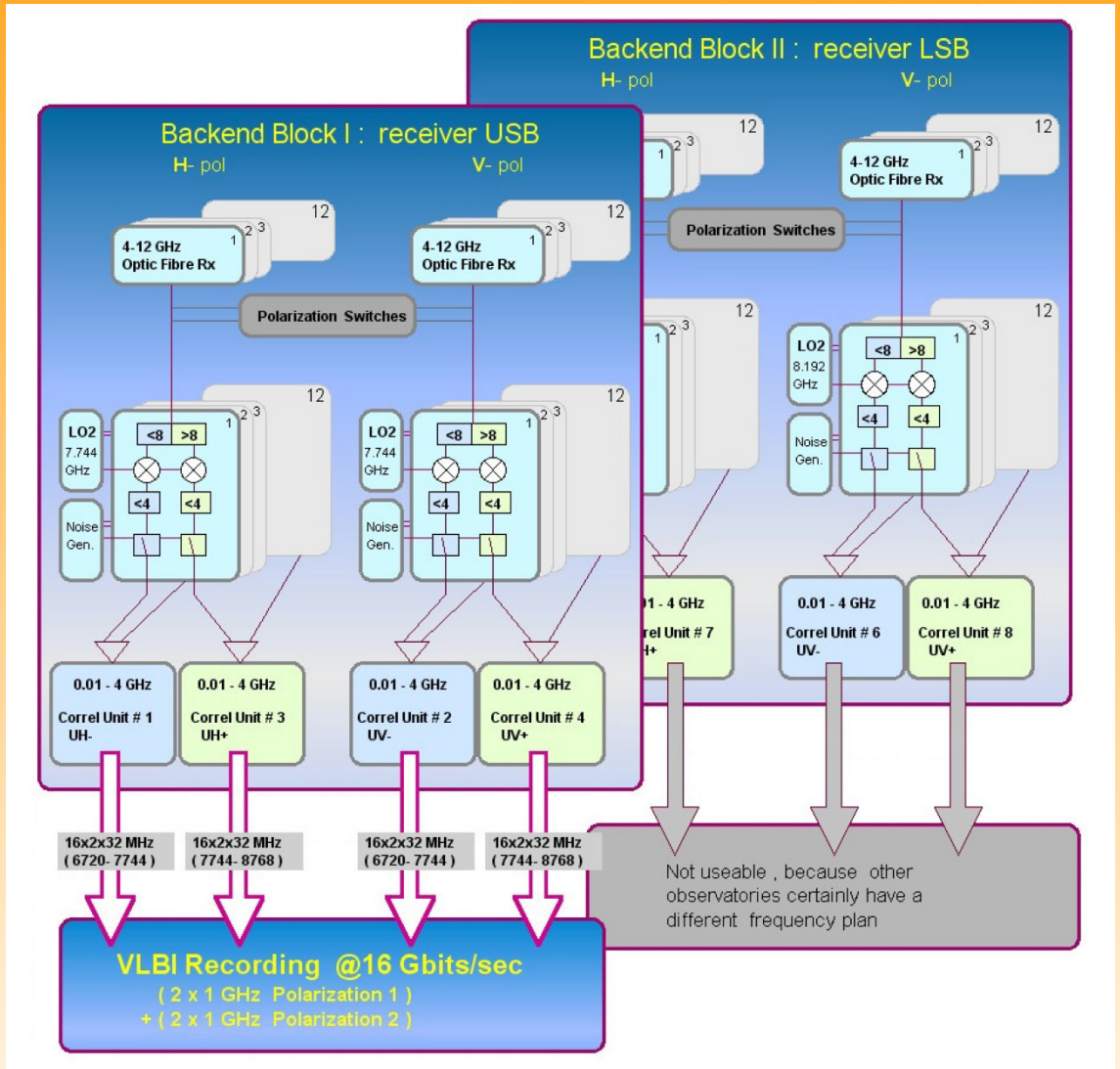
Architecture is VLBI compatible but will be **without** the adder cards

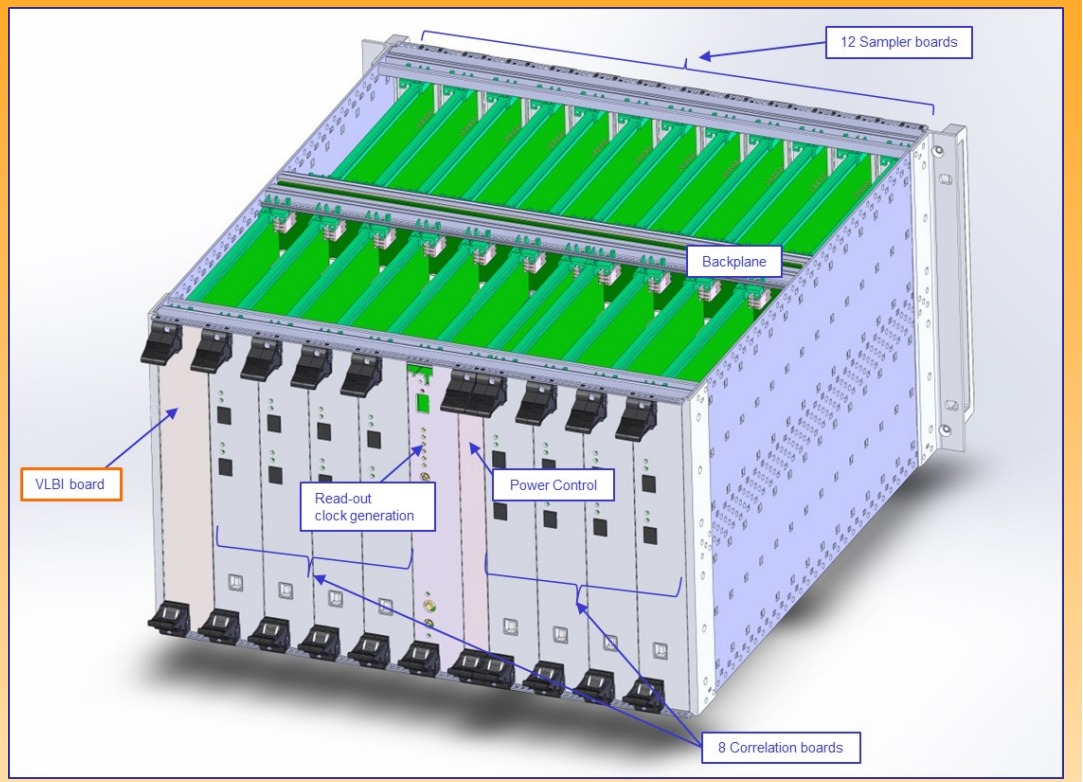
End 2016: The 5th generation correlator on Bure

(first phase – extension to VLBI capabilities around 2018)



The 5th generation correlator – second phase





VLBI mode:

16 Gbits/s for one receiver sideband

32 Gbits/s if the second sideband can be used

[64 Gbits/s are close to the design limits, and cannot be guaranteed at this time at full S/N]

But how do we VLBI until then?

Problem: the old narrowband correlator will disappear at the end of 2016.

However, one single NOEMA antenna with broadband (16 Gbit/s or more) backend would be more powerful than this old phased array backend.

Solution : Install a broad-band VLBI backend on a single dish of the array. (we are working on that).

Still further in the future: a second correlator for simultaneous dual-frequency, dual-polarization observations.

IRAM has multiplied the capacities of its instruments by many orders of magnitude during its 36 years of existence. And it's still going on …

Thank you!