SKA Pathfinders

Hans-Rainer Klöckner

Slides stolen from
Joseph Lazio, Richard Schilizzi, Justin Jonas,
Colin Lonsdale, Leo Blitz, David DeBoer, Daniel Mitchell, …

path finding

… boldly go where no man has gone before.

QuickTime and a
decompressor
are needed to see this picture.

But when, why and where we are going ?

When - SKA timeline

QuickTime and a
decompressor
are needed to see this picture.

Why - SKA key science drivers

Probing the Dark Ages

- When & how were the first stars formed?

Cosmology and Galaxy Evolution

- Galaxies, Dark Energy and Dark Matter

Strong-field tests of General Relativity

- Was Einstein correct?

Origin & Evolution of Cosmic Magnetism

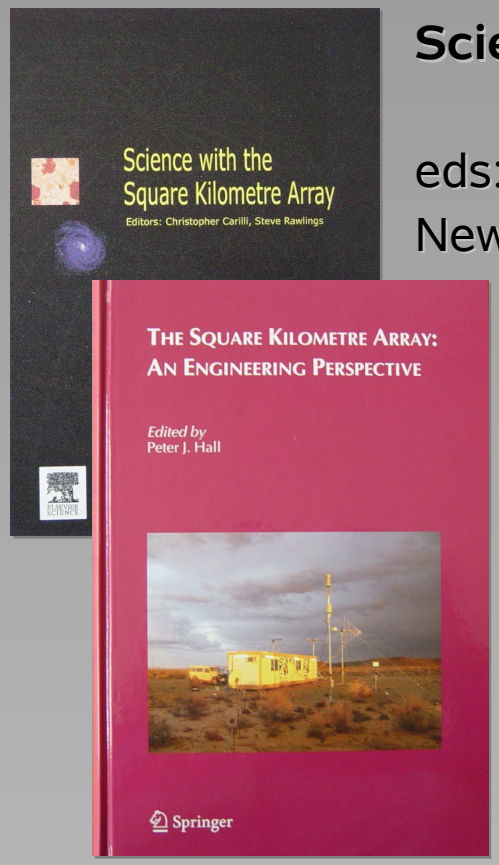
- Where does magnetism come from?

Cradle of Life

- What and where are the conditions for life?

Exploration of the Unknown

SKA literature



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Science with the Square Kilometre Array

eds: C.Carilli, S.Rawlings,
New Astronomy Reviews, Vol.48, Elsevier, Dec. 2004

The Square Kilometre Array An Engineering Perspective

eds: P. Hall
Experimental Astronomy, Vol.17, Springer, Nov. 2004

Cosmology, Galaxy Formation and Astroparticle Physics on the Pathway to the SKA

eds: H-R. Klöckner, S.Rawlings, M. Jarvis, A. Taylor
Astron , March 2008

Where - SKA requirements

- **sensitivity to detect and image hydrogen in the early universe → very large collecting area**

- **Central concentration of the collecting area for *optimal detection of hydrogen, pulsars, and magnetic fields***

- **fast surveying capability over the whole sky → very large angle field of view and broad frequency coverage**

- **capability for detailed imaging of compact objects like active galactic nuclei → large physical extent**

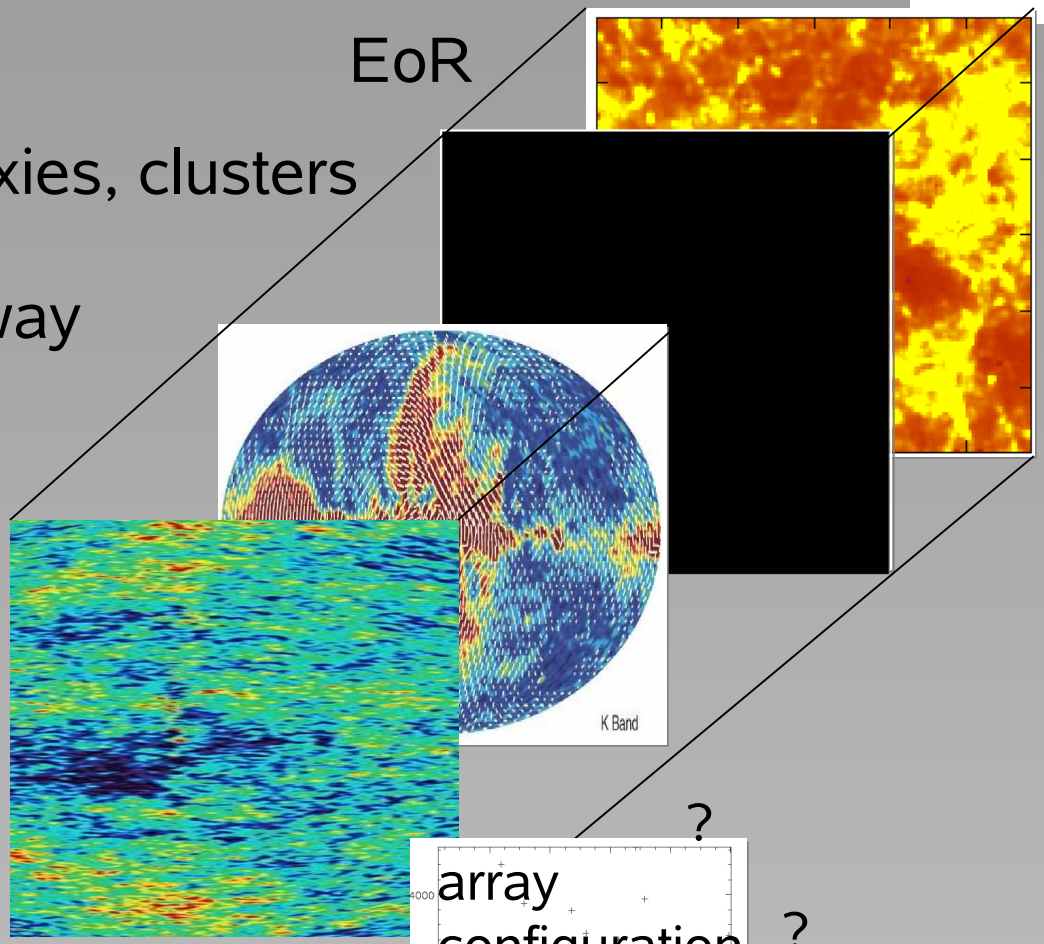
What do we want to understand

EoR

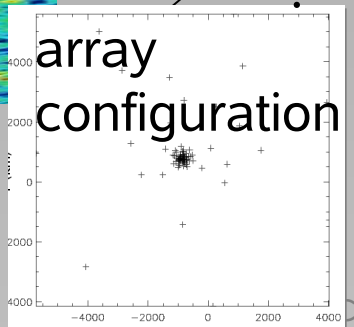
galaxies, clusters

Milkyway

Ionosphere / Troposphere



array configuration



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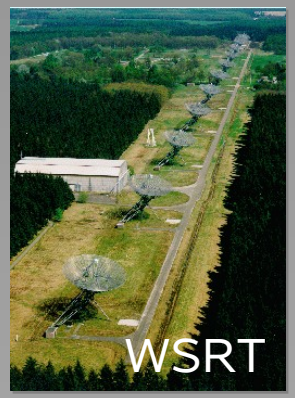
Inventory of Telescopes



ATCA

		[m²]	dish [m]	SKA [%]
ATCA	6 x 22 m	760	31	0.0
WSRT	14 x 25 m	6872	94	0.7
VLA	27 x 25 m	13253	130	1
GMRT	30 x 45 m	47712	246	5
Arecibo	1 x 305 m	73061	305	7
LOFAR				< 17

Not to forget the high freq. arrays (e.g. ALMA, SMA)

Shopping list of a “NEW” Interferometer

Do we need to redo all ?

Telescopes
Software
Hardware

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decompressor
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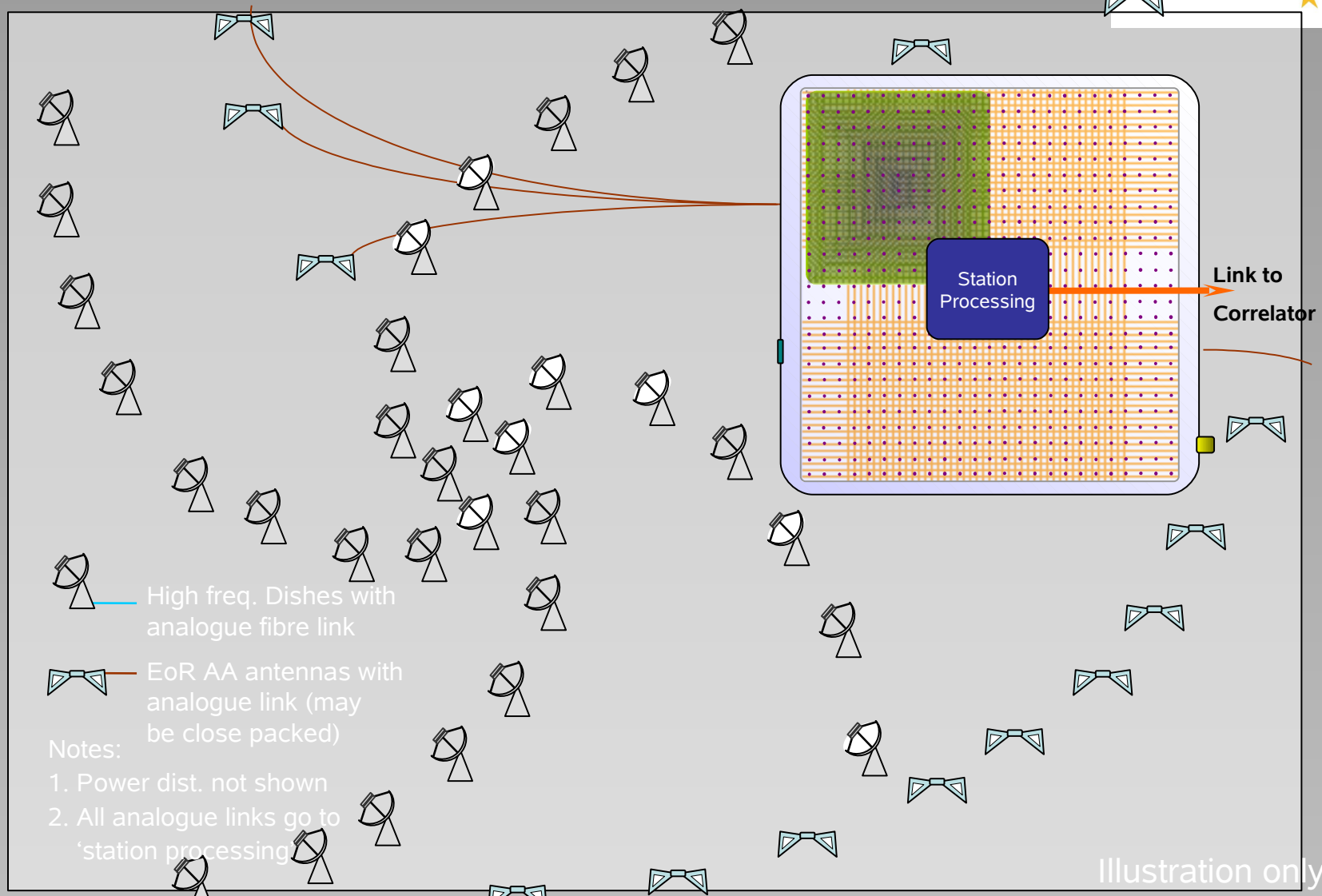
SKA station

0.07 – 0.3 GHz (low-band), 0.3 – 10 GHz (mid-band), 10 – >25 GHz (hi-band)



Dishes & Single Pixel Feeds

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Dishes & Phased Array Feeds

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Spare aperture arrays

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current software

Dynamic range

- Antenna sidelobes [bright sources]
- Pointing
- Beam calibration

Ionosphere Calibration

wide bandwidth deconvolution

post

processing

Calibration & Imaging

continues updating
a sky model

new algorithm for
parallelized synthesis

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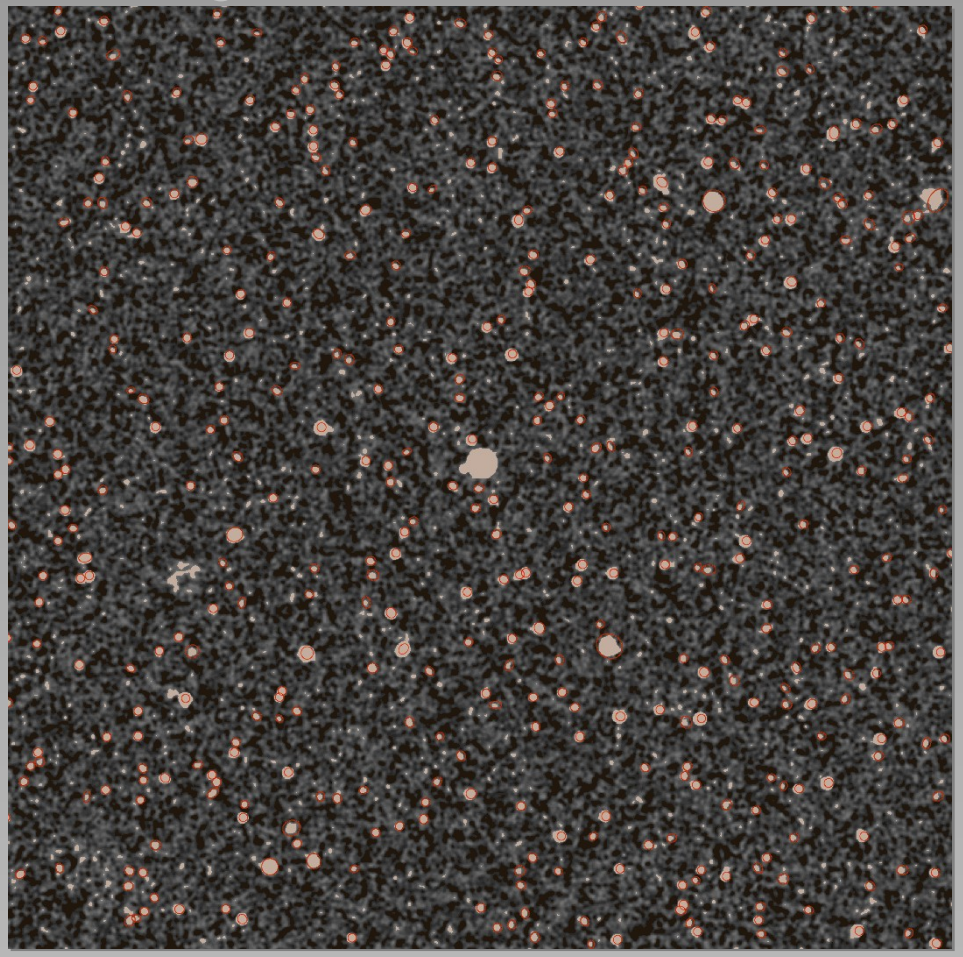
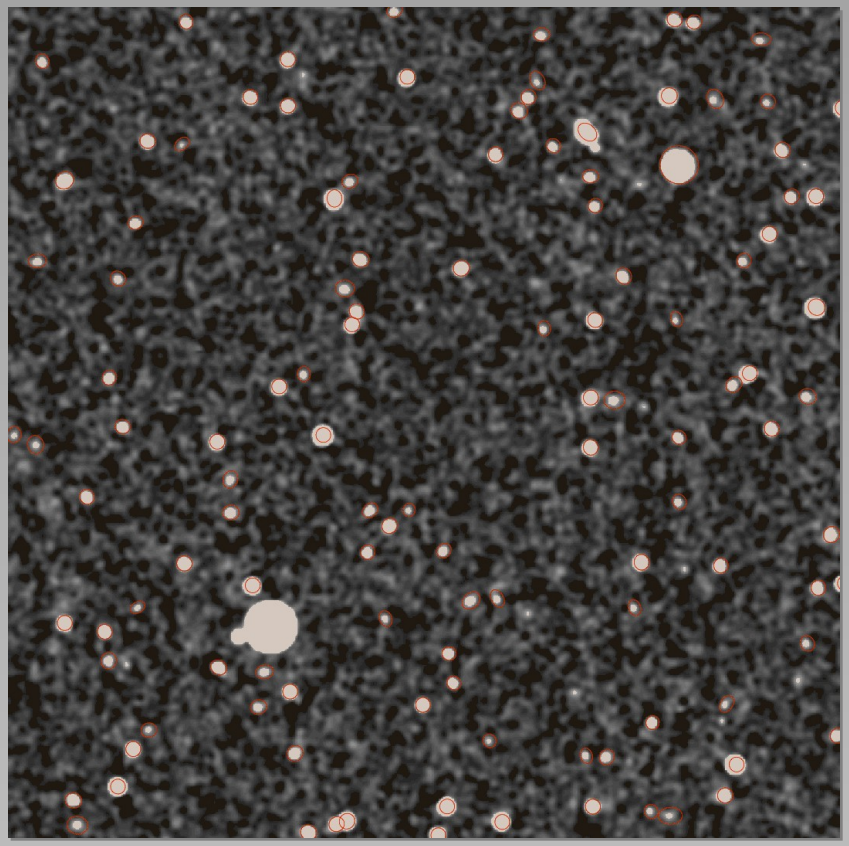
analysis of the continuum sky



SAD (AIPS), Source extractor, Miriad



diffuse & extended Structure is the challenge

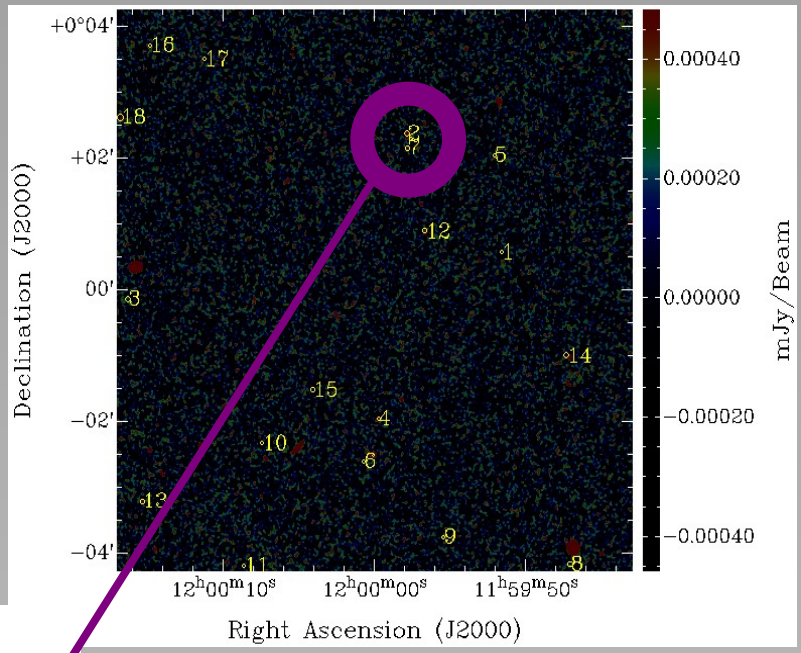
Source HI Extraction

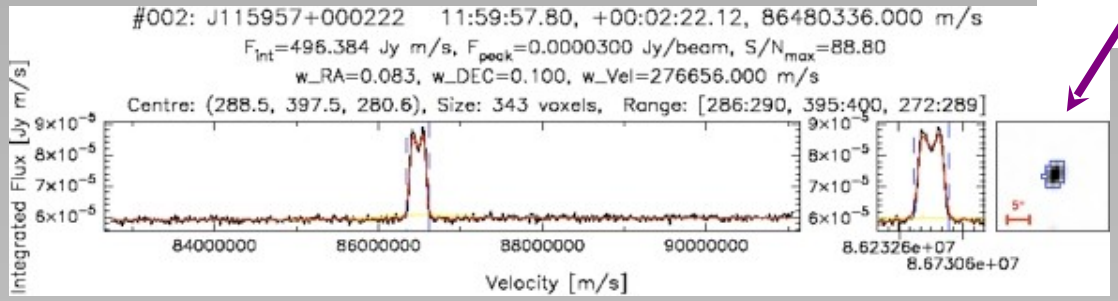
R. Auld (Cardiff)

MapMaker → *HI cube* → Duchamp

Duchamp

- ATNF (M. Whiting)
- Locates sets of contiguous voxels above some threshold
- Uses spectral, spatial or wavelet smoothing for enhancement
- Very quick (30 minutes for 512 x 512 x 1024 cube on a laptop)
- VO-compliant
- Memory and process intensive
- Completeness issues (misses high S/N sources)





Sizes of Catalogue

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Shopping list of a “NEW” Interferometer

Do we need to redo all ?

Telescopes ☑
Software ☑
Hardware

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Hardware

a lot of it

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- Software ☑
- Hardware ☒

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SKA - Pathfinder

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LOFAR
Ralph Wijers

also touch
LWA
FAST

- location
- hardware in place
- science
- technical development

a NOT complete view

Global location

LOFAR

ATA

LWA

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NVSS - VLA

MeerKat

MWA

ASKAP

Galactic Centre

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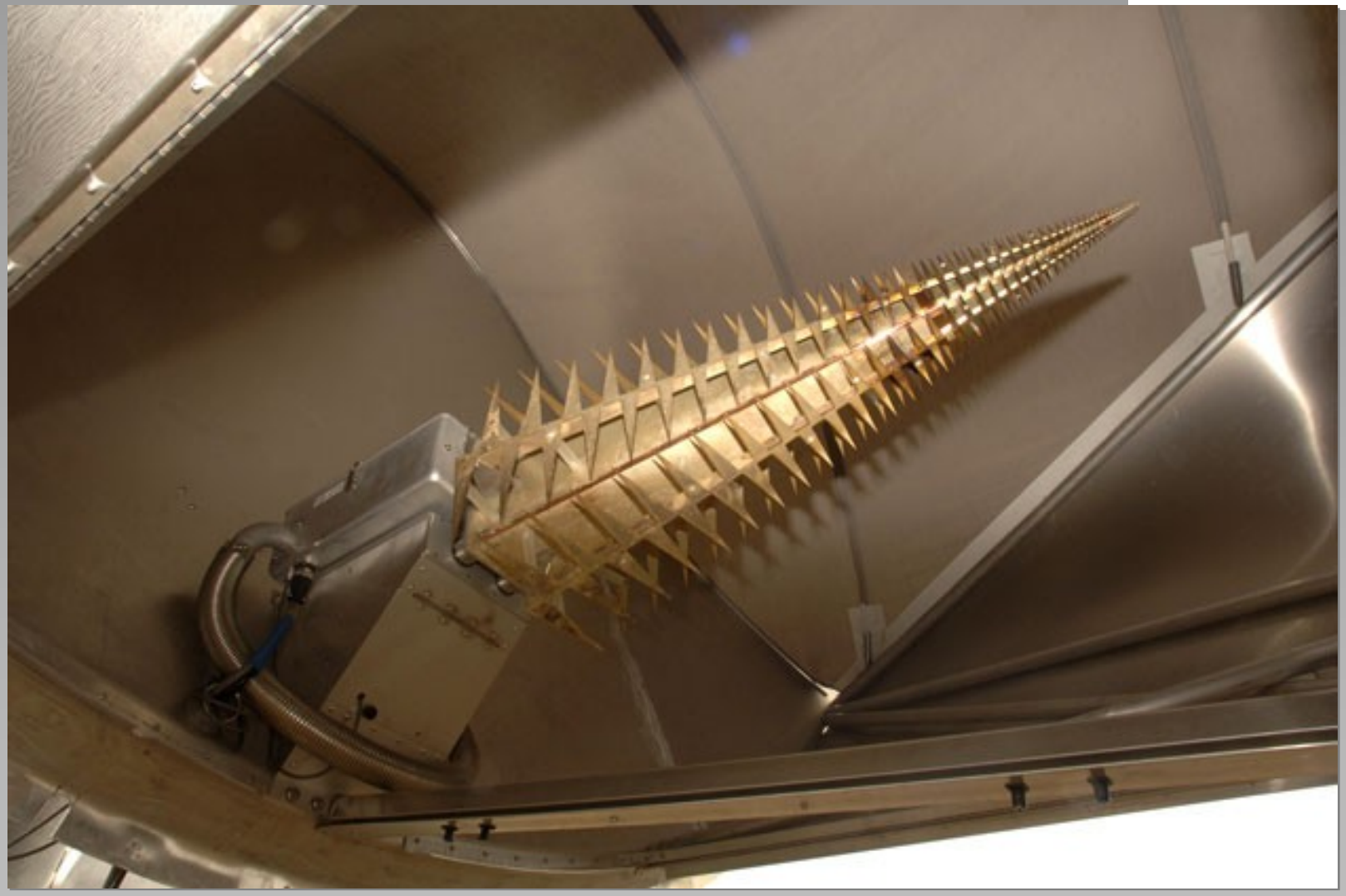

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MWA Science

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path finding

… boldly go where no man has gone before.

Ahhhhh my brain hurts are
we to ambitious ?

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NO

Putting this a little bit together

LWA	20 MHz - 80 MHz
MWA	80 MHz - 300 MHz
LOFAR	30 MHz - 80 MHz &
	120 MHz - 2 40 MHz
ASKAP	700 MHz - 1.8 GHz
KAT	500 MHz - 2.5 GHz
ATA	500 MHz - 11.2 GHz

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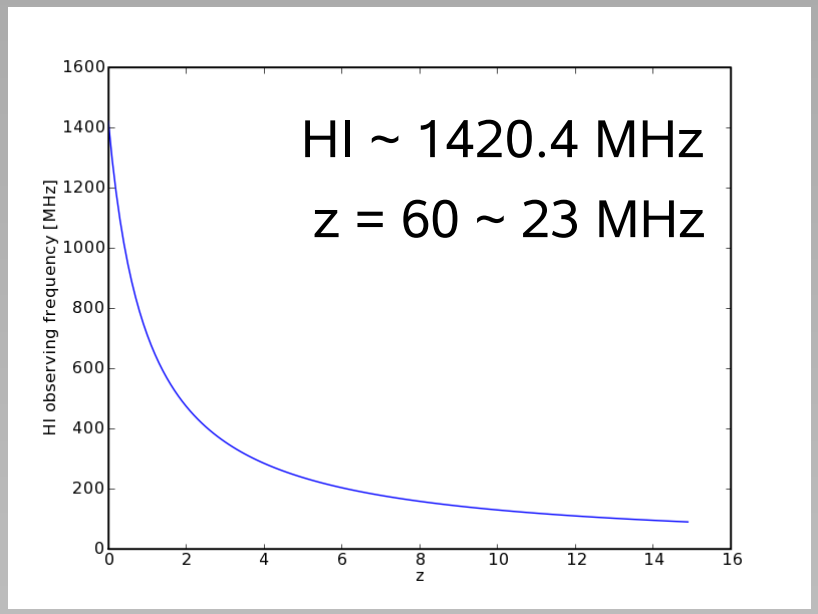
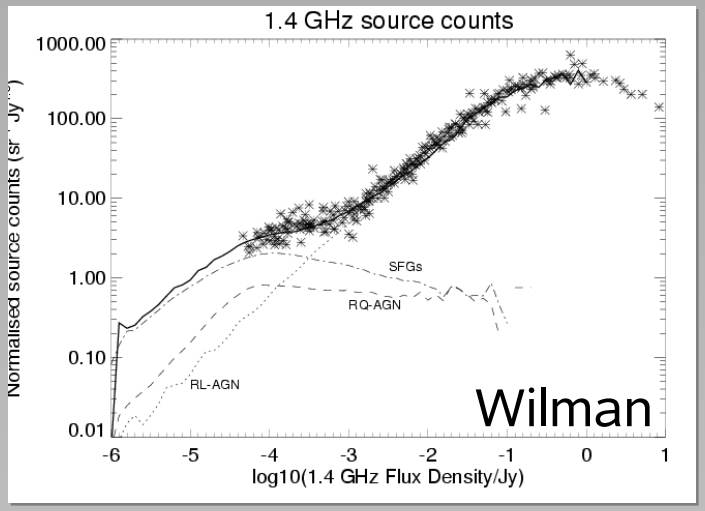
Kellerman





WSRT or VLA < ATA 350 and MeerKAT

Science with Pathfinder

Line observations:

need to wait until they have superior Tsys/Aeff ratio
but opportunity to do Galactic research

Continuum observations:

broader bandwitdh Tsys/Aeff ratio

Pulsar - high frequency

Transient

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EoR

Ken Kellerman

Science with Pathfinder

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… and much more !!!

from Justin Jonas

2.0 ASKAP 30
1.4 ASKAP 45
1.2 Meerka 50
0.76 Meerkat 80
5.8 ATA 42
0.69 ATA 350

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