Summary and Closing remarks

Steven Tingay

Meeting by the numbers

- 68 talks in three days;
- ~100 participants;
- ~20% female participants, ~80% male;
- ~35% particpants > 35 yrs old, ~65% < 35 yrs old;

- Plethora of instruments and techniques, across a wide range of project team sizes, budgets, and science goals;

- About a dozen facilities/instruments represented:
  - 10 facilities commissioned/operational;
  - ~3 facilities aspirational.

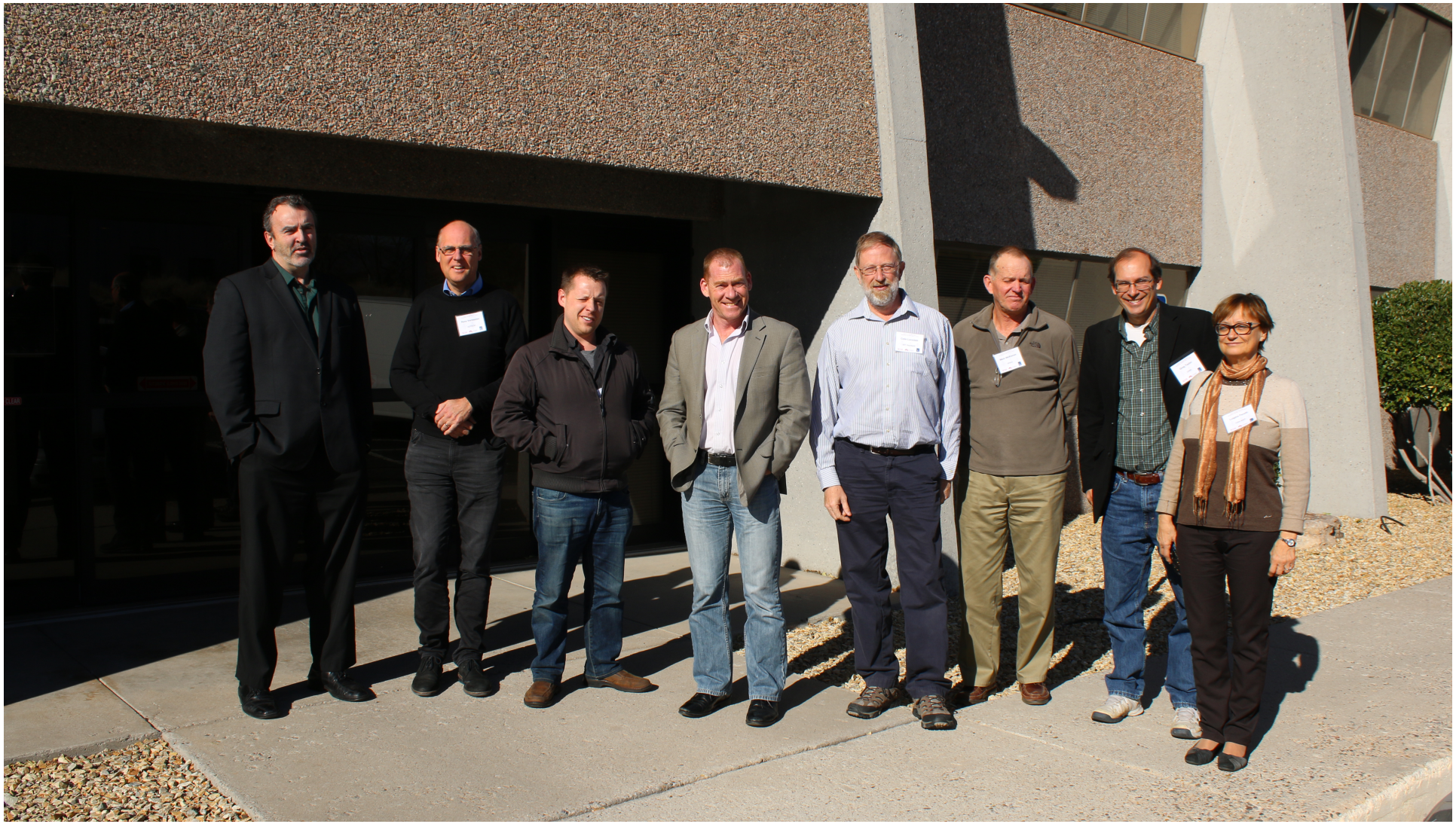
- LOFAR (~8000 hrs -> 20 PB);
- MWA (~8000 hrs -> 8 PB);
- VLITE (~6000 hrs -> ??);
- OVRO-LWA (24 TB/hr);
- LWA (????);
- .
- .

- Low frequency radio astronomy so much more than just the EoR.

- LOFAR, MWA, LWA, PAPER, GMRT in title and/or abstract in last 5 yrs (VLA too hard to separate out; apologies to other instruments):

http://adsabs.harvard.edu/cgi-bin/nph-abs_connect?db_key=AST&db_key=PRE&qform=AST&arxiv_sel=astro-ph&arxiv_sel=cond-mat&arxiv_sel=cs&arxiv_sel=gr-qc&arxiv_sel=hep-ex&arxiv_sel=hep-lat&arxiv_sel=hep-ph&arxiv_sel=hep-th&arxiv_sel=math&arxiv_sel=math-ph&arxiv_sel=nlin&arxiv_sel=nucl-ex&arxiv_sel=nucl-th&arxiv_sel=physics&arxiv_sel=quant-ph&arxiv_sel=q-bio&sim_query=YES&ned_query=YES&adsobj_query=YES&aut_logic=OR&obj_logic=OR&author=&object=&start_mon=&start_year=2011&end_mon=&end_year=2015&ttl_logic=OR&title=LOFAR+MWA+PAPER+LWA+GMRT&txt_logic=OR&text=LOFAR+MWA+PAPER+LWA+GMRT&nr_to_return=200&start_nr=1&jou_pick=NO&ref_stems=&data_and=ALL&group_and=ALL&start_entry_day=&start_entry_mon=&start_entry_year=&end_entry_day=&end_entry_mon=&end_entry_year=&min_score=&sort=CITATIONS&data_type=SHORT&aut_syn=YES&ttl_syn=YES&txt_syn=YES&aut_wt=1.0&obj_wt=1.0&ttl_wt=0.3&txt_wt=3.0&aut_wgt=YES&obj_wgt=YES&ttl_wgt=YES&txt_wgt=YES&ttl_sco=YES&txt_sco=YES&version=1


Refereed publications: 345
Citations: 3954
Five year H-index: 31
+ve gradient is steep……



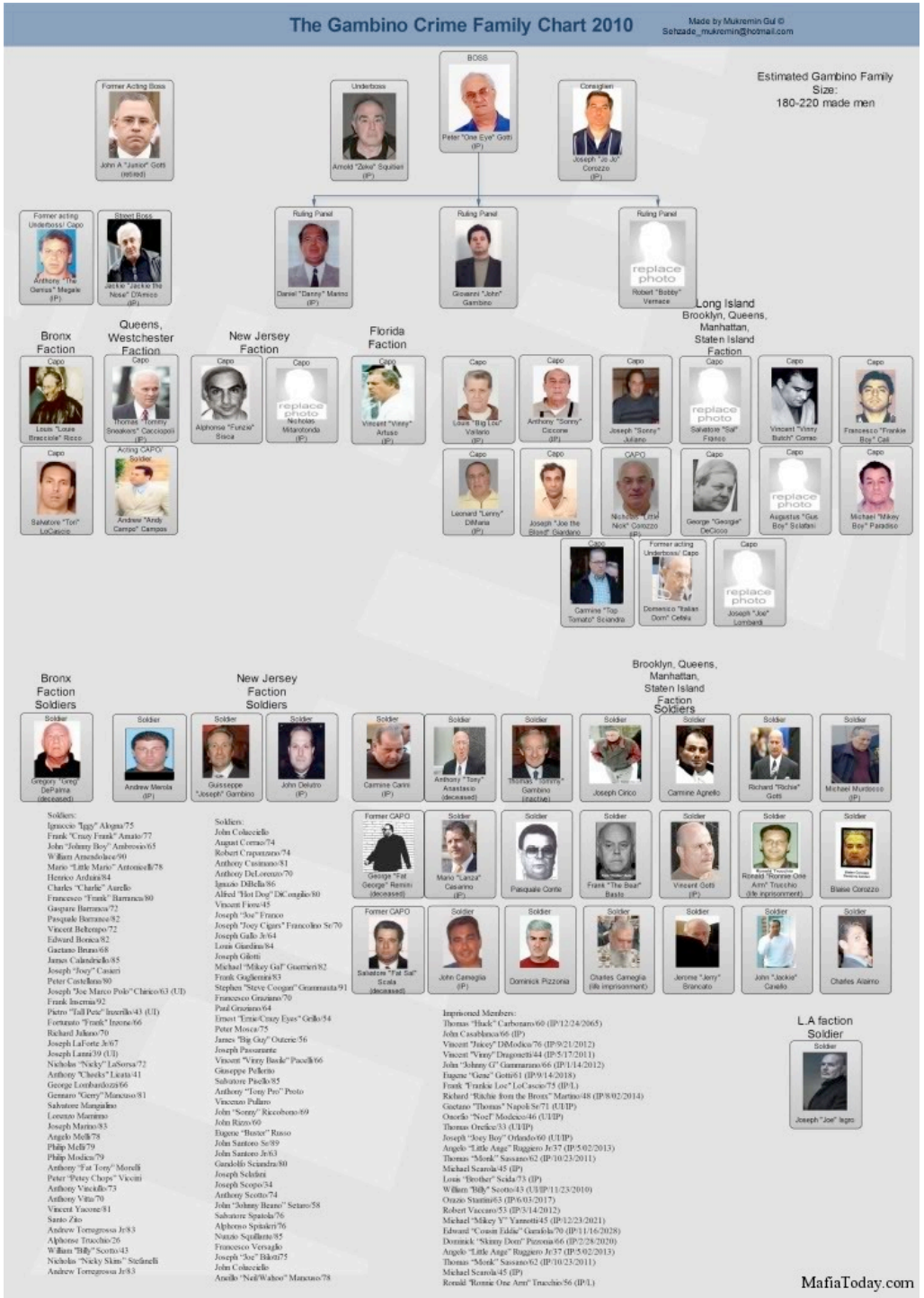
Current publication impact:

- instrumentation;
- pulsars;
- EoR;

- Clusters;
- AGN/galaxies;
- Algorithms;

- transients (fast and slow);
- solar, heliospheric, ionospheric.

http://mafiatoday.com/mafia-families-gangs-gangsters/mafia-family-charts-and-leadership-2011/



Overall impressions

- New instruments and upgrades of old instruments enabled by power, affordability, and usability of signal processing hardware, data transport (RF over fibre), computing facilities.

- Ever increasing capability of FPGAs, but increasingly HPC platforms and hybrid platforms make it "easy" to build "large-N" correlator architectures.

- New facilities and facility upgrades interact dynamically with new science (FRBs, pulsars, space weather etc etc) opportunities.

- Lessons for how to develop/build low frequency SKA??

- Is this good? Overall, brilliant!

- No SKA talks on the program. Talks on telescopes that exist and people/teams dealing with real data.

- Biggest technical challenges are in generalised/ optimised imaging/calibration algorithms, processing pipelines, and large-scale data handling.

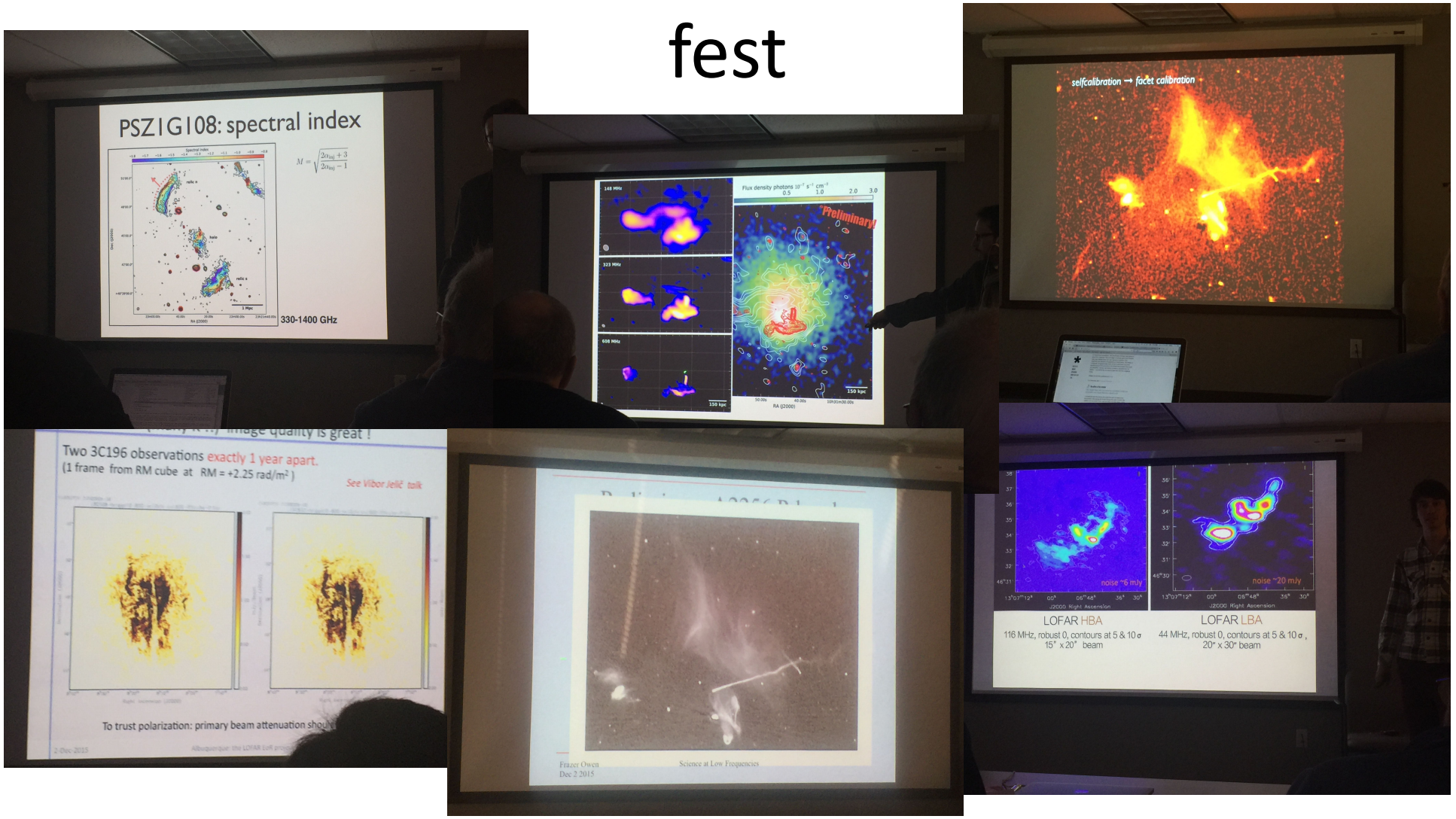
- A different challenge is to harness this community to design, build, and operate at the level of SKA, while keeping the dynamism of the current community and the diversity of approaches.

Highlights

- Instruments:
  - Abundantly clear that LOFAR has really now gathered huge momentum, across lots of science areas. Leading the way in low frequency astrophysics (many speakers);
    - Shows me that multi-use LOFAR++ scales are the future (SKA-low).
  - GMRT/Ooty show what is possible in refreshing existing instruments (Gupta/Chengular);
  - VLITE/VLITE-FAST – clever and effective (Clarke/Owen/Ray);
  - 21CMA still working!! (Zheng).

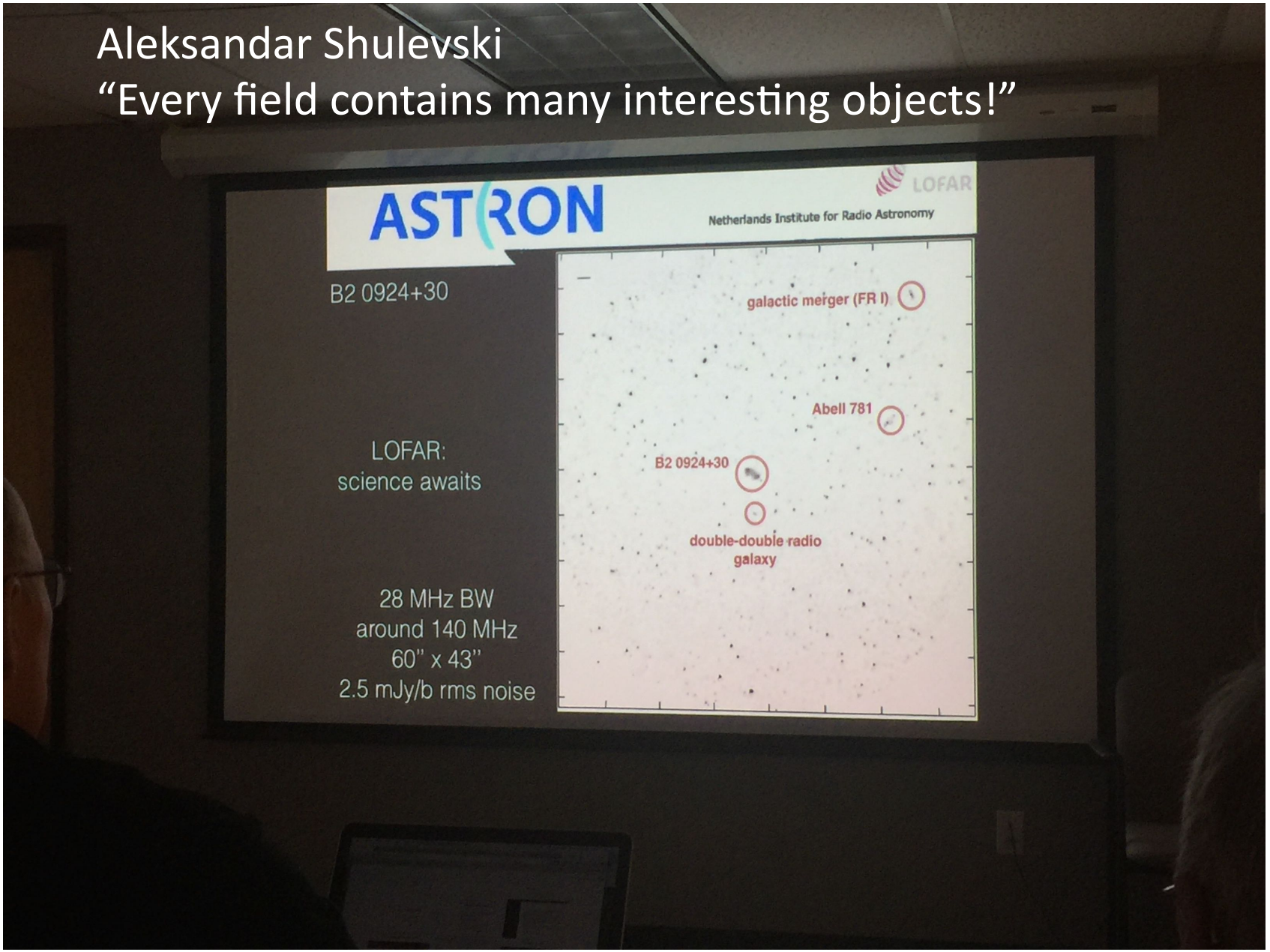
- Algorithms/software
  - WSCLEAN/AOFLAGGER being used/shared across different instruments (Offringa);
  - TraP being used/shared across different instruments.

Pure imaging quality….AKA a LOFAR-fest

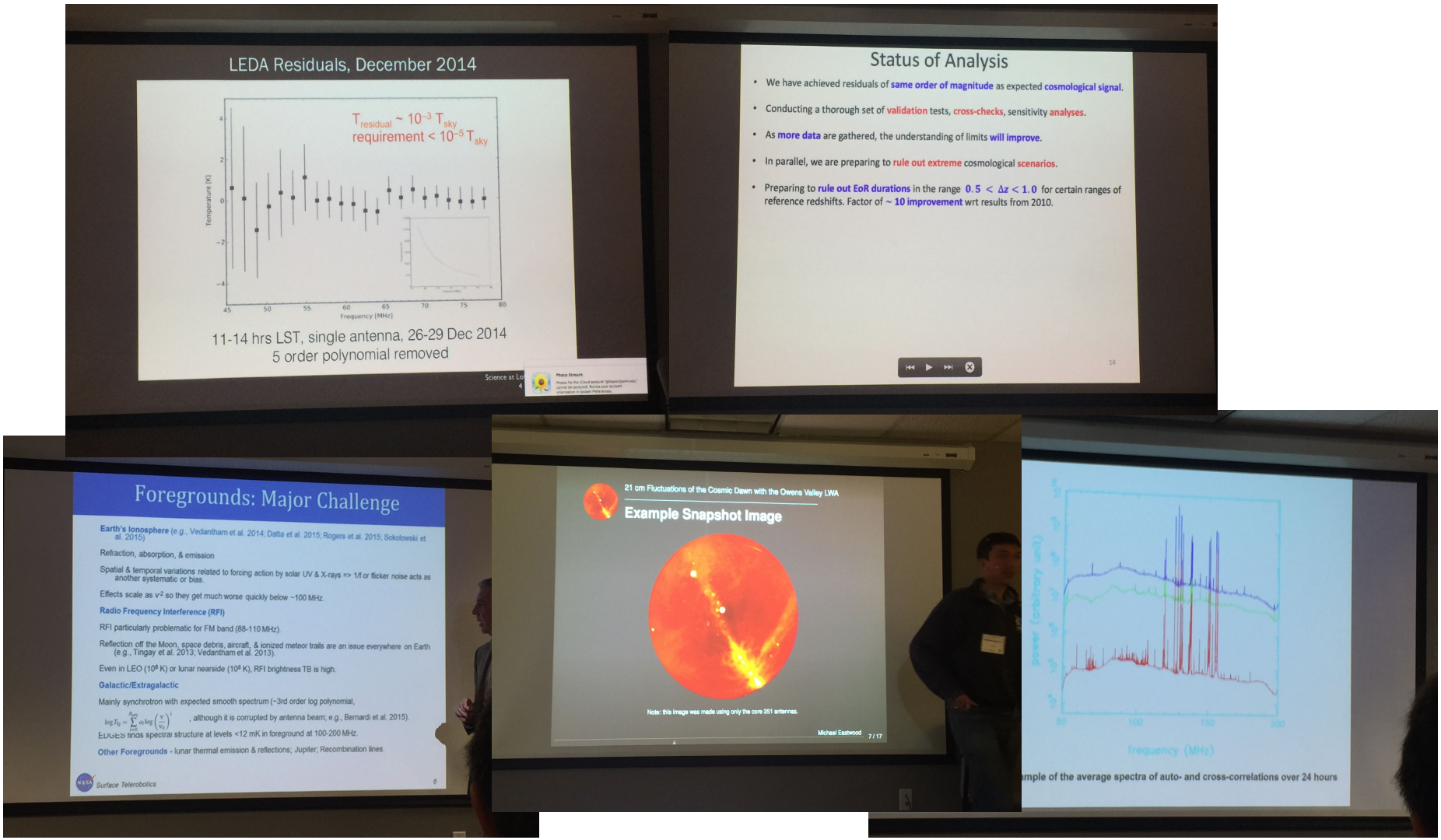


Aleksandar Shulevski

“Every field contains many interesting objects!”



Experiments across global signal and power spectrum techniques, interferometers etc etc

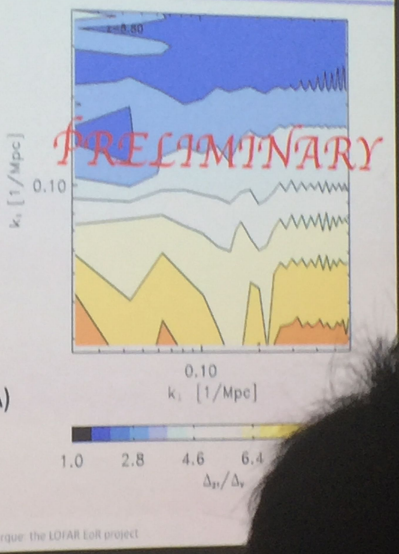


2-D power spectrum: ratio of Stokes I / V

Stokes V is close to the thermal noise level

Stokes I noise higher depending on frequency scale

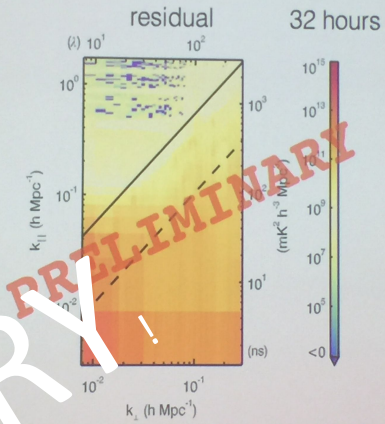
Possible sources of excess noise in Stokes I:
- miriad of faint sources
- imperfect subtractions
- foreground fitting (GMCA)
- ??



2-Dec-2015 Albuquerque: the LOFAR EoR project

LOFAR

After some data cuts*

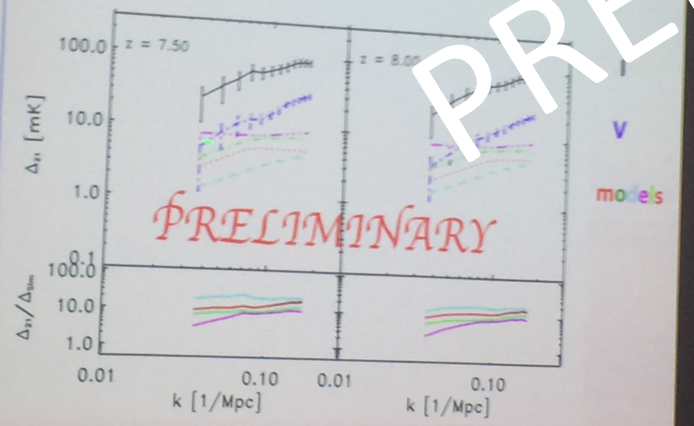


...n jackknives, delay spectra, and residual fluxes

MWA

PRELIMINARY

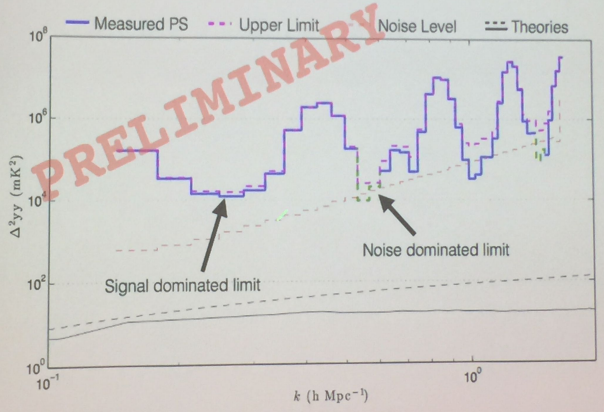
Upper limits on the 3-D power spectrum



Zaroubi etal, 2016

2-Dec-2015 Albuquerque: the LOFAR EoR project 25

Deep 1D Power Spectrum



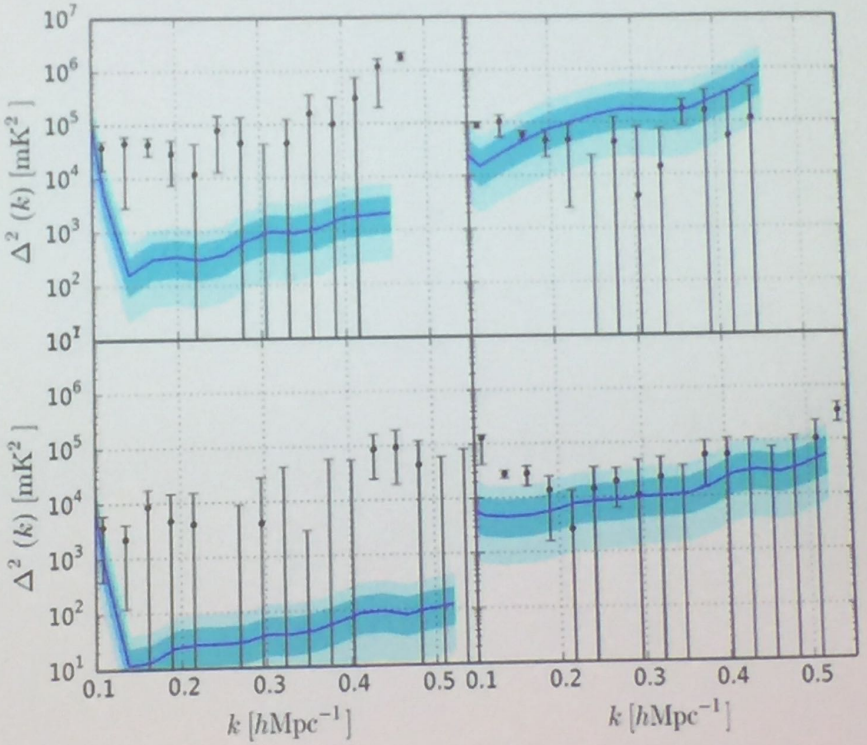
Penn

effective pol frac ~ 0.002

I Q

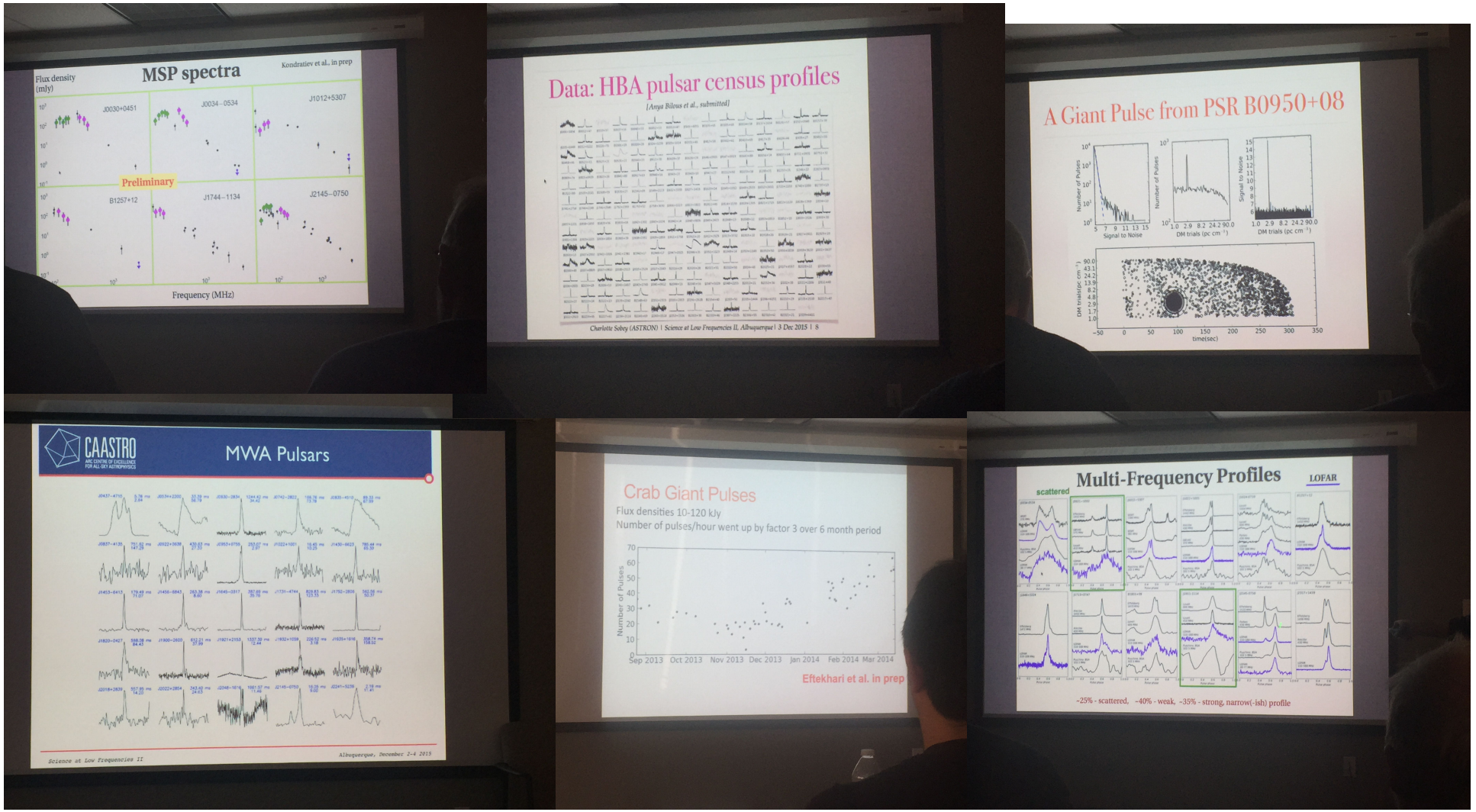
126 MHz

164 MHz



Moore et al. in prep.
Moore et al. 2013

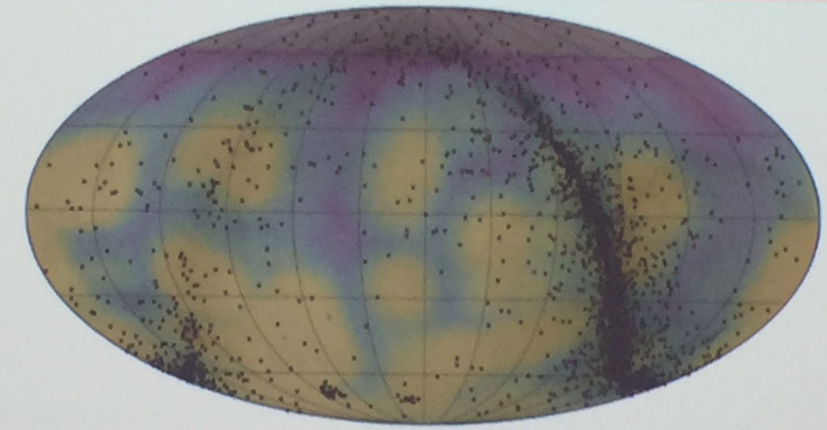
Pulsars, pulsars, and more pulsars…

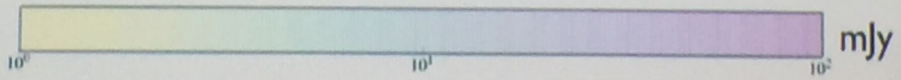


The sky on disk - forever

CAASTRO
ARC CENTRE OF EXCELLENCE FOR ALL-SKY ASTROPHYSICS

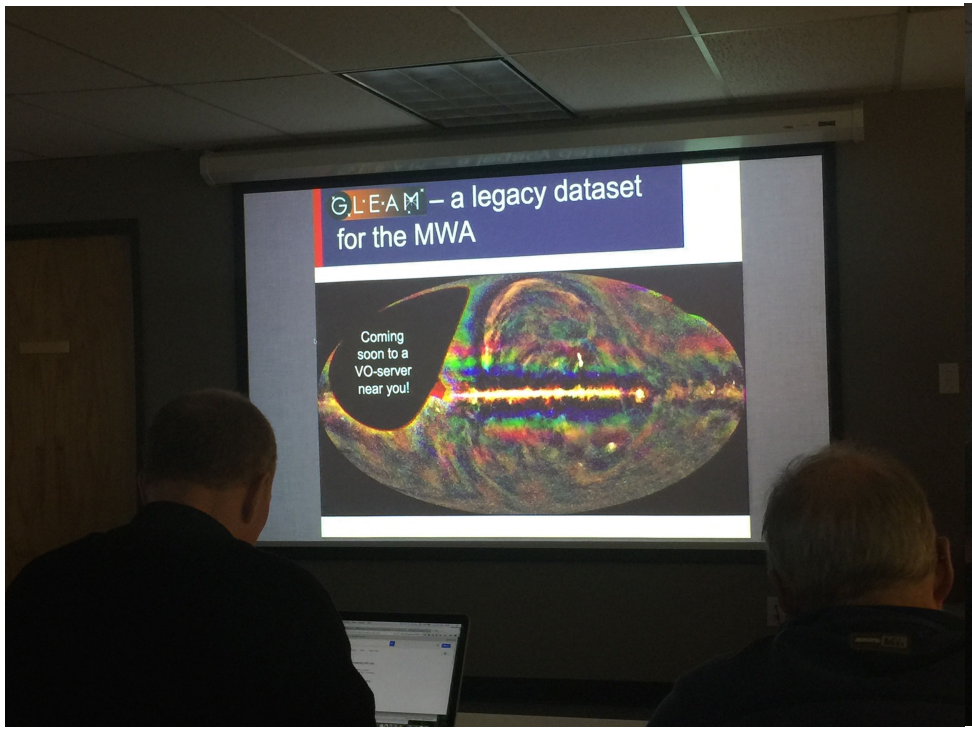
Archived MWA Voltages

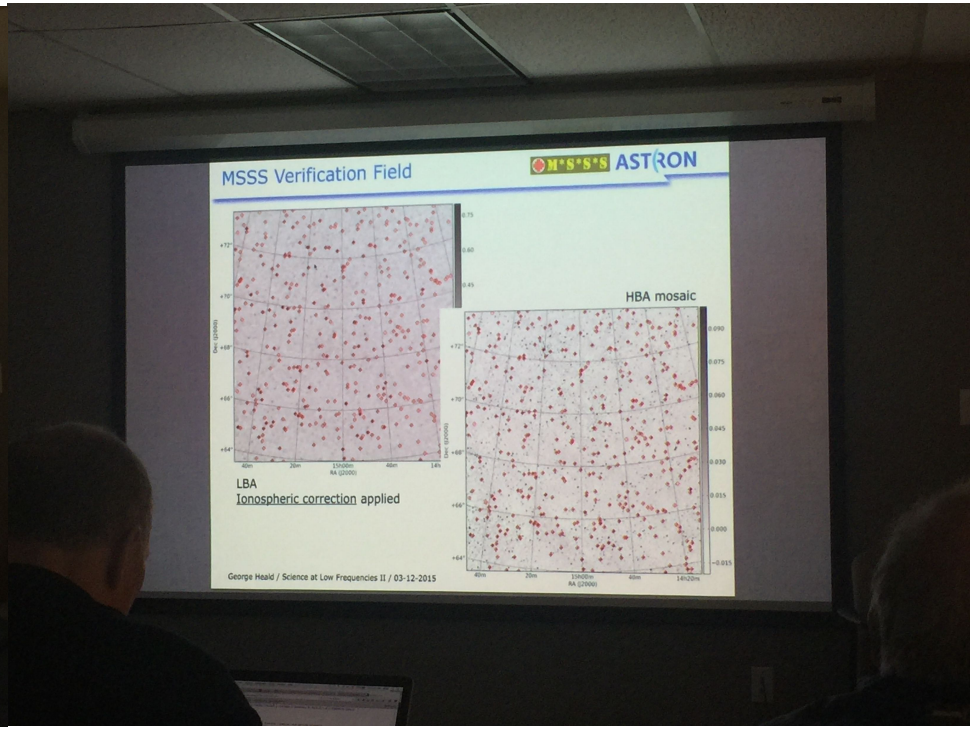




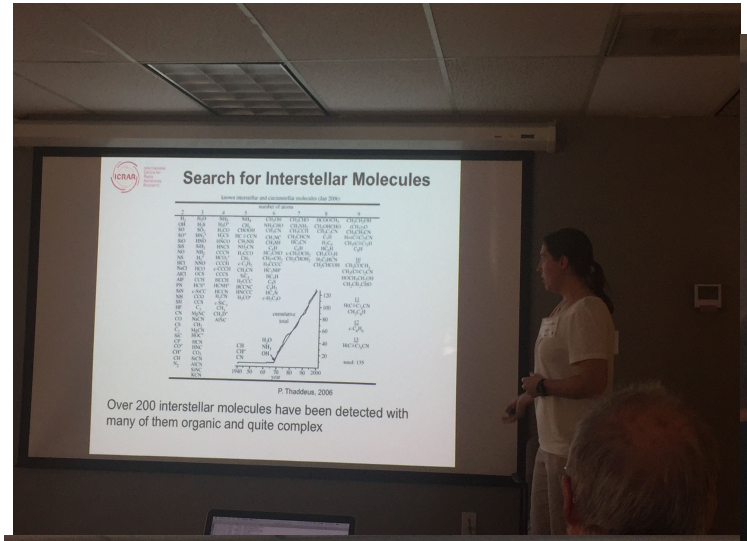
Integrated rms of archived VCS data (Oct. 9 2015)

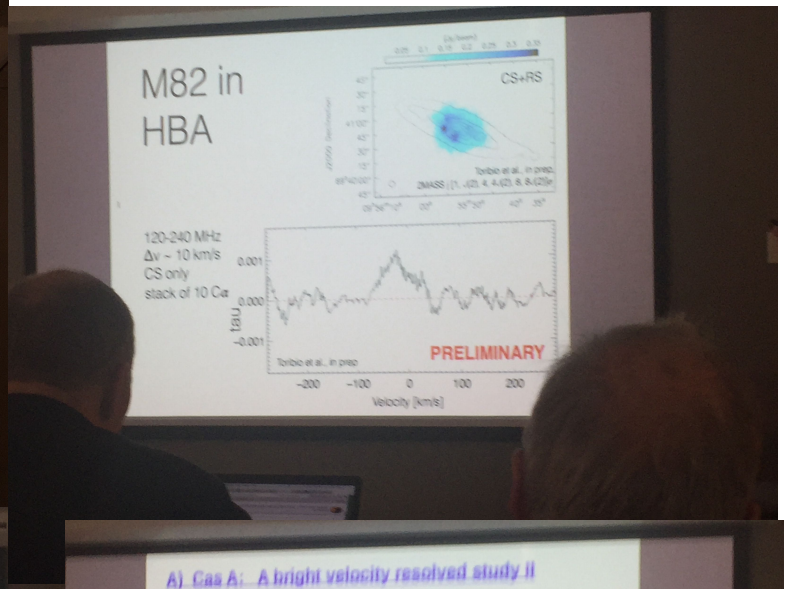
Continuum surveys (all-sky)

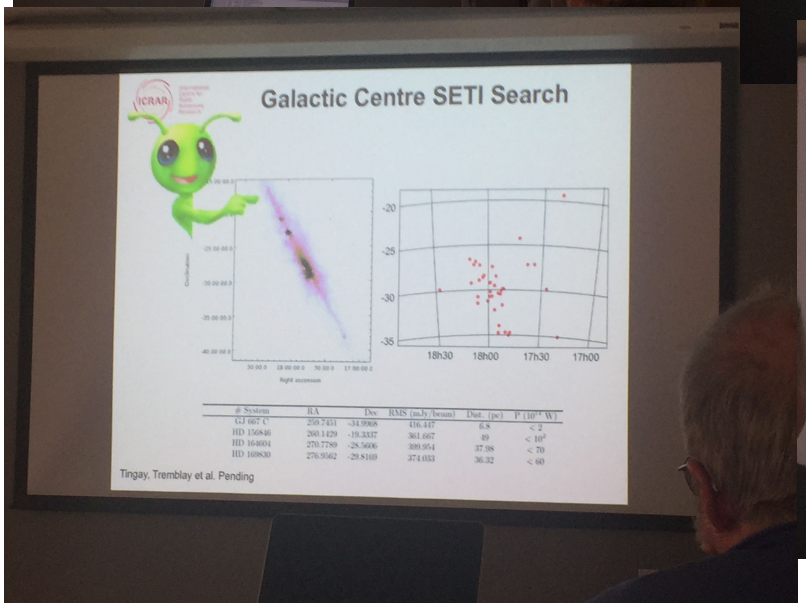


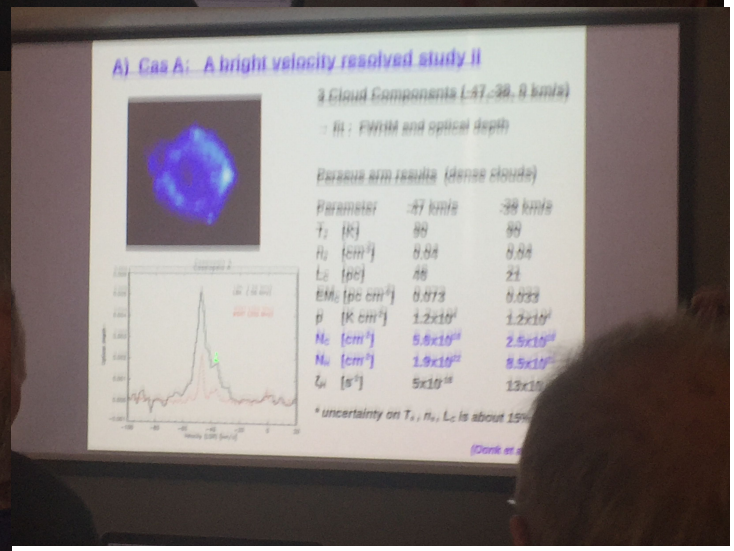


Molecules/spectral lines

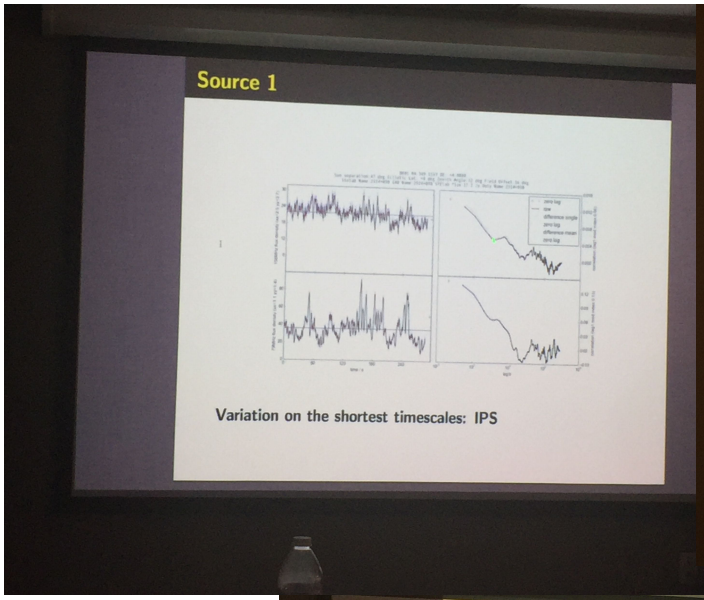


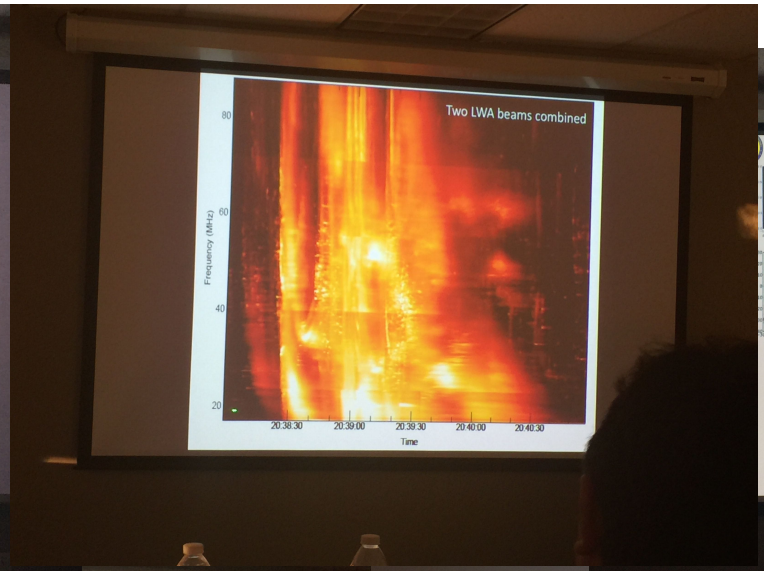


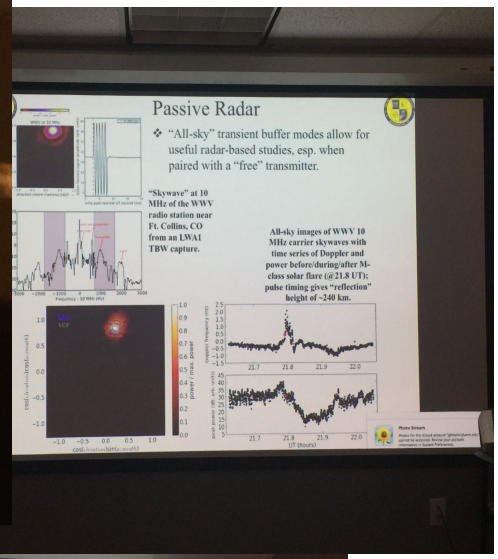


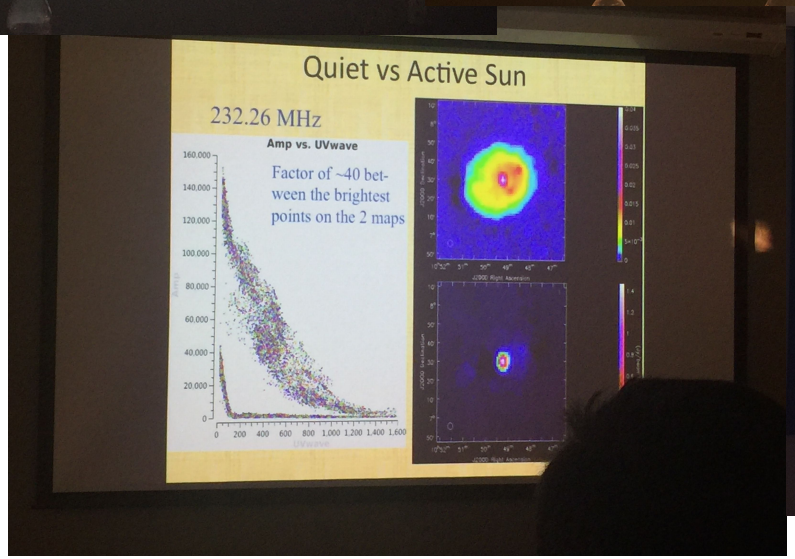


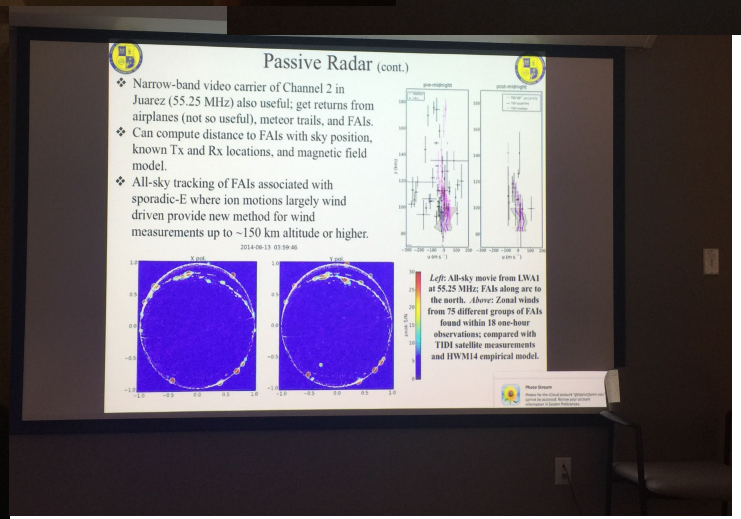
Solar and space science



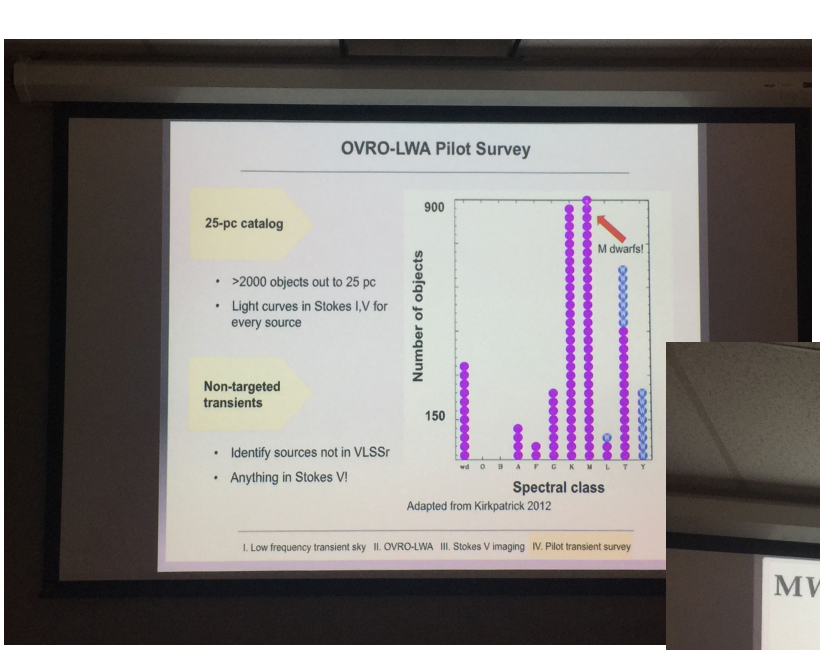


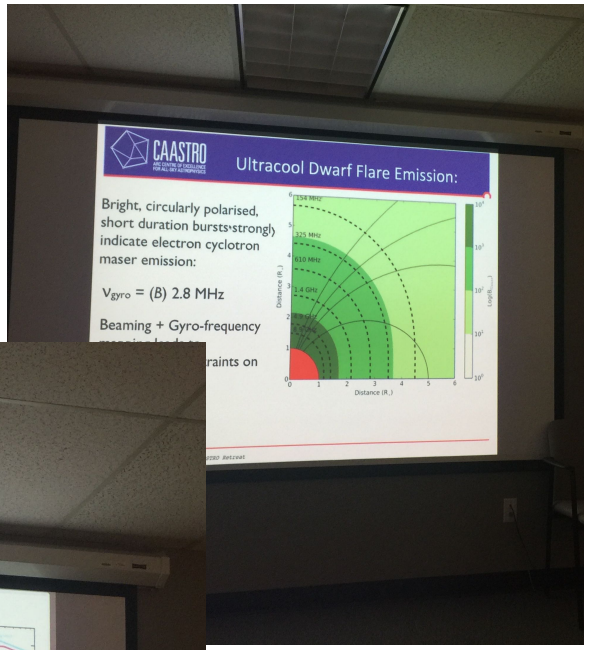


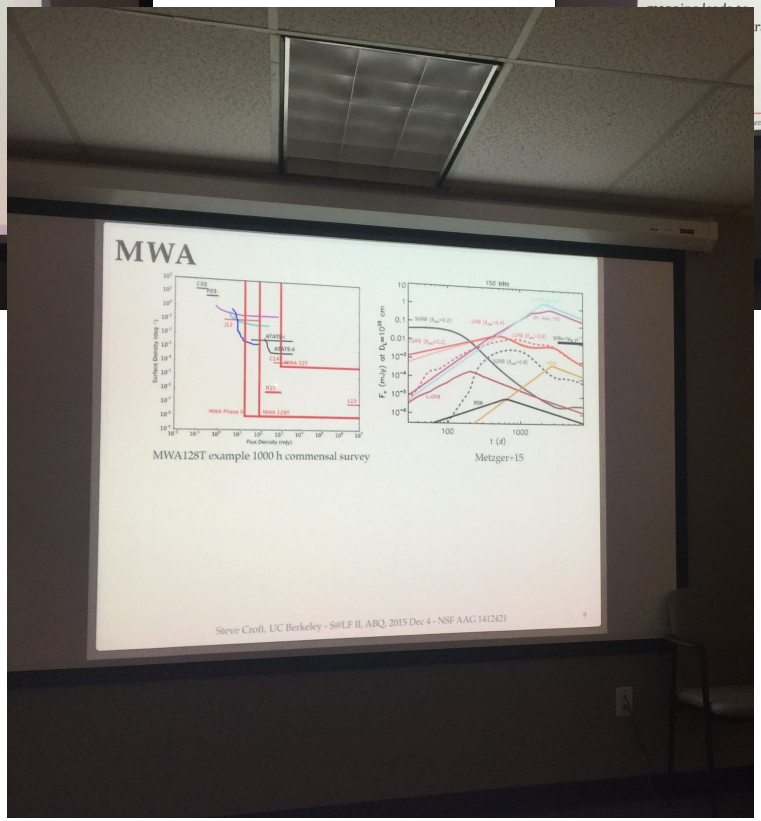




Transients (mostly slow)







BLIND TRANSIENT SEARCHES

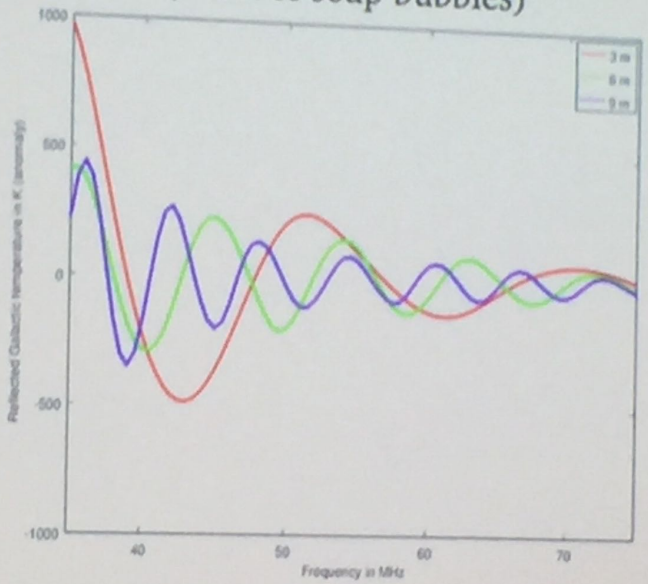
PI

Grad student

"In the field of observation, fortune favours the prepared mind" (Louis Pasteur, 1854)

“Know thy instrument” (Adam Beardsley, 2015)

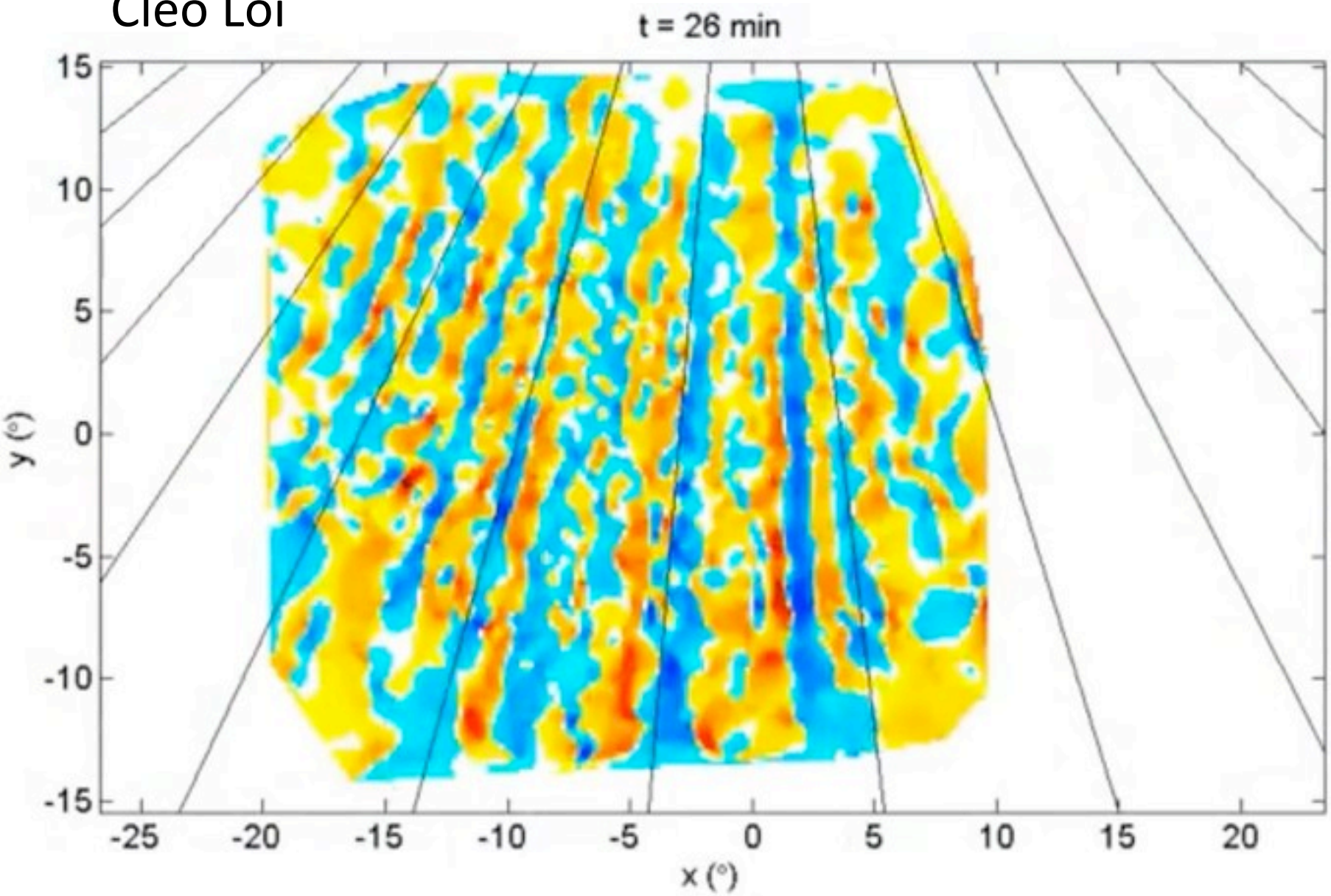
Albedo may be frequency dependent due to thin-film interference (think of soap bubbles)



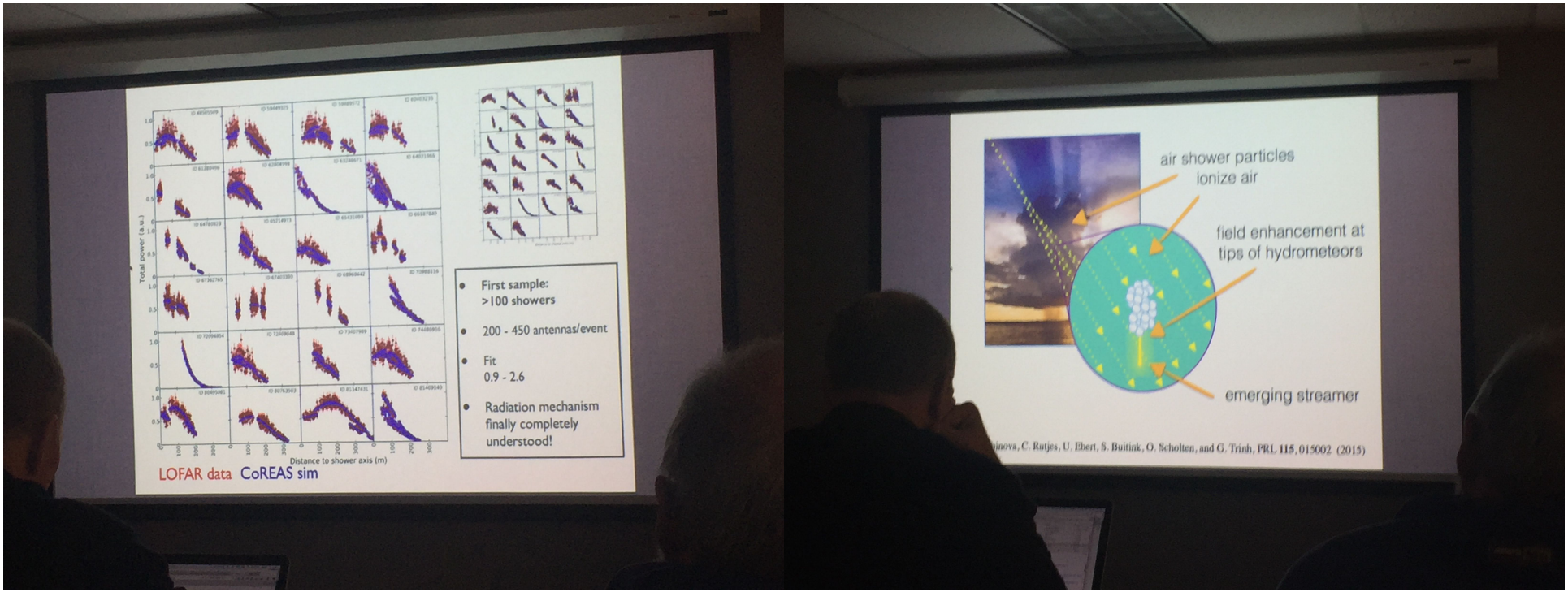
Might be a show-stopper for cosmic dawn experiment (future work)
Wealth of information on regolith vertical structure (first 10s on meters)

Harish Vedantham

Cleo Loi



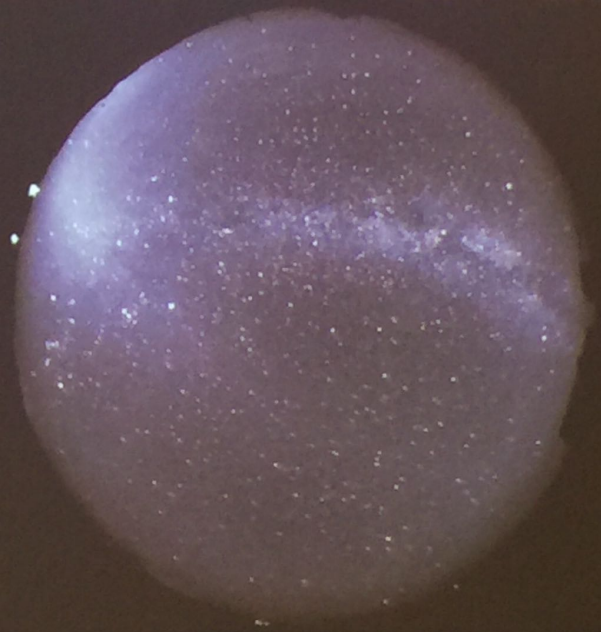
Stijn Buitink

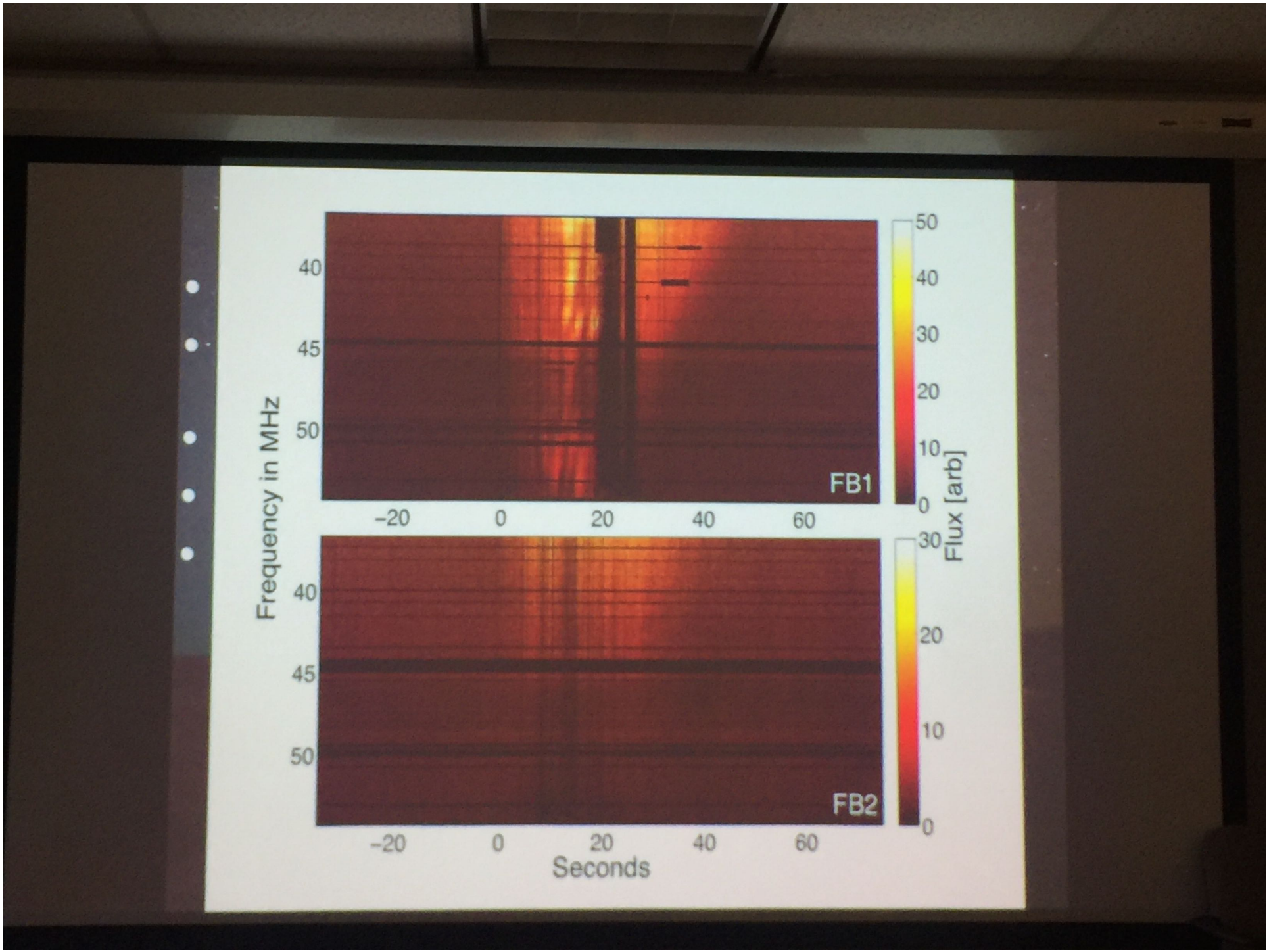


Ken Obenberger

Simultaneous Search for Radio and Optical Trains

- Goal is to see if the persistent trains are associated with the radio emission
- Run the LWA1 All-Sky imager
- Simultaneously Image the sky with two all-sky lenses attached to cooled CCDs
- take 5 s integrations every ~ 7-10 seconds
- Created a pipeline using the Hough Transform to pick out meteors
- We have detected 75 bright meteors in 13 nights, of observing during the Perseids and Leonids
- We also found 3 radio fireballs simultaneous with clear night observations




Frequency in MHz
40
45
50
FB1
−20
0
20
40
60
50
40
30
20
10
0
Flux [arb]
40
45
50
FB2
−20
0
20
40
60
30
20
10
0
Seconds

- Aside from ALMA, the most dynamic, diverse, and exciting area of radio astronomy (can't call it radio astronomy any more);

- Huge strength in instruments (diversity, flexibility, cost effectiveness);

- Huge strength in people (young, dynamic, unburdened by traditional radio astronomy);

But….

- Every instrument/facility is under-resourced to a greater or lesser degree;
- Ratio of fun things to people is too high;
- Ratio of PB to people is too high;
- Natural evolution is toward SKA-scale instruments…..change of thinking?