DACOTA

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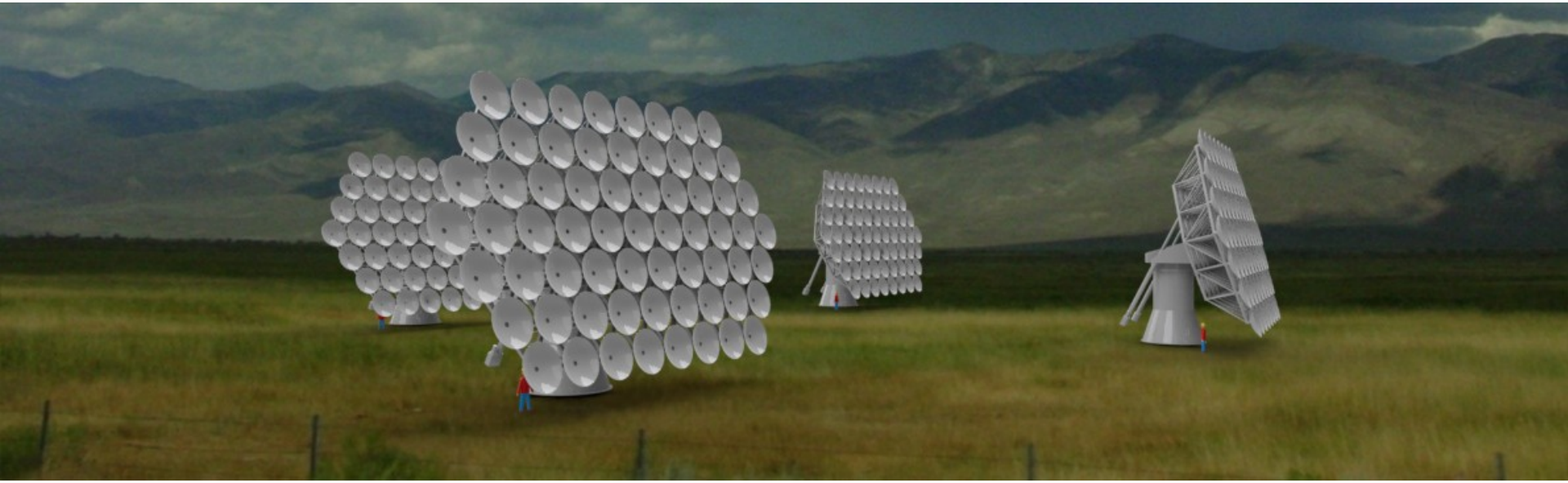
UC Berkeley

DACOTA

- Dense
- Array for
- COsmology and
- Transient
- Astrophysics

Our Logo

DACOTA



- Transients
- CO at redshift of EOR
- SZ Effect
- Galactic Water and Ammonia
- Other…

- Dense array of 4 x 64 x 2m antennas
- 10 – 40 GHz (2 feed horns)
- T_{sys} ~ 25 - 50 K
- 10 GHz Bandwidth, 8k channels
- Spatial FFT Correlator
- Resolution: 1’ – 22’
- Survey speed ~ EVLA speed
- 2 years to complete 100 deg^2 CO survey

Key Science

- Detect redshifted molecular gas from the epoch of reionization through integrated emission (intensity mapping)
- Is this the optimal means to understand the molecular gas?
- Is CO the best tracer?
- What else do we learn about galaxy evolution via this technique?

Driving Specifications

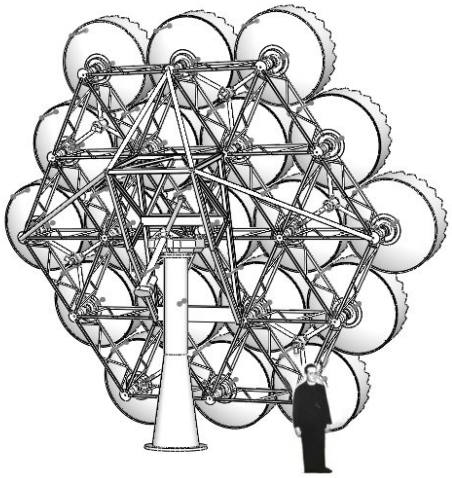
- ~1 microK in power spectrum on scales of ~10 arcmin
- Line widths ~300 – 1000 km/s
- Ultimately, need to survey volume large enough to address cosmic variance
- Two transitions of CO necessary to eliminate line confusion

Inteferometry vs. Single Dish

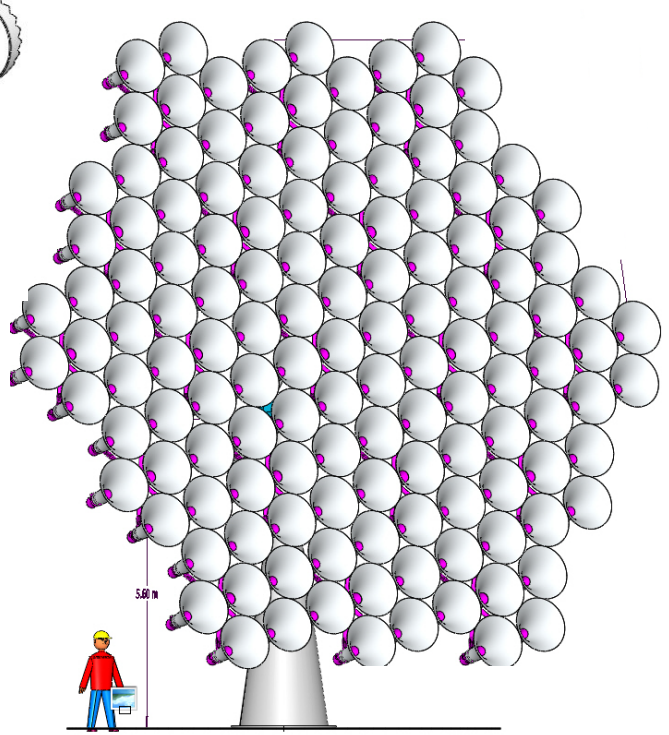
	Interferometry	Single Dish
Gain stability	✔	
K-mode targeting	✔	
Calibration flexibility	✔	
Cryogenic complexity		✔
Digital complexity	?	✔
Other science applications	?	?

Bracketing Strawmen

- 1.8m x 19 x N

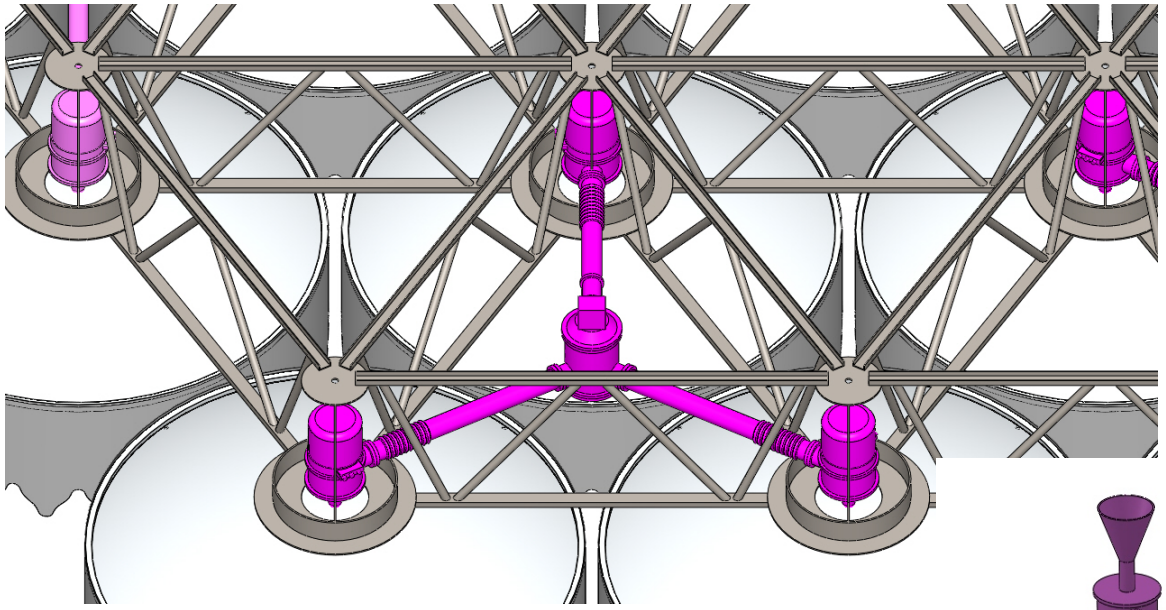


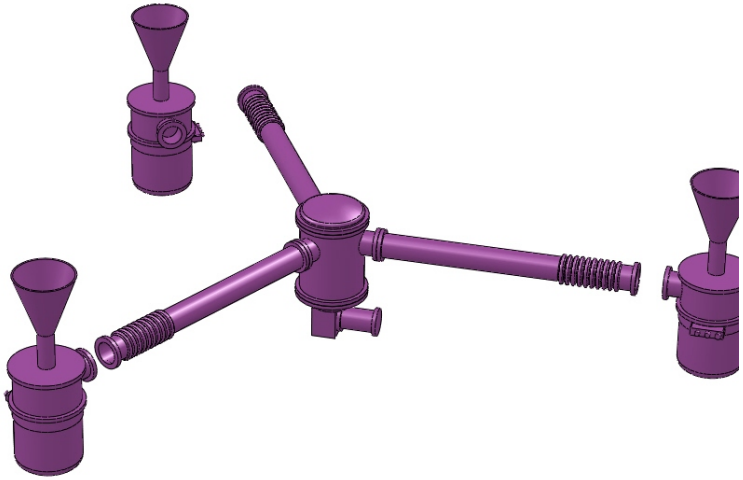
- 1.0m x 133 x n



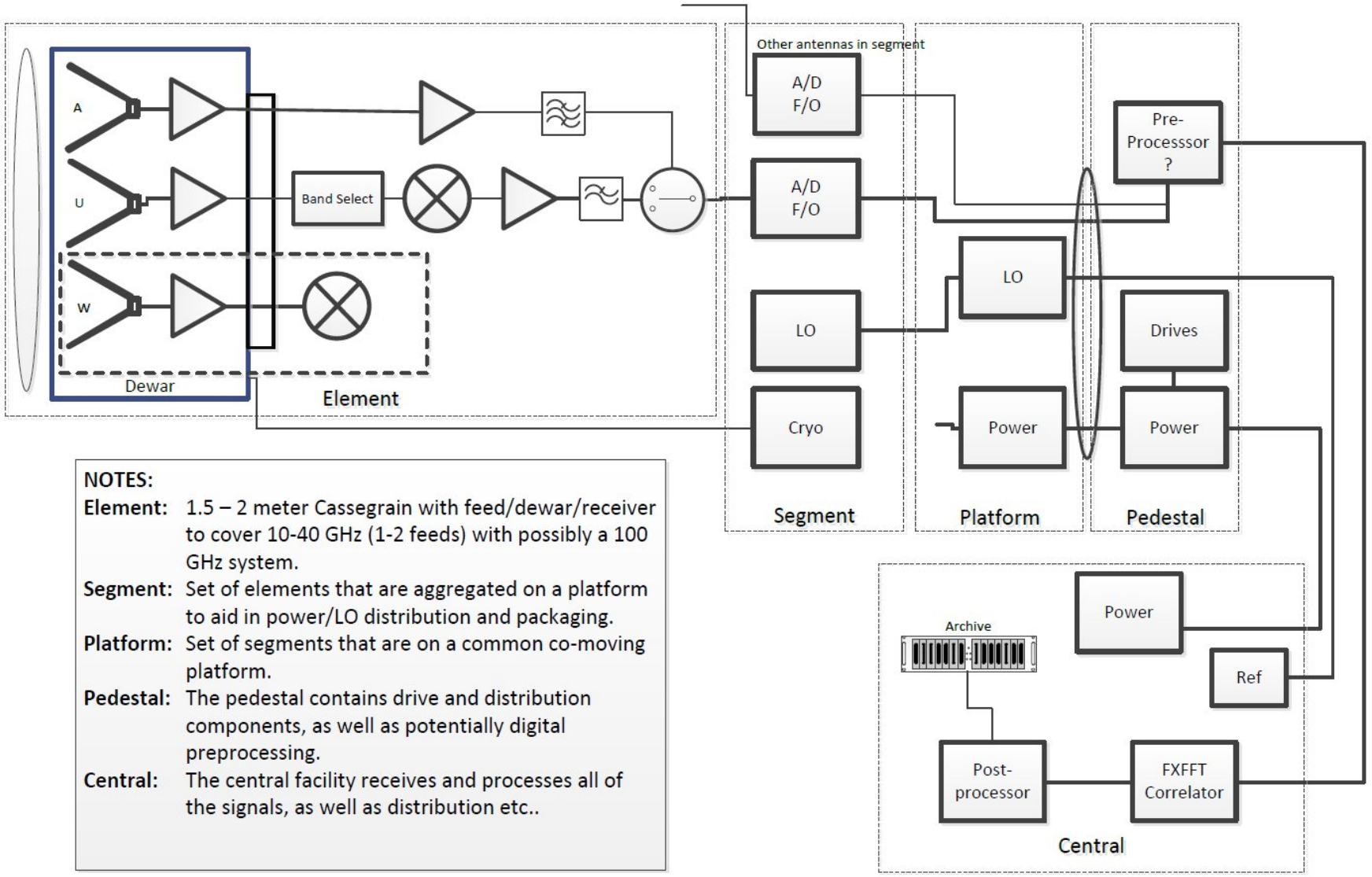
- Cost drivers: receivers & correlators

Simplify Cryogenics





System



NOTES:

Element: 1.5 – 2 meter Cassegrain with feed/dewar/receiver to cover 10-40 GHz (1-2 feeds) with possibly a 100 GHz system.

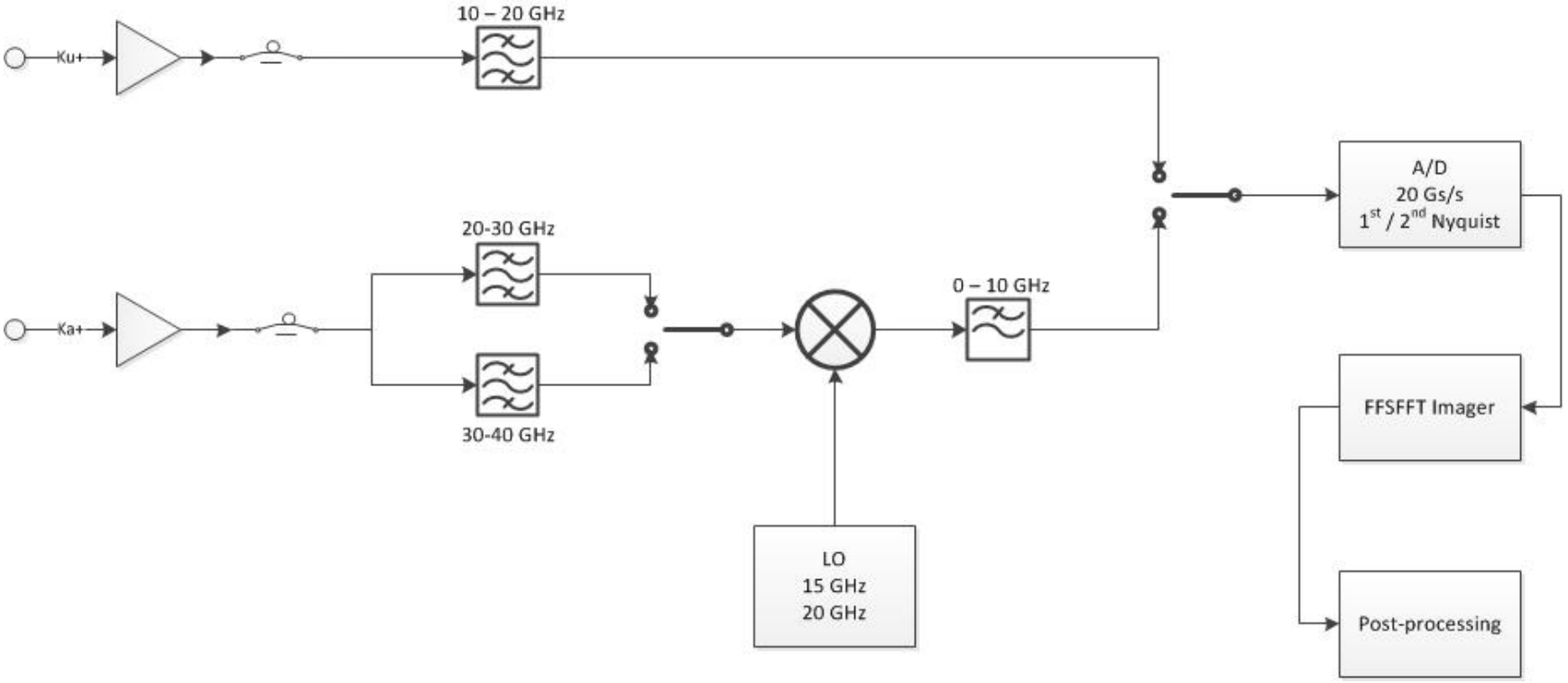
Segment: Set of elements that are aggregated on a platform to aid in power/LO distribution and packaging.

Platform: Set of segments that are on a common co-moving platform.

Pedestal: The pedestal contains drive and distribution components, as well as potentially digital preprocessing.

Central: The central facility receives and processes all of the signals, as well as distribution etc..

Receiver


Ku+
10 – 20 GHz
Ka+
20-30 GHz
30-40 GHz
0 – 10 GHz
LO
15 GHz
20 GHz
A/D
20 Gs/s
1st / 2nd Nyquist
FFSFFT Imager
Post-processing

Direct Imaging Correlator

- N log(N) processing of N^2 baselines
- Real-time results
- Far fewer data products

But there's no going back…

Conclusions on Calibration

- Calibration very feasible (phew)
- Additional calibrators feasible with additional collecting area
- Algorithm development will be required
- Modeling of calibrator fields will likely be required, should be considered early science/engineering goal

DACOTA Workshop

- 3 – 4 August 2011, Berkeley
- Participants
  - Adam Lidz
  - Tzu-Ching Chang
  - Aaron Parsons
  - Chris Carilli
  - Lincoln Greenhill
  - Yuh-Jing Hwang
  - Matt Fleming
  - Carl Heiles
  - Dick Plambeck
  - Dave DeBoer
  - Mel Wright
  - Geoff Bower
  - Garrett Keating
  - Bill Holzapfel
  - Alberto Bolatto (Telecon)
  - Steve Furlanetto (T)
  - John Carlstrom (T)
  - Dan Marrone (T)
  - Steve Myers (T)

- Outcomes
  - Central theoretical question of CO luminosity in low-mass galaxies:
    - What is the optimal redshift to probe?
    - Should we probe CII instead?
    - ALMA/EVLA measurements unlikely to inform on this question.
  - Cross-correlation of CO J=1-0 and J=2-1 is powerful discriminant
  - Cross-correlation of CO & HI is potentially powerful…
    - but may be difficult to match resolutions, sky coverage, etc
  - Foregrounds are manageable (but require more thought)

  - Take a phased approach to deployment
  - Phase 1: Optimize DACOTA for power spectrum detection on large angular scales (*must learn to think in k-space!*)
  - Phase 2: Imaging, larger angular scales

Additional Science

- SZ effect
  - DACOTA angular scales probably too large
- Transients
  - OGRBAs, TDFs, GW counterparts
- Galactic gas
  - Spinning dust
- Zeeman effect
  - CCS is potential target
- …
- Can an instrument optimized for the key project be powerful for other topics?

Technology Spin Offs/Synergies

- FFT correlator development
  - Real time calibration & imaging
  - More suitable for this than low-frequency telescopes
- Large-N cm receiver development
  - Exploit efforts for ALMA band 1
- EVLA collecting area expansion concept
  - Use of phased array signals
- Potential CARMA collaboration

Next Steps

- Design Optimization for Phase 1
  - Dish diameter (D/2 for λ/2)
  - Horns or dishes?
  - Number of elements & configuration: linear or grid?
  - Third axis for parallactic angle correction
  - Optimal redshift range