

The Path to HERA

Colin J. Lonsdale

MIT Haystack Observatory

Status of the Technology

- EoR is the most demanding application
- EoR is the most compelling application
- Getting it right for EoR serves SKA goals
- 3 EoR- and SKA-relevant implementations
 - MWA
 - PAPER } = HERA phase 1
 - LOFAR
- Each is based on different design principles

	MWA	PAPER	LOFAR
antenna	symmetric bowtie dipole	broadband dipole with shaped groundscreen	asymmetric fat dipole
steerable?	yes	no	yes
beamforming	1 level analogue	none	2 levels, analogue + digital
architecture	<p style="text-align: center; color: red; font-size: 2em; font-weight: bold;">There are MAJOR differences between these approaches</p>		
observability			
calibration strategies			
rennement			
design emphasis	information flow, solution overconstraint	antenna pattern, incremental development	station beam, collecting area, manufacture

Which approach is best?

- We don't yet know
- We **can't** know until full scale experiments are executed and analyzed
 - Far too many unknowns
 - Depends on algorithms not yet developed
 - Depends on sky properties not yet measured
 - Depends on performance not yet assessed
- Some other approach may in fact be best!

When will we know?

- Not until MWA, PAPER and LOFAR are completed and evaluated over time.
- US Timeline laid out in HERA documents
 - HERA-I experiments 2010-14
 - HERA-II design+development ~2012-15
 - HERA-II construction ~2015-17
 - HERA-II operations ~2018-21
 - HERA-III 2020 onward
- ~3-4 years until HERA-II design converges

Non-EoR Science

- Galactic, extragalactic, solar, time domain, ...
- Flexible and capable technology
 - LOFAR will explore many applications
 - HERA technology is complementary
- In US, other science must be independently justified and funded
 - Try not to design out capabilities unnecessarily
 - Must not undermine EoR focus
 - Exploit capabilities of the EoR instrument
 - Augment where feasible and affordable

HERA Technical Directions

- Larger-N designs
 - Based on current understanding, this is helpful
- Earlier digitization
 - Per-dipole if possible
 - Becoming more affordable
- Novel architectures
 - FFT arrays? Highly redundant measurements?
- Lower frequencies?
- Details (and detailed design) **must** be driven by EoR experience in next few years

The HERA Plan

- Astro 2010 survey endorsed EoR, HERA
- US groups focused on EoR as prime driver
- Will pursue HERA-II plan and \$100M scope
 - Complete HERA-I (MWA + PAPER)
 - Use lessons learned for HERA-II design
 - Thorough preparation for HERA-II investment
 - Timeline driven by EoR needs

END