DARE Mission Overview

The Dark Ages Radio Explorer (DARE) reveals when the first stars and galaxies formed in the early Universe and their characteristics, from the Dark Ages (z=35) to the Cosmic Dawn (z=11) (~80-420 million years after the Big Bang). **This time period in the Universe has never been observed.** The DARE Observatory is composed of a dual bicone antenna, pilot tone stabilized polarimetric receivers, and a spectrometer, which measures the redshifted 21-cm spectrum from neutral hydrogen that surrounds the first luminous objects at frequencies 40-120 MHz. DARE acquires data from the only truly radio-quiet environs while in orbit above the lunar farside. DARE explores an entirely new epoch in the early Universe as a successor to WMAP/Planck observations of the Cosmic Microwave Background and in conjunction with JWST observations of bright galaxies during Cosmic Dawn.

DARE realizes NASA's strategic objective in astrophysics to:

"...explore how (the Universe) began and evolved..."

DARE executes small-scale mission described in Astrophysics Roadmap:

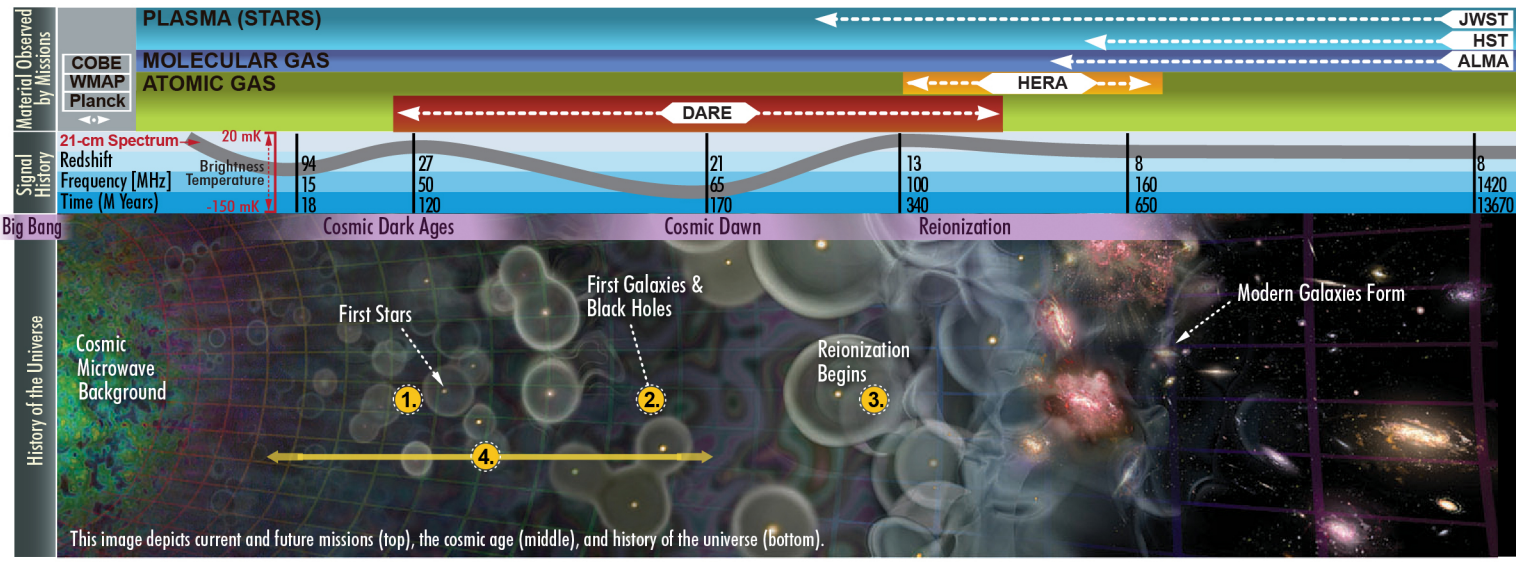
"Mapping the Universe's hydrogen clouds using 21-cm radio wavelengths via lunar orbiter from the farside of Moon."

DARE Science Goal:

Investigate first stars and galaxies along with their environs.

DARE Science Objectives:

1. Determine when the First Stars ignited and their characteristics.
2. Determine when the first Black Holes began accretion and their characteristics.
3. Determine the Reionization history of the early Universe.
4. Determine if there is evidence for exotic physics, such as Dark Matter decay, in the Dark Ages.



This image depicts current and future missions (top), the cosmic age (middle), and history of the universe (bottom).

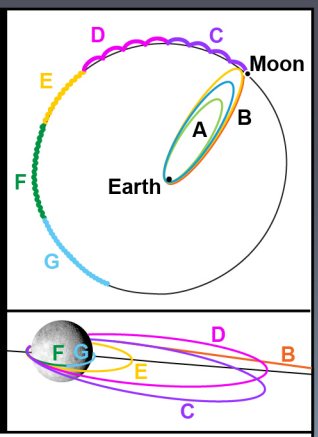
Mission Overview

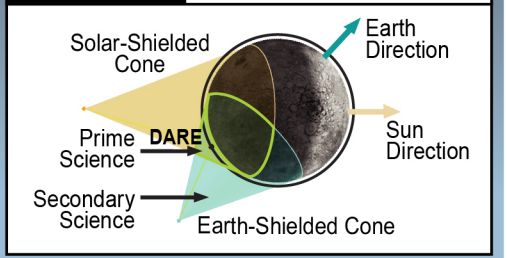
DARE's lunar orbit provides efficient access to the radio-quiet zone above the lunar farside. At this location, the DARE spacecraft is shielded from Earth's ionosphere, human-generated RFI, and solar interference, opening the entire RF spectrum to astronomical use.

Key features of the DARE mission design include:

- Baseline DARE launch date of August 2023
- Compatible with NASA's standard launch service capability
- Proven Earth phasing loop transfer trajectory with insertion into an equatorial lunar orbit
- 50x125 km "frozen" lunar science orbit with 0-3° inclination optimizes science observation and elimnates the need for orbit maintenance
- 2-years of science operations at the moon meets all science requirements
- Ample propellant margin and unused propellant tank capacity

(A) DARE phasing orbits
(B) Lunar transfer orbit
(C) Lunar insertion 18 hr orbit
(D) Inclination trim orbits from 5° or 20° to equatorial 0-3°
(E) Apoapsis lowering into 4 hr orbit
(F) Staging orbit
(G) Frozen science orbit





DARE Project Team

Principal Investigator:
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Project Manager:
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Project Systems Engineer:
Robert Hanel, NASA ARC

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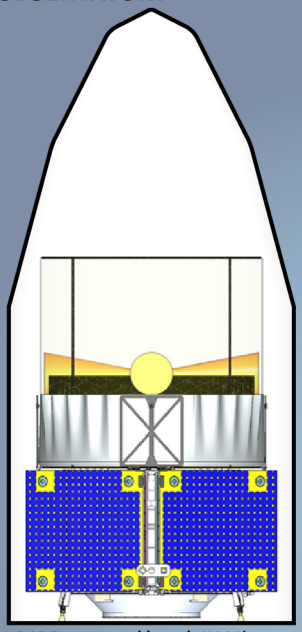
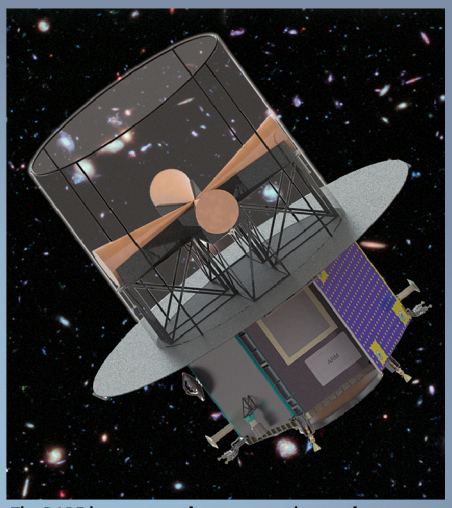
PARTNER-

OBSERVATORY



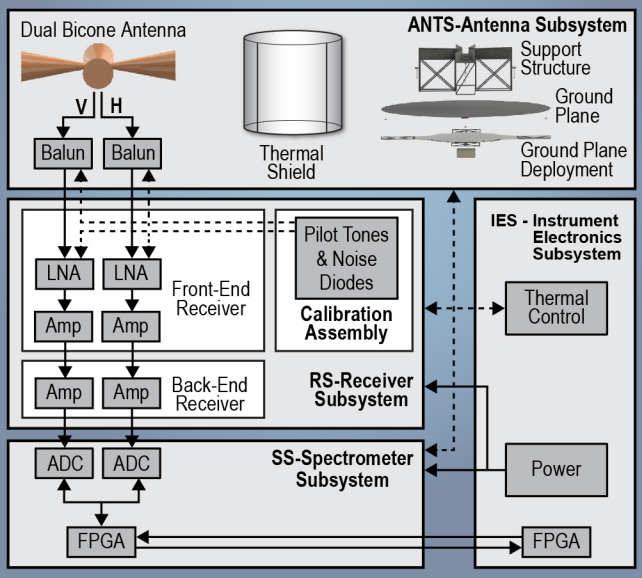
DARE is compatible with NASA's standard launch service capability.



The DARE bus consists of an integrated suite of flight-proven components and traces its high heritage to Kepler, Deep Impact, WISE, STPSat2, STPSat3, and GPIM.

SCIENCE INSTRUMENT

The DARE instrument is comprised of four subsystems: dual-polarization Antenna, pilot tone calibration Receiver and temperature control, high-resolution digital Spectrometer, and a standard Instrument Electronics for power, data handling, and instrument control that interfaces simply with the S/C. This radiometer is the only instrument needed to produce the science data that meets the science requirements.



OBSERVATORY CHARACTERISTICS

Total Dry Mass (MEV)	588 kg
Total Wet Mass (MEV)	1002 kg
Array Power BOL/EOL	1010W / 910W
DV Available	1260 m/s
EMI	50 dB shielding better than MIL-STD-461F
Communications	Ka-Band & S-Band
Data Storage	12 GB
Solar Array Type	Fixed panel

OBSERVATORY MARGINS

Launch Mass	59%	Data Downlink	>3 dB
Power (EOL)	31%	EMI	41%
Science Data Storage	99%	Unused Propellant Tank Capacity	11%
Pointing Knowledge & Control	233%/ 73%	ΔV, Statistical losses/corrections	290%

WBS	WBS Element	FY17$K
01	Project Management	5,709
02	Systems Engineering	4,731
03	S&MA	4,127
04	Science/Technology	12,797
05	Instrument	59,182
06	Spacecraft Bus	55,892
07	Mission Operations	24,936
08	Launch Vehicle	-
09	Ground Systems	$7,090
10	Observatory I&T	15,066
	Reserves	54,424
	% Reserves	29%
	ARC CM&O	5,885
	PI-Managed Mission Cost:	249,840
	Contributions:	2,990
	Total Mission Cost:	252,830

Cost Reserves (Phase B-D):
37% Instrument
28% S/C Bus
31% Phases B-D Average

Cost Reserves (Phase E-F):
15% Phases E/F Average

Schedule Reserve & Margin:
33.6 wks FSR on critical path
59.4 wks additional schedule margin

Risk Mitigation Budget Total:
$6,275K

Risk Mitigation Budget Prior to PDR:
$4,325K