PICO -Probe of Inflation and Cosmic Origins

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Executive Committee Crill, Bock, Borrill, Devlin, Flauger, Hanany, Jones, Knox, Kogut, Lawrence, McMahon, Pryke, Trangsrud

> Steering Committee Bennett, Dodelson, Page

PICO in Brief

- Millimeter/submillimeter-wave, polarimetric survey of the entire sky
- 1.4 meter aperture telescope
- 21 bands (25% bandwidth) between
 21 GHz and 799 GHz
- Diffraction limited resolution: 38' to 1'
- 12,356 transition edge sensor bolometers + multiplexed readouts
- 4 year survey from L2
- Open collaboration led by Executive and Steering Committees



Explore How The Universe Began

- Detect or set upper bound on the energy scale of inflation
 Figures are proposal ne
 - $\sigma(r) = 5 \cdot 10^{-5}$
 - $r < 10^{-4}$ 95%
- Figures are from proposal, need updating; Values quoted need checking/ updating



- includes internal delensing and foreground separation (uncorrelated foregrounds)
- Excludes systematic uncertainties



Explore How The Universe Began

 Exclude classes of potentials as the driving force of inflation

Figure is from proposal, need updating

- Detection is a first observation of quantum gravity
- Detection motivates connection between large field inflation and string theory



Discover How The Universe Works

- Determine the number of relativistic degrees of freedom in the early Universe: $\sigma(N_{eff}) = 0.027$
- Determine the sum of neutrino masses: Figures are from $\sigma(\Sigma m_{\nu}) = 14 \text{ meV}$ Green is working

on revisions



Discover How The Universe Works

 Determine neutrino mass hierarchy, or mass of the lightest neutrino (if mass hierarchy known)



Figure is from S4 Science Book, Dan Green is working on new version

Explore how the Universe Evolved

• Determine the reionization history of the Universe



Nick and Marcelo are working on a new figure. Red dots (= various simulated models would be eliminated)

Explore how the Universe Evolved

• Extragalactic Science TBC

Explore how the Universe Evolved

- Determine the role of galactic magnetic field in Milky Way dynamics and star formation efficiency
- Determine whether the Milky Way magnetic field is unique by comparing to other galaxies
- Include other points? need to discuss with Laura/Dave

Laura and Dave are working on visuals

Legacy Science

- Discover thousands of protoclusters selected homogeneously over the sky and extending to high redshift: determine the initial stages of cluster formation and evolution
- Discover thousands of magnified dusty sources: learn about dark matter substructure; probe star formation history in high-z dusty galaxies
- Detect polarization properties of thousands of radio and dusty galaxies

Visual to be completed. Need to talk to Giancarlo. Need comparison to current state of knowledge

PICO Status - I

- 5/17 12/17:
 - clarified science case
 - designed instrument
 - conducted community workshop to discuss foregrounds
 - identified key sources of systematic uncertainty
- First instrument-TeamX: Dec. 19 21, 2017 (awaiting final summary)
 - Instrument design mature; no technical challenges identified
 - Instrument cost within initial estimates

PICO Status - II

- 1/18 6/18:
 - simulate extraction of science in the presence of foregrounds and systematics
 - refine instrument design: second instrument-TeamX in March
 - prepare for mission-TeamX in March
 - PICO Science and Complementarity Workshop (May in Minneapolis)
- 6/18 12/18 Report writing

Additional Slides