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Construction of a Quantum Matter Synthesizer JONATHAN TRISNADI, MICKEY MCDONALD, CHENG CHIN, James Franck Institute, Enrico Fermi Institute, and Department of Physics, University of Chicago — We report progress on the construction of a new platform to manipulate ultracold atoms. The Quantum Matter Synthesizer (QMS) will have the capability of deterministically preparing large 2D arrays of atoms with single site addressability. Cesium atoms are first transferred into a science cell (specially textured to reduce reflectance to 0.1% across a wide range of wavelengths and incident angles) via a moving 1D lattice, where they are loaded into a magic-wavelength, far-detuned 2D optical lattice. Two NA=0.8 microscope objectives surround the science cell from above and below. The lower objective will be used to project an array of optical tweezers created via a digital micromirror device (DMD) onto the atom-trapping plane, which will be used to rearrange atoms into a desired configuration after first taking a site-resolved fluorescence image of the initial atomic distribution with the upper objective. We provide updates on our magnetic-optical trap and Raman-sideband cooling performance, characterization of the resolution of our microscope objectives, and stability tests for the objective mounting structure.

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