**GOAL:** Perform imaging using ~13 nm illumination produced by high harmonic generation (HHG) in both transmission and reflection geometries using ptychographic coherent diffraction imaging.

**Experiments**

**Coherent Diffraction Imaging: Lensless**

- **Apparatus:**
  - Reflection: Regenerative Amplifier
    - 38 fs, 3 mJ pulses, 60 nm bandwidth, 3 kHz, 8.5 W
  - Transmission: Ring Amplifier
    - 23 fs, 2 mJ pulses, 80 nm bandwidth, 3 kHz, 6 W

- **HHG Source**
  - Generates 12.7 nm or 13.5 nm light
  - ~600 tera Hz to hollow-core glass fiber
  - 10 phasor’s (cubic) coherent, single harmonic flux

- **Reconstruction:**
  - Psychography:
    - Robustly decodes object and illumination (probe) using redundant info from scan with overlap. Returns amplitude & phase image for each.
  - Modulus Enforced Probe (MEP):
    - Imposes amplitude constraint for probe on detector to improve probe gain & algorithm convergence.
  - MEP can yield RAPTR CDI images:
    - Reconstructed Absolute Phase-Diverse Transmissivity/Reflectivity CDI

- **Data Collection:**
  - Diffraction patterns from overlapping, area-by-area scan of sample + image of undiffracted illumination on detector.

- **Transmission and Reflection-Mode TableTop Imaging wiTh 13 nm illuminaTion via pTychoGraphy cdi**

**Results:**

- **High NA Reflection-Mode Psychographic Imaging:**
  - 1st sub-λ resolution
  - 6 from axial resolution

- **Quantitative Buried Layer Imaging:**
  - RAPTR CDI yields depth-dependent chemical composition, imaging unseen at buried interfaces

- **Hyperspectral Imaging:**
  - Worldwide psychography allows harmonics to illuminate sample, yields an image for each wavelength with one ptychographic scan

- **Lines, Power Spectral Density & Phase Retrieved Transfer Function:**
  - All support 1.6 nm Resolution

**Previous Work**

- (λ=30 nm)

**λ=13.5 nm Transmission Results:**

- 1ST EUV Sub-λ Resolution

**λ=12.7 nm Reflection Results:**

- 1ST ~13nm TableTop Reflection