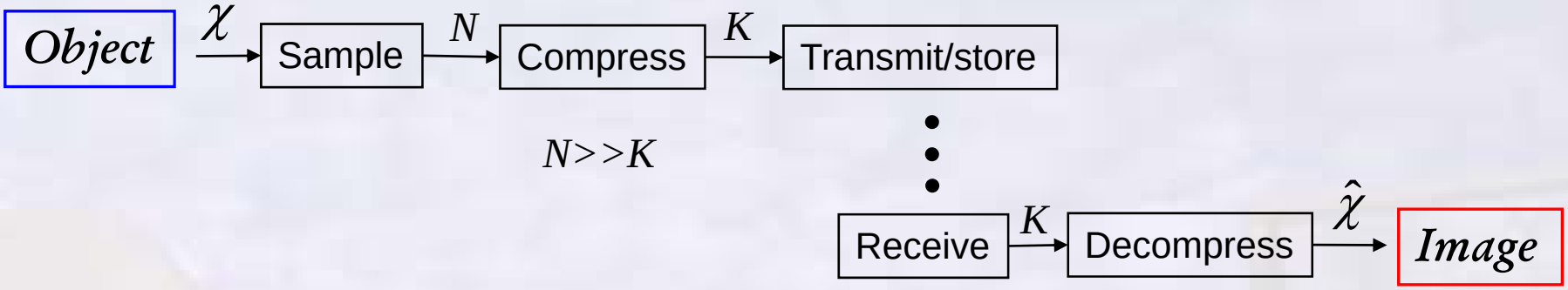
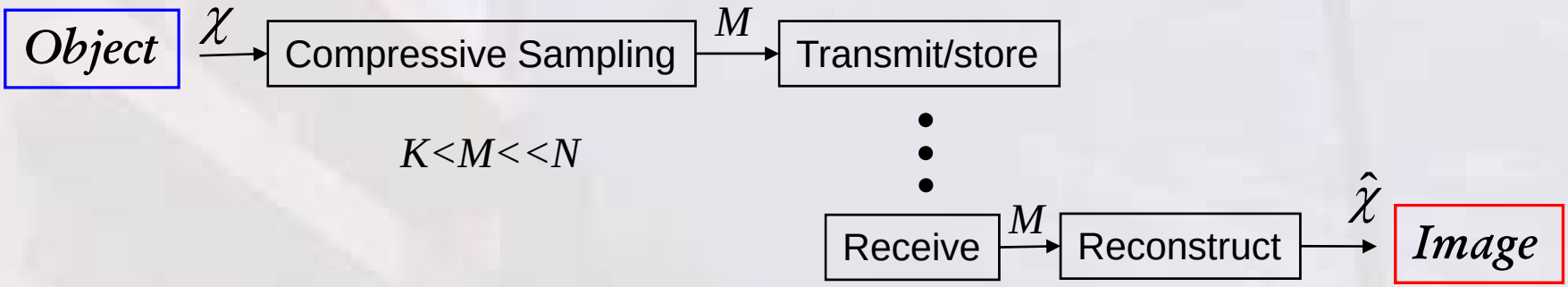
Compressive Imaging

Conventional Imaging: sensing by sampling

- Step 1: sample data
- Step 2: compress data



Compressive Sampling: Directly acquire a compressed image

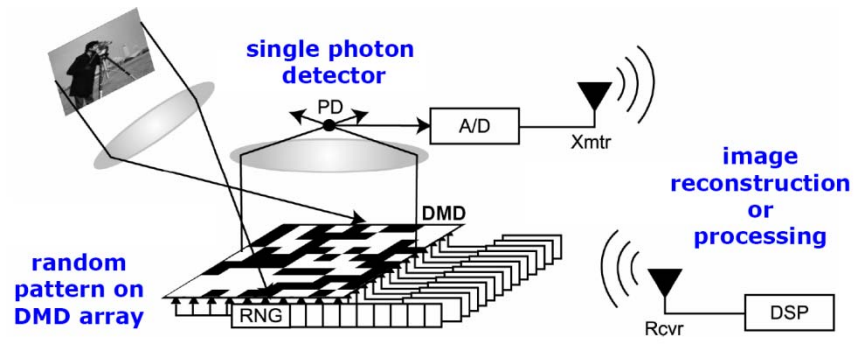


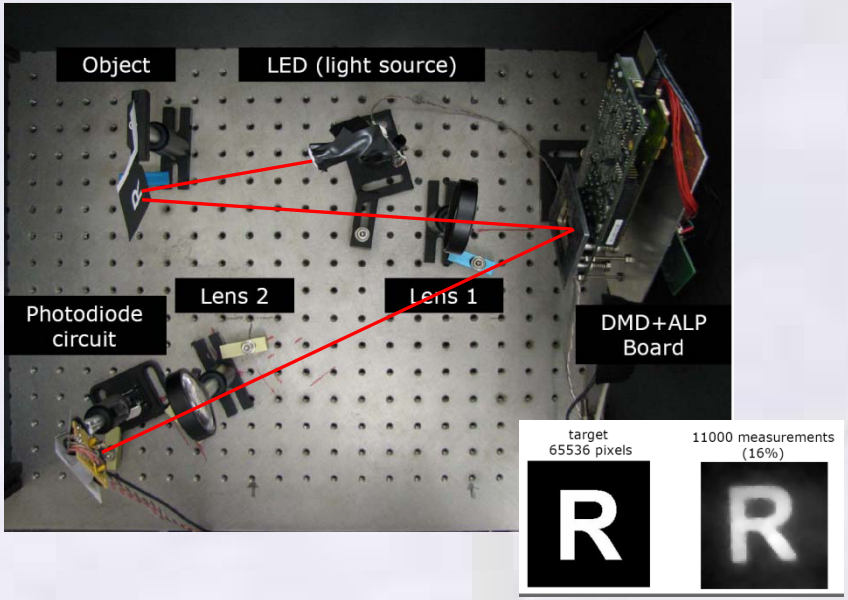
- E. Candès et al., "Robust uncertainty principles: Exact signal reconstruction from highly incomplete frequency information," IEEE Trans. Inform. Theory, 52, 489-509, (2006).
- D. L. Donoho, "Compressed sensing," *Information Theory, IEEE Transactions on* , 52, 1289-1306 (2006).

Compressive Imaging

First Demonstration: Rice table-top system

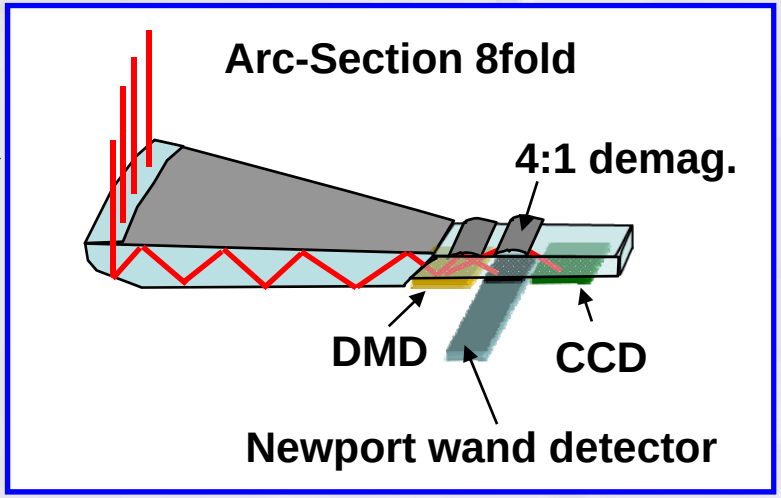
D.Takhar et. al. "A New Compressive Imaging Camera Architecture using Optical-Domain Compression" (Proc. of Computational Imaging IV at SPIE Electronic Imaging, San Jose, CA, Jan. 2006)





Can we make a compact version?

Visible-Light Demo System
- **Physically compact**
- **Straight-forward Translation to IR operation**

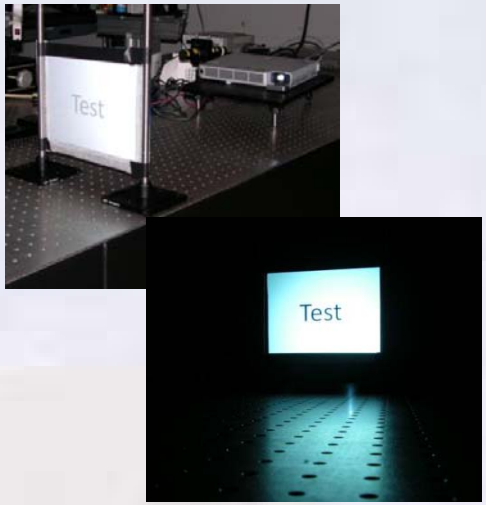


Collaboration with Mark Neifeld, Jun Ke & Pawan Baheti @ UAZ & Peter Ilinykh & Pavel Shekhtmeyster @ PSI Lab

CI Demonstration Setup

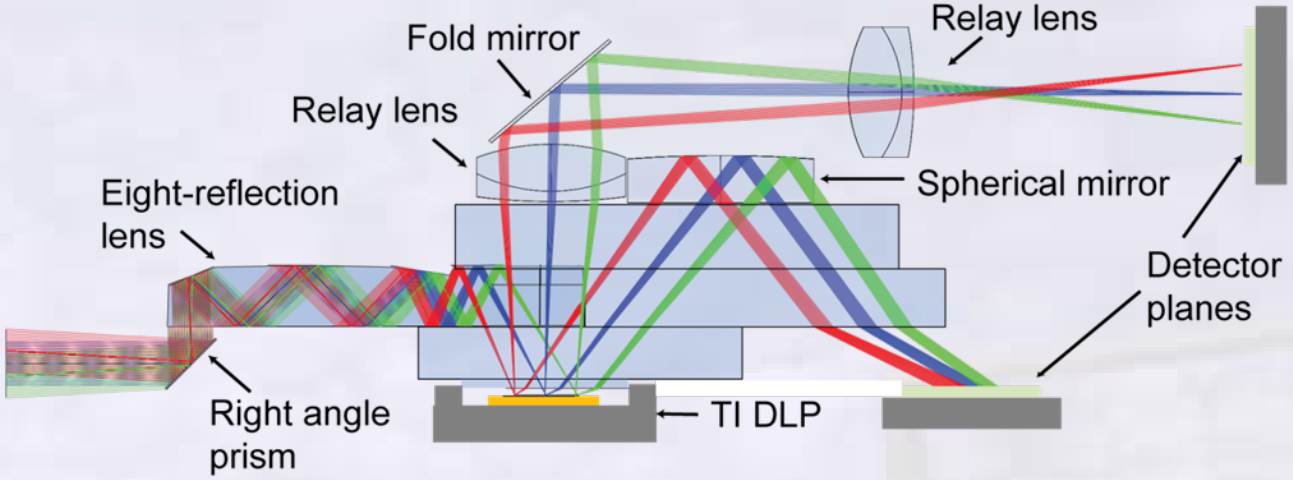
UCSD Photonics

Projected object scene



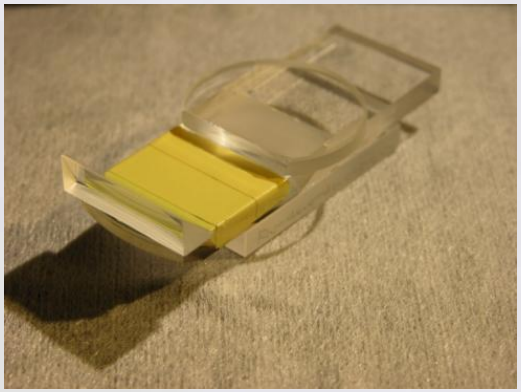
...

Optical Layout



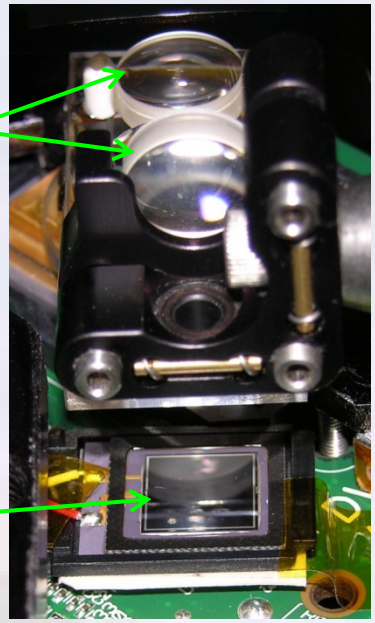
Cut Eight-Reflection lens

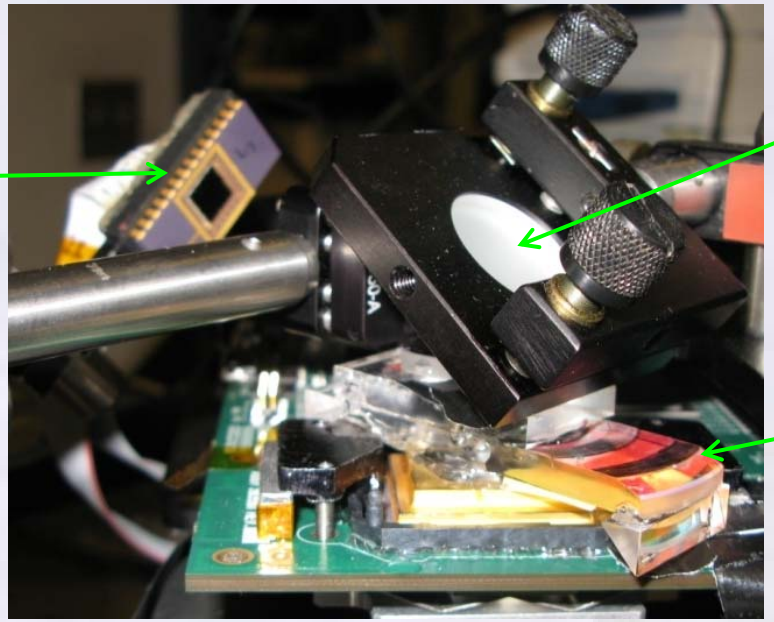
Cut & assembled optics



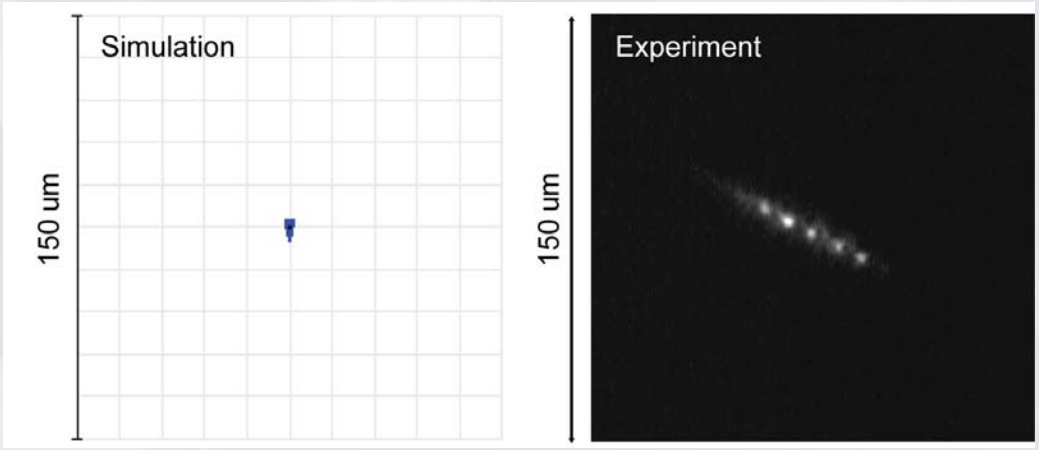
Apogen DMD board

CI Demonstration Setup (2)





System PSF:



~ 5 pixel spread caused by edge scattering at the modified facets due to the short, suboptimal object conjugate:

Best Focus (design) = 2.5 m
Best Focus (measured) = 1.65 m

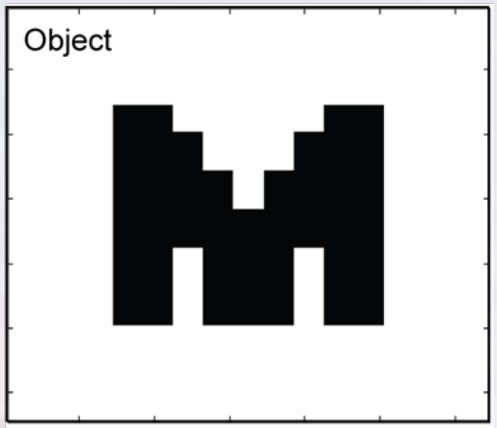
First Results: Linear Reconstruction

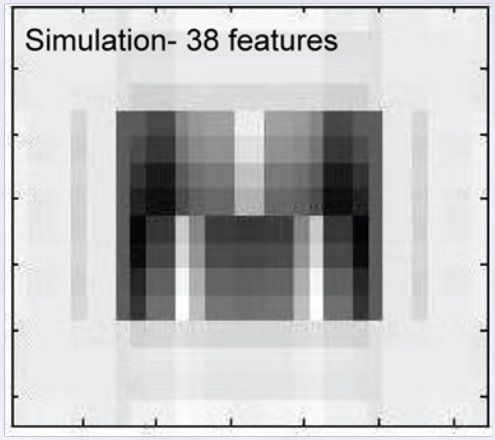
UCSD Photonics

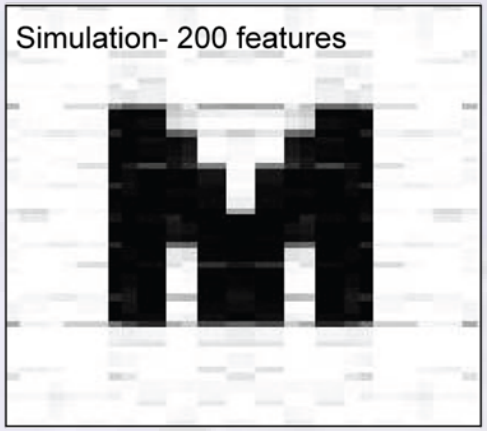
LMMSE estimation of Hadamard Features

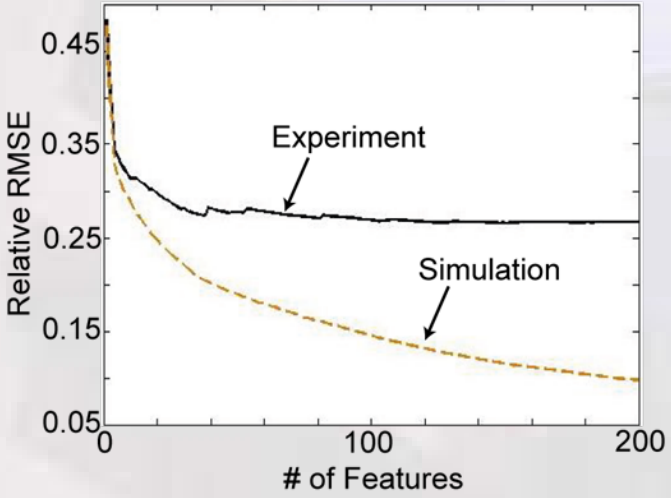
Reconstructions performed by Jun Ke (UAZ)

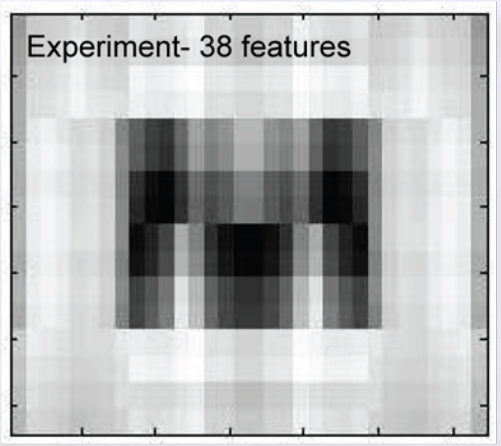
Object: 64x64 (4096 data points)

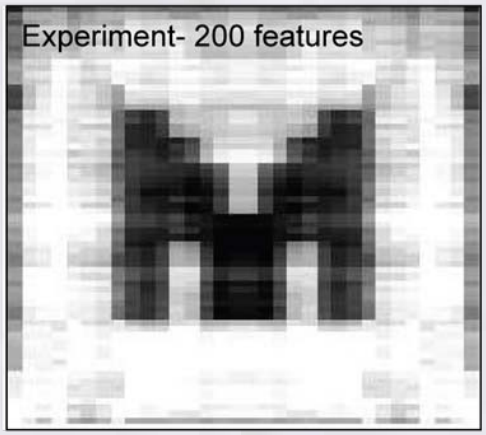












38 measurements
1% of object's dimensionality

200 measurements
5% of object's dimensionality

First Results: Random features

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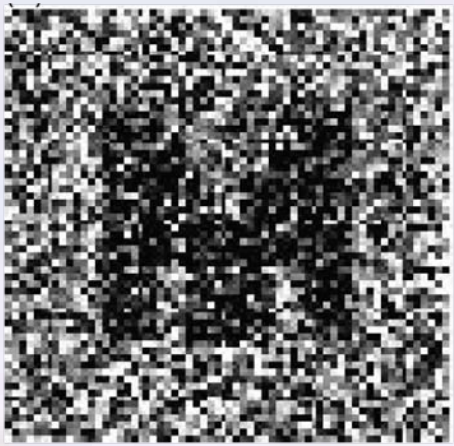
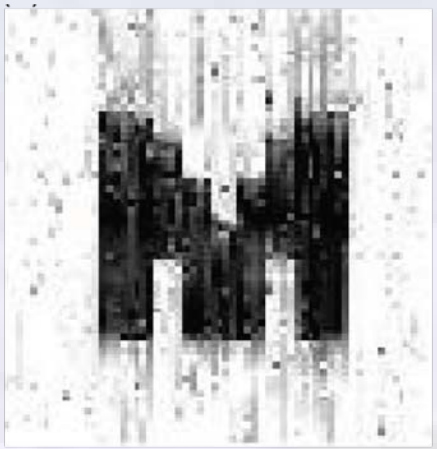
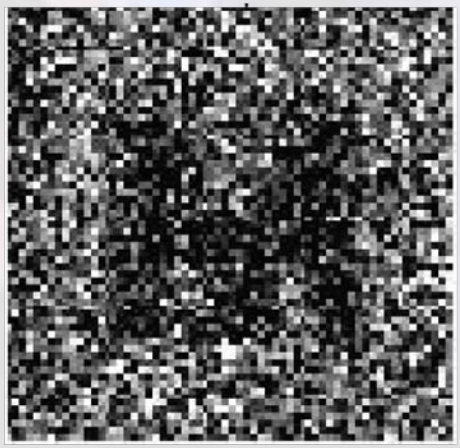
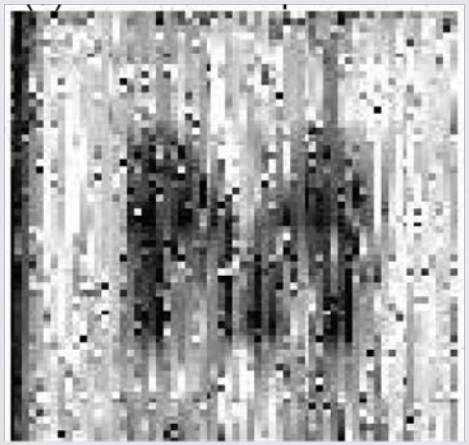
Reconstructions performed by Jun Ke (UAZ)

Linear and Nonlinear reconstruction of Random Features:

	Linear Reconstruction (1000 random masks)	Nonlinear Reconstruction (1000 random masks)
Simulated Results		
Experimental Results		

Random Features do not contain ordered spatial frequency information.

Object sparsity provides an advantage to nonlinear reconstruction