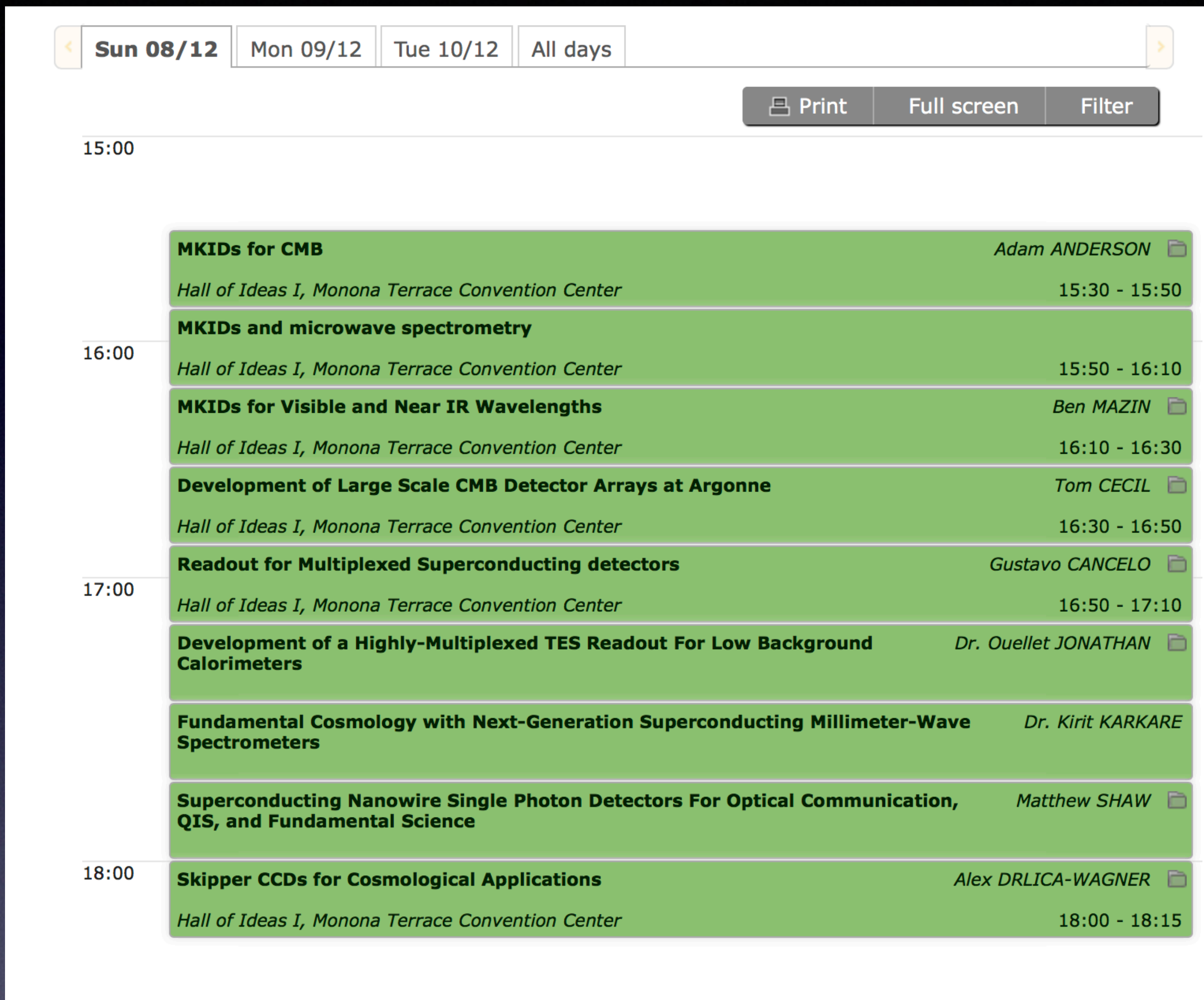
"Summary" : SC/Quantum detectors

2 hr 45m 3 hr 30m



Sun 08/12 | Mon 09/12 | Tue 10/12 | All days

Print | Full screen | Filter

15:00

- **MKIDs for CMB** — *Adam ANDERSON* — *Hall of Ideas I, Monona Terrace Convention Center* — 15:30 - 15:50
- **MKIDs and microwave spectrometry** — *Hall of Ideas I, Monona Terrace Convention Center* — 15:50 - 16:10

16:00

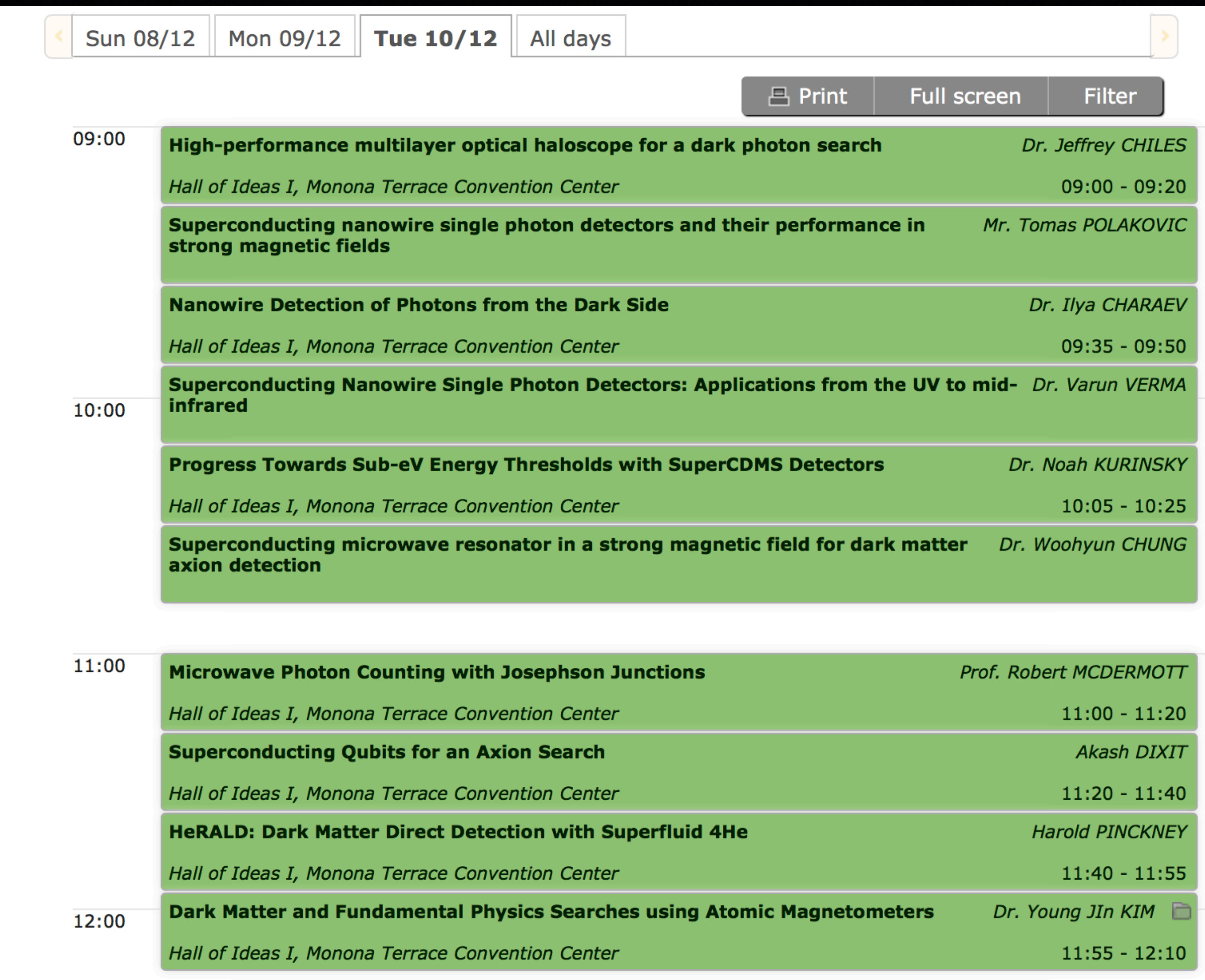
- **MKIDs for Visible and Near IR Wavelengths** — *Ben MAZIN* — *Hall of Ideas I, Monona Terrace Convention Center* — 16:10 - 16:30
- **Development of Large Scale CMB Detector Arrays at Argonne** — *Tom CECIL* — *Hall of Ideas I, Monona Terrace Convention Center* — 16:30 - 16:50
- **Readout for Multiplexed Superconducting detectors** — *Gustavo CANCELO* — *Hall of Ideas I, Monona Terrace Convention Center* — 16:50 - 17:10

17:00

- **Development of a Highly-Multiplexed TES Readout For Low Background Calorimeters** — *Dr. Ouellet JONATHAN*
- **Fundamental Cosmology with Next-Generation Superconducting Millimeter-Wave Spectrometers** — *Dr. Kirit KARKARE*
- **Superconducting Nanowire Single Photon Detectors For Optical Communication, QIS, and Fundamental Science** — *Matthew SHAW*

18:00

- **Skipper CCDs for Cosmological Applications** — *Alex DRLICA-WAGNER* — *Hall of Ideas I, Monona Terrace Convention Center* — 18:00 - 18:15



Sun 08/12 | Mon 09/12 | Tue 10/12 | All days

Print | Full screen | Filter

09:00

- **High-performance multilayer optical haloscope for a dark photon search** — *Dr. Jeffrey CHILES* — *Hall of Ideas I, Monona Terrace Convention Center* — 09:00 - 09:20
- **Superconducting nanowire single photon detectors and their performance in strong magnetic fields** — *Mr. Tomas POLAKOVIC*
- **Nanowire Detection of Photons from the Dark Side** — *Dr. Ilya CHARAEV* — *Hall of Ideas I, Monona Terrace Convention Center* — 09:35 - 09:50

10:00

- **Superconducting Nanowire Single Photon Detectors: Applications from the UV to mid-infrared** — *Dr. Varun VERMA*
- **Progress Towards Sub-eV Energy Thresholds with SuperCDMS Detectors** — *Dr. Noah KURINSKY* — *Hall of Ideas I, Monona Terrace Convention Center* — 10:05 - 10:25
- **Superconducting microwave resonator in a strong magnetic field for dark matter axion detection** — *Dr. Woohyun CHUNG*

11:00

- **Microwave Photon Counting with Josephson Junctions** — *Prof. Robert MCDERMOTT* — *Hall of Ideas I, Monona Terrace Convention Center* — 11:00 - 11:20
- **Superconducting Qubits for an Axion Search** — *Akash DIXIT* — *Hall of Ideas I, Monona Terrace Convention Center* — 11:20 - 11:40
- **HeRALD: Dark Matter Direct Detection with Superfluid 4He** — *Harold PINCKNEY* — *Hall of Ideas I, Monona Terrace Convention Center* — 11:40 - 11:55

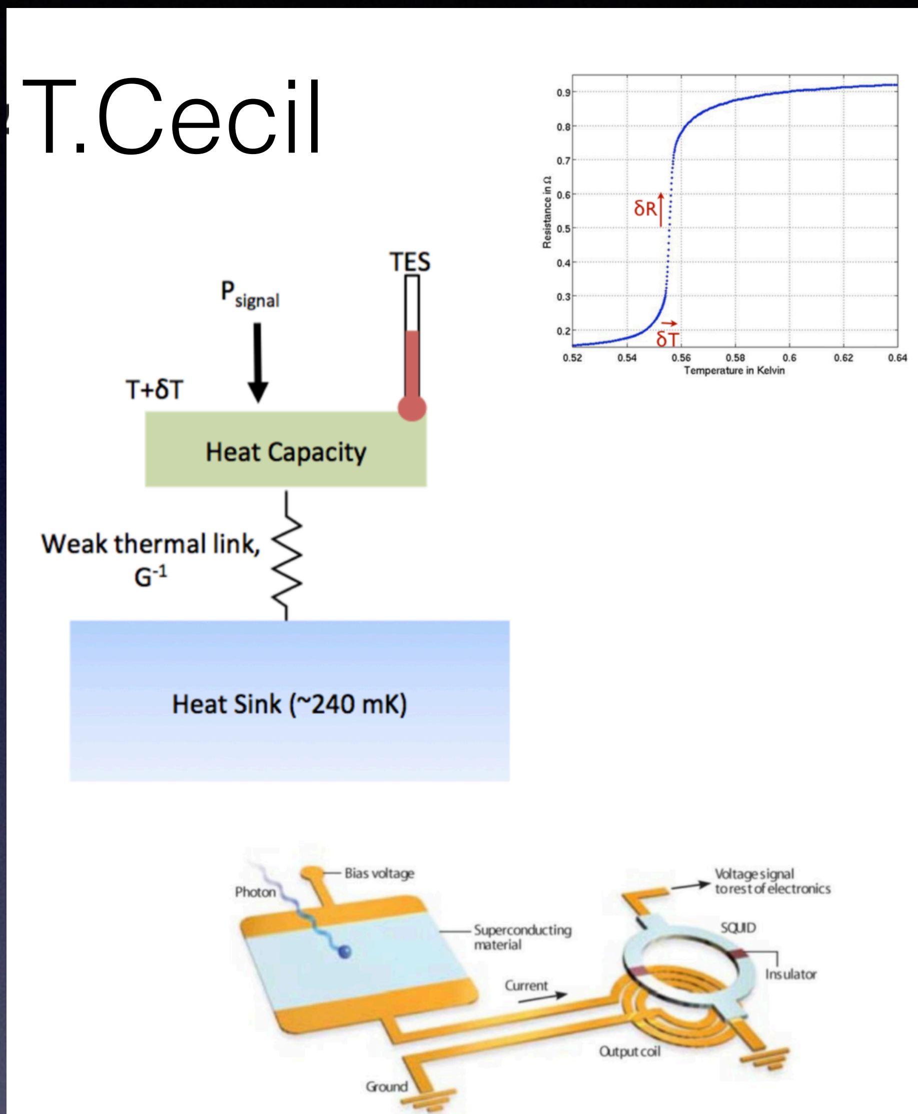
12:00

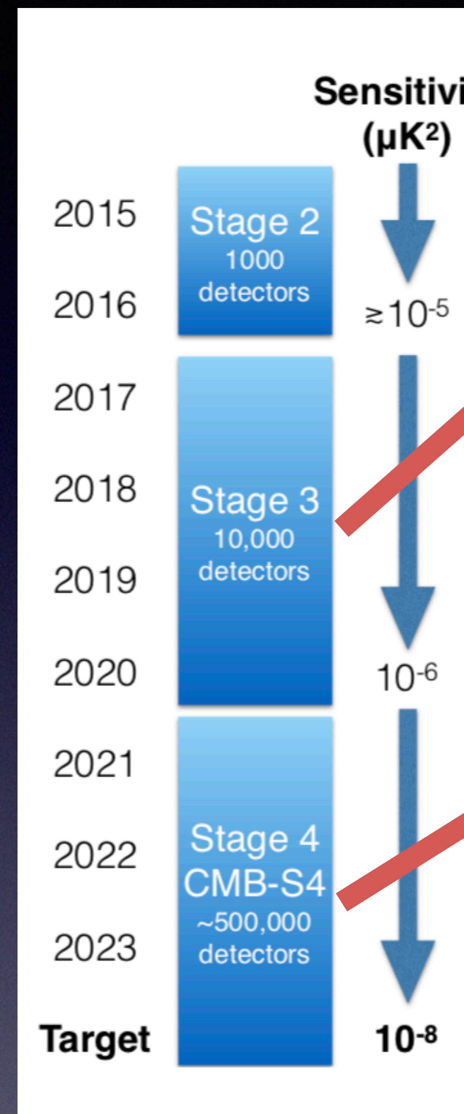
- **Dark Matter and Fundamental Physics Searches using Atomic Magnetometers** — *Dr. Young JIn KIM* — *Hall of Ideas I, Monona Terrace Convention Center* — 11:55 - 12:10

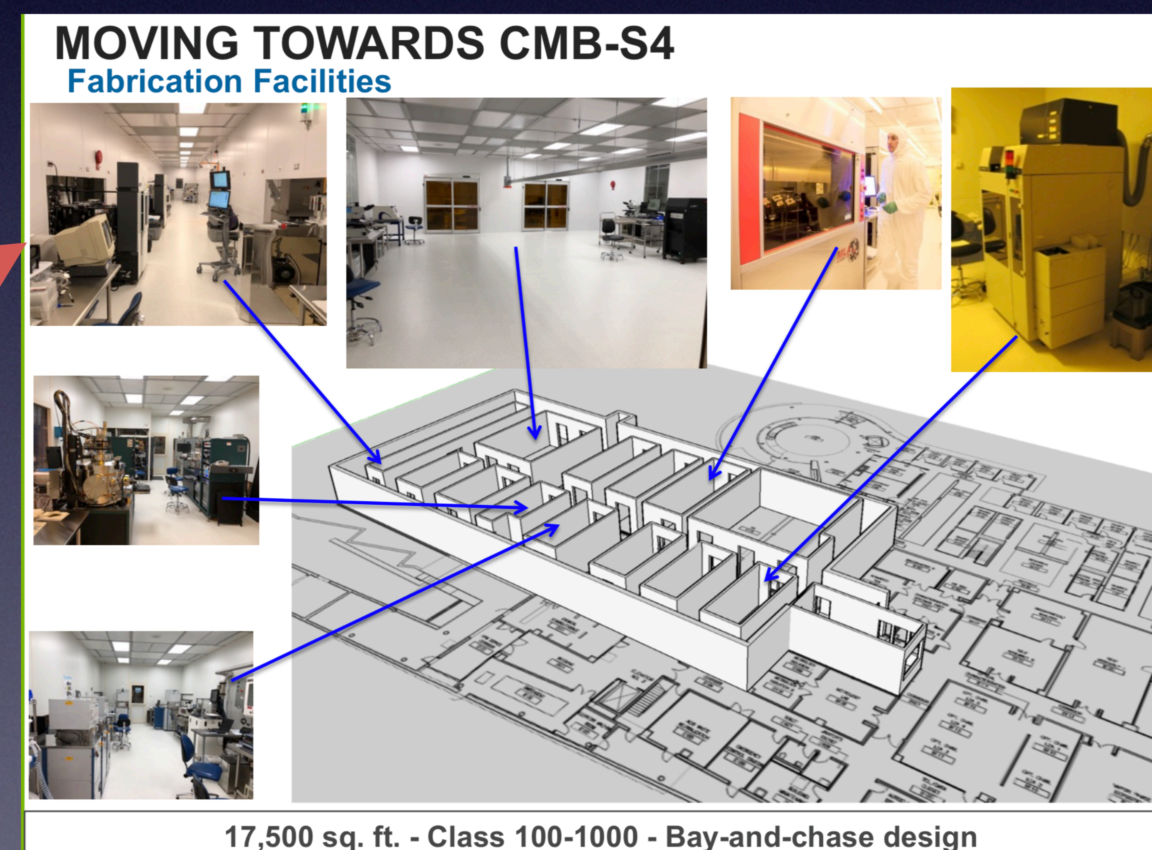
two long days with detectors for astronomy, dark matter and neutrinos… and photo-detectors in genera: TES,SNSPDs, MKIDs

J.Estrada (fnal)

Transition Edge Sensors for CMB going BIG!



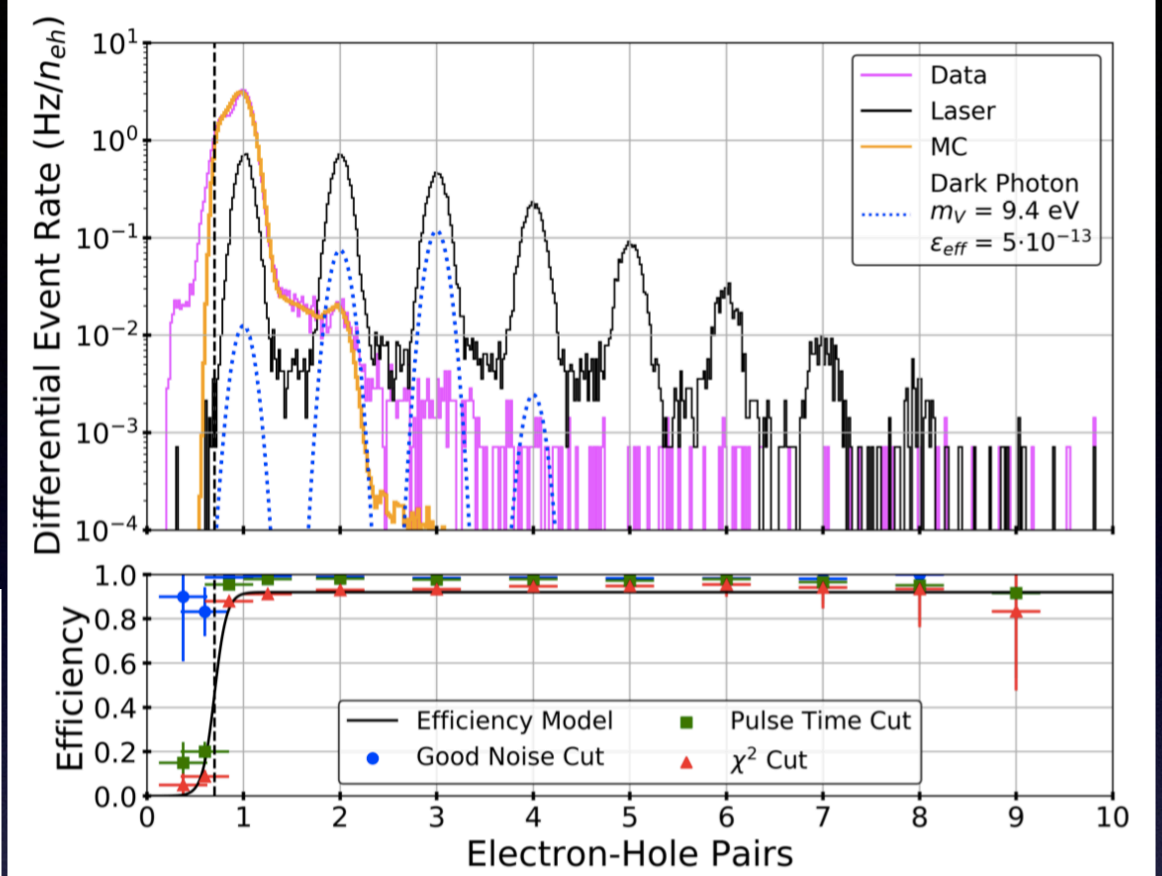




TES in direct DM : going low!

N.Kurinsky

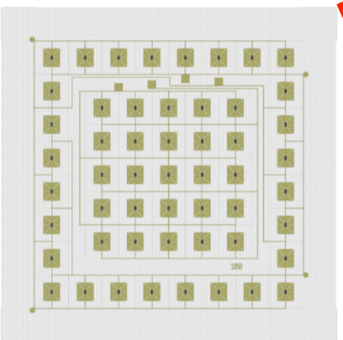
SuperCDMS Collaboration 2018 (https://arxiv.org/abs/1804.00088)



large R&D effort exploring several options, impressive progress

R&D 'HVeV' Prototype Progress

HVeV v1



Device: https://arxiv.org/abs/1710.09335
DM: https://arxiv.org/abs/1804.10697

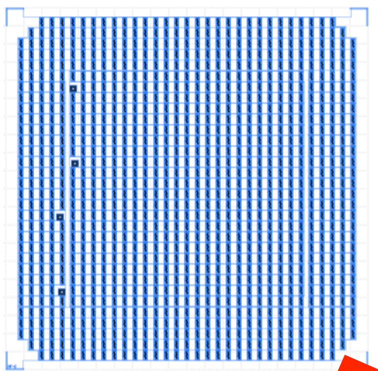
- 10 eV Resolution
  - 0.07 electron-hole pairs (140V)
- 3-5% energy efficiency
- 1 gram mass
- No position resolution
- ~1.2 Ohm Resistance
- ~55 mK Tc
- Amorphous Layer

HVeV v1.5

Device: https://arxiv.org/abs/1903.06517

- 3 eV Resolution
  - 0.06 electron-hole pairs (50V)
- 25% energy efficiency
- 0.25 gram mass, contact-free design
- High position resolution
- ~400-900 mOhm Resistance
- 65 mK Tc
- No Amorphous Layer

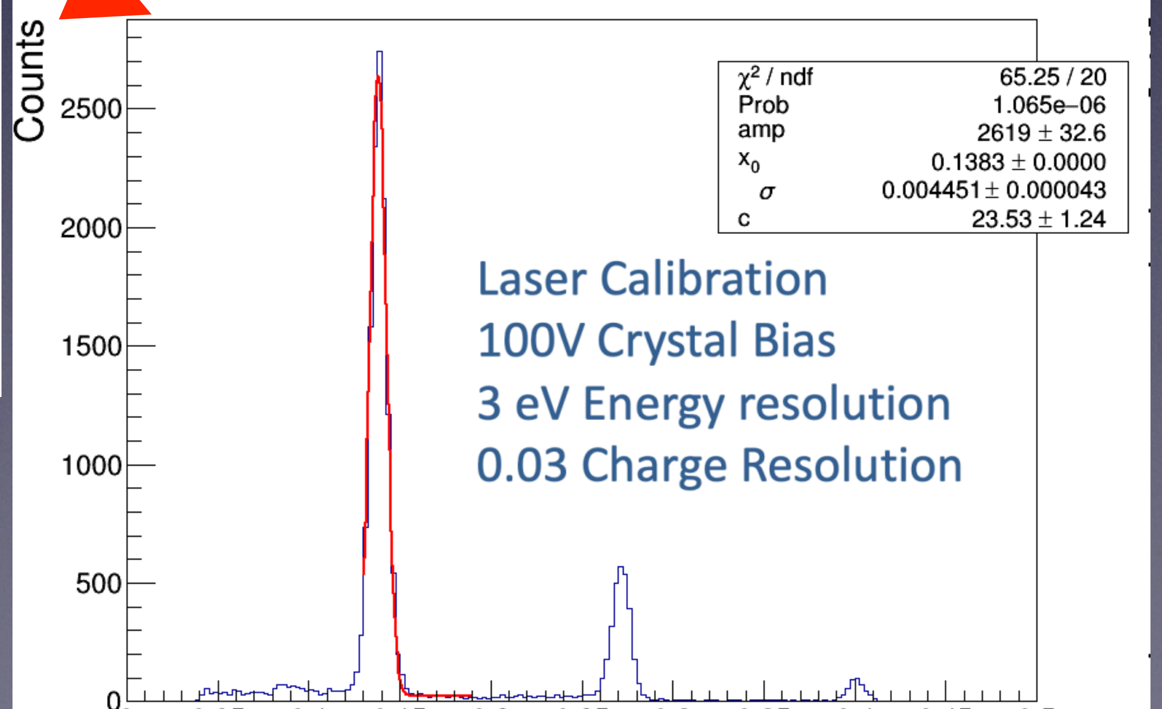
HVeV v2 (NF-C)



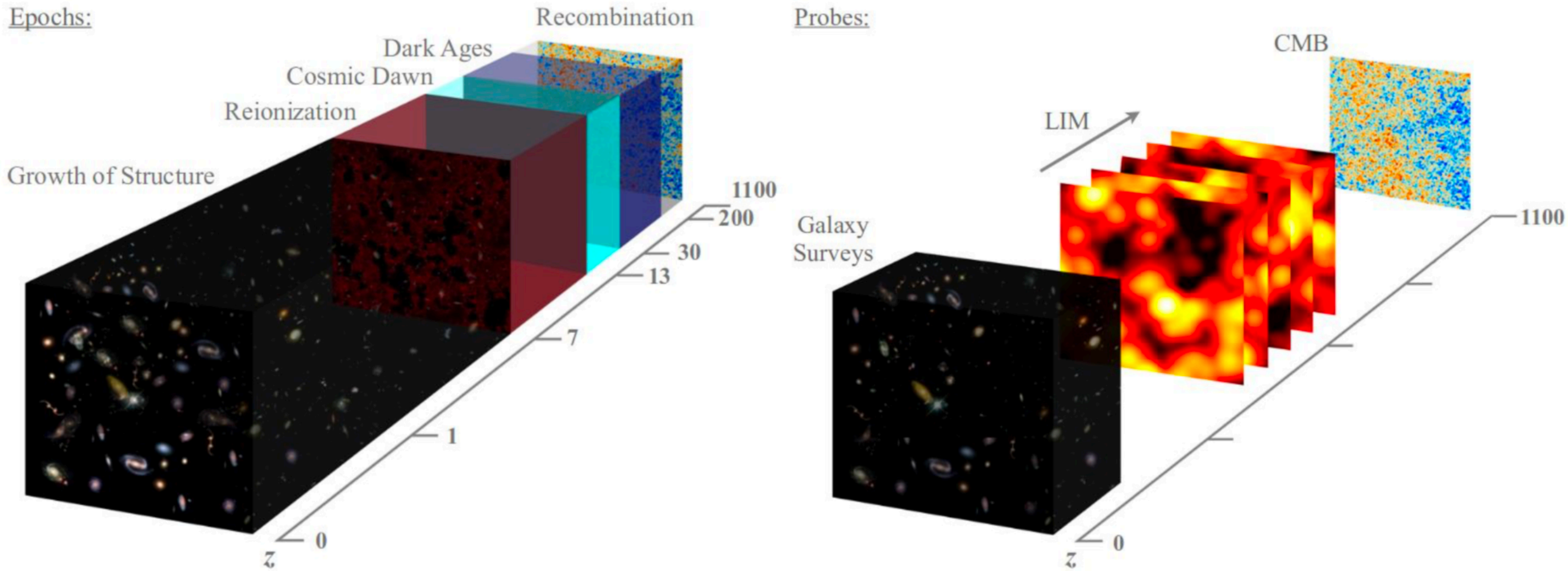
In Prep (TUNL, DM)

- 3 eV Resolution
  - <0.01 electron-hole pairs (100V)
- 25% energy efficiency
- 1 gram mass, backside contact
- High position resolution
- ~300 mOhm Resistance
- 65 mK Tc
- No Amorphous Layer

HVeV v2: Combining Lessons



K. Karkare : Line Intensity Mapping (with MKIDs)



Line intensity mapping white paper
1903.04496

Galaxy surveys become extremely expensive at high redshift, as identifying individual faint objects above a threshold becomes more difficult.

Cosmology at z > 3: Expansion History

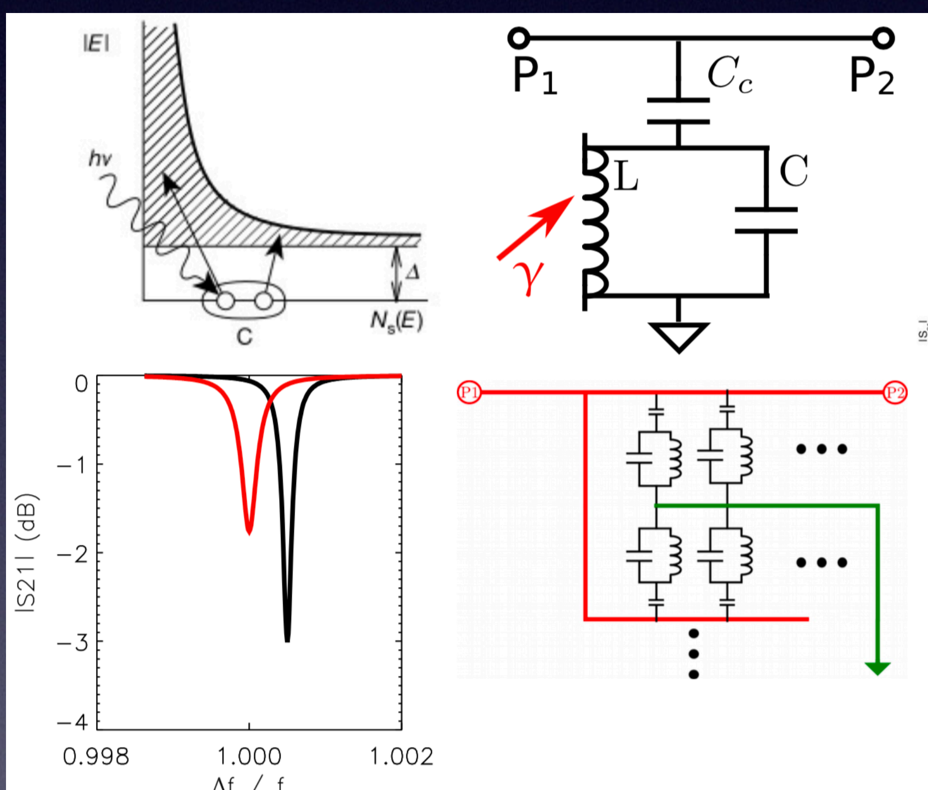
Using baryon acoustic oscillations, characterize the expansion history in the pre-acceleration era to the same precision as low-z measurements

What kind of instrument do we need to measure cosmology / fundamental-physics with submm-IM?

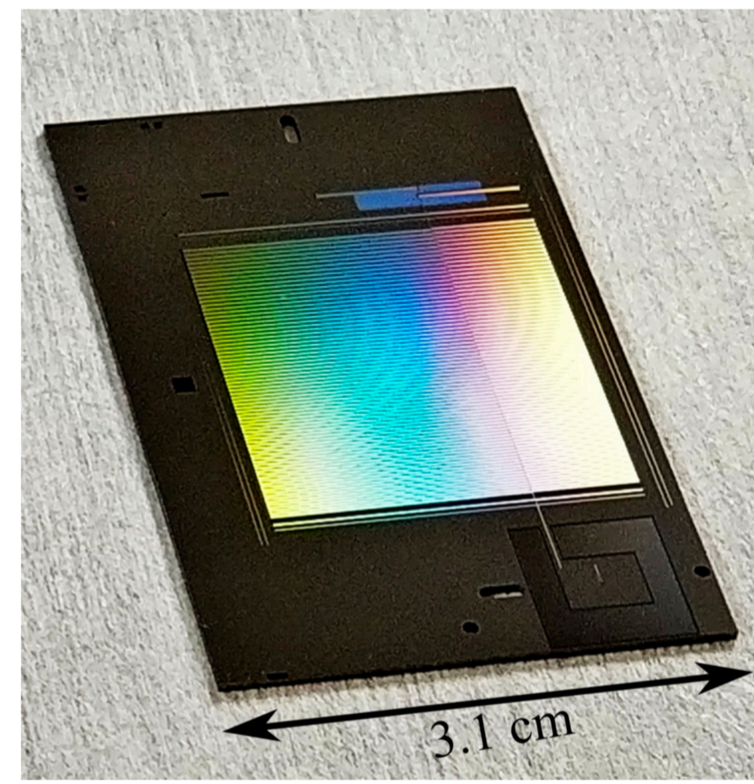
- Background-limited narrow band detectors with resolving power R~hundreds
- Hundreds of pixel-years on a 10m-class submm telescope.

deployment in January 2020

MKIDs



3 dual-pol pixels
R=300, covering
195-310 GHz



spectrograph on a chip!

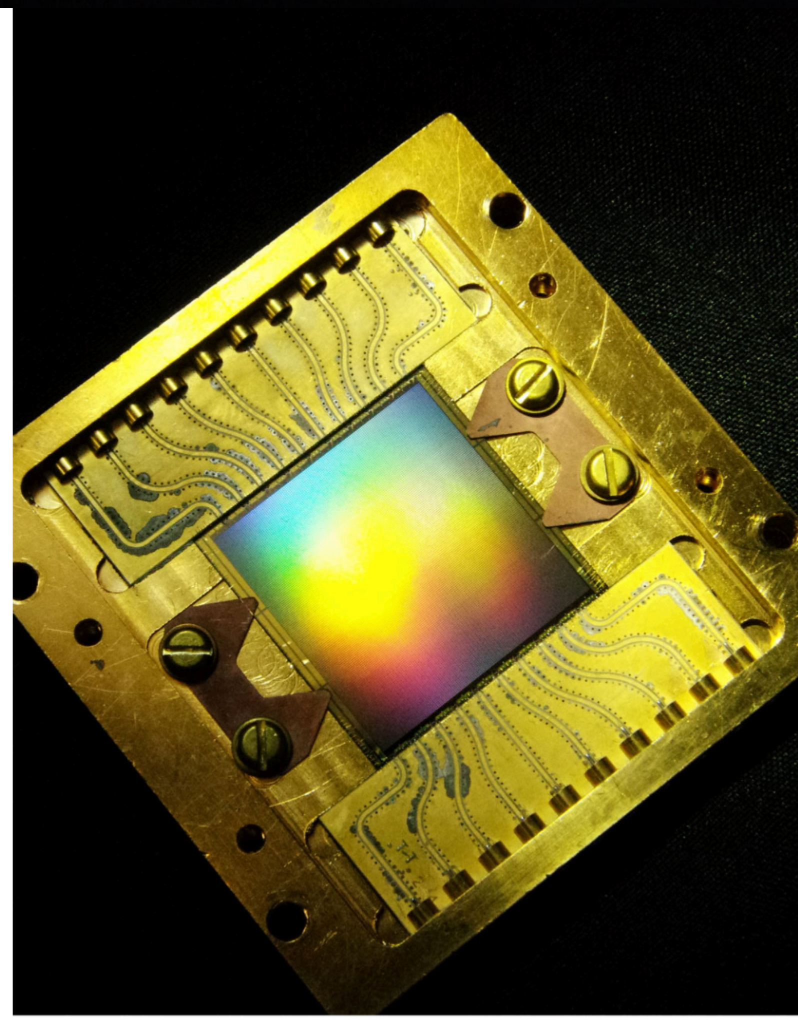
E. Shirokoff

MKIDs for optical and near IR
B. Mazin

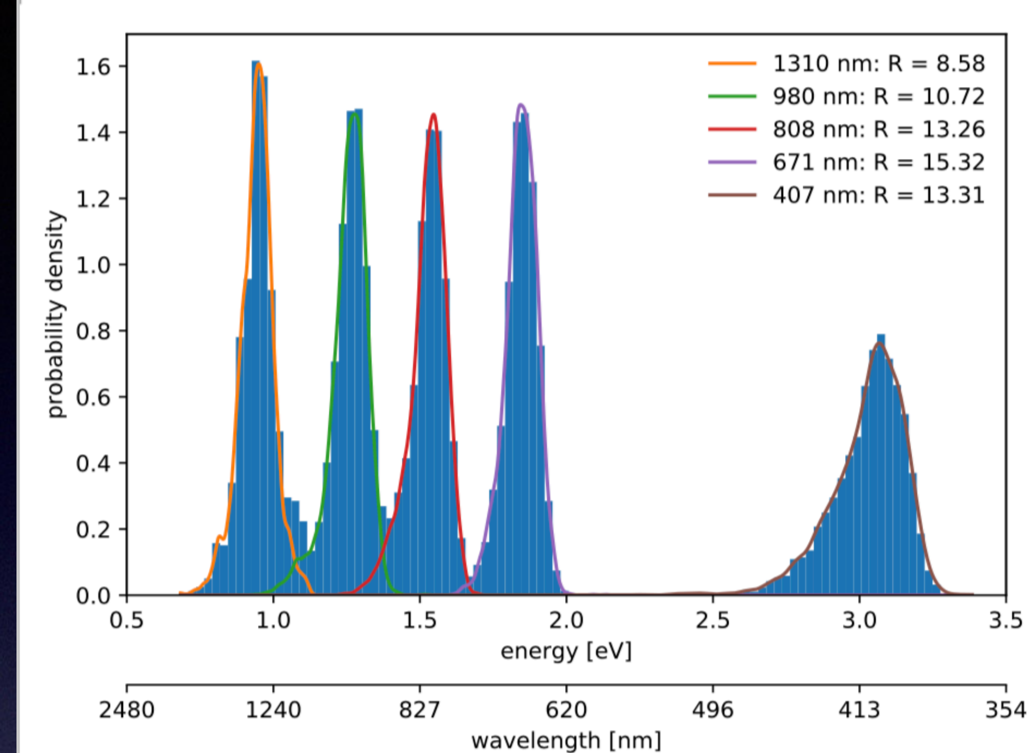
- 20 kpix PtSi MKID array for Subaru SCExAO-MEC
- 140x146 pixels
- 150 micron pixel pitch
- 22x22 mm imaging area
- Pixel Yield ~85%
- R≅10 at 1 micron

Array fabricated at UCSB by P. Szypryt and G. Coiffard.

Szypryt et al. 2017, Optics Express



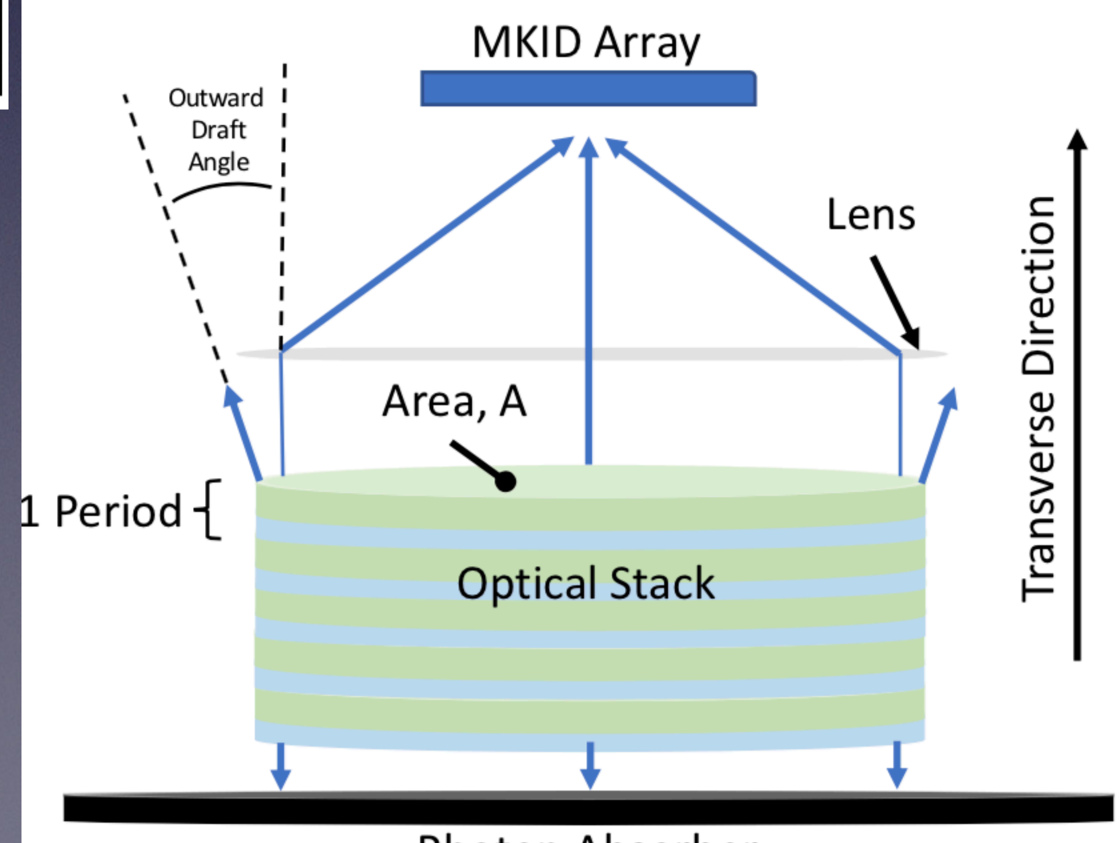
improving resolution



Low Q_m

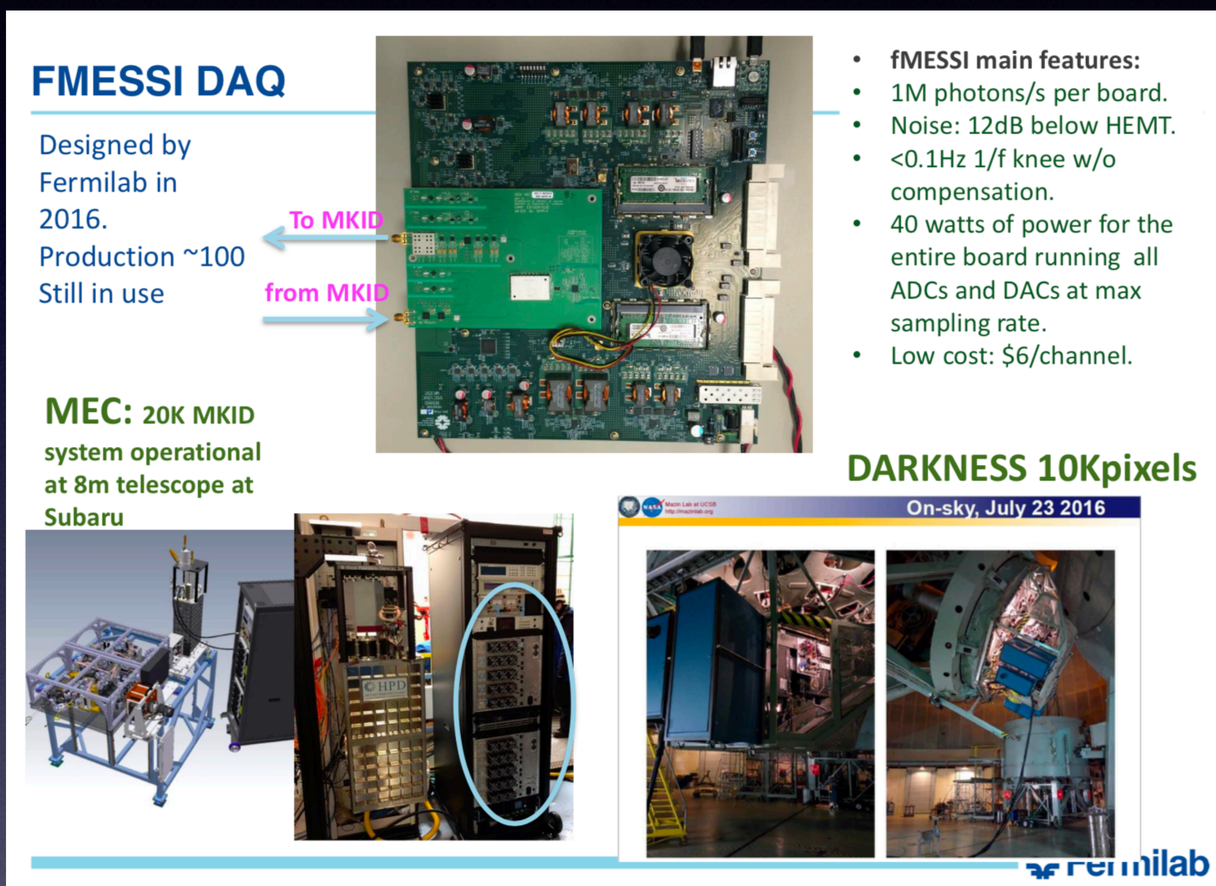
20k channels of spectroscopy with R~10… at telescope

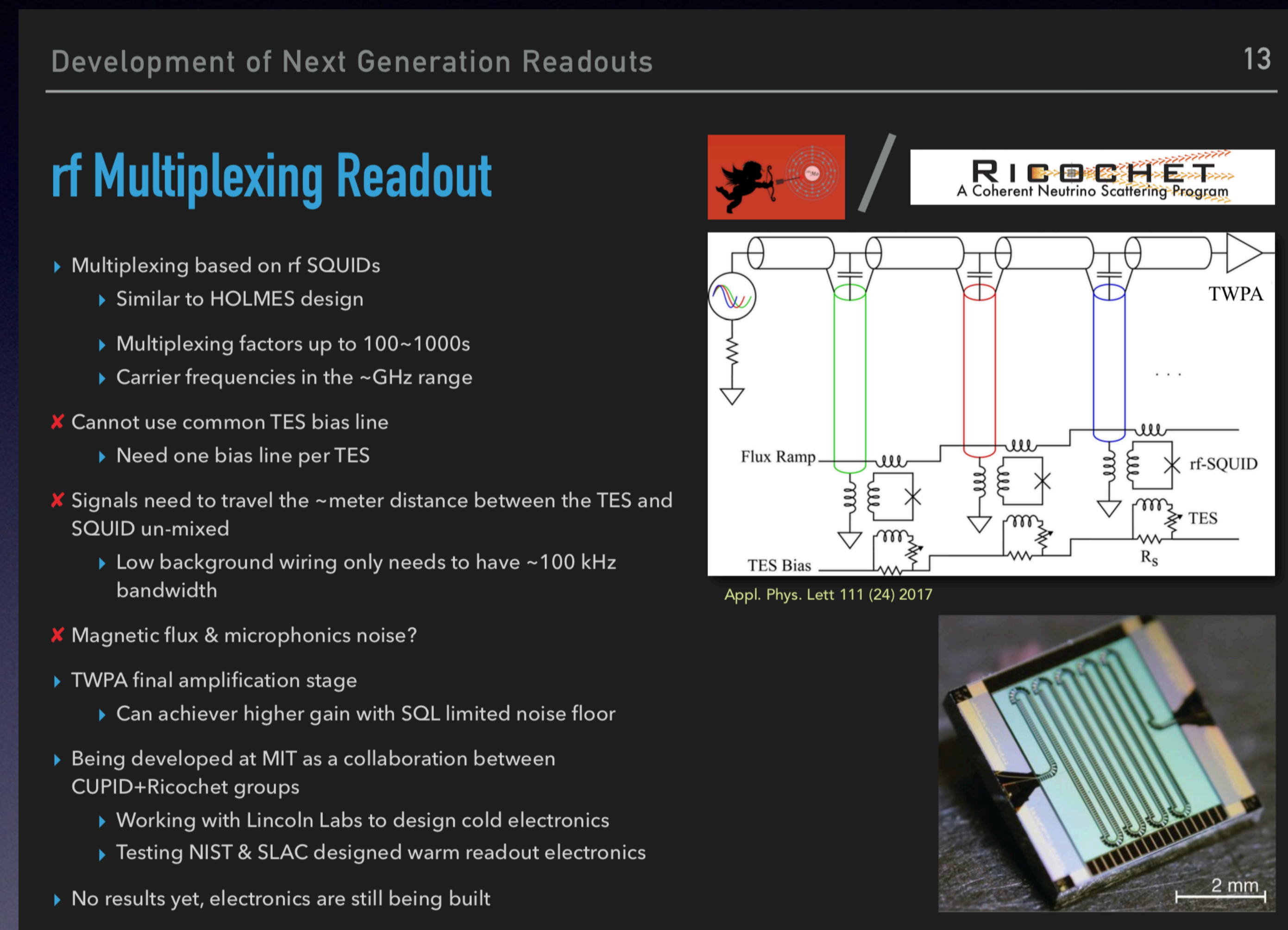
also for axion/dark photon ⟶



G. Cancelo
electronics needed for these highly multiplexed arrays of MKIDs and TES

J. Ouellet
quantum devices (TWPA) to improve the performance of these highly multiplexed systems

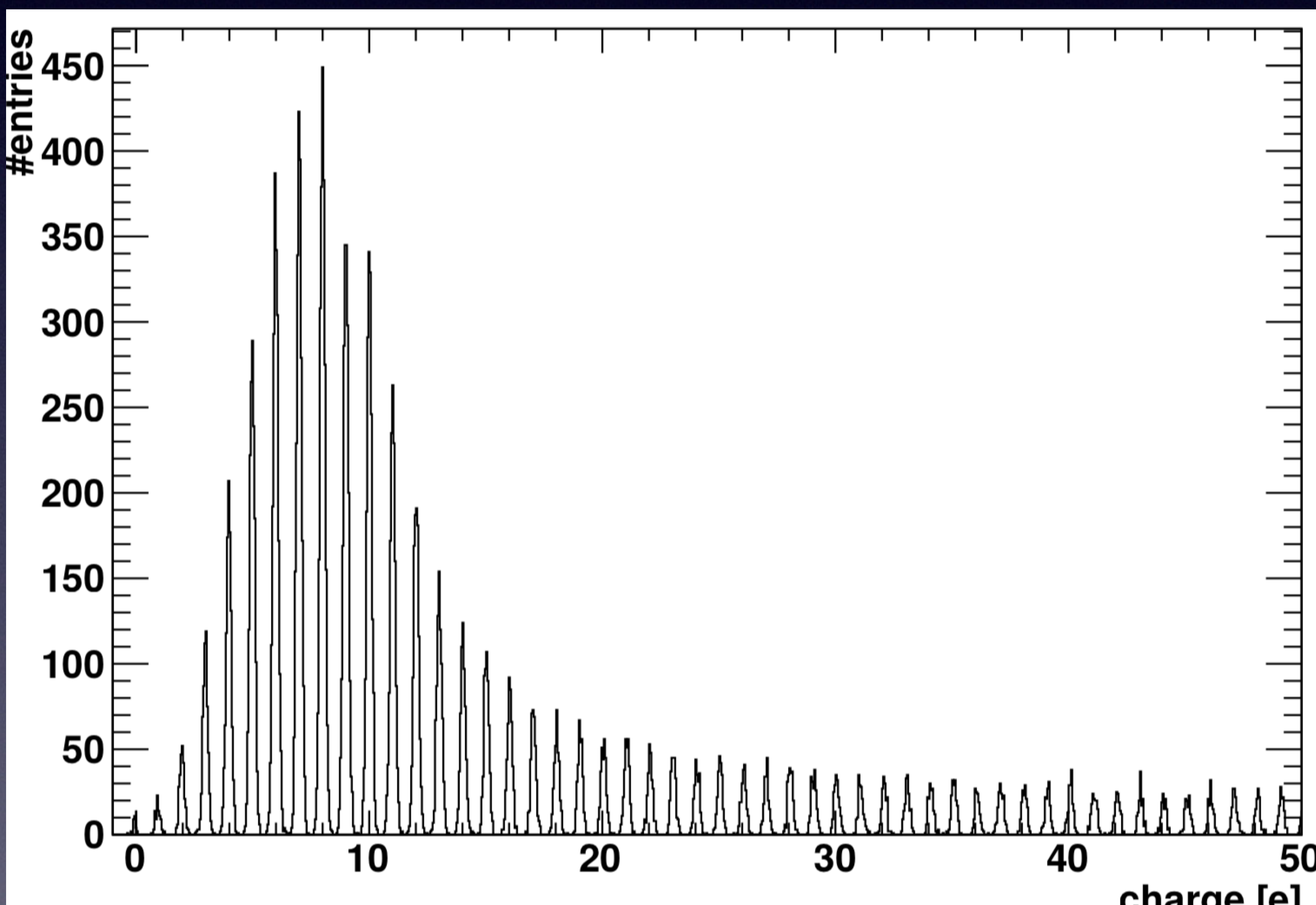


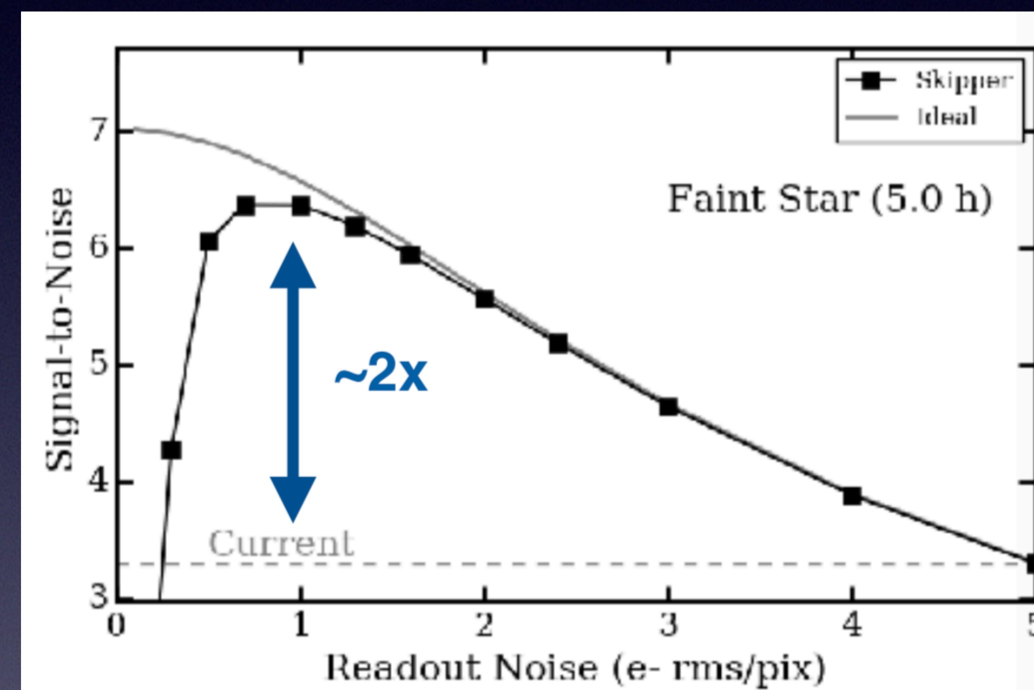


A. Drilica-Wagner

Summary: Skipper CCDs for Cosmology

- **The Skipper CCD pitch…**
  - Skipper CCDs allow you to **control readout noise** directly on a **pixel-by-pixel** basis
  - Configurable **per object** and **per exposure**
  - **Every CCD used for astronomical observations should be a Skipper CCD**

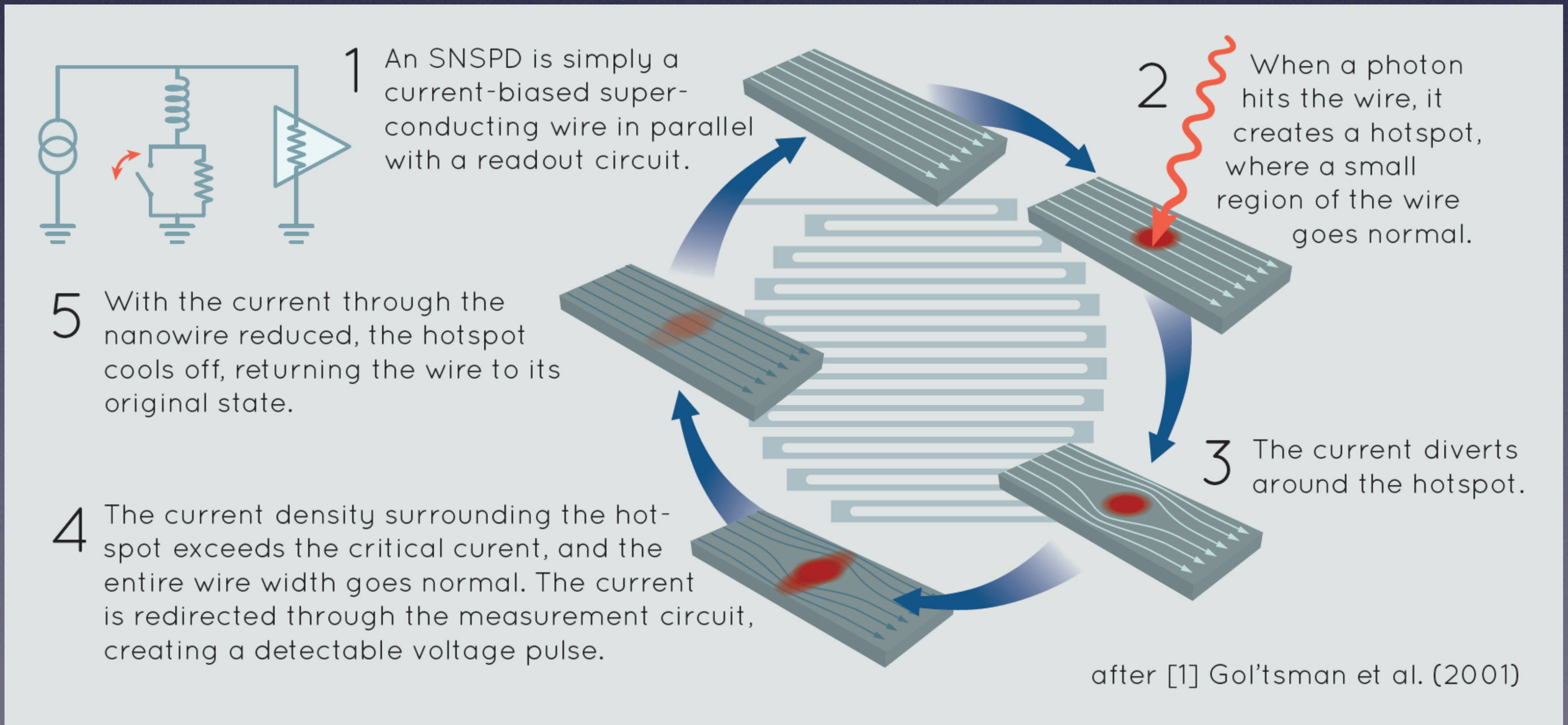


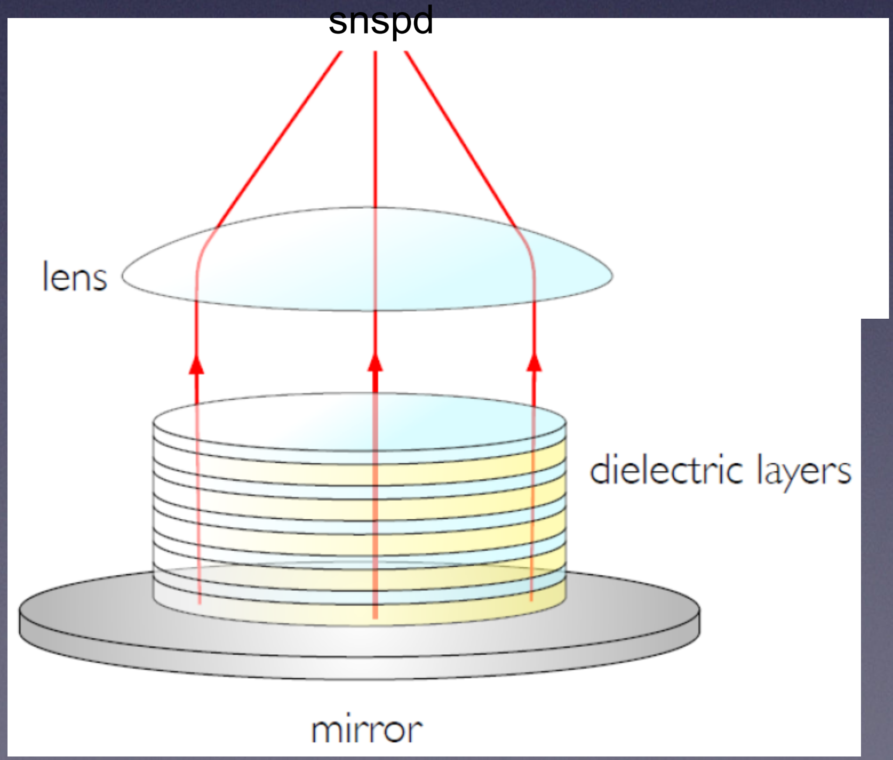


non destructive readout with skipper-CCD could enhanced cosmological observations

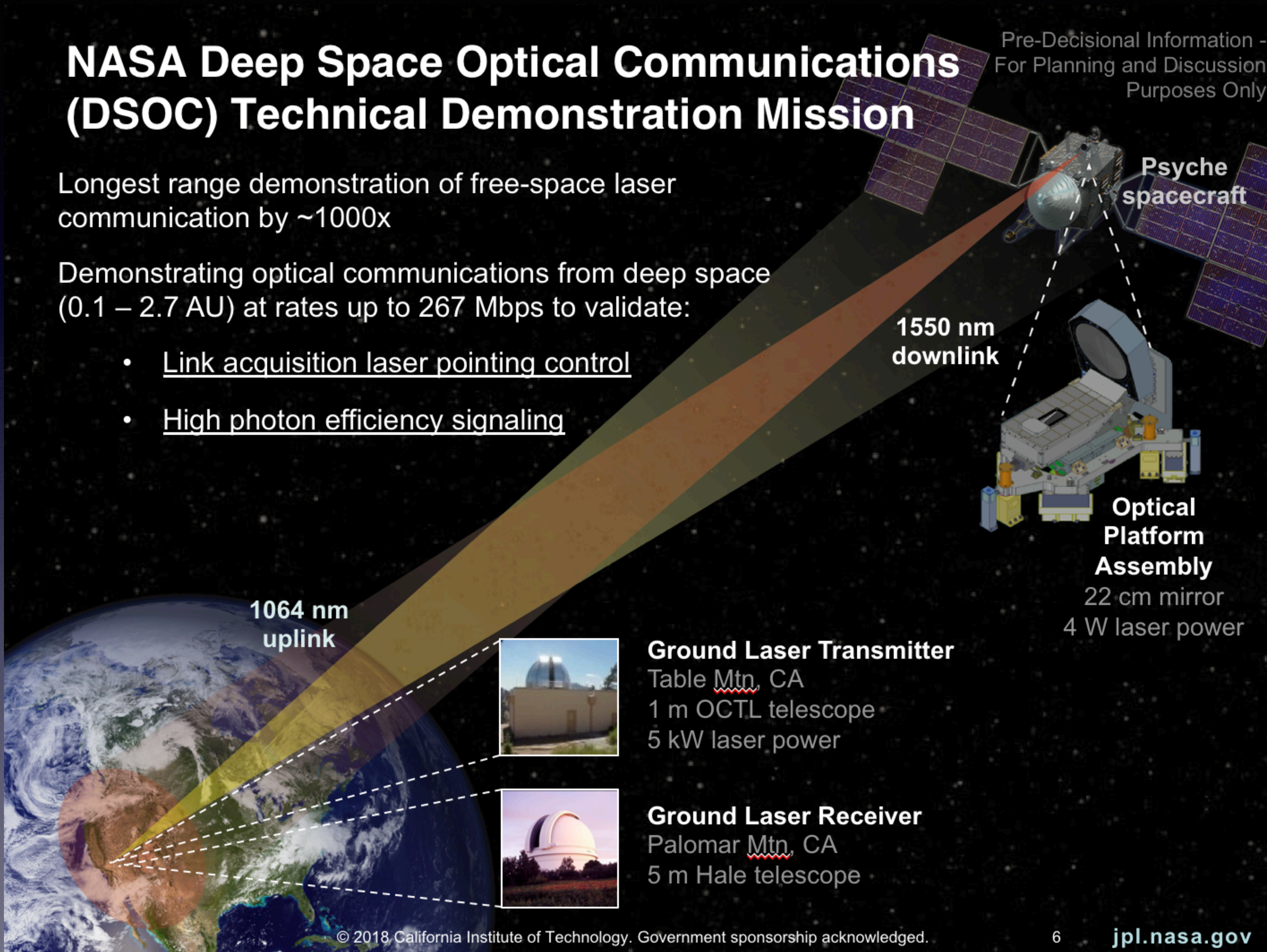
M. Shaw started us on SNSPDs

Parameter	SOA 2019	SOA 2016	Group
Efficiency	98% @ 1550 nm	93% @ 1550	NIST
Dark Counts	< 1e-5 cps	< 0.1 cps	MIT
Energy	0.125 eV	0.250 eV	NIST/JPL/MIT
Timing Jitter	2.7 ps	16 ps	MIT/JPL/NIST
Active Area	0.92 mm^2	0.058 mm^2	NIST
Max Count Rate	1.2 Gcps	0.3 Gcps	JPL
Pixel Count	1024 (32x32)	64 (8x8)	NIST/JPL
Photon Number	1 from 2 or more	None	MIT
Operating Temp	4.3 K @ 1550	2.5 K @	Single Quantum





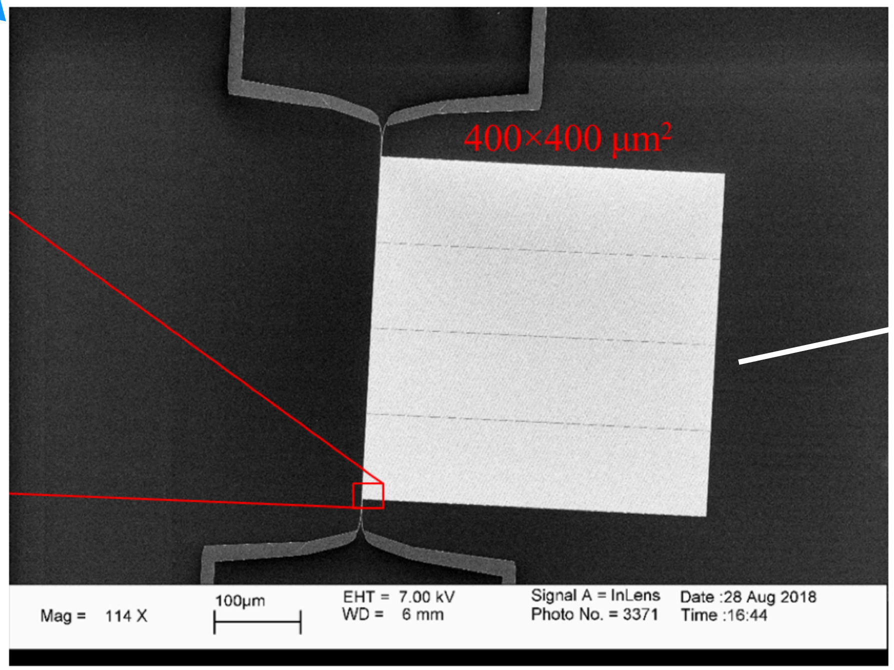
perhaps these guys are having too much fun…

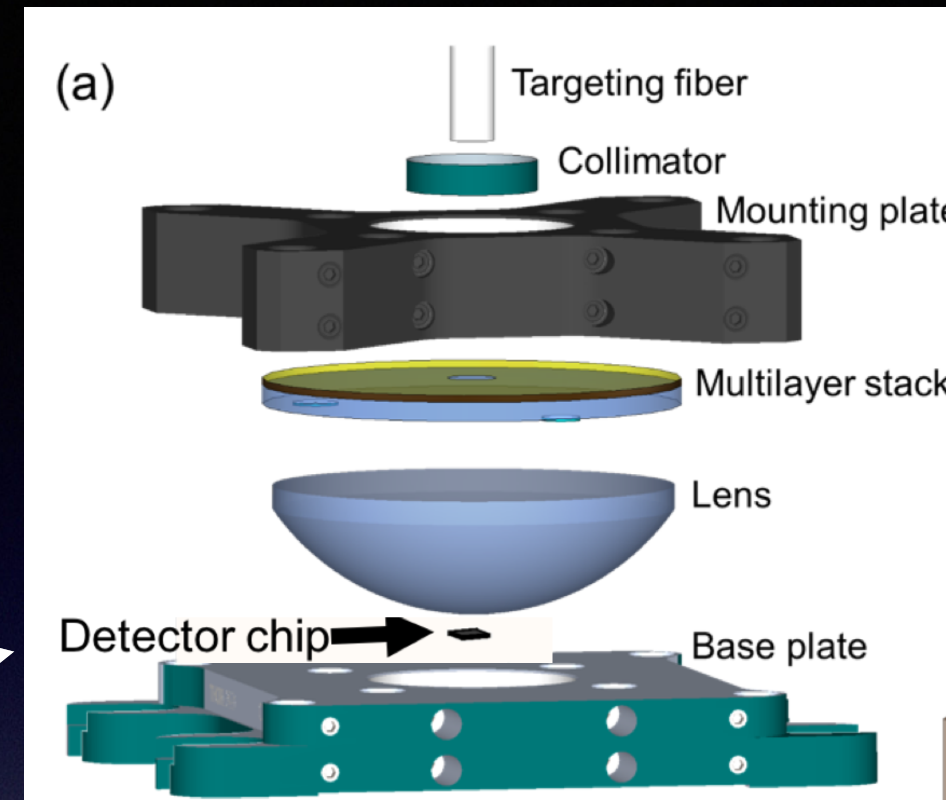


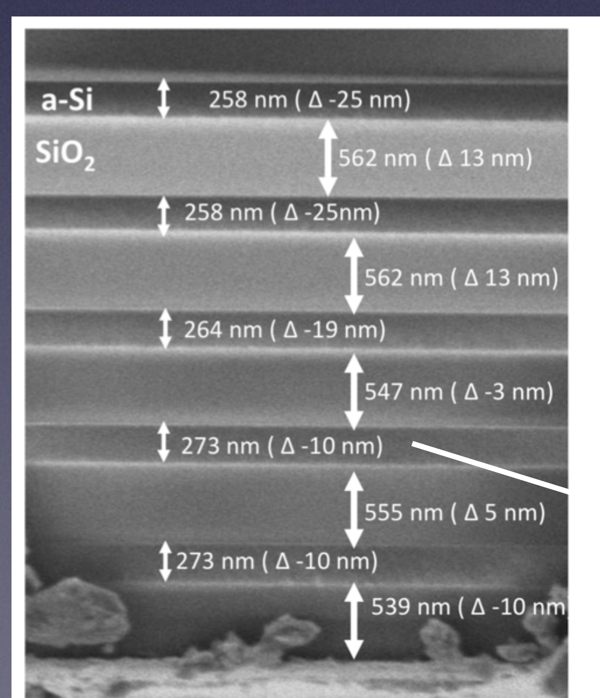
J.Chiles SNSPD+haloscope

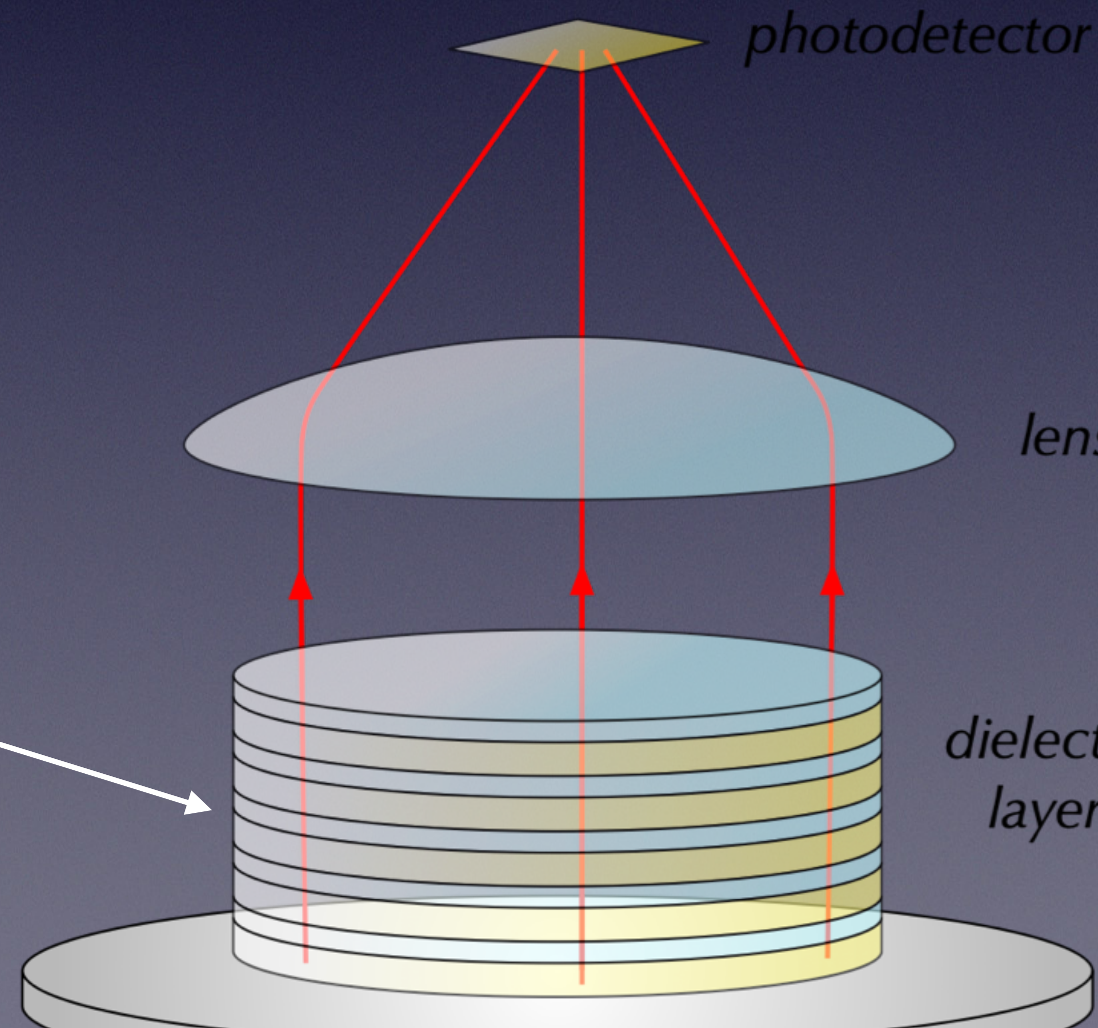
Detector for optical haloscope

- See Ilya Charaev's talk at 9:35 AM
- 400 x 400 um^2 detectors with 10^{-5} Hz dark count rate



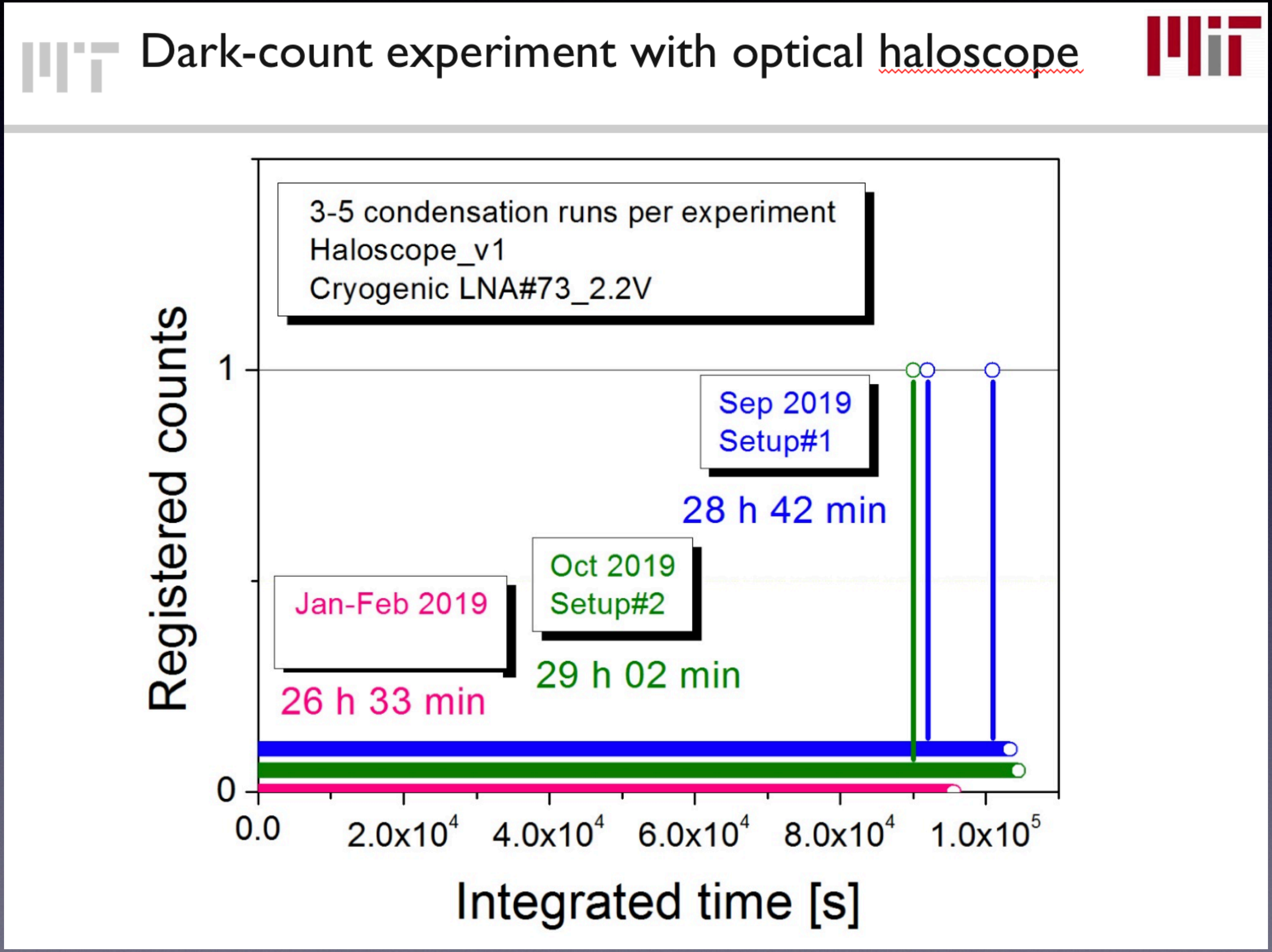






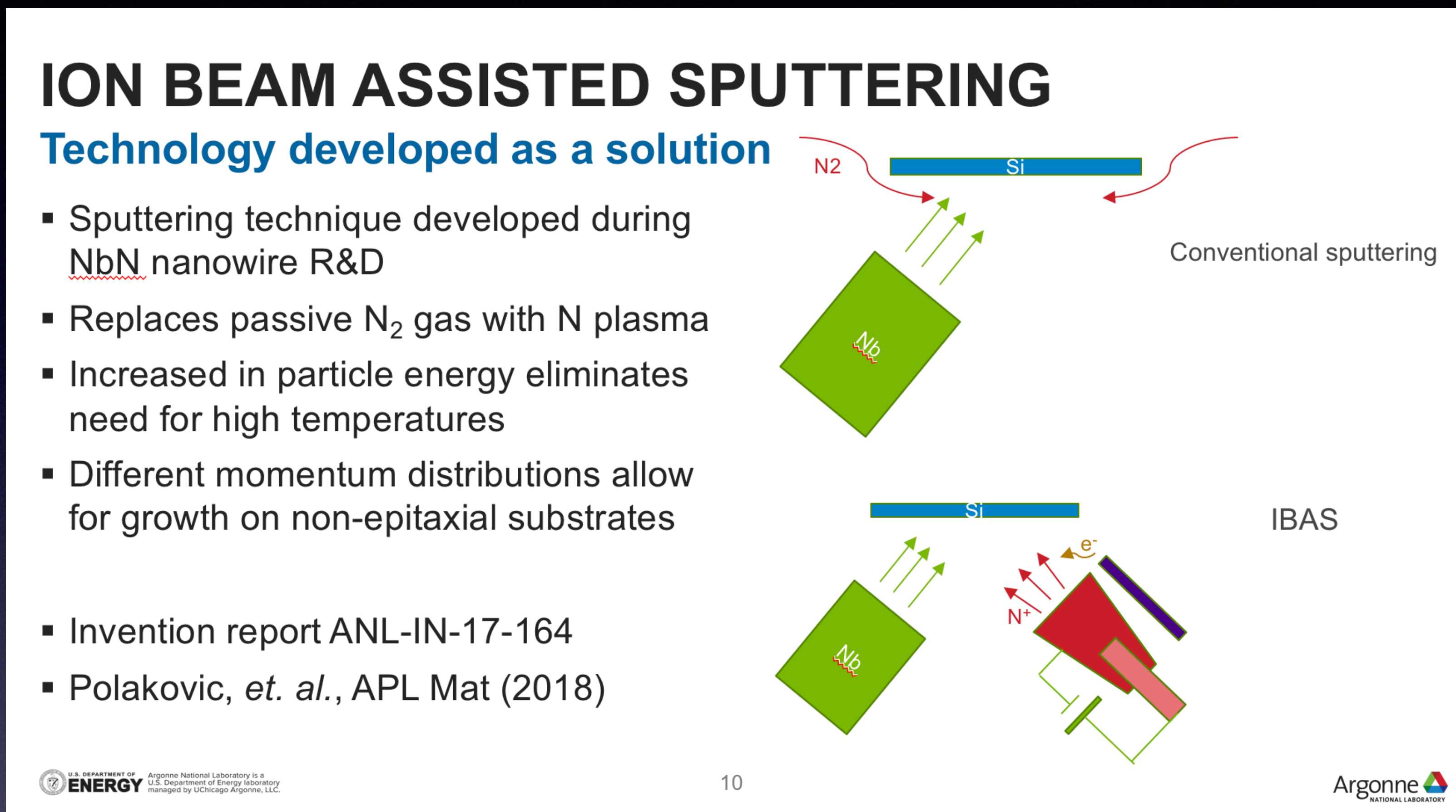
large detectors
low dark
current!

I.Charaev
the SNPD detectors for haloscope
(impressive dark count rate!)



T.Polakovic

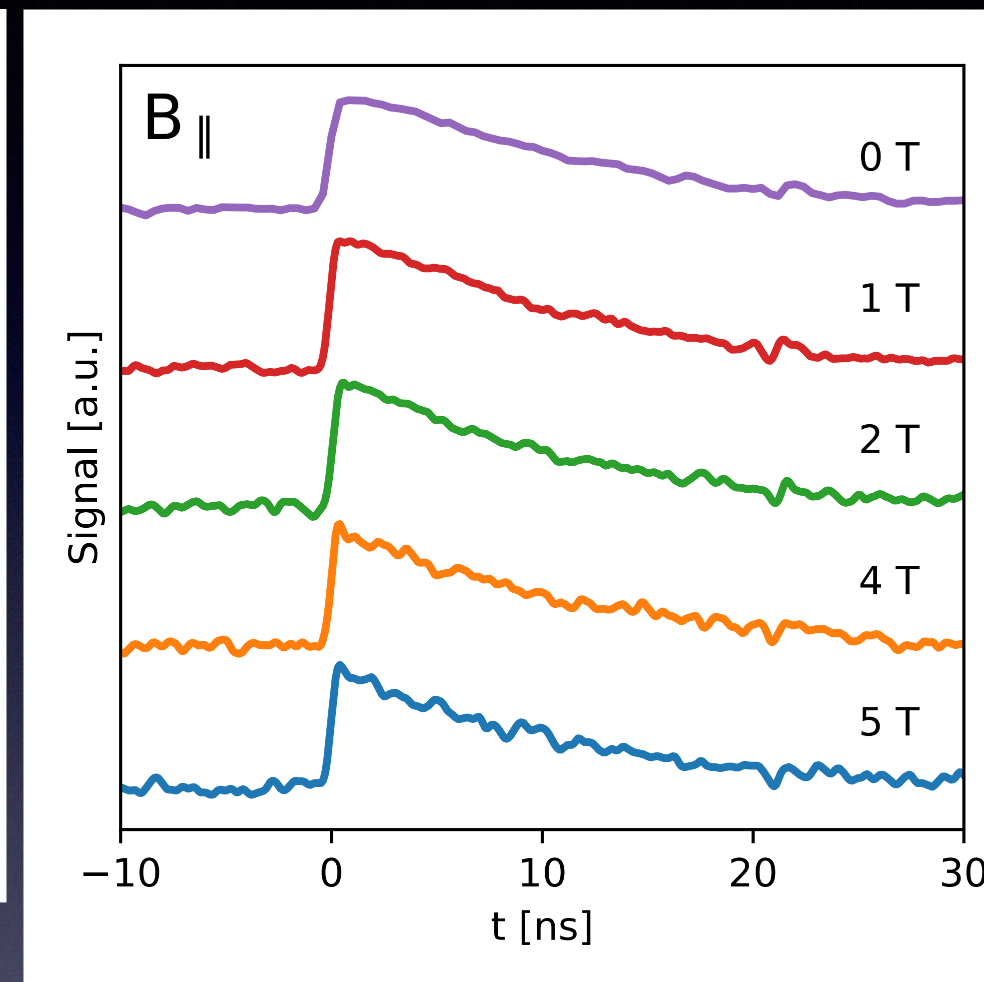
SNSPDs in strong magnetic field


ION BEAM ASSISTED SPUTTERING

Technology developed as a solution

- Sputtering technique developed during NbN nanowire R&D
- Replaces passive N_2 gas with N plasma
- Increased in particle energy eliminates need for high temperatures
- Different momentum distributions allow for growth on non-epitaxial substrates

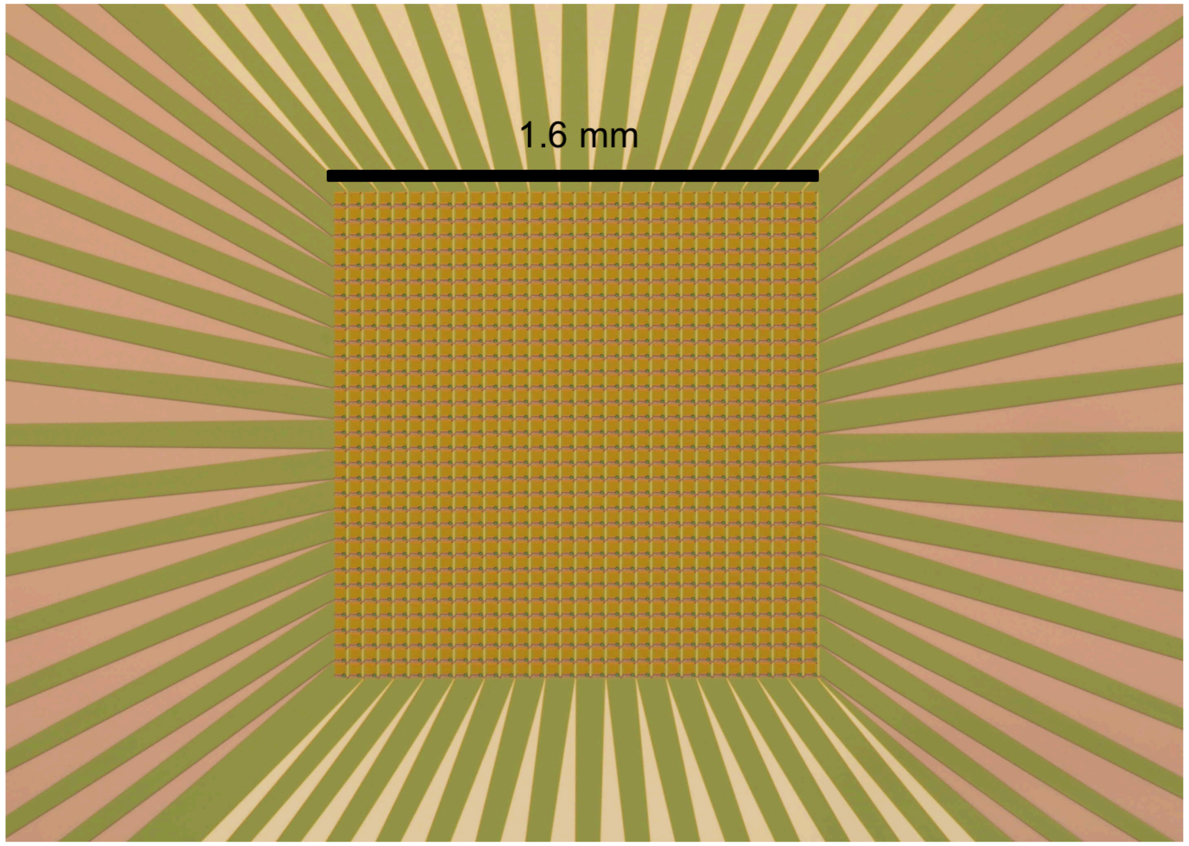
- Invention report ANL-IN-17-164
- Polakovic, *et. al.*, APL Mat (2018)



Developed a new technique for the fabrication of films that can operate in very high field.

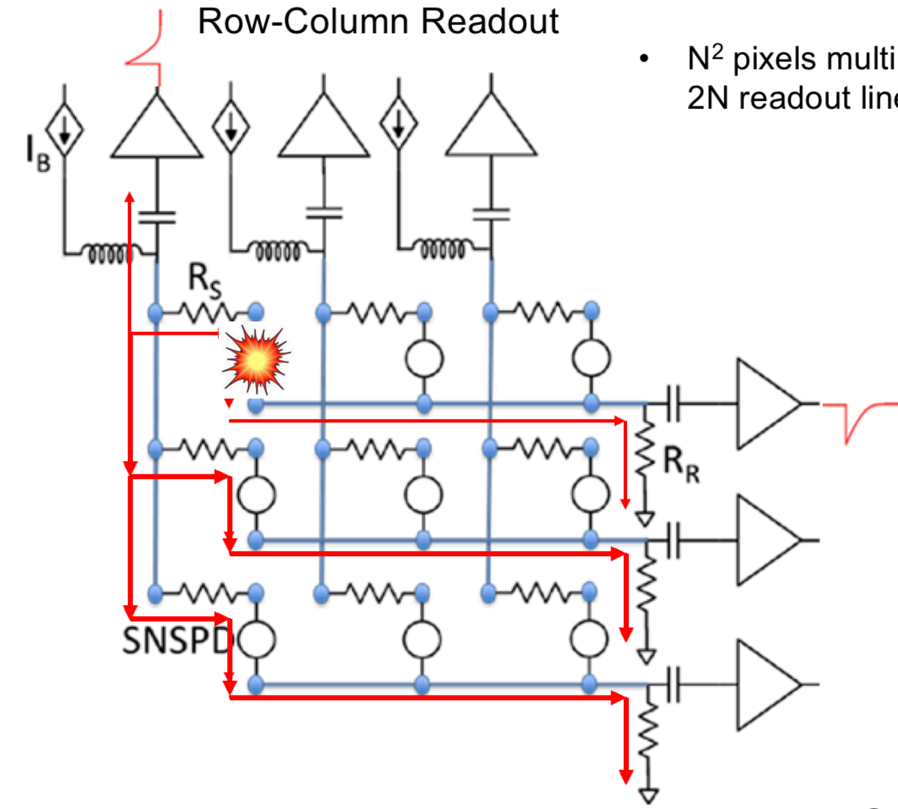
V.Verma

Kilopixel (32 x 32) Array



NIST

Row-Column Readout for SNSPD Arrays

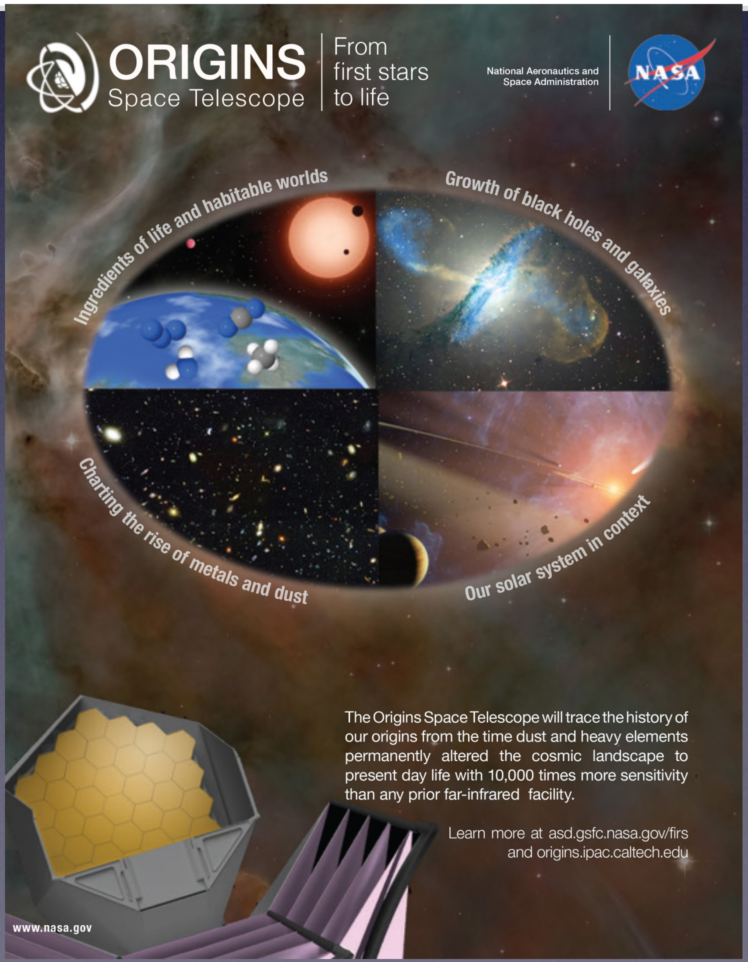


- N^2 pixels multiplexed on 2N readout lines

NIST

Developments in SNSPDs at NIST/JPL

- Kilopixel scale arrays, megapixel arrays have been fabricated and will be tested in coming weeks
- Readout technology needs further development to make these large-format arrays practical (cryo-CMOS, single-flux-quantum or other types of superconducting logic for low-temperature signal processing)
- Optimization for the mid-infrared (up to 10 μm)
- Optimization in the UV for integration with ion traps
- Potential for high energy physics experiments requiring high efficiency and timing resolution, but can tolerate small active areas



astronomy in the plans

W. Chung
speeding up axion search

- Maximize Signal (B^2VQ)
  - 25T 10cm bore HTS magnet by BNL (?) ~ x100 faster scan
  - 12T 32cm bore LTS magnet by Oxford (2020) > x100 faster scan
    - Higher frequencies without shrinking volume
      - Pizza Cavity (S. Youn)
      - Dielectric rings (TM_{030} and TM_{050}) (O. Kwon)
  - Improving Q-factor of cavity – YBCO cavity (D. Ahn) > x 20 faster scan
- Minimize Noise ($T_{system} = T_{physical} + T_{amp}$) ~ x100 faster scan
  - Quantum Amplifier - SQUID and/or JPA
  - Optimize cryo-RF receiver chain

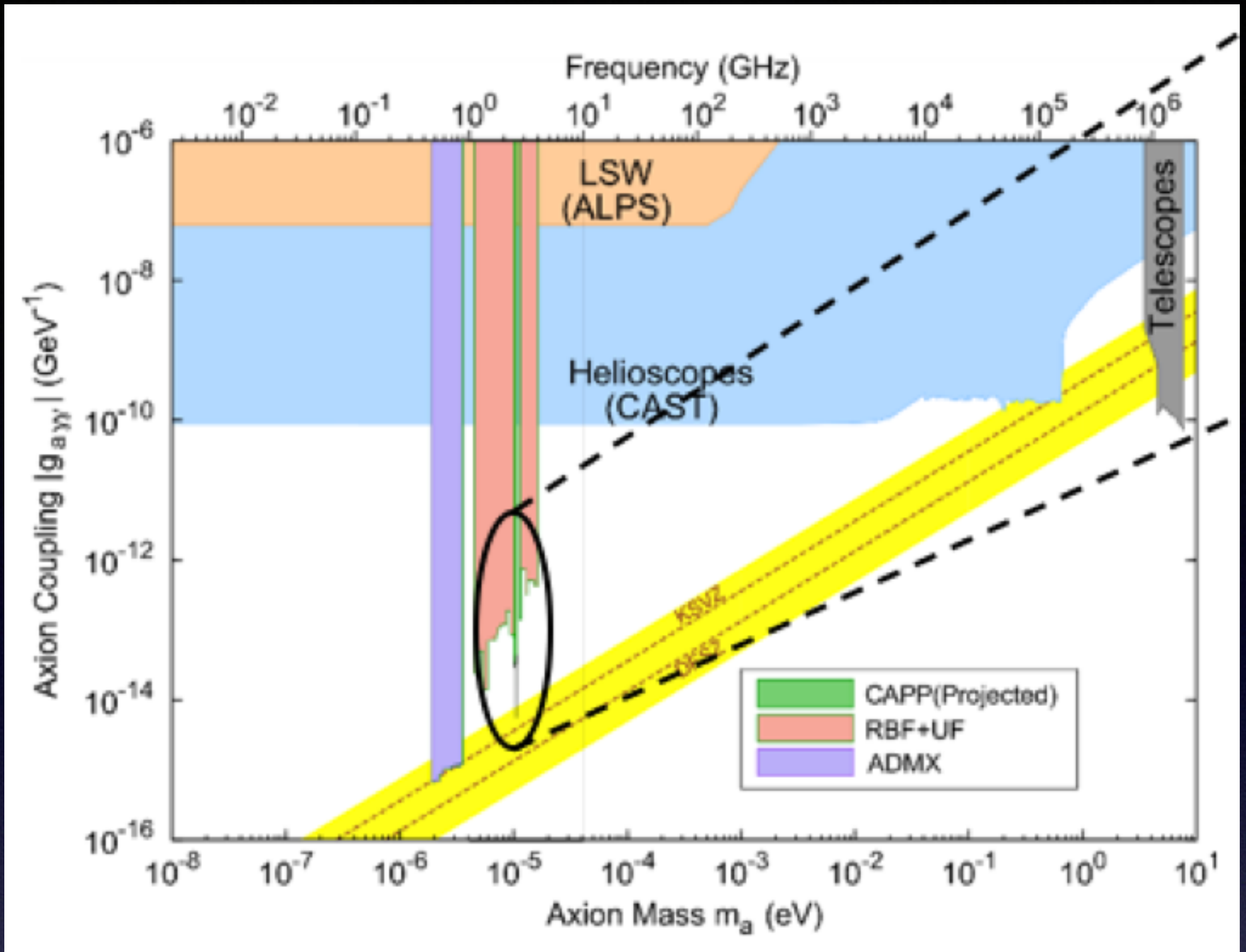
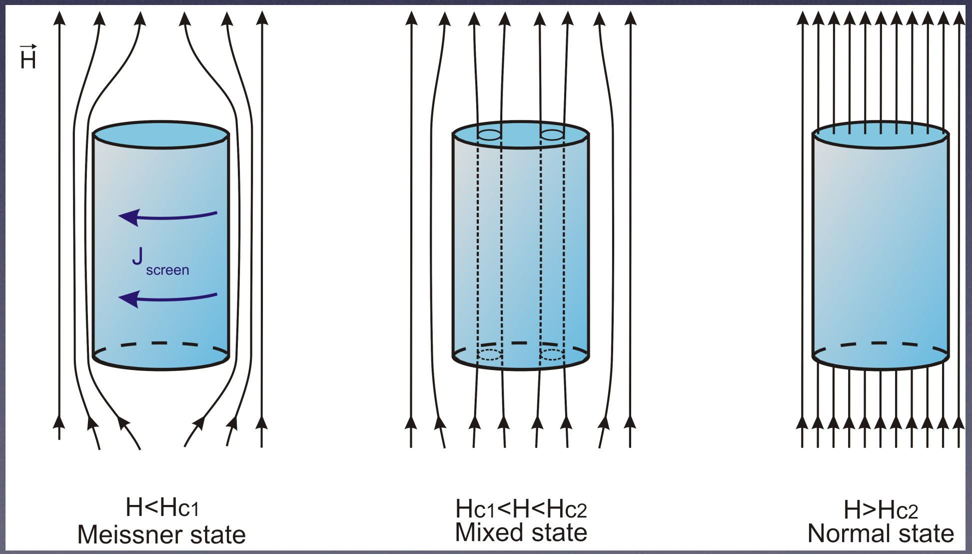
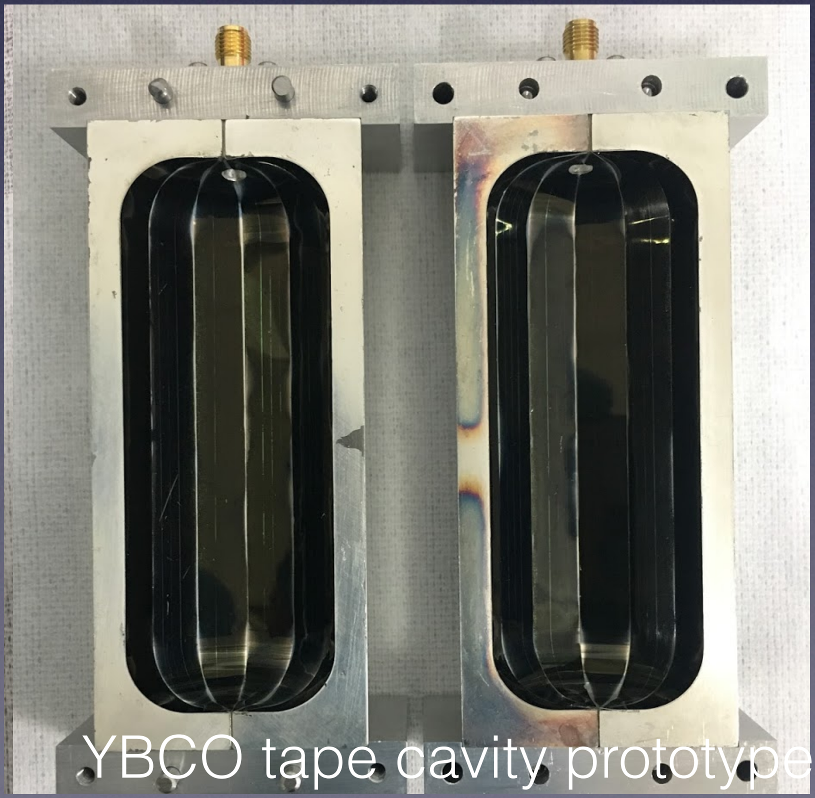


Figure 9: Exclusion plot showing CAPP-PACE results along with other haloscope experim...

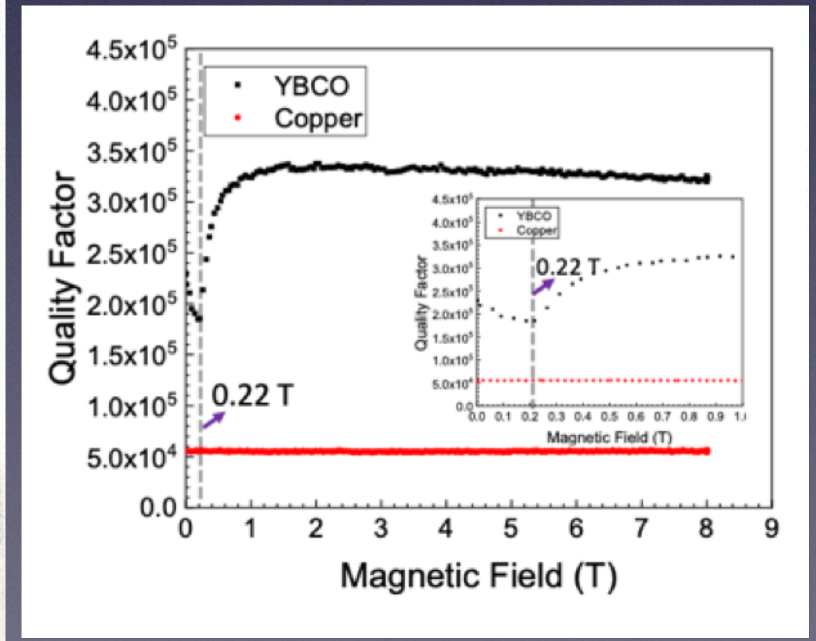
$$\frac{df}{dt} \sim B^4 V^2 C^2 Q_L T_{syst}^{-2}$$

SC cavity could allow high B, in mixed state



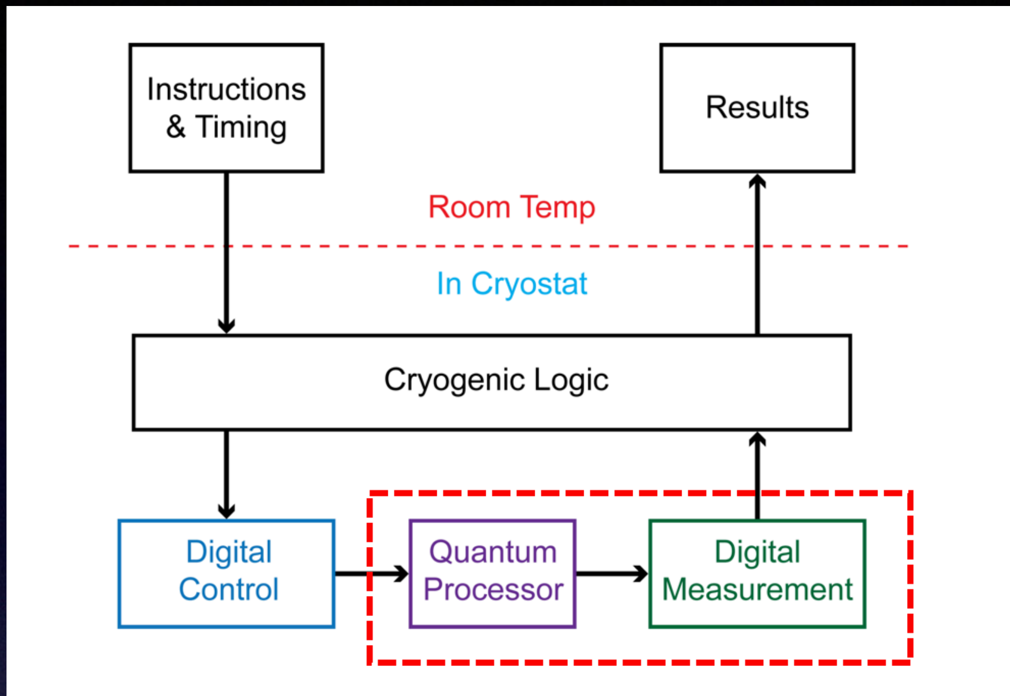


YBCO tape cavity prototype

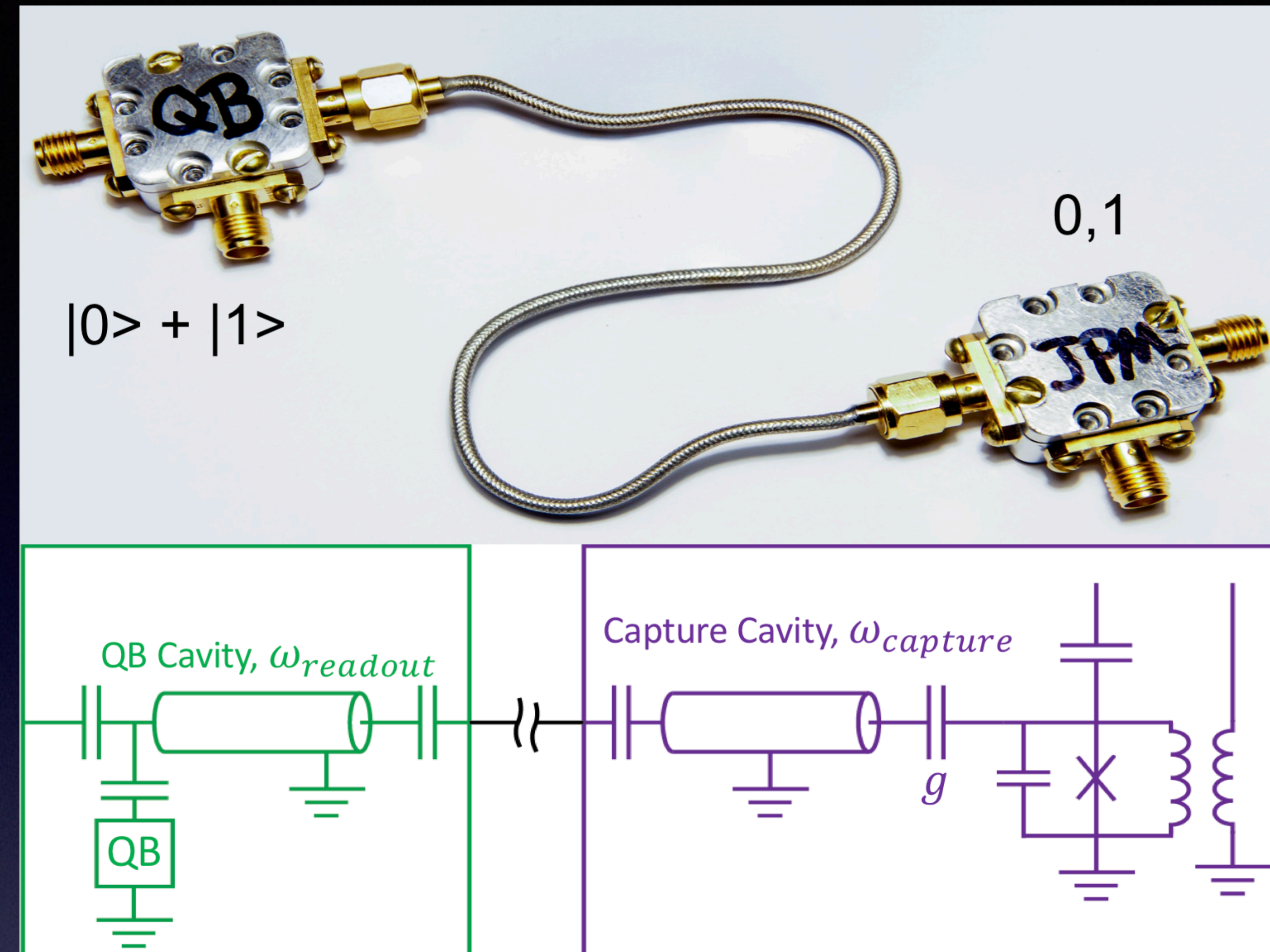


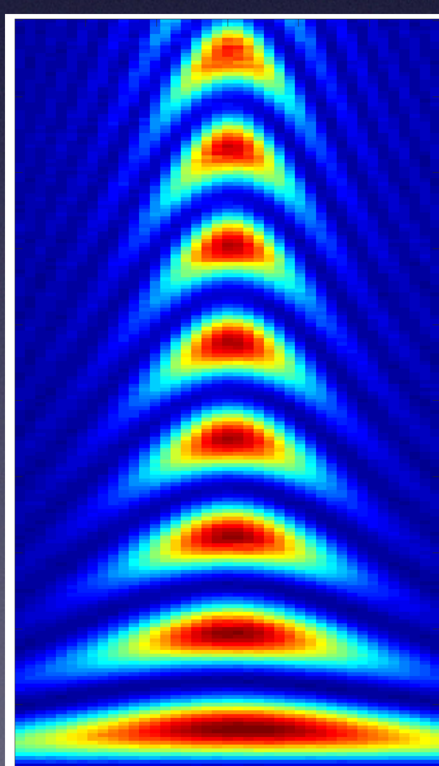
tested

R.McDermott



Josephson Photomultiplier (JPM)

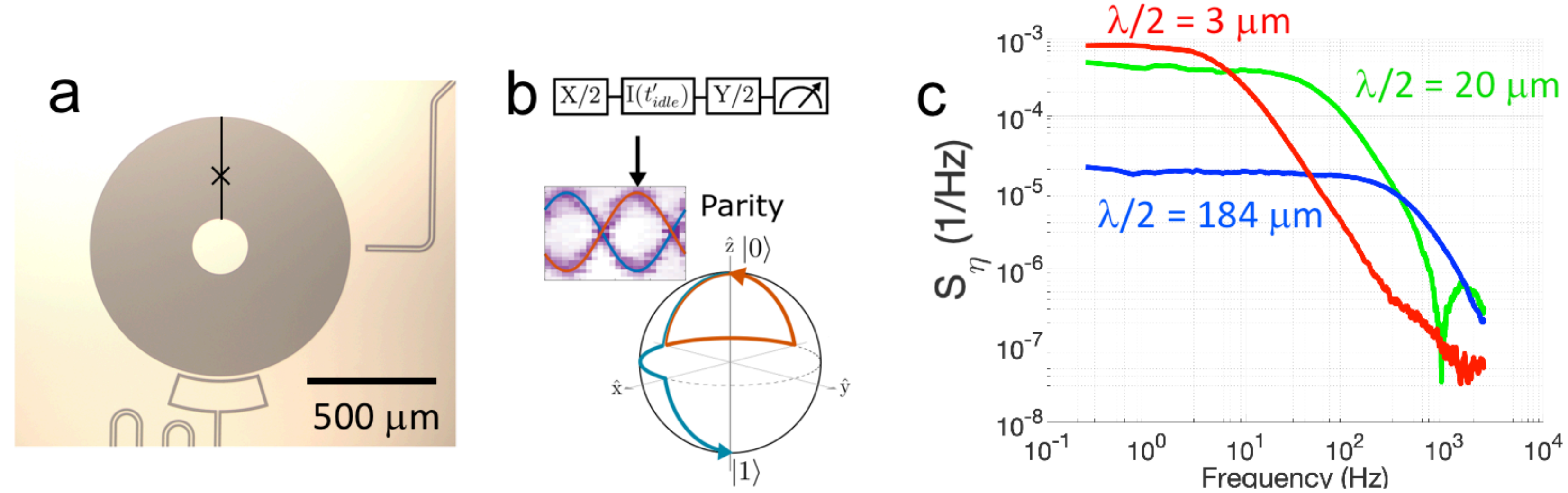




High-fidelity counter-based QB measurement

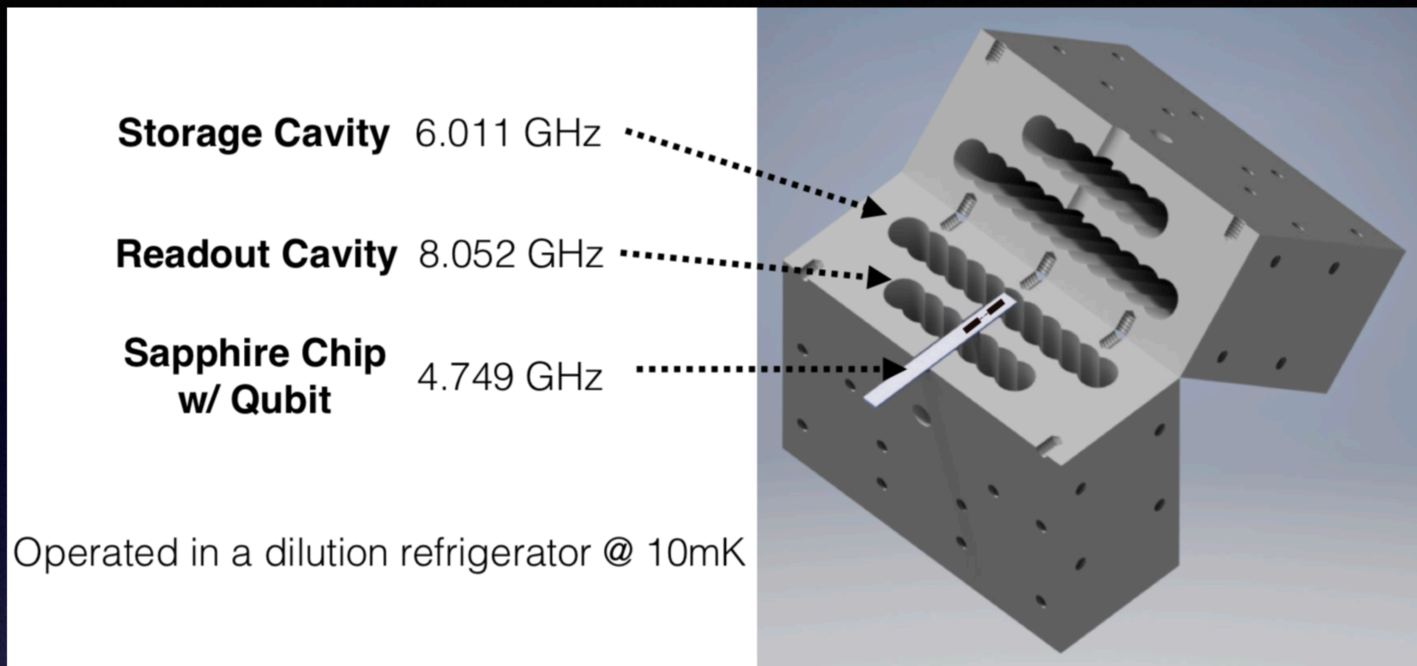
***Science* 361, 1239 (2018)**

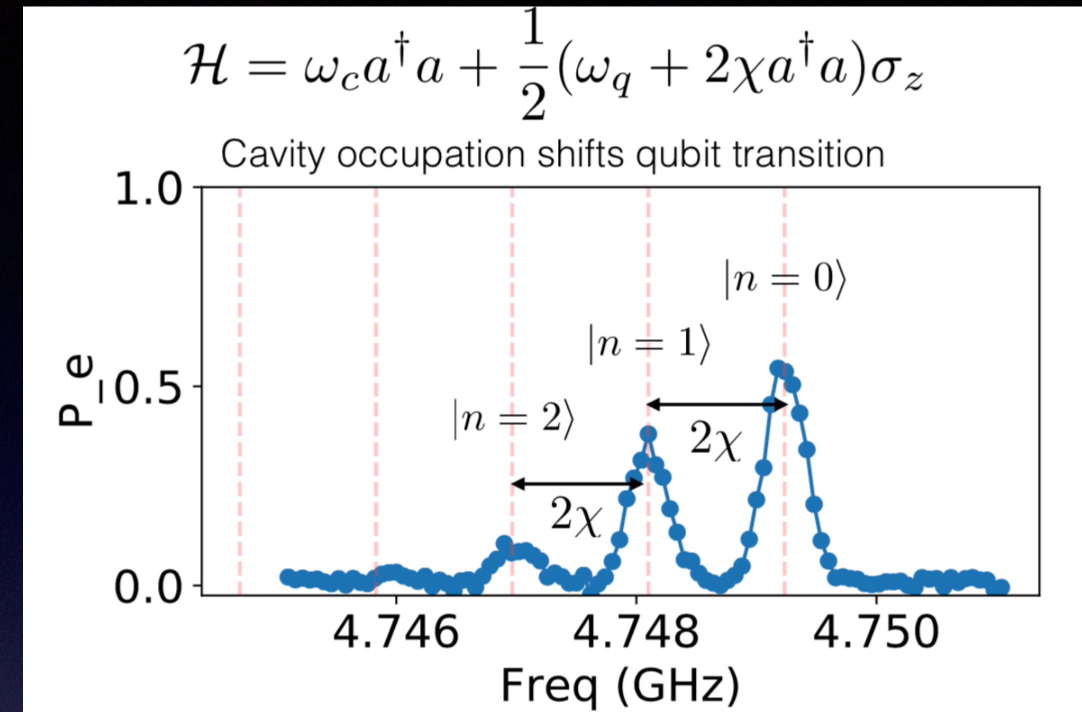
QP Parity-based Detection of Transduced Photons

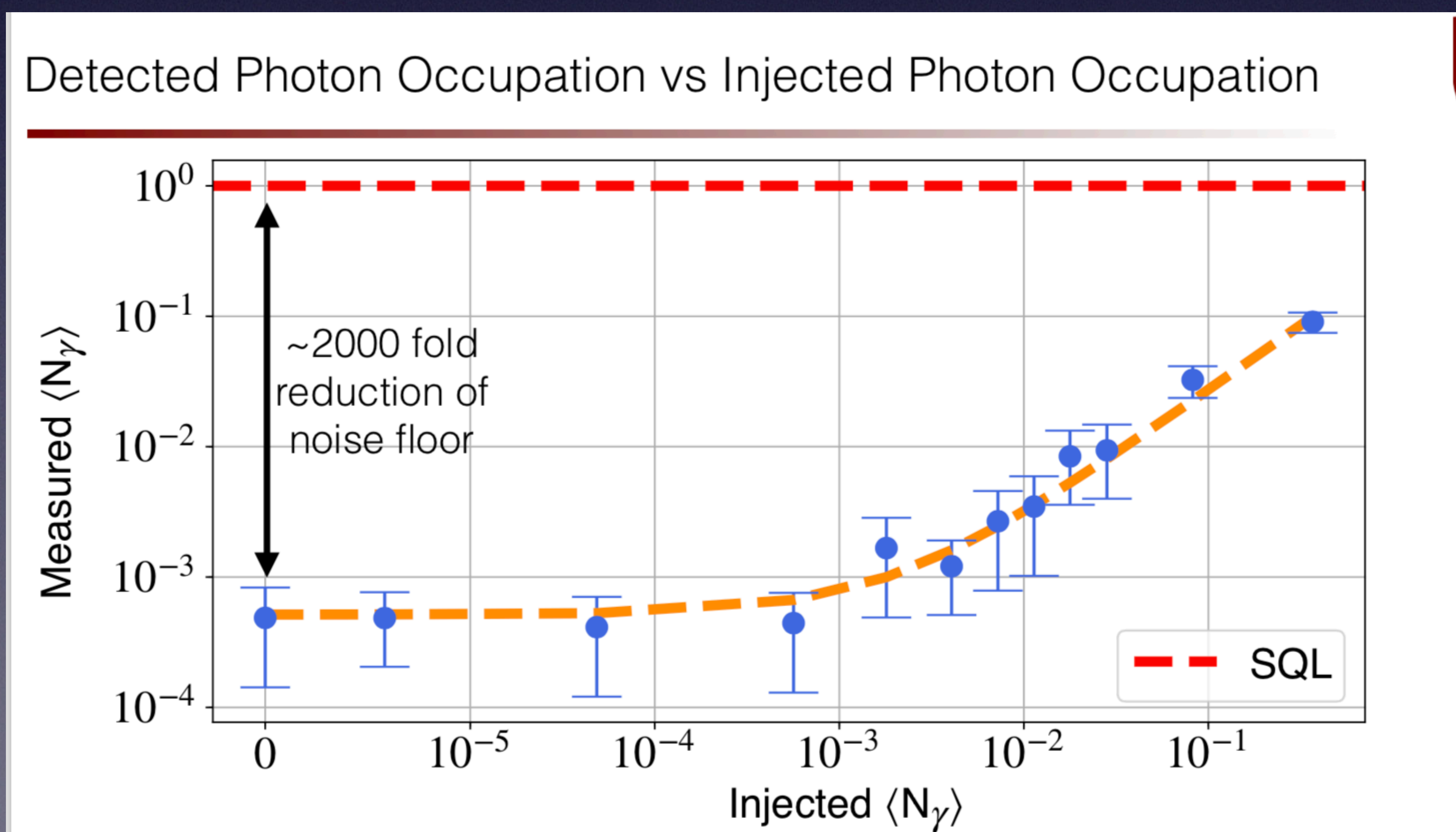


- Possible next-gen. axion detector (collaboration with A. Chou, FNAL)
- Accessible frequency range: 10 GHz to 10 THz

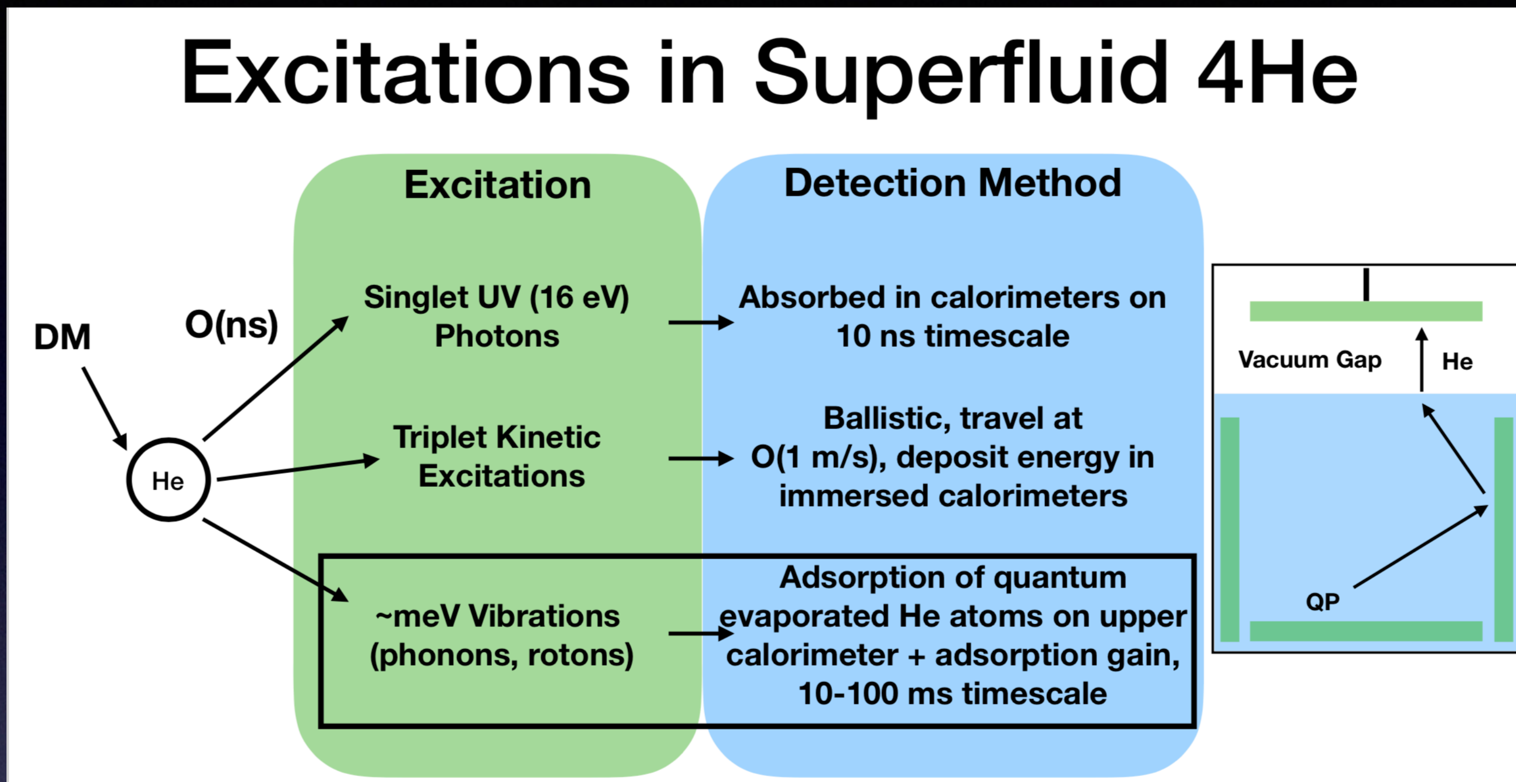
A. Dixit: qubits for single photon detection in Axion search.

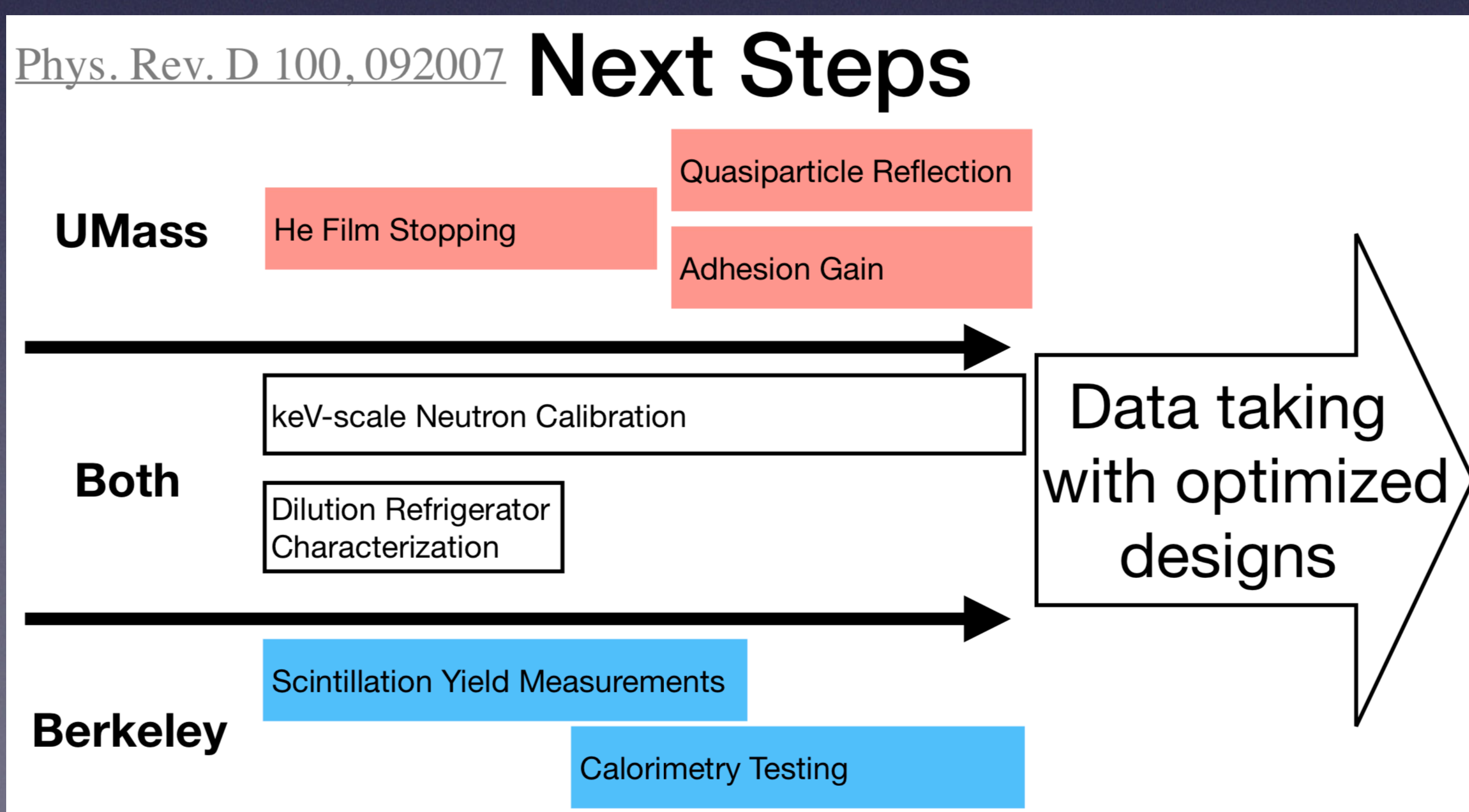




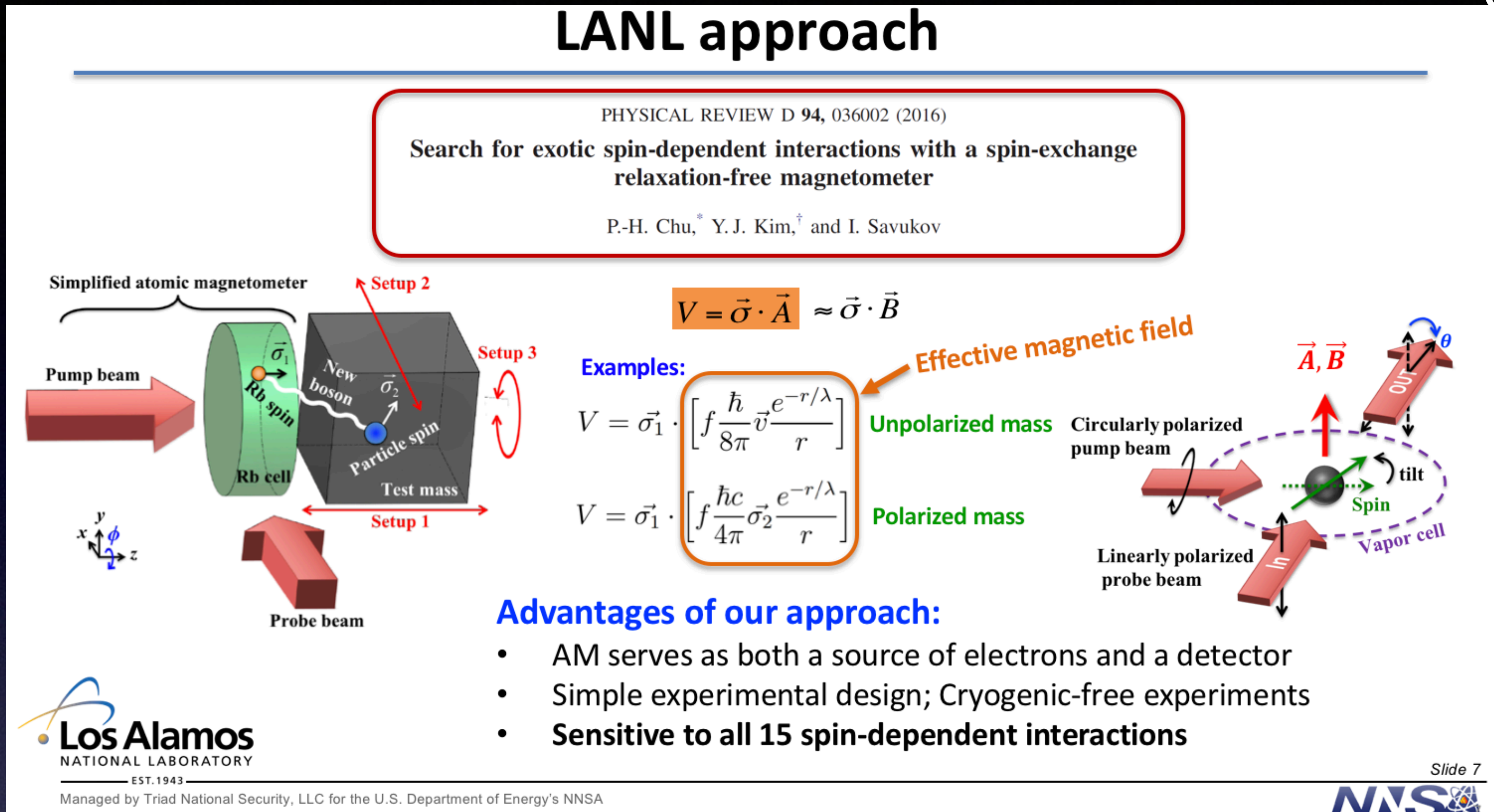


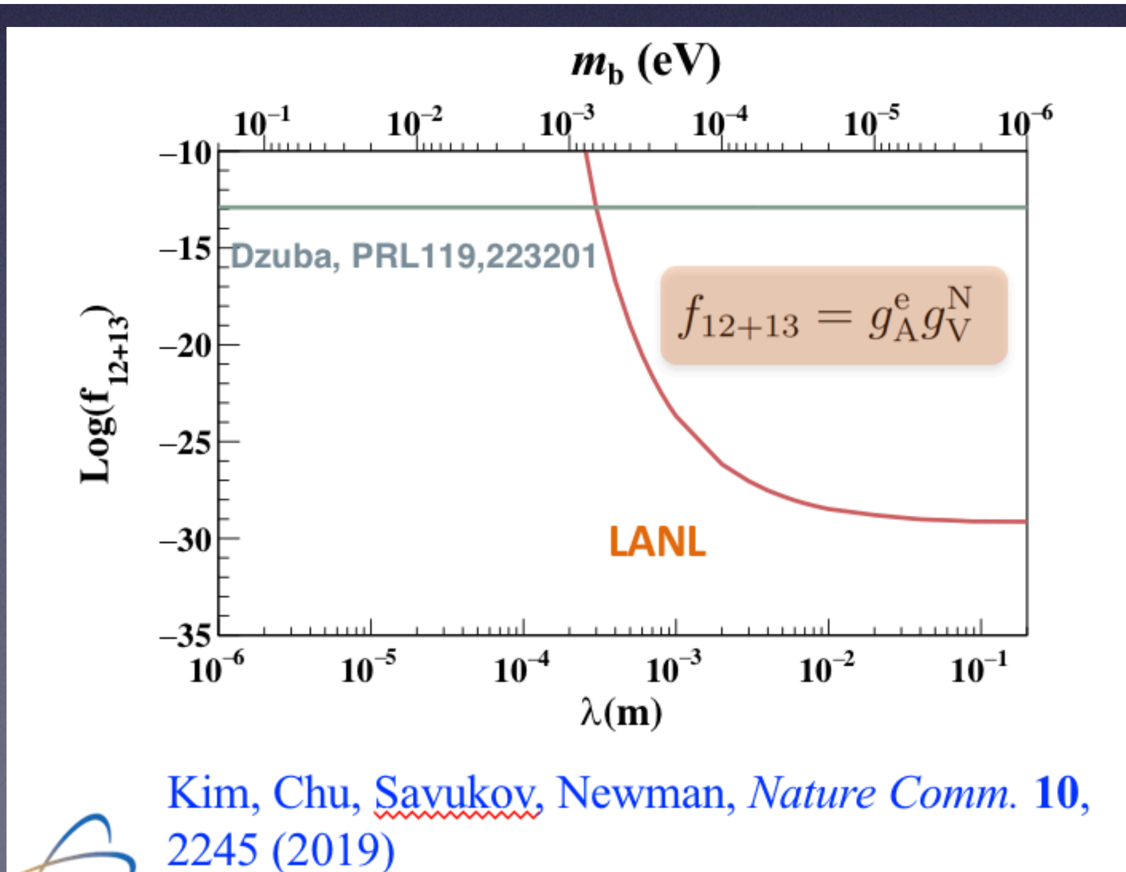
Doug Pinckney : HeRALD





Y.J.Kim
dark matter search with atomic magnetometers





recently published constraints