Tranfer of CCD technology to industry

- CCD technology transfer to industry is underway (cont')

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Development of the fully-depleted thick back-illuminated CCD by Hamamatsu

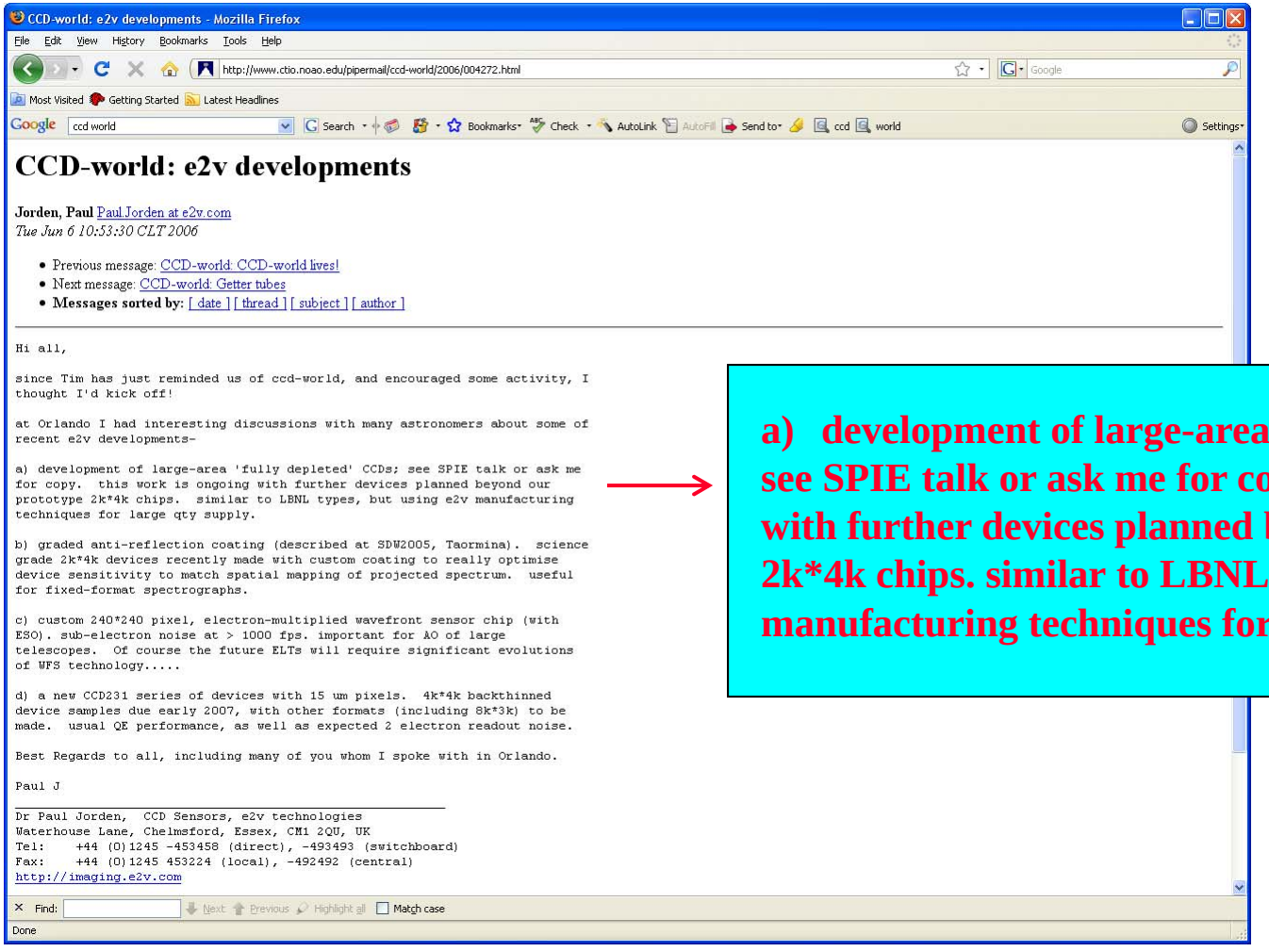
H.Suzuki, M.Muramatsu, K.Yamamoto, S.Miyazaki and Y.Kamata

A group at Lawrence Berkeley National Laboratory (LBNL) developed p-channel CCD on the high resistivity n-type silicon wafer[1]. They have successfully built 2k × 4k, 15μm pixel CCD which has excellent performance[2].

Stimulated by the LBNL development and realizing the scientific importance of this type of detectors, we started an independent development project to build the same type of CCDs in collaboration with National Astronomical Observatory of Japan (NAOJ) for a next generation instrument for Subaru Telescope: a very wide-field CCD camera which named Hyper Suprime-Cam[3], with Kyoto University and Osaka University for X-ray astronomy by NeXT (Non-thermal energy eXploration Telescope)Project / JAXA[4].

Tranfer of CCD technology to industry

- CCD technology transfer to industry is underway (cont')



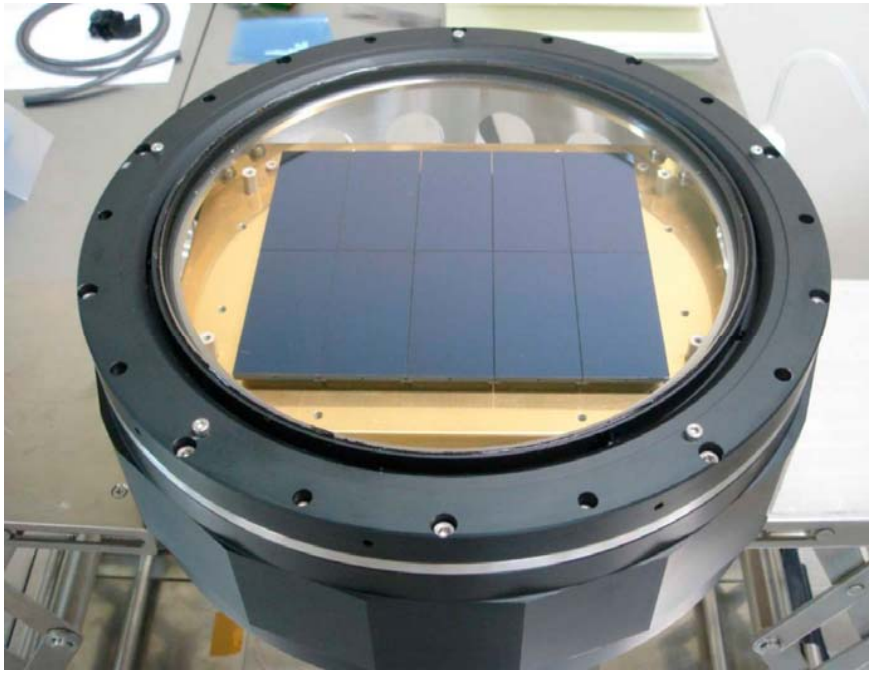
a) development of large-area 'fully depleted' CCDs; see SPIE talk or ask me for copy. this work is ongoing with further devices planned beyond our prototype 2k*4k chips. similar to LBNL types, but using e2v manufacturing techniques for large qty supply.

Impact of fully depleted, back-illuminated CCDs on astronomy and astrophysics

- Many major camera upgrades at ground-based telescopes are using or are planning to use fully depleted, back-illuminated CCDs:

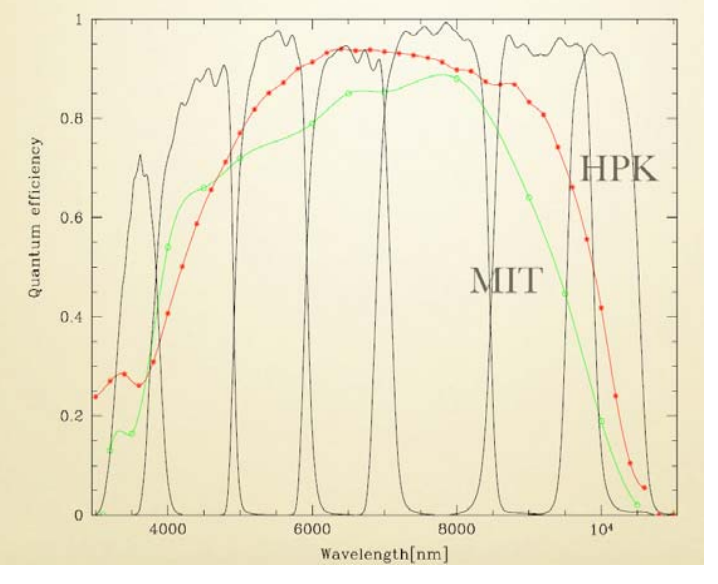
  —Subaru Super and HyperSuprime Cameras
  - 10, 2048 x 4096 (15 μm pixel), 200 μm thick, fully depleted p-channel CCDs in operation since August 2008 (Super Suprime-Cam)
    —http://www.naoj.org/Pressrelease/index_2008.html#081120
  - HyperSuprime-Cam will require ~ 200 CCDs
  - Fabricated by Hamamatsu Corporation

Commercial development of FD CCDs



2k x 4k CCDs fabricated at Hamamatsu Corporation for the Subaru Telescope

http://www.naoj.org/Pressrelease/index_2008.html#081120

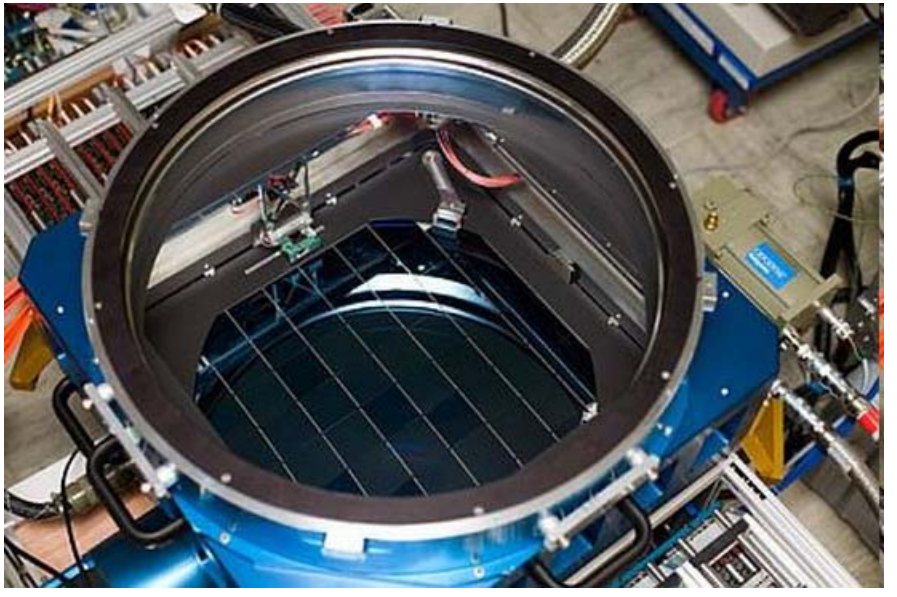


—Pan-Starrs (University of Hawaii)

- 1.4 Gpixel camera, 1 installed August 2007 with 3 more proposed
- MIT Lincoln Laboratory orthogonal transfer, 75 μm thick fully depleted n-channel CCDs fabricated on ~ 5 kΩ-cm, p-type silicon
- 60, ~ 5k x 5k (10 μm pixel) CCDs per camera
- http://pan-starrs.ifa.hawaii.edu/public/
- Similar project: WIYN Observatory One-degree imager

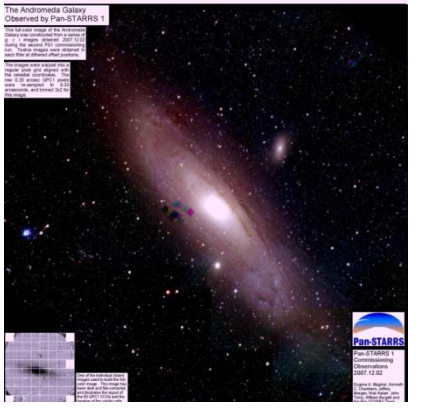
Impact of fully depleted, back-illuminated CCDs on astronomy and astrophysics

—Pan-Starrs (University of Hawaii) cont'



Images from Pan-Starrs 1 Camera

Early 2008 commissioning



Impact of fully depleted, back-illuminated CCDs on astronomy and astrophysics (cont')

—Dark Energy Survey camera

- 62, 2048 x 4096 (15 μm pixel), 250 μm thick, fully depleted p-channel CCDs (~ 0.5 Gigapixel camera)
- Fabrication at DALSA/Lawrence Berkeley National Laboratory, packaging and testing at Fermi National Accelerator Laboratory
- http://www.darkenergysurvey.org/

—Large Synoptic Survey Telescope (LSST)

- ~ 200, 4k x 4k (10 μm pixel), 100 μm thick, fully depleted CCDs required (~ 3.2 Gigapixel camera)
- http://www.lsst.org/lsst/science/concept_camera

LBNL support of MSL

- LBNL continues to invest GPE in MSL to maintain it as a unique core competency:
  - —2001 $62k Particle monitor system + $40k photoresist developer
  - —2005 $575k Furnace conversion to 6" wafers
  - —2008 $226k PECVD system for passivation + $150k photoresist coater
  - —2009 $525k for new sputtering system
  - —∑ = $1.4 million

- Regular LDRD support
  - —2008 support for wafer saw
  - —2009 support for R&D CCD fabrication lot