



Transfer 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 $2k \times 4k$, $15\mu\text{m}$ 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].

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



CCD-world: e2v developments - Mozilla Firefox

http://www.ctio.noao.edu/pipermail/ccd-world/2006/004272.html

Google ccd world

CCD-world: e2v developments

Jorden, Paul Paul.Jorden@e2v.com
Tue Jun 6 10:53:30 CLT 2006

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Hi all,

since Tim has just reminded us of ccd-world, and encouraged some activity, I thought I'd kick off!

at Orlando I had interesting discussions with many astronomers about some of recent e2v developments-

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.

b) graded anti-reflection coating (described at SDN2005, Taormina). science grade 2k*4k devices recently made with custom coating to really optimise device sensitivity to match spatial mapping of projected spectrum. useful for fixed-format spectrographs.

c) custom 240*240 pixel, electron-multiplied wavefront sensor chip (with ESO). sub-electron noise at > 1000 fps. important for AO of large telescopes. Of course the future ELTs will require significant evolutions of WFS technology.....

d) a new CCD231 series of devices with 15 um pixels. 4k*4k backthinned device samples due early 2007, with other formats (including 8k*3k) to be made. usual QE performance, as well as expected 2 electron readout noise.

Best Regards to all, including many of you whom I spoke with in Orlando.

Paul J

Dr Paul Jorden, CCD Sensors, e2v technologies
Waterhouse Lane, Chelmsford, Essex, CM1 2QU, UK
Tel: +44 (0)1245 -453458 (direct), -493493 (switchboard)
Fax: +44 (0)1245 453224 (local), -492492 (central)
<http://imaging.e2v.com>

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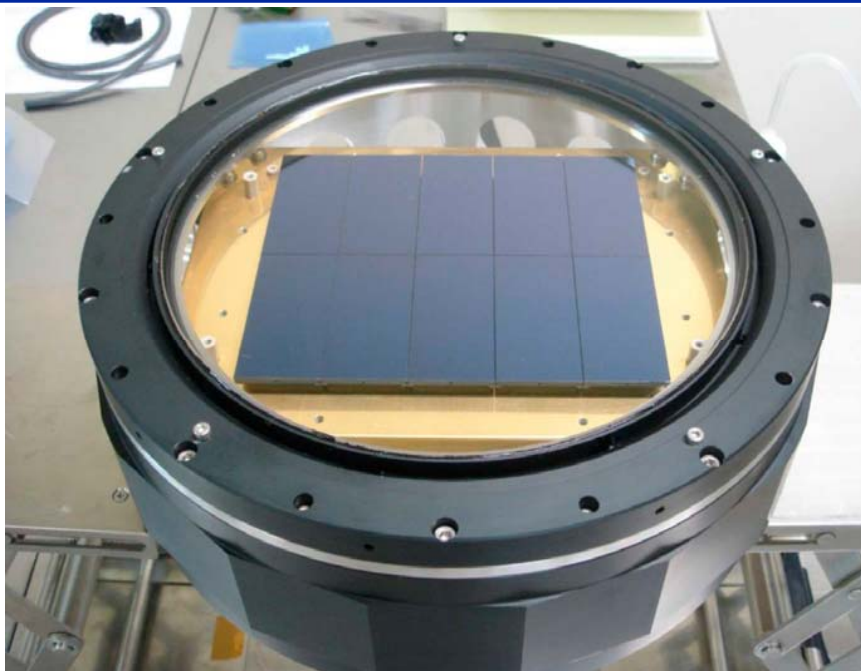
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Impact of fully depleted, back-illuminated CCDs on astronomy and astrophysics

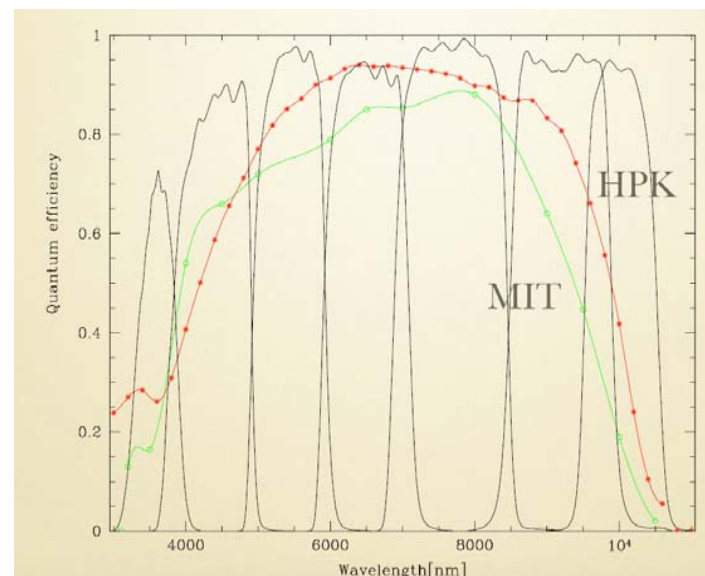
- Many major camera upgrades at ground-based telescopes are using or are planning to use fully depleted, back-illuminated CCDs:
 - Subaru Super and HyperSuprime Cameras
 - 10, 2048 x 4096 (15 μm pixel), 200 μm thick, fully depleted p-channel CCDs in operation since August 2008 (Super Suprime-Cam)
 - 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





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

—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 $\sim 5 \text{ k}\Omega\text{-cm}$, p-type silicon
- 60, $\sim 5\text{k} \times 5\text{k}$ (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 (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
 - $\Sigma = \$1.4$ million
- Regular LDRD support
 - 2008 support for wafer saw
 - 2009 support for R&D CCD fabrication lot