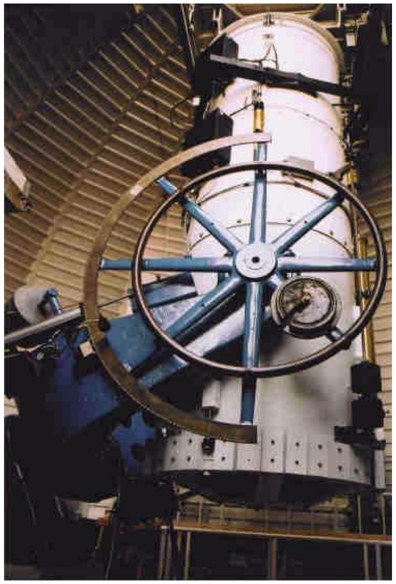
History 0f the 0.9-meter Telescope of Steward Observatory:

Spacewatch® personnel run the Steward Observatory 0.9-meter telescope, the oldest on Kitt Peak. It was installed in 1923 on the University of Arizona campus and houses the first large telescope mirror successfully cast in the United States. The telescope was then moved to Kitt Peak in 1962. In 1969, it was used to discover the first optical pulsar. By the year 1982 the telescope had fallen into disuse, so the Director of the Steward Observatory granted the Spacewatch® Project exclusive access to the telescope on the condition that Spacewatch® take on all the tasks of refurbishing the telescope and performing all maintenance. Spacewatch® rose to this challenge, developed an electronic imaging detector system, and made the first trial scans with a small CCD in May 1983.

On this telescope, Spacewatch® developed the technique of scanning the sky with a charge-coupled device (CCD), and has been using it to survey for asteroids and comets since 1984. In October of 2002 the conversion to a mosaic of CCDs was completed and a new primary mirror was installed. See the Photo Gallery of the conversion.

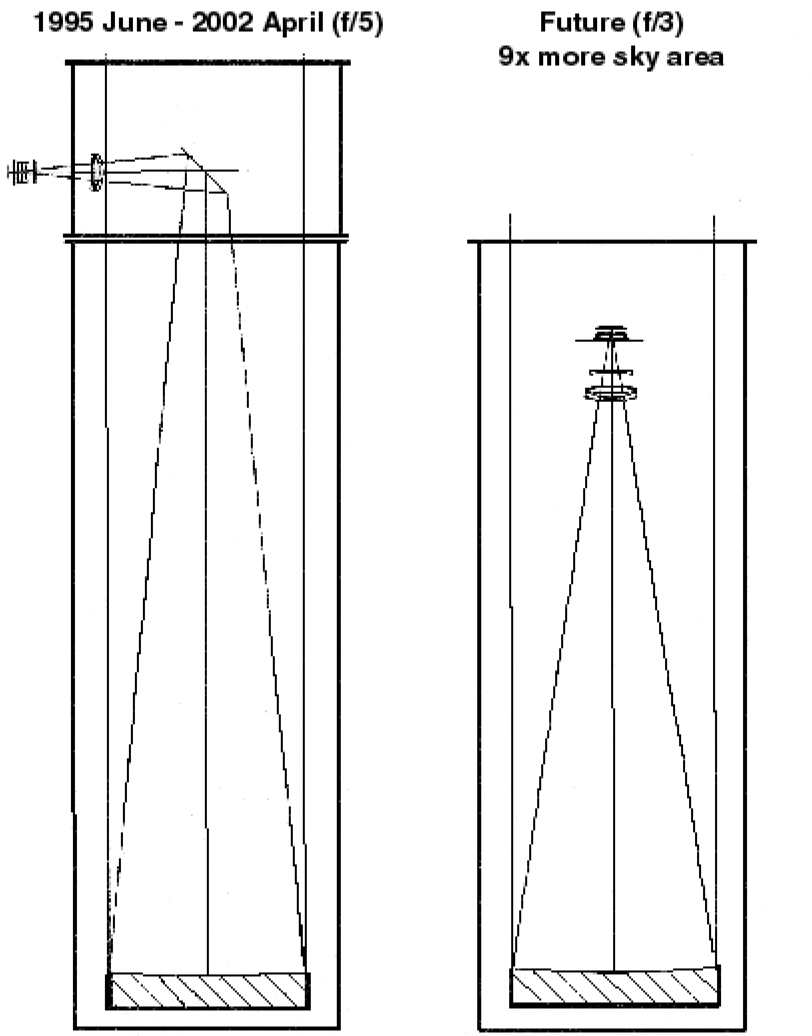
After visiting the Spacewatch® facilities on Kitt Peak in 2012, Dr. Roger Carpenter, MD (ret.) provided us with images of the 36 inch telescope during construction (PPT) and in its dome on the University of Arizona campus taken by his father Prof. Edwin Carpenter, in the 1920s and 1930s. Also included are a few images taken by himself during his visit to Spacewatch® showing the 36 inch in its present configuration in its dome on Kitt Peak.

Photograph by Jim Scotti
1983 May - 2002 April



Photograph by Robert McMillan
2002 October – Present

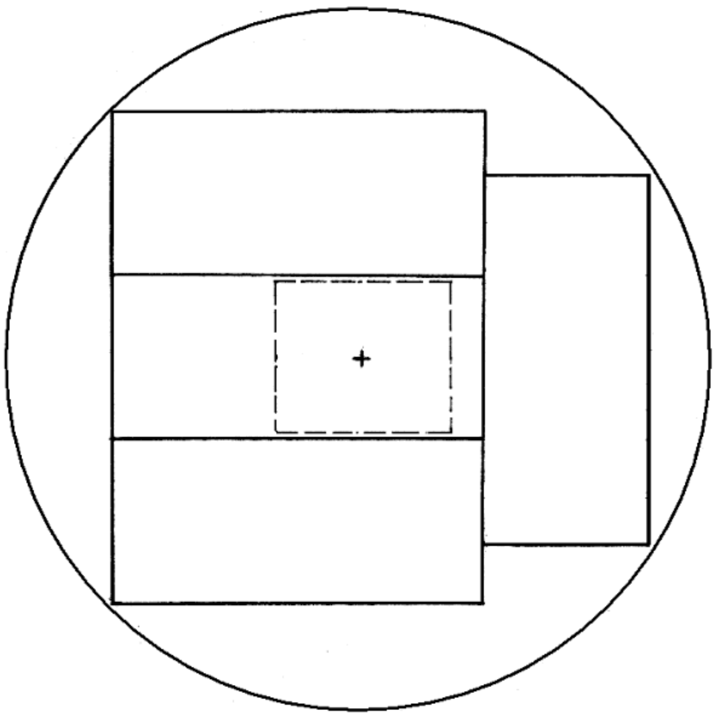
Spacewatch 0.9-meter Telescope Upgrade for Mosaic of CCds



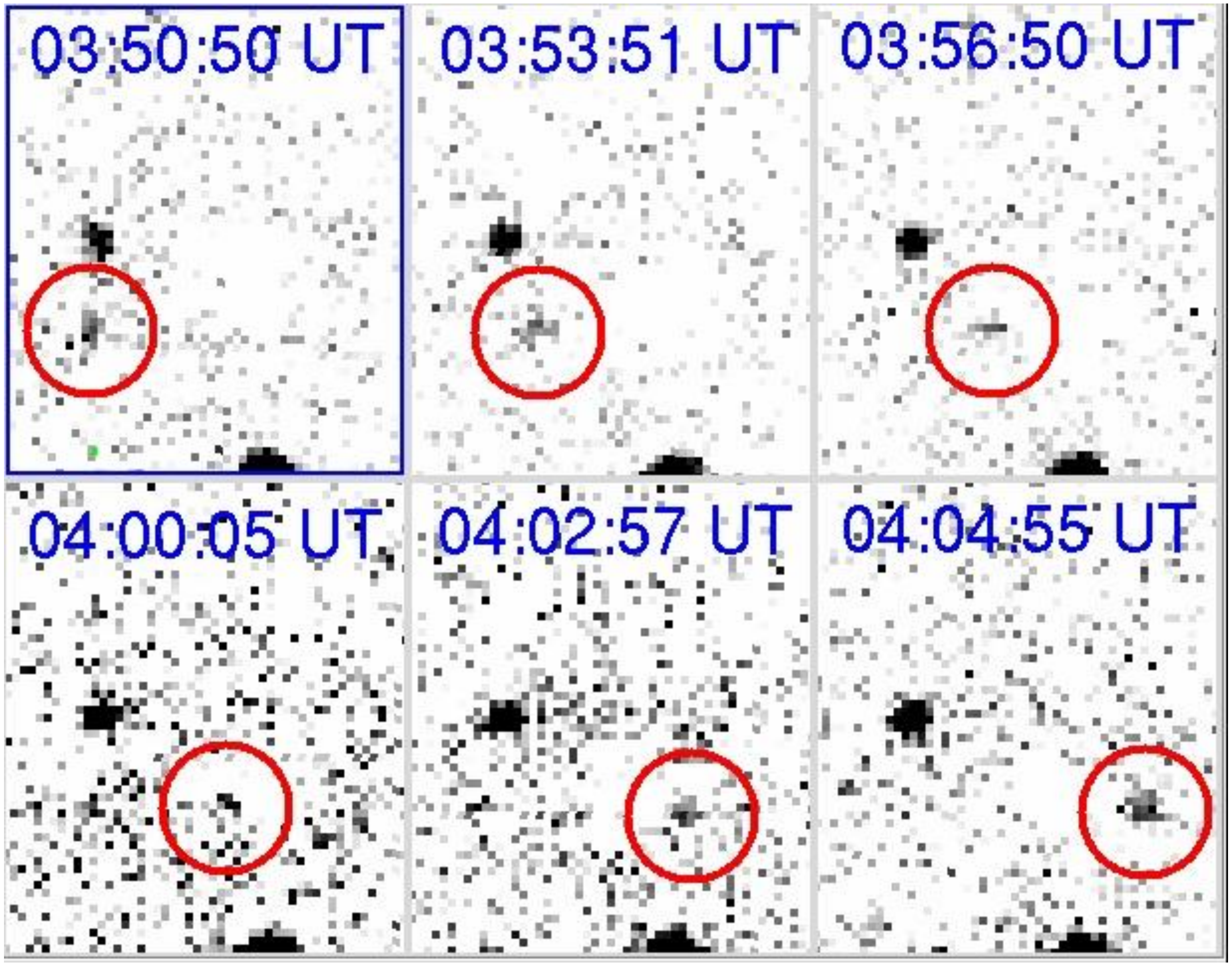
(Drawing by Joe Montani)

Spacewatch Mosaic of CCDs

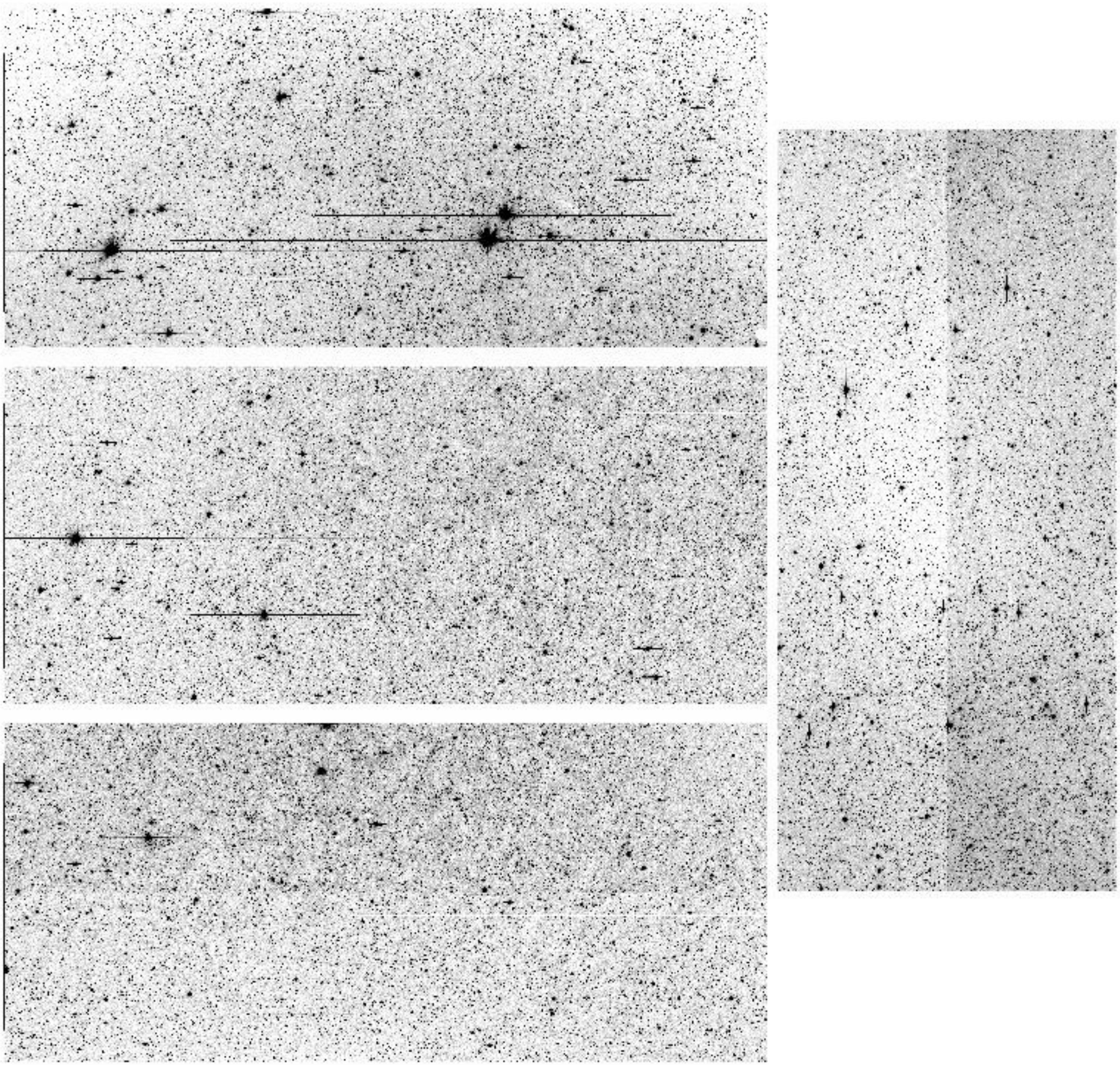
Full scale focal plane compared with projected effective size of 2k x 2k CCD used previously.



Four 4608 x 2048 Marconi Technologies thinned, back-illuminated CCDs.



Successful recovery of potentially hazardous asteroid 2002 TD66 (a=1.86 AU, e=0.54, i=4.93) taken by the 0.9 meter Spacewatch® Mosaic on Oct 23, 2002 between 03:50:50 and 04:04:55 UT. Observation was taken at Right Ascension 22:50:54 and Declination +08:49:14 in of date coordinates. The asteroid was V=19.5, or more than a quarter of a million times fainter than the faintest star visible with the unaided eye. The asteroid moved 30 arcseconds in 15 minutes -- an motion equivalent to a person walking from the front bumper to the tail bumper of a car 13 miles away.



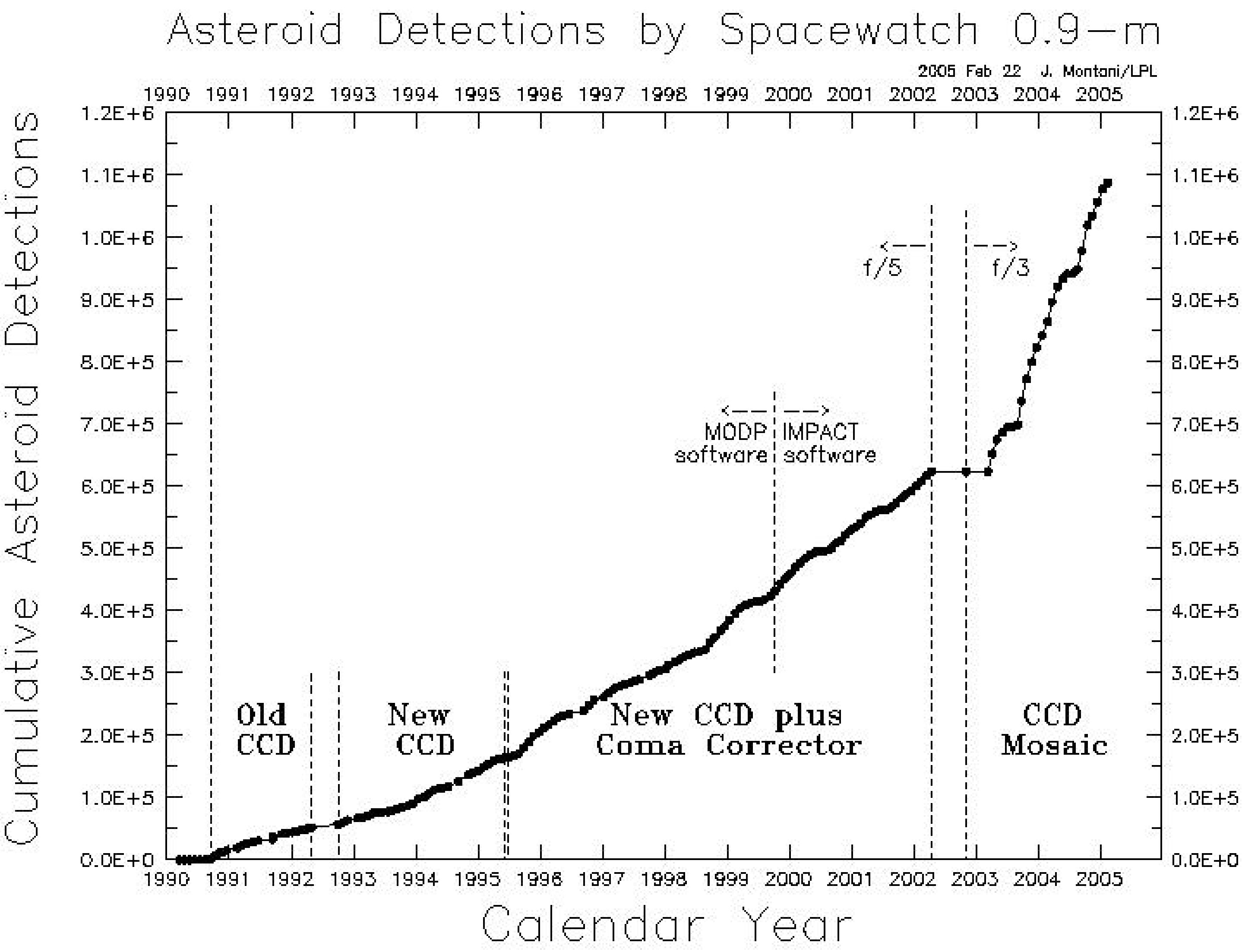
The first "long" (120 second) exposure of the Spacewatch® Mosaic Camera on the sky (RA 20:31:34, DEC +31:57:48), taken 2002 October 23 at 02:01:41 UT during engineering trials in bright moonlight. This "printer-friendly" version is like a photographic negative in which brighter sources are blacker and the dark sky shows white.

Three CCDs are aligned east/west and the fourth one is aligned north/south to fill a round field of view as efficiently as possible. Each CCD covers 0.6 x 1.3 degrees on the sky, so the total area covered by the system is 15 times greater than that usually covered by the Earth's moon. It is also 9 times larger than that covered by the usable area of the detector we had previously on this telescope.

The gaps between the CCDs are much smaller in reality than the spacing between these images. This is a "raw" (unprocessed) image that shows various effects that are easy to correct in post-processing. The variations of the background level are due to the nonuniformity of sensitivity across the CCDs. The image also shows slight differences between electronic bias levels between the two halves of the CCDs, due to the fact that the image areas are read out in two directions through two different amplifiers. Black (in reality bright) lines are due to signal bleeding away from overly saturated images of bright stars. Whitish (dark) lines are either dead columns or crosstalk from bright lines located elsewhere on the CCD. Such crosstalk is an unavoidable but removable characteristic of data collected from mosaics of CCDs.

The image validates several aspects of our engineering. The uniformity of focus and quality of the star images over the whole area shows that the CCDs were mounted in the same plane and that the optical system is collimated and works as designed. Furthermore there is no "ghost pupil", or "donut" image of the optical entrance pupil, another validation of the fine optical system. The roundness of the star images also shows that the charge transfer efficiency of the CCDs is good.

Discovery and Followup of Amor Asteroid 2003 EN16; First NEO Discovered with Spacewatch® CCD Mosaic. In MPEC 2003-E38.



[Asteroid Detections by Spacewatch® 0.9m telescope]

Early MPECs from observations with Spacewatch® CCD Mosaic

MPEC	Object	Type	H	Obs. Type	Vmag	Comments
2003-E38	2003 EN16	Amor	18.7	Discovery	20.4	First discovery
2003-E41	2003 EZ16	Amor	22.7	Discovery	20.4	Not planet crossing
2003-F57	2003 FQ6	Amor	21.1	Discovery	21.0	Low e, i
2003-F58	2003 FR6	Amor	19.9	Discovery	19.4	High e, i
2003-G38	2003 GJ21	Amor	23.1	Discovery	20.2	High e
2003-G44	2003 GS22	Amor	23.0	Discovery	21.6	High a, e
2003-H36	2003 HB6	Amor	17.8	Precovery	19.8	High a, e
2003-J05	2003 HU42	Amor	18.6	Discovery	21.5	N/A
2003-J21	2003 JG4	Amor	23.1	Discovery	21.4	High e
2003-J35	2003 JC11	MC	18.6	Discovery	21.0	High a, e, i
2003-J41	2003 JC13	Apollo	20.6	Discovery	19.8	PHA; low a
2003-J45	2003 JF13	MC	21.0	Discovery	21.6	High e
2003-J52	2003 JV14	Apollo	21.1	Discovery	19.4	High e
2003-K14	C/2002 U2	Comet	N/A	Incidental	20.0T	Comet LINEAR
2003-K26	2003 KU2	Apollo	17.9	Discovery	20.7	PHA; High e
2003-K34	P/2003 H4	Comet	N/A	Incidental	17.8T	Comet LINEAR
2003-K37	C/2003 K1	Comet	N/A	Discovery	20.2N	Comet Spacewatch®
2003-K54	2003 KN18	Apollo	19.1	Discovery	20.8	PHA; High e
2003-L11	2003 KK20	Hungaria	17.9	Discovery	22.0	a=3.02, e=0.24, i=42
2003-L30	0053P	Comet	N/A	IA Obs.	14.7T	N/A
2003-L33	C/2003 L1	Comet	N/A	Discovery	19.7T	Comet Scotti
2003-M42	2003 MT	Amor	19.1	Discovery	18.7	High a,e
2003-M43	2003 MU	Amor	20.5	Precovery	20.4	PHA; high e