Intercomparison of passive radiation monitors in Russian segment of ISS (Space intercomparison/BRADOS)

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Space intercomparison/BRADOS

We conducted an intercomparison experiment for passive Radiation dosimeters, Space intercomparison/BRADOS, aboard the International Space Station.

Passive dosimeters from five laboratories in four countries were contained within a standard BRADOS box.
The BRADOS box was exposed on the wall of the Flight Engineer's sleeping quarters in the Russian Service Module for a period of 91.5 days in early 2004.

Purposes

o Experiment#1 (3 months (91.5days))

Intercomparison for passive dosimeters

- Five detectors from four institution
- Depth distributions of dose (rate) from wall

o Experiment#2 (10 months)

- Spatial distribution (5 locations)
- Depth distributions of dose (rate) from wall

Flight information (Experiment#1)

Launch (Progress M1-11(13P)):
2004/01/29 20:58(JPT) 2004/01/29 11:58(UTC)
Docking:
2004/01/31 22:13(JPT) 2004/01/31 13:12 (UTC)
Return (Soyuz TMA-3(7S)):
2004/04/30 21:12 (JPT) 2004/04/30 0:12 (UTC)

On board duration
in ISS Russian Segment (#443 panel): 91.5 days

Mean altitude -- 367.9 km
Apogee -- 373.0 km
Perigee -- 362.9 km
Period -- 91.9 min.
Inclination (to Equator) -- 51.63 deg

Participants and detectors

NIRS-CHIYODA
Plastic detector (TT-P3(CR-39): Chiyoda technol corporation)
Glass detector (GD: Chiyoda Technol corporation)

NIRS-NAGASE
Plastic detector (TD-1(CR-39), BARYOTRAK(CR-39): Nagase landauer Inc.)
Optical stimulated detector (OSL Al2O3:C : Nagase landauer Inc.)
Thermo luminescence detector (LiF(TLD-100): Nagase landauer Inc.)

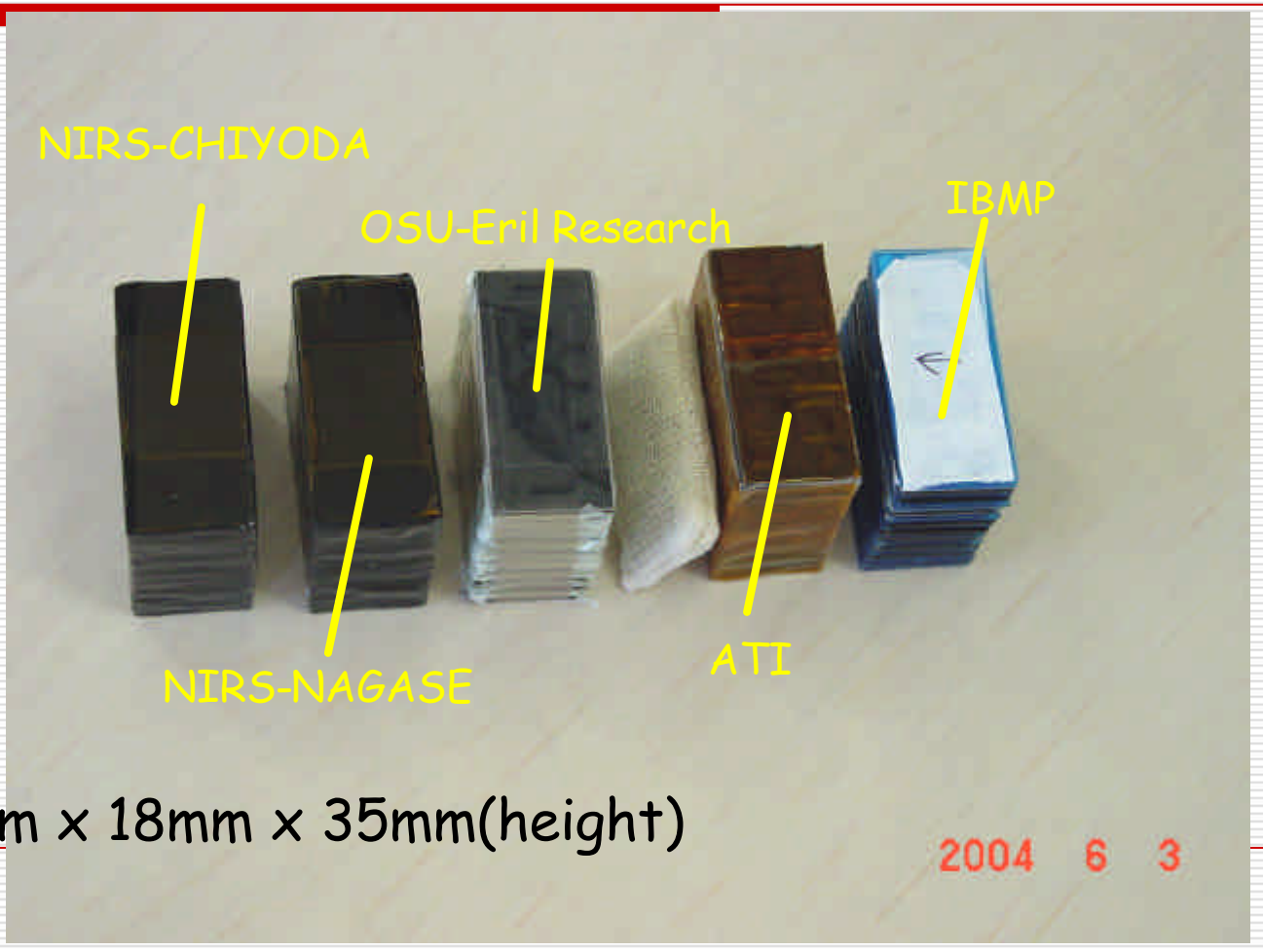
IBMP
Thermo luminescence detector (TLD-100)

ATI
Thermo luminescence detector (LiF-600, 700)

OSU
Plastic detector (USF-4(CR-39): ?)
Optical stimulated detector (OSL Al2O3:C : Landauer Inc.)

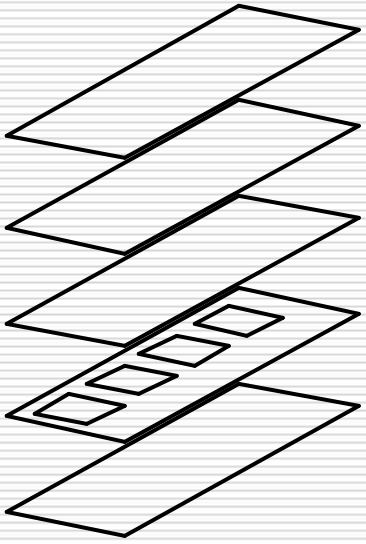
Detector assembly

Detector packages



55mm x 18mm x 35mm(height)

Detector component



PC 0.2mm

Paper 0.05mm

CR-39 1mm

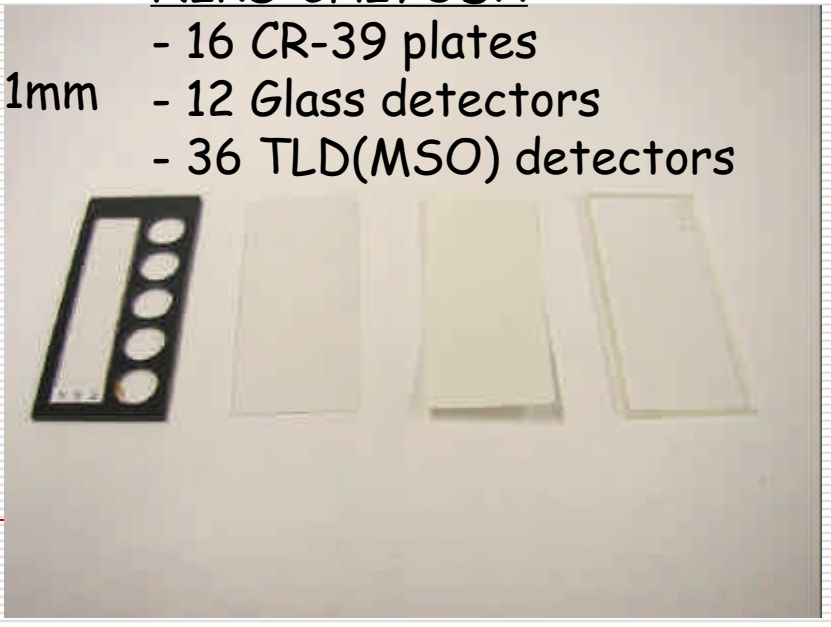
TLD holder (PC) 1mm

CR-39 1mm

< 10 g/cm^2

NIRS-NAGASE
- 24 CR-39 plates
- 36 Al2O3 detectors
- 60 TLD LiF detectors

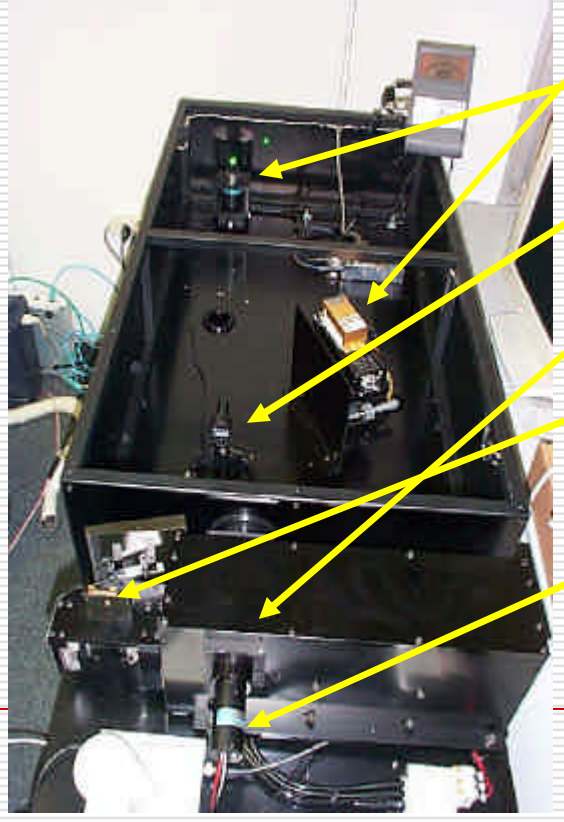
NIRS-CHIYODA
- 16 CR-39 plates
- 12 Glass detectors
- 36 TLD(MSO) detectors



TLD(LiF) reader

Glass detector reader

OSL reader



Compass315M laser unit

Optical scanner

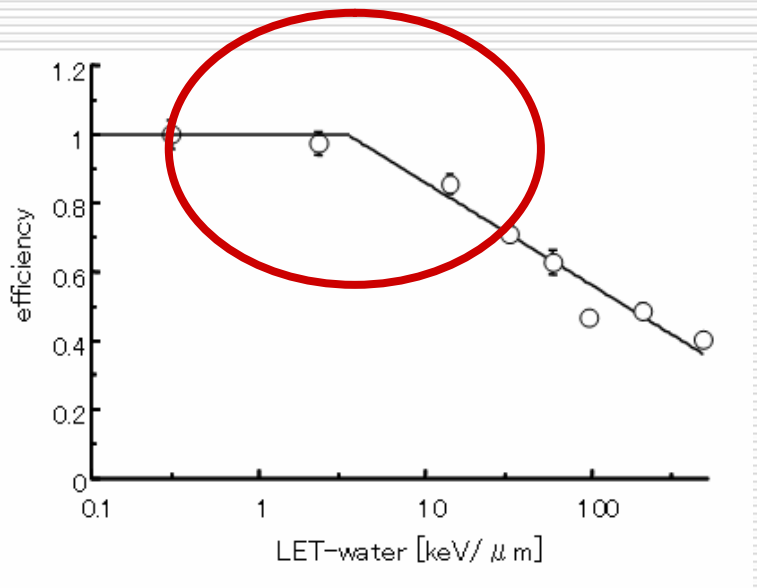
Laser Power meter

Optical filter unit

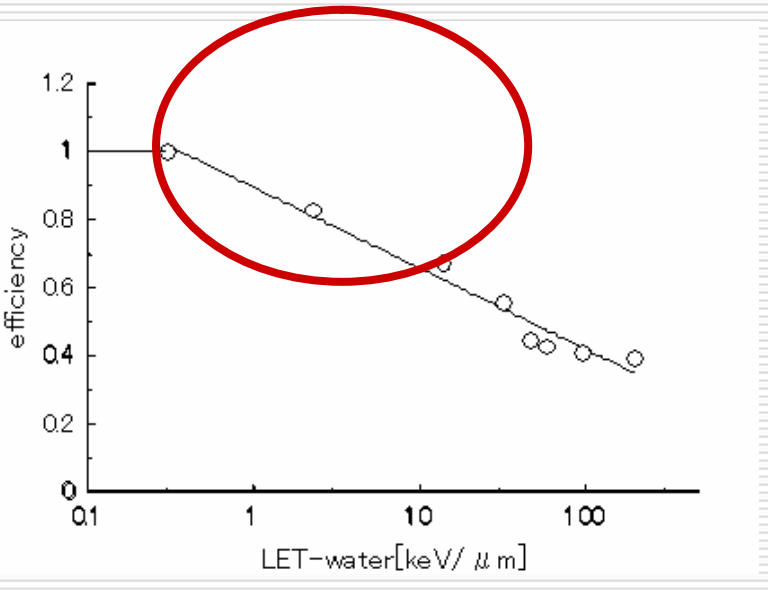
Detector transportation system

PMT

PL efficiency for high LET partcles



OSL

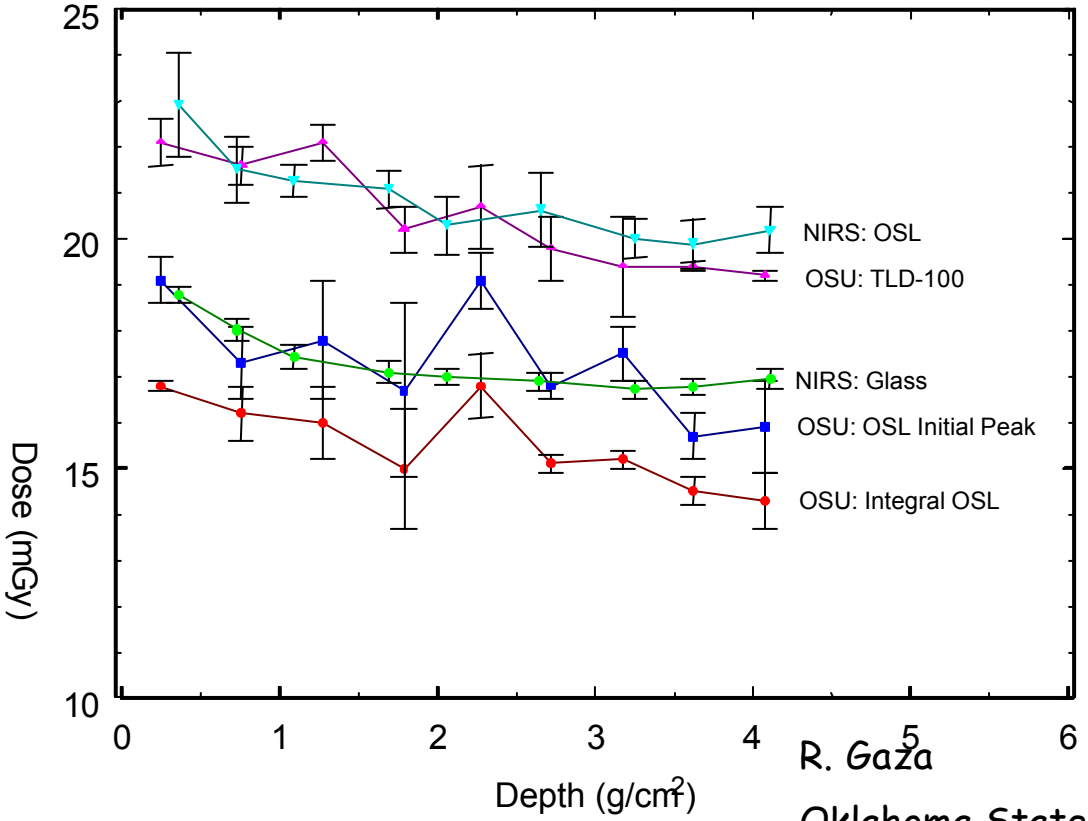


Glass

BRADOS Preliminary Results
NIRS and OSU Depth Dose Curves

91.5 days

Absorbed dose rate
> 200 μGy/day



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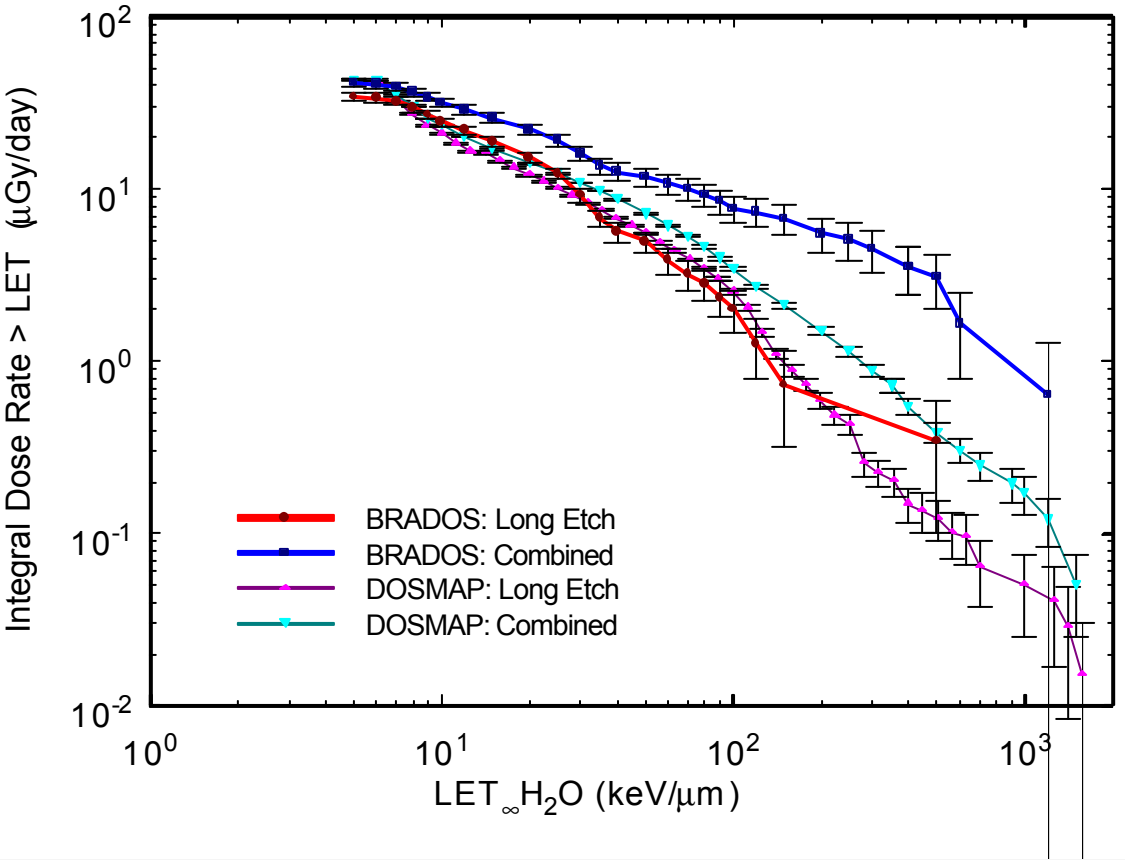
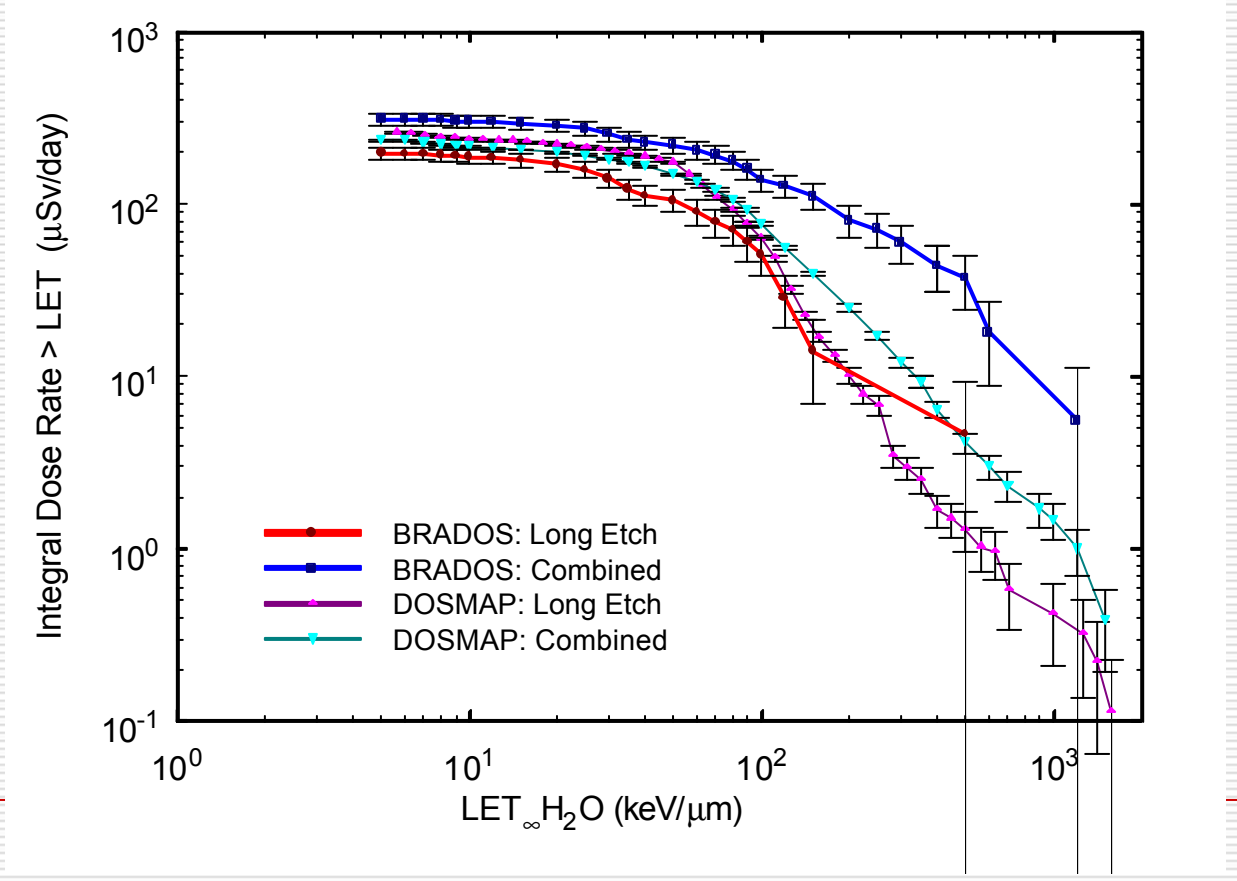
Oklahoma States University, Oklahoma, USA

BRADOS: ERI Preliminary Results
Integral LET Dose Rate Spectra



BRADOS: ERI Preliminary Results
Integral LET Dose Equivalent Rate Spectra



Dose & Dose Equivalent Rate Comparisons on ISS and Mir

Mission	Dates	Dose Rate (μGy/d)	High LET Dose Rate (μGy/d)	High LET Contrib. to Dose	Dose Eq. Rate (μSv/d)	High LET Dose Eq. Rate (μSv/d)	High LET Contrib. to Dose Eq.	Mean Quality Factor
Mir-9	18 May–11 Oct 1991	365 ± 46	46.0 ± 1.2	12.6%	653 ± 42	334 ± 13	51%	1.79 ± 0.25
Mir-18	14 Mar–26 Jun 1995	273 ± 40	29.9 ± 3.1	10.9%	589 ± 101	346 ± 47	59%	2.16 ± 0.49
Mir-21	22 Mar–26 Sep 1996	336 ± 19	22.6 ± 1.1	6.7%	595 ± 25	282 ± 15	47%	1.77 ± 0.14
Mir-22	16 Sep1996 – 22 Jan 1997	319 ± 17	28.3 ± 1.5	8.9%	649 ± 28	358 ± 22	55%	2.03 ± 0.17
Mir-23	12 Jan–22 May 1997	335 ± 16	29.5 ± 1.1	8.8%	706 ± 23	400 ± 16	57%	2.11 ± 0.13
ISS DOSMAP	3 May–9 Aug 2001	190 ± 6	23.5 ± 0.2	12.4%	383 ± 12	216 ± 2	56%	2.01 ± 0.07
ISS BRADOS	31 Jan–30 Apr 2004	255 ± 20	31.6 ± 1.8	12.3%	528 ± 51	304 ± 24	58%	2.07 ± 0.23

Conclusions

- We conducted an intercomparison experiment for passive Radiation dosimeters, Space Intercomparison/BRADOS, aboard the International Space Station.

- The absorbed dose rates at the wall of the Flight Engineer's sleeping quarter were measured as a function of depth from the wall.
- Preliminary results shows that the absorbed dose rates was about 250 μGy/day, and gradually decreased (~10% or more) with depth.

- We plan a future experiment of larger scope to include passive dosimeters from all laboratories participating in the ICCHIBAN project.

MATROSHKA-R

Traditional image acquisition by CCD

The size of the image is limited by the area of CCD element and, although dependent on total magnification, typical image sizes are limited to several hundred micrometers square.
In order to digitize substantially larger areas, the total image must be reconstructed out of a composite of multiple smaller images captured individually by the CCD camera.
This method is often referred to as "image tiling".
A major limitation of this method is the time consumed by the mechanical movement of the stage, followed by auto focusing, between the capture of each individual image .

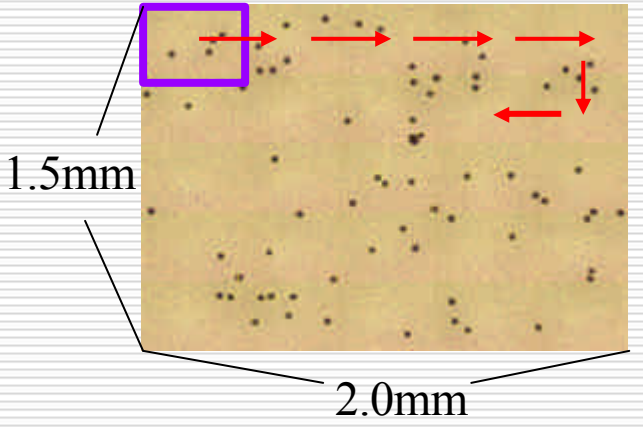
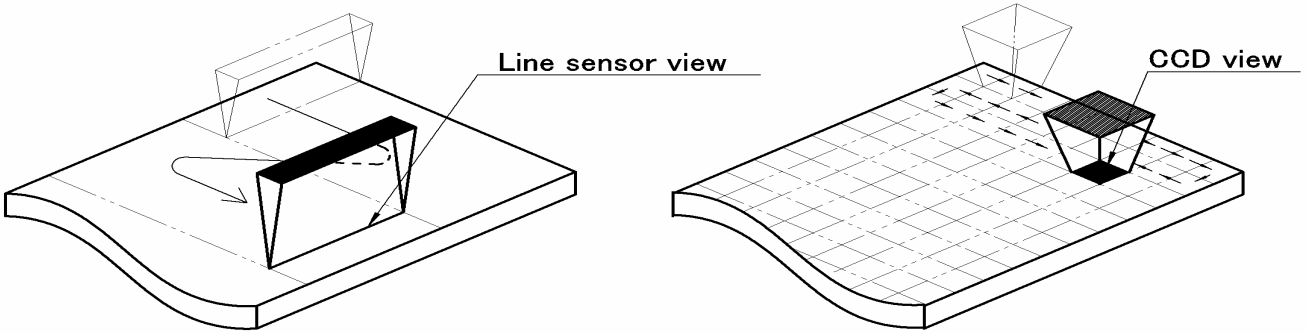
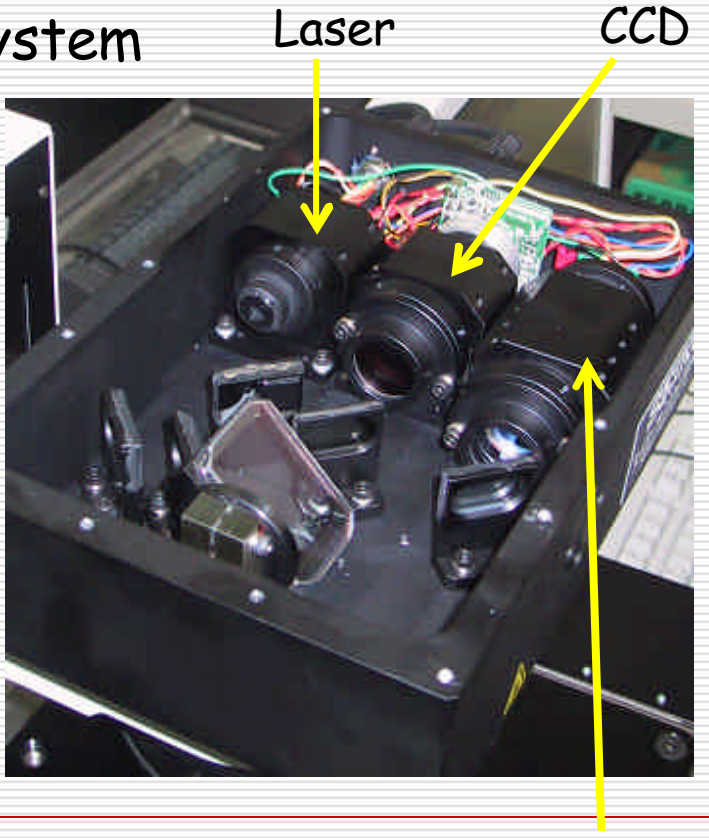


Image Acquisition

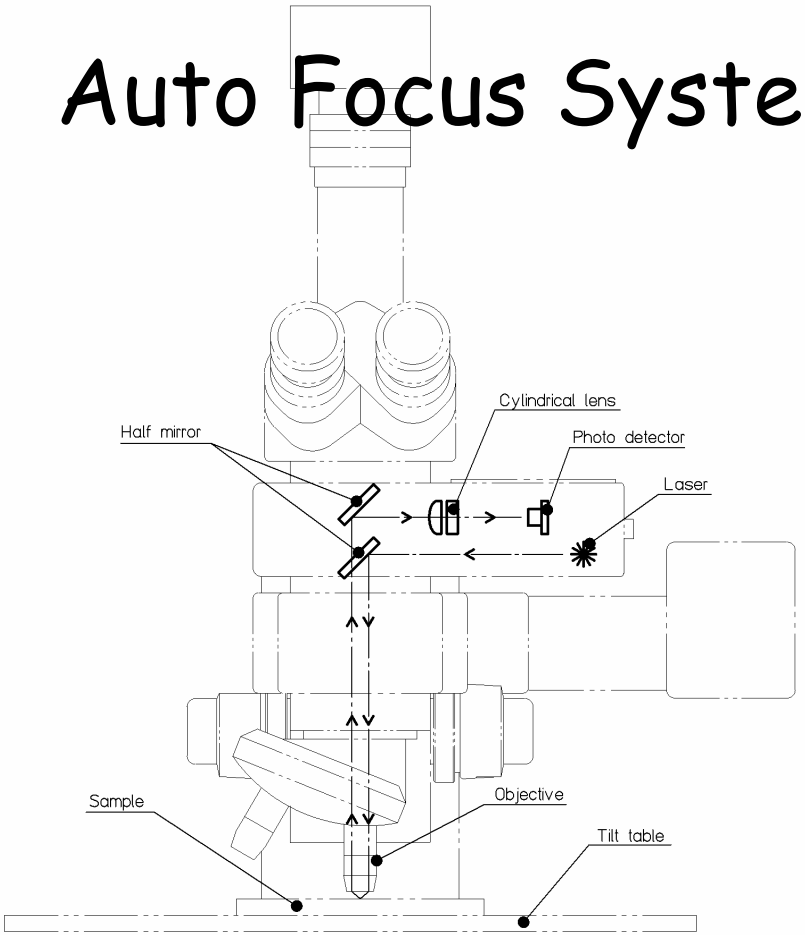


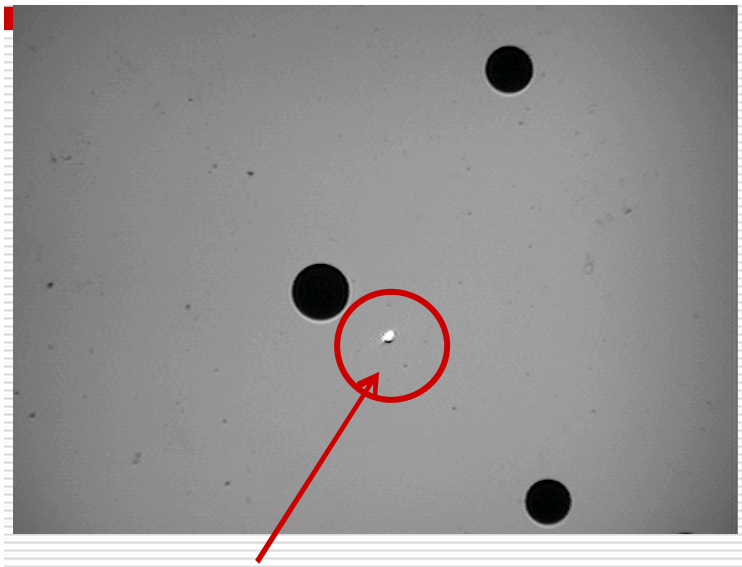
To achieve this high rate of image acquisition, the system makes of a line sensor in place of the traditionally-used CCD camera and the microscope stage is constantly in motion.

Auto Focus System



Auto Focus System

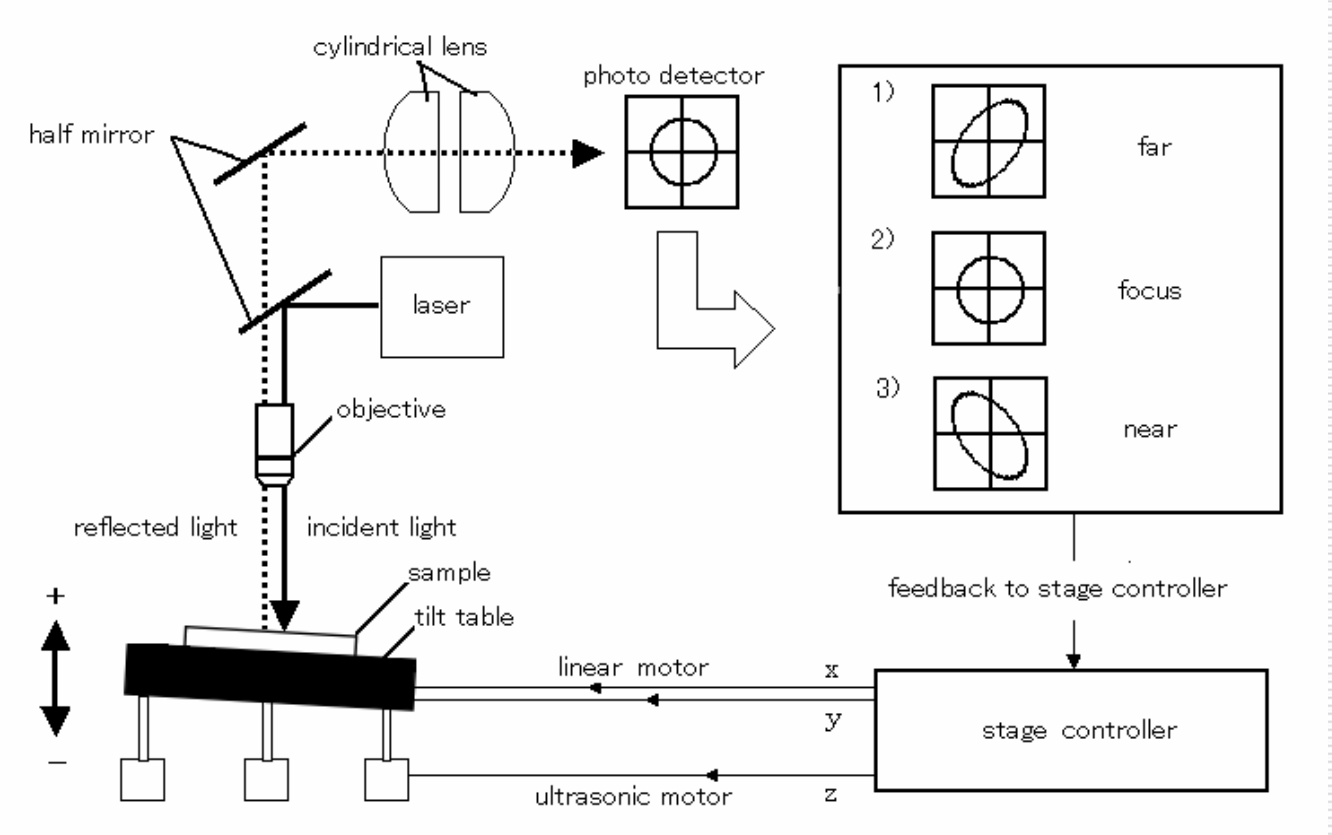




Laser spot

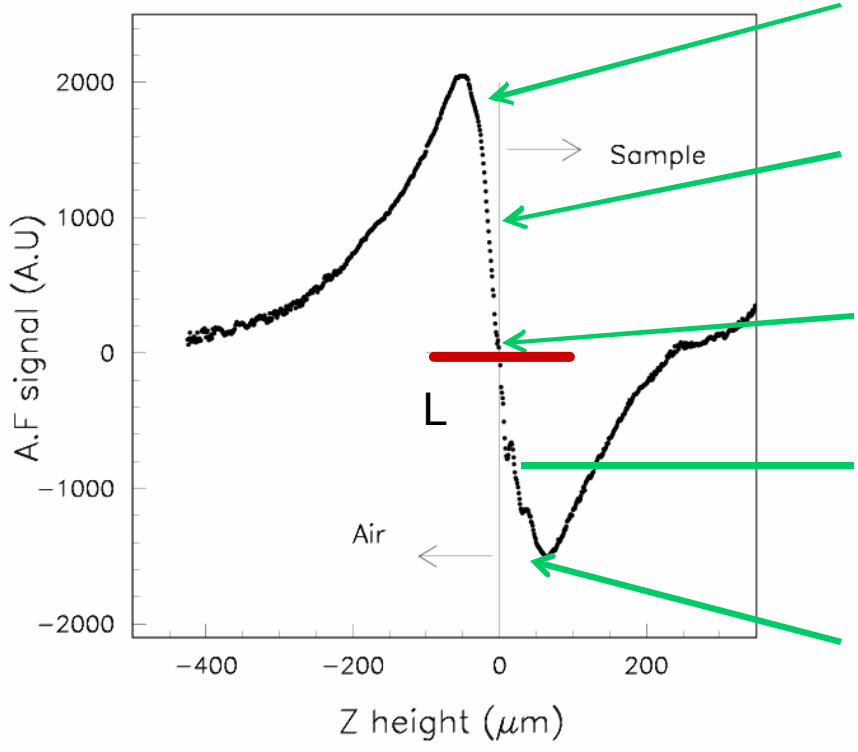
The microscope's auto focus system uses the same type of optical pick-up mechanism ~~used in Compact Disc (CD) and~~ Magneto-optical Disc (MO) drives.

Principle of AF system



Distance and Direction detection for focusing

Performance of autofocus system



Auto focus signal

AF = [(A+C)-(B+D)] / [A+B+C+D]

Objective lens: 40x (NA=0.45)

Distance of L: 60 μm

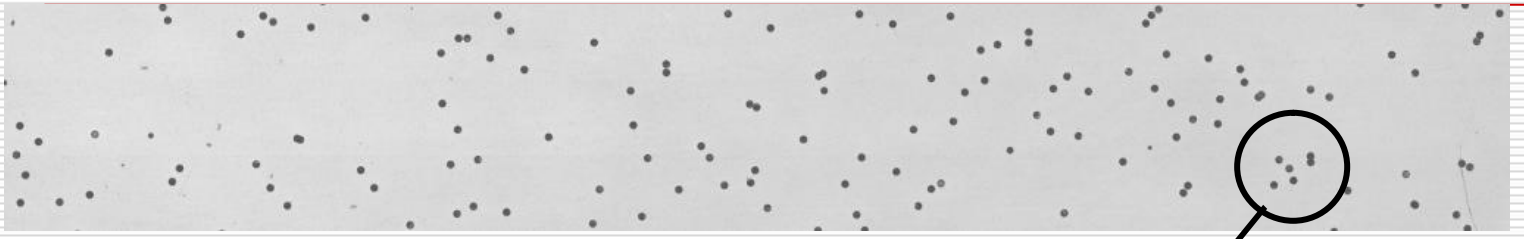
Resolution for Z-axis: 15 nm

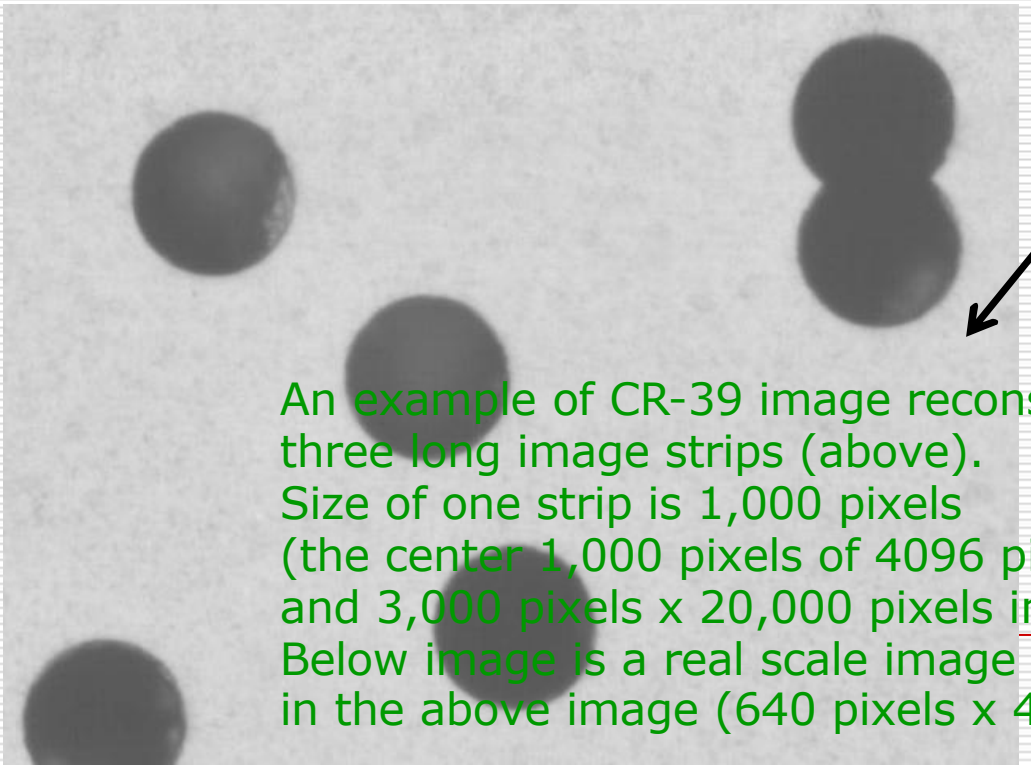
Specifications of microscope

- AF system
  - feedback : every 200 μm
  - accuracy : +- 1μm (@780nm laser, 400x objective)

- Imaging speed
  - 4cm x 4cm / 10 min @200x (0.35 μm/pixel)

Strip image





An example of CR-39 image reconstructed from three long image strips (above).
Size of one strip is 1,000 pixels (the center 1,000 pixels of 4096 pixels/line) x 20,000 pixels and 3,000 pixels x 20,000 pixels in total.
Below image is a real scale image of framed area in the above image (640 pixels x 480 pixels).

Examples