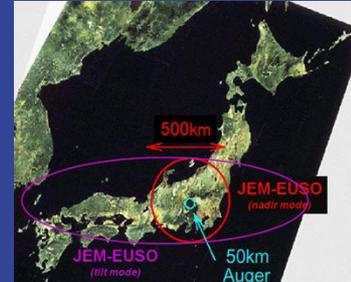
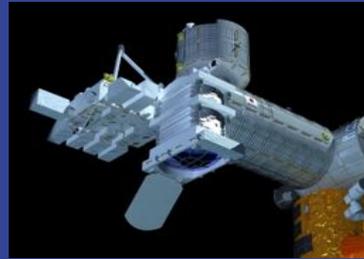


Yoshiyuki Takizawa (1), Alessandro Zuccaro Marchi (2), Yousuke Hachisu(1), Naoki Tone(1), Hitoshi Omori(1) and Roy Young (3) for the JEM-EUSO WG
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 (3) NASA—Marshall Space Flight Center, Huntsville, AL, USA

The Telescope



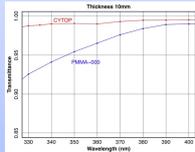
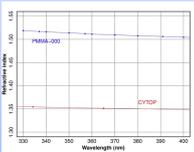
Optics

LENS MATERIALS

Two different materials are under investigation: CYTOP and PMMA-000. CYTOP is an amorphous, soluble perfluoropolymer (AGC Co.,Ltd. product). PMMA-000 is a special Grade UV transmittance polymethyl methacrylate (Mitsubishi Rayon Co., Ltd. product).

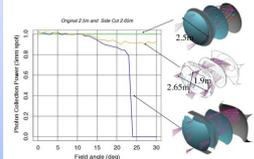
Refractive index of CYTOP and PMMA-000

Transmittance of CYTOP and PMMA-000 in the and PMMA-000 (for 15-mm near UV region.)



Performance of the HSV stowing type. Optics, normalized w.r.t. the 2.5m Ø case (green line). Blue curve: FOV on the 1.9m Y direction, yellow curve: FOV on the 2.65 m X direction.

Side cut type for the HTV stowing



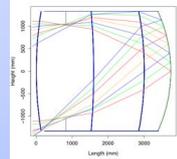
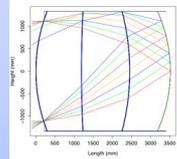
DESIGN

The Optics Module has 2 types of design: the "Baseline" and the "Advanced". Both are made of 2 curved double-sided Fresnel lenses, 10 mm thick, and one intermediate lens with one Fresnel surface and one diffractive surface (for chromatic corrections). The Baseline is in PMMA-000, the Advanced has the front lens in CYTOP and the two others in PMMA-000. The designs are rotationally symmetric, but for stowing issues into the Japanese HTV module, the dimensions on the two axes are different.

| | Requirements | Baseline optics | Advanced optics |
|-------------------------|--------------|--|--|
| Field of View | > 60° | 60° (±30° in X and ±24° in Y if with side-cut) | 60° (±30° in X and ±24° in Y if with side-cut) |
| Optical bandwidth | 330 ÷ 400 nm | — | — |
| F/ number | < 1.25 | 1.0 | 1.0 |
| Entrance Pupil Diameter | ≥ 2.3 m | ~2.3 m | ~2.3 m |
| Lens diameter | > 2.5 m | 2.65minXand 1.9minY if with side-cut | 2.65minXand 1.9minY if with side-cut |

BASELINE: PMMA-000+PMMA-000+PMMA-000

ADVANCED: CYTOP+PMMA-000+PMMA-000



Mass of the lenses for the 2007 and 2010 optics designs (after side cut)

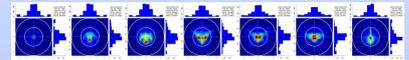
| | Design 2007 (kg) | Design 2010 (kg) | Mass reduction (kg) |
|-----------------|------------------|------------------|---------------------|
| Baseline | 222 | 154 | 68 |
| Advanced option | 342 | 202 | 140 |

OPTICS PERFORMANCE

Encircled Energy (EE): ration between the number of photons in the spot area and the photons reaching the focal surface. Throughput: ration between the number of photons in the spot area and those passing through the Aperture Stop (i.e. the iris). EE and throughput were estimated using a ray-tracing code taking into account the material absorption, the Fresnel structure and the surface reflections. Advanced optics has better performance than Baseline optics also because CYTOP has better transmittance than PMMA-000.

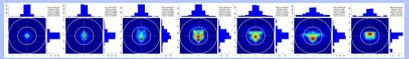
BASELINE

Spot Diagrams for angles from 0° to 30°(outer circle: 5mm Ø, inner circle: 2.5 mm Ø)

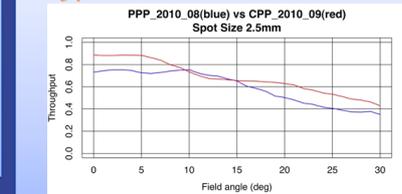


ADVANCED

Encircled Energy. Baseline vs. Advanced for 5mm and 2.5mm spot sizes



Throughput. Baseline vs. Advanced.



1.5m BBM Lens (Central area of 2.5m lens) Manufacturing

June, 2009: Rear lens



Dec 2009: Middle lens



Dec 2010: Front lens



Lens test in US

started from Sep. 2010.

