US Plans for the JEM-EUSO

Presented by Jim Adams

- Optics Investigations
- Trigger Design
- Event Reconstruction
Issues for the US proposal

- Low Technical Risk for Optics
  - We must demonstrate the capability to make the optics
- Concerns
  - Diffractive
    - We need to find someone who can make it
  - CYTOP
    - How to diamond turn it
    - Uniformity
    - Other maturity issues?
  - Other optics manufacturing issues
    - Surface roughness
    - Throughput
    - Scattered light from outside the field of view
Optics Investigations

• Lens Manufacturing
  – Manufacture two 1 meter lenses from PMMA
  – Test lenses in the UV to determine
    • Spot size versus field angle
    • Throughput versus field angle

• CYTOP Testing
  – Diamond turning tests
  – Refractive index uniformity tests

• Diffractive Testing
Lens Manufacturing

• Manufacture two lenses from PMMA
  – Diamond turn on the Moore machine
  – Post-polish to reduce surface roughness

• Manufacture a metering structure
  – Holds the lenses to create the optic for testing

• Test the optic
  – Use the AMOR facility
    • 2 meter uniform beam
    • ~350 nm
CYTOP Testing

• Diamond Turning
  – We have a limited amount of CYTOP
  – We were not successful in our first try
  – We are looking for advice

• Uniformity Testing
  – We plan to use a Fizeau interferometer
  – Use a tank with optically flat walls
  – Immerse CYTOP in index matching fluid
Diffractive Testing

- We can test a diffractive for JEM-EUSO
  - We understand that a diffractive can be manufactured in Japan
  - We have a design for a 10 cm f/5 diffractive lens with 1 meter focal length
  - If it can be manufactured in Japan, we will test it at UAH
Optics Investigations

• Lens Manufacturing
  – Manufacture two 1 meter lenses from PMMA
  – Test lenses in the UV to determine
    • Spot size versus field angle
    • Throughput versus field angle

• CYTOP Testing
  – Diamond turning tests
  – Refractive index uniformity tests

• Diffractive Testing
Lens Manufacturing

- Manufacture two lenses from PMMA
  - Diamond turn on the Moore machine
  - Post-polish to reduce surface roughness
- Manufacture a metering structure
  - Holds the lenses to create the optic for testing
- Test the optic
  - Use the AMOR facility
    - 2 meter uniform beam
    - $\sim 350 \text{ nm}$
Diffractive test details

- Diffractive Design
  - Design wavelength: 0.357 microns
  - Maximum depth of cut: 0.695 microns
  - Total number of facets = 3500
  - Mean facet width = 14 microns
  - Maximum facet width = 845 microns
  - Minimum facet width = 7 microns
- Matching smooth plano-convex lens
  - Radius of curvature 513.58 mm
- Determine the diffractive efficiency by comparison
Trigger Design

• Space Sciences Lab (UCB) trigger
  – Designed by Crawford and Judd

• Multilayer trigger
  – 1\textsuperscript{st} layer trigger (rate \sim 1 \text{ kHz})
    • Overlay frames from successive gate timing units
    • Shift successive frames to account for
      – Shifting image of non-vertical tracks
    • Look for good signal/noise
  – 2\textsuperscript{nd} layer trigger (<0.1 Hz)
    • Use pattern recognition to recognize CR tracks
Event Reconstruction

• Use ESAF simulations
  – Investigate trigger threshold
    • Use ESAF simulated events
    • Determine trigger efficiency
  – Investigate event reconstruction threshold
    • Examine ESAF simulated events
    • To find the lowest energy event that can be reconstructed to find its energy and arrival direction
  – Can JEM-EUSO be done without a diffractive?
100 events simulated at 60° and $10^{20}$ ev
Point Spread Function

- 100 events were simulated at 60° and $10^{20}$ ev.
- Each photon is tagged with its’ GTU.
- For GTUs that contained more than 10 photons
  - The mean radius vector for the GTU was calculated
    - Subtracted this from the radius vector for each photon.
    - Giving the distance spread about the GTU center
    - This distance is plotted in the next figure.

Note: The event moves across the focal plane during the time of one GTU broadening the distribution. At 60° the movement is estimated to be about 2.5 mm per GTU.
Discussion Points

How can we coordinate our investigations for JEM-EUSO?

• Cytop Testing
  – Can we work with you to find out how to machine CYTOP?

• Can you manufacture a diffractive for us to test?

• How can we coordinate simulation efforts better?