

GLAST Calorimeter

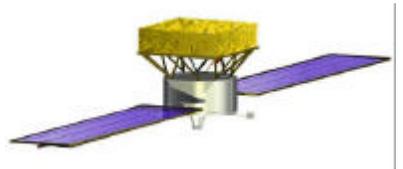
GLAST Team Mtg.
22-24 June 1999

CsI Crystal Preparation Status 22 June 1999

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Washington DC





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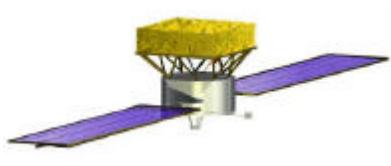
Beam Test Calorimeter Prototype CsI Status

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- ❑ All 90 CsI crystals (310 x 30 x 23 mm) have been received and acceptance tested at NRL.
 - 40 Crismatec, 50 STCU Ukraine
- ❑ 10 40-cm crystals have been received from Ukraine.
 - 6 have been cut to 37 cm and surface-treated. Sent to France.
- ❑ Ukrainian crystals delivered with fine polish - NRL applied light taper.

- ❑ Visual inspection
 - Crismatec:
 - Clear as glass. Typically one or two small, dark inclusions. Rare internal crystal flaws, crystal boundaries.
 - Fine polish on ends and two surfaces. Occasional small surface flaws. Scratches, chips.
 - Ukrainian:
 - Milky. Typically one or two dozen small, dark inclusions. Occasional internal crystal flaws, crystal boundaries, small cracks.
 - Surface polish is not as fine as Crismatec. All have thin smudge line from adhesive in wrapper. Occasional surface flaws, scratches, pits, chips, cracks, crystal boundaries, goobers.





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Crystal Metrology

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- Metrology summary
 - Bars are typically too large in cross section by ~ 0.1 mm.
 - Large-scale ($>$ few cm) surface variations of order 0.1 mm.
 - Crismatec crystals are superior to Ukrainian. Dimensions are closer to spec. Surface variations are smaller in height. e.g. one Ukrainian is warped by ~ 0.3 mm.

Worst crystal: Ukrainian U-02-21.

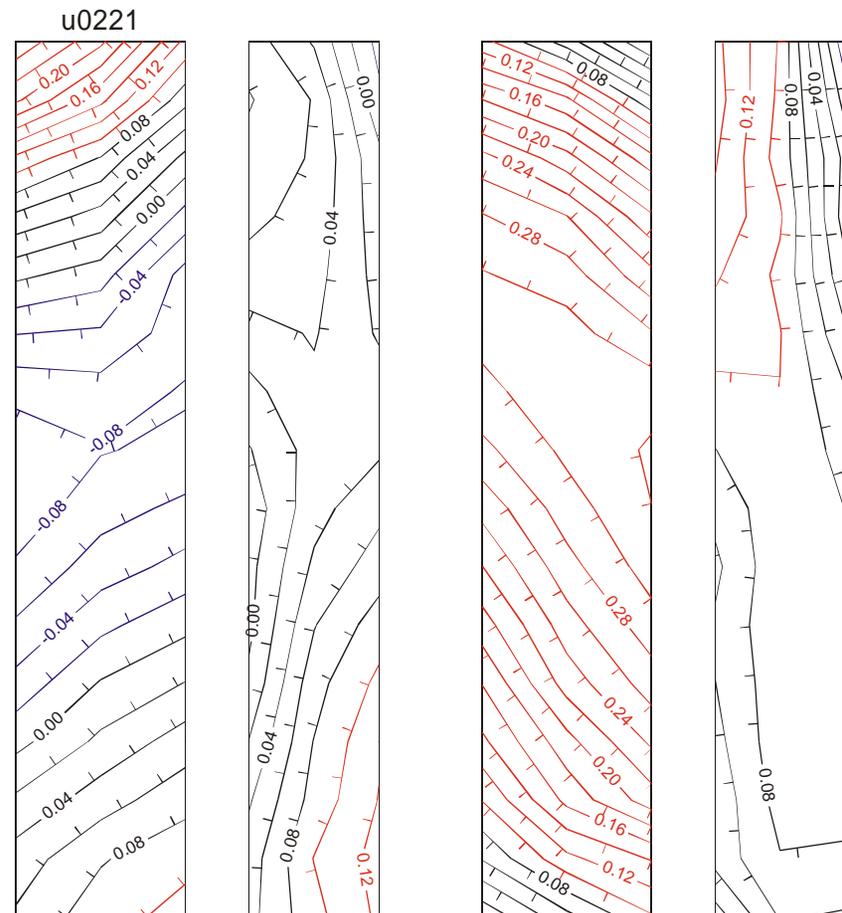
Units are mm.

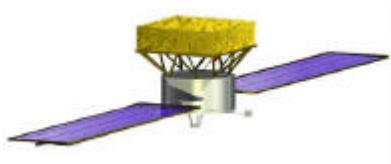
Contours are 0.02 mm.

Red: More than ± 0.1 mm from spec.

Black: 0.0 to $+0.1$ mm from spec.

Blue: -0.1 to 0.0 mm from spec.





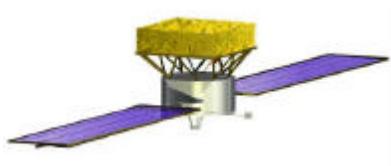
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CsI Crystal Processing

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- ❑ Acceptance testing
 - inspection, metrology
 - light yield vs position w/ ^{22}Na source (PMT dry mount, both ends)
- ❑ Surface processing (Ukrainian crystals only, Crismatec delivered with light taper)
- ❑ Crystal resizing (Ukrainian only)
- ❑ End treatment - blacken with aperture for PIN photodiode or white Tetrtek.
- ❑ Light yield vs position w/ ^{22}Na source
- ❑ Mount PIN photodiodes
- ❑ Final optical wrap
 - Tetrtek (2 x 10 mil)
 - Aluminized mylar with adhesive
- ❑ Muon testing (and ^{228}Th source)



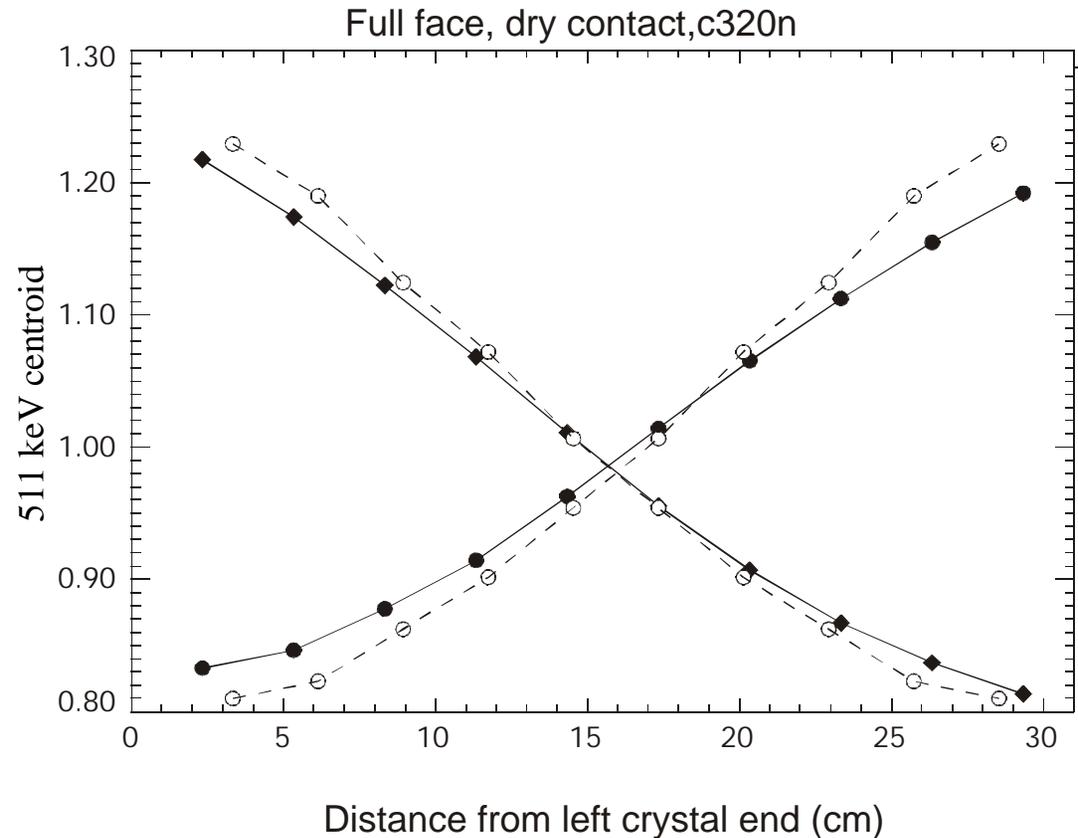


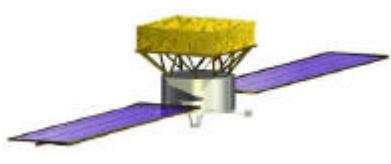
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CsI Light Tapering Crismatec Material

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- ❑ ^{22}Na source scanned along length of crystals.
- ❑ Crystals arrive from factory scanned from one end. We scan simultaneously from both ends.
- ❑ Crismatec crystal with factory surface treatment and factory wrap.
 - Open symbols: factory testing.
 - Filled symbols: NRL testing.
 - Normalized to mean response.





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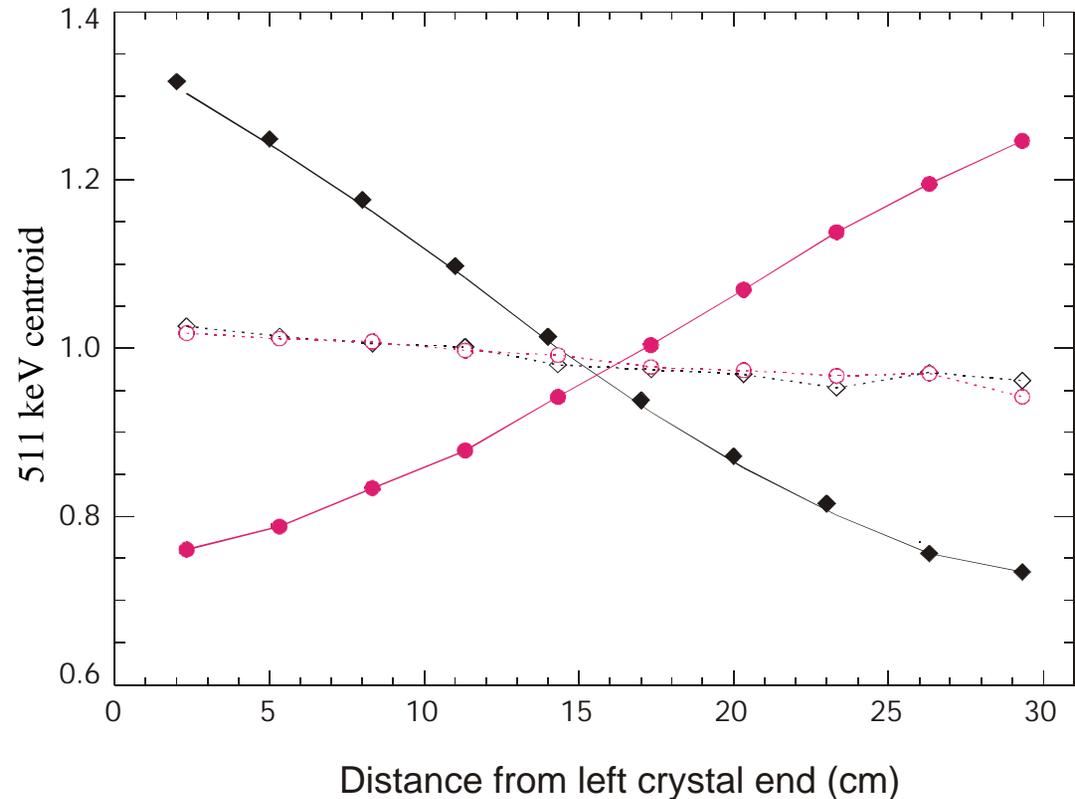
Surface treatment of Ukrainians

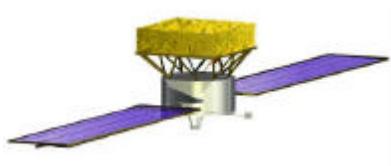
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- Ukrainian bars arrive with “fine” polish.
 - Light collection ~ uniform, varies by dopant.
 - (red and black curves, open symbols).

- NRL surface treatment gives tapering equivalent to Crismatec.
 - (red and black curves, filled symbols).
 - Treatment leaves absolute light yield ~ unchanged.
 - Can tune treatment to give desired slope.
 - Bars with slope too steep can even be flattened!

Full face, dry contact, u207s





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Crystal End Treatment

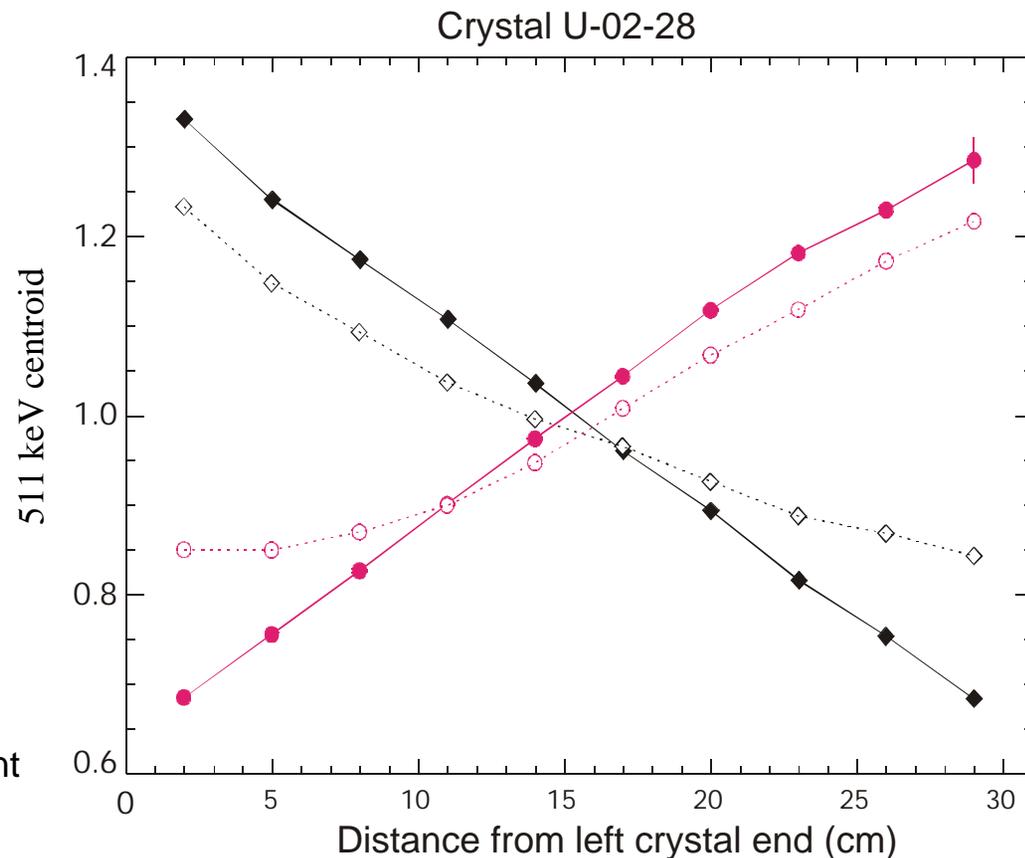
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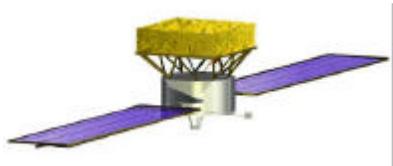
- ❑ Ends of crystal are blackened outside open area of photodiodes.
- ❑ As our previous studies have shown, blackening the ends steepens the slope of light attenuation and straightens the curves.
- ❑ Bad news: light output with blackened ends is less than anticipated by factor of two.

Ukrainian bar U-02-28.

Open symbols: after surface treatment

Filled symbols: after blackening





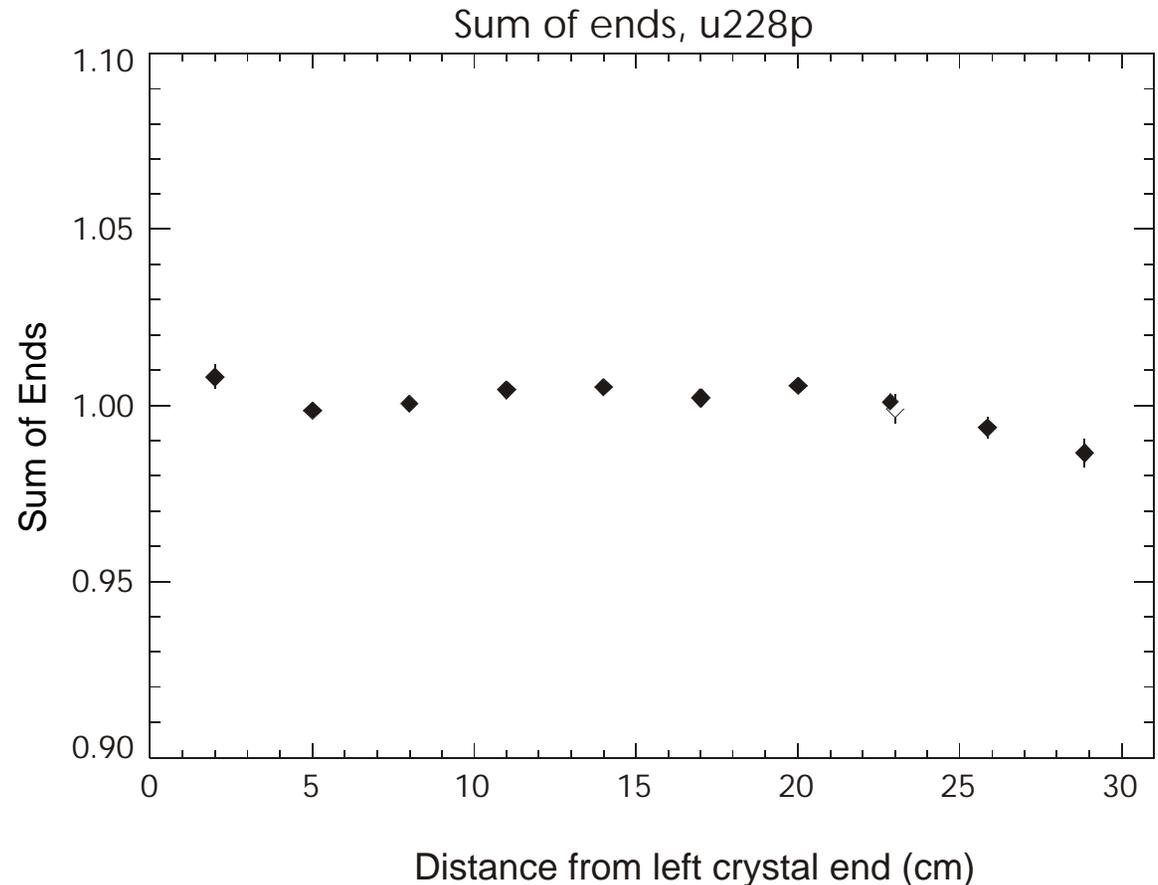
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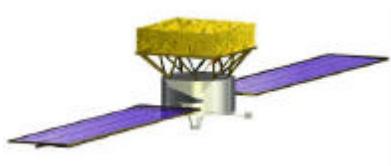
Light Tapering Total Light vs Position

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- ❑ Tapered bars still give good energy resolution: Sum of two ends is nearly constant.
- ❑ Crismatec from factory and Ukrainian after surface treatment achieve similar performance.

Ukrainian U-02-28 after surface and end treatments.



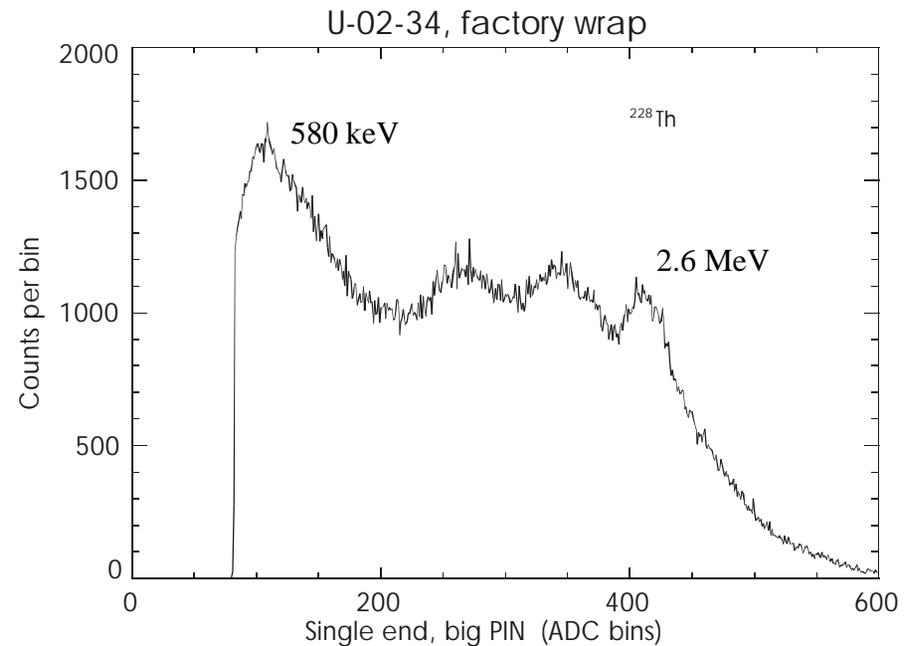


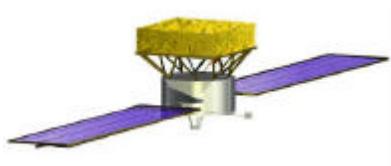
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Final Performance

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- ❑ Crystals with final surface and end treatments achieve excellent performance with custom dual PIN.
- ❑ Ukrainian crystal.
- ❑ Spectrum of ^{228}Th in 1 cm^2 custom PIN.
- ❑ Factory wrap.
 - Tyvek with aluminum foil.
 - Tetratek gives ~20% more light.
- ❑ Laboratory bench electronics.





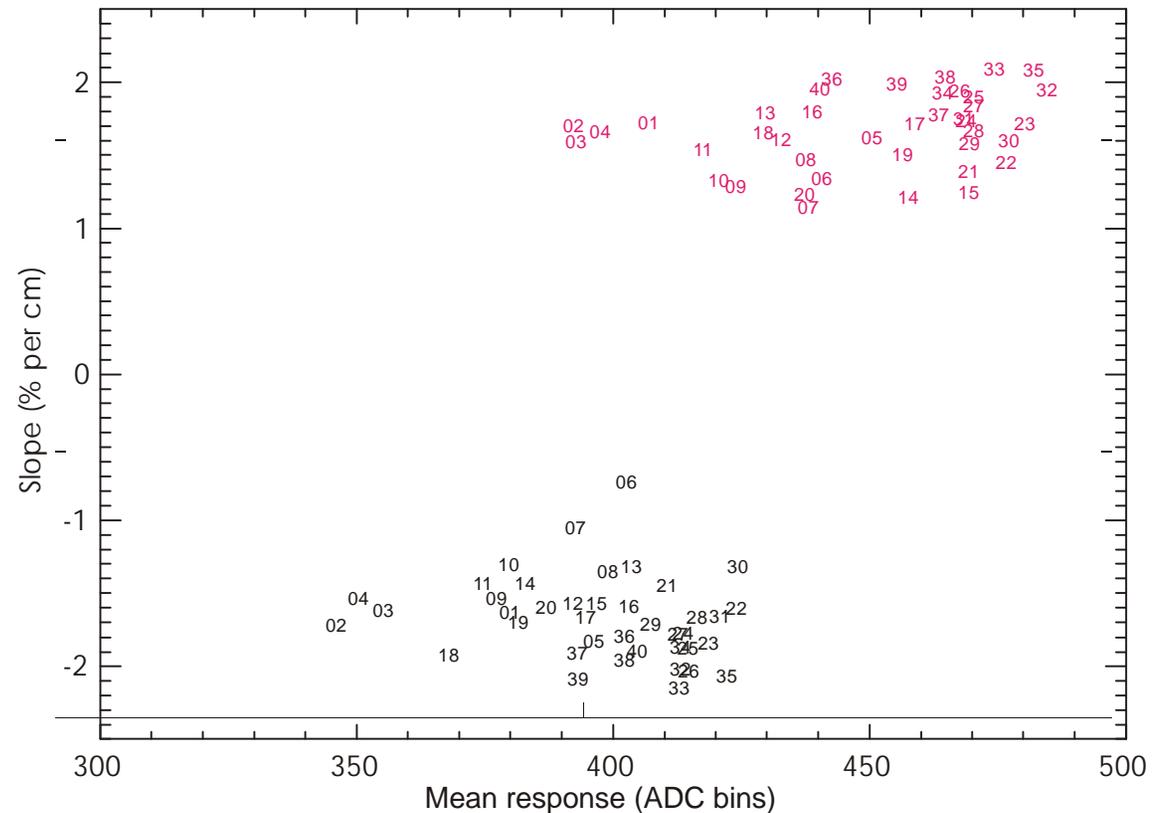
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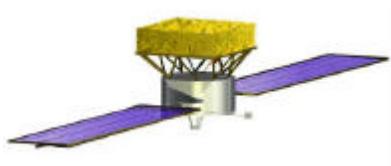
Crystal Sorting - Crismatec 40

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- ❑ After surface and end treatments are applied, crystals can be sorted according to light yield and tapering.

- ❑ Mean response v. slope for each end of Crismatec crystals (labeled by ordinal number on receipt).
 - “Left” end (black) has negative slope.
 - “Right” end (color) has positive slope.
 - Note, e.g., that crystals 1-4 all have small light yield. Initial shipment contained crystals 1-4 only.



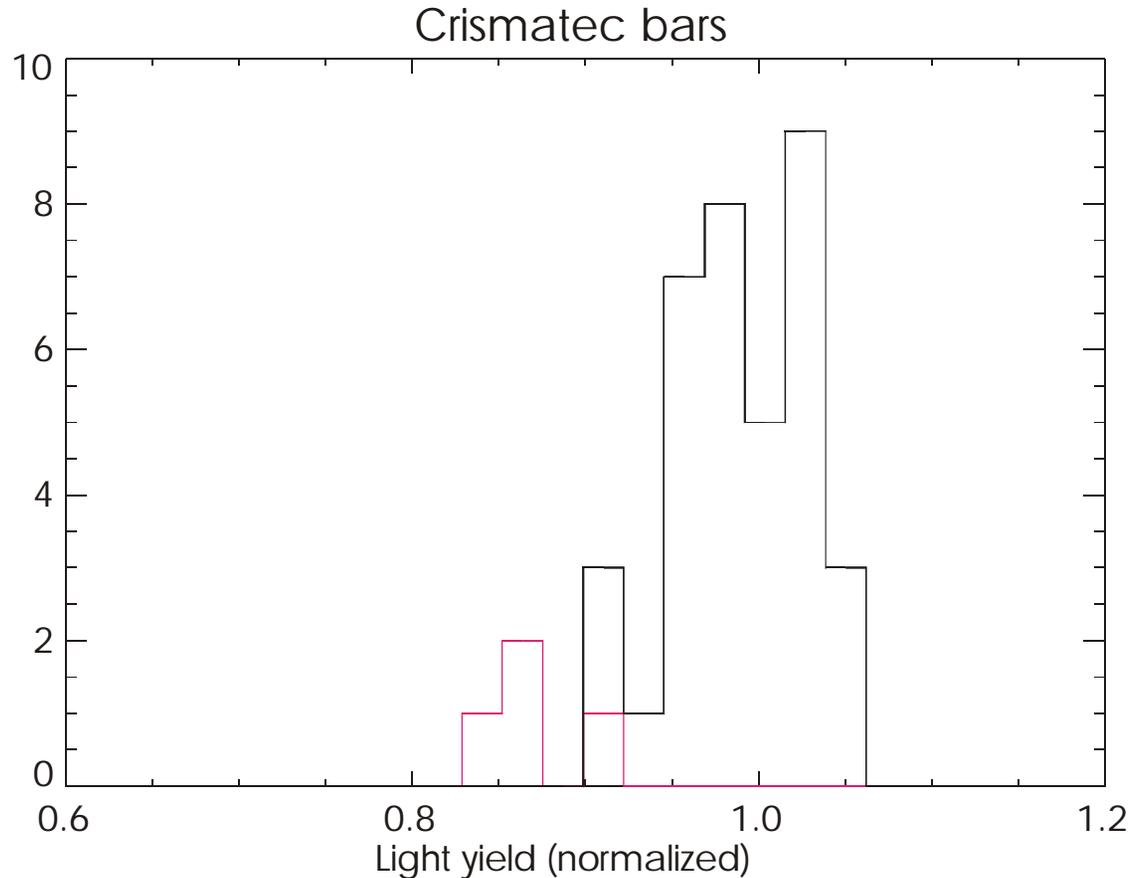


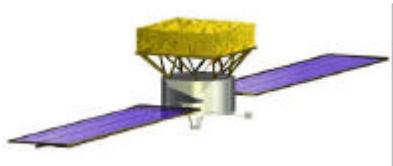
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Distribution of Light Yields Crismatec 40

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- ❑ Light yield of Crismatec bars, normalized to mean yield over all bars.
- ❑ Variation from bar to bar is small.
- ❑ Rms light yield = 3.7%
- ❑ Note: colored histogram is four bars from first shipment. All have low yield.
- ❑ There is some variation from lot to lot.



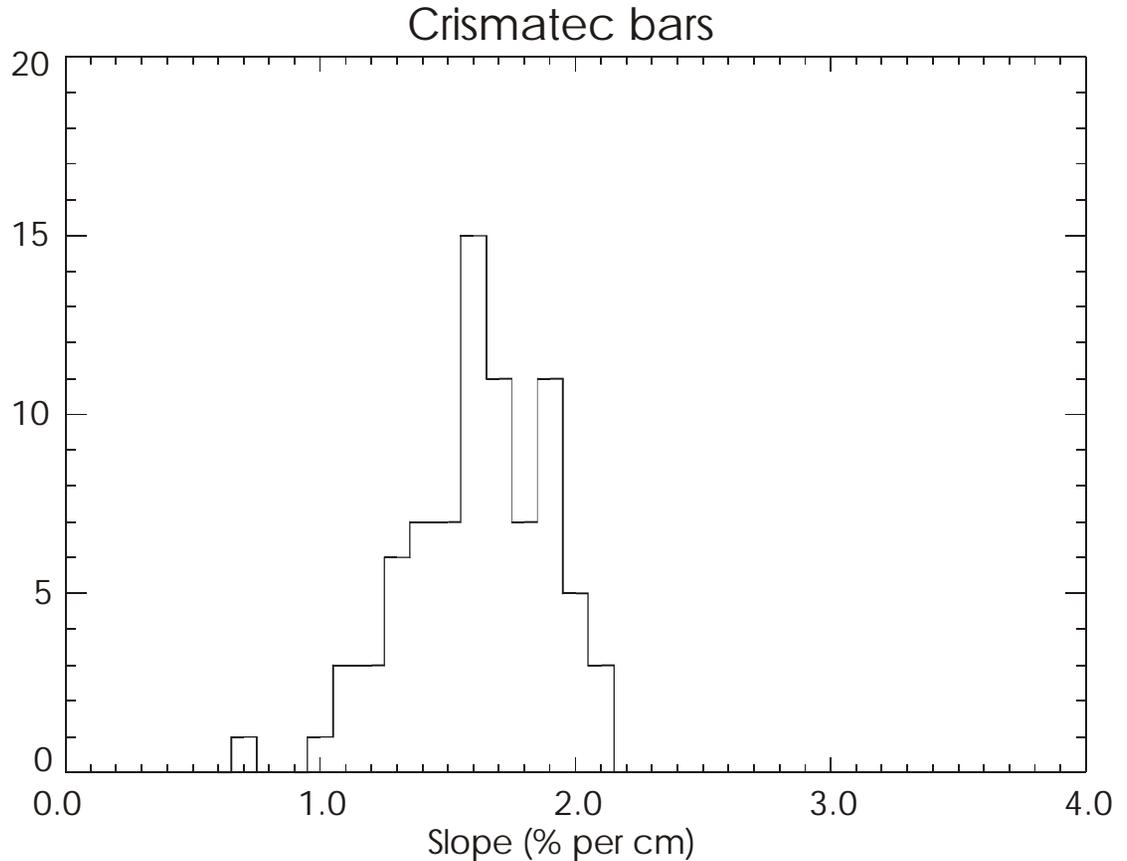


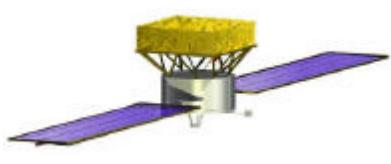
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Distribution of Slopes (Light Attenuation Lengths)

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- ❑ Fit linear model to light yield as a function of position for each end of crystal.
- ❑ Crismatec bars, factory surface treatment and wrap.
- ❑ Mean slope = 1.7 % per cm
- ❑ rms of slope = 0.3% per cm (16% of mean slope)





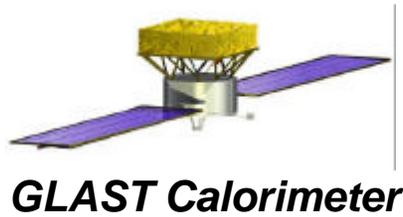
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CsI Detector Processing Summary

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- ❑ Established two vendors for CsI crystals
 - Crismatec material better looking than Ukrainian, both perform well.
 - Light yield of Ukrainian material appears to be within ~5% of Crismatec.
 - Crismatec material met all dimension specs - some Ukrainian oversized.
- ❑ Dual PIN photodiode
 - Slight modifications to package design will simplify epoxy process.
- ❑ Wraps
 - For BeamTest 99, will use two layers of 10-mil Tetratek + “heat shrink” adhesive aluminized mylar outer layer.
- ❑ For BeamTest 99, cannot use blackened ends and achieve nominal gain with GSFC ASIC. It was designed for $\sim 5000 e^-/\text{MeV}$.
 - For flight system, adjust ASIC gains, and the issue becomes S/N.
 - With blackened ends, GIDSC-approved threshold of 5 MeV is 5σ above noise.

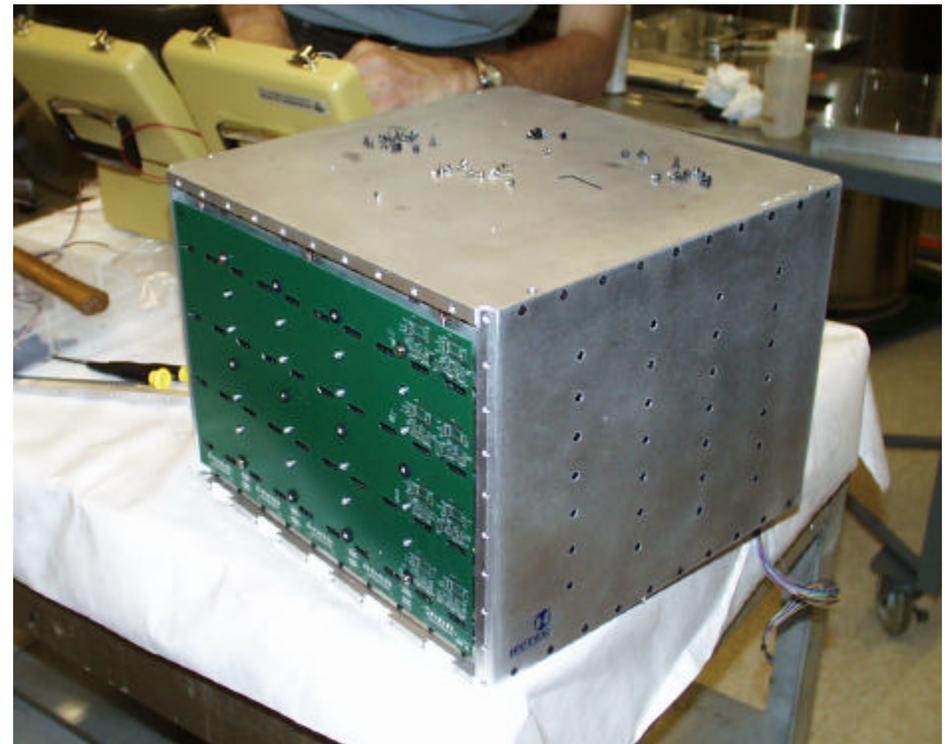


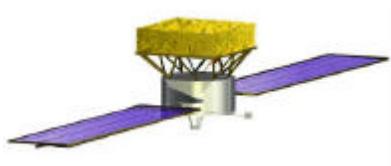


Beam Test Calorimeter Compression Cell

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- ❑ NRL has stacked a whole calorimeter with crystal dummies. The alignment and shimming strategy worked well.
- ❑ The compression press has been used at NRL to apply compression load. The strain gauges are installed to permit monitoring of the load.
- ❑ Installation of prototype FEE PCB has been verified. Access to Nanonics jack screws is possible.
- ❑ Hytec to begin assembly of 2nd unit for environmental testing in August.
- ❑ NRL will assemble beam test prototype in mid July as tested CsI detector modules become available.

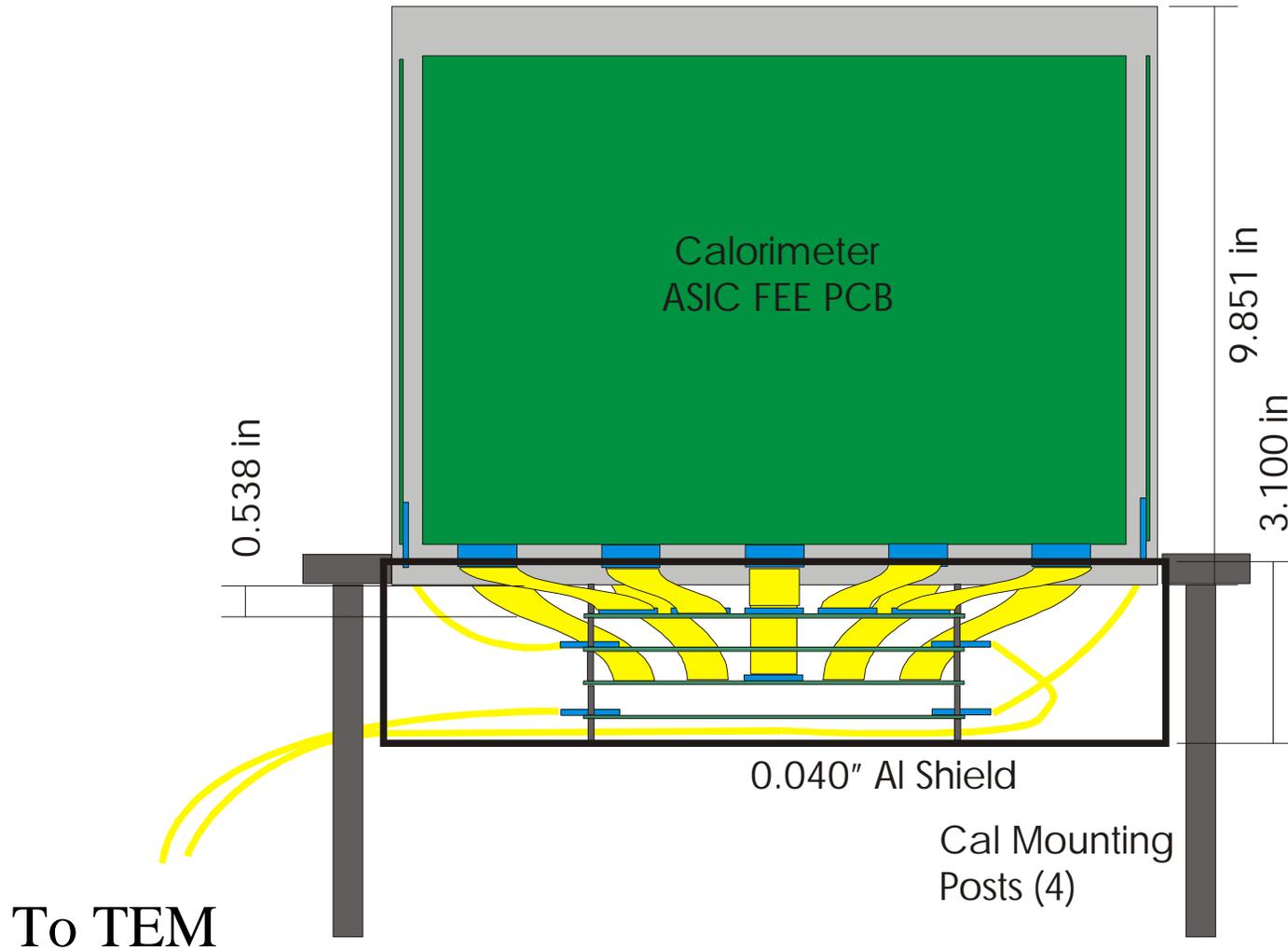


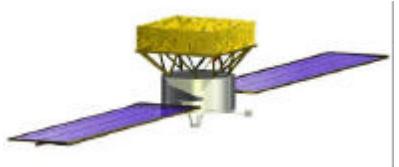


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Beam Test Calorimeter Side View

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Calorimeter Schedule

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Critical path to Beam Test is through ASIC and electronics fabrication / test.
(Two months behind original schedule due mostly to Orbit problems.)

- ASIC delivery expected 6/21/99
- Packaging at ASAT completed by 6/30/99
- Testing at GSFC & NRL completed by 7/16/99
- FEE PCB functional testing begins 7/26/99
- Mount FEE boards on compression cell begins 8/9/99
- I&T begins 8/23/99
- Pack and ship to SLAC, arriving 10/12/99.

