5/16/2000

Recommendation
of the GLAST Silicon Detector Group

Executive Summary

We recommend that the GLAST silicon detector design be frozen by 5/17/2000 such that prototyping of the final design at Hamamatsu can start June 1, 2000.

We recommend that the pitch be adjusted from 7 readout chips/detector to 6 readout chips/detector to increase the tracker power reserves by 12%. This will increase the pitch from 201micron to about 230 micron. At the same time, the implant width will be chosen to keep the maximum fields on the implants to the same levels as in the AO design.

We recommend that the detector size be decreased from 9.2cm x 9.2cm to 8.95cm x 8.95cm (exact size TBD with Hamamatsu) to increase the mass reserves of the instrument. This will decrease the mass by ~4.1% and the effective area by ~5.5%.

With the decision on the silicon detector size, the footprint of the 16 tower instrument will have been frozen for all practical purposes. Thus one design option to manage resources will have been removed. We recommend that all instrument resources (mass, power, cost, schedule…) be re-audited immediately and monitored closely in the future.

Charge to the Committee by W.A. Althouse (April 20, 2000):

The group should make recommendations concerning the detector configuration (dimensions, strip pitch, etc), strategy and timing of procurements, and other relevant factors. Risks associated with delaying the decision(s), as well as those incurred by taking the decision prematurely, should be identified and evaluated. The documentation should summarize the facts and assumptions which affect these choices (make assumptions if the data are not readily available), identify issues considered but found not relevant and justify the recommendations. The group should consider strategies, which haven't been previously discussed (at least not with me), such as producing prototype detectors with more than one strip pitch.

I would like the chairman to have a report ready for the videoconference on May 11 (4 weeks), and to provide brief interim reports at each videoconference before then.

Membership:

Elliott Bloom EB	elliott@SLAC.Stanford.EDU	
Robert Johnson RJ	johnson@scipp.ucsc.edu	
Tune Kamae TK	kamae@hirax6.hepl.hiroshima-u.ac.jp	
Takashi Ohsugi TO	ohsugi@hirax6.hepl.hiroshima-u.ac.jp	
Steve Ritz SR	ritz@milkyway.gsfc.nasa.gov	
Hartmut Sadrozinski HS	hartmut@scipp.ucsc.edu	
Tim Thurston TT	thurston@SLAC.Stanford.EDU	
Bill Althouse	wea@slac.stanford.edu	Ex officio
Peter Michelson	peterm@leland.stanford.edu	Ex officio

Points of Discussion

The group met for the last 4 weeks for at least one phone conference/week. The following items were considered and reports with background material related to them can be found on the following web site: http://scipp.ucsc.edu/groups/glast/detector:

Item	Responsible	Report	Explanantion
GLAST Sensor inventory	TO&HS	Y	
Detector Technology			
Crystal Orientation	TK&RJ		Mechanical strength
Fields	TO&HS	Y	Breakdown with large gaps
Review of Specs	TO&HS		Layout for every geometry
Detector Performance			
S/N	HS&RJ	Y	BTEM: Eff at large angles
Trigger	HS&SR	Y	(included in above)
PSF	HS&SR	Y	Simulations are done
Science	SR&HS	Y	Applying PSF to science signals
Background	SR&HS	Y	Does a larger pitch compromise the background rejection?
Layout Questions			
Aeff	SR&HS	Y	Changing the Footprint vs. # of trays
Superglast	RJ&SR&HS		PSF from BTEM, Sim
Resources & Reserves & Margins			
Power	TT&RJ	Y	How much reserves?
Footprint	TT&SR	Y	What is the maximum allowed?
Mass	TT&RJ	Y	What is missing?
Descope (TRK)	RJ&TT&TK		Descope down the line: TRK only
Descope (LAT)	SR&TT&EB		Descope down the line: LAT
Schedule			
Production	TK&RJ	Y	Delivery schedule (& testing)
Pre-production (Need, numbers)	TO&RJ		Make several types of sensors first?
Funding	TK&EB		Schedule and funding profile agree?

Recommendations

The group is making four recommendations to GLAST management.

1) Decision Date June 1, 2000

This is the date by which GLAST has to commit to a new design. It is necessitated by the procurement schedule of the long lead-time item, the silicon detectors:

Fix detector size	end of May 2000
Proto-type run(50)	June-Oct 2000
Bidding Process	June -August 2000
Pre-production (300)	Oct 2000-March 2001
Production 500/month	April 2001-Dec 2002

The above schedule includes about 1month for verifying the soundness of the design in each of the two runs planned before going into production. Because of the relative short time available for every step, we have limited the extend of the proposed design changes, such that the detector performance can be reliably predicted from existing prototypes.

We would like to agree on the details of the design by May 17, which allows us to make progress on several fronts. We should review procurement strategies. Specifications have to be written between now and June 1. At that point, Hamamatsu can start engineering and CAD work. It was emphasized that the specs should be GLAST wide specs, and that they should be finalized with the participation of our Italian collaborators.

2) Increase Pitch and Implant width (~230, ~60) (TBD, see below)

The increase of the pitch (change from 7 readout chips/detector to 6 readout chips/detector) will result in a tracker power savings of 12%, coupled with a worsening of the high-energy PSF and the high latitude point source sensitivity of approximately 5% and 3%, respectively.

The moderately wider pitch will have a number of effects on instrument performance, all of which are likely to be small.

- First, the wider pitch will have a negative effect on the chance to measure the photon polarization. Since the ability to measure the polarization with GLAST has never been demonstrated, this change is deemed acceptable.
- The pitch increase also will have a somewhat negative effect on the two-track separation, and hence the background rejection. However, this proposed change is incrementally small, and earlier GLAST designs had pitches of comparable size. The impact is being evaluated quantitatively, but is expected to be acceptably small.
- Theoretically, the hit efficiency at large track angle should improve with the wider pitch, which will help the background rejection, effective area, and PSF tails. The size of this improvement has not been quantified yet, but is being evaluated with the 1999 beam test data.
- The implant width will be adjusted to keep the fields on the implants in a safe region. The end-of-mission signal-to-noise ratio is predicted to be comparable to that of the AO design.

We believe that we will be able to predict the electrical performance of the detectors well enough so that we need to prototype only one design.

3) Footprint ~8.95x8.95cm^2

The two most effective and least damaging measures for saving mass are reducing the depth of the calorimeter and reducing the overall instrument footprint. Reducing the footprint has a direct negative effect on the effective area, whereas a reduction of calorimeter depth compromises the energy resolution at high energy. At the time of writing our response to the AO, we took both steps with the understanding that we would revisit this question once we were approved. Once the silicon strip detector dimensions are fixed, the footprint of the instrument is effectively frozen. Thus, the option of saving some mass with a footprint reduction can only be exercised before June 1, 2000. Furthermore, it is clear that the overall schedule is extremely tight, and that adequate margins are necessary to ensure that we can meet this schedule; at the same time, we do not want to compromise the performance of the instrument unnecessarily.

A credible scenario was presented that our mass reserves are not big enough. We are proposing a reduction of linear dimension of the detectors from 9.2cm to 8.95cm, subject to discussions with Hamamatsu Photonics. This will also fix the pitch: we are proposing 6 readout chips of 64channels each to cover the square detectors. The final decision on the linear dimension should be made before May 17, 2000. This reduction in footprint amounts to a mass savings of about 4.1% and a reduction in effective area of about 5.5% relative to the AO layout.

4) Final Design Decision Strategies Understand baseline

In our response to the AO, we committed ourselves to reviewing our performance whenever our performance metric hit a trigger point (AO Response Vol. 2, Table 1.2.1).

Now is the last time the silicon detector size and layout can be changed. Further de-scopes have to come from items other than the footprint of the instrument.

This study was the first to look seriously at the resources, taking into account the impact of a design change. There is a series of final design choices that must be made over the next year. These choices must balance the schedule and resource pressures with the desire to optimize the instrument performance. The better the resource needs are understood, the better these decisions will be. The power, mass, schedule, and money requirements must be carefully audited, tracked and re-evaluated continuously. In addition, the performance impacts of these design choices must be better quantified. Upcoming design choices include:

- radiator thicknesses, and the impact on the performance of the tracker and calorimeter
- calorimeter mechanical design, light yield, noise performance, and zero suppression
- ACD segmentation
- DAQ architecture and on-board computing resources.