Towards a Network of GRB Detecting NanoSats

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Plan for Meeting

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Why are We Here?

- (Judy will speak to the Science Case)
- We are all working towards building and launching NanoSats (here I define these as 6U CubeSats or smaller) that can detect Gamma-ray Bursts.
- It’s all about leveraging our resources to maximize the science return.
  - None of us has the resources to build a true ‘network’ of GRB detecting smallsats
  - We are better as a group than individually.
  - We need to get to know each other and learn from each other’s successes (and failures)

We are here to learn from each other, figure out how to work together, and make each other’s projects the best they can be.

Be conscious of each other

This is the time to listen and learn and develop a community. We are not here to compete with each other or take from each other. Think about what you can bring to the discussion.

Be mindful…

- of the young people and new people in our community (these people will be leading us soon)
- of the biases you might have (unconscious or explicit)
- of letting people talk that might not be talking (ask questions of your peers)

That doesn’t mean you have to agree with everything someone says; you should challenge each other but do it respectfully with the intent of improving our projects.

How we get there

- This first session is setting the stage.
- The rest of this day will be listening to updates from all of the projects.
- Tonight we get to know each other over dinner.

- Tomorrow is when the work begins.
  - We will start by hearing about the GCN, IPN, and SVOM
  - Then we will breakout into discussion sessions.

Discussion Sessions

4 Discussion session in 2 parallel tracks.

We have identified chairs who will be leading the discussions. Your first order of business is to designate a note taker. The chair's job is to facilitate so it's important that there's someone keeping track of the discussion.

Once the discussions have run their course (we have provided 90 minutes) each chair will present a summary of the breakout to the full room. This should be in the form of a google doc/google slides or equivalent. This is the main deliverable from your group and will be what we can take away from this meeting. Our plan is to make these documents public on the website.

This summary provides a chance for all of us to participate in the discussion.

The four breakouts and the facilitators

The facilitators are here to help guide the discussion and have already done a lot of work prepping to make sure that we are successful. Make sure you thank them.

Data Sharing is facilitated by **Antonino Cucchiara** from the University of the Virgin Islands. Nino is leading the UVI BurstCube Project (3U CubeSat).

Hardware Development and Mission Formulation is facilitated by **Riccardo Rando** from INFN/Univ. of Padova. Riccardo is building GammaMeV.

Communications is facilitated by **Abe Falcone** from Pennsylvania State University. Abe is leading the BlackCAT project.

Software Development is facilitated by **Michael Briggs** from the University of Alabama, Huntsville. Michael is PI of the TryAd project.

Data Sharing: https://goo.gl/forms/AygZ2mPH04yDHNSg2

Each NanoSat/CubeSat will collect data of different types. The possibility of data overlap and complementary datasets needs to be addressed and discuss in lieu of achieving scientific goals that 1) enhance the single mission goal; 2) strengthen each mission data quality and provide cross-calibration opportunity.

Open Questions:

- Data format (binning, requirements, drivers for the different choices)
  Inconsistent temporal phase/binning makes joint analysis extremely difficult (e.g., CGRO).
  Individual photons enables joint analysis (e.g., Fermi) or very fine time bins, but requires high data volume, likely difficult for most nanosats
- File formats (FITS?)
- Coordinated observations for calibration purposes
- Coordinated observations for science enhancement
- Do we need Cubesat1-Cubesat2 working groups for specific purposes?
- Data sharing: public vs. private (all?, some?, proprietary period?)
- What format for data distribution? Database ? Join efforts?
- What data quality and data product needs to be distributed? The example of Swift/Fermi teaches that good data sharing with the community enhance the science outcomes beyond the mission team.

Hardware Development and Mission Formulation

Define the topic: each NanoSat has a specific choice of detectors, so a common hardware design is not possible. On the other hand, operating a set of different satellites as a constellation will increase the science output.

Open Questions:

- Some library of available hardware technologies? E.g. readout ASICs for scintillators?
- Compatible time binning (counters etc.)
- What to make available in Telemetry?
- Alert capabilities, including responding to triggers from outside (e.g. GW). Is repointing necessary (depends on FOV)?
- Coordinate and optimize sky coverage
- High data volume tends to be difficult for nanosats. How to obtain high temporal (esp.) and spectral resolution data for GRBs? 1) triggering, or 2) commanded download of stored data. #2 provides data for sub-threshold GRBs and GW events.

Communications

Define the topic: uplink/downlink of commands/code, downlink of housekeeping and science data, downlink of rapid alert telemetry
Open Questions: What communications methods are available to nanosats? Which methods are available for low latency? Both for downlink and uplink? (uplink could request downlink of data for a GRB or GW signal).

1) Sharing of ground station resources throughout globe
    - international cooperation, buy uplink/downlink time Vs collaborative arrangements, S-band Vs. X-band, availability of specific ground stations
2) Sharing of experience with building a small-scale ground station on your own campus; cost
3) rapid alerts and rapid data downlink (specifically for GRBs, GW events, etc.)
    - TDRSS, network of many ground stations, commercial satellite relay networks: GlobalStar, Inmarsat, Iridium, Orbcomm and Thuraya
    - How-to and cost, accommodation/cost for various related antennas
4) lessons learned on various COTS comm boards
5) Data compression to ease telemetry requirements
6) Other topics?

Software Development

Define the topic: Mention all the software required for a space mission. What tools might be available commercially or from previous missions? What software tools might be shared or co-developed in the GRB nanosat community?

Open Questions:

Several types of software are required for a space mission: Spacecraft, Instrument, Ground “pipeline”, Data analysis.
Earliest is more mission-specific and less sharable, later is less mission specific and will have more commonalities.

- Instrument software: perhaps some commonalities in trigger algorithms or localization.
- Ground pipeline: perhaps some commonalities in converting raw data into scientific data in standard format.
- Ground software with commonalities: localization, spectral analysis. Simulations of atmospheric scattering are S/C independent -- needed for GRB localization. Need software for localization using data from multiple nanosats.

Homework!

Prepare for tomorrow. Think about what **you** want to get out of this workshop. How will **you** make this a successful collaboration. How will **you** contribute to the discussion. Reach out and make a new connection!

Be open, be honest, and be willing to help. Find someone that isn’t contributing and find out their strengths.