Notes on FD Session, Saturday afternoon 10 June 2023 (Bruce Dawson)

chair: Matthias K.
presentations from Michael, Toshi and Tameda-san

Opening discussion:

- does GCOS need an FD component? It can provide an energy calibration, a mass calibration, and hybrid data (ground densities, longitudinal profile...). Can other detectors (e.g. radio) replace this capability? FD is expensive, at least in its traditional form.

- from 2022 GCOS meeting: Focus is E>30 EeV. If we have an FD we would aim for 50% coverage of the detector area with FD. This would mean 5% of events would be FD/surface hybrids.

Michael's presentation:

- new work by bachelor student on the MACHETE design, optimal layout.

- one conclusion is that a MACHETE cyclops eye, and an array of FAST-like telescopes covering the same area, have similar costs.

- Considering S/N arguments it is plausible to have 3 sites in a "superman" arrangement covering 30,000 km^2 (ie 50% of the proposed GCOS area). This would require each site to cover a radius of 60km for E>30 EeV. The MACHETE design only has a 10 degree elevation coverage, so a co-located FAST or CRAFFT array of telescopes would be necessary at each of the 3 sites to view nearby showers.

- this plan would need a significant investment in atmospheric monitoring, including a number of CLF-style steerable lasers (blue dots on the superman plot).

- the presentation includes a cost estimate (I didn't write it down, have no access to slides now!)

- Discussion:
    - Matthias: stereo is not part of this plan, it is a luxury

    - Toshi: likes the idea of the Superman/(FAST or CRAFFT) combination

    - Joerg: need a building for the Machette? Answer: a garage, nothing fancy

    - Bruce: what cost is assumed in your estimate for electronics? Answer: for the MACHETE $1000 per pixel, including silicon PM and FADC electronics.

Toshi's presentation:

- an update on work with FAST

- stand-alone (no SD) results for bias and resolution in Xmax, for a 20km triangle of FAST 12-telescope stations.

- monocular resolution using convolutional neural network "not perfect"

- with true geometry, sigma(Xmax) ~ 23 g/cm^2

- progress on array of 3 sites @Auger. New electronics developed, new PMT with more uniform response.

- Discussion:

    - Joerg: 60-80 g/cm^2 stand-alone resolution in Xmax. Is this good enough?

    - Michael: No, but can use SD geometry to do better, towards the "perfect geometry" result in Toshi's presentation.

Tameda-san's presentation:

- update on the CRAFFT project, efficient light collector (Fresnel lens), no obstacles (e.g. camera shadow with a mirror system), simple housing.

- prototype at TA Black Rock Mesa (4 systems, each with 8x8 degree FoV)

- move to new PMT configuration for 30x30 deg FoV, using 5" PMTs rather than 8" PMTs. Progress on electronics, uniformity, calibration. Plan to install 4 of these new configuration telescopes @TA (starting in a small way this summer).

- Discussion:

    - Matthias: likes the monitoring/slow control work

    - Bruce: any results on Xmax resolution? Answer: currently estimating geometry resolution with mono. Will consider stereo, and core information from an SD.

    - Michael: good, this (using SD info) is important in the context of GCOS.

    - Matthias: what about a self-trigger? Answer: this is work to be done. [FAST has the same issue].

    - Lukas: common R&D possible between FAST and CRAFFT? [see below]

Closing Discussions:

- Toshi: aim to set up a Japanese consortium for purposes of GCOS. Collaboration between FAST and CRAFFT people important, as well as the broader UHECR community in Japan.

- Ioana: is CRAFFT the same as FAST in its capabilities? We probably cannot use both.

- Michael: time will tell. Eventually we will converge on a solution.

- Frank: How much overlap do we need with SD? Needs to be optimized given the science case.

- Michael: Baseline from 2022 GCOS meeting: 50% of area coverage giving 5% overlap of events. Maybe duty cycle of FD would be higher if using SiPM.

- Toshi: combination strawman design (as outlined in Michael's presentation) is important for everybody to get R&D funds.

- Fred: constraints on site? With 60km viewing required, the

atmospheric characteristics will be important.

- Michael: this is a tricky point, needs work

- Ioana: cost of atmospheric monitoring? Steerable lasers would be useful. Need to factor in atmospheric R&D.

- Bruce: [added when writing these notes]. If we want to view out to 60km, a 1400m altitude site is superior to a sea-level site to minimize the Rayleigh attenuation of light. The SD might prefer the 1400m site in any case.

End of session.