**APOGEE fiber feed cost reduction Options**

At the request of the fiber feed study group I have developed the following options for reducing project cost for running fibers from the APOGEE instrument to the 3.5 m focal plane. There are certainly many more combinations that could be considered. I’ve tried to present options that include the largest effect on total project cost. Many permutations on these 6 options could be considered but this should give us a bases for talking through the benefits and costs of a reduced scope project.

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| Reduced Cost Options for the APOGEE Fiber feed to the 3.5 m Telescope | | | | |
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| Project Description |  | Cost Reduction |  | Total Project cost |
|  |  |  |  |  |
| Original Proposal |  | $0 |  | $351,820 |
|  |  |  |  |  |
| Elimination of the ARC-SAT Run |  | $17,964 |  | $333,856 |
|  |  |  |  |  |
| Reduce IFU fiber count to 91 |  | $100,472 |  | $251,348 |
|  |  |  |  |  |
| Reduce IFU fiber count to 37 |  | $128,628 |  | $223,192 |
|  |  |  |  |  |
| Eliminate Lenslet Coupling |  | $75,928 |  | $275,892 |
|  |  |  |  |  |
| Bare Bones (30 fibers to Echelle focal Plane) | | $283,650 |  | $68,170 |

**Elimination of the ARC-SAT Run**

Almost $18k was allotted in the budget to run 15 fibers to the dome of the ARC-SAT telescope. Removing this cost from the project has no effect on the 3.5m run or the replacement of the 1m run.

**Reduce IFU fiber count to 91**

This reduces the number of elements in the IFU by a little over half. For a simple hexagonal packed IFU with a 1.4 arc-sec fiber size the long axis of the IFU would be reduced from 37 to 23 arc-seconds. This still assumes 47 sky fibers terminated in mini bundles around the central IFU.

**Reduce IFU fiber count to 37**

This reduces the number of elements in the IFU by almost a factor of 6. For a simple hexagonal packed IFU with a 1.4 arc-sec fiber size the long axis of the IFU would be reduced from 37 to 15 arc-seconds. This still assumes 47 sky fibers terminated in mini bundles around the central IFU.

**Eliminate Lenslet Coupling**

The primary effect of eliminating the lenslet coupling to the IFU is a reduction in the fill factor. Coupled IFUs can reach fill factors near unity (~90%). By switching to a ‘bare’ fiber system the fill factor of the IFU would be reduced to ~38%. This assumes the f-ratio of the 3.5m telescope is corrected to f/5 which will maintain the 1.4 arc-second spaxal size. MaNGA has shown that accurate dither patterns will fill in the gaps of bare fiber IFUs so the primary cost is a ~62% reduction in observing efficiency. There may also be some implications to the data regularity when the dither sets are combined.

**Bare Bones Option**

This is an option proposed by Bruce to use as much existing infrastructure as possible to join APOGEE to the 3.5 m. It would involve using existing conduits and would integrate into the Echelle focal plane utilizing the Echelle guider. I am assuming we would still correct the f-ratio to f/5, which is one of the remaining high cost items in this option. The two obvious advantages of this system are that it is far cheaper than any other option proposed, and it does not require forest service approval as no modifications to the site is required. The primary affects are as follows. 1) There is no field rotator on NA1. So the system would only be available for single object point source work no MOS or IFU mode would be available. 2) Throughput would be reduced due to the longer fiber run an extra ~12% (~10% to ~22%).