**2x2 Cryocoolers vs. LN2 Cooling**

1.5 KWatt Total Heat Load used as Basis of Estimate

**Costs**

|  |  |  |
| --- | --- | --- |
|  | **Liquid Nitrogen** | **Cryocoolers** |
| **Annual Usage**  | LN2 consumption | 20K | Electricity | 50K |
| **Annual Maintenance**  | Dewar rental, filling etc. | 17K | NA | NA |
| **Installation Labor** | VJ transfer line | 200K | Cryocoolers and Support Structure | 2K |
| N2 Vent piping | 75K |
| Condenser, phase separator, transfer line, etc. | 25K |
| Piping, etc. | 15K |
| **Equipment**  | VJ transfer line | 100-200K | Cryocoolers | 200K |
| Valves, Instruments, Support Structure, etc. | 150K | Support Structure | 5K |
| N2 Vent Piping | 10K |
| Phase Separator | ~10K |
| Condenser  | ~25K |
| Piping, hoses, etc. | 50K |
| ***Engineering Documentation*** | *18 months FTE (notes, specs, etc.)* | *4 months FTE (1 piping note)* |
| ***Engineering Support*** | *9 months FTE (install oversight, drawings, etc.)* | *6 months FTE (install oversight, drawings, etc.)* |
| **Total** | **632 - 732 (+ extra ODH?)****27 months engineering FTE** | **322 K****10 months engineering FTE** |

**Other Considerations**

* Potential secondary ODH system in Minos surface building if LN2 piping runs through it
* Installation time of LN2 system may stretch beyond when system should be running
* LN2 System may add significant cost to cavern ODH upgrade

**Cryocooler Sketch**

