North American Electrical Testing Operation/Maintenance

The electrical testing of hybrids, modules, and rods is performed at 4 different sites, using 20 test stands of 5 different types in the North American CMS Silicon Strip Tracker group. The hybrid and module test stands have been in use for over a year and have tested on the order of 1,000 components. With rods becoming available recently, the development of the rod test stands is rapidly progressing. This note will give the current status of the different test stands and present plans for maintenance and operational scenarios for different component failures. Each stand type will be presented separately with a total current inventory and a list of all components needed is given at the end of the note.

4 Hybrid Thermal Cycler Test Stands:

The 4 Hybrid Thermal Cycler Test Stands serve a dual purpose. First, the test determines the quality of the hybrids after wire bonding the APVs to the pitch adapter. Second, the test acts as a 30 minute burn-in at the final operating temperature of -20°C. There are 3 hybrid thermal cycler test stands: 1 at FNAL, 1 at UCSB, and 1 at Mexico City. Over 9,000 hybrids will be tested during production at an average rate of approximately 40 hybrids per day. With the current set of tests, approximately 30 hybrids can be tested per day, per stand. With the removal of one redundant test, the rate of testing can be increased to about 40 hybrids a day without any loss in functionality. With three stands in the group, we have a large over-capacity of testing, which provides a simple means of dealing with a failure of a test stand. If a particular stand goes down, hybrid wire bonding and testing can be shifted to the other two sites, with minimal impact on module production.

The stands have three primary weaknesses: software, the cooling element (Peltier), and the chiller. Initially, the test stands had problems with software stability which have since been solved. In order avoid having similar problems during production after a computer failure, each site is obtaining and setting up a spare computer which will have a complete, functional software package. In case of a computer failure, the spare computer will have the ISA controller board installed from the failed computer, and will then be put into service. Such action should take less than an hour to perform.

The second weakness of these systems is the Peltier element. In the past such elements have failed at UCSB (twice) and in a similar stand at CERN. Each site has ordered a spare Peltier element which can be substituted for a failed element in approximately 2 hours. The Peltier elements were failing for two reasons: the rapid cycling of the power in order to have a stable temperature in the stand at the beginning and ending of thermal cycles; and the interruption of cooling fluid for the elements from the NESLAB chillers. The control software has been changed since the failures in order to reduce the severe cycling of the power. An interlock on the cooling fluid has also been designed and implemented on one stand which will turn off the power to the Peltier if there is an interruption in the cooling fluid flow. Once commissioned, the interlock will be implemented on the other two stands.

Finally, without the NESLAB chiller to remove heat from the Peltier element, the stand will not be operational. A spare chiller is now being acquired which can be shipped over-night in case of failure.

Most other components are easily obtainable, can be borrowed from our ARCS module test stands, or can be built in house. See the appendix for a complete list of components. We are currently obtaining a spare of every component used in the stand. They will be available to be shipped overnight from UCSB in case of a failure. In addition, a copy of every custom electronic board built at UCSB will be made as a spare which can be shipped in case of failure of that component. All other electronics have at least one spare within the group including: NIM crates and logic, ARCS electronics, and high current power supplies. With all the spares in hand or being built, we believe the longest down time of any given stand will be less than 2 days.

ARCS Module Test Stands:

The ARCS module test stands are designed to quickly determine the electrical quality of modules after assembly and wire bonding. Currently, there are 8 stands: 4 at FNAL, 3 at UCSB, and 1 at UC-Riverside. The stands at FNAL and UCSB will test the modules produced at the two sites while UC-Riverside will act as a repair/failure diagnosis center.

Concerted efforts have been made by the group to improve the automation of data handling and database interfacing. Due to this effort over the last year and a half, the testing capacity of each stand has increased from 10 to approximately 17 tests per day. With the expected peak rate of production of less than 30 modules per site, only 2 test stands are needed at

UCSB and FNAL to test a full days worth of production. The additional test stands, therefore, act as complete system spares. In the case of the failure of a component of a test stand during production, the operators will move to the available spare stand while experts diagnose the problem. If repairs are necessary, the components will be sent back to RWTH Aachen III, the manufacturer of the components. In the past, Aachen has been able to repair or replace faulty components in a 2-4 week time period. In order to further reduce stand downtime, each site is now obtaining a complete set of cable and power supply spares.

During production, the only foreseen problem which could slow the testing rate would be a failure of the central database in Lyon. The CMS database group has reduced the risk of this failure by having two separate, independent relays to the central database. In the past, when the default relay was down, all stands were switched to the second relay with at most a 15 minute loss of testing ability. In the rare occasion of both relays going down (1 occurrence last year for a 4 hour time period), testing can still proceed. As there will be no information available on the known bad channels in used hybrids and sensors, each module may have be tested twice in order to remove/diagnose all problems. This would result at most in a 50% loss in efficiency during the period that the database was unavailable. Due to the over-capacity of the system, we can most likely maintain the 30 modules a day testing rate by operating all of our test stands. In the extremely unlikely case when the testing could not keep up with production, we would be able to rapidly test the backlog of components by running all of our test stands once the database is restored.

Long Term Module Test Stands (Vienna Boxes):

The long term module test stands (Vienna Box) are the most complex module testing systems being used. Three stands are in use in the group: at the production sites of FNAL and UCSB, and at the repair center at UC-Riverside. Due to the length of testing, only 15 modules can be tested per day on each stand. Therefore only about half of the production can be sampled at the predicted peak rate. We are currently exploring options for removing redundant tests, which could increase the testing capacity to 20 modules without impacting performance.

Each stand contains over 50 separate types of elements, many of which can render the stand non-functional. In order to reduce stand downtime to a minimum, we have obtained or are in the process of obtaining spares of each of these elements (with the exception of the NESLAB chiller and the CAEN HV crate) for both production sites. An industrial PC has been purchased by FNAL and UCSB in order to have a live spare in case of a computer failure. Orders have been placed for spares of each of the DAQ electronics boards for both FNAL and UCSB. These spares should arrive prior to full-scale production. A recent inventory of components has found a shortage of unique cables which can cause the entire stand to fail. We are in the process of either manufacturing these cables or obtaining spares from the original producer for all three stands. These spare cables should also arrive prior to full-scale production.

We have also found that spares of environmental controls and interlocks are missing. We have no reason to believe these elements will fail, but in order to be conservative, spares are being ordered for both FNAL and UCSB. LV power supply spares have already been obtained.

Each Vienna box has a backplane that feeds signals from the modules inside the box to the readout electronics on the outside. In order to minimize the potential for damage to the backplane, modifications have been made to the box. The backplane was removed, and replaceable extension connectors were added. Thus, if a module is inserted improperly, it will damage the extender and not the backplane itself. Spare extensions are currently being produced. In addition, a spare set of temperature and humidity sensors from inside the Vienna box has been ordered for each site. Brass plates are used to hold the modules in place in order to eliminate Aluminum dust due to micro-welding of the previous Aluminum plates to the cooling plates.

Spare modules which control our CAEN HV crates have been obtained by both FNAL and UCSB. Spare HV modules have also been obtained. A spare CAEN crate for the US has been rented from CERN PREP recently, which can be shipped in case of failure to the effected site. The crate failure would results in a 1-3 day downtime of the Vienna Box.

Another potential component that could fail that is the NESLAB chiller. We are acquiring a spare unit which could be shipped in case of failure to the effected site. With maintenance and proper usage, we have no reason to believe the chiller will fail.

In either case, the effects of the loss of the functioning Vienna box can be reduced by having a short pipeline to rod assembly and burn-in. In the original production plan, module burn-in was not envisioned for the TOB or TEC modules. Instead, the modules would be burnt-in on the rods and petals, respectively. There is no reason why such a model could not work in the short term. At FNAL where only TOB modules are produced, this will work without the adjustment of production. At UCSB, where both TOB and

TEC modules can be assembled, production would be restricted to TOB modules until the Vienna box was functional again, because the time between module assembly and rod burn-in (at most 1 week) is much shorter than the time between module assembly and petal burn-in (approximately 1 month).

Single Rod Test Stands:

After the modules are fully tested, they are assembled onto rods at UCSB and FNAL. The expected rod assembly rate during production is 2-4 rods per day. As the single rod tests take only 45 minutes, the stand has a factor of 2 over-capacity. The rod test stands use the same type of DAQ electronics as the module long term test stands. The optical read-out of the rods necessitates the OEC, which converts the optical signals to electrical signals that are readable by the rest of the DAQ system. The single rod test stands are used to check for basic functionality of the rod after assembly; more complex tests are left for the multi-rod systems.

Due to the numerous common items, the operation and failure analysis for the single rod stand is very similar to the module long term test stands. Spares of all DAQ equipment and cables should be available before large scale production. To eliminate the re-cabling of the OFED-MUX cables, 3 additional MUX cards have been obtained from the Karlsruhe group. This should both improve the speed and quality of the data and reduce the chance of cable failure.

The CERN TOB group has supplied cables unique to the rod stands. They have agreed to supply spare cables to both sites prior to full scale production. The plan for the CAEN HV power supplies is the same as the module long term test stands. Spares of all CAEN modules and a spare CAEN crate have been obtained. The industrial computer used as a spare for the module long term test stands will also have all of the single rod software installed and be available as a spare.

Two items unique to the rod stands and for which we have no spares are the OEC and the Delphi LV power supplies used for rods. In both cases if an OEC or Delphi LV power supply fails in the single rod stand, a unit from the multi-rod stand can be used, until the broken unit is replaced or repaired. During such a time period, the multi-rod capacity would be reduced by 7% and 12% for an OEC or Delphi power supply failure, respectively.

In the extreme case that a single rod stand is completely non-functional, rod testing could still proceed at a slower rate. Instead of pre-testing the rods using the single rod stand, the rods would first be tested in the multi-rod stand. The multi-rod stand would then spend one extra day testing while loading, reducing the testing capacity of the multi-rod stand by 25% or 33% depending on whether the multi-rod test time period is 2 or 3 days. The rod assembly will also have to be reduced to match the testing capacity until the single rod stand is functional.

Long Term Multi-rod Test Stands:

The multi-rod test stands, produced by the University of Rochester group for FNAL and UCSB, constitute a miniature experiment in and of themselves - the 8 rod capacity of the stand is over 1% of the total installed TOB. The test stands therefore have complex interlock and monitoring systems. Adding to the complexity of the system is the use of the final cooling fluid (C_6F_{14}) necessitated by the test stand's operational temperature of -20°C. The fluid is expensive ($200/gallon) and evaporates rapidly if any leak in the cooling circuit is present.

The situation for DAQ equipment, CAEN HV systems, cables, and Delphi LV power supplies is the same as for the single rod stands. A failure would be dealt with in the same manner as for the single rod stands. An OEC or Delphi LV power supply failure would result in a 7% and 12% loss in efficiency, respectively.

The multi-rod test stand's interlock system, cooling system, and infrastructure all add failure points to the system. All of these have the potential for rendering the system non-operational. The burn-in of the rods is done in a commercial freezer. The same coolant (C_6F_{14}) that is to run in the final CMS tracker is used in the burn-in. The temperature and pressure of the coolant are maintained by a commercial chiller. Thus the chiller constitutes a single-point in which failure can result in the non-functionality of the system. To reduce the chance of this, we have obtained spare parts for the most important components of the chiller according to the manufacturer. These are detailed in the following list:

Pump, stainless steel. 4GPM Hot
Power Supply, LCD
Power Supply, Main
Electrical relay DPDT 24 VAC

Relay, main
Solid State relay (RH)
Temperature sensor RTD
Temperature sensor RTD Input module
Water Filter cartridge 70 Mesh SS screen
(Total of US$3200)

We still need to buy one spare bypass valve ($223 + S&H). The company does not provide a "rapid repair plan". If the compressor fails, the company will have them in stock, and will provide a new one for $950 with a lead time of 1 day. According to the company, the compressor very rarely fails: the company estimates the failure rate of compressors is approximately 1 in a 1,000.

The burn-in is controlled and monitored by the "Interlock and Control System" (ICS). The ICS takes into account all factors for the safe operation of the rods, providing interlock signals for the low voltage power supplies, the high voltage power supplies, flow control and others. A variety of failures can occur in the ICS, which can be categorized in three types. The first type is a failure that can happen in devices/parts that are easy to access for repair. For these potential failures, we have purchased spare parts that can be replaced "on the spot" and would only delay production for a matter of hours. The second kind of device failure can happen in non-critical elements deep inside the system, for example flow meters inside the freezer. For these devices, the replacement is optional, depending on the time available. The CIS has been designed with redundancy so as to allow this degree of freedom. The third, and most serious type of failure, is of parts that, although they might have easy access, are very expensive and spare parts are not available because a decision has been made, based on the reliability of the device and on a specific backup plan, not to obtain spares. This applies specifically to the SCXI chassis, all the modules and the terminal blocks. In case of the failure of any of these components the plan is to:

A): Proceed with the "RMI Express" plan of the NI company. They will fix whatever problem hardware we send them in 48 "business" hours.

B): During this time both the interlocks and controls are compromised.

-For the interlock, the hardware interlock of the power supplies can be used. It is not as accurate but can be used as a successful interlock for the period needed.

-The control of the burn-in, with reduced functionality can be done manually during the time the repair takes. A specific procedure is currently being written. This will only be necessary when the test starts or when an interlock condition occurs.

Buying a spare interlock crate now costs about $5500 +S&H.

In the case where a multi-rod stand is rendered completely inoperative, rod assembly at the affected site can proceed at a rate which is yet to be determined. The assembled rods would then have to be tested on the single rod stand. The amount of testing on the single rod stand would have to be increased to find all failures. The amount of time these tests would take is not yet known. The rod assembly might have to be slowed down to match the new testing capacity when the multi-rod stand is unavailable. This scenario would have the added risk of producing rods without the ability to test them at operating temperatures or for extended periods. As no such failures have been seen so far, this risk appears to be minimal. In addition once the multi-rod stand is operational, the backlog of produced rods will have to be tested in addition to the newly assembled rods. The only way to remove such a backlog is to reduce the multi-rod test length or to reduce the rate of rod production. If the rods tested up to the time of the stand's failure do not show any time dependent failures, reducing the testing time period would be an acceptable option.

Appendices on the Following Pages:

ARCS Hybrid and Module Testing Spreadsheet
DAQ Module and Rod Testing Spreadsheet 1
DAQ Module and Rod Testing Spreadsheet 2

ARC Electrical Components / Inventory of Components

	UCSB hybrids	UCSB modules	FNAL hybrids	FNAL module	Mexico	UCR	Spares	Total Need	Have	Need	Source	Status of parts	FNAL	UCSB	Mexico	UCR
PCMIO Board	1	3	1	4	1	1	0	11	11	0	Aachen		5	4	1	1
ARCS Controllers	2	3	2	4	2	1	0	14	14	0	Aachen		6	5	2	1
ARCS FE	4	3	4	4	4	1	0	20	20	0	Aachen		8	7	4	1
LEPP	0	3	0	4	0	1	0	8	6	2	Aachen	requested	4	2	0	0
DEPP	0	3	0	4	0	1	0	8	9	-1	Aachen		4	5	0	0
tec-to-utri	0	3	0	0	0	0	3	6	6	0	Wim		0	6	0	0
hybrid-to-utri (ver d)	4	3	4	4	4	1	18	38	27	11	Patrice	requested	8	14	4	1
Coolie Box	1	0	1	0	1	0	1	4	4	0	Aachen		2	1	1	0

ARC Cables / Inventory of Components

	UCSB hybrids	UCSB modules	FNAL hybrids	FNAL module	Mexico	UCR	Spares	Total Need	Have	Need	Source	Status of parts	FNAL	UCSB	Mexico	UCR
Triple Interface Cables (50 pin)	1	3	1	4	1	1	4	15	13	2	Aachen	requested	6	5	1	1
FE cable (26 pin)	4	3	4	4	4	1	4	24	23	1	Aachen	requested	10	8	4	1
LED (34 pin)	0	3	0	4	0	1	3	11	10	1	Aachen	requested	5	5	0	0
LV Power Cables	2	9	2	12	2	2	4	33	31	2	Aachen	requested	12	16	2	1
TEC HV down	0	3	0	0	0	0	0	3	7	-4	Wim		0	7	0	0
TEC HV up	0	3	0	0	0	0	16	19	19	0	Wim		0	19	0	0
HV Cables	0	3	0	4	0	2	3	12	12	0	Aachen		7	3	0	2

ARC auxalliary / Inventory of Components

	UCSB hybrids	UCSB modules	FNAL hybrids	FNAL module	Mexico	UCR	Spares	Total Need	Have	Need	Source	Status of parts	FNAL	UCSB	Mexico	UCR
5 V LV PS (Low Current	4	6	4	8	4	2	3	31	30	1	Leader	on order	12	12	4	2
5 V LV PS (High Current)	0	3	0	0	0	0	0	3	3	0	Leader		0	3	0	0
Crowbar	0	3	0	4	0	1	0	8	10	-2	Aachen		4	6	0	0
Clamshells	0	3	0	4	0	1	0	8	8	0			5	3	0	0
Hybrid PC	1	0	1	0	1	0	0	3	3	0	Aachen		1	1	1	0
Module PC	0	3	0	4	0	1	0	8	8	0	Aachen		4	3	0	1
Hybrid & Module PC	0	0	0	0	0	0	2	2	0	2	Aachen	on order	0	0	0	0

4 hybrid cycler components / Inventory of Components

	UCSB hybrids	UCSB modules	FNAL hybrids	FNAL module	Mexico	UCR	Spares	Total Need	Have	Need	Source	Status of parts	FNAL	UCSB	Mexico	UCR
Chiller Neslab RTE-211	1	0	1	0	1	0	1	4	3	1	Neslab	on order	1	1	1	0
Delta Electronica SM7020	1	0	1	0	1	0	1	4	4	0	CERN		1	2	1	0
Omega FLR 1000 FM-Liquid	1	0	1	0	1	0	1	4	3	1	Omega	on order	1	1	1	0
Omega FLR 1000 FM-Air	1	0	1	0	1	0	1	4	3	1	Omega	on order	1	1	1	0
ASCO Valves	3	0	3	0	3	0	1	10	9	1	ASCO	on order	3	3	3	0
Peltier	1	0	1	0	1	0	1	4	3	1	Supercool	on order	1	1	1	0
Temperature Sensors/Cables	5	0	5	0	5	0	1	16	15	1		on order	5	5	5	0
Humidity Sensor/Cable	1	0	1	0	1	0	1	4	3	1		on order	1	1	1	0
Flow Control Interface Board	1	0	1	0	1	0	1	4	3	1	Milan	in process	1	1	1	0
Sensor Control Interface Board	1	0	1	0	1	0	1	4	3	1	Milan	in process	1	1	1	0
Water Flow Interlock	1	0	1	0	1	0	1	4	3	1	Milan	in process	1	1	1	0
NIM Crate	1	0	1	0	1	0	0	3	3	0	FNAL		1	1	1	0
LeCroy 688AL Level Adaptor	1	0	1	0	1	0	1	4	3	1	FNAL		1	1	1	0
LeCroy 622 Quad Coincidence	1	0	1	0	1	0	1	4	4	0	FNAL		1	2	1	0
LeCroy 222 Dual Gate Generator	2	0	2	0	2	0	2	8	6	2	FNAL		2	2	2	0
LVDS-TTL Converter	1	0	1	0	1	0	1	4	3	1	Milan		1	1	1	0
LVDS-TTL Converter Cables	2	0	2	0	2	0	2	8	6	2	Milan		2	2	2	0
GPH Water Flow Meter	1	0	1	0	1	0	1	4	3	1	GPH	on order	1	1	1	0
LPM Air Meter High	1	0	1	0	1	0	1	4	3	1	LPM	on order	1	1	1	0
LPM Air Meter Low	1	0	1	0	1	0	1	4	3	1	LPM	on order	1	1	1	0

DAQ Electronics Components

Inventory of Components

	UCSB module	Cosmic Stand	UCSB Rod	FNAL module	FNAL Rod	UCR	Spares	Total Need	Have	Need	Source	Status of parts	FNAL	UCSB	UCR
TSC	1	1	2	2	2	1	1	10	8	2	Ariella/Patrice	requested	4	4	0
FED	1	2	3	2	3	1	2	14	13	1	Ariella/Patrice	requested	7	6	0
TPO	1	0	2	1	2	1	2	9	6	3	Ariella/Patrice	requested	3	3	0
FEC (LT)	0	1	0	0	0	0	0	1	1	0	Patrice		0	1	0
FEC (ROD)	1	0	2	2	2	1	2	10	11	-1	Patrice		5	5	1
eMUX Crates	1	0	0	1	0	1	0	3	3	0	Karlsruhe		1	1	1
eMUX Boards	3	0	0	3	0	3	1	10	8	2	Karlsruhe	requested	3	3	2
oMUX Crates	0	0	3	0	3	0	0	6	6	0	Karlsruhe		3	3	0
oMUX Boards	0	0	22	0	22	0	2	46	39	7	Karlsruhe	requested	21	18	0
FEC2CCUM	1	0	2	1	2	1	2	9	13	-4	Duccio		8	4	1
CCU6	0	0	0	0	0	0	0	0	5	-5	Patrice		2	3	0
CCU25	2	1	0	3	0	2	2	10	8	2	Patrice	requested	3	4	1
VUTRI	10	5	0	11	0	10	4	40	36	4	Patrice	requested	14	17	5
PAACB	10	5	0	11	0	10	2	38	32	6	Wim	requested	10	16	6
OEC	0	0	14	0	14	0	2	30	28	2	Duccio	requested	14	14	0
DI/O CIO-DAS6402/12	1	0	1	1	1	0	2	6	4	2		on order	2	2	0
NIM-to-LVDS	1	0	0	1	0	0	0	2	2	0	Lyon		1	1	0
tec-to-utri	9	0	0	0	0	0	0	9	9	0	Wim		0	9	0
hybrid-to-utri (ver d)	13	5	0	21	0	10	0	49	50	-1	Patrice		32	18	0

DAQ Electronics Cables

	UCSB module	Cosmic Stand	UCSB Rod	FNAL module	FNAL Rod	UCR	Spares	Total Need	Have	Need	Connect Person/Source	Status of parts	FNAL	UCSB	UCR
TSC to FEC	1	1	2	2	2	1	3	12	10	2		on order	4	6	0
TSC to FED	1	1	3	2	3	1	3	14	11	3		on order	5	6	0
TSC to Nim-to-LVDS	1	0	0	1	0	0	2	4	2	2		on order	1	1	0
FEC/CCUM to CCUM (20 pin)	3	0	0	5	0	3	3	14	10	4			4	3	3
FEC/CCUM to CCUM (10 pin)	0	2	0	0	0	0	1	3	11	-8			6	5	0
CCUM to VUTRI	10	5	0	11	0	10	3	39	37	2		on order	10	17	10
VUTRI/MUX to FED	3	10	22	6	22	3	2	68	69	-1	Patrice		27	39	3
Electrometer Adapter Board	1	0	1	1	1	0	2	6	3	3		in process	1	2	0
DI/O CIO Cable	1	0	1	1	1	1	2	7	4	3		in process	2	2	0
TPO to TSC (50 pin)	2	0	4	2	4	2	3	17	11	6		on order	5	6	0
TPO to MUX cable	1	0	3	1	3	1	3	12	8	4		on order	4	4	0
HV Cables	10	5	0	10	0	10	0	35	35	0			10	25	0

Vienna Box Cables

	UCSB module	Cosmic Stand	UCSB Rod	FNAL module	FNAL Rod	UCR	Spares	Total Need	Have	Need	Connect Person/Source	Status of parts	FNAL	UCSB	UCR
NIM-to-LVDS to PAACB cables	1	0	0	1	0	0	2	4	2	2		on order	1	1	0
TPO to PAACB cables	1	0	0	1	0	1	3	6	2	4		on order	1	1	0
TPO to NIM-to-LVDS	1	0	0	1	0	0	2	4	2	2		on order	1	1	0
Vienna LV Cables	12	0	0	12	0	12	3	39	27	12	UCSB	in process	15	12	0
NIM-to-LVDS LV Cable	1	0	0	1	0	0	2	4	2	2		on order	1	1	0
NIM-to-LVDS to TPO LV Cable	1	0	0	1	0	0	2	4	2	2		on order	1	1	0
Vutri to PAACB LV Cable	10	0	0	10	0	10	3	33	21	12	Wim	on order	10	11	0
Vienna Box to TRHX_base (20 pin to Auxiliary I/O)	1	0	0	1	0	3	3	8	2	6		in process	1	1	0
Vienna Box to TRHX_base (12 pin - 2x 6 pin)	1	0	0	1	0	3	3	8	2	6		in process	1	1	0
Vienna Box to TRHX_base(24 pin - 4x 6 pin)	1	0	0	1	0	3	3	8	2	6		in process	1	1	0
THRX_base to Cooling Box (20 pin Remote/THRX)	1	0	0	1	0	3	0	5	4	1		in process	2	2	0
VTH CTRL to VTH Power Box (2 pin to orange plug)	1	0	0	1	0	1	3	6	2	4	Torino	on order	1	1	0

Rod Teststand Cables

	UCSB module	Cosmic Stand	UCSB Rod	FNAL module	FNAL Rod	UCR	Spares	Total Need	Have	Need	Connect Person/Source	Status of parts	FNAL	UCSB	UCR
I_JMPR	0	0	7	0	7	0	6	20	14	6	Duccio	on order	7	7	0
I_CTRL_1	0	0	1	0	1	0	2	4	3	1	Duccio	on order	2	1	0
I_CTRL_1 or 2 short	0	0	1	0	1	0	2	4	2	2	Duccio	on order	1	1	
I_CTRL_2	0	0	1	0	1	0	2	4	2	2	Duccio	on order	1	1	0
I_CTRL_3	0	0	1	0	1	0	2	4	4	0	Duccio		2	2	0
I_CTRL_3 short	0	0	1	0	1	0	2	4	2	2	Duccio	on order	1	1	0
O_CTRL_0	0	0	1	0	1	0	2	4	4	0	Duccio		1	3	0
O_CTRL_0 homemade	0	0	1	0	1	0	0	2	2	0	Duccio		1	1	0
O_CTRL_1	0	0	1	0	1	0	2	4	2	2	Duccio	on order	1	1	0
O_CTRL_2	0	0	1	0	1	0	2	4	3	1	Duccio	on order	2	1	0
O_CTRL_3	0	0	2	0	2	0	2	6	4	2	Duccio	on order	2	2	0
O_PWR_0 (10 M)	0	0	9	0	9	0	2	20	18	2	Duccio	on order	9	9	0
O_PWR_1 (long)	0	0	8	0	8	0	2	18	19	-1	Duccio		11	8	0
O_PWR_1 (short)	0	0	1	0	1	0	2	4	4	0	Duccio		3	1	0
OFED-MUX Cable Bundles (12 cables)	0	0	14	0	14	0	2	30	32	-2	Duccio		18	14	0
Rod HV Cables (Single Rod)	0	0	1	0	1	0	2	4	2	2		in process	1	1	0
Rod HV Cables (Multirod)	0	0	8	0	8	0	2	18	16	2		in process	8	8	0
Optical Fibers	0	0	14	0	14	0	2	30	28	2	Duccio	3 old spares	14	14	0

	UCSB module	DAQ auxalliary Cosmic Stand	UCSB Rod	FNAL module	FNAL Rod	UCR	Spares	Total Need	Have	Need	Connect Person/S	Status of parts	FNAL	UCSB	UCR
VME Crate	0	0	1	0	1	0	2	4	2	2		in hand, confirming wor	1	1	0
NIM crate	1	0	1	1	1	0	2	6	5	1		in hand, confirming wor	2	3	0
Electrometers	3	0	2	3	2	0	0	10	10	0	Ariella		5	5	0
Vienna Boxes	1	0	0	1	0	1	0	3	3	0	Vienna		1	1	1
RH and Temp. Sensor Unit (Inside Vienna Box)	1	0	0	1	0	1	2	5	3	2		on order	1	1	1
TRHX Base	1	0	0	1	0	1	2	5	5	0	Vienna		2	2	1
Vienna Box Chillers	1	0	0	1	0	1	1	4	3	1	NESLAB	1-2 week delivery	1	1	1
VTH Control Box	1	0	0	1	0	1	2	5	2	3	Torino	on order	1	1	0
VTH Power Box	1	0	0	1	0	1	2	5	2	3	Torino	on order	1	1	0
VTH Temperature Sensors	2	0	0	2	0	2	6	12	4	8	Torino	on order	2	2	0
Transformers	2	1	1	0	0	0	1	5	5	0	UCSB	purchase at MARVAC	1	4	0
Vienna Box PCs	1	0	0	1	0	1	0	3	3	0			1	1	1
Rod PCs	0	0	2	0	2	0	0	4	4	0			2	2	0
Interlock PC	0	0	1	0	1	0	0	2	2	0			1	1	0
Vienna Box-Rod-Interlock PC Backup	0	0	0	0	0	0	2	2	1	1		on order	1	0	0
AOH Test Kit	0	0	1	0	1	0	0	2	2	0			1	1	0
AOH 88cm 2las (preprod)	0	0	1	0	1	0	0	2	2	0			0	2	0
AOH 88cm 2las	0	0	1	0	1	0	0	2	2	0			0	2	0
AOH 70cm 2las	0	0	1	0	1	0	0	2	2	0			0	2	0
AOH 56cm 2las	0	0	1	0	1	0	0	2	2	0			0	2	0
AOH 35cm 2las	0	0	1	0	1	0	0	2	2	0			0	2	0
AOH 88cm 3las	0	0	1	0	1	0	0	2	2	0			0	2	0
AOH 70cm 3las	0	0	1	0	1	0	0	2	2	0			0	2	0
AOH 56cm 3las	0	0	1	0	1	0	0	2	2	0			0	2	0
AOH 35cm 3las	0	0	1	0	1	0	0	2	2	0			0	2	0
NI SCXI 1001	0	0	1	0	1	0	0	2	2	0	UR		1	1	0
1102 NI SCXI 1303	0	0	1	0	1	0	0	2	2	0	UR		1	1	0
1162/1163 NI SCXI 1326	0	0	2	0	2	0	0	4	4	0	UR		2	2	0
NI 6034-E SCXI PCI Card	0	0	1	0	1	0	0	2	2	0	UR		1	1	0
Rod Quick-connect (type a)	0	0	16	0	16	0	0	32	32	0	UR		16	16	0
Rod Quick-connect (type b)	0	0	16	0	16	0	0	32	32	0	UR		16	16	0
Oringsfor above	0	0	32	0	32	0	0	64	100	-36	UR		50	50	0
Flowmeters	0	0	8	0	8	0		16	16	0	UR		8	8	0
Thermistors	0	0	2	0	2	0		4	4	0	UR		2	2	0
RH Sensor (hih-2610)	0	0	2	0	2	0		4	4	0	UR		2	2	0
Pressure sensor (GEM)	0	0	1	0	1	0		2	2	0	UR		1	1	0
CRYDOM relay	0	0	1	0	1	0		2	3	-1	UR		1	2	0
C6F14 (Gallons)	0	0	?	0	?	0		0	5	-5	UR			5	0
ASCO V052 Valve	0	0	1	0	1	0		2	2	0	UR-help define		1	1	0
Presence Detectors	0	0	8	0	8	0		16	16	0	UR-help define		8	8	0
Gas flowmeter (acrylic)	0	0	1	0	1	0		2	2	0	UR		1	1	0
Freezer HW	0	0	1	0	1	0		2	2	0	UR		1	1	0