

WBS 1.3

IST Overview

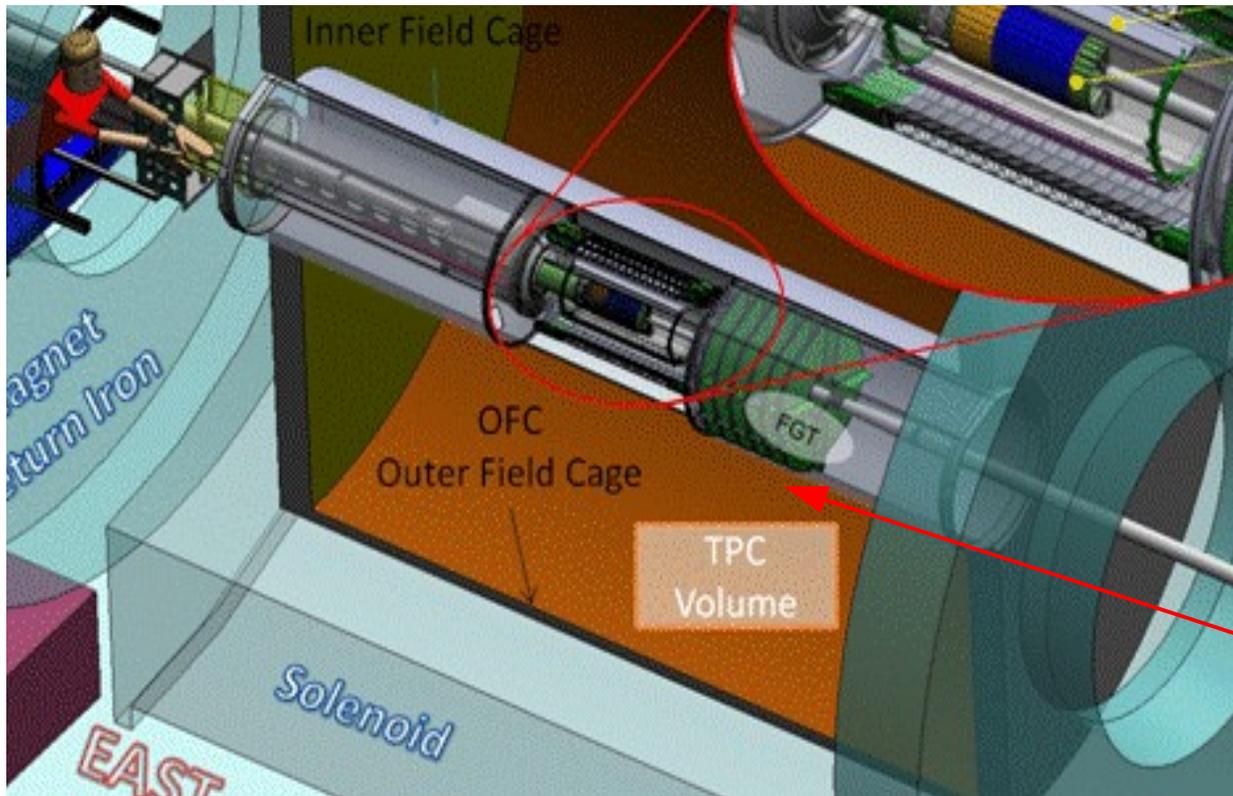
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MIT

IST presentation overview



- Detector overview
- Deliverables
- Timeline
- Stave production
- Readout system
- Cooling system
- ? Human resources ?
- ? Milestones and risk assessment ?

IST in HFT



TPC – Time Projection Chamber
(main tracking detector in STAR)

HFT – Heavy Flavor Tracker

- SSD – Silicon Strip Detector

- $r = 22$ cm

- **IST – Intermediate Silicon Tracker**

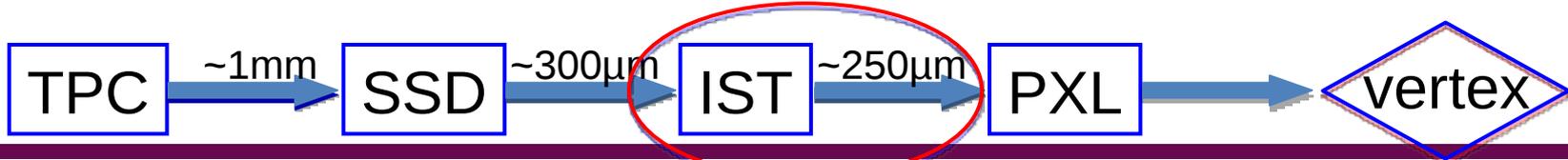
- $r = 14$ cm

- PXL – Pixel Detector

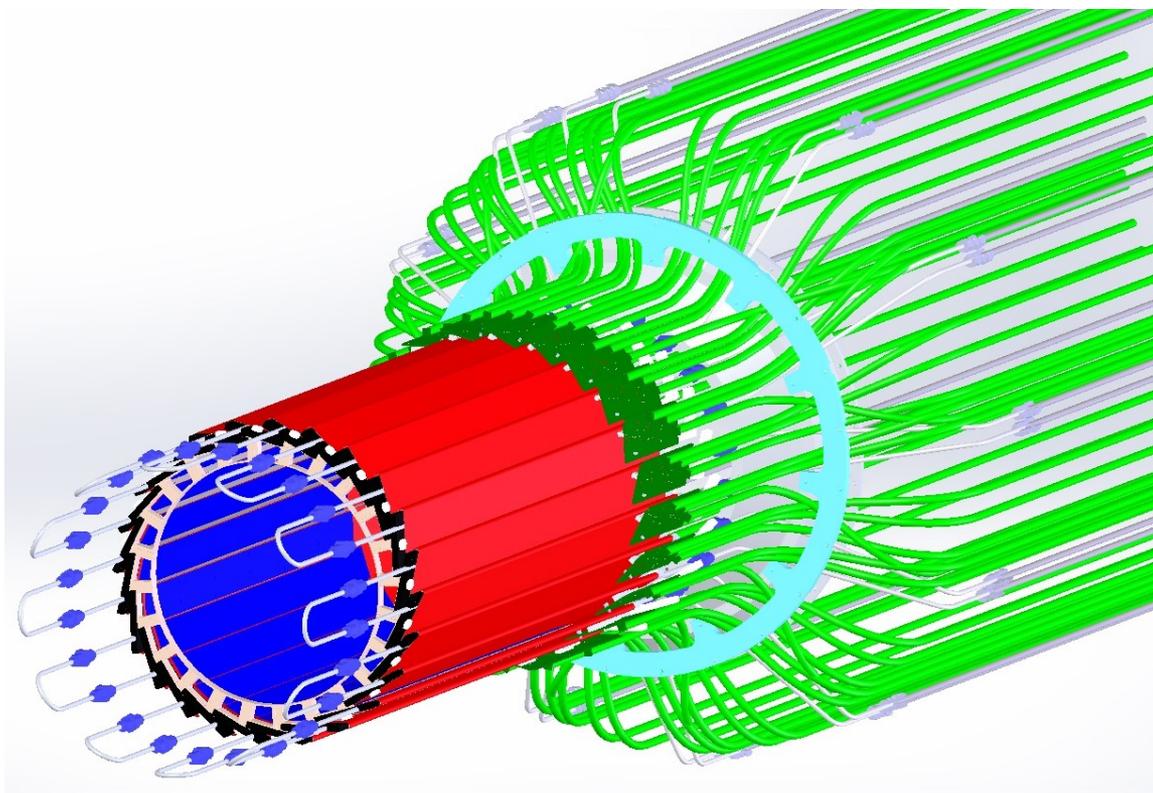
- $r = 2.5, 8$ cm

FGT – Forward GEM Tracker
Shares almost identical readout system with IST

We track inward from the TPC with graded resolution:



IST overview



Radius	14cm
Length	50cm
ϕ -Coverage	2π
$ \eta $ -Coverage	≤ 1.2
Number of ladders	24
Number of hybrids	24
Number of sensors	144
Number of readout chips	864
Number of channels	110592
R- ϕ resolution	172 μ m
Z resolution	1811 μ m
Z pad size	6000 μ m
R- ϕ pad size	600 μ m

IST in production

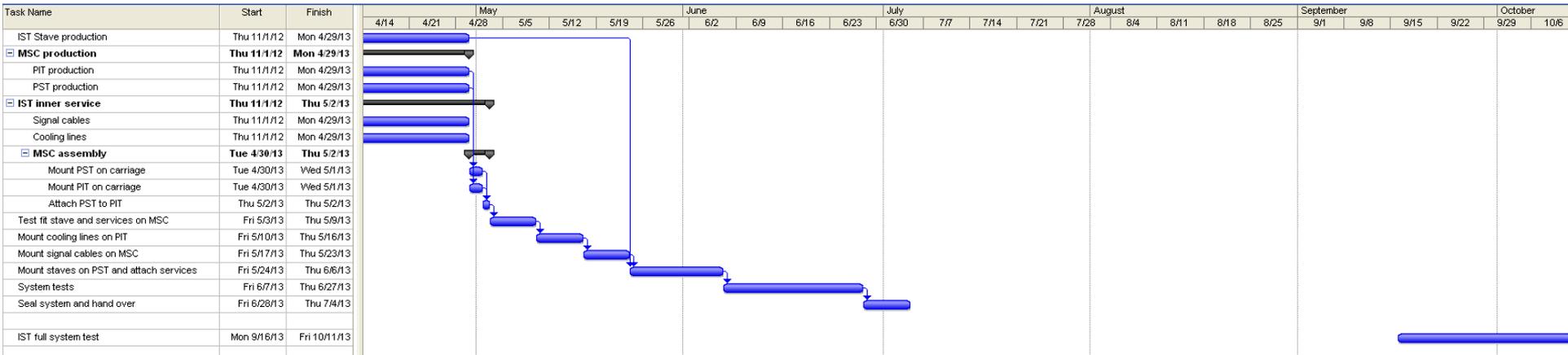
IST deliverables



- 27 (24+3 spares) staves with six sensors per staff
- 24 IST staves installed on the Middle Support Cylinder
- Readout and bias voltage system for 24 staves
- Cooling system

Delivered by August 2013

IST timeline

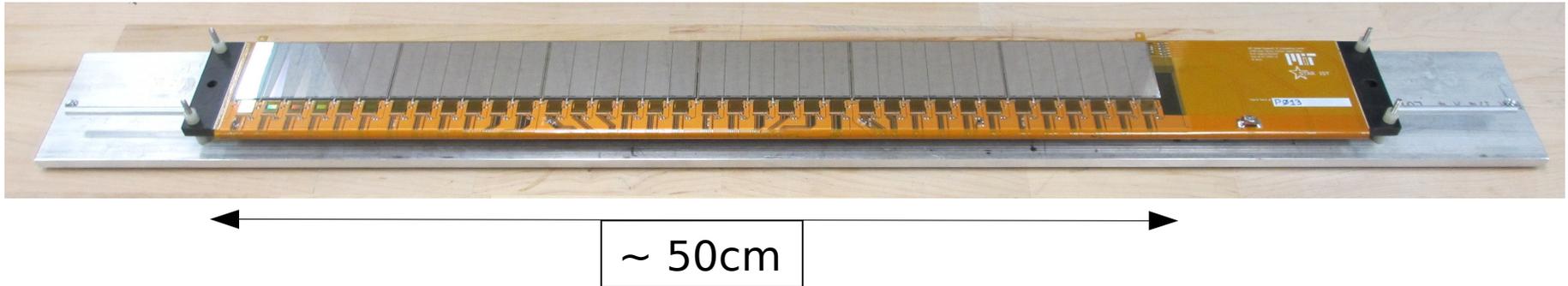


Roughly 1 month slack left if handover deadline is August 1st

IST stave



IST prototype stave



IST stave = carbon fiber ladder + cooling tube +
kapton flex hybrid + passive components
+ 6 silicon pad sensors
+ 3 x 12 APV25-S1 readout chips

Electrically divided in 3 units to reduce chance of failure of a full stave

Several stages of production

IST Kapton flex hybrid



- 6 months delay because original vendor couldn't deliver acceptable quality (like prototypes)
- new vendor (Compunetics) did deliver, but underestimated complexity a bit
- good quality hybrids
- all sent to LBNL for co-curing with CF ladder core

All required hybrids are in hand

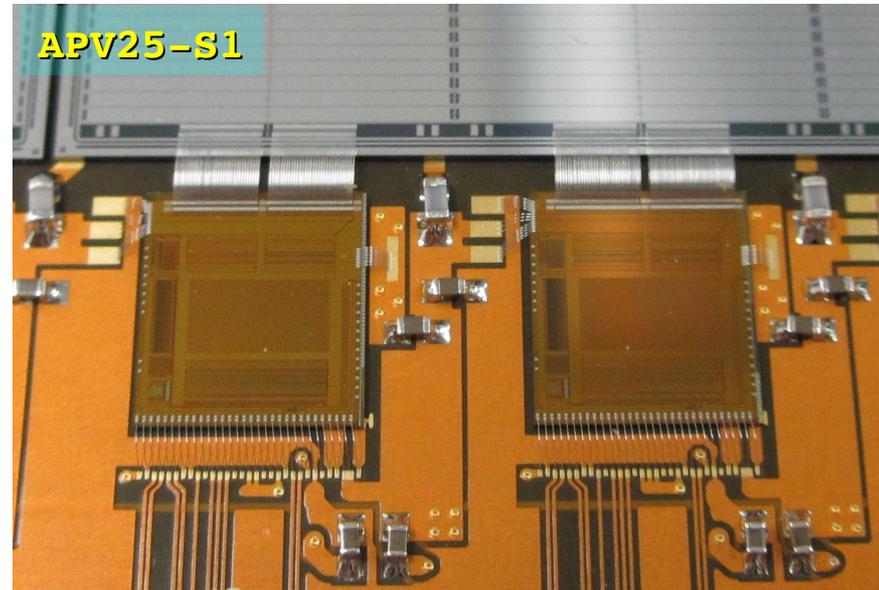
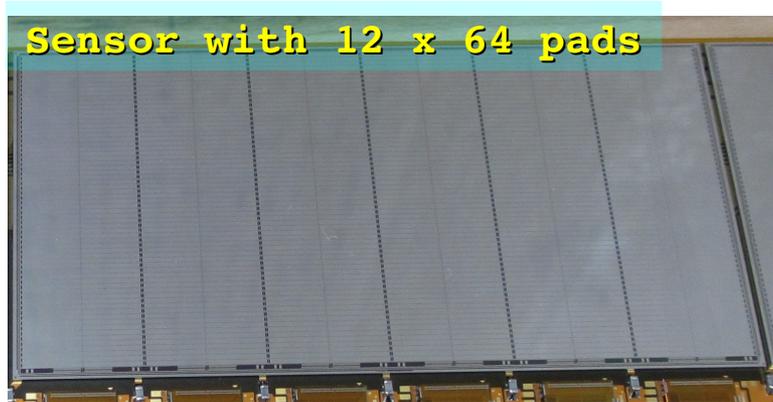
IST CF ladder and hybrid



STAVE Numbers				Prep			Open Stave				Assembly				Bare Staves				Quality Assurance			Shipping		
STAVE Starts	Hybrid Serial Number	Production Database Number	LBNL Serial Number	Received	Pictures	Masking	Co-Cure	Foam Bot	Honey-C	Close-Out	Core Gro	Foam Ma	Tube Bot	Stave Clos	Tube Sw	Connect	Ground C	Plasma C	Pressure Cycle	In Survey	Survey R	Finish Date	Boxed	Shipping Number
1	IST-001	Pre-Prod.													n/a		n/a		n/a	n/a	n/a		x	Delivered
2	IST-002	Pre-Prod.													n/a		n/a		n/a	n/a	n/a		x	Delivered
3	IST-003	Pre-Prod.													n/a		n/a		n/a	n/a	n/a		x	Delivered
4	IST-004	104455													*		*	*	*	*	*	11/12/2012	x	794056251734
5	IST-005	104456													*		*	*	*	*	*	11/12/2012	x	794056251734
6	IST-006	104463													*		*	*	*	*	*	12/4/2012	x	794214631445
7	IST-007	104467													*		*	*	*	*	*	12/4/2012	x	794214631445
8	IST-008	104471													*		*	*	*	*	*	12/4/2012	x	794214631445
9	IST-009	104481													*		*	*	*	*	*	1/11/2013	x	794498410645
10	IST-010	104485													*		*	*	*	*	*	1/11/2013	x	794498410645
11	IST-011	104497													*		*	*	*	*	*	1/11/2013	x	794498410645
12	IST-012	104501													*		*	*	*	*	*	1/17/2013	x	794545163503
13	IST-013	104505													*		*	*	*	*	*	1/17/2013	x	794545163503
14	IST-014	104509													*		*	*	*	*	*	1/17/2013	x	794545163503
15	IST-015	104513													*		*	*	*	*	*	1/17/2013	x	794545163503
16	IST-016	104517																						
17	IST-017	104586																						
18	IST-018	104590																						
19	IST-019	104596																						
20	IST-020	104600																						
21	IST-021	104604																						
22	IST-022	104608																						
23	IST-023	104612																						
24	IST-024	104616																						
25	IST-025																							
26	IST-026																							
27	IST-027																							
28	IST-028																							
29	IST-029																							
30	IST-030																							
31	IST-031																							

~ 4 staves per week

IST sensors and readout chips



**All readout chips in hand
All Hamamatsu sensors delivered on schedule
and of excellent quality**

IST stave assembly



- 4 to 10 days at Proxy for inactive component mounting
- 18/18 split assembly at MIT/BNL and UIC/FNAL
- MIT/BNL assembly plagued by personal issues
- temporarily shift bulk of assembly to UIC/FNAL
- 4 staves fully assembled, 2 accepted, 1 needs testing, 1 needs rework (chip replacement probably)
- 3 staves ready to be assembled at MIT/BNL and UIC/FNAL
- 4 staves at Proxy, 9 soon out of LBNL pipeline

IST readout system



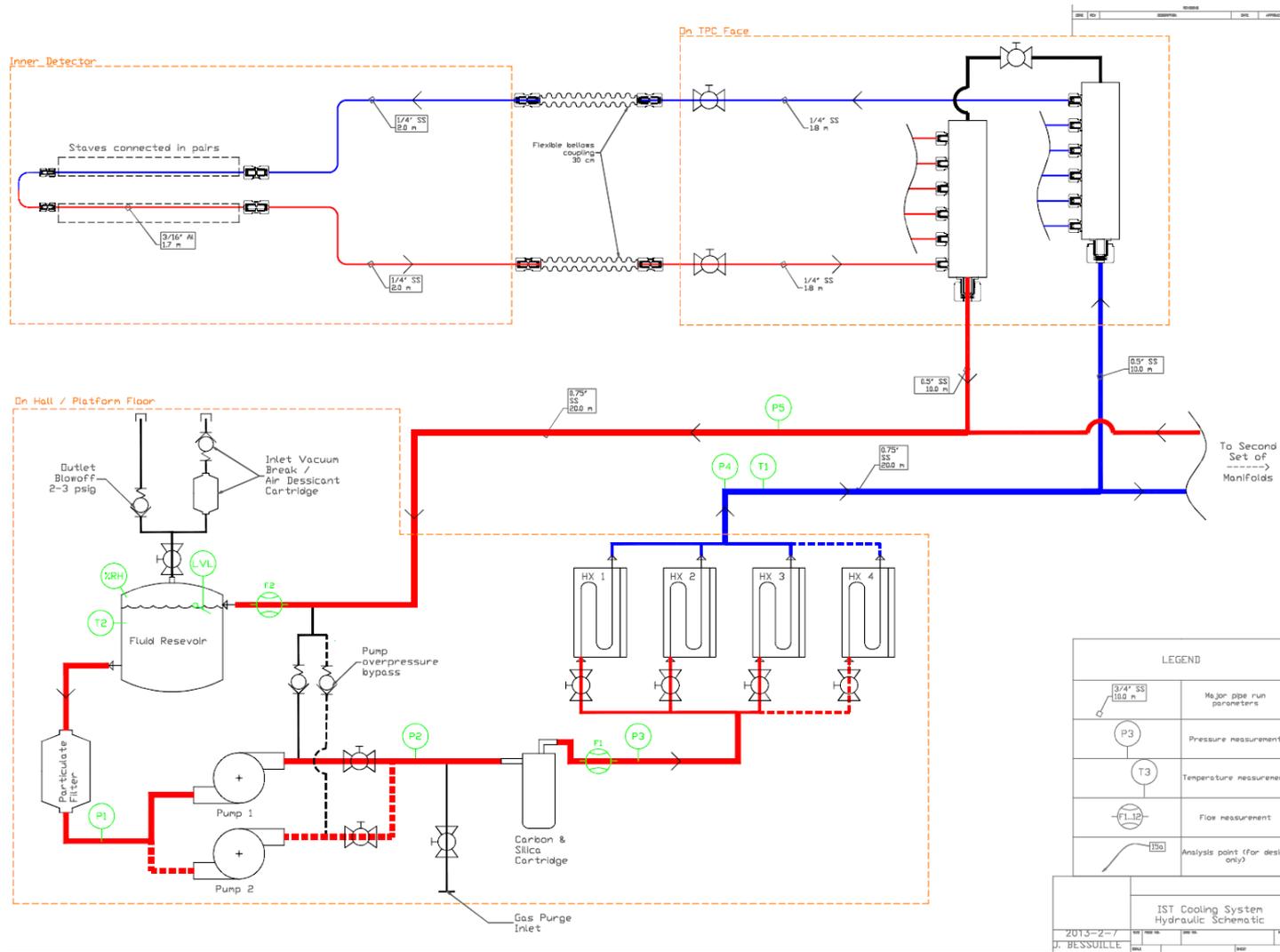
- **All readout crates ordered, delivery April 15th**
- **All sensor bias supplies ordered, delivery April 15th**
- **APV readout modules in production, first boards to arrive at the end of February**
- **APV readout controllers in production, first boards tested at the end of February**
- **Inner cables ready to be assembled, delivery ???**
- **Outer cable stock material ordered after delay, delivery ???, assembly of 12 cables should be ready on June 1st for partial system tests, rest ready by August 1st**
- **Back of Crate boards are ready?**
- **Patch Panel boards will be ready ???**
- **Short BNC bias supply cables need to ordered**

IST cooling system overview



- Novec 7200 chosen for its high dielectric strength and vapor pressure (so it will evaporate if it leaks)
- Challenging to use for several reasons:
 - High vapor pressure
 - Low surface tension
 - Extremely good solvent of most plastics and elastomers
- Design features
 - Custom-designed chiller
 - Almost all-metal system with VERY few exceptions
 - Magnetically driven pump and bellows actuated valves eliminate all dynamic seals
 - Compression fittings used whenever possible
 - Reservoir maintained at positive pressure to reduce vapor losses
 - Water removal in circulating fluid and incoming air
 - Solute removal via charcoal
 - Multiple redundant coolers and pumps for reliability

IST cooling system schematic



IST cooling system details



Fluid Species	HFE-7200 (a.k.a. 3M Novec)
Fluid Temperature	20 C / 68 F
Flow Rate	12 lpm / 190 gph
Pressure	350 kPa / 50 psi
Hydraulic power	70 W / 0.1 HP
System volume	5 gal incl. reservoir

IST Stave Power (all 24 staves)	269.1 W (nominal) 345.6 W (max)
Max Ambient Temperature*	83 F / 28.3 C
Max Dewpoint Temperature*	63 F / 17.2 C

**Based on data from 2012 run*

Cooling device	3 x Thermolectric liquid-to-air
Cooling capacity @27 C ambient	510 W
Electrical Power max	1200 W

Instrumentation			
Measurement	Device	Location	Usage
Temperature	1 x Thermistor	HX outlet	TEC feedback control
	1 x RTD	Coolant supply near staves	Remote monitor
	1 x Thermistor	Coolant supply near staves	Hardware interlock
	1 x RTD	Reservoir	Remote monitor
Pressure	5 x Transducer	Various	Remote monitor
Flow	2 x Turbine flowmeter	Main supply / return lines	Remote monitor
Liquid Level	1 x Float sensor	Reservoir	Remote monitor
Relative humidity	1 x Hygrometer	Reservoir headspace	Remote monitor



IST cooling system bom



BOM	Revised 2013-02-07 16:00			Highlighted = Estimates / Needs Review	
Item	Qty	Make	Model	Price	Cost
Pump	2	Clark Solutions Inc	TSFRSS401-110V-NBR	\$672.73	\$1,345.46
Heat Exchanger	8	TE Technology, Inc	LC-SSX1	\$129.00	\$1,032.00
Thermoelectric Cooler	4	TE Technology, Inc	CP-200	\$585.00	\$2,340.00
TEC Controller	2	TE Technology, Inc	TC-48-20	\$286.00	\$572.00
TEC Thermistor	2	TE Technology, Inc	MP-3193	\$24.00	\$48.00
TEC Thermal Paste	1	TE Technology, Inc	TP-1	\$16.50	\$16.50
TEC Power Supply 1	1	TE Technology, Inc	PS-24-20	\$228.00	\$228.00
TEC Power Supply 2	1	TDK-Lambda	HFE1600-24	\$723.00	\$723.00
Auxiliary Power Supply	1	TBD		\$200.00	\$200.00
1/2" Valve	2	Swagelok	SS-8BW	\$273.47	\$546.94
3/8" Valve	4	Swagelok	SS-6BW	\$272.45	\$1,089.80
1/4" Valve	26	Swagelok	SS-4BW	\$201.82	\$5,247.32
1/4" Flexible Hose	24	Swagelok	SS-FM4SL4SL4-12	\$130.70	\$3,136.80
Pressure Transducer	5	Omega	PX209 series	\$235.00	\$1,175.00
Flow Meter	2	Omega	FTB-1315	\$950.00	\$1,900.00
Level Sensor	1	Omega	LVR31	\$775.00	\$775.00
Temperature Sensor	1	Omega		\$50.00	\$50.00
Humidity Sensor (Hygrometer)	1	Omega		\$450.00	\$450.00
DAQ Electronics	1	Omega		\$3,000.00	\$3,000.00
Reservoir Tank	1	McMaster Carr	1481K14	\$748.03	\$748.03
Equipment Rack	1	Hammond Mfg	REFK1904924BK1	\$550.00	\$550.00
Blowoff valve	1	TBD		\$100.00	\$100.00
Vacuum Break	1	TBD		\$100.00	\$100.00
Air dessicant cartridge	2	McMaster Carr	3297T31	\$65.51	\$131.02
Liquid dessicant cartridge		TBD		\$300.00	\$0.00
Particulate filter	2	Swagelok	SS-8F-VCR-15	\$237.90	\$475.80
Charcoal Filter	1	TBD		\$300.00	\$300.00
Tubing and Fittings	1	various		\$5,000.00	\$5,000.00
Manifolds	4	Bates Shop		\$1,000.00	\$4,000.00
Coolant	2	3M	Novec HFE-7200 (5 gal)	\$1,213.00	\$2,426.00
Total					\$37,706.67

IST summary



- Stave production ready in May
- Readout and bias system complete in May
- External (long) cables are late, but still on time
- Cooling system design is finished, ready for procurements and assembly
- Schedule holds and has 1 month of slack left before start of installation in STAR in August