Intermediate Silicon Tracker (IST)

Technical implementation, Cost, R&D plan, Schedule

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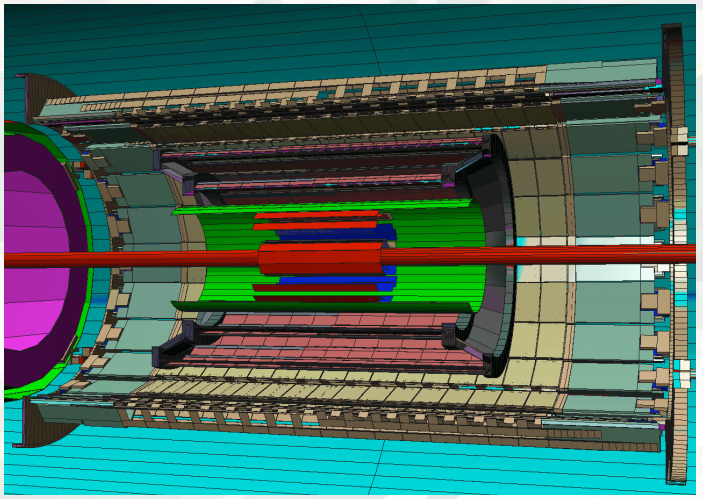
Outline

- Technical realization
- Layout
- Requirements



- R&D plan
- Cost estimate
- Schedule

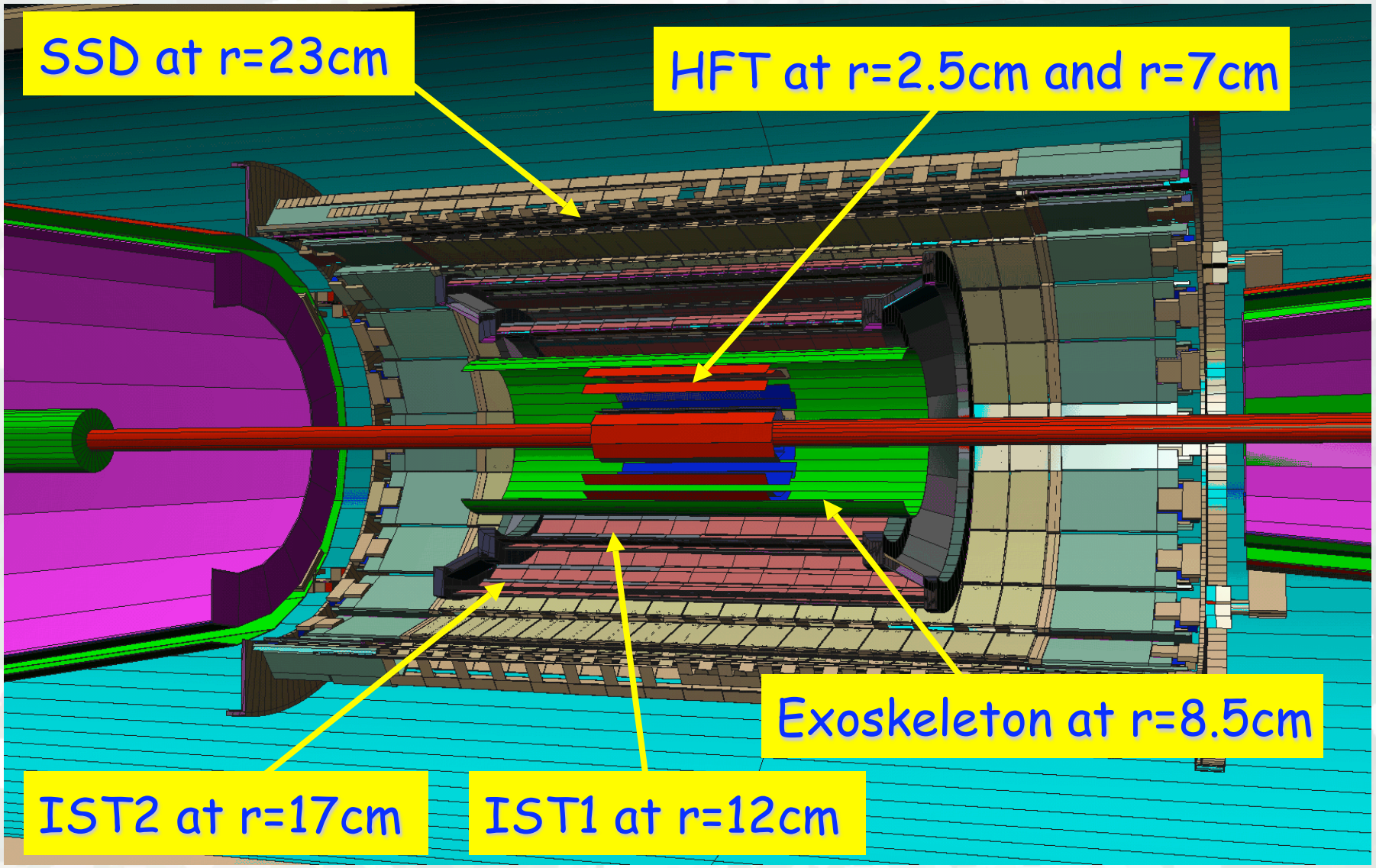
IST group

- Institution list
  - Argonne National Laboratory
  - Brookhaven National Laboratory
  - Lawrence Berkeley National Laboratory
  - Massachusetts Institute of Technology

Requirements

- Location: Between HFT and SSD covering $-1 < \eta < +1$
- Material budget: <4.5% X_0 and <1.5% X_0 per layer, <10% $(1 < \eta < 2)$
- Occupancy: <10% for central Au+Au events at 200GeV CME
- Tracking efficiency / purity: Meet physics requirements of efficient D^0 reconstruction $(D^0 \rightarrow K+\pi)$
- Rate capability: Handle RHICII peak luminosities for Au+Au and p+p
- Sampling speed: Resolve individual beam bunches (107ns - bunch crossing time)

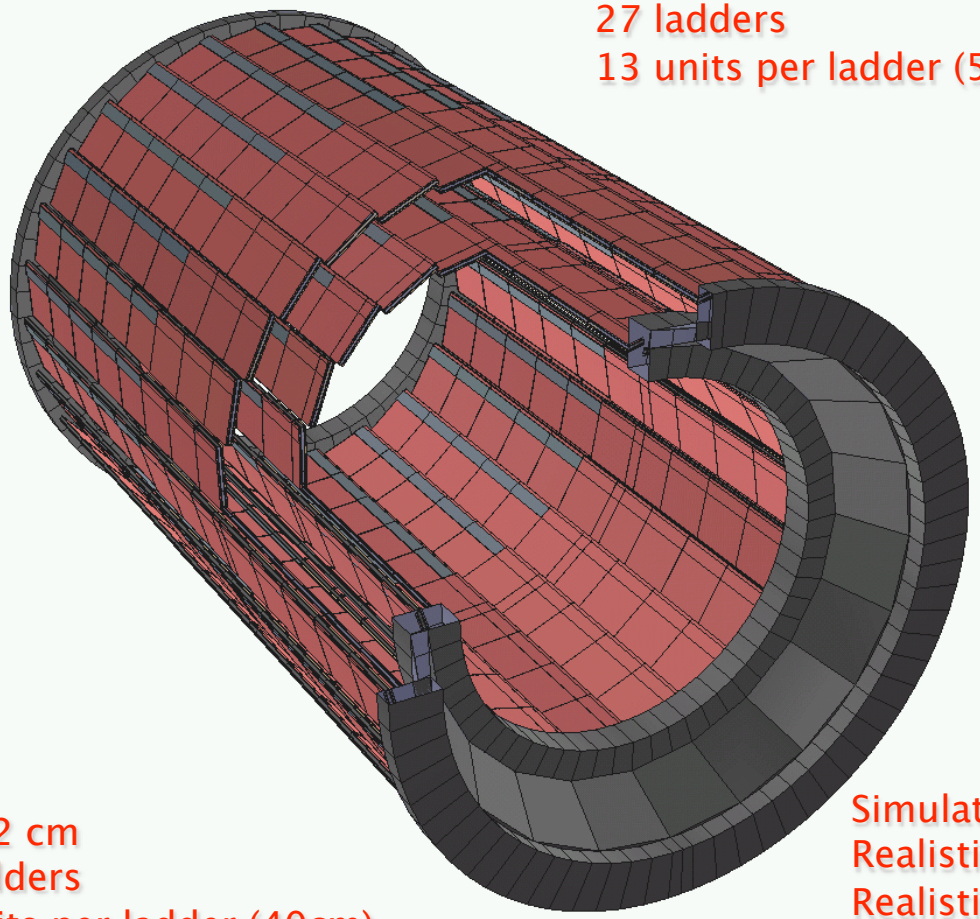
Layout


SSD at r=23cm
HFT at r=2.5cm and r=7cm
Exoskeleton at r=8.5cm
IST2 at r=17cm
IST1 at r=12cm

Layout

IST2

R = 17 cm
27 ladders
13 units per ladder (52cm)

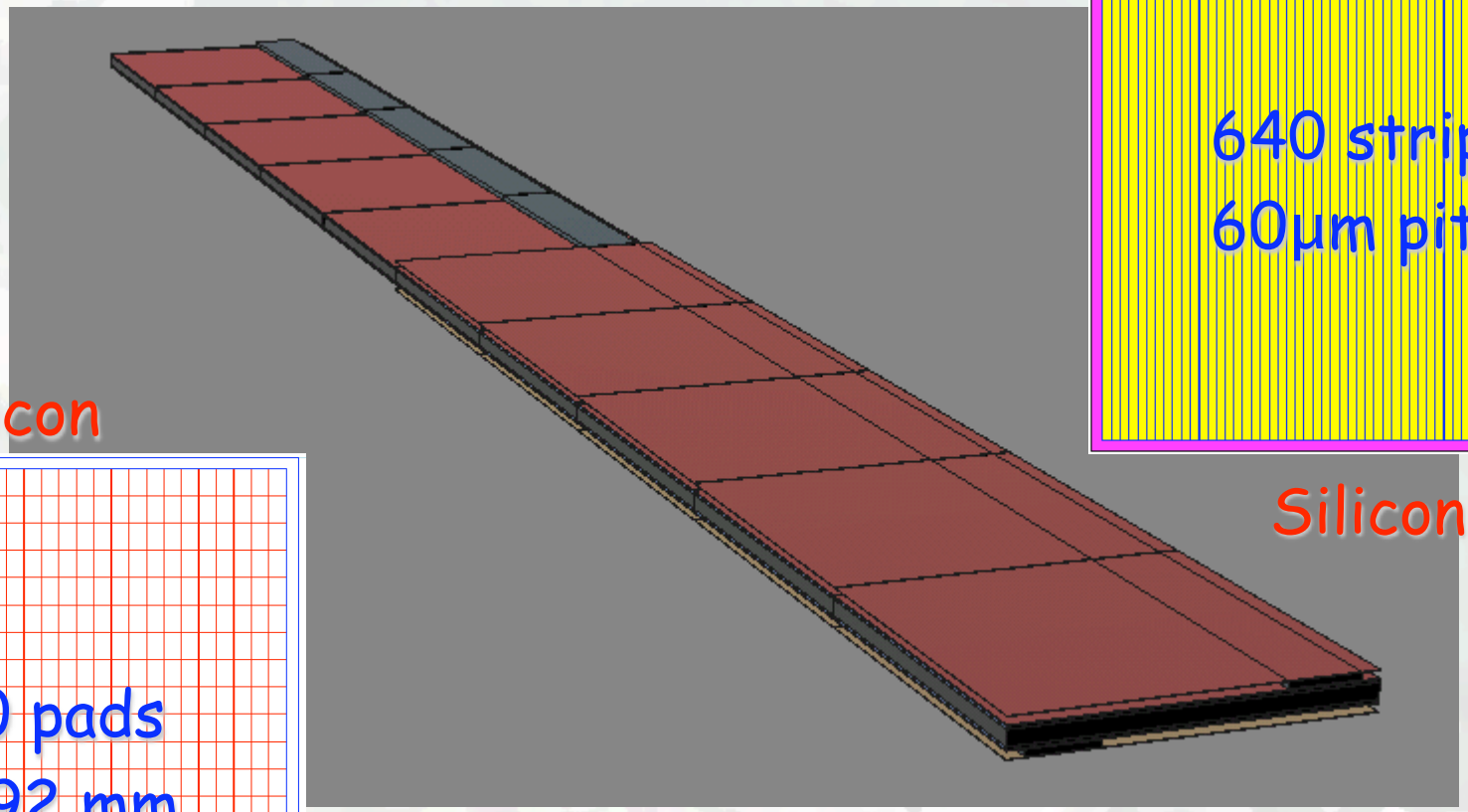


IST1

R = 12 cm
19 ladders
10 units per ladder (40cm)

Simulations
Realistic ladders
Realistic support
Realistic cables
No utilities yet

Layout



640 strips
60µm pitch

Silicon Strip

Silicon

32 x 20 pads
1.2 x 1.92 mm

For the readout the pad sensors are identical to the strip sensors: 640 channels

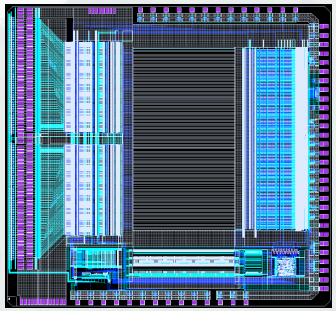
Technical realization

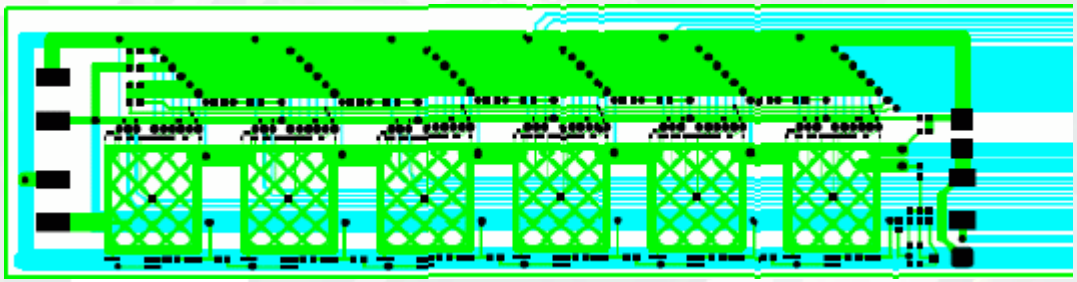
- IST technology choice
  - Conservative approach to minimize risk
  - Build upon existing expertise
  - Silicon sensors (Strip/Pads) from commercial vendor (Hamamatsu)
    - Proven to be a reliable technology at numerous applications
    - MIT-LNS silicon labs (Successful PHOBOS silicon system)
  - Off-the-shelf readout chip: APV25-S1 for CMS (Silicon) and COMPASS (GEM)
  - Basis for a cost-effective solution

Technical realization

- IST module details

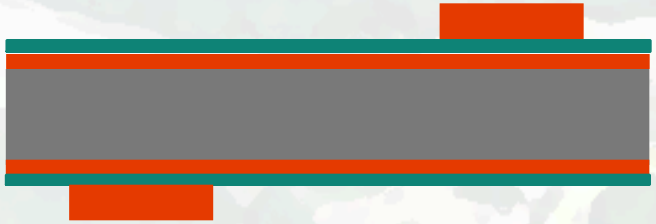
APV25-S1





Average X_0:

~1.5% ($\eta \sim 0$)



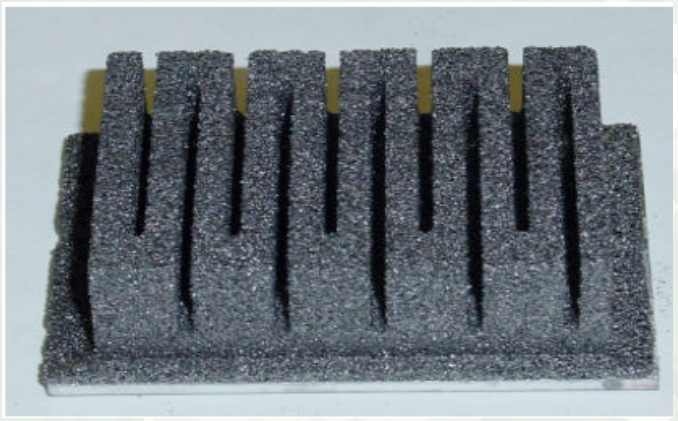
100µm Kapton Hybrid

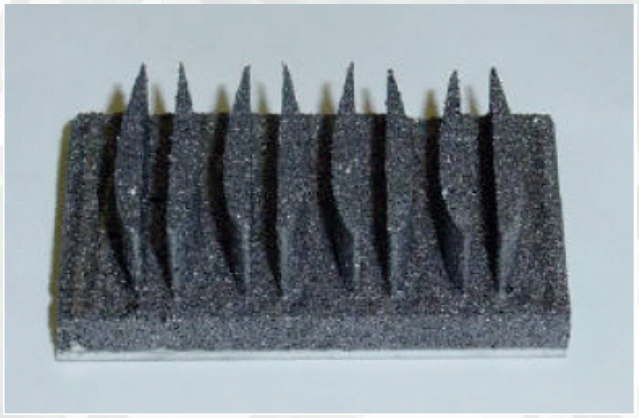
Silicon Sensor

Thermal conducting carbon foam

Silicon Sensor

100µm Kapton Hybrid

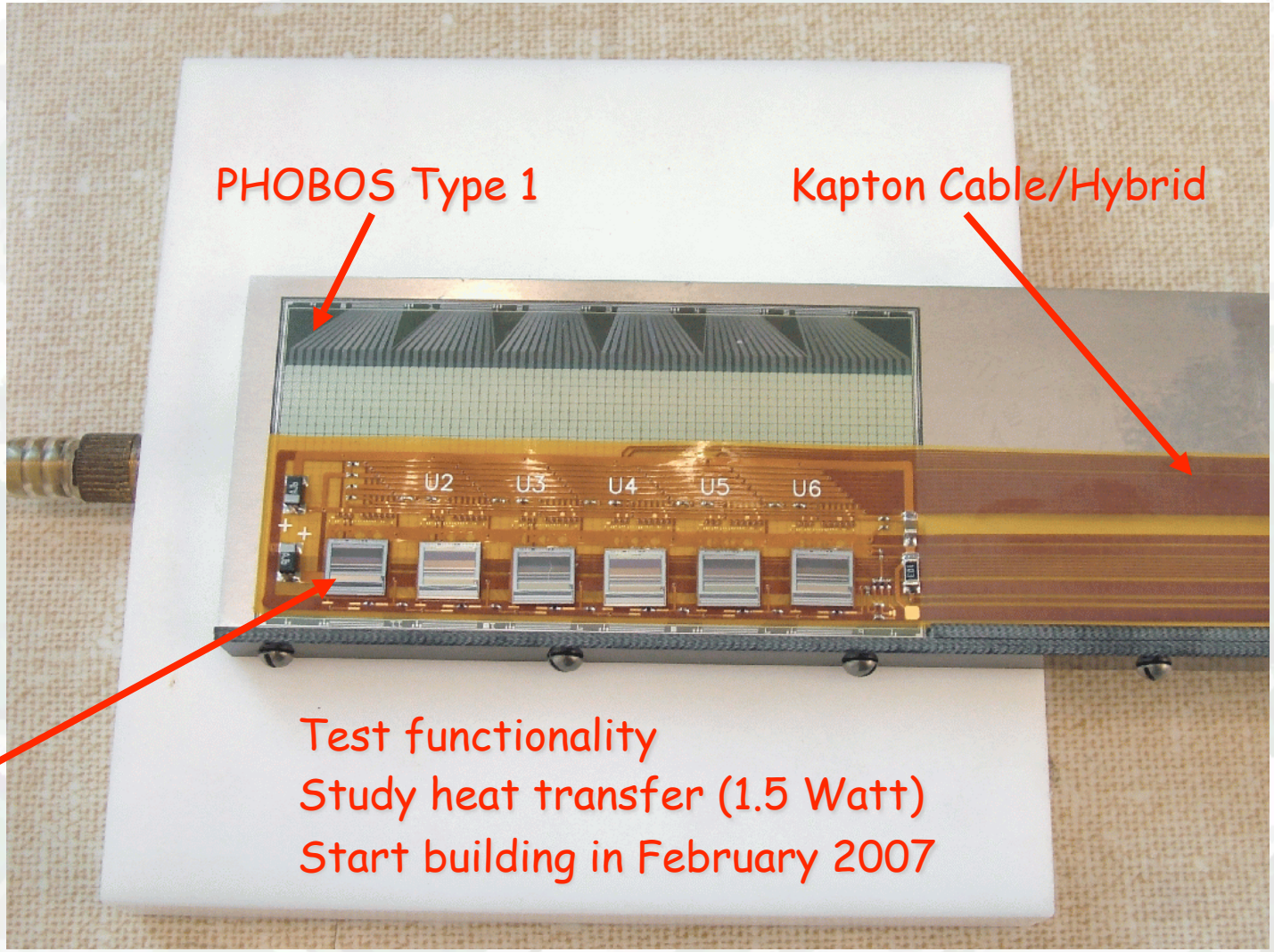




Investigating air cooling

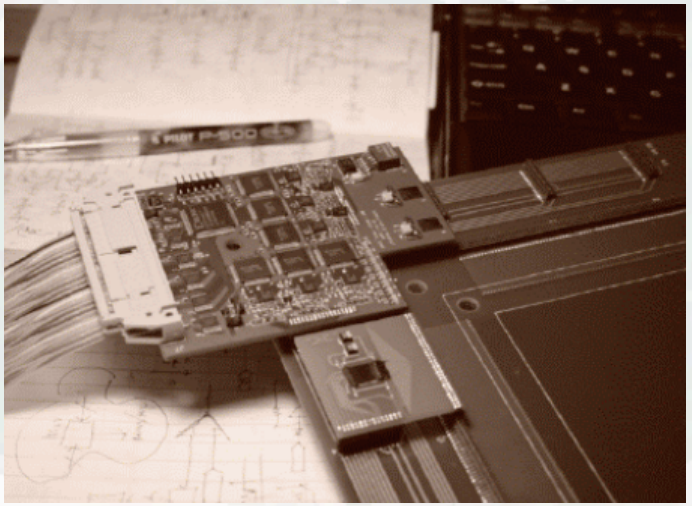
Technical realization

- IST prototype

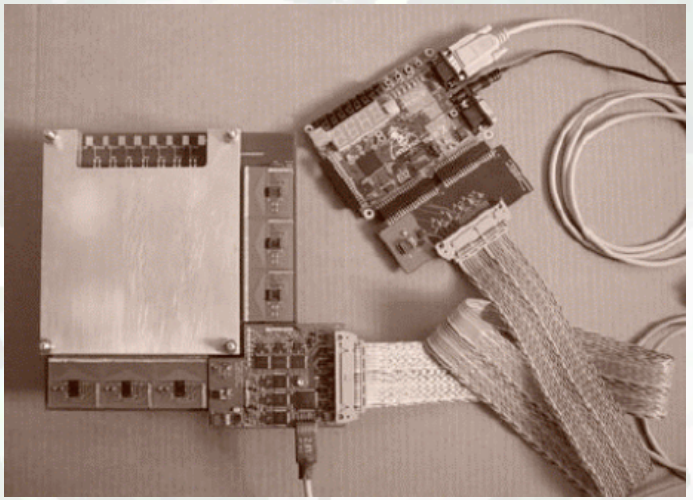


Technical realization

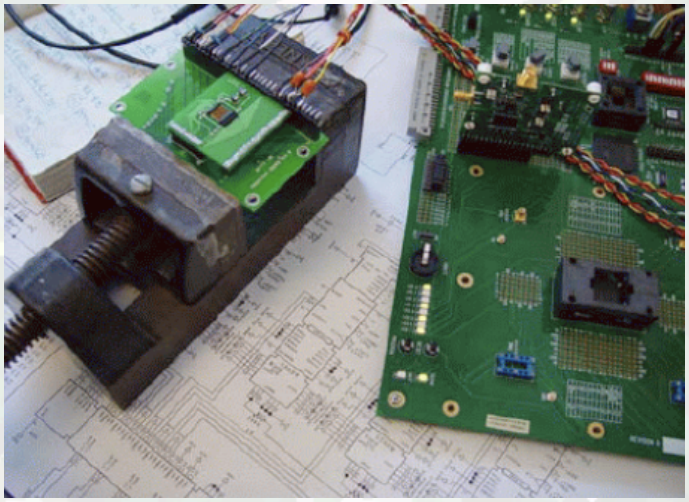
- IST readout system



Readout Controller



Readout Prototype

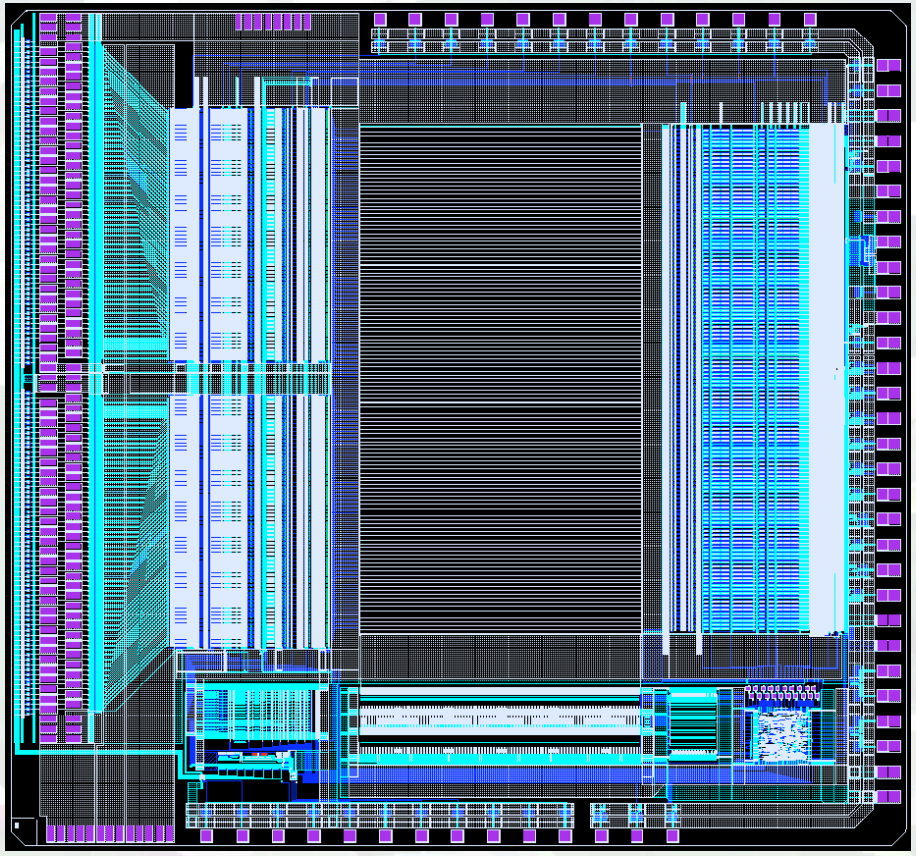


APV25-S1 Module

To be used in IST and FGT (1 readout system)!

Technical realization

- APV25-S1 readout chip



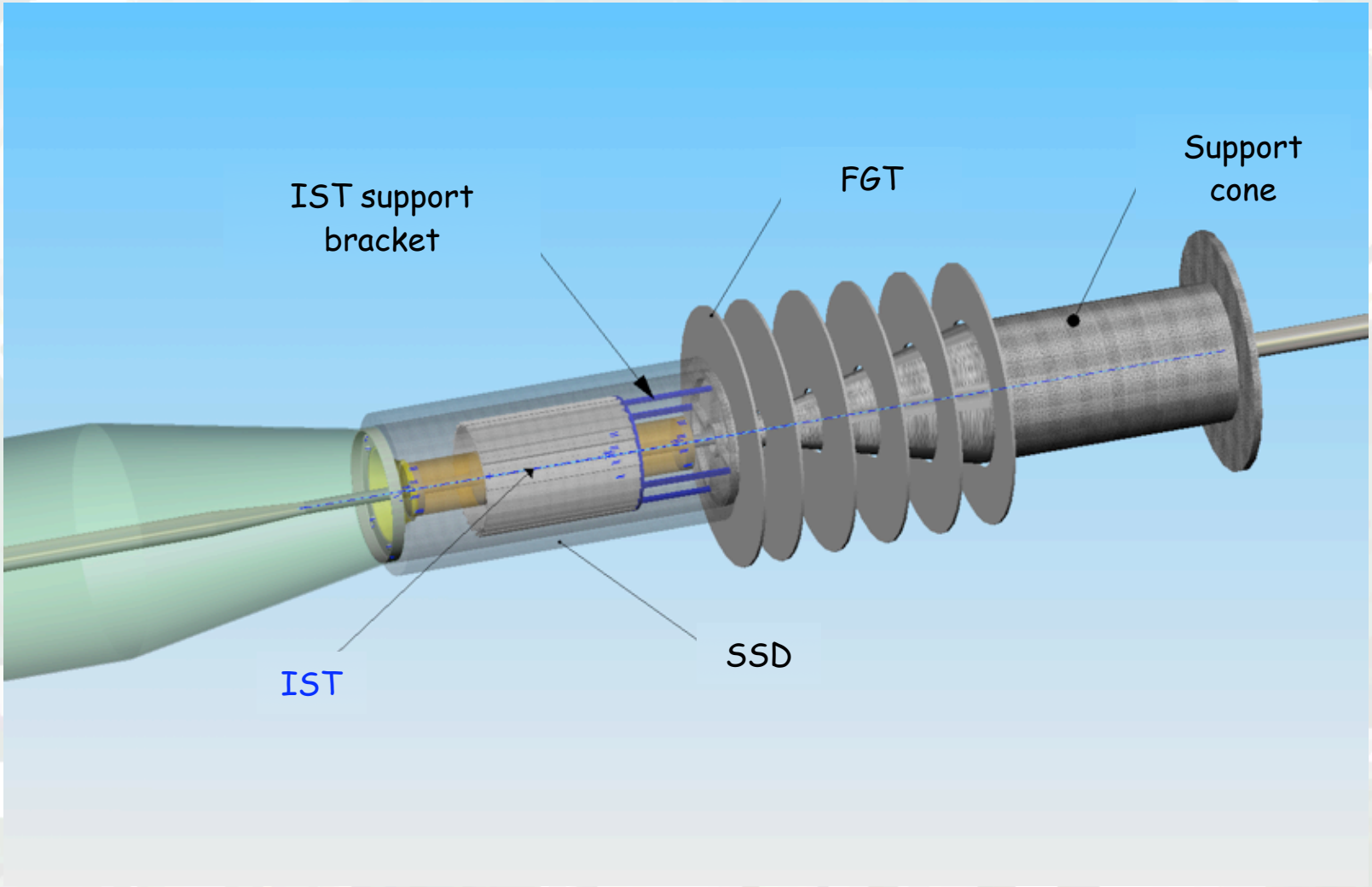
- Developed for CMS

  (75000 in CMS tracker)
- 128 channels
- 40 MHz sampling rate
- 4μs analogue pipeline
- 11:1 Signal / Noise
- 0.25Watt/chip
- 0.25μm CMOS
- Radiation hard

To be used in IST and FGT (1 readout system)!

Technical realization

- Mechanical design - Support structure



R&D plan

- R&D items - 2007
  - The following R&D activities are foreseen in 2007
    - Prototype and test of IST hybrid chip readout system
    - Optimization of IST silicon strip / pad prototype sensors
    - Feasibility study on the usage of light-weight carbon foam material to design IST ladders
    - Feasibility study on the usage of air cooling using prototype
    - Stability of carbon foam material
  - Requested funds: $120k
    - R&D engineering reserach: $75k
    - Readout components (APV25-S1 chip, cables, hybrids): $15k
    - Carbon foam material and air cooling: $30k

R&D plan

- R&D items - 2008
  - The following R&D activities are foreseen in 2008
    - Build IST prototype ladder
    - Investigate performance of IST prototype ladder inside STAR under beam conditions
    - Feasibility study on a zero-suppression system
  - Requested funds: $336k
    - R&D engineering research: $100k
    - Sensor prototypes (Strip/Pads): $68k+$77k = $145k
    - Zero suppression system (Mercury cell system): $66k
    - Test beam prototypes: $25k

Cost estimate

- Assumptions on cost estimate
  - Estimate is based on baseline design
  - The readout system is based on the APV25-S1 chip which is already part of a prototype readout system (PHOBOS expertise at LNS on chip readout systems)
  - Current estimate relies heavily on the PHOBOS experience at LNS gained during the silicon detector design and construction

Cost estimate

Material

	IST1		IST2		
Item	Amount	k$	Amount	k$	Remarks
Strip sensors	263	167	471	297	
Pad sensors	263	736	471	1319	
APV25-S1 chips	2625	93	4713	165	
Carbon foam ladders	26	72	36	132	
Flex cable/hybrid	105	30	218	62	
Control Units	26	43	36	91	
Ribbon cables	26	4	36	6	
LV power supplies	4	39	6	59	
HV power supplies	4	19	6	29	
Subtotal layers		1203		2160	
DAQ				130	
Air cooling				98	
Mechanics				420	
Misc. items				140	
Sub total				788	
Total					4151
Grand total					4525

Spares:

- IST1 (19 ladders + 2 spares)
- IST2 (27 ladders + 2 spares)
- 25% spares: Sensors, readout chips, carbon foam ladders, flex cables/hybrids, control units and ribbon cables

Contingency:

- 20% on catalogue items and 40% on non-standard items

Allocation:

- 9% of Total

Cost estimate

- Mechanical engineering
  - MIT-Bates mechanical engineering division: MIT
- Electronics engineering
  - ANL and MIT-Bates electronics engineering division: ANL / MIT
- Silicon lab
  - LNS Silicon laboratory (PHOBOS production facility): MIT
- Assembly and integration (BNL Physics Department silicon lab): BNL / MIT
- Computing / Software: LBL / MIT
- DAQ integration: ANL / MIT

Cost estimate

- Labor

Institute (6.5)	MIT (4.5)	BNL (2)
Mechanical FTE (3.5) (Engineer / Technician)	1.5 ($300k) / 1 ($100k)	0.5 ($100k) / 0.5 ($50k)
Electrical FTE (3) (Engineer / Technician)	1 ($200k) / 1 ($100k)	0.5 ($100k) / 0.5 ($50k)
Total:	$500k / $200k	$200k / $100k

(1 FTE: 1 Full-Time Employee per year including overhead)

Total: $1300k (With 30% contingency)

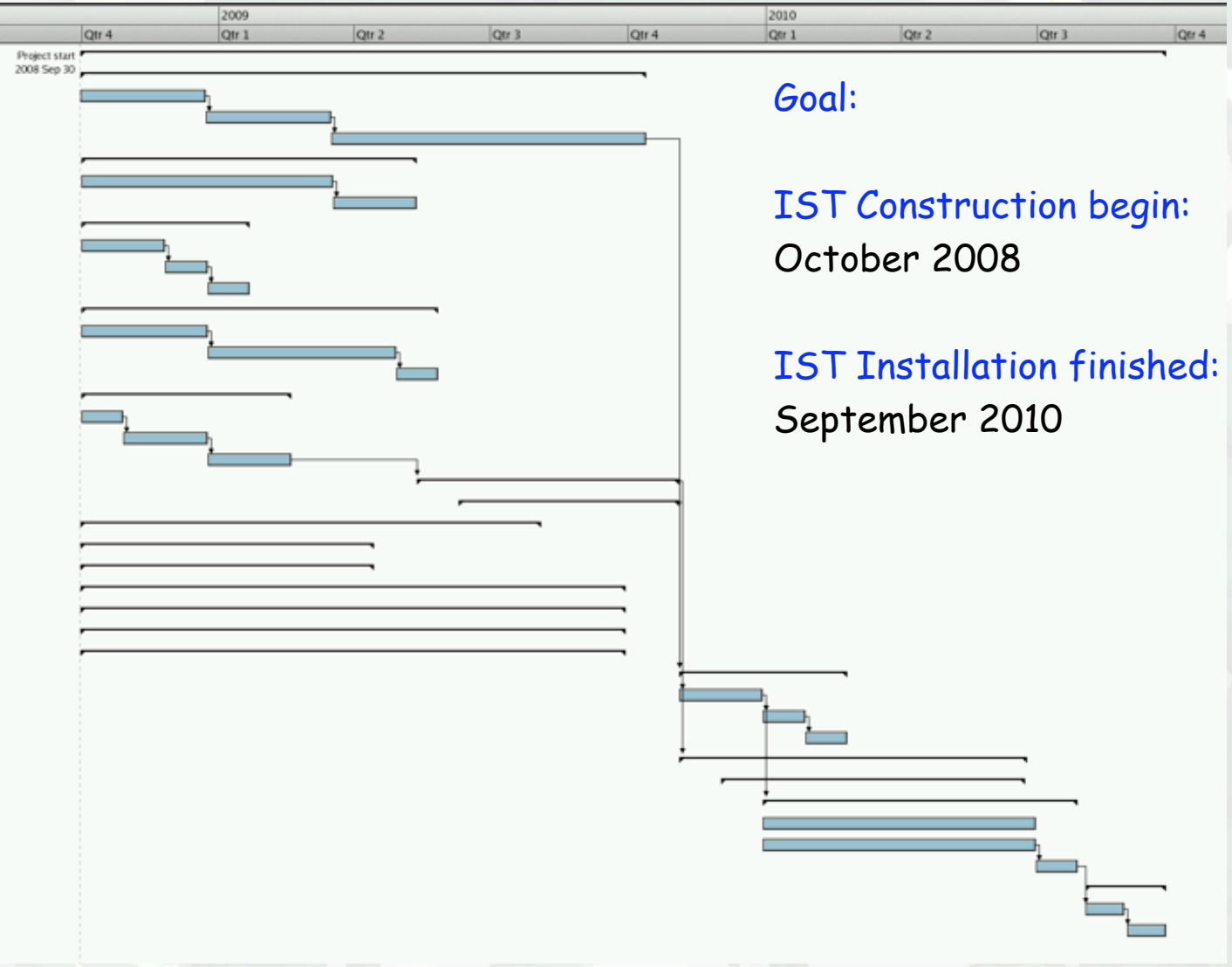
Total IST project cost: Material ($4525k) + Labor ($1300k) = $5825k

(Estimated contributed labor (Not subtracted): 0.5 FTE (Technician)

Schedule

- IST work flow - WBS

WBS	Name
1	**IST Construction**
1.1	**Support structure**
1.1.1	Design
1.1.2	Procurement
1.1.3	Construction
1.2	**Sensors**
1.2.1	Procurement
1.2.2	Testing
1.3	**Readout chips**
1.3.1	Procurement
1.3.2	Dicing
1.3.3	Testing
1.4	**Carbon foam ladders**
1.4.1	Design ladders
1.4.2	Procurement
1.4.3	Inspection
1.5	**Flex cable/hybrids**
1.5.1	Design
1.5.2	Procurement
1.5.3	Testing
1.6	**Assemble hybrids IST1**
1.7	**Assemble ladders IST1**
1.8	**Control Units**
1.9	**LV Power Supplies**
1.10	**HV Power supplies**
1.11	**DAQ system**
1.11.1	**VME system**
1.11.2	**Zero suppression syste**
1.12	**Air cooling system**
1.13	**System integration IST1**
1.13.1	Assembly BNL
1.13.2	Testing
1.13.3	Survey
1.14	**Assemble hybrids IST2**
1.15	**Assemble ladders IST2**
1.16	**System integration IST2**
1.16.1	Assembly BNL
1.16.2	Testing
1.16.3	Survey
1.17	**Installation in STAR**
1.17.1	Installation
1.17.2	Testing



Goal:

IST Construction begin:
October 2008

IST Installation finished:
September 2010