Forward GEM Tracker (FGT)
Technical implementation, Cost, R&D plan, Schedule

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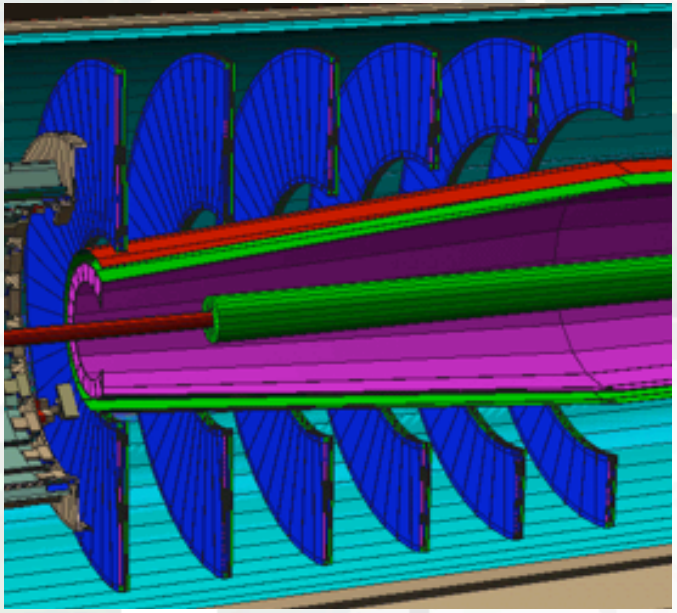
Outline

- Technical realization
- Layout
- Requirements



- R&D plan
- Cost estimate
- Schedule

FGT group

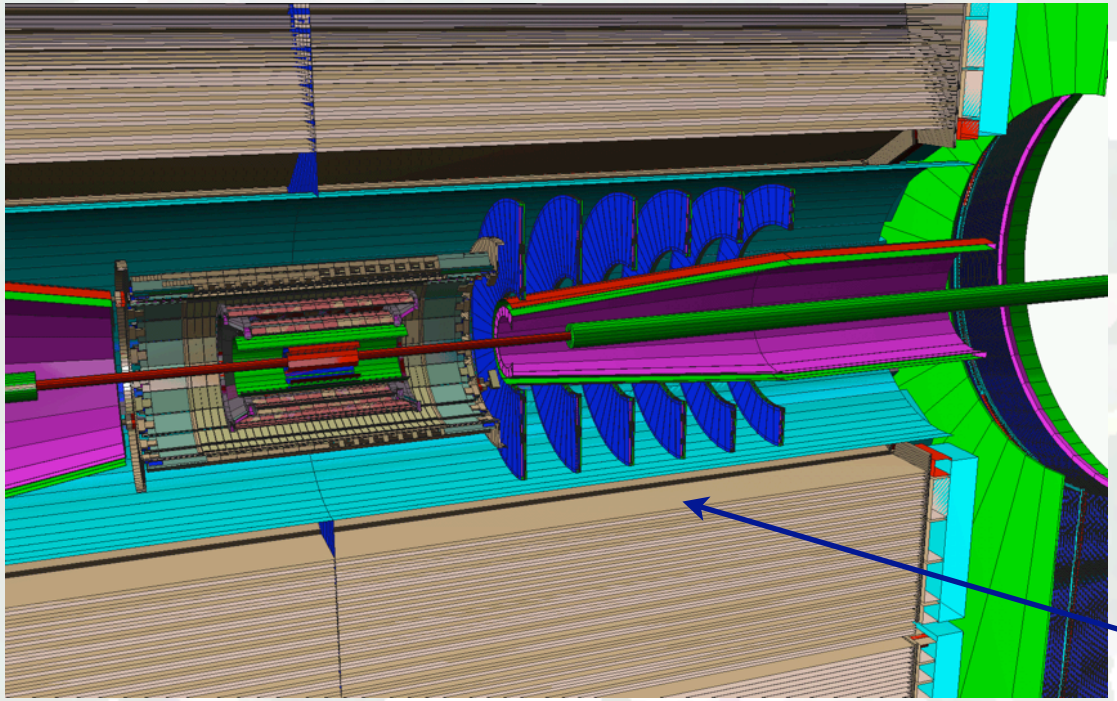
- Institution list
  - Argonne National Laboratory
  - Indiana University Cyclotron Facility
  - Lawrence Berkeley National Laboratory
  - Massachusetts Institute of Technology
  - Valparasio University
  - Yale University

Requirements

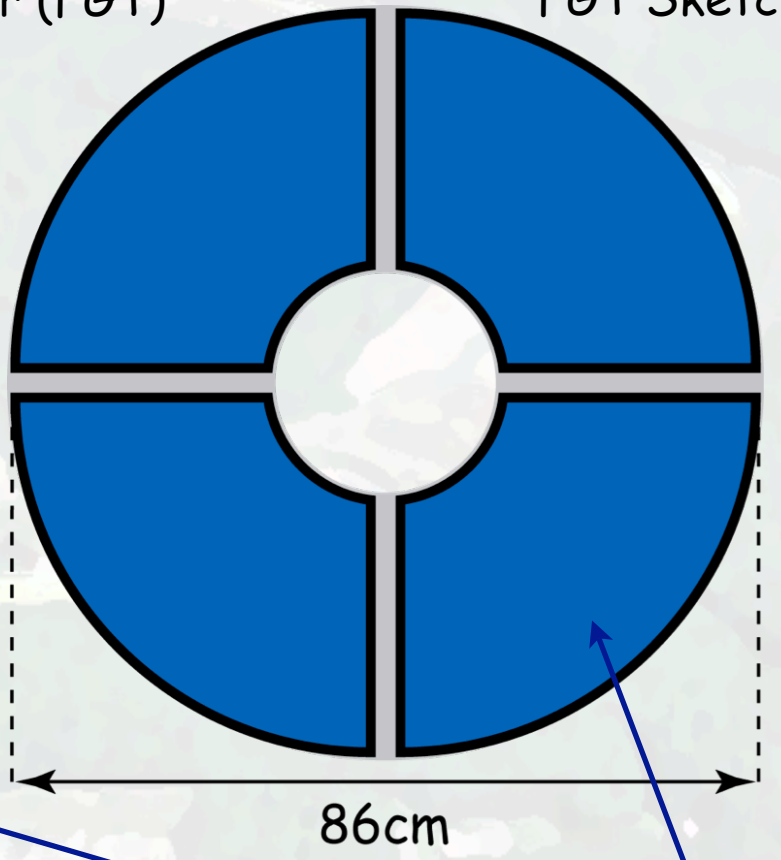
- e^-/e^+ separation for high-p_T tracks in STAR EEMC acceptance ($1 < \eta < 2$)
- Material budget: <10% ($1 < \eta < 2$)
- Rate capability: Handle RHICII peak luminosities for p+p
- Sampling speed: Resolve individual beam bunches (107ns - bunch crossing time)

Layout

- Triple-GEM detector disks: Forward-GEM Tracker (FGT)



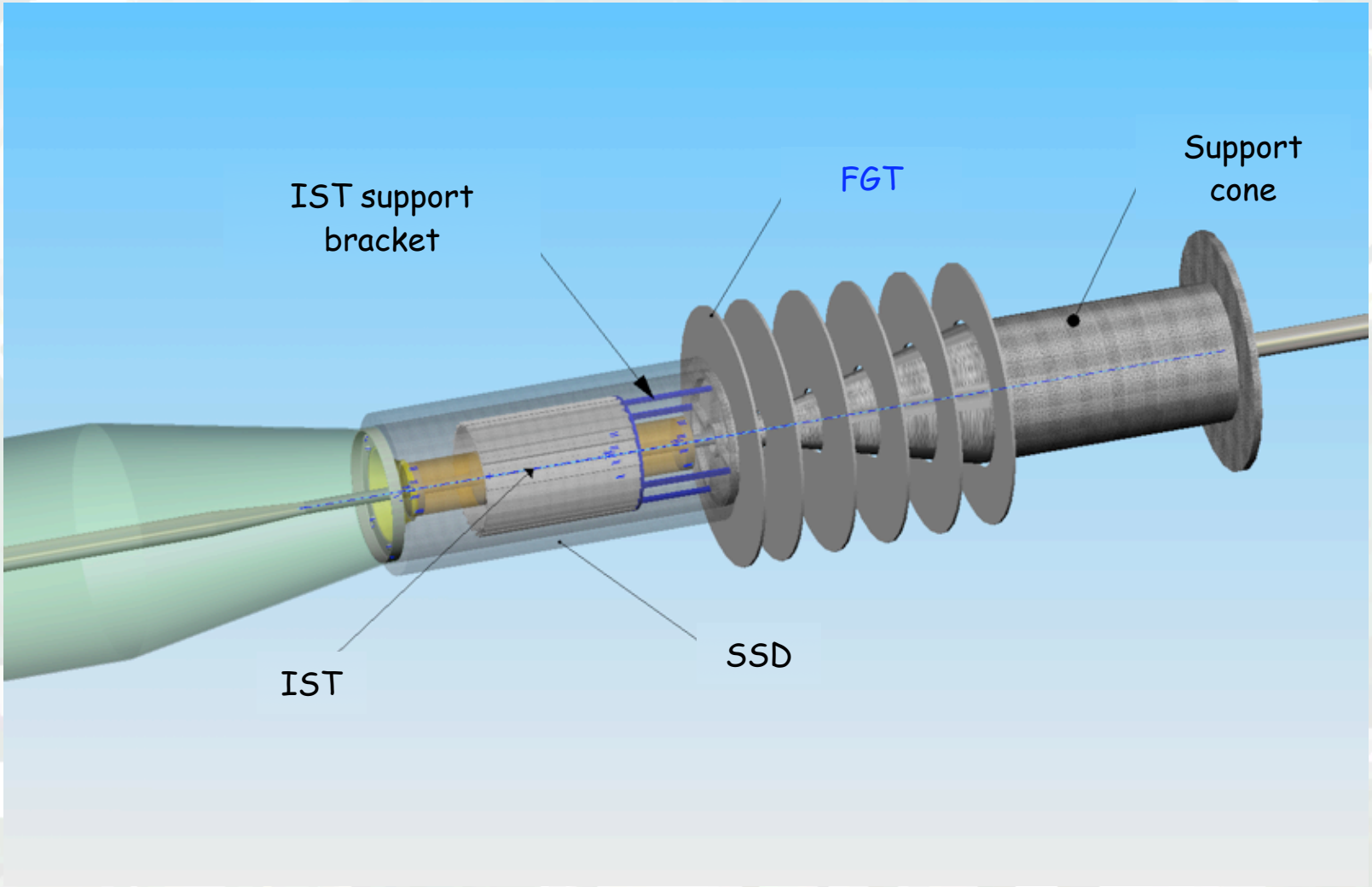
FGT Sketch



- FGT: 6 light-weight disks
- Each disk consists of 4 triple-GEM chambers

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 FGT hybrid chip readout system
    - Feasibility study on the usage of light-weight carbon foam material to design a triple-GEM prototype chamber including support structure
    - Feasibility study on the usage of laser-etched readout board optimized for hit resolution requirement and STAR conditions
    - Explore the usage of air cooling
    - Stability of carbon foam material
  - Requested funds: $120k
    - R&D Engineering research: $75k
    - Readout components (APV25-S1 chip, cables, hybrids): $15k
    - Carbon foam material, air cooling and readout board: $30k and larger GEM foils (SBIR effort)

R&D plan

- R&D items - 2008
  - The following R&D activities are foreseen in 2008
    - Test hybrid chip readout system and STAR DAQ integration
    - Investigate performance of triple-GEM light-weight prototypes on the bench
    - Investigate performance of triple-GEM light-weight prototypes chamber inside STAR under beam conditions
  - Requested funds: $125k
    - R&D engineering research: $100k
    - STAR beam test: $25k

Cost estimate

- FGT cost estimate assumptions
  - 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 collaboration with Tech-Etch Inc. as part of the ongoing SBIR program

Cost estimate

Material

Item	Amount	k$
GEM chamber mechanics	36	51
Readout board	36	51
GEM foils	150	42
APV25-S1 chips	828	29
Flex cable/hybrid	75	21
Control Units	15	8.4
Ribbon cables	15	2.8
LV power supplies	2	20
HV power supplies	2	11
DAQ		200
Air cooling		35
Mechanics		250
Misc. items (Incl. gas system)		70
Total		791
Grand total		862

Spares:

- GEM foils (42/150)
- GEM chamber mechanics (12/36)
- 50% spares: Readout chips, 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
- GEM lab
  - LNS and Yale laboratory: MIT / Yale
- Assembly and integration: MIT / BNL
- Computing / Software: IUCF / LBL / MIT
- DAQ integration: ANL / MIT

Cost estimate

- Labor

Institute (6)	MIT (4)	BNL (2)
Mechanical FTE (3) (Engineer / Technician)	1 ($200k) / 1 ($100k)	0.5 ($100k) / 0.5 ($50k)
Electrical FTE (3) (Engineer / Technician)	1 ($200k) / 1 ($100k)	0.5 ($100k) / 0.5 ($50k)
Total:	$400k / $200k	$200k / $100k

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

Total: $1170k (With 30% contingency)

Total FGT project cost: Material ($862k) + Labor ($1170k) = $2032k

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

Schedule

- FGT work flow (In weeks)
  - Design phase (Support structure / Triple-GEM chambers): 12 weeks
  - Procurement of material: 6 weeks
  - Construction of detector quarter sections: 18 weeks
    - Delivery of 10 GEM foils from Tech-Etch per week
    - Test of GEM foils (Electrical tests, optical scan on flatbed scanner): 0.5 week
    - Test of readout board (Parallel to GEM foil tests): 0.5 week
    - Construction of GEM detectors: Mechanical assembly, foil mounting, testing between each gluing step: 2 weeks
    - Test of assembled chamber: Gas tightness, X-ray test, Gain map: 2 weeks
    - Estimated total construction of one quarter section: 5 weeks
    - Assume: 2 detectors in parallel starting every week
  - Construction of full system: 10 weeks
    - Assemble 6 disks on support frame from 4 quarter sections each: 1 week
    - Assemble electrons and test: 2 weeks
    - Test disk electrons and detectors and full system test (Cosmic ray test): 7 weeks
  - Installation: 3 weeks
  - Integration: 5 weeks

Total: 12 + 42 = 54 weeks

Schedule

- Realization
  - If FGT project is >2M$ DOE line item, construction may begin in October 2008 (FY09) - Installation only in summer 2010
  - If FGT project is <2M$, explore with BNL and DOE if there is any way to accelerate the schedule - Potential for installation before summer 2010
  - RHIC schedule and Beam-Use request is still subject to ongoing discussion - Strong push to start before summer 2010 with 500 GeV CME polarized pp program
  - Ideally: Complete installation of FGT with beginning of 500 GeV CME polarized pp program