Cavity & Cryomodule Fabrication Plans at Fermilab

Tug Arkan

ILC Workshop, Snowmass

8/17/05

Outline

- Goals
- Plans to Accomplish Goals
- Current Status of Work
- Overall Fabrication Strategy
- Conclusion

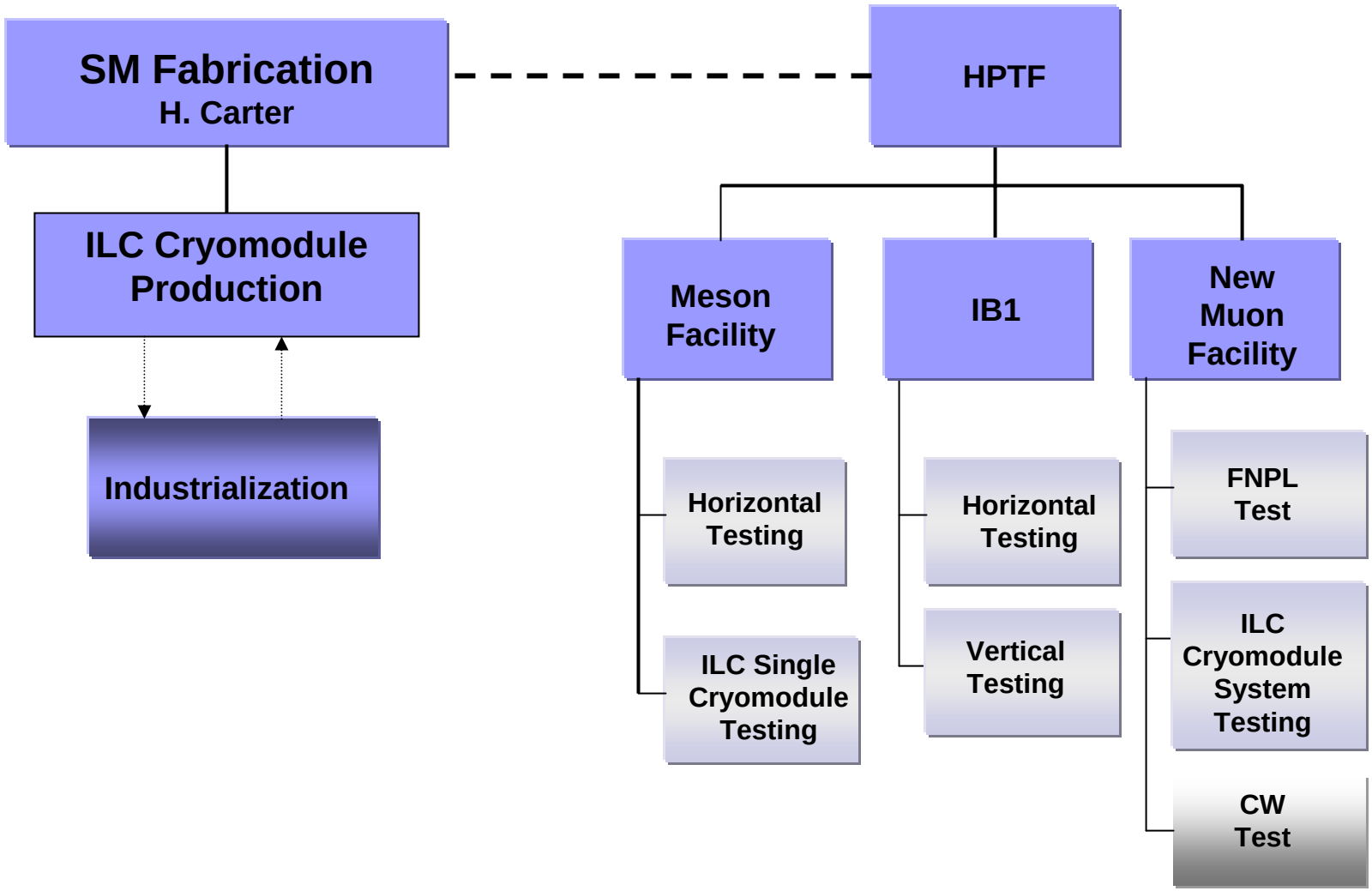
FNAL ILC Goals

- Goals are established and prioritized by FNAL SRFSC
- FY05 goals shown on next slide
- The primary goal is to fabricate sufficient ILC cryomodules within a given period to populate the High Power Test Facility (HPTF)
- Another important goal is the establishment of a substantial R&D effort in cavity fabrication and processing which results a repeatable method of producing cavities which meet the desired accelerating gradient of $\geq$ 35MV/m

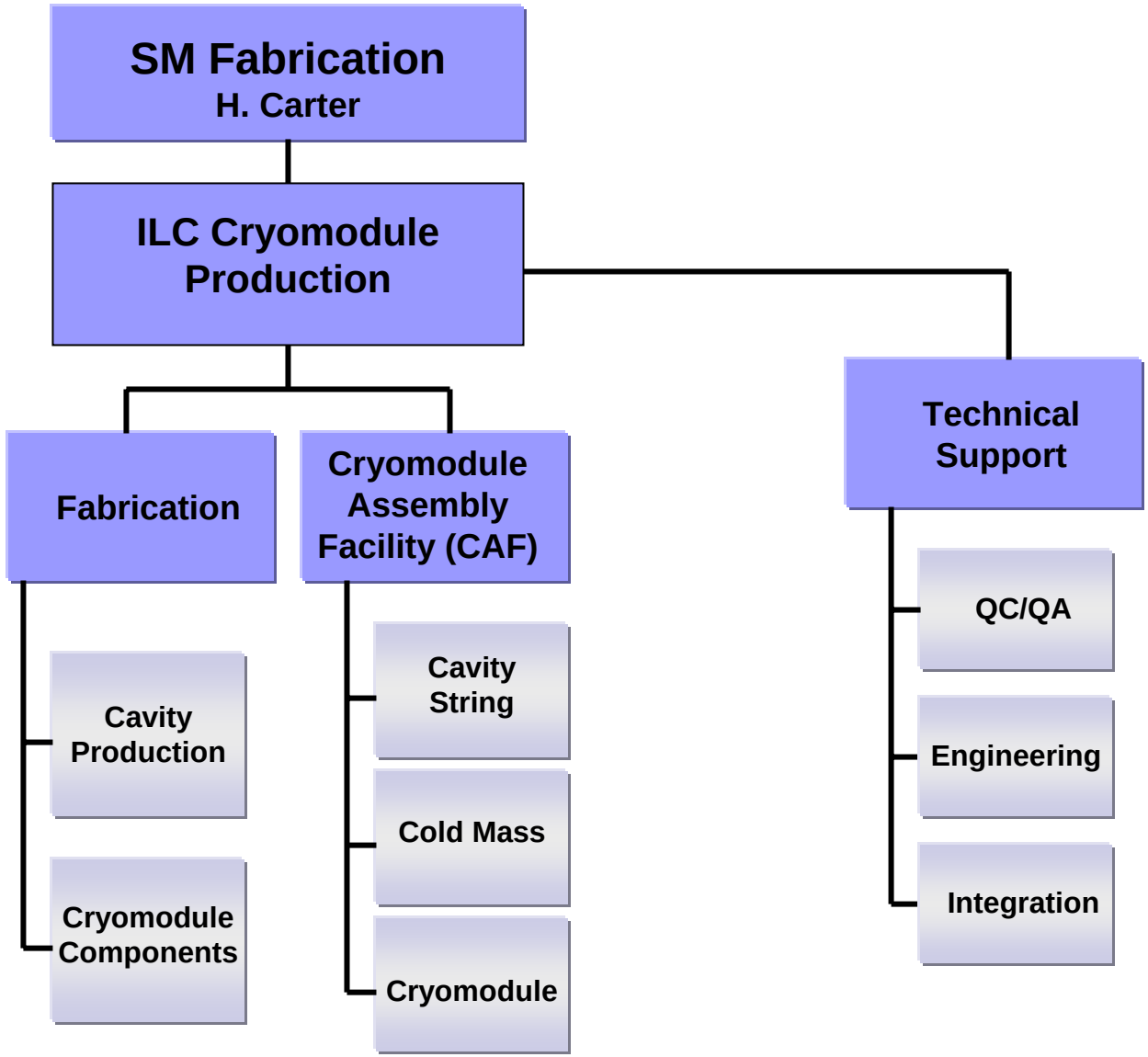
FY05 Goals Established by the FNAL SRFSC (*in support of ILC & HPTF)*

- Design & build Horizontal Test Cryostat (or Chechia vessel)
- Create infrastructure to support 1st U.S. built cryomodule fabrication in FY07
- Complete joint FNAL / ANL BCP facility
- Begin 1.3 GHz cavity industrialization efforts

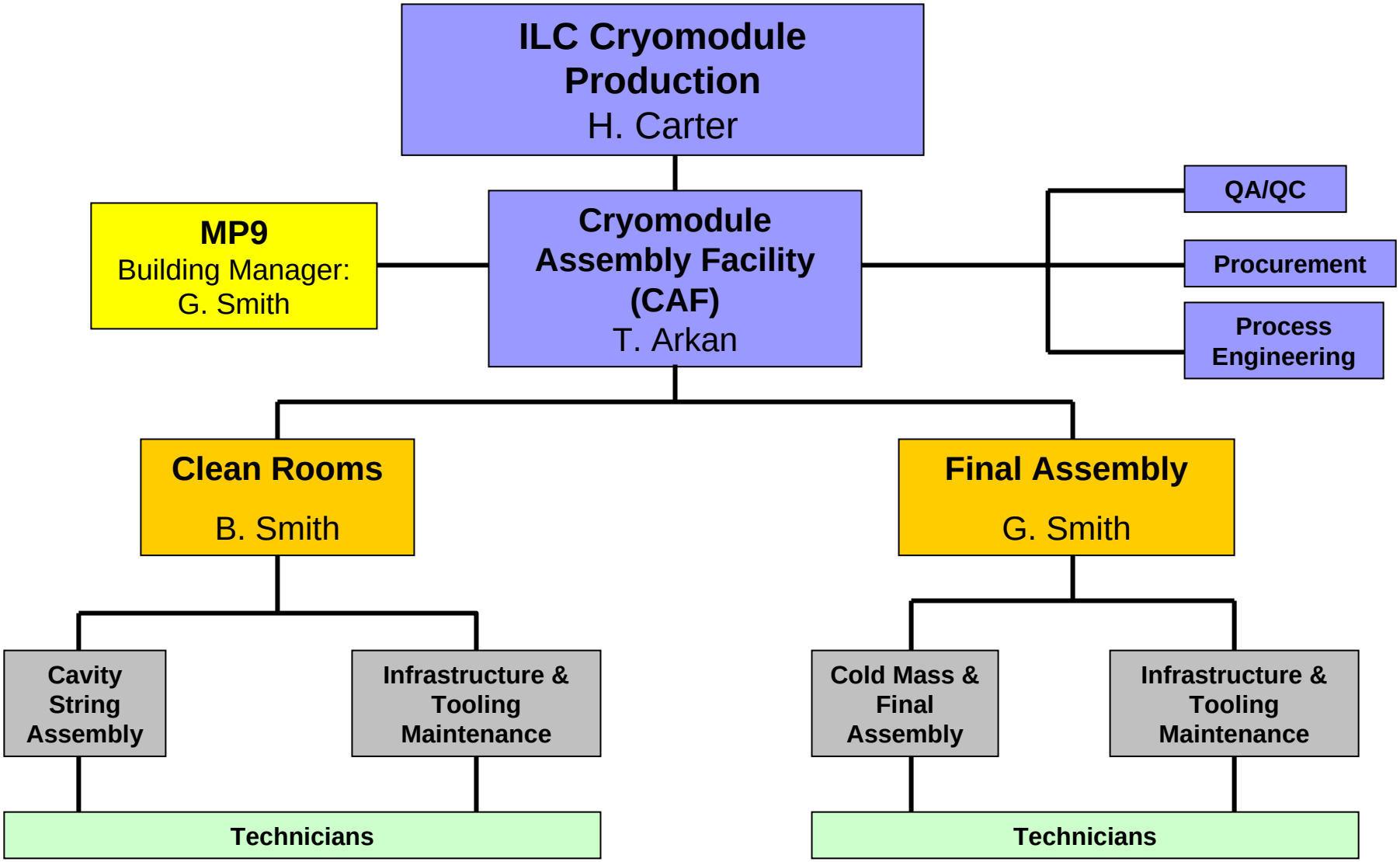
SM Fabrication and Testing: General Organization



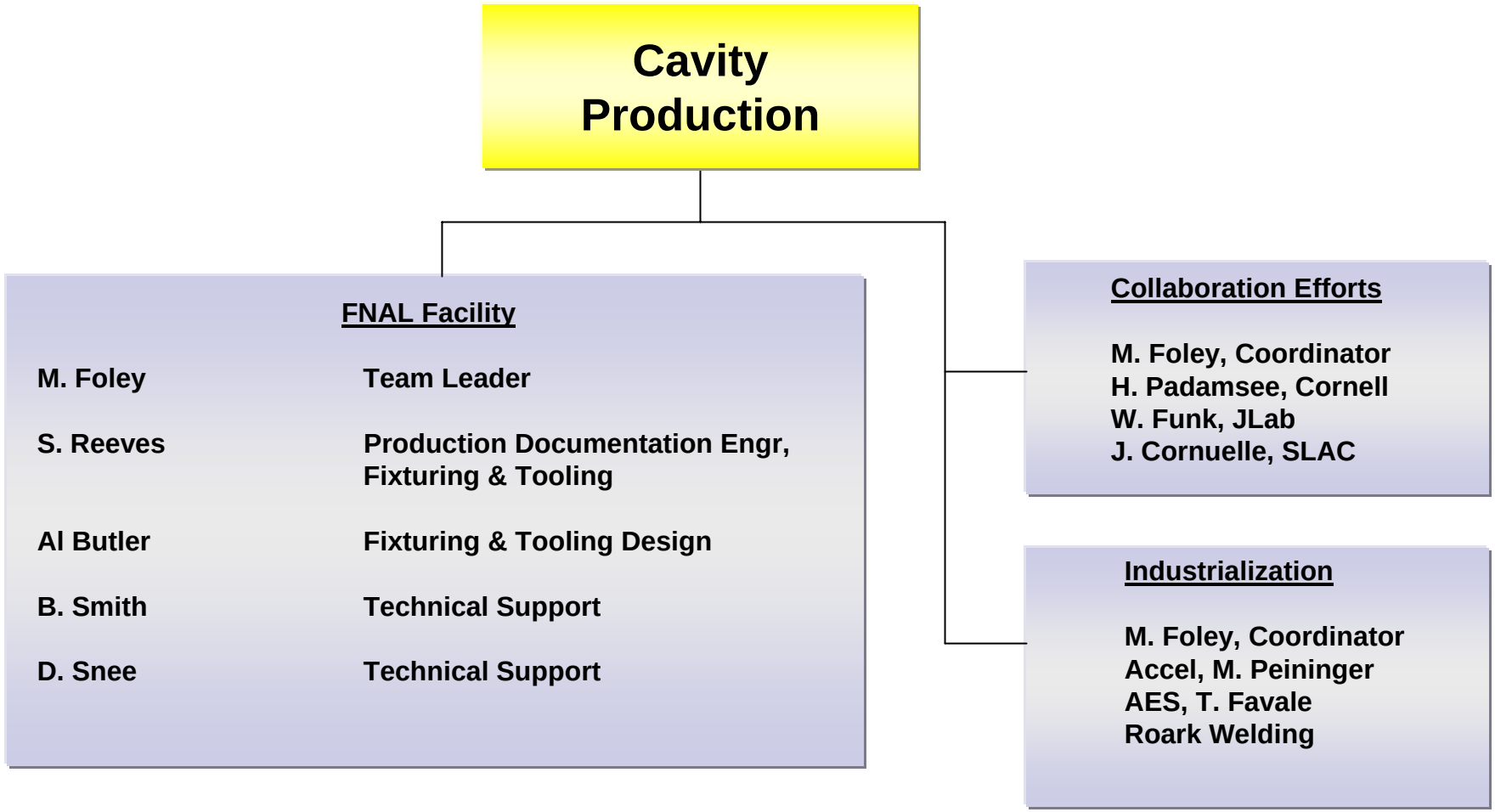
SM Fabrication General Organization



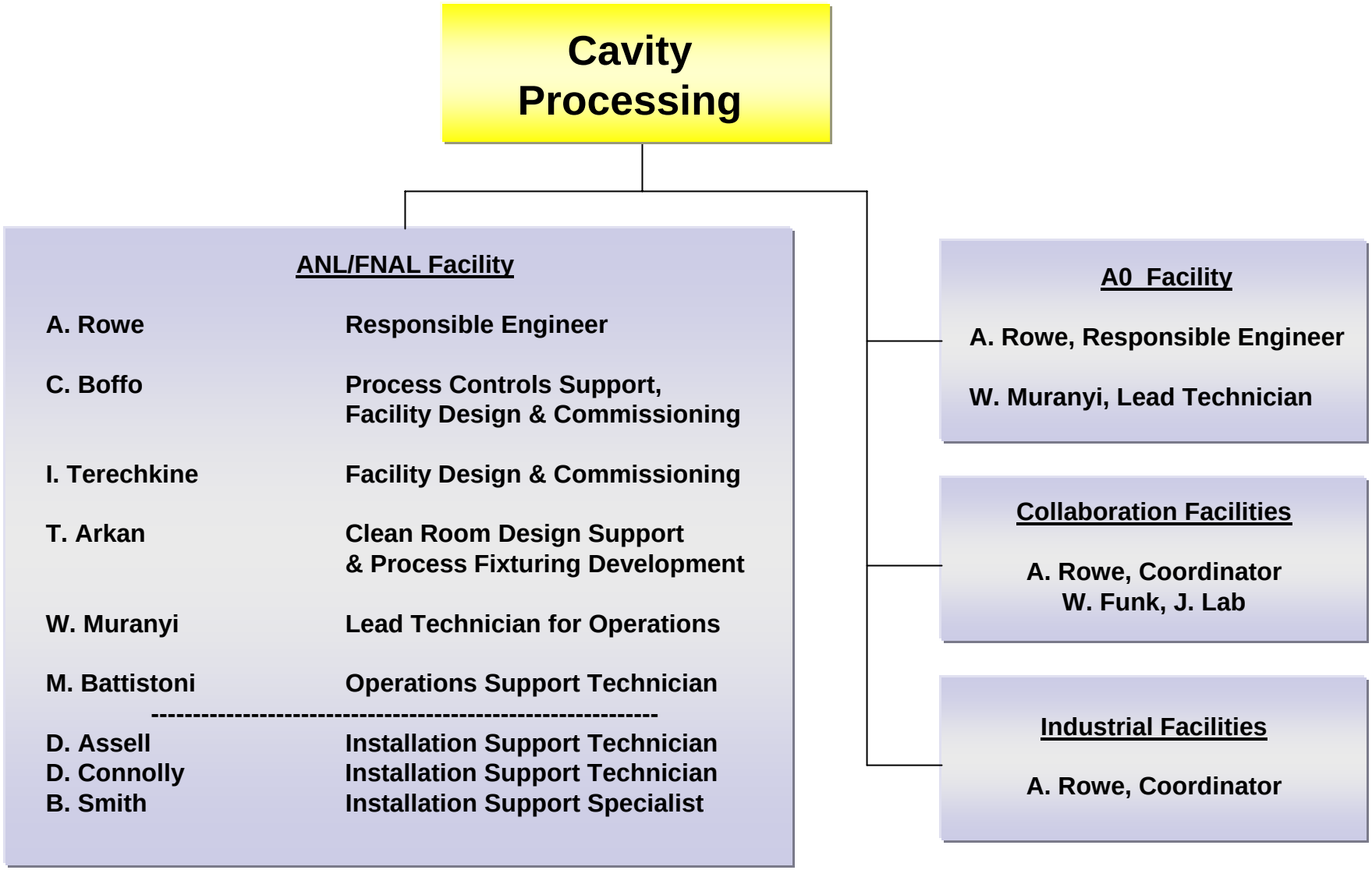
ILC Cryomodule Assembly Organization



Fabrication: Cavity Production Organization Chart



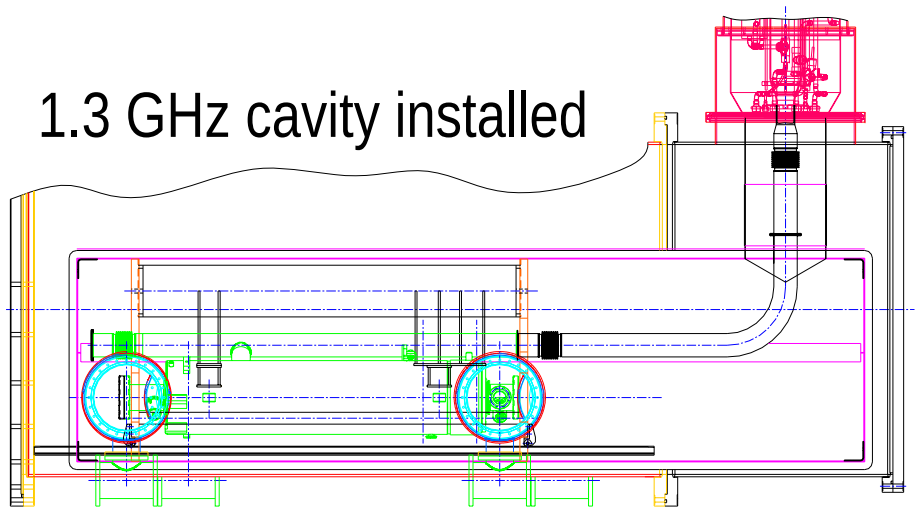
Cavity Processing Organization Chart



Horizontal Test Cryostat (Chechia)

- Required for high power testing of single, dressed cavities
- Design work will be completed in FY05
- Major components will be ordered early in FY06
- Planned to be operational in Spring 2006

1.3 GHz cavity installed

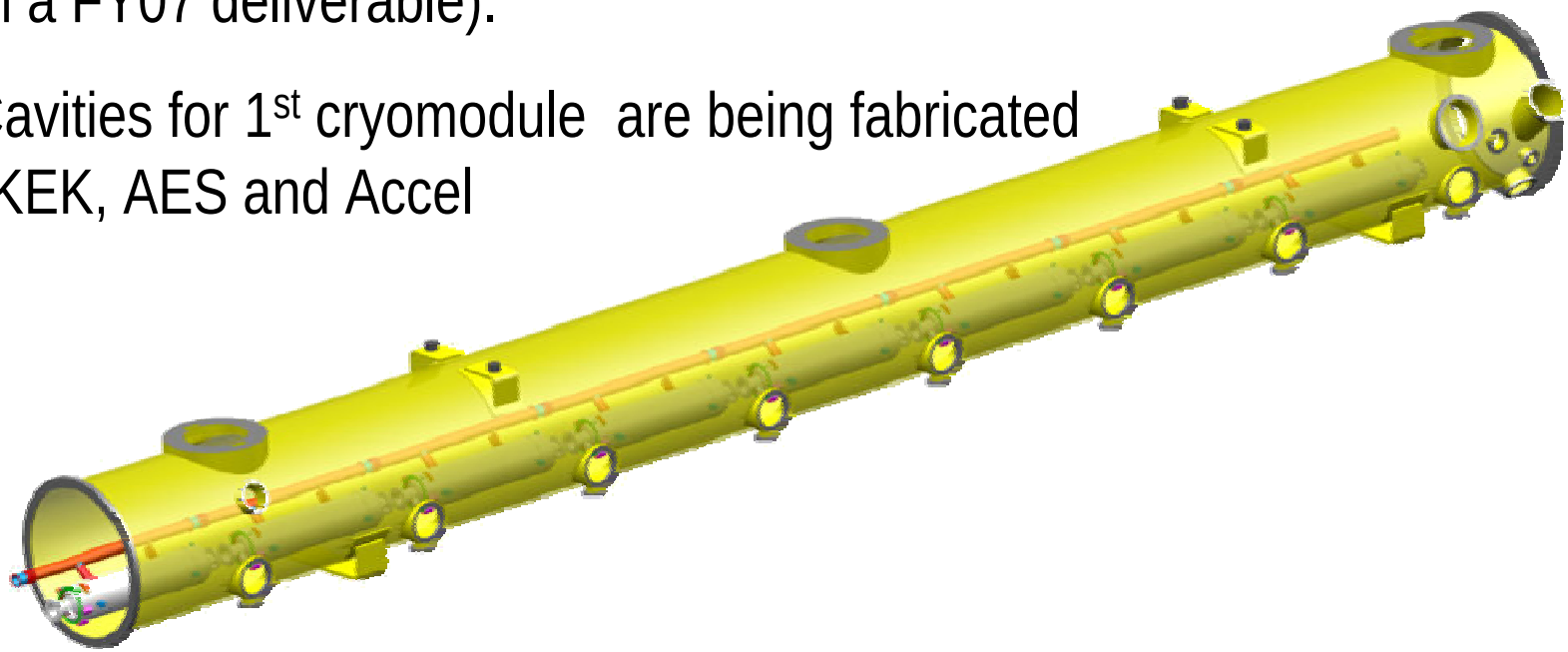


Cryomodule Fabrication Plans

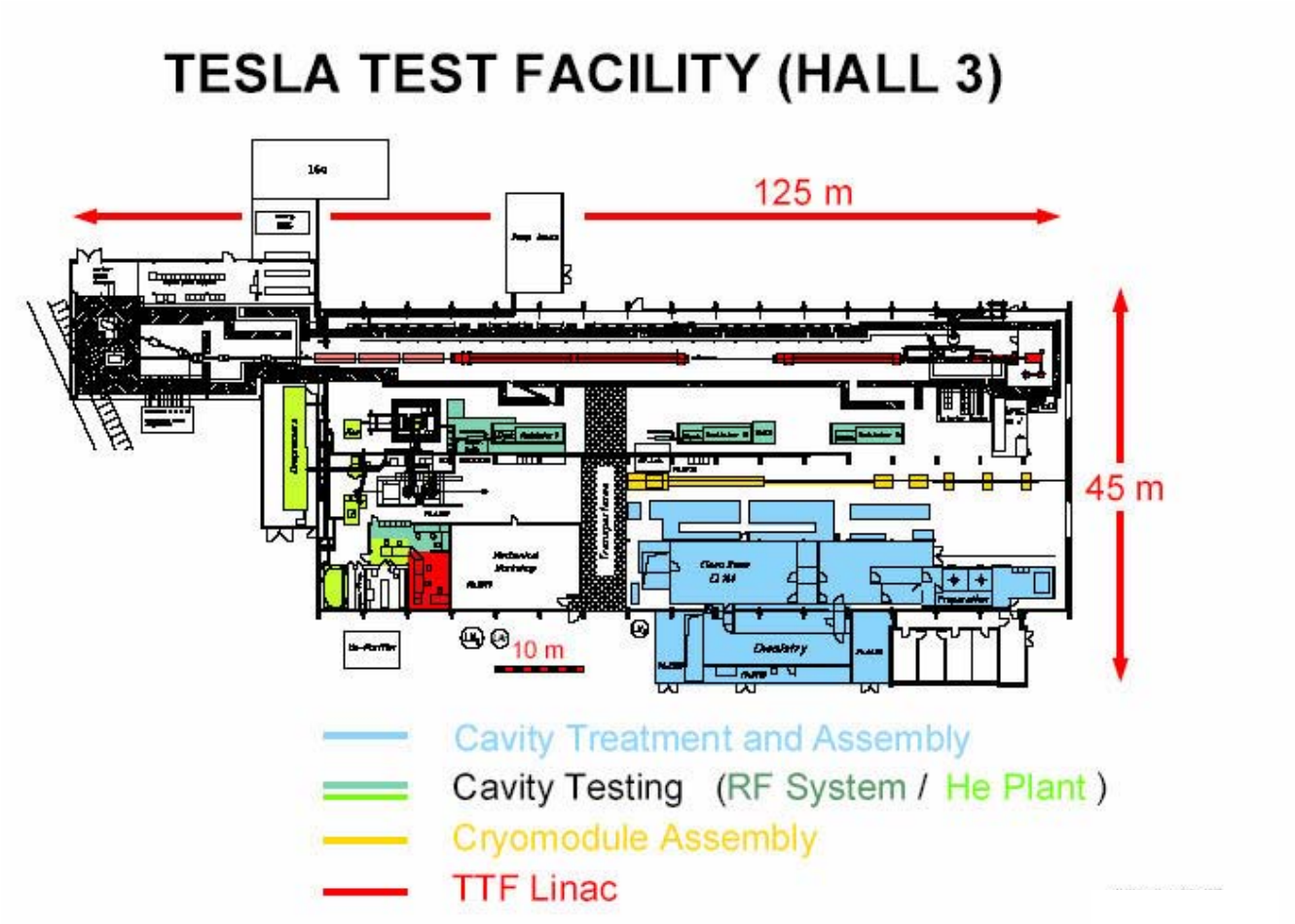
- A plan is being developed to assemble 1.3 GHz Elliptical cryomodules at Fermilab.
- Current plan involves two1.3 GHz (β=1) TTF III+ type cryomodules to be assembled in 2006 and 2007.
- High power RF and Beam testing of these cryomodules will be done on the Fermilab site in the proposed High power test facility (HPTF).
- MP9 building will be used to setup the infrastructure to assemble these cryomodules (CAF).
- There has been considerable discussion within ILC regarding the need for a 4th generation cryomodule.
  - Quadrupole package at the center
  - Quadrupole package as a separate unit
- Starting from FY08, next generation (Type IV) cryomodules will be assembled at Fermilab.

Support Infrastructure for 1st U.S. Built Cryomodule

- A 3-D model of the TTF 1.3 GHZ Cryo3+ Vessel has been created.
- Preparation of "Americanized" drawings is in progress (consistent with a FY07 deliverable).
- Cavities for 1st cryomodule are being fabricated by KEK, AES and Accel



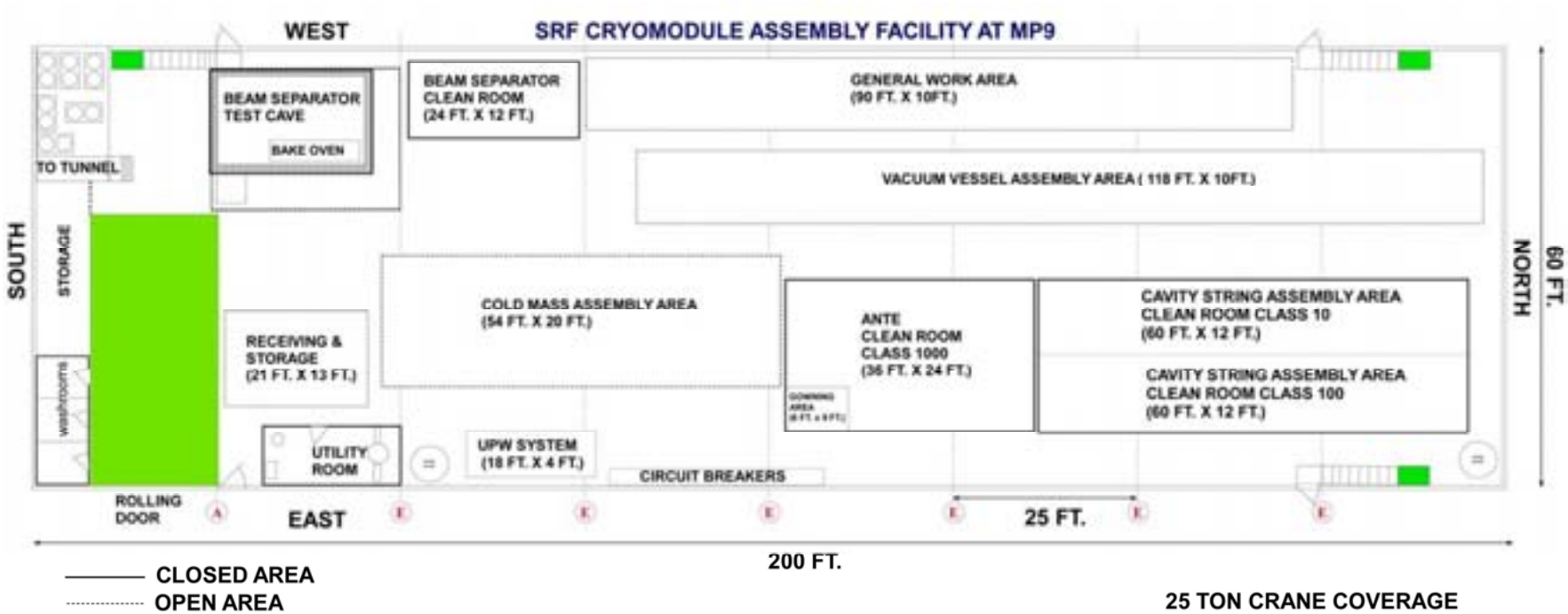
Support Infrastructure for 1st U.S. Built Cryomodule: MP9 Cryomodule Assembly Facility (CAF) Development



A facility layout based on DESY's Hall 3 facility is planned

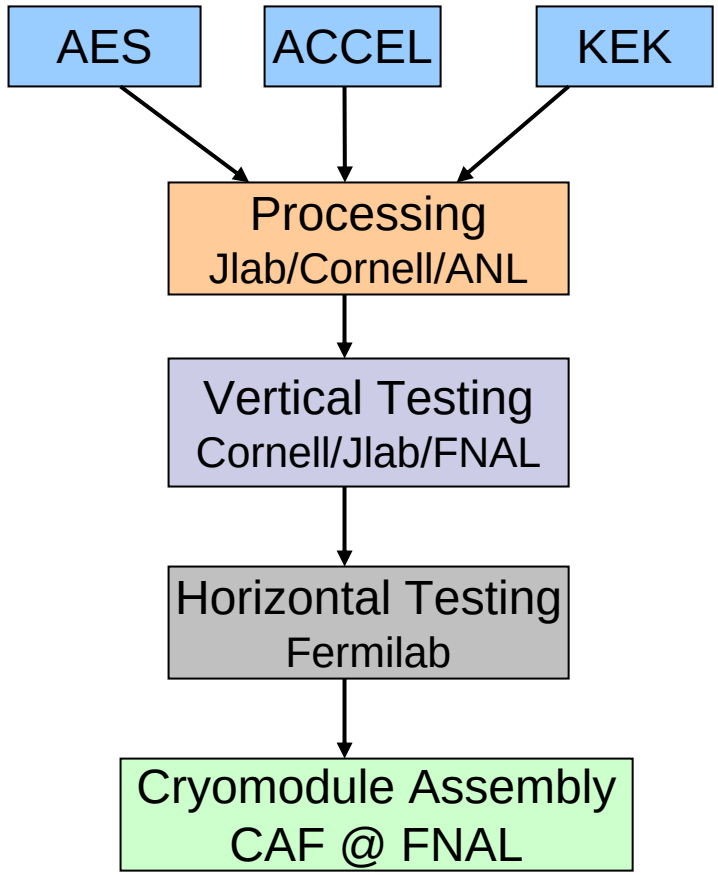
Support Infrastructure for 1st U.S. Built Cryomodule: MP9 Cryomodule Assembly Facility (CAF) Development

- Tevatron Separator Work at MP9 ends this Fall (~Nov. 2005)
- Building is sufficiently sized for small scale mass production rate quantities (1 per month)



Cryomodule Assembly Plans in FY06 & FY07

- Assumptions for the assembly of two 1.3 GHz Elliptical cryomodules in FY06 & FY07: *(R&D production rate)*
  - SRF bare cavities are fabricated in industry. (Form/machine parts, electron beam welding)
  - Cavities are processed (tuned for field flatness, baked, chemical etched {BCP and/or electro-polished}, high pressure water rinsed and vertical dewar tested).
  - Cavities are outfitted with helium vessel and input power coupler and further dressed (tuner, magnetic shielding) for the horizontal dewar test.
  - It is assumed that these steps (processing & dressing) are carried out elsewhere (collaborating laboratories, universities).
  - After passing horizontal dewar test, the cavity with helium vessel and cold part of the input coupler is shipped sealed to the CAF.
  - The sealed cavities with cold input coupler are received at the CAF for incorporation into cryomodules. 8 dressed cavities are assembled into a string at CAF clean rooms. The cavity string is then assembled into cold mass. Cold mass is then inserted into vacuum vessel and the cryomodule assembly is complete.



Work Flow at CAF

Receive dressed Cavities

Receive peripheral (vacuum vessel, cryogenic pipes, super-insulation etc.) Cryomodule Parts

Assemble dressed Cavities to form a String in the **Cavity String Assembly Area** (Clean Room)

Install String Assembly to Cold Mass in the **Cold Mass Assembly Area**

Install the String assembly with the cold mass into the Vacuum vessel in the **Vacuum Vessel Assembly** area

Ship completed cryomodules to **HPTF**

Cryomodule Testing at **HPTF**

pass

fail

Cyomodule production is successful

Send the Cryomodule back for repair

Cryomodule Repair (assumes one or more cavities must be replaced)

-Disassemble the module

-Disassemble the string in the Clean Room

-Install a new dressed cavity to the string

Cavity Repair

MP9 Cryomodule Assembly Facility Development

MP9 Building inside views

Beam Separator work at MP9 will be completed by the end of November 2005

Floor space is being cleaned up and prepared for Cavity String Assembly Clean Rooms

CAF Infrastructure Procurement Plans

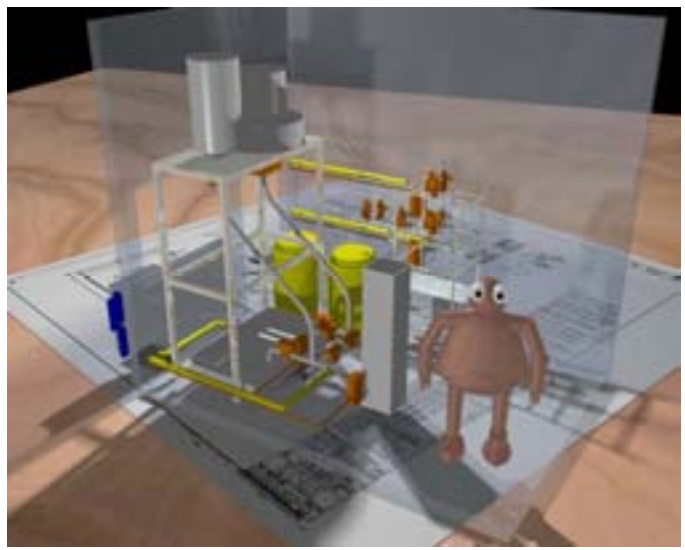
- **FY05:**
  - Elliptical cavity string assembly clean rooms
  - String Assembly & Transport Rail System
  - 1.3 GHz elliptical cryomodules cold mass to string assembly fixture
  - 1.3 GHz elliptical cryomodules cold mass to vacuum vessel assembly fixture
- **FY06:**
  - Elliptical cavities string assembly fixtures
  - Clean room equipment
  - Portable clean rooms
  - Miscellaneous fixtures

CAF Cavity String Assembly Clean Rooms

- We are working with a consultant. Specs were developed through discussions with DESY and feedbacks by the consultant.
- Contract has being awarded to Luwa USA Inc.
- **Design Phase**
  - Award Contract to Luwa (August 05)
  - Design Start Preparation meeting with Luwa at FNAL (September 05)
  - Preliminary & detailed engineering at Luwa (October 05)
  - FNAL lab wide design review (November 05)
  - Parts procurement at Luwa (February 06)
- **Construction Phase**
  - Clean the floor space at CAF (August 05)
  - Survey the floor space at CAF (September 05)
  - Procure cavity string assembly rail (October 05)
  - Install cavity string assembly rail at CAF (November 05)
  - Start Clean room construction at CAF by Luwa (December 05)
  - Complete Clean room construction (March 06)
- **Testing & Acceptance Phase**
  - Clean room testing preparation (March 06)
  - Conduct acceptance testing (March 06)

Joint FNAL/ANL BCP Facility

- Design, construction, and test operation (using water) of FNAL system completed. System now at ANL and ready for installation in the newly constructed room inside Building 150.
- FNAL safety review of system completed. A complete ANL safety view will be conducted once the system is installed there.
- Design of 1.3 GHz etching jackets are under progress.
- Infrastructure tooling and fixturing development to support 1.3GHz cavity etching is underway.
- Facility is scheduled for completion and initial operations by February 06.



Overall Fabrication Strategy

- Infrastructure Development:
  - Utilize as much existing engineering designs for fixturing, tooling, processes and procedures to establish facilities at Fermilab as quickly as possible
  - Utilize existing facilities at collaborating institutions and laboratories
- Cavity Development:
  - Utilize available resources for cavities for first cryomodule (KEK, ACCEL, AES, DESY, et. al.)
  - Work with laboratories and universities (JLab, SLAC, Cornell, ANL, DESY, etc.) to develop cavity fabrication and processing capability and to develop processes and new techniques
- Coupler Development:
  - Utilize available resources for couplers for first cryomodules (CPI)
  - Develop new, simpler designs with cost reduction and manufacturability as prime goals

Overall Fabrication Strategy (Cont.)

- Cryomodule Development:
  - The first U.S. built cryomodule will be of the TESLA Type III+ design
  - The DESY supplied 8 cavities will be of the TESLA Type III+ design
  - Type IV (ILC Prototype?) cryomodule development will proceed while the first two cryomodules are being assembled
- Industrialization:
  - Identify potential suppliers of cryomodule components and initiate discussions with them
  - Conduct informational meetings or workshops with industry
  - Establish R&D efforts with interested, “qualified” candidates ($$$$$)
  - Work with known component vendors to improve manufacturability and reduce costs

Conclusions

- We are making very good progress on our FY05 goals
- Infrastructure development to support 1.3GHz cryomodule fabrication is well underway
- "Deliverables" to the ILC GDE:
  - Development of cavity processing that repeatably achieve 35MV/m accelerating gradient (tight-loop processing)
  - First U. S. cryomodule will be utilized for development of assembly techniques and infrastructure
  - Development of the next generation (Type IV) ILC Cryomodule
- A strategic approach for cryomodule production and testing that makes use of existing capabilities within the national laboratories and universities has been presented
- Industrialization is only beginning at this time. Initial efforts are with cavity manufacturing companies, both in the United States and in Europe