

Cavity Processing Facility

**Harry Carter, Tug Arkan, Cristian Boffo,
Dan Olis and Allan Rowe**

Fermilab Technical and Accelerator Divisions

Outline

- **Establishing the Need for this Facility**
- **Process Definition**
- **Cavity Processing Facility (CPF) Scope and Infrastructure Requirements**
- **CPF Cost Estimate**
- **CPF Schedule**
- **Conclusion**

Goals for SRF Infrastructure: CPF

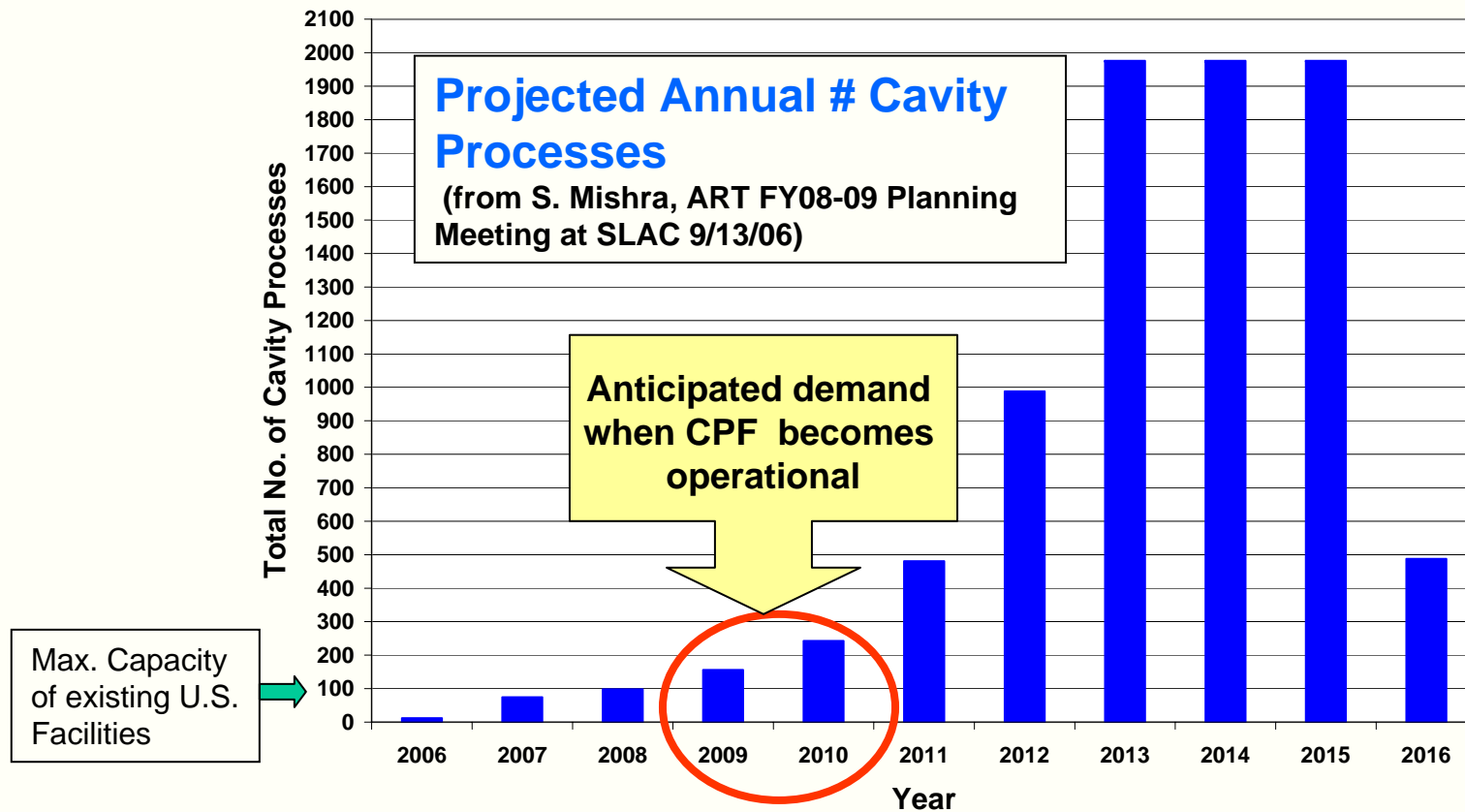


- To perfect U.S. fabrication & processing of SRF cavities and modules and to demonstrate performance with a full range of testing (including beam)
 - Deploy ILC design / processing / assembly techniques ←
 - Establish process controls to reliably achieve high gradient cavity operation and module performance ←
 - Test cavities and modules at the component level and in a systems test to demonstrate yield, reproducibility and beam performance
- To facilitate commercial production of SRF components and modules ←
 - Train and transfer SRF technology to the US industry
 - Allow industrial participation and input to the process
 - Similar to SC cable and magnet technology transfer
- To participate in SRF Research and Development
 - Develop expertise in SRF technology and provide training base for construction and operation of future accelerators
 - Our attempt to fit into the world's SRF community

All of this work will be carried out with US/international collaboration

Establishing the Need for this Facility

- Existing U.S. capability is insufficient to meet the anticipated demand---as demonstrated in Shekhar's talk



US Laboratories Capacity



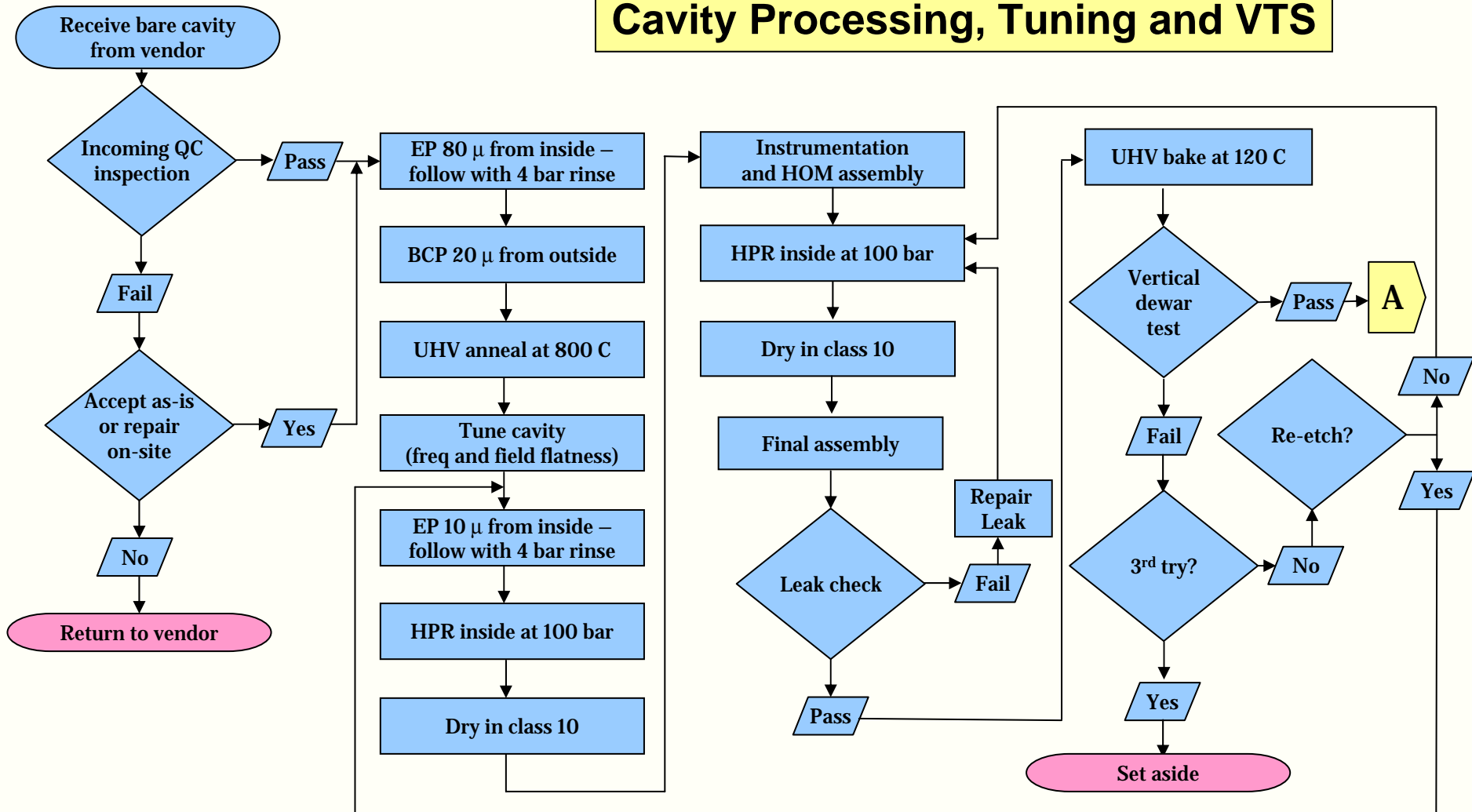
Program	FY07	FY08	FY09	FY10	Capacity Needed/yr by FY10
Cavity Processing (EP, HPR, Bake)	Jlab-30 Cornell-10	Jlab-40 Cornell-10 ANL-40	Jlab-40 Cornell-10 ANL-40 Fermilab-20	Jlab-40 Cornell-10 ANL-40 Fermilab-100	200
Vertical Testing	Jlab-30 Cornell-10 Fermilab-20	Jlab-40 Cornell-10 Fermilab-75	Jlab-40 Cornell-10 Fermilab-75	Jlab-40 Cornell-10 Fermilab-200	200
Horizontal Testing	Fermilab-6	Fermilab-24	Fermilab-24	Fermilab-72	72
Cryomodule Assembly	Fermilab-1	Fermilab-4	Fermilab-12	Fermilab-12	12
Cryomodule Test	Fermilab: ILCTA_NML	Fermilab: ILCTA_NML	Fermilab: ILCTA_NML	Fermilab: ILCTA_NML CMTS	12

Process Definition

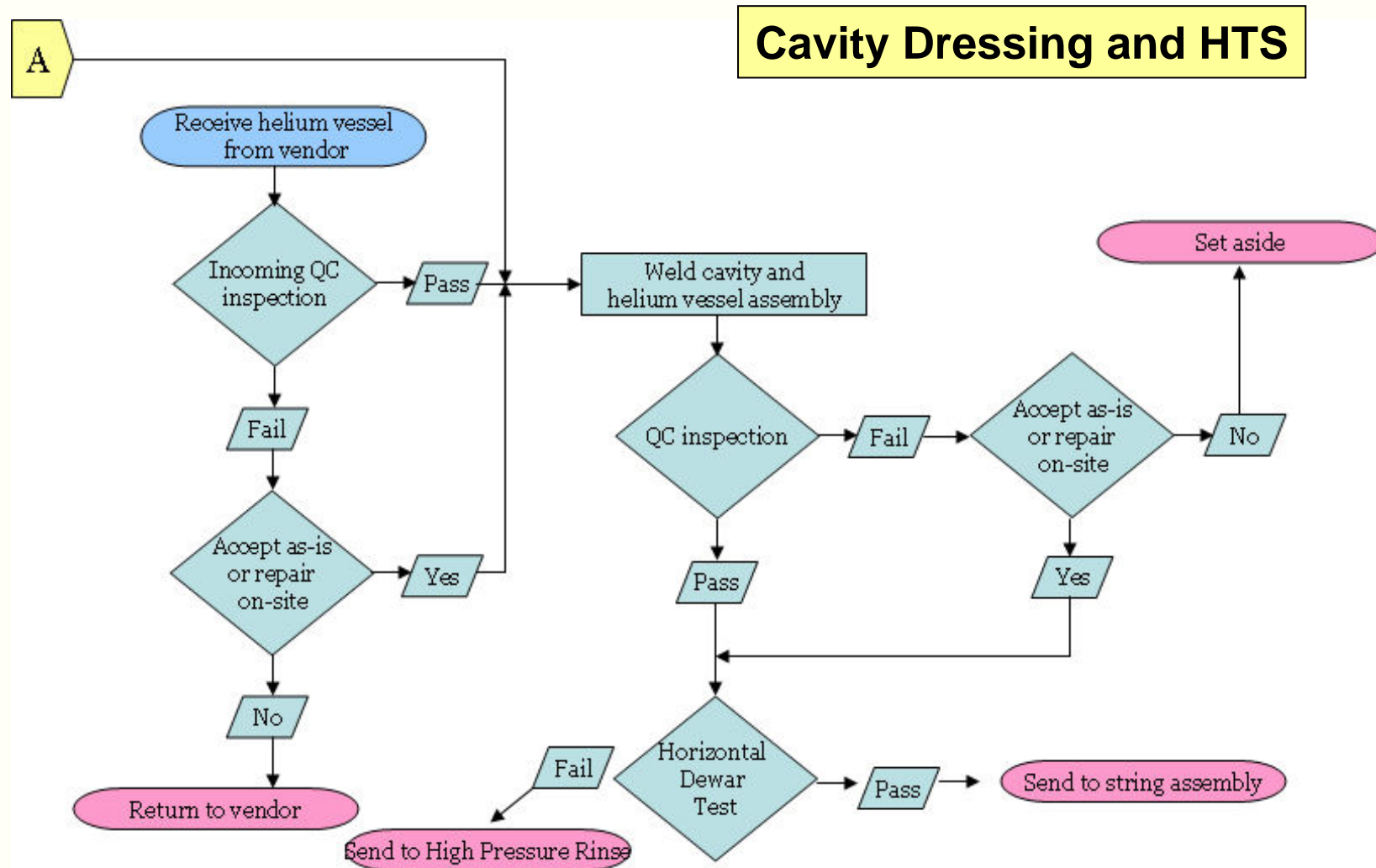
- The term “process” defines the complete procedure that transforms a fabricated cavity into a fully qualified cavity at a specified operating gradient and quality factor (in our case 35MV/m and $1.0e10$). It includes the following operations:
 - Cavity processing
 - Cavity tuning
 - Vertical testing
- A flow chart delineating the procedure is presented on the next slide

Process Flow Chart

Cavity Processing, Tuning and VTS



Cavity Flow Chart Subsequent to Completing the Process Flow Chart



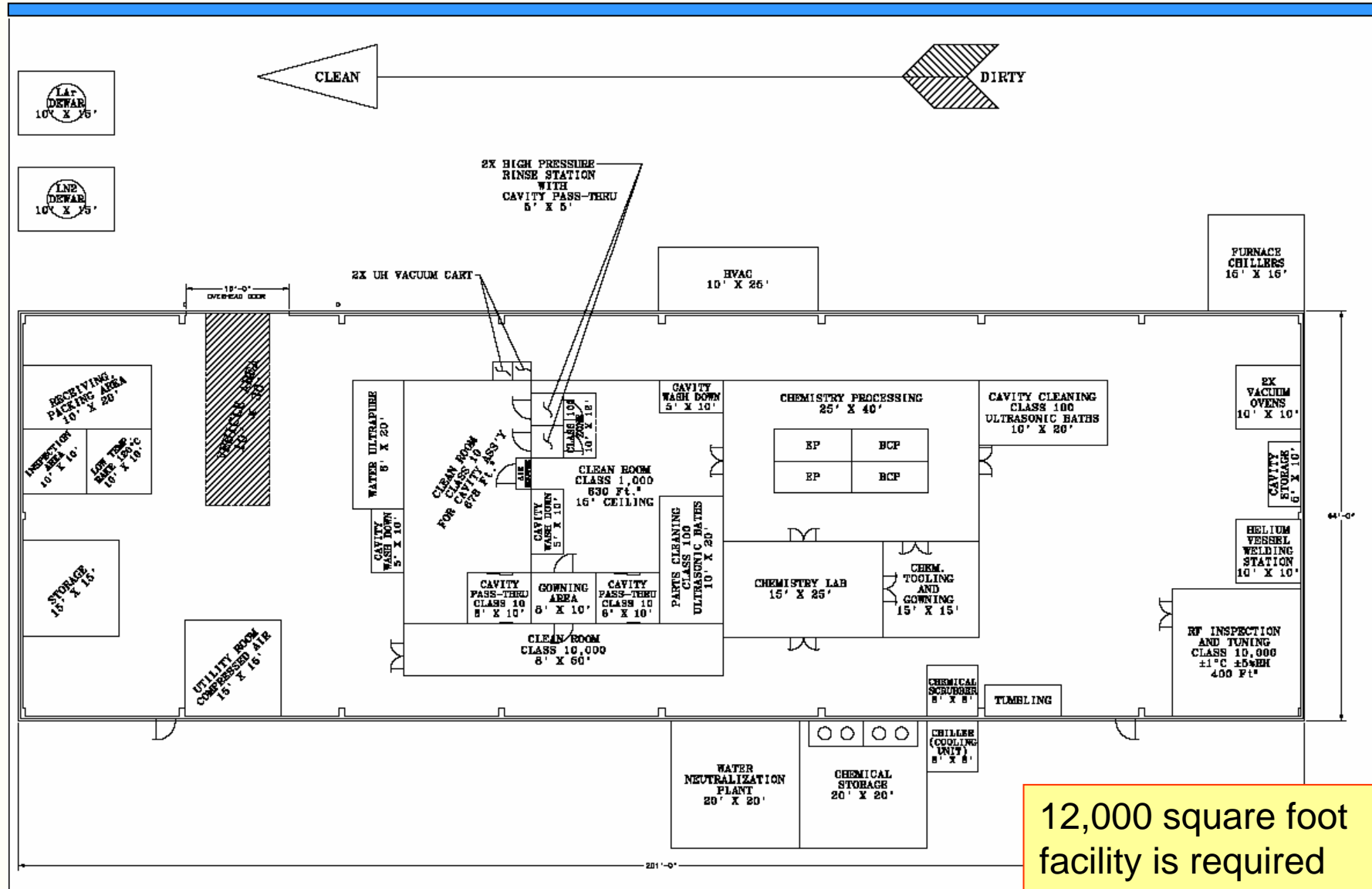
CPF Functions

- Perform pre-EBW etching of cavity components
- Receive and store fabricated cavities
- Perform mechanical inspection of cavities
- Perform internal and external chemical processing
- Perform high pressure rinsing
- Perform high and low temperature cavity bakes
- Tune cavities for fundamental frequency and field flatness
- Prepare cavity for vertical test
- Receive vertically tested cavities
- Install helium vessels (dress cavities)
- Prepare dressed cavities for horizontal testing
- Receive cavities from HTS and send to string assembly facility (CAF)

Cavity Processing Facility Features

- **Separate chemical storage building**
- **Chemistry laboratory for small samples and pre-EBW etching**
- **Wet station area for component cleaning prior to bringing into clean rooms**
- **Class 1000 clean room housing major chemical processing equipment (EP and BCP cabinets, etc.)**
- **Exhaust fume scrubber**
- **Acid neutralization system**
- **Ultra Pure Water (UPW) system**
- **High Pressure Rinse (HPR) stations**
- **High and low temperature furnaces**
- **RF inspection and Automated cavity tuning system**
- **Class 10 clean room for final prep of cavities prior to VTS**
- **High purity gaseous argon and nitrogen systems**
- **TIG welding station for helium vessel installation**
- **Ultra clean vacuum pumping system and leak checking systems**

CPF Floor Plan at MW

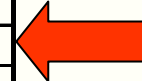


12,000 square foot facility is required

CPF Funding Requirements



Infrastructure	M&S	SWF	Total with Indirect
Cavity Fabrication Infrastructure	\$ 3,000	\$ 675	\$ 4,380
Cavity Processing Facilities	\$ 11,100	\$ 4,590	\$ 18,945
Vertical Test Stand (VTS 2 & 3)	\$ 2,625	\$ 1,845	\$ 5,475
Horizontal Test Stand (HTS 2)	\$ 1,220	\$ 1,057	\$ 2,805
Cavity/Cryomodule Assembly Facilities (CAF_MP9 & ICB)	\$ 690	\$ 270	\$ 1,158
NML Facility (ILCTA_NML)	\$ 18,270	\$ 23,220	\$ 51,700
Cryogenics for Test Facilities	\$ 10,690	\$ 950	\$ 13,692
Cryomodule Test Stand	\$ 5,400	\$ 2,970	\$ 10,180
Material R&D	\$ 870	\$ 722	\$ 1,960
Illinois Accelerator Research Center	\$ 20,000	\$ 4,050	\$ 28,605
Grand Total (\$k)	\$ 73,865	\$ 40,349	\$ 138,900



Item	\$K
M&S:	11,100
SWF:	4,590
Grand Total w/o Indirect:	15,690
Grand Total with Indirect:	18,945

Assumptions

- Facility is located on FNAL site
- 3 year schedule from inception to completion and fully operational
- Funding profile assumes 1/3 TPC available each fiscal year

CPF Itemized (Direct) Cost Estimate



Item	M&S Costs	Labor	SWF	Total Cost
	\$K	FTE*Yrs	\$K	\$K
Building Preparation	\$ 250	0.5	\$ 68	\$ 318
Building Utility Infrastructure	\$ 250	2.5	\$ 338	\$ 588
Clean Rooms	\$ 1,000	0.5	\$ 68	\$ 1,068
Ultra-Pure Water System	\$ 150	1.5	\$ 203	\$ 353
Clean Room Hardware	\$ 150	1.25	\$ 169	\$ 319
Ultrasonic Cleaning Tanks	\$ 150	0.5	\$ 68	\$ 218
Vacuum Furnaces (2)	\$ 1,000	0.25	\$ 34	\$ 1,034
Lo temp. furnaces (2)	\$ 200	1	\$ 135	\$ 335
Cavity Tuning Devices and RF test equipment & fixtures	\$ 1,000	1.25	\$ 169	\$ 1,169
HPR Systems (3)	\$ 1,200	1.25	\$ 169	\$ 1,369
EP Systems (3)	\$ 1,600	1.75	\$ 236	\$ 1,836
BCP Systems (2)	\$ 1,000	1.25	\$ 169	\$ 1,169
Tumbling (2)	\$ 500	1	\$ 135	\$ 635
Chemistry Lab	\$ 450	4	\$ 540	\$ 990
Chemistry storage, preparation, treatment infrastructure	\$ 1,000	1.25	\$ 169	\$ 1,169
Vacuum Equipment and Hardware	\$ 400	1.25	\$ 169	\$ 569
TIG Welding Machines, fixtures	\$ 150	0.75	\$ 101	\$ 251
Miscellaneous Fixtures and Equipment	\$ 400	4	\$ 540	\$ 940
Monitoring, controls, HMI integration	\$ 250	3.25	\$ 439	\$ 689
ES&H preparation		5	\$ 675	\$ 675
Totals	\$ 11,100	34	\$ 4,590	\$ 15,690

- ## Cost Drivers
- Clean Rooms (Classes 10, 100, & 1000)
 - Vacuum Hi Temp Bake Furnaces
 - Cavity Tuning Devices & RF test equipment
 - HPR Systems
 - EP Systems
 - BCP Systems
 - Chemistry Storage, Preparation & Treatment Infrastructure

3 Year CPF Procurement Plan



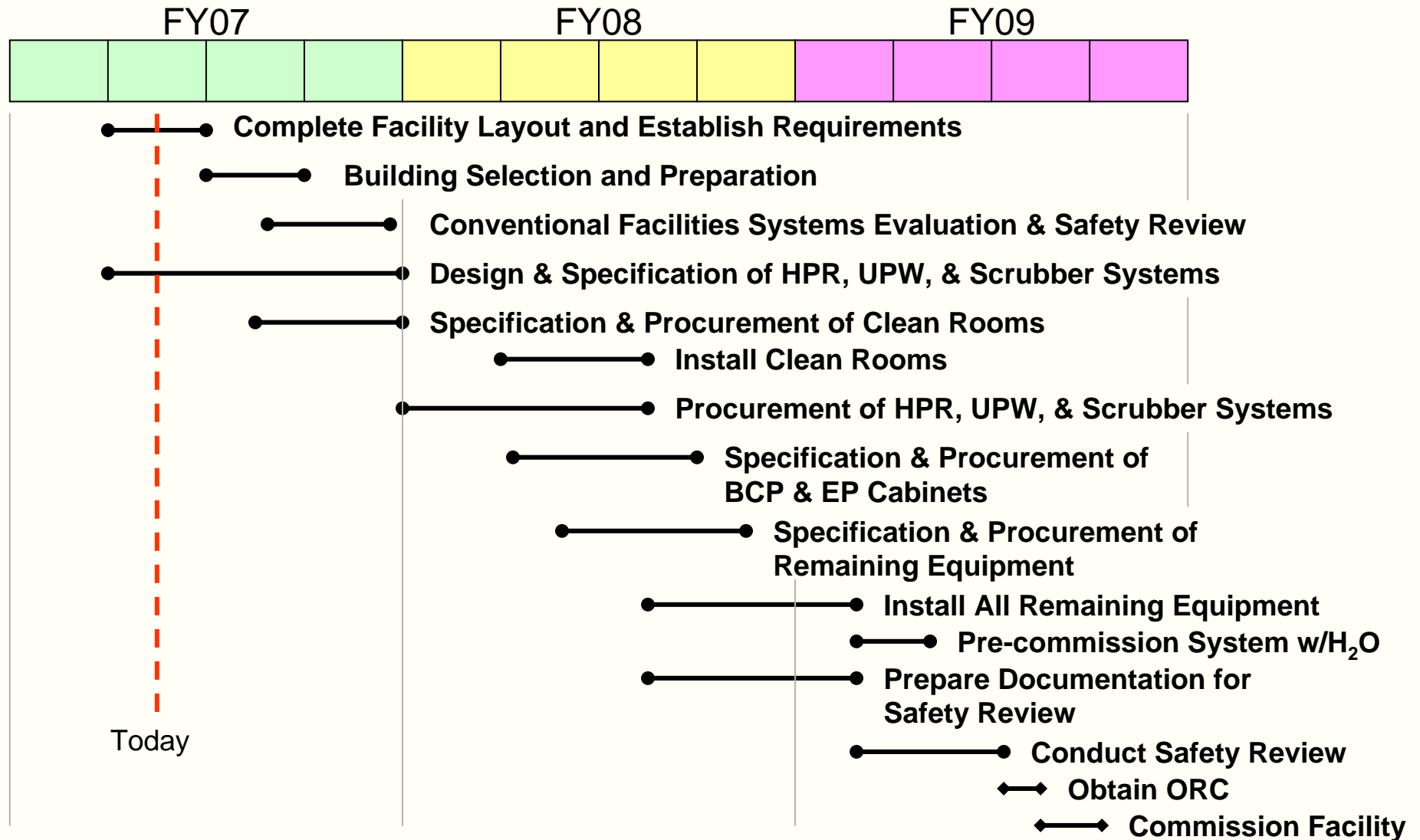
- Year One
 - Prep building for CPF, inc. utility infrastructure
 - Procure & install clean rooms
 - Procure clean room hardware
 - Procure high and low temp. vacuum furnaces
 - Procure & install UPW system
 - Procure & install ultrasonic cleaning tanks
 - Procure cavity tuning system

} ~\$5.4M
- Year Two
 - Procure EP and BCP systems
 - Procure HPR systems
 - Procure mechanical polishing (tumbling) systems
 - Procure chemistry lab equipment

} ~\$6.0M
- Year Three
 - Procure & install scrubber system & treatment infrastructure
 - Procure vacuum equipment & hardware
 - Install all remaining equipment
 - ES&H preparation
 - Conduct safety review
 - Commission facility

} ~\$4.3M

CPF Schedule Timeline

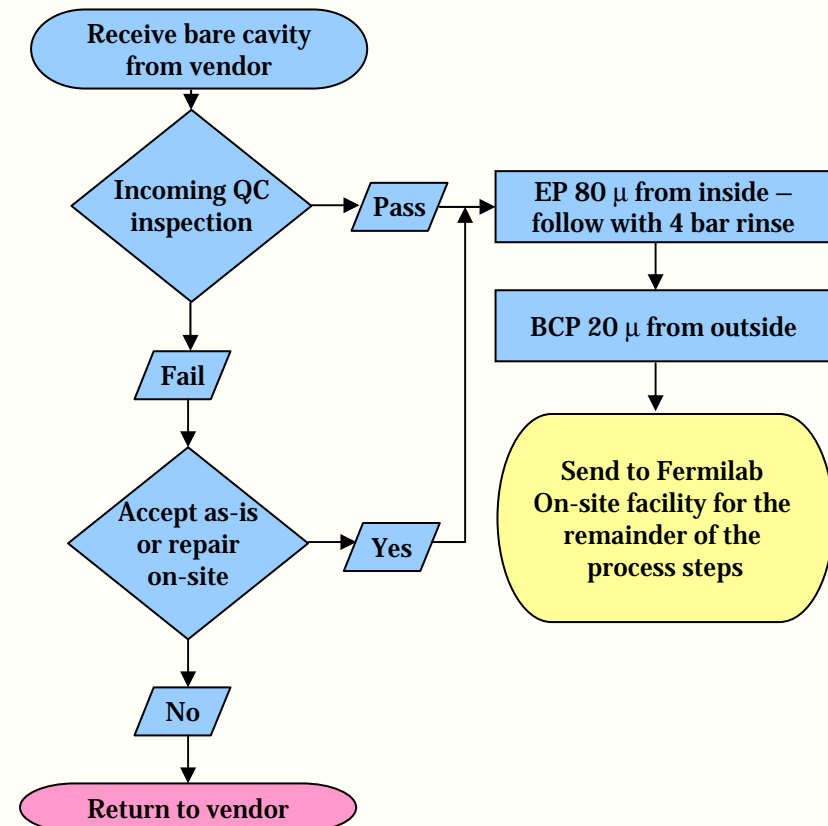


Alternative: An Off-Site CPF

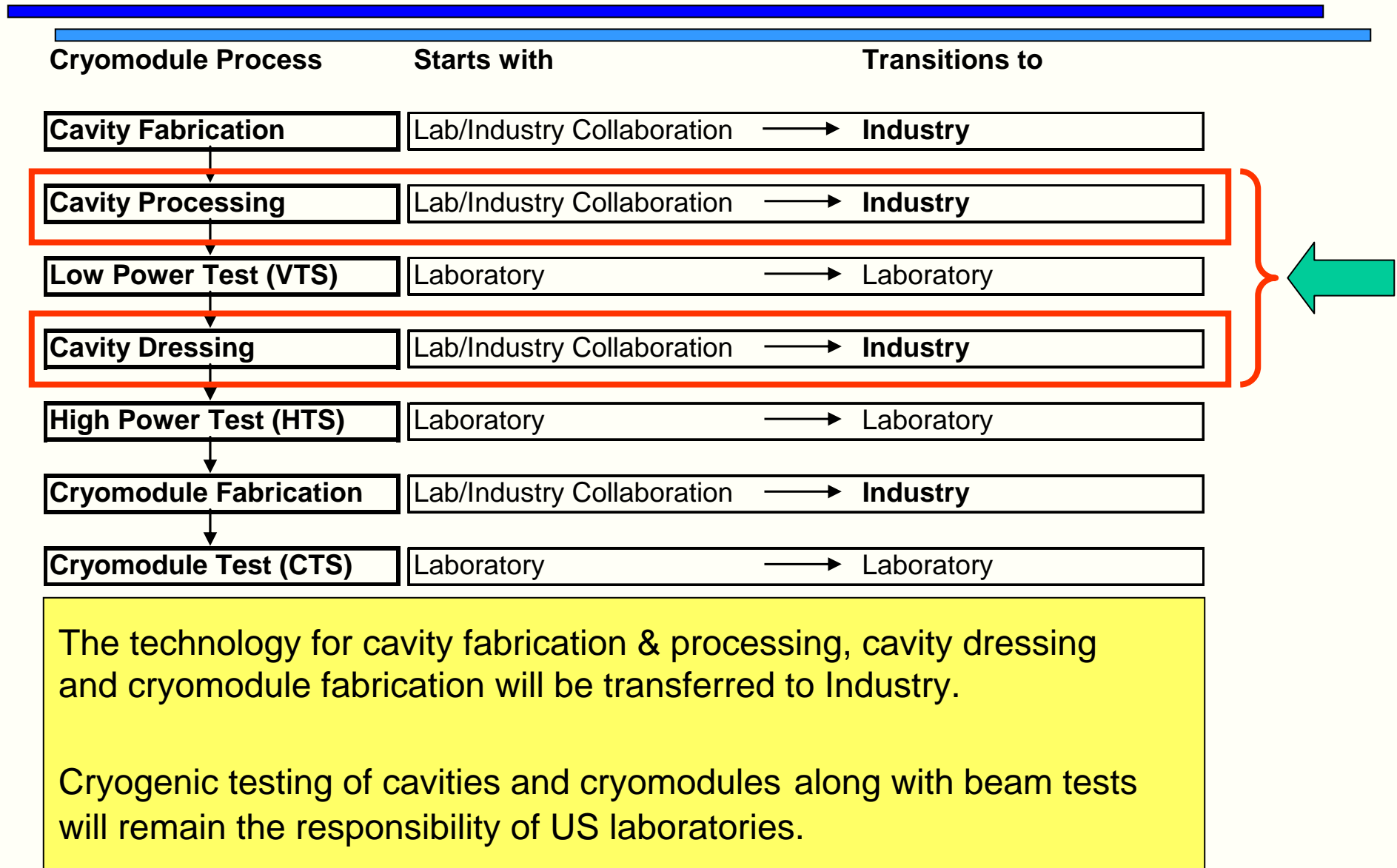
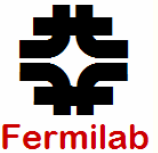
- A contract could be written for the design, construction, and operation of an off-site facility located very near FNAL.
- Facility would be financed by ILC funds and owned by government, but operated by industry
- Advantages:
 - Operation by an experienced electropolishing industrial firm using their manpower
 - Significantly reduces the need for large quantities of nasty chemicals on FNAL site
 - Initiates the industrialization program cavity processing
- Unknown total cost, estimate ~ \$6M due to the cost of a building (either leased or purchased)

Off-Site CPF Scope of Work

- Perform initial cavity inspection
- Perform bulk chemistry operations
 - Internal 80u EP
 - External 20u BCP
- Possibly include HPR; otherwise, ship cavity to FNAL in container filled with UPW



Development of Industry



Conclusion

- **The combined total process capacity of present U.S. cavity processing facilities has been shown to be inadequate to handle the anticipated near term demands.**
- **A concept for a new facility (CPF) capable of meeting the ILC pre-production demands has been presented. Development of the facility specification and design is underway at FNAL.**
- **If located on the Fermilab site, the CPF could be completed in ~2 years at a total cost of \$15.7M.**
- **Splitting the CPF along the lines of completing the bulk chemistry processing in an off-site facility may be advantageous and merits further investigation**