Cavity Processing Facility

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Fermilab Technical and Accelerator Divisions

Outline

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- 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

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- **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

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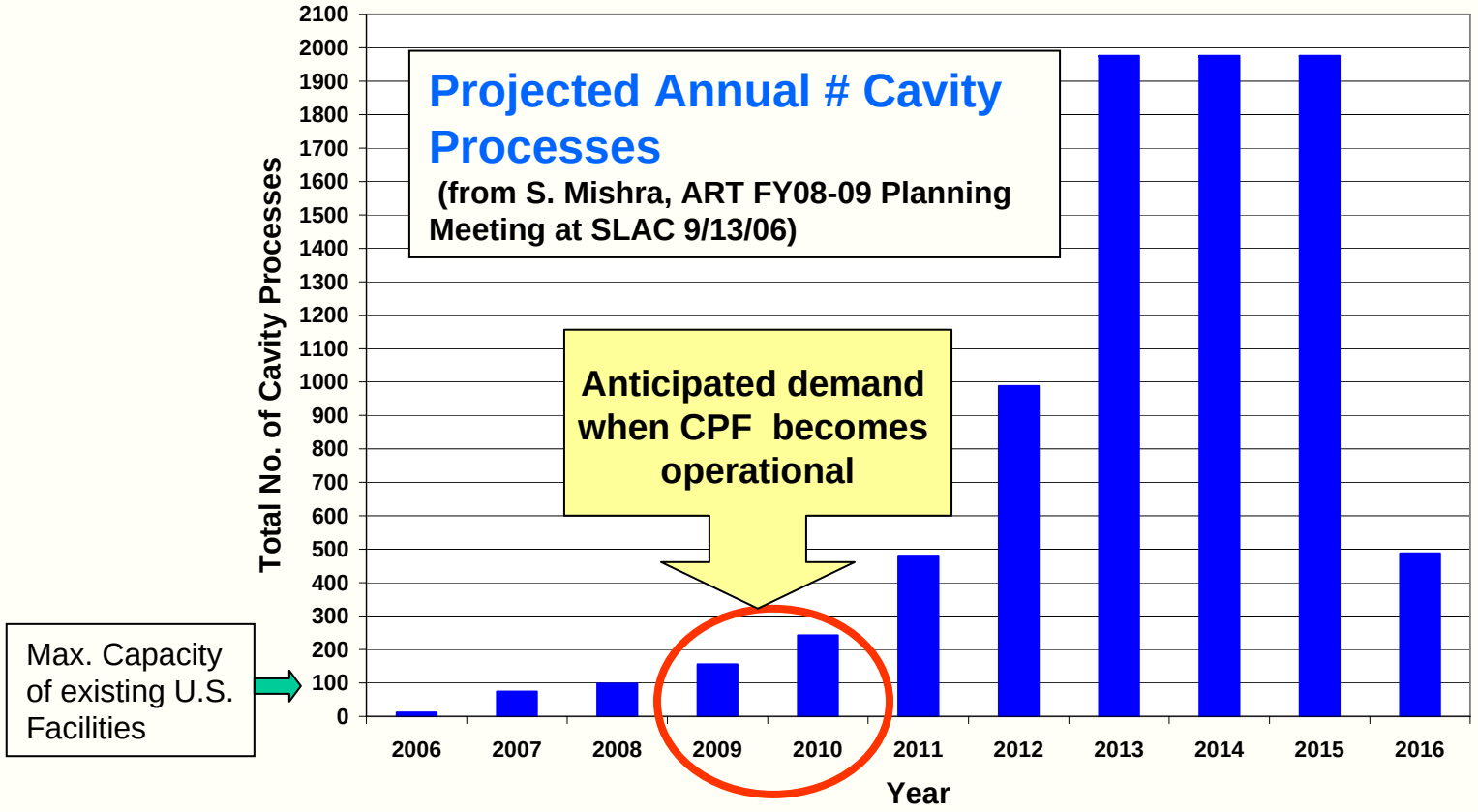
- **Existing U.S. capability is insufficient to meet the anticipated demand---as demonstrated in Shekhar's talk**



US Laboratories Capacity

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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

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- 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

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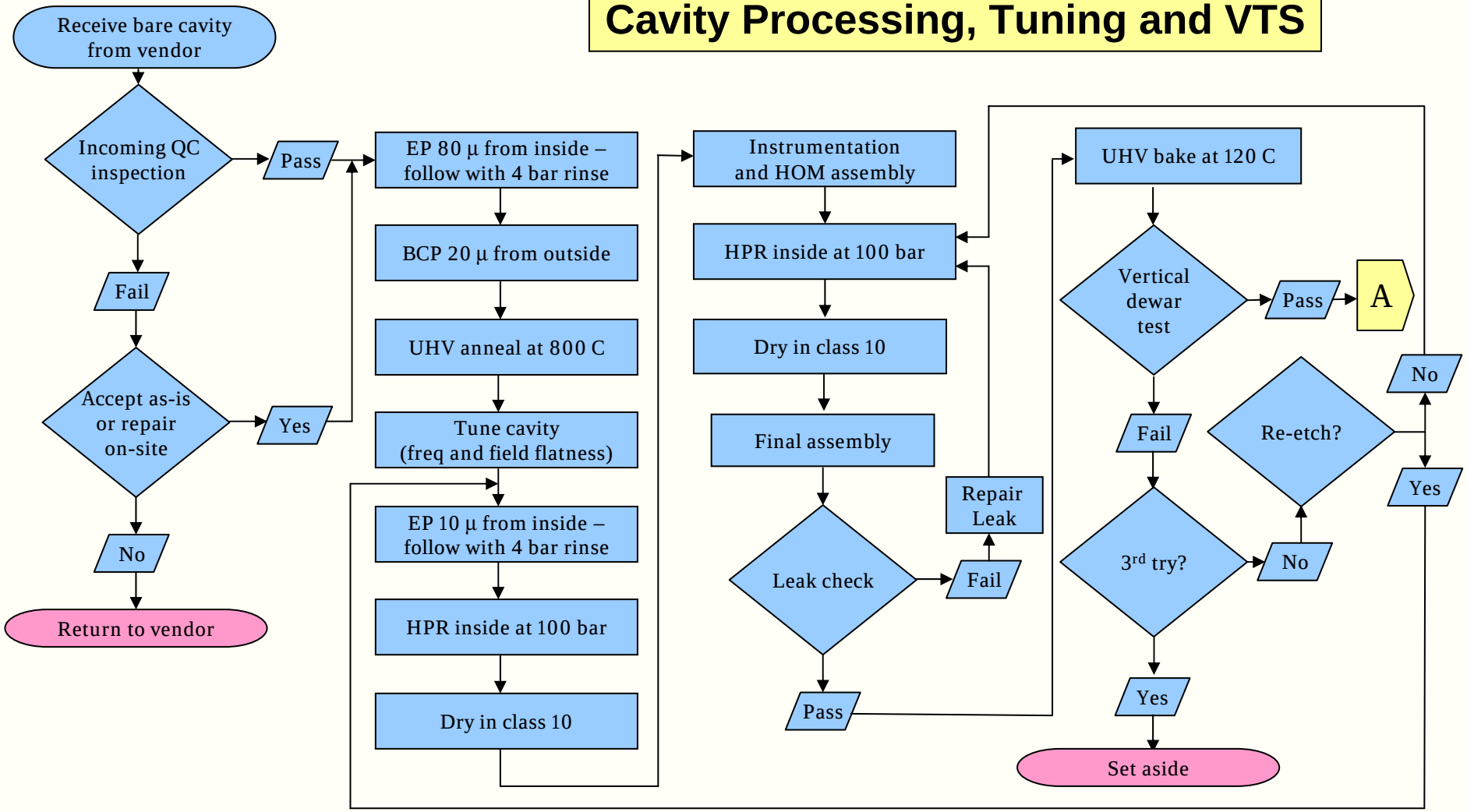
Cavity Processing, Tuning and VTS



Cavity Flow Chart Subsequent to Completing the Process Flow Chart

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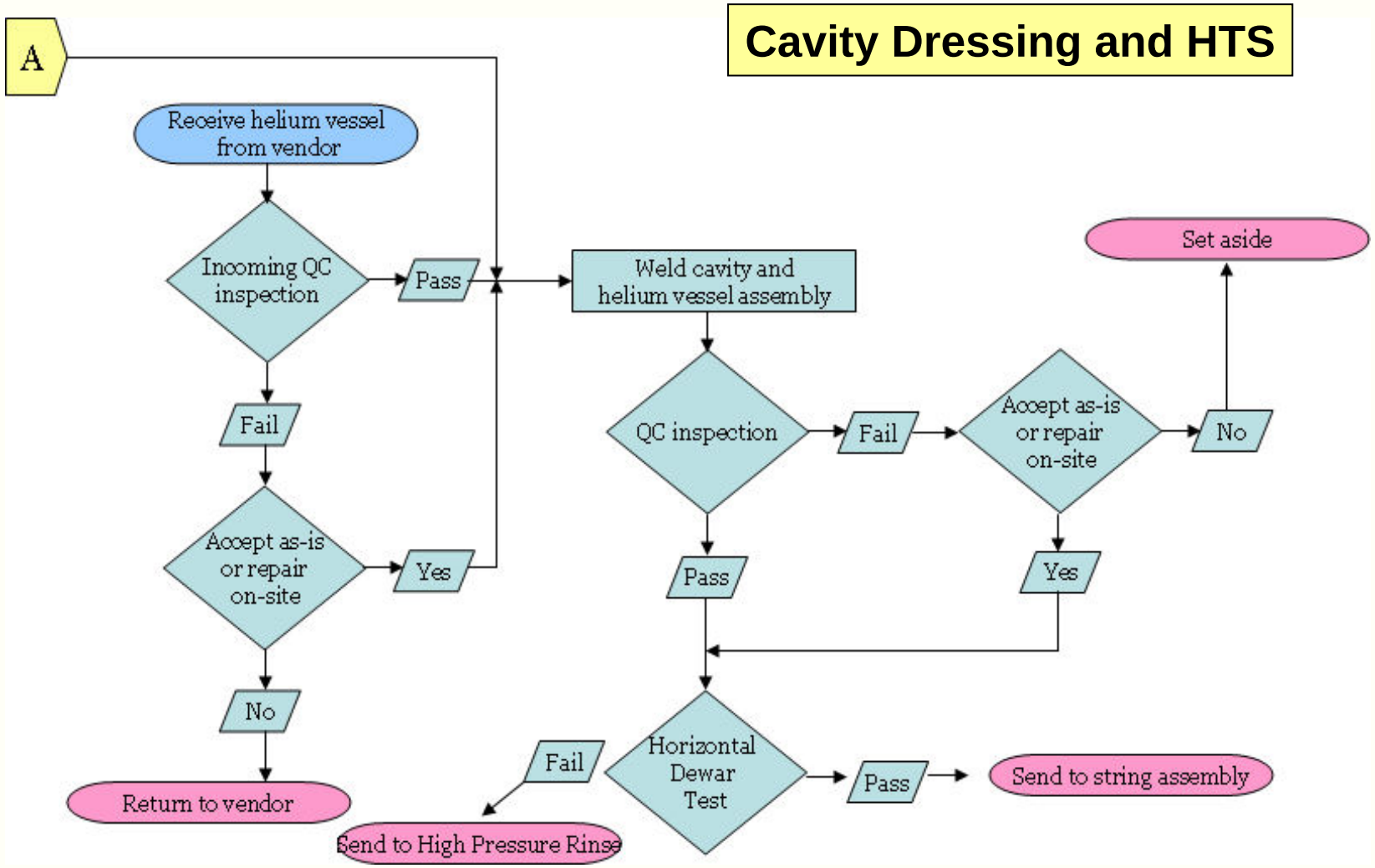

CPF Functions

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- 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

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- 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

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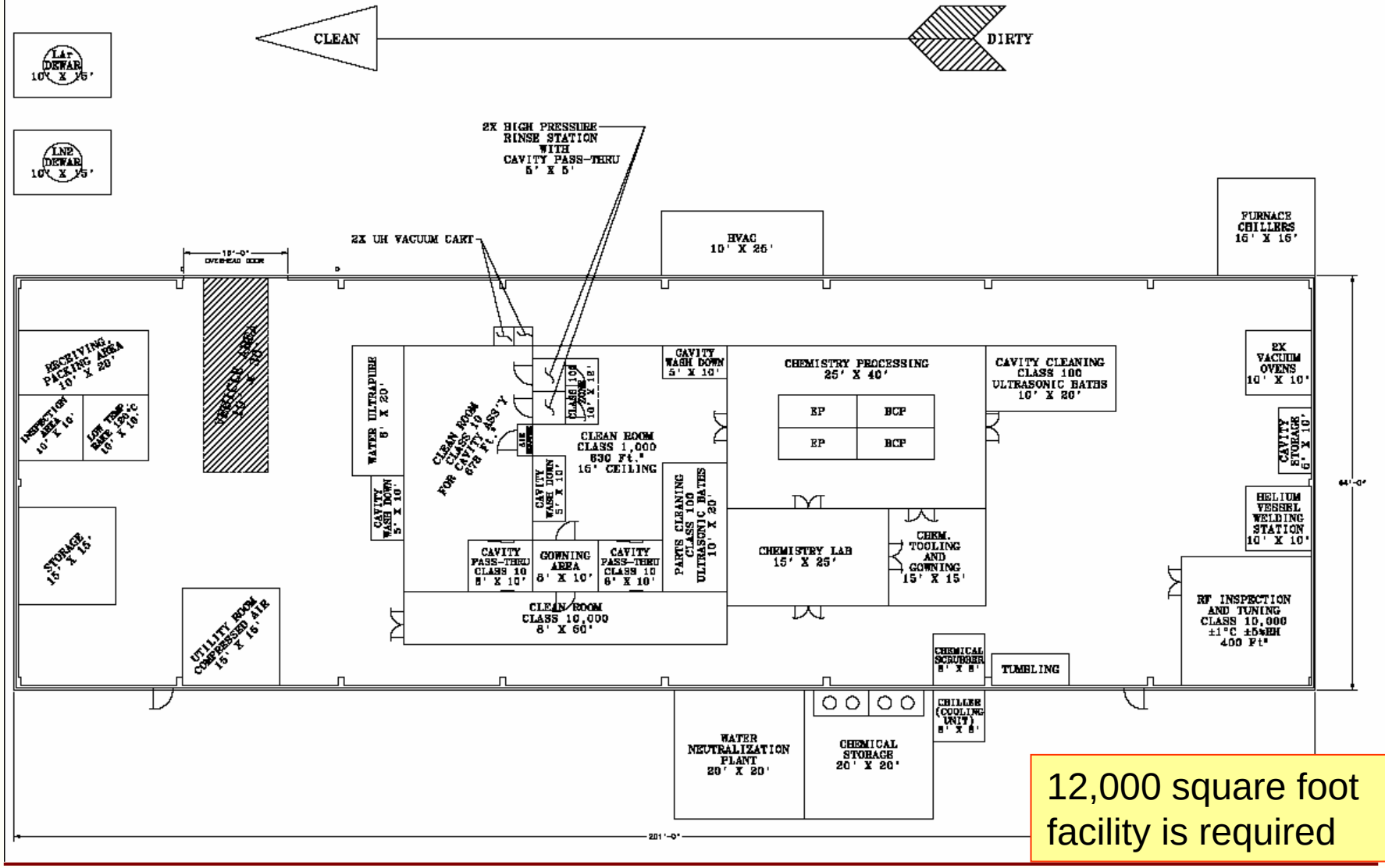

12,000 square foot facility is required

CPF Funding Requirements

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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 Facilties (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

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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

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- **Year One** — ~$5.4M
  - 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
- **Year Two** — ~$6.0M
  - Procure EP and BCP systems
  - Procure HPR systems
  - Procure mechanical polishing (tumbling) systems
  - Procure chemistry lab equipment
- **Year Three** — ~$4.3M
  - Procure & install scrubber system & treatment infrastructure
  - Procure vacuum equipment & hardware
  - Install all remaining equipment
  - ES&H preparation
  - Conduct safety review
  - Commission facility

CPF Schedule Timeline

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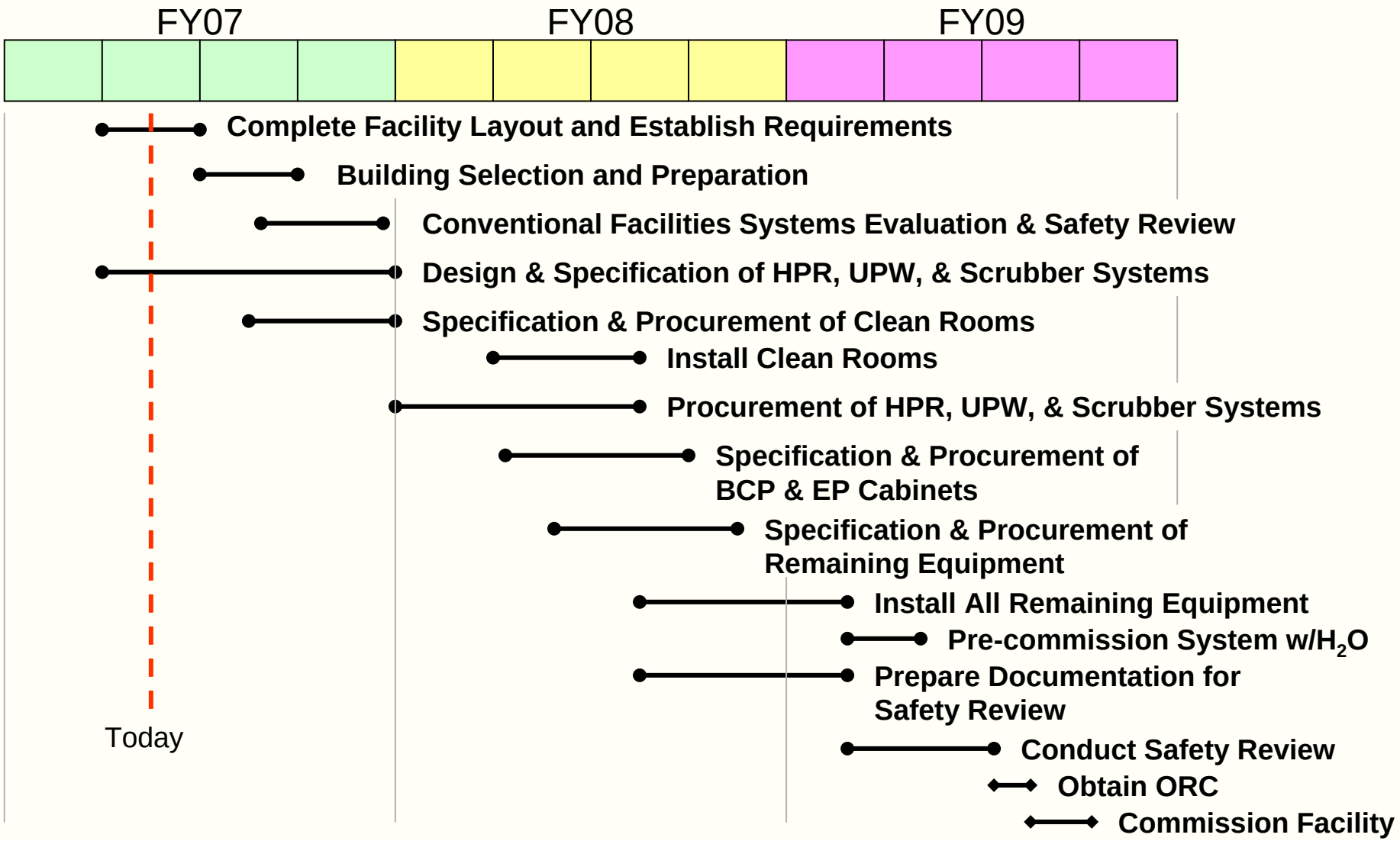

Alternative: An Off-Site CPF

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- 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 quantites 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

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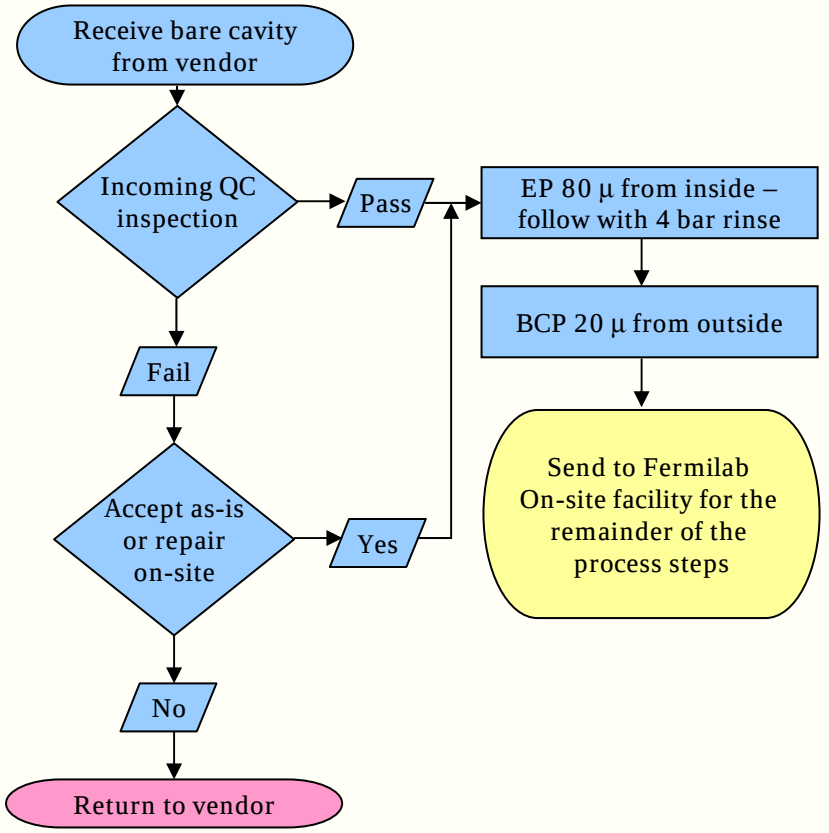
- Perform initial cavity inspection
- Perform bulk chemistry operations
  - Internal 80u EP
  - External 20u BCP
- Possibly include HPR; otherwise, ship cavity to FNAL in container filled with UPW



Development of Industry

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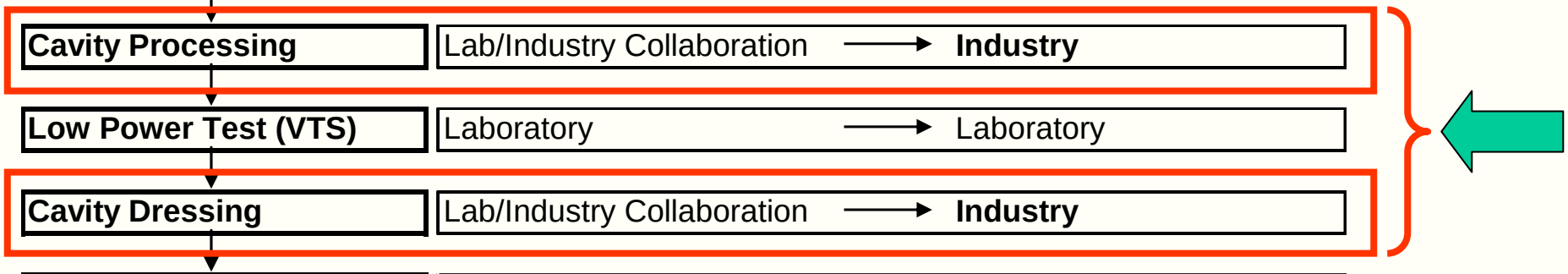
Cryomodule Process	Starts with	Transitions to
Cavity Fabrication	Lab/Industry Collaboration →	**Industry**
Cavity Processing	Lab/Industry Collaboration →	**Industry**
Low Power Test (VTS)	Laboratory →	Laboratory
Cavity Dressing	Lab/Industry Collaboration →	**Industry**
High Power Test (HTS)	Laboratory →	Laboratory
Cryomodule Fabrication	Lab/Industry Collaboration →	**Industry**
Cryomodule Test (CTS)	Laboratory →	Laboratory



The technology for cavity fabrication & processing, cavity dressing and cryomodule fabrication will be transferred to Industry.

Cryogenic testing of cavities and cryomodules along with beam tests will remain the responsibility of US laboratories.

Conclusion

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- 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