A European SCRF Infrastructure

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-MPY-

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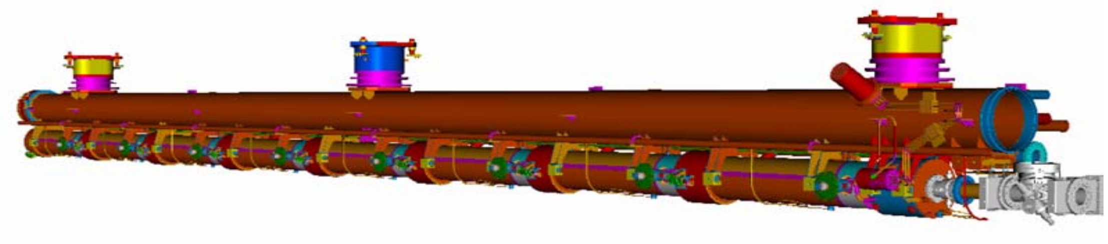
- Goals of the Infrastructure
  - ILC
  - Other projects
- Timeline
  - Phasing of work
- Needs for the Infrastructure

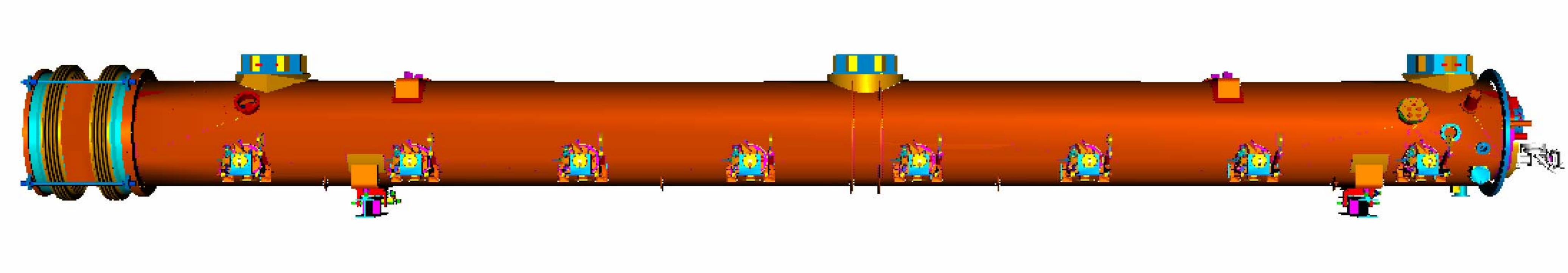
Research and Development

- GDE Discussions show that an effort is needed
  - To make ILC-gradients more reproducible
    - The baseline process is clear, but some parameters are yet to be determined (details of post-electropolishing rinses)
      - This is the work of the labs
    - Any step in Europe should be integrated in the larger R&D framework
  - Step toward a integrated systems test
    - Build a 4th generation module
    - At least the size of one RF unit, which determines the number of cavities to at least 30
  - Knowledge transfer to industry
    - Significant work is needed enabling industry to produce cavities on the level of the ILC gradients (see above)
      - After having worked out details, transfer this to industry
    - But Industry can do things today (and the more in 2007/8)
      - Large contribution of the XFEL
      - Fabrication, First EP can/should be done in industry
    - After results from the facility are available
      - Final preparation and tank welding in industry
    - Final step
      - Module assembly in industry
- Other projects
  - Access to state-of-the-art cavity preparation

Primary goal:
Production of ILC prototype modules (4th generation) in Europe

- Scope
  - Should include building all parts
    - Cavities
    - Couplers
    - Magnet
    - BPM
    - Cryostat vessel
  - Must include a next generation cavity preparation facility
    - Improve processes
    - Avoid bottlenecks

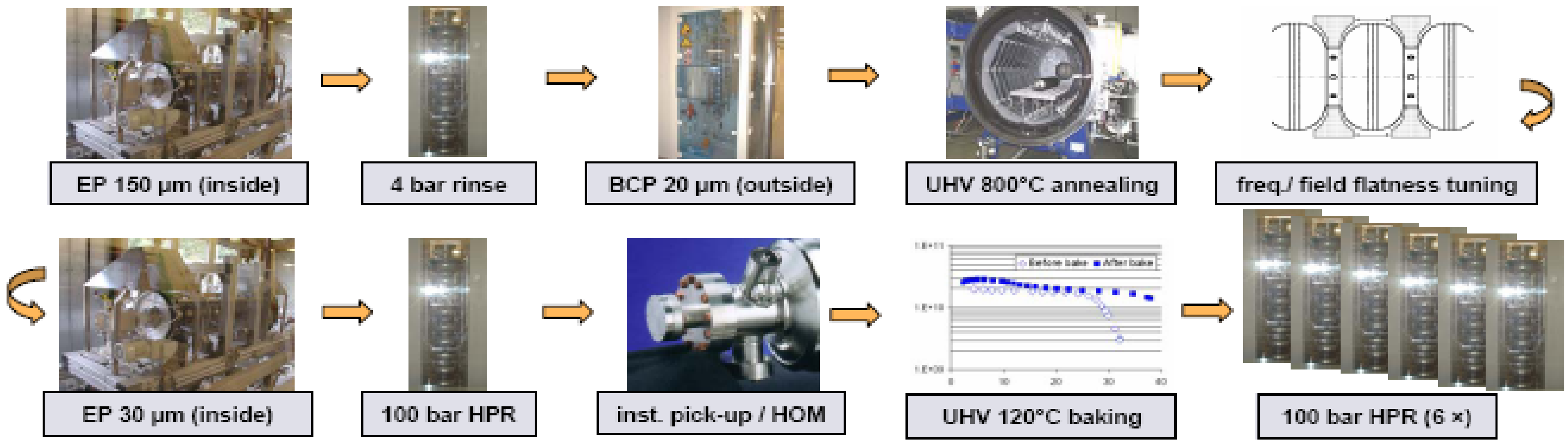




Cavity Preparation Infrastructures Today

- Some infrastructure is available in Europe (not only DESY)
- Most setups are still R&D size
  - Often single-cell cavities
  - Small through-put
- Single-line of processing
  - No redundancy
- Have come to age
  - Materials
  - Overall layout needs significant re-work with today‘s knowledge
    - Electropolishing as the baseline process
    - required number of high pressure water rinses

Cavity Prep. (XFEL Industrial Production)



1. electro-chemical removal of a thick niobium layer (so-called damage layer) of about 150 µm from the inner surface
2. a rinse with particle free / ultra-pure water to remove residues form the electro-chemical treatment
3. outside etching of the cavities of about 20 µm
4. ultrahigh vacuum annealing at 800°C
5. tuning of the cavity frequency and field profile
6. removal of a thin and final layer of about 30 µm
7. rinsing with particle free / ultra pure water at high pressure (100 bar) to remove surface contaminants
8. assembly of auxiliaries (pick-up probe and HOM pick-up)
9. baking at 120°C in ultra high vacuum
10. additional six times rinse with high pressure ultra-pure water (100 bar)

Next Generation
Cavity Preparation Infrastructure I

- Main Features
  - Improved electropolishing
    - Focus to avoid sulphurus contamination
    - Redundancy
  - Improve Final cleaning
    - Flexibility needed here e.g. alcohol rinses
  - High pressure rinse (HPR)
    - Online particle count integrated in drain water line
    - Redundancy
  - Cleaning of parts
    - Automation needed: screws used as example
  - Improved/novel methods of QA/QC

Next Generation Cavity Preparation Infrastructure II

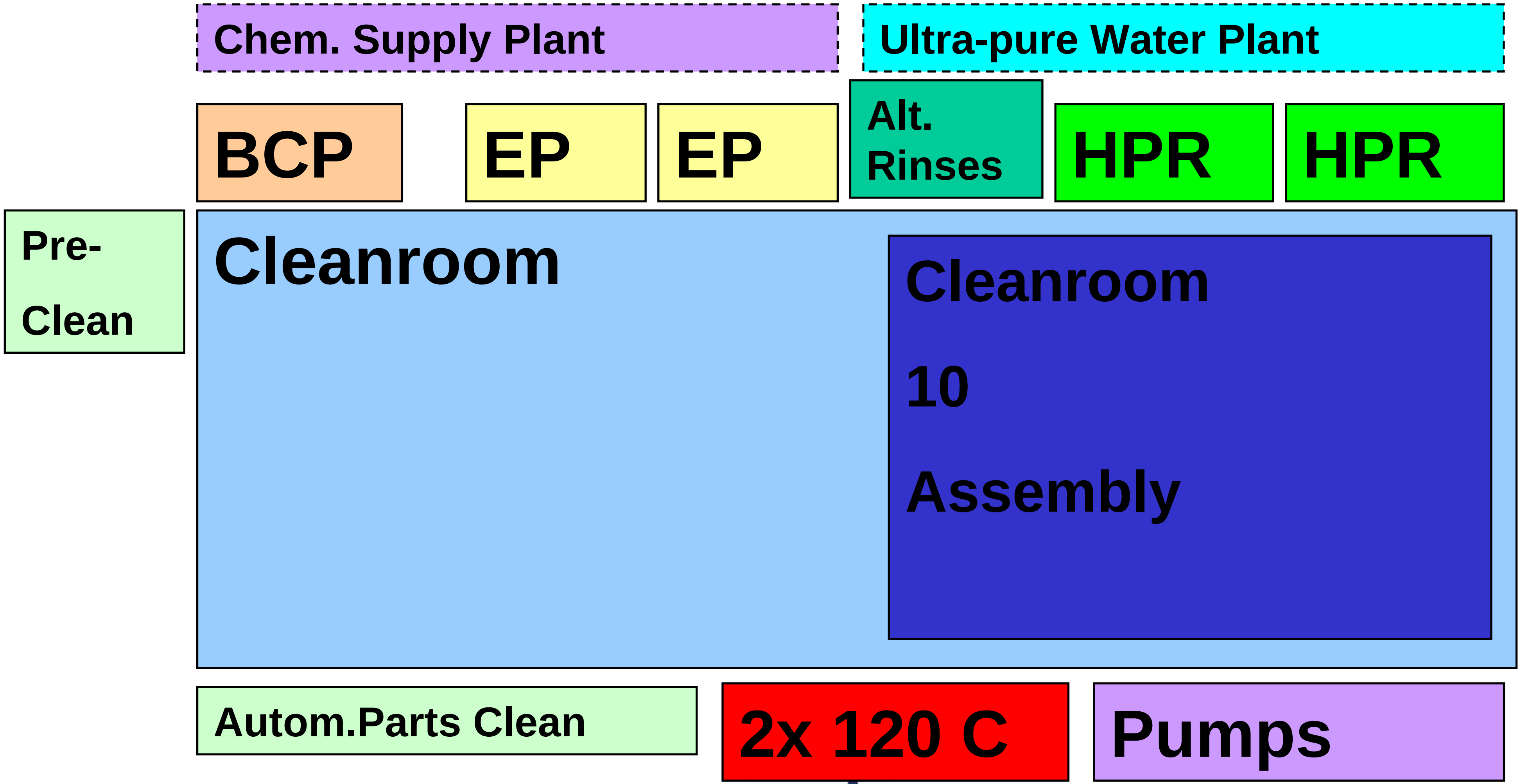
- Modular setup
  - Institutes get responsibility for part of the process (HPR design, EP design etc.)
- Redundant setup
  - 2 x EP,
  - 2 x HPR,
  - 2-3 120 °C bakeout stations
- Other infrastructure
  - Etching needed (e.g. outside cleaning)
  - designated 800°C furnace
  - Sufficient pump stations, etc.
- Optional
  - Dry-ice cleaning
    - Needs feasibility demonstration

Layout of Preparation Facility

Tuning

Tank welding

Oven



Time scales:

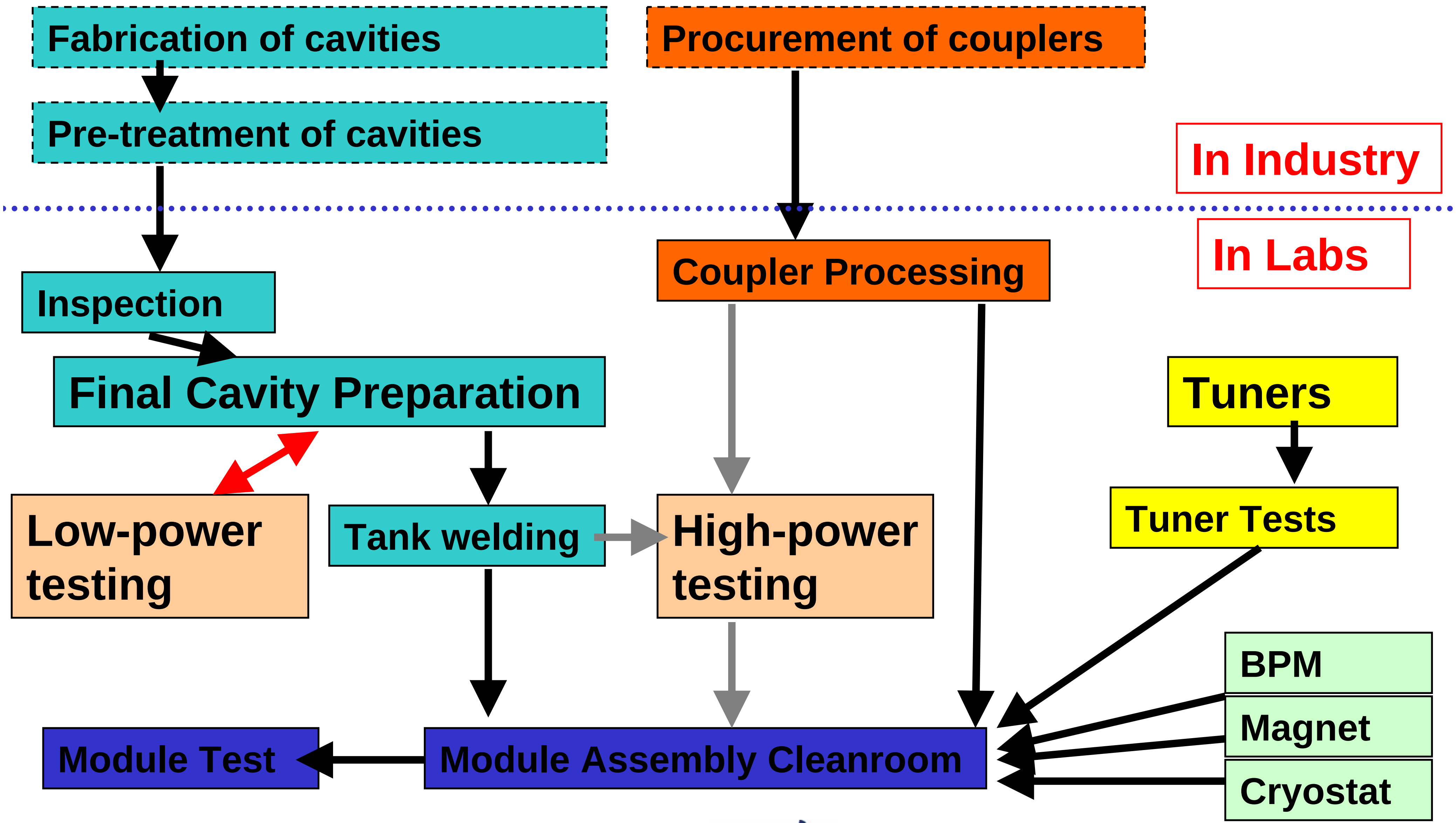
– >2008

- Time scale would have this infrastructure running parallel to XFEL cryomodule production, which could provide ‘mass production’ feedback for foreseen ILC program.
- some of the design work will be done until end 2007 by ILC worldwide
- setting up of preparation infrastructure is most time-consuming
  - This could partially start in 2007
  - if parts of TTF infrastructure can be used the cavity preparation can be started earlier
  - at CERN the adaptation of the infrastructure needs to be cross-checked but should be rather straight-forward

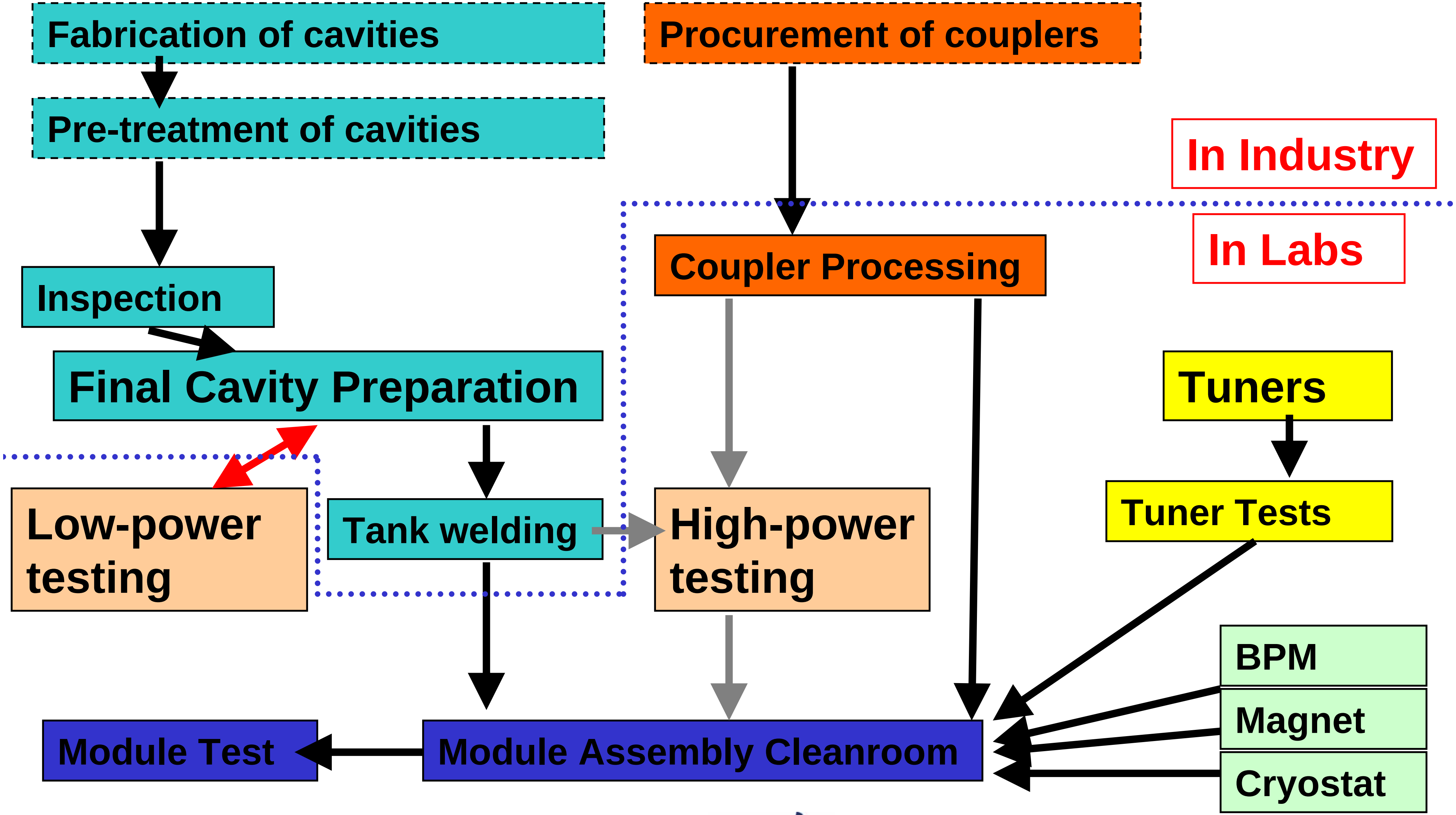
Timelines for R&D Infrastructure

	ILC Work	Other projects	Year
Setup phase	• Installation of infrastructure • Procurement of parts (e.g. cavities)	Define cavity shapes etc.	2007-2008
Research phase	•Use of preparation and test systems •Defining the details of the preparation (e.g. rinsing parameters)	Design of infrastructure (e.g. EP bench)	2008-2009
Transfer phase	Transfer parameters for final cavity preparation to industry	Installation of infrastructure	2009 - 2010
Industrialization phase	Module assembly in industry	Use of Infrastructure	2010+

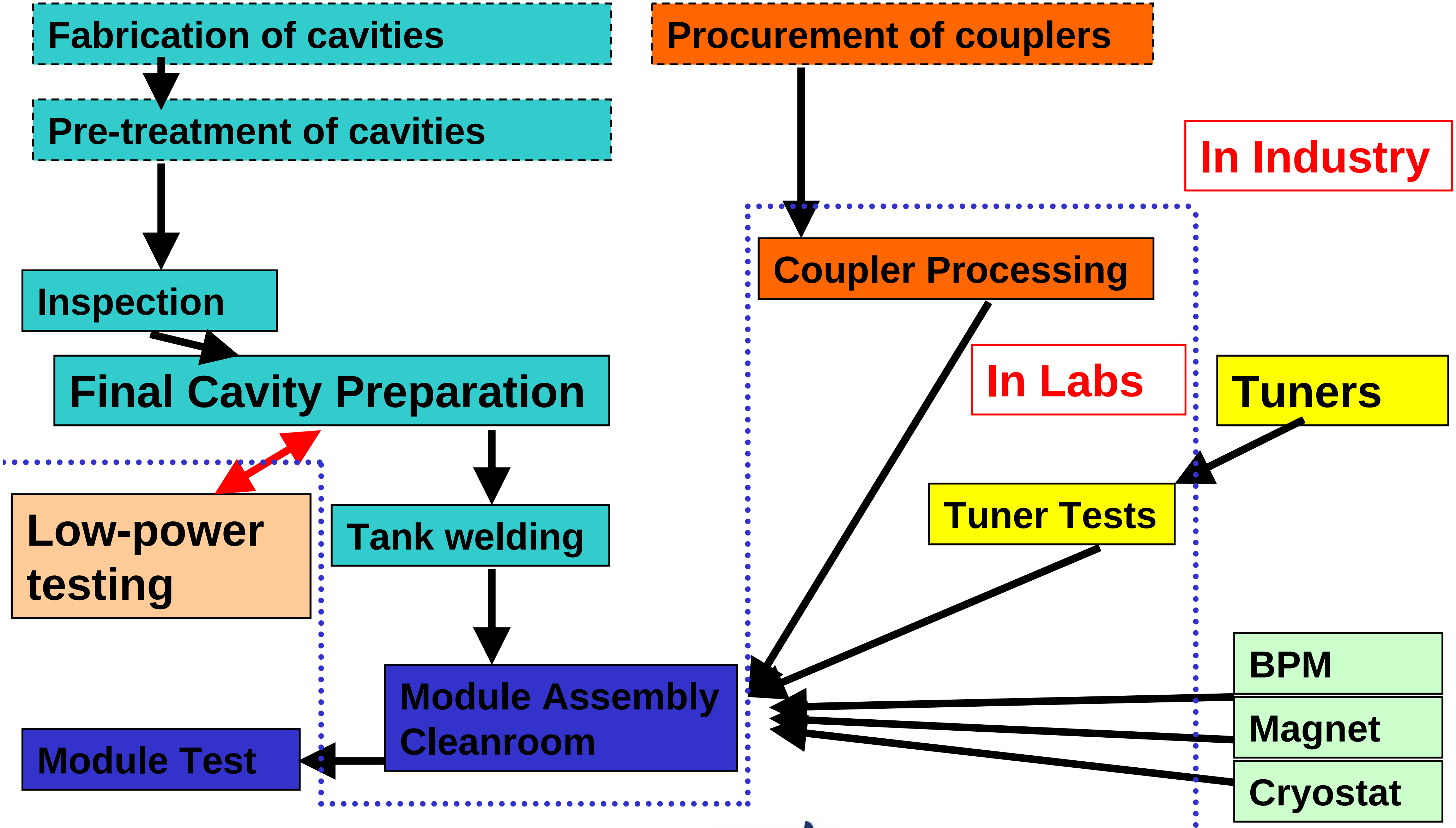
Scheme of Cryomodule Production (Research phase)



Scheme of Cryomodule Production (Technology Transfer)



Scheme of Cryomodule Production (Industrialization Phase)



Implementation of a Facility

- Location Alternatives:
  - Makes sense to site this at existing TTF infrastructure here at DESY.
    - Additional manpower would be a pre-requisite
  - CERN
  - Available:
    - 2K cryogenic-infrastructure
    - Vertical Teststands
    - Module Teststands
    - Single-cell preparation infrastructure
    - Surface science department in-house
  - Needed
    - Infrastructure for multi-cells with redundancy
    - RF Power
- Manpower
  - Qualified manpower is a critical issue on all levels (engineers, technicians)
  - How ‘free’ could this expertise be in 2008+?
  - How much additional manpower could be made available?

Conclusion

- Such a facility is needed
- CERN is a clear option as some (costly) part of the infrastructure is there
  – Not to be forgotten: Some Know-how as well!
  – DESY can be an alternative
- Evaluation is needed on who can provide what
  – Need to start making a 'shopping list'
- Other projects should come up with some rough sizes of their components when facility design starts

Backup slides

- Design goals of components
- Possible implementations
- Has been discussed in Orsay

Sketch of possible programme:

- Component design in framework of world-wide effort
  - Some design work might be finished by 2007 e.g. cryostat vessel
  - but this should not stop people stop from thinking about sub-components like magnet and cold BPM
- Details…

ILC Cryomodule Design

- Goals
  - 4th generation module
    - Quadrupole in the center
    - Shorter cavity spacing
  - Module assembly capability
  - Module testing capabilities
  - Prototyping of cryostat vessel in European industry
- Implementation:
  - Finish design work as collaboration of FNAL, INFN, DESY,..
    - ILC design finished in 2007?
  - Assembly of modules
    - Need a cleanroom for string
      - » Could use refurbished CERN cleanroom in SM18
      - » could be at TTF?
  - Test facility without beam
    - Could refurbish CERN infrastructure in SM18
    - Could be extension to XFEL module test hall, then use single module test stand for ILC
  - If Beam test is needed somewhere (e.g. HOM damping), could be just a probe beam.

High-quality cavity production and preparation including full-power test

- Cavity design
  - Goals:
    - Compact with shortened beam tubes
    - Cavity shape options
      - Standard
      - Low-Loss
  - Implementation
    - ILC LL
      - complete design available done at SLAC, DESY and others
    - Initial tests will be available
- Material options
  - Goals:
    - Large-grain or single-crystal
    - Standard material
  - Implementation
    - Built 30 ILC-cavities and test

High quality cavity production ctd.

- Cavity preparation
  - Goals
    - Improve preparation process
      - Improve EP (is a must…)
      - Etching needed (e.g. outside cleaning)
      - Improve Final cleaning
      - High pressure rinse (HPR)
        - » Online particle count integrated in drain water line
      - Dry-ice cleaning?
        - » Needs feasibility demonstration
      - Cleaning of parts
        - » Automation needed: screws used as example
      - Improved/novel methods of QA/QC
  - Implementation
    - Setup of new infrastructure
        - » DESY: Independent of TTF
        - » CERN: partial refurbishment might be an option
      - Modular setup
        - » Institutes get responsibility for part of the process (HPR design, EP design etc.)
      - Redundant setup
        - » 2 x EP,
        - » 2 x HPR,
        - » 2-3 120 °C bakeout stations
      - designated 800°C furnace
      - Sufficient pump stations, etc.

High quality cavity program ctd.

- Cavity testing capabilities
  - Goals :
    - Low-power and high-power individual cavity tests
  - Implementation
    - DESY: Extension of XFEL infrastructure or use TTF
    - CERN: Make SM18 1.3GHz compatible
      - Minor work cryostats
      - Improve pumps for 2K ?
      - RF system esp. for Pulsed operation
        - » obtain MBK from America

Cavity Auxiliaries

- TTF-III coupler
  - Goals
    - Lower cost
    - Even faster processing
  - Implementation
    - Continue work at LAL Orsay
    - Full synergy with XFEL
- Compact Tuner design
  - Goals
    - Develop compact tuner
    - Including fast tuning (e.g Piezo)
  - Implementation
    - Blade tuner at INFN
    - Compact lateral tuner at Saclay ? – needs confirmation

ILC magnet design

- Goals
  - Full design to ILC specs
  - Follow discussions on ILC issues
- Implementation
  - Continue work with CIEMAT
  - Acquire magnets in America?

ILC BPM design

– Goals
  - More compact re-entrant
  - Eventually integrated (closely attached) to quadrupole
– Implementation
  - Basic layout XFEL-like ?
    – XFEL Resolution insufficient for ILC
    – Continue CEA work
    – Need compact design

From Cavity to Modules

- Step 1 inspection of incoming cavities
  - Optical inspection
  - tuning of cell for field flatness (frequency)
  - mechanical measurements (length/ eccentricity)
  - Optical inspection of surface
- Step 2 preparation for acceptance/ vertical test
  - Damage layer removal
  - Annealing
  - Final surface treatment
  - assembly in class 10 Cleanroom
  - High pressure rinsing with Ultra pure water @ 100bar –
  - assembly of variable input power antenna for vertical test
  - Assembly to test insert
- Step 3 Vertical TEST

From Cavity to Modules ctd.

- Step 4 Preparation for Module
- Tank welding
  - Installation of in situ field measurement device
  - Welding of Nb to Ti connections (EB/ Bellows & Inter-connection ring)
  - Tuning of field profile and frequency
  - Helium vessel welding (TIG)
- Final preparation of dressed cavities
  - Removal of in situ field profile device
  - Assembly of HOM Coupler
  - High pressure rinsing
  - Assembly of Power coupler
- Step 5 Module assembly
  - Horizontal test of cavity and all accessories (Chechia)
  - Module assembly

Estimation of Sizes for Preparation Facility

- Precleaning
    - 1 x 1 x 2
- Ultrasonic
    - 1 x 1 x 3
- Pure water rinse
    - 1 x 1 x 3
- EP (2x)
    - EP table area
        - 2,5 x 4 x 3
        - Allow for working on both sides
- BCP
    - Etching Enclosure
        - 1 x 1 x 2
- HPR (2x)
    - Housing with hole for cane
        - 1 x 1 x 4
- Alternate rinse (2x)
    - Like etching enclosure
        - 1 x 1 x 2
- Area for pumping
    - In cleanroom
        - 3 x 2
    - Outside
        - 2 x 2
- Cleanroom 100
    - 8 x 15 ?
- Cleanroom 10 (2-3x)
    - 2.5 x 2.5
- Chemical Supply
    - 6 x 4 x 3
- Ultra-pure water Plant
    - 4 x 4 x 3
- Parts clean
    - 2 x 2
- 120 Bake (2x)
    - 1 x 1 x 2
    - Inside and outside cleanroom?