400 MHz system (ACS): cavities.

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AB-RF

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TOC

- Status of the cavities
- Documentation
- Cavities in UX45
  - Integration
  - Cryogenics
  - Installation schedule
- Test in SM18
- Conclusions.

Status of the Cavities (1)

- 8 cavities *per beam* (grouped by 4 in a "module"), delivering 1 MV each at injection, and up to 2 MV during collision
- Cavities in Nb/Cu, nominal conditions:
  - P=1350 mbar ± 15 mbar
  - T=4.5K
- Second beam traveling in a warm drift tube placed inside the cryostat: nominal vacuum reached through NEG film;

Status of the Cavities (2)

- Mechanical Tuner (faster than LEP thermal tuner);
- Four HOM couplers per cavity, 2 narrowband for 500 MHz transverse modes, 2 high pass for all the others;

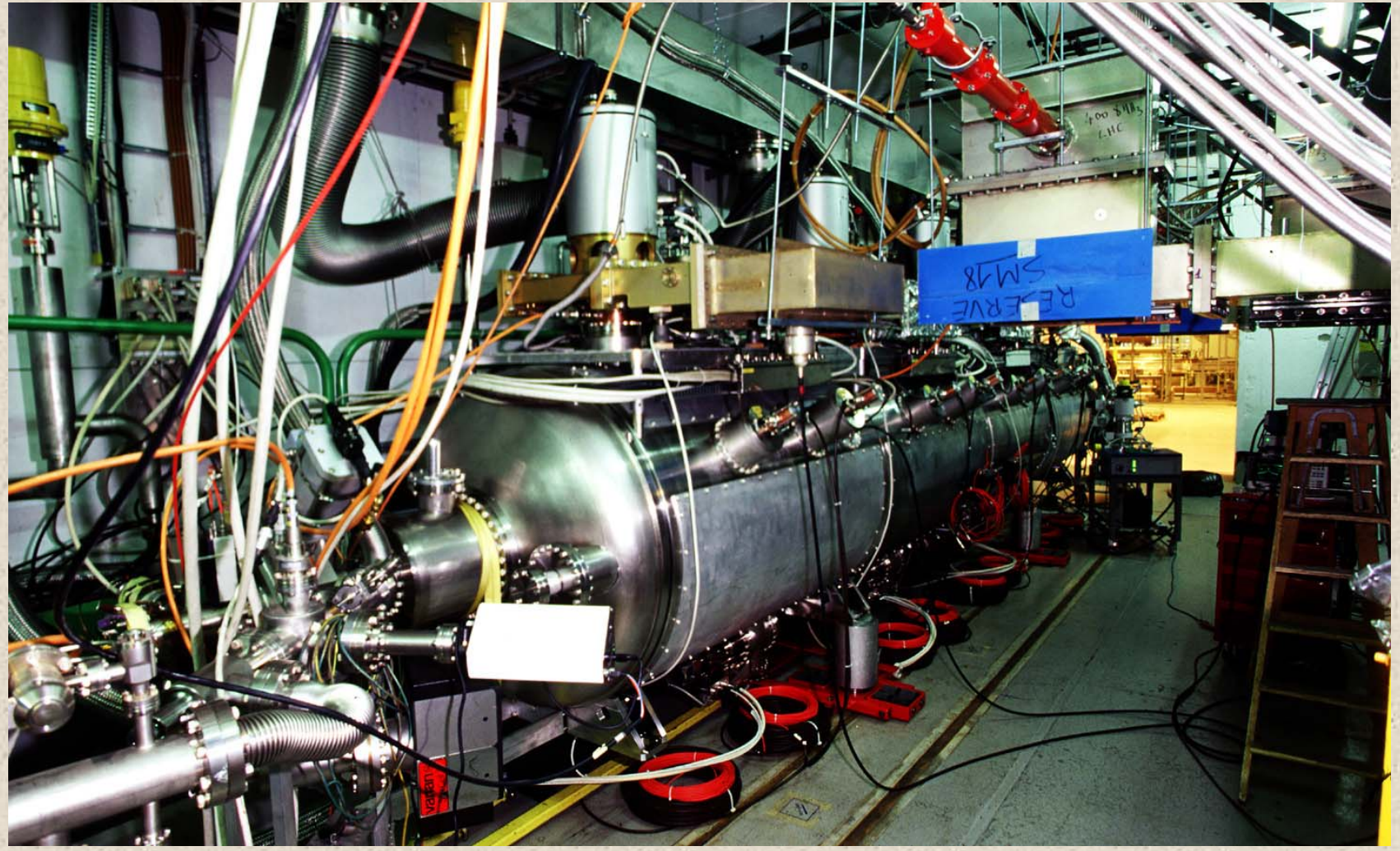
Status of the Cavities (3)

- 5 modules built and Low Power RF tested (4 for the tunnel + 1 spare); Performances OK;
- During Low power test, we realized that the mechanical structure needs several thermal cycles before stabilization.
- ~6 fast cooldowns/warmups are to be applied to each module after re-tuning the cavities.
- Test done on module n.3, the frequency is now stable.

Status of the Cavities (4)

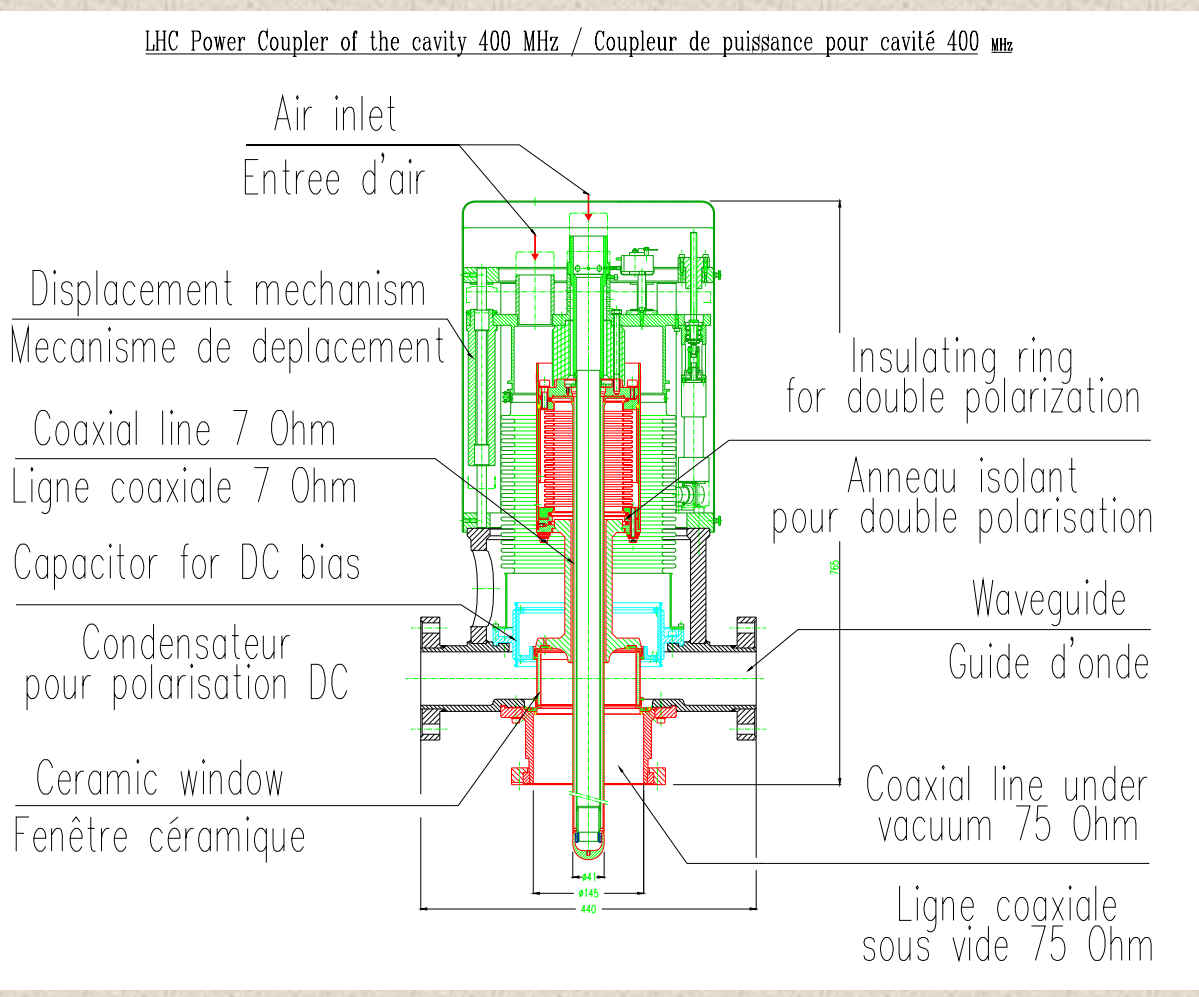
- Components to be delivered yet:
  - 2nd beam tube for 2 modules, by the end of the year;
  - Power couplers, 4 prototypes mounted, 4 series couplers by beginning 2004, the 16 for the tunnel within 2004;
  - Instrumentation (level/pressure gauges, safety valves etc..)
- High Power Test:
  - Started this week with prototype couplers on the first module.
  - 1st cavity is going very well;
  - 2/3 weeks per cavity, not possible to condition two cavities at the same time in SM18.

Status of the Cavities (5)



Status of the Cavities (6)

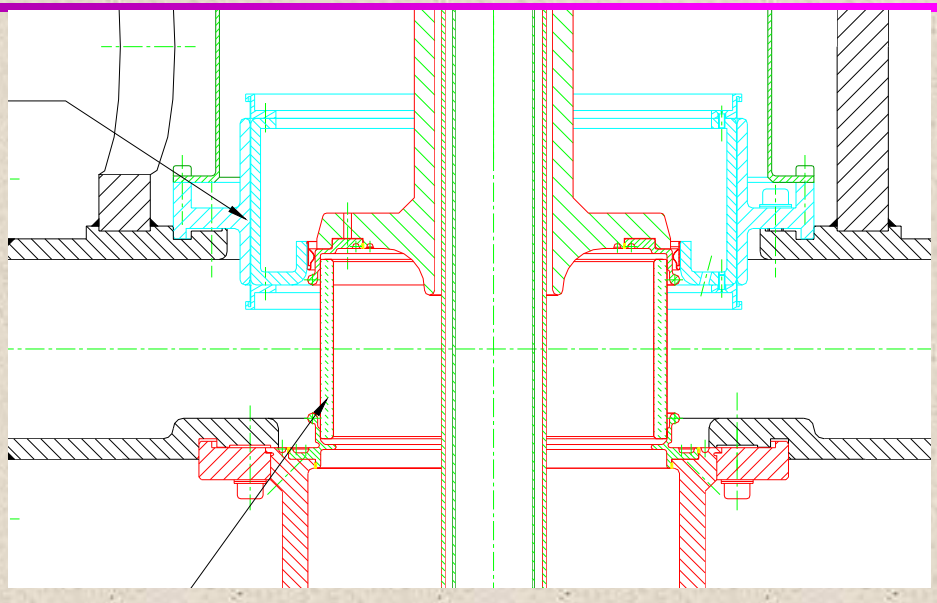
- Power Coupler (Courtesy of E. Montesinos)



It is a ***mobile*** RF power coupler with ***very high power***

Requirements (300 kW CW RF + beam loading), which is a very difficult technological challenge.

Status of the Cavities (7)



Very good RF results on the room temperature test stand in full reflection:

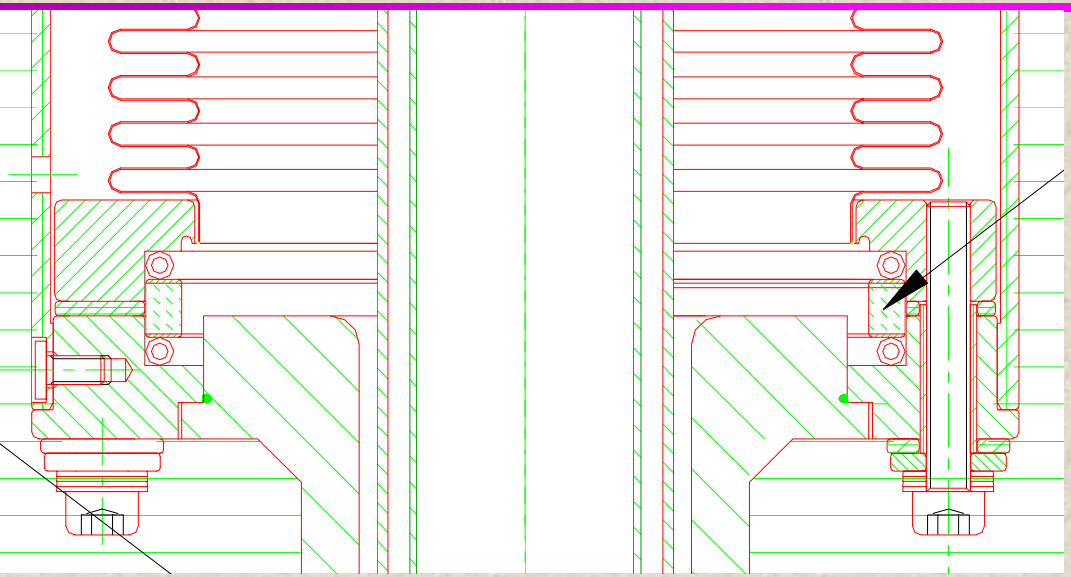
550 kW CW for hours,

and

450 kW CW for days.

- However, this was only possible after a ***significant modification*** of the copper part geometry with respect to the original design to permit efficient and reliable brazing

Status of the Cavities (8)



- To avoid multipactoring, it has a double DC bias polarization through a second ceramic insulator.

- During some recent baking out processes, that ceramic has experienced similar problems as with the main ceramics: ***evolutive cracks***.
- We are waiting for tests with new methods of manufacturing: no machining, new materials, brazing with final dimensions, which should allow us to avoid problems.

Status of the Cavities (9)

- All the mechanical components have been already produced.
- We have half of the RF windows, the production is on schedule (end: December 2004)
- For the 2nd ceramic, once the problem solved, there should not be any delay
- This assembly ***will stay very critical*** - we need the support of everybody to finish on time.
- Since the manufacture of the components is extremely delicate, all the process is very lengthy so:
  - we need ***priority treatment*** from:
  - Brazing, Main Workshop, Transport, Vacuum, etc…

Documentation

- We were too fast: quality plan, MTF etc. not yet available and established when contracts started (and when most of them ended...);
- Documentation exists, both in electronic and paper format: all drawings available under CDD;
- Some information already in EDMS;
- PBS sketched for the cavities, excel file stored in EDMS;
- Web site of LHC – RF in construction, hot news available there:
  - http://proj-lhcrf.web.cern.ch/proj-lhcrf/

Cavities in UX45 (1)

- High Power related issues to be addressed by O. Brunner
- Beam control related issues to be addressed by P. Baudrenghien
- What else??
- Vacuum, Cryogenics & Integration →Safety of personnel and material

Cavities in UX45 (2)

- Integration:
  - 99% OK, only some details to be defined yet;
  - Two modules will be very problematic (no room..) (but feasible? See O. B.);
  - Installation procedure to be defined in details. Sequence of installation critical for certain components that are not accessible once everything is mounted.
  - Are those components accessible for repair? (O.B)

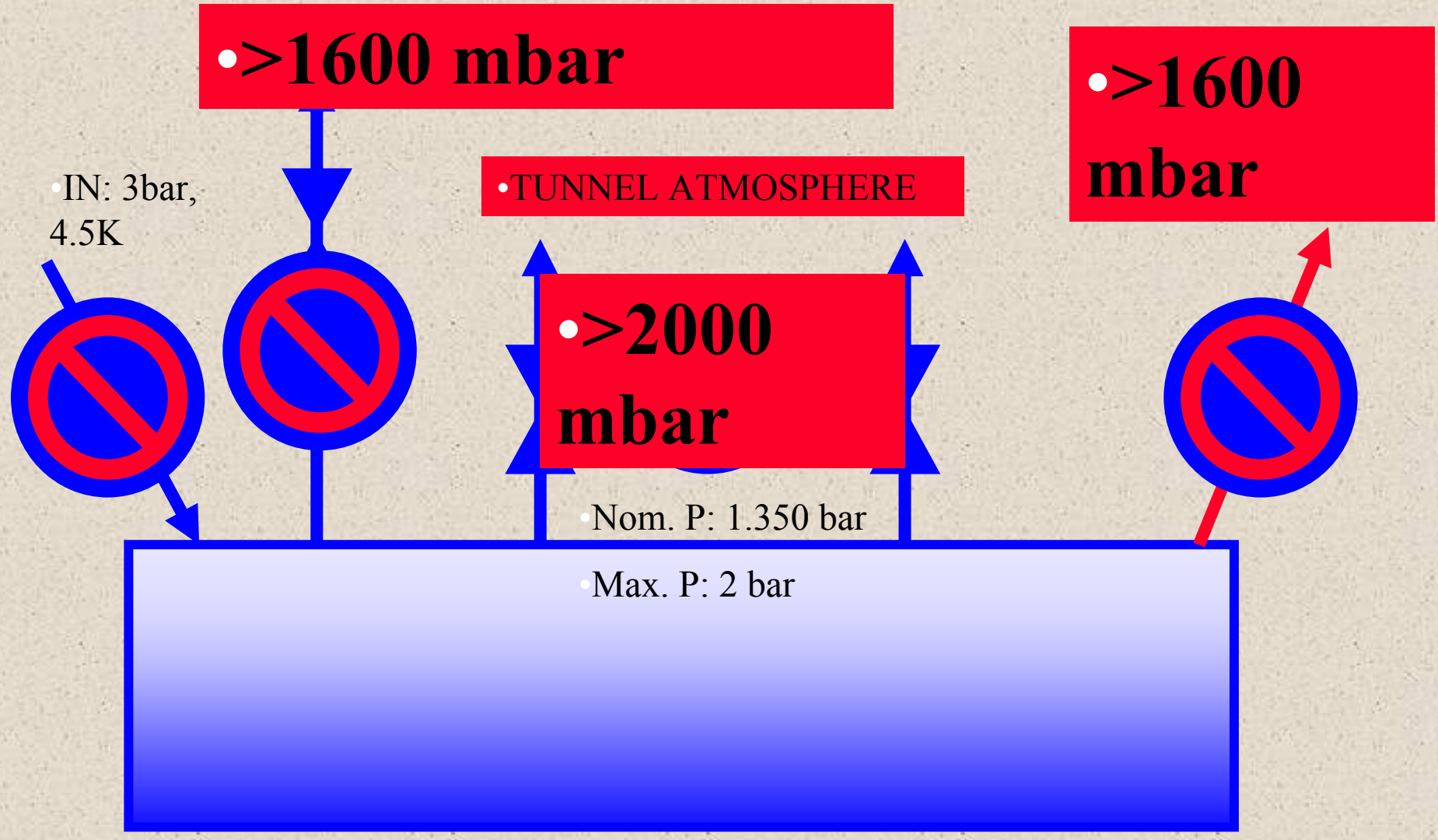
Cavities in UX45 (3)

- Vacuum (AT/VAC):
  - 2nd beam tube defined and tested.
  - It is a warm (~300K) tube, will need activation of the NEG through bake out at 250°C inside the cryostat: special insulation has been foreseen not to burn superinsulation and cabling inside the modules;
  - Bake out to be done only once. To be repeated only if exposed to atmosphere;
  - We keep the possibility to perform Helium processing "in situ", in case of degradation of cavity performances. This requires Vacuum personnel accessing the UX45 with cavities filled with LHe.

Cavities in UX45 (4)

- Cryogenics (AT/ACR):
  - The Liquid Helium distribution system (QRL) has been conceived for the magnets, we had to adapt to it;
  - Main problem: admissible pressures very different from magnets.

Cavities in UX45 (5)



Cavities in UX45 (6)

- Cryogenics :
  - Problems?

1) Personnel Safety;
2) Downtime in case of problems;
3) Path for Helium discharge through cavities.

Cavities in UX45 (7)

1) Personnel Safety;

- A policy for security of people accessing UX45 with cavities full has to be studied in details.
- Access with cavity filled with LHe will be needed
  - During commissioning for calibrations and debugging (not sure)
  - Vacuum people for He Processing
  - For all other cases should be possible to empty the modules before going inside the tunnel

Cavities in UX45 (8)

2) Downtime in case of problems.

- The purge can only be done in parallel with the magnets;
- If a safety relief valve is opened, a leak check will be necessary, even if the chosen model should be tight.
- Probability not very high during operation, more probable during commissioning.

Cavities in UX45 (9)

3) path for Helium discharge through cavities

- If something goes wrong with the valves, the whole sector may discharge through the cavities' safety valves.
- Probability very low, but not zero.

Cavities in UX45 (10)

- Installation:
  - Schedule very tight:
    - Installation during 2006
    - Start of commissioning only after magnet commissioning (October 2006 according to the official schedule)
    - 1st beam April 2007

Cavities in UX45 (11)

- Test in SM18
  - Most of the “debugging” has to be done before the installation on a full RF chain:
    - High power Supply
    - Klystron, circulators, waveguides
    - Cavities
    - Low Level Controls
  - We are upgrading SM18 to perform all the checks we can do without a beam

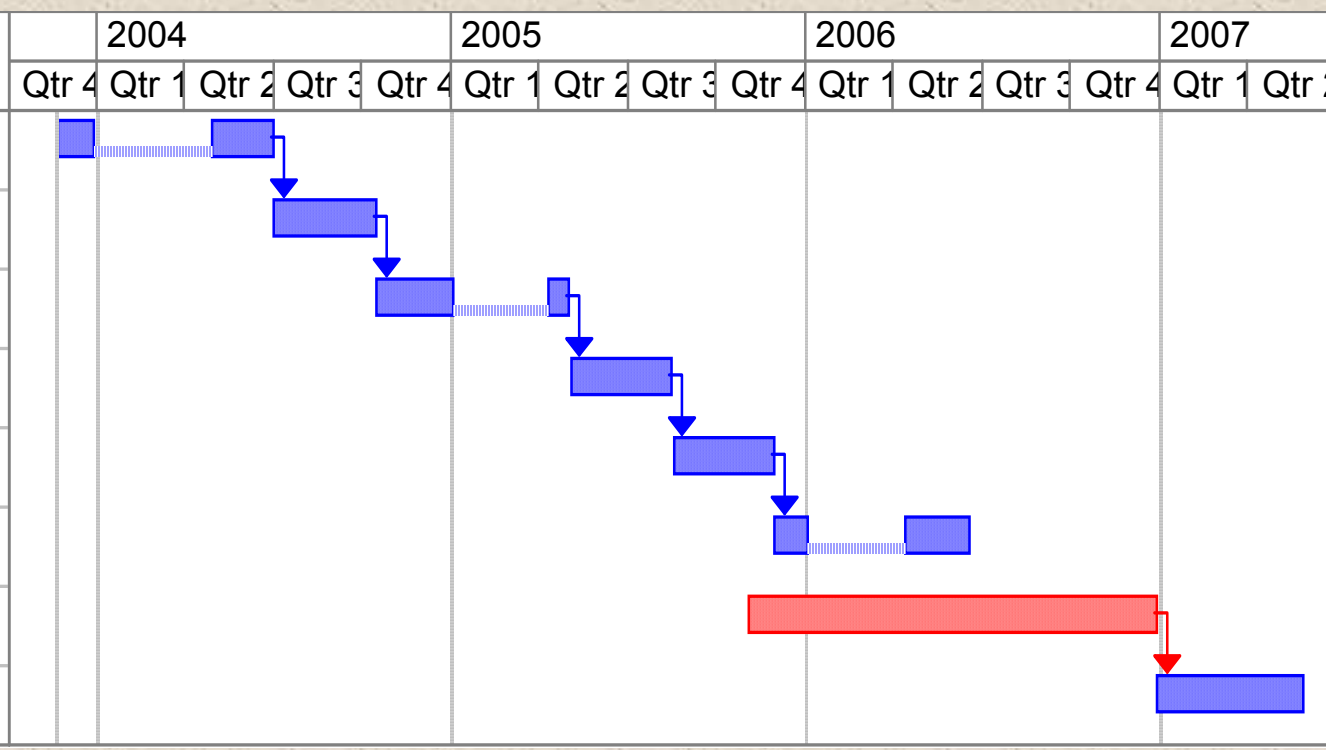
Test in SM18

- The full chain test has to be carried out together with high power conditioning (2/3 weeks/cavity) and thermal cycling.
- That means 48 weeks for conditioning + connection/disconnection from the test stand + Full chain test = ~ 2 years : 2004/2005
- Some more time for the spare module and thermal cycling.

Test in SM18

- tentative schedule

ID	Task Name
1	Module 3
2	Module 1
3	Module 2
4	Module 4
5	Module 5
6	Module 3
7	Installation
8	Commissioning



Conclusions

- Status
  - cavities' assembly 95% ready: all the modules are in SM18;
  - Power Couplers: We have had to overcome serious technological problems. There is still a remaining problem with the polarisation ceramic to solve.
- Cavities in UX45
  - Main problem is safety;
  - Installation schedule is tight
  - Need availability of SM18 installations AND space till 2006;

Conclusions (2)

- Once tested and qualified for installation, they have either to stay in SM18 or to leave for their final destination:

- There are 13 (!) Ceramic feedthroughs on each cavity (52 per module), each one might break during transport. Number of travels has to be minimized.
  - Breaking a ceramic would need a complete dismantling of the module to rinse the cavities.

Acknowledgements

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