Superconducting Cavities: Development/Production

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LEP FEST 2000, 10-11 October 2000
Science Symposium

List of Topics

- Brief history
- Research and Development at CERN
- Industrial Production
- Conclusion

Brief History

- In the last two decades many laboratories around the world decided to develop the technology of superconducting accelerating cavities
- Aims:
  - to increase the accelerator energy
  - to save electricity consumption
- Two different technologies: bulk Nb (traditional) and Nb/Cu (niobium film deposited on copper)

Brief History

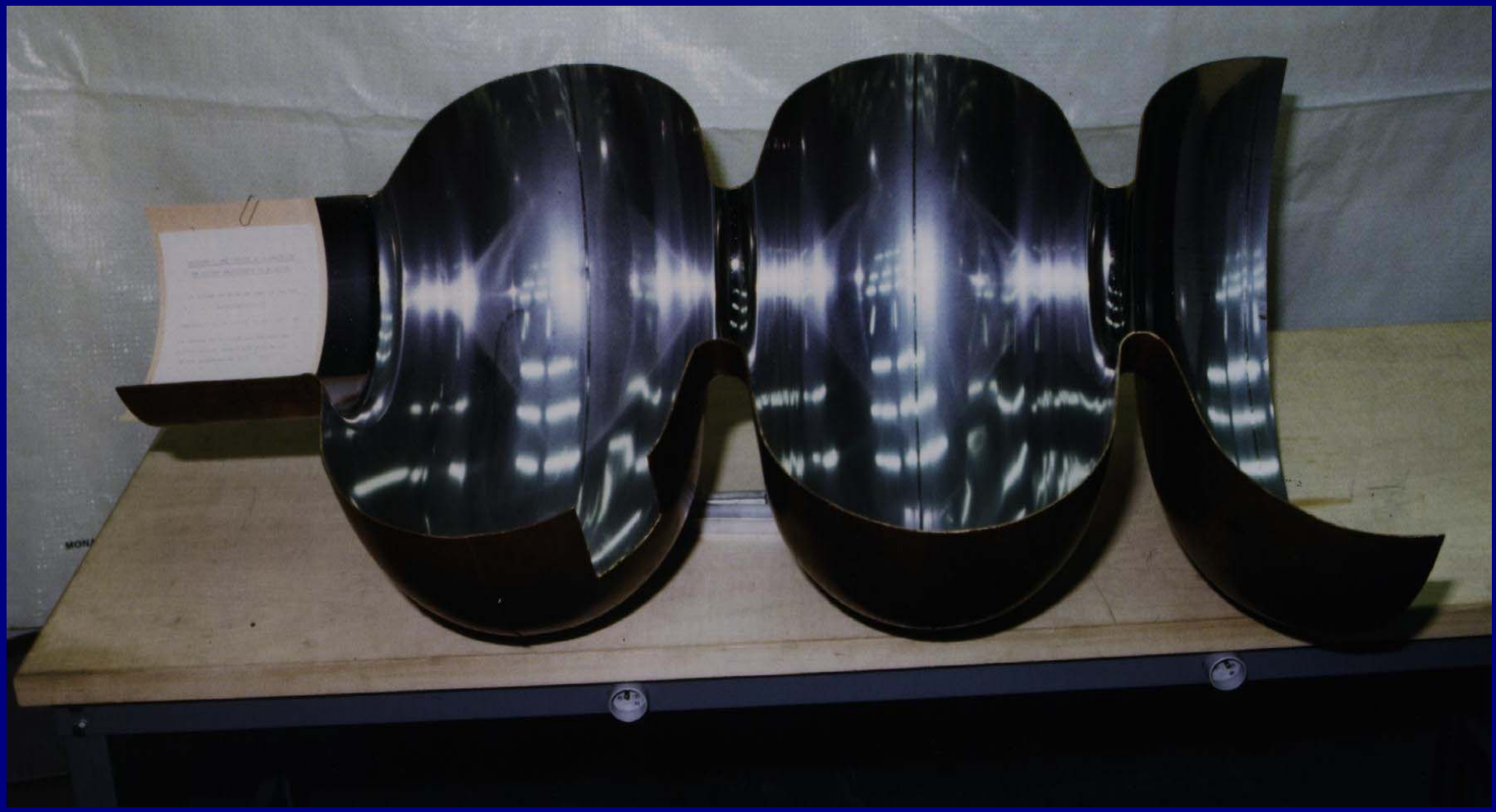
- In 1979 R&D on Superconducting RF started
- In 1980 a development programme aiming at the production of coated SC RF cavities was started at CERN
- High purity copper presents at 4.2K a thermal conductivity an order of magnitude higher than the high-purity niobium

Nb/Cu Technology

- C. Benvenuti
- Ph. Bernard
- E. Picasso

R&D at CERN

- Advantages of Nb/Cu technology
  - considerably higher stability against quenches
  - insensitivity to small magnetic fields
  - quality factor (Q) higher than bulk Nb (same frequency and temperature 4.5K)
  - cost saving



R&D at CERN

- Problems encountered
  - substrate preparation before coating is a major problem
  - to avoid “peel-off” of the Nb film any contamination has to be avoided
  - A defect of mm^2 size on the **6 m^2 surface** of a cavity can spoil the RF performance

R&D at CERN

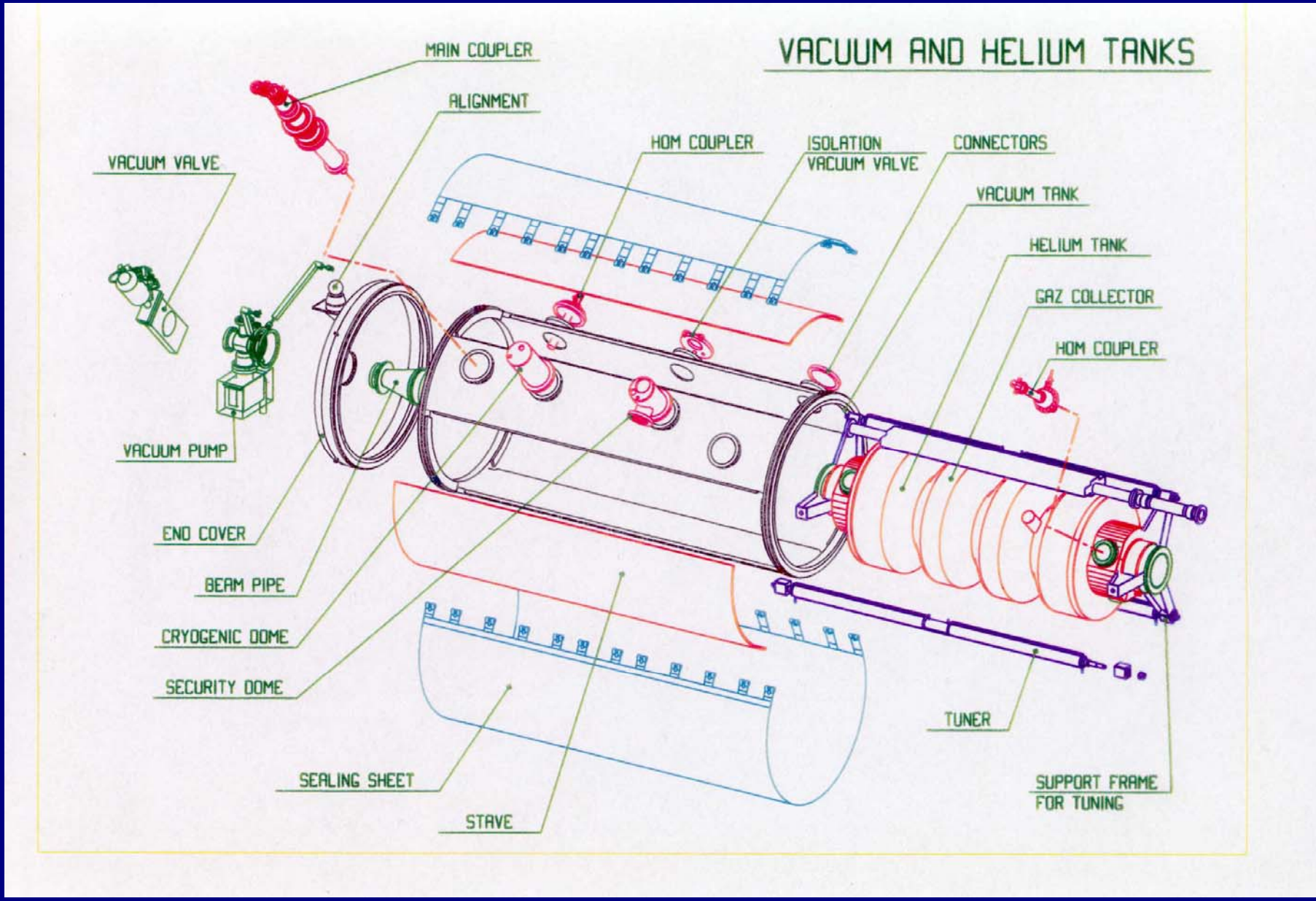
- Special “recipe” has been developed at CERN
  - chemistry preparation
  - rinsing with high-purity water (18 MΩ)/cm)
  - clean room (class 100) conditions for any critical stage (magnetron installation on cavity, rinsing and drying)
- Equivalent procedure for silicon wafers used for VLSI (Very Large Scale Integration) integrated circuit (surface 20 cm^2!!!)

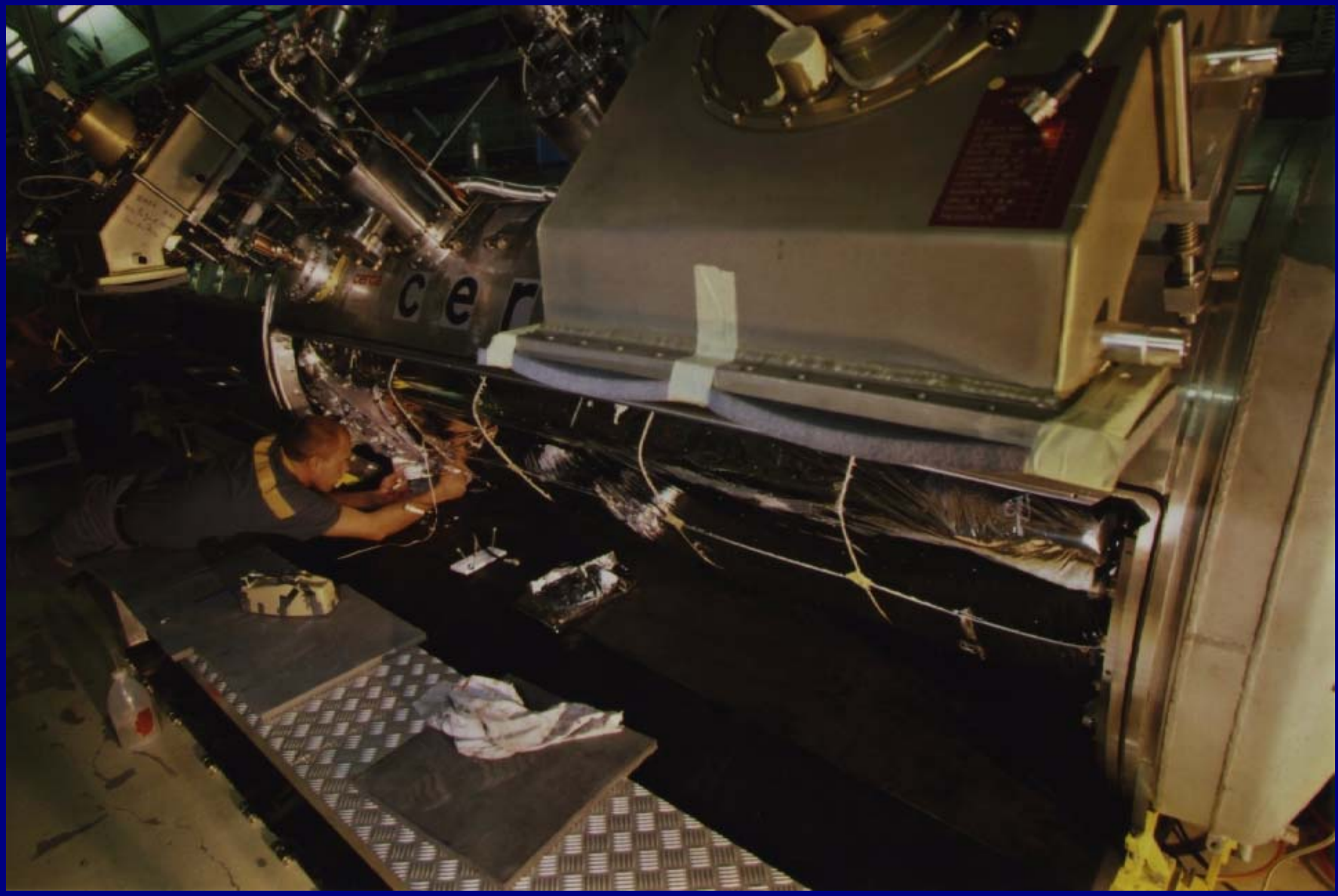
R&D at CERN

- Vacuum vessel
  - special vacuum vessel was designed and developed at CERN to provide high accessibility for all critical parts (RF, HOM, tuners, RF cables etc.)

Vacuum vessel

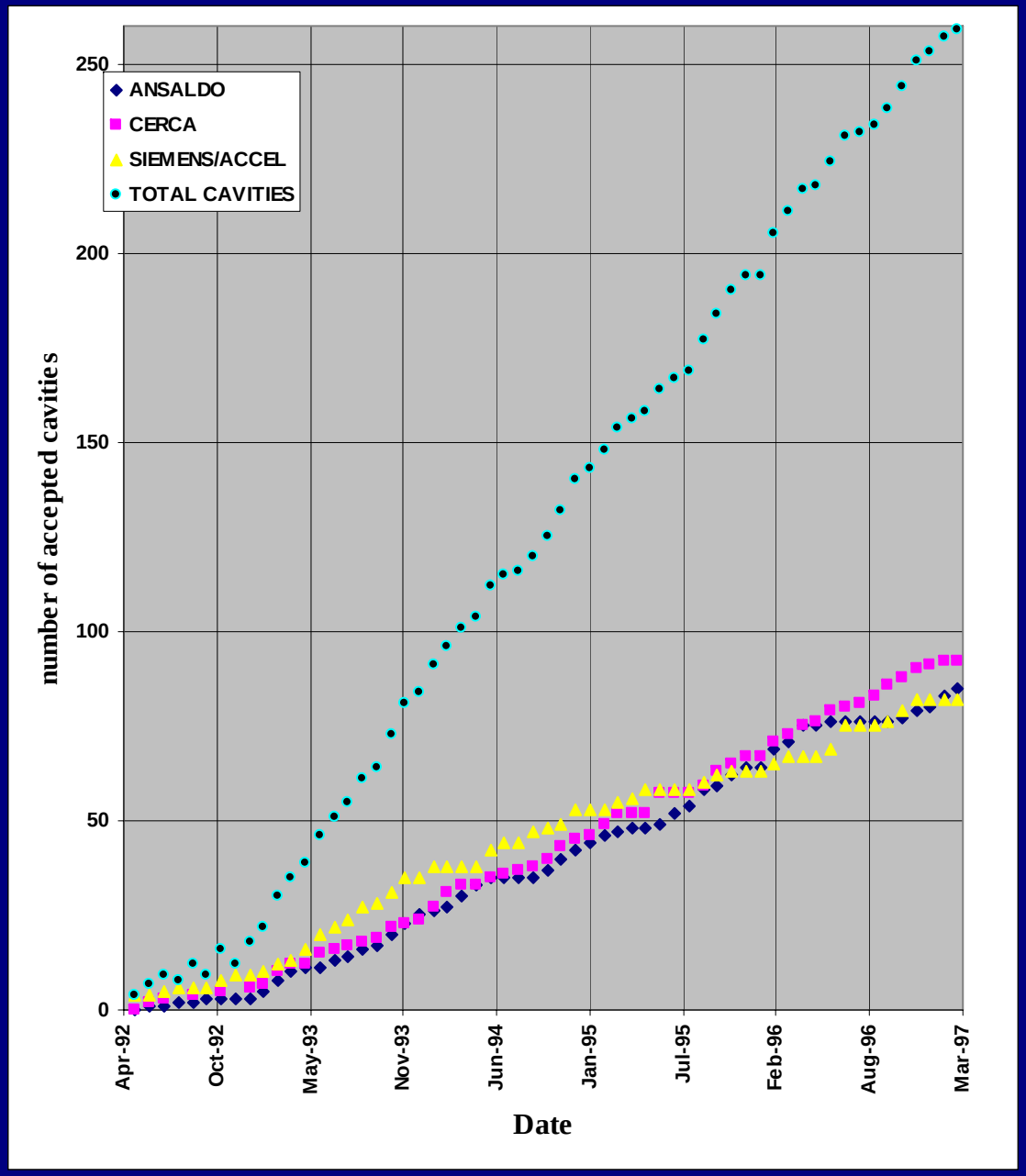
- Ph. Bernard
- R. Stierlin


VACUUM AND HELIUM TANKS
MAIN COUPLER
ALIGNMENT
HOM COUPLER
ISOLATION VACUUM VALVE
CONNECTORS
VACUUM VALVE
VACUUM TANK
HELIUM TANK
GAZ COLLECTOR
HOM COUPLER
VACUUM PUMP
END COVER
BEAM PIPE
CRYOGENIC DOME
SECURITY DOME
TUNER
SEALING SHEET
STAVE
SUPPORT FRAME FOR TUNING



Industrial Production

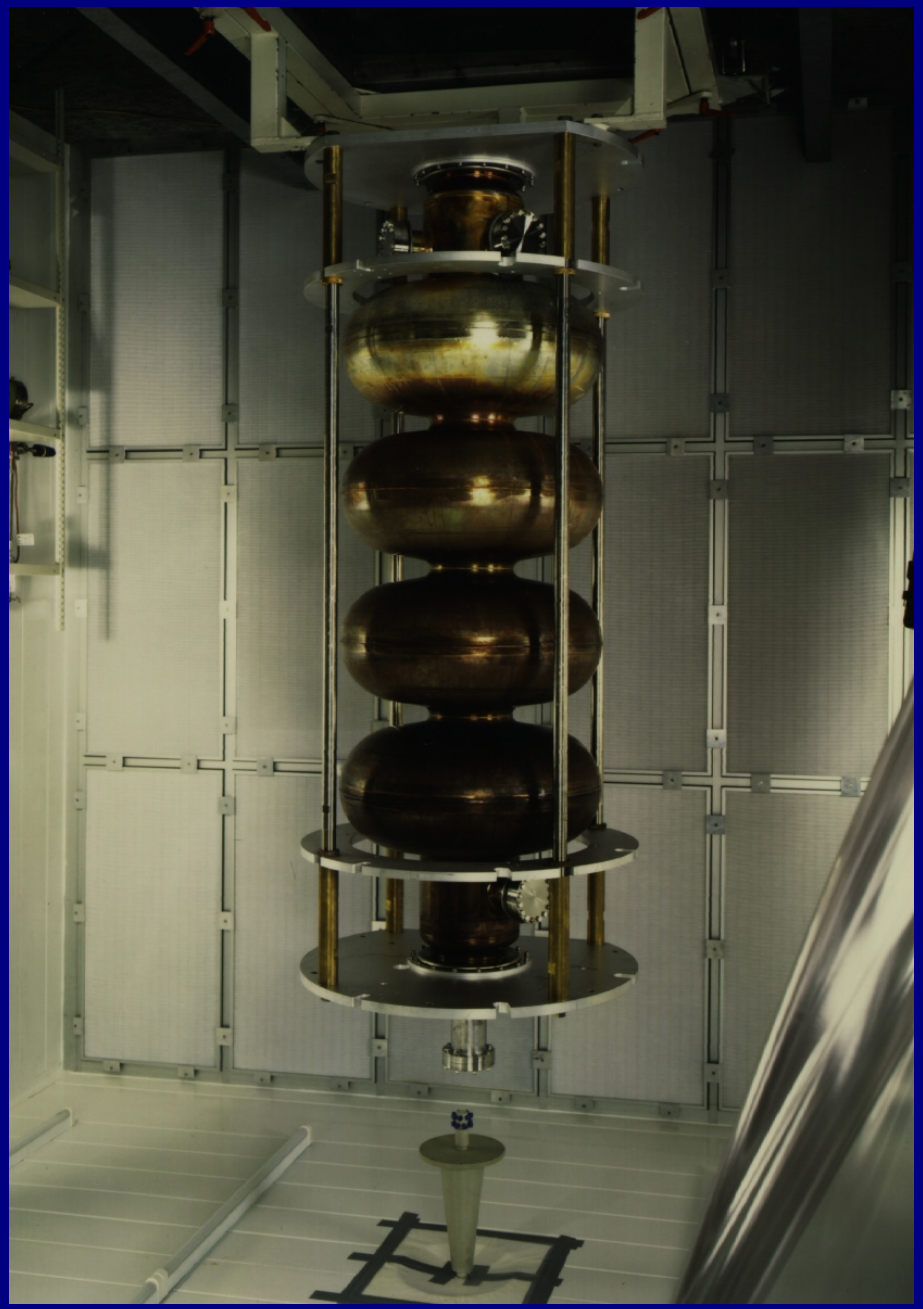
- LEP Project:
  - Three European companies:
    ANSALDO, CERCA, SIEMENS (now ACCEL)
  - Why three companies?
    - Reduce risks associated with the most critical element of LEP2
    - Increase speed of production


ANSALDO
CERCA
SIEMENS/ACCEL
TOTAL CAVITIES
number of accepted cavities
0
50
100
150
200
250
Apr-92
Oct-92
May-93
Nov-93
Jun-94
Jan-95
Jul-95
Feb-96
Aug-96
Mar-97
Date

Industrial Production

- Major challenge for CERN was to transfer the technology to industrial firms in order to master different technologies:
  - electron beam welding
  - ultra-high vacuum
  - chemical cleaning
  - Nb sputtering
  - clean room and high-purity water facilities


ANSALDO



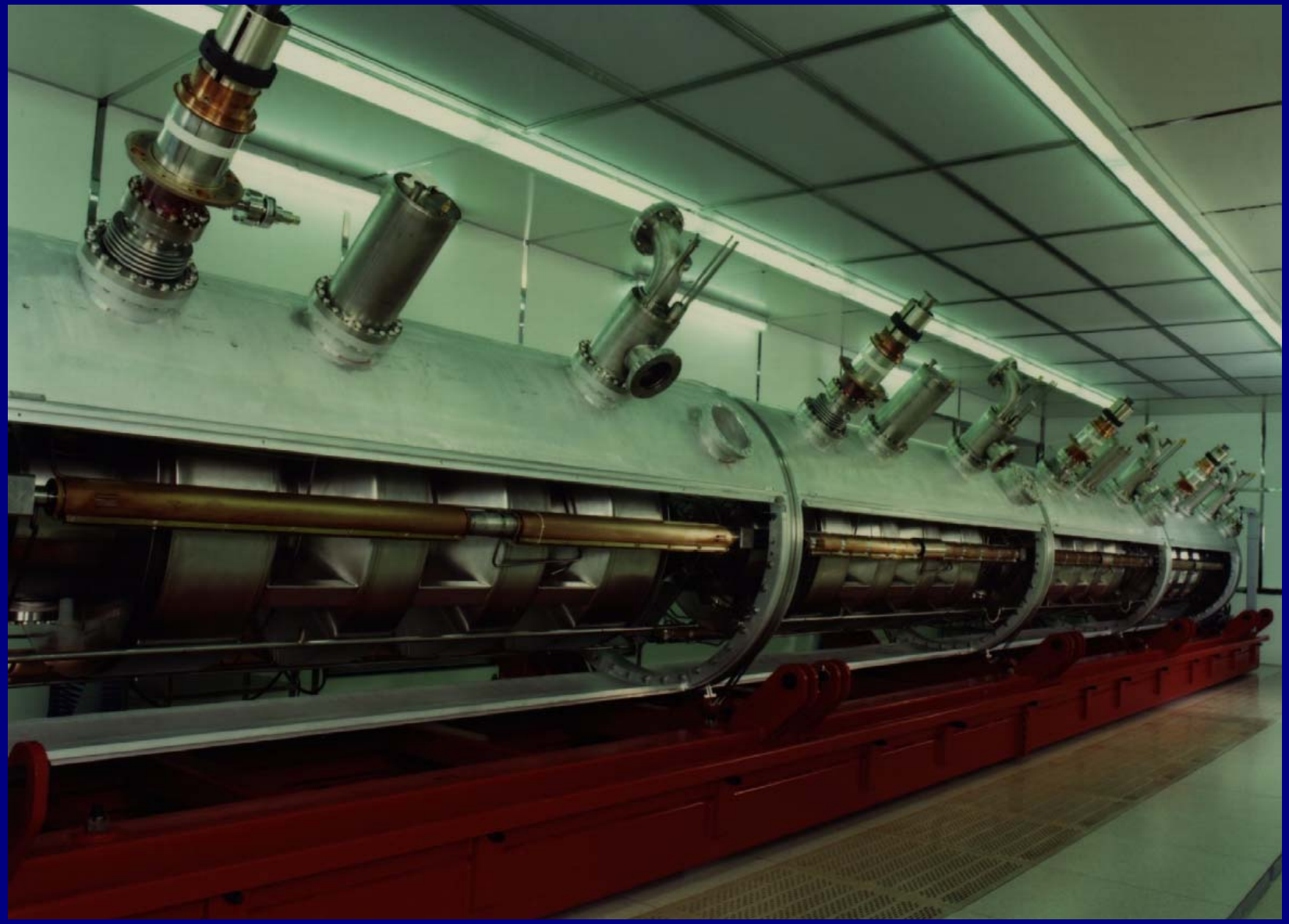
Industrial Production

- Problems encountered during industrial production:
  - surface preparation of copper cavity before the Nb coating
  - final assembly of RF module in the clean room

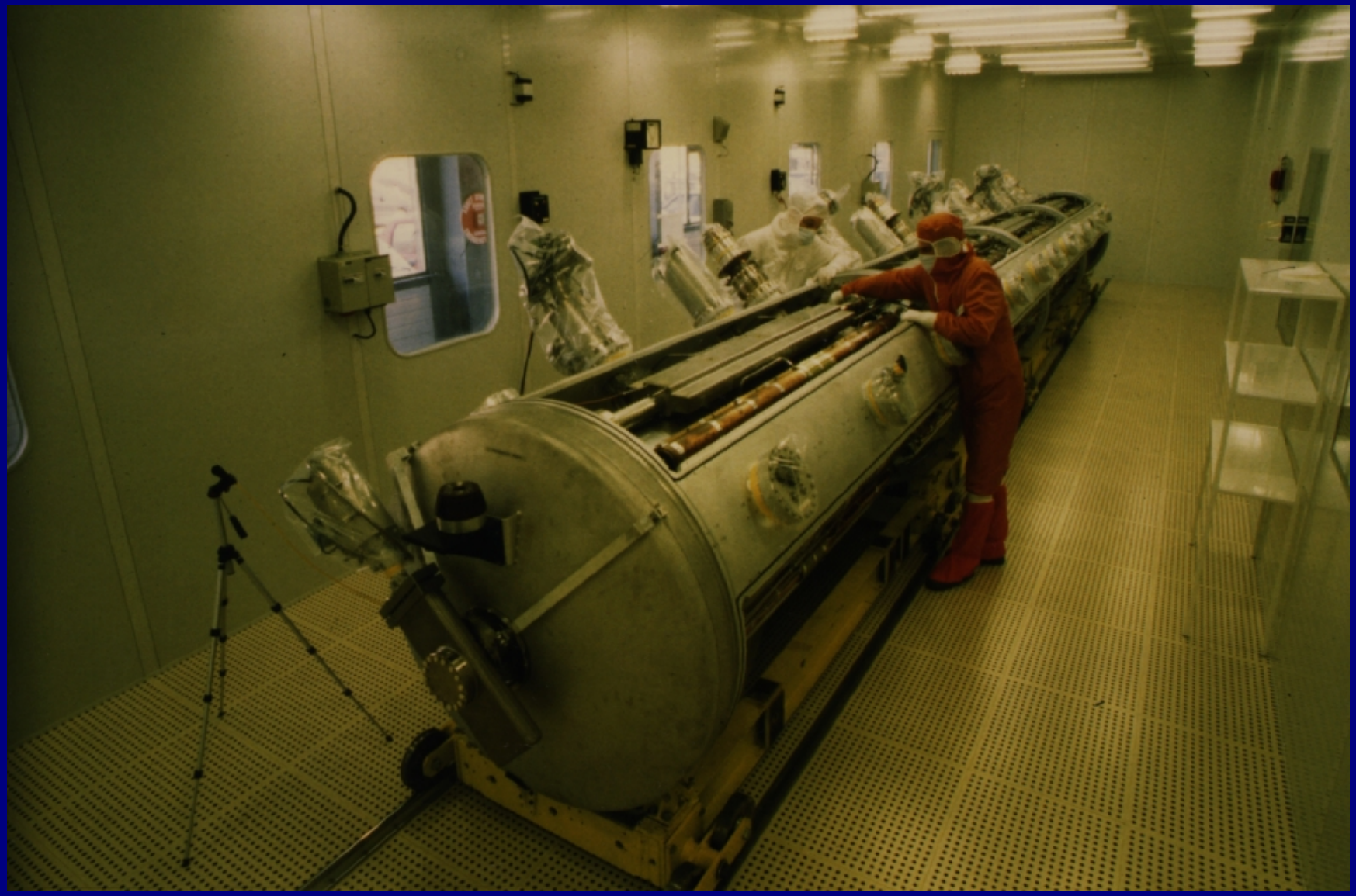
Industrial Production

- Solutions to the problems:
  - for surface preparation:
    - very precise quality control procedure
  - for final assembly:
    - sequence of precise procedures and development of a special behavioural “culture” for clean room technique


ANSALDO
GIE
CAVITA' SUPERCONDUTTRICI 352 MHZ
LEP 200 - CERN 1992




10 CM



Conclusions

- Cavity production for the LEP2 project (niobium on copper) can be considered a great technological success, fruit of the excellent collaboration between CERN and European industry

Conclusion

- I would like to stress that the new technology has attained sufficient maturity to make it attractive for future applications.

Conclusions

- The superconducting cavities would not be an industrial reality without the technical competence and strong motivation of all CERN technical staff involved.