# TESLA Quad Package With BPM

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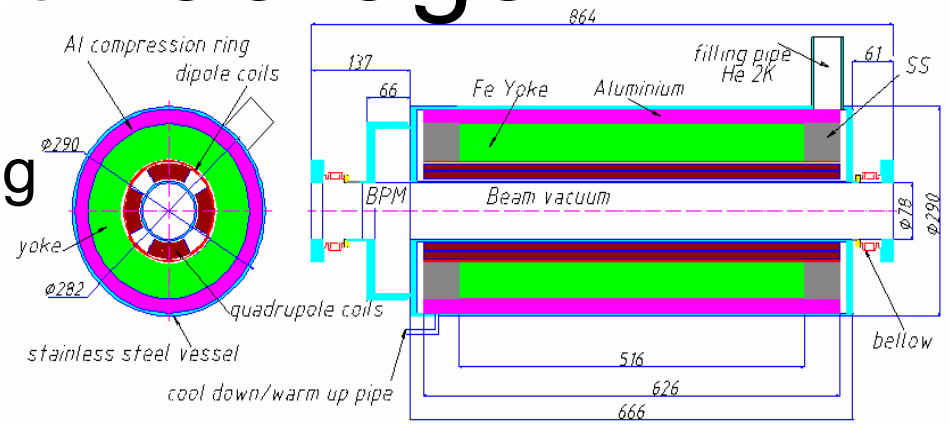
Technology Working Group

# Topics

- The TESLA Quadrupole Package
- Status of Components
  - Magnet
  - Feedthroughs
  - HTc Leads
  - BPM
- Test in ACC6

# Tesla Magnet Package

- cos2Θ superconducting quadrupole
- vertical and horizontal correction dipoles
- iron yoke, aluminum shrink cylinder, helium vessel
- HTc current leads (≤50 K)
- beam position monitor (BPM) attached



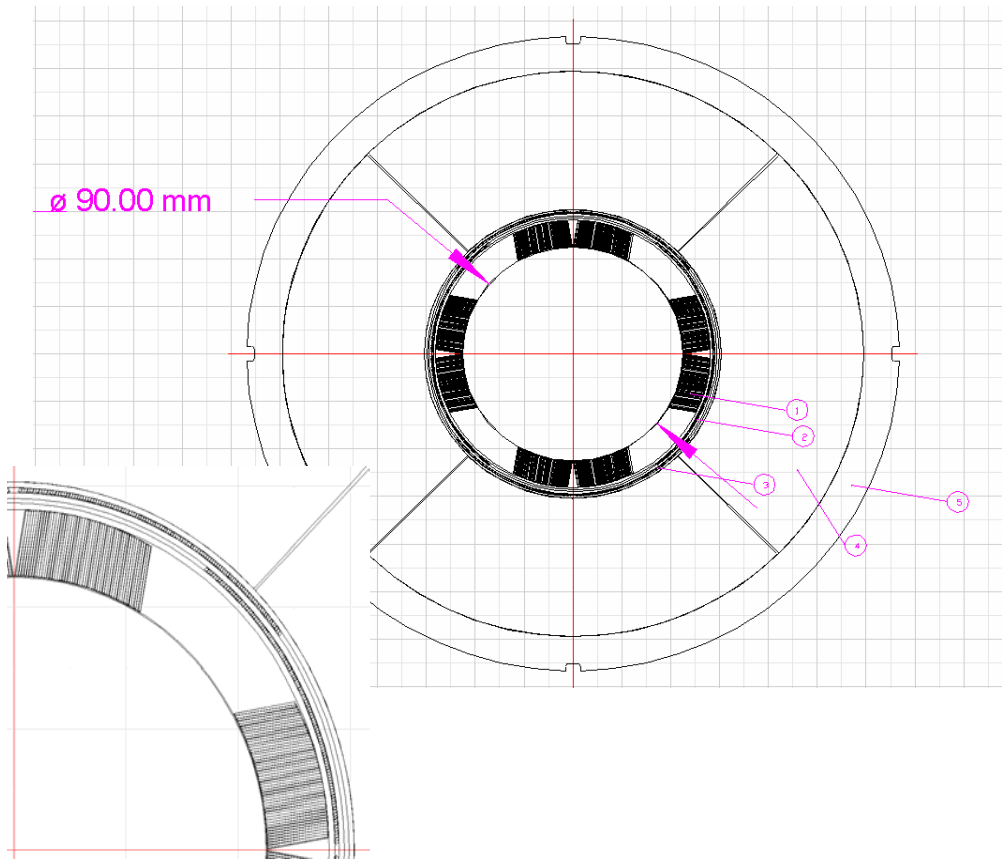

| | |
|---|---|
| **quadrupole gradient** | **63.5 T/m** |
| **quadrupole current** | **100 A** |
| **quadrupole inductance** | **~ 2.53 H** |
| **dipole field** | **0.11 T** |
| **dipole current** | **40 A** |
| **dipole inductance** | **~29 mH** |
| **max. field at conductor** | **3.22 T** |
| **field length** | **0.52 m** |
| **alignment error (angle)** | **0.1 mrad rms** |

# The TESLA Magnet Package

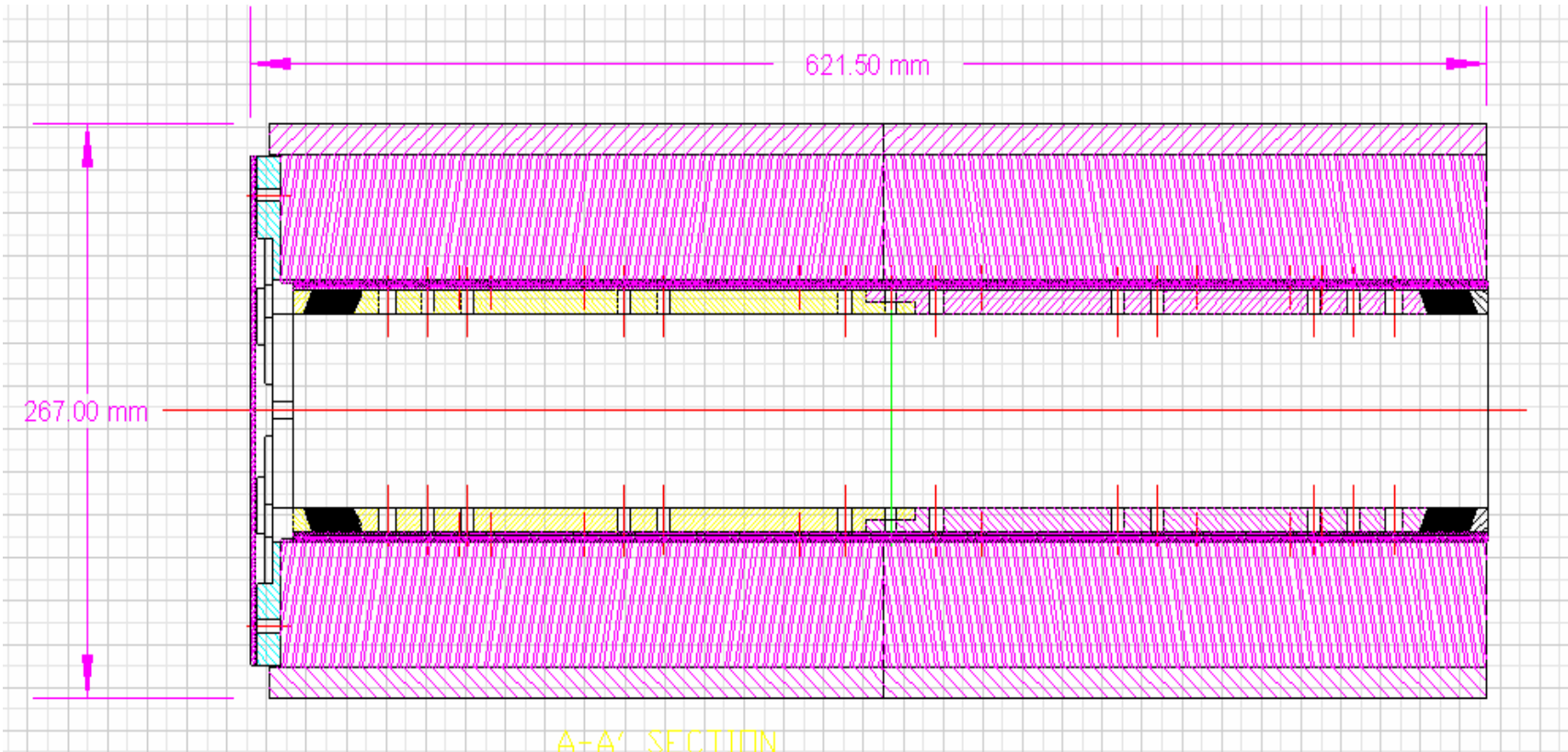
- Development of the package and fabrication of 2 prototype modules by Ciemat/CEDEX, Madrid, Spain
- Responsible Luis Garcia-Tabares, Fernando Toral
- Tests of components and final magnets at DESY

# The Tesla Magnet Prototype

- Quadrupole
  - double layer
  - multi wire ribbon
- 2 Correction dipoles between quad and yoke
- Solid iron yoke (4 blocks, split in length)
- Aluminum shrinking cylinder (split in length)
- Package operated at 2K

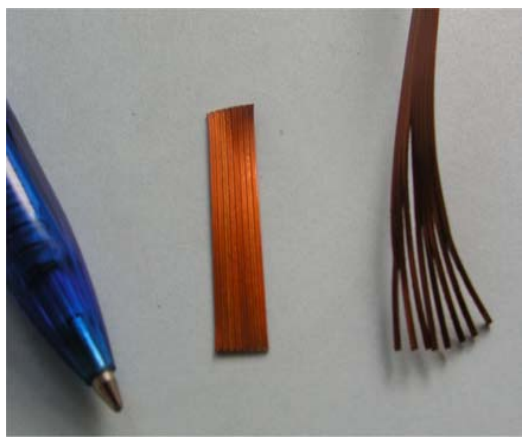


# The Tesla Magnet Prototype

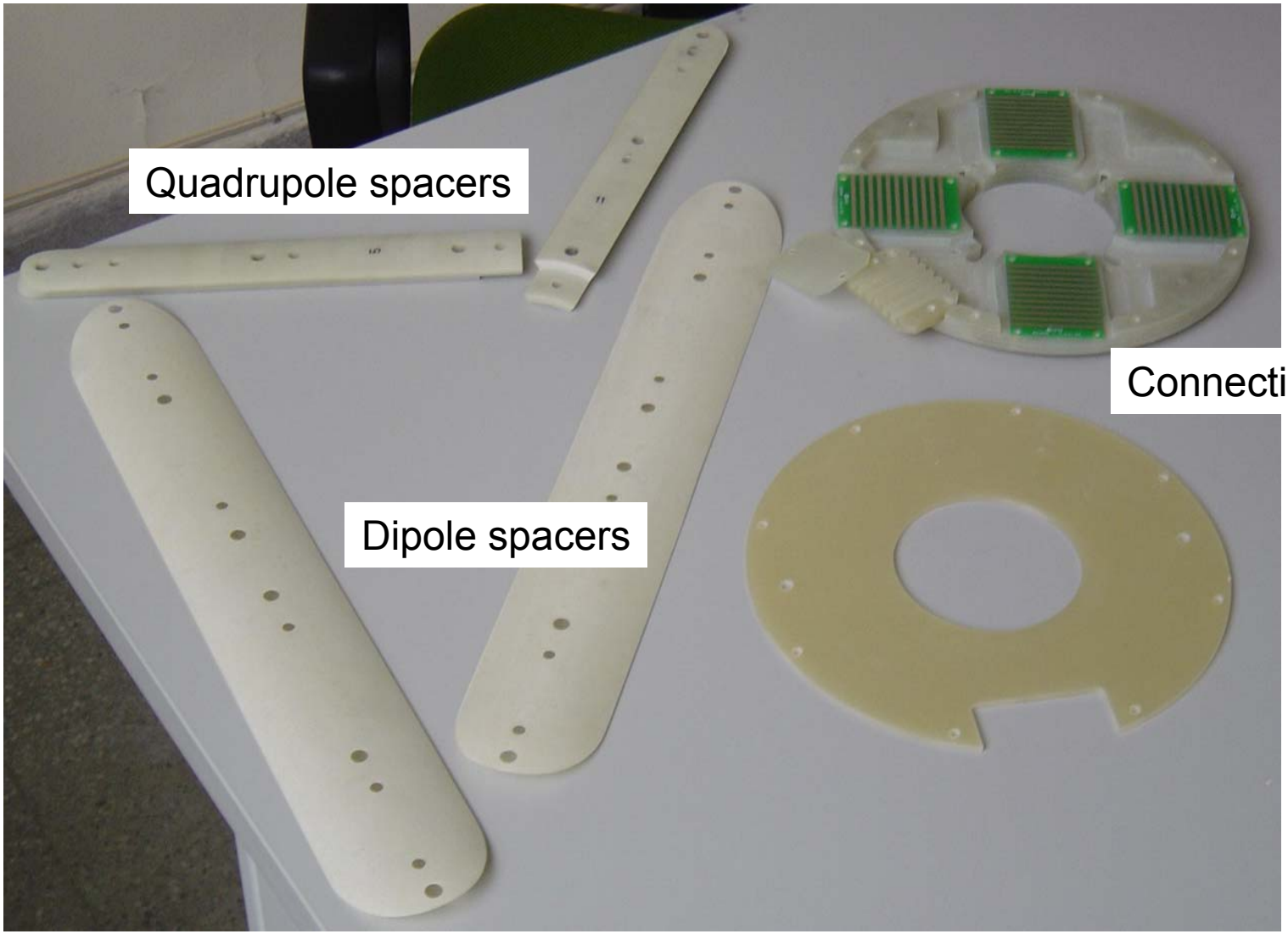


# Ribbon Machine

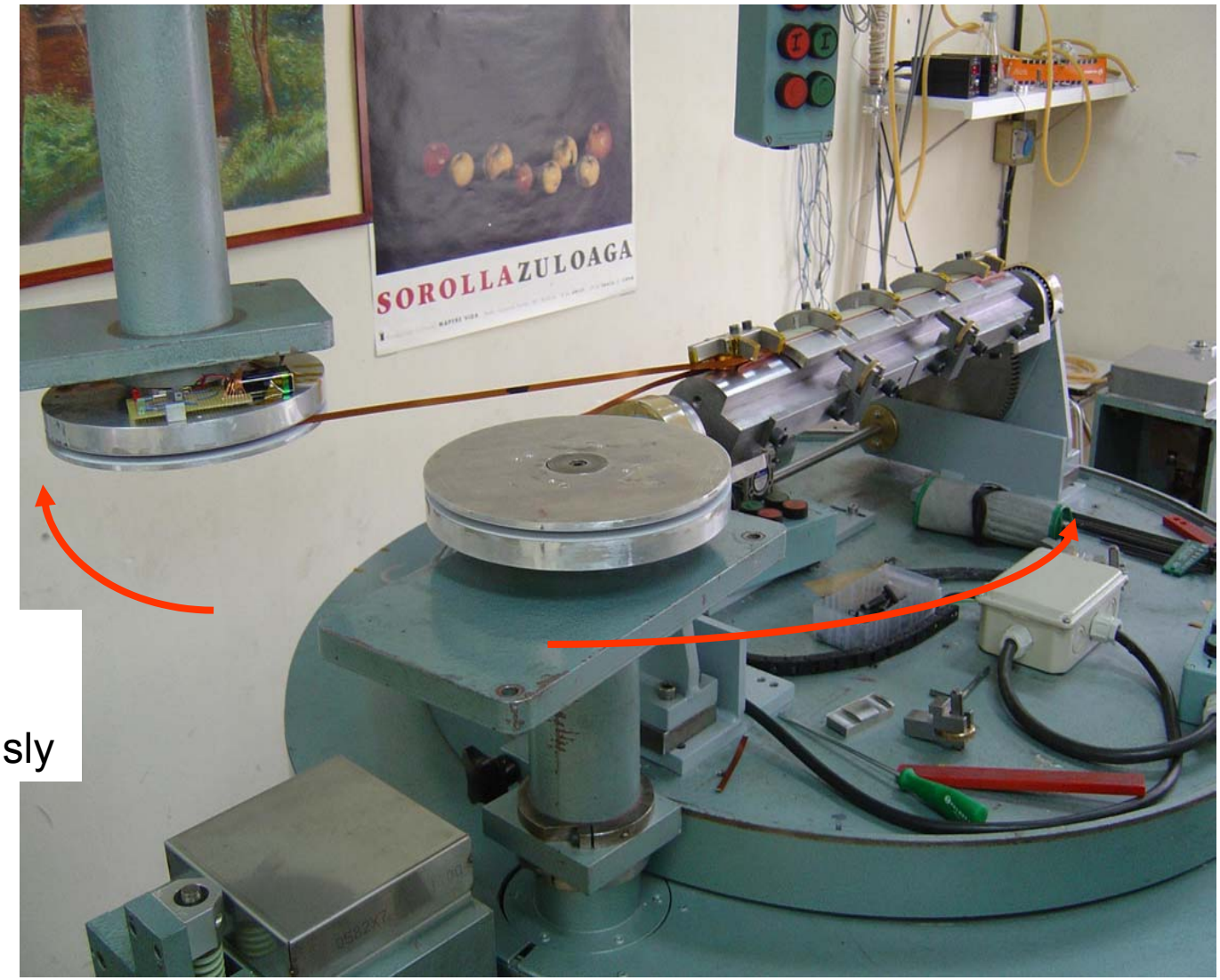
- 8 wires glued by EPOXY to flat cable
  - 0.41x0.64 mm nude dimensions
  - 0.46x0.69 mm PVA enamel insulated,
  - Cu/Sc=1.84, 4182 filaments, 5.2 micron, RRR=119
  - tolerances are 0/-0.01 mm
- Machine able to produce 130m long ribbons as needed for a coil



# Glass fiber pieces for the coils, connection plate

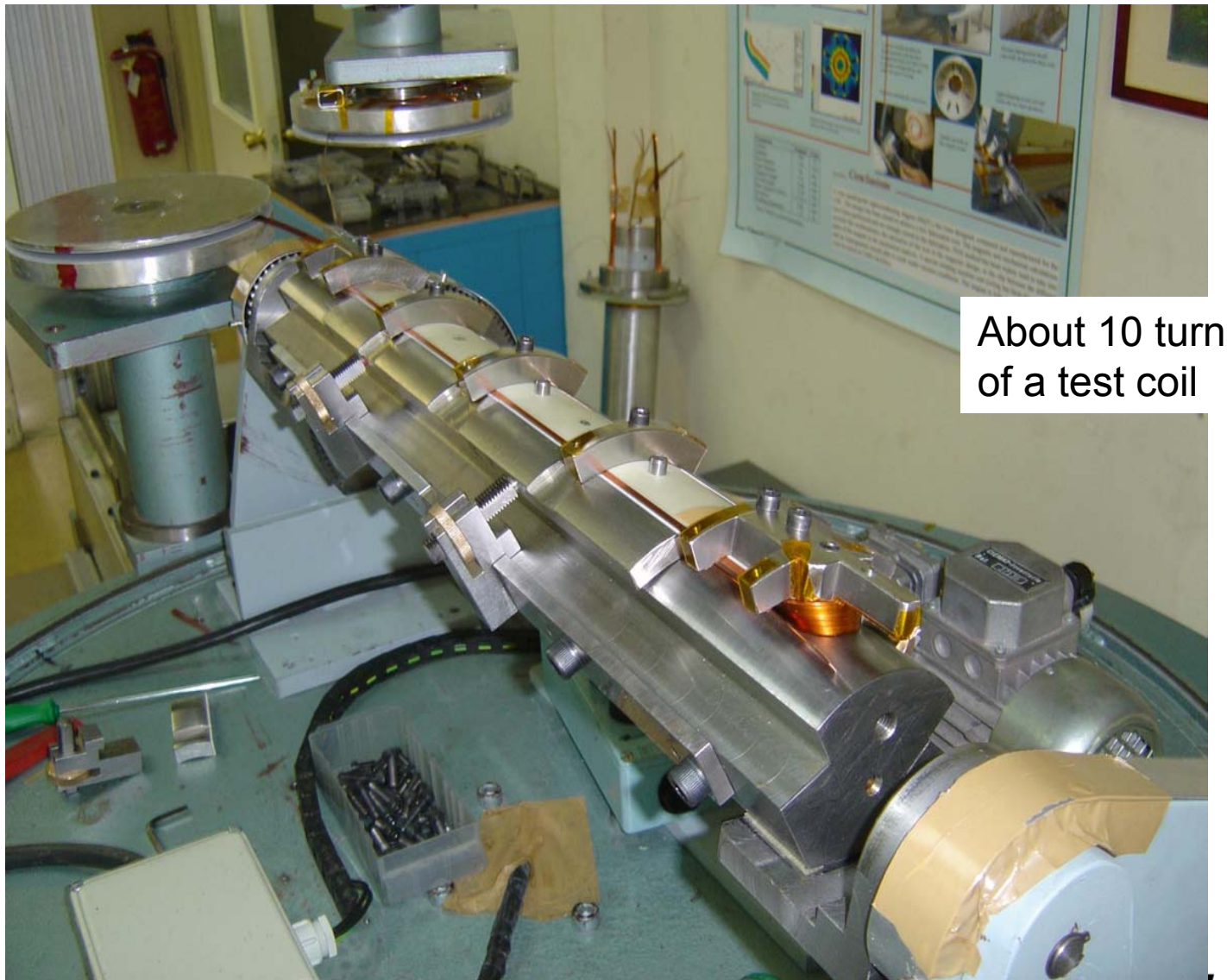


# Winding machine with quad coil




Both layers wound simultaneously

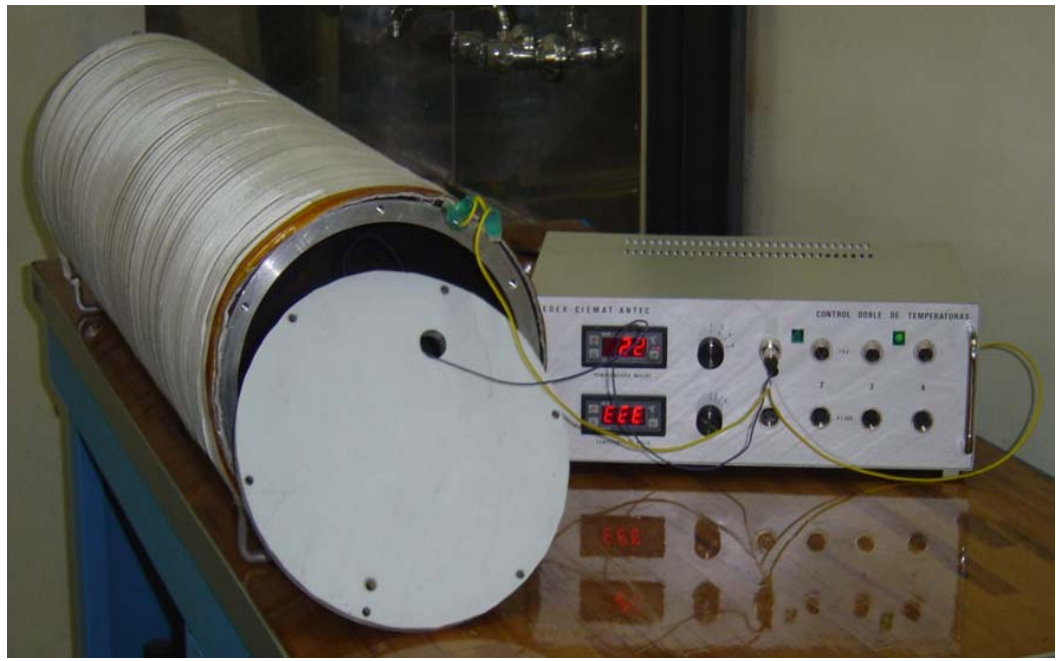
# Winding machine with quad coil



About 10 turns of a test coil

# Vacuum chamber for impregnation

## Curing oven

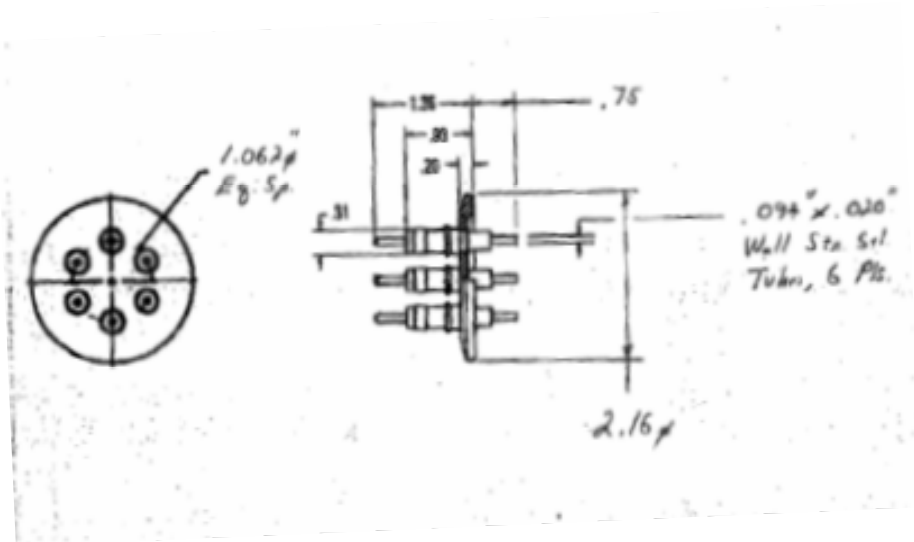


# Status of the magnet fabrication

- Ribbon machine working, first ribbon produced
- Winding tooling is finished
- Vacuum impregnation chamber ready and tested
- All spacers ready, problems with the layer jump fixed
- First quadrupole coil next week
- Curing oven available
- Iron yoke an aluminum cylinder ready soon
- Complete magnet expected at DESY in April
- Ciemat/CEDEX needs input for the cryostat design

# Feedthroughs

- CEDEX in-house development
  - Based on printed circuit boards
  - First pieces got leaky after some cryo cycles
  - Improvements in preparation
- Commercial FT from CABURN
  - Ok, but expensive





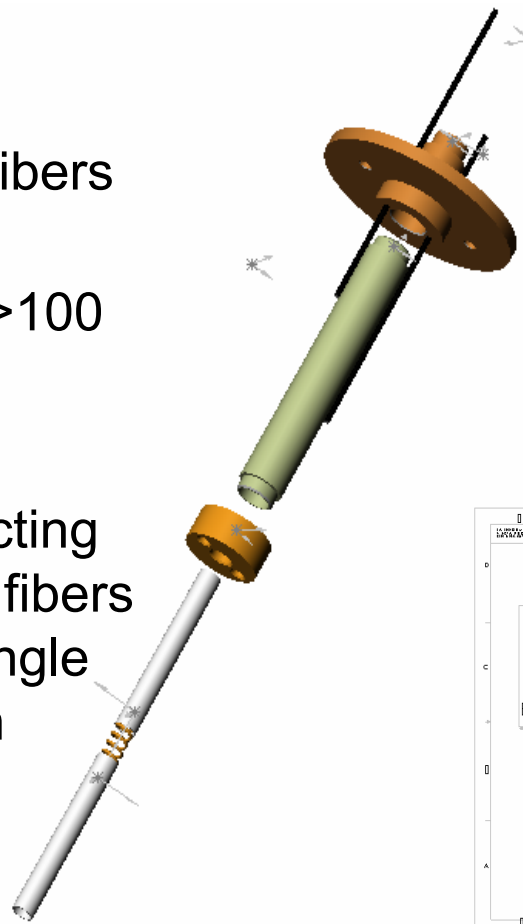

Ciemat CEDEX DESY

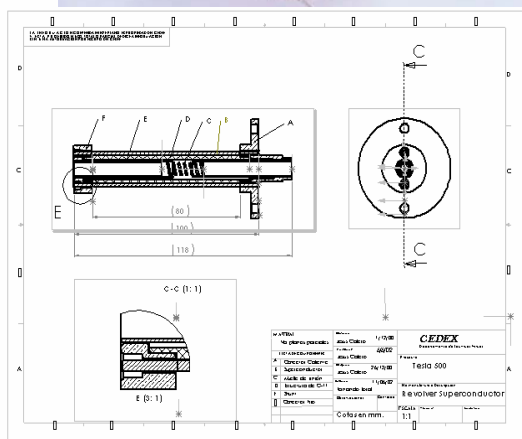
# Feedthrough Tests

- Ciemat/CEDEX FT
  - 4 pieces tested
  - Leak rate up to $10^{-7}$mbar $l^{-1}$
  - Ciemat/CEDEX is working on an improved version
- CABURN FT
  - 2 (of 5 available) pieces tested
  - Leak rate below to $10^{-9}$mbar $l^{-1}$

# HTc Lead

- Two BiSCCO 2212 HTc fibers Ø 2 mm
- High purity copper, RRR>100
- Glass-Fiber tube (G-11), supporting the HTc fibers
- Two Low Tc superconducting wires are soldered to the fibers and the cup, forming a single wire highly stabilized with copper.
- Stainless-Steel Shunt





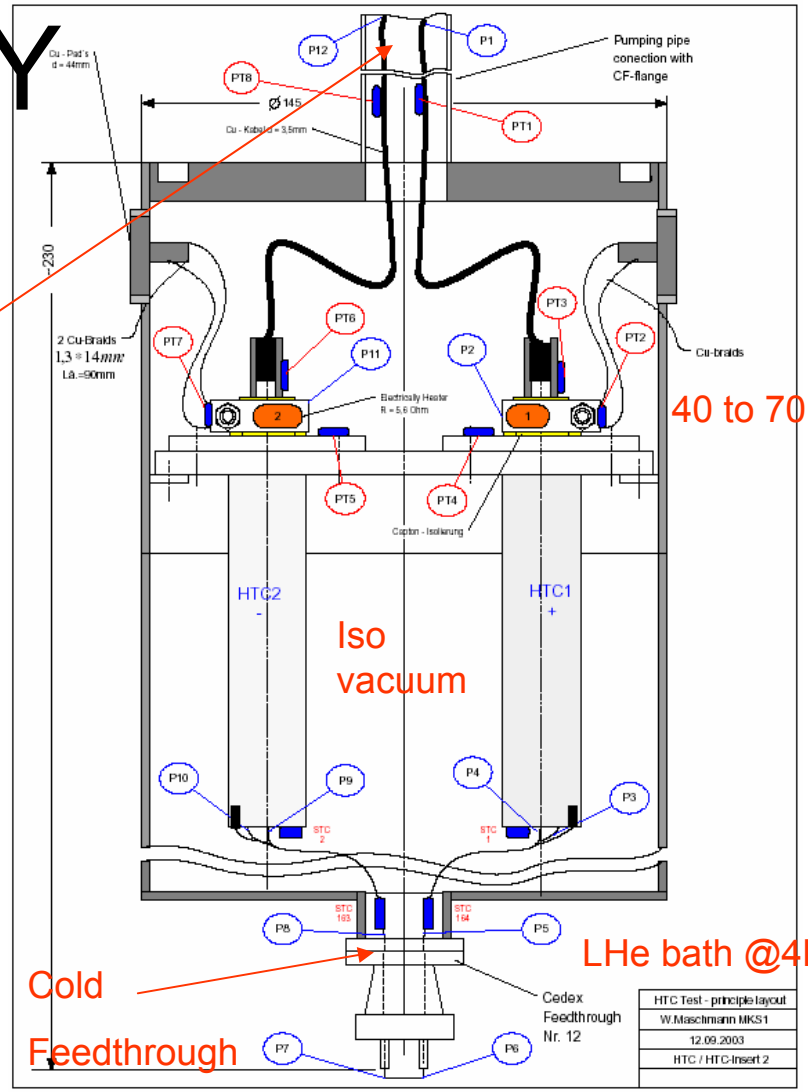
# Tests at CIEMAT with $LN_2$

- Critical current @ 77K is larger then 210A
- Contact resistance @ 77K is less then 0.7μΩ
- No degradation in 5 T cycles (cool down time 30 min)

# Lead Test at DESY

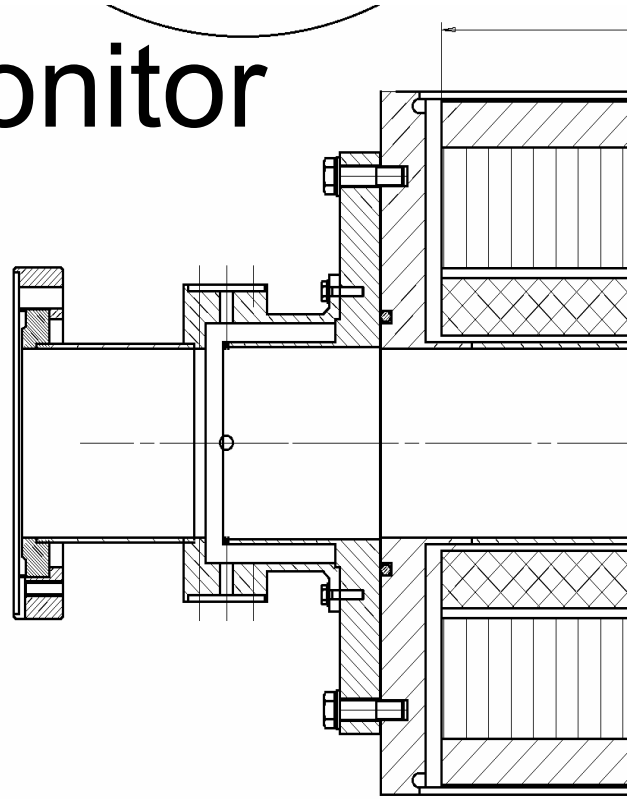
- Test in vertical bath cryostat at 4K
- LTc superconducting connection between the two leads
- Voltages and temperatures monitored
- Operated up to 160A
  - Then short developed
  - Due to copper cables connected on the warm side of the lead
  - 160A was not limited by the HTc part
- Test will be repeated in march with correct cables and improved design

Work by Maschmann, Eschke, Lange



# Beam Position Monitor

- No final decision yet
  - Cavity type monitor not good
  - “Reentrant” monitor favored
  - Cleaning problem probably solved
- BPM test stand is being build
- Responsible Dirk Noelle



Reentrant Monitor

Entwurf
BPM ohne Faltenbalg,
angeflanscht an Quadrupol,
gedichtet durch Al-Kantendichtung.

Ba.
15.01.04

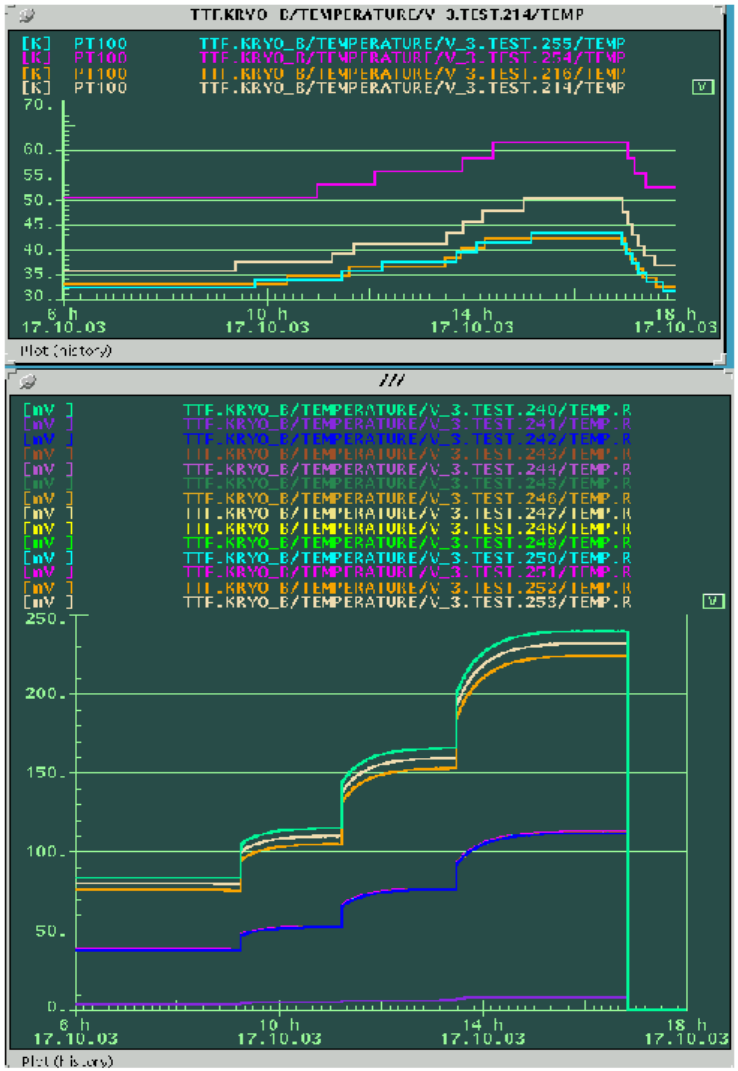
# Test of Magnet Package at TTF

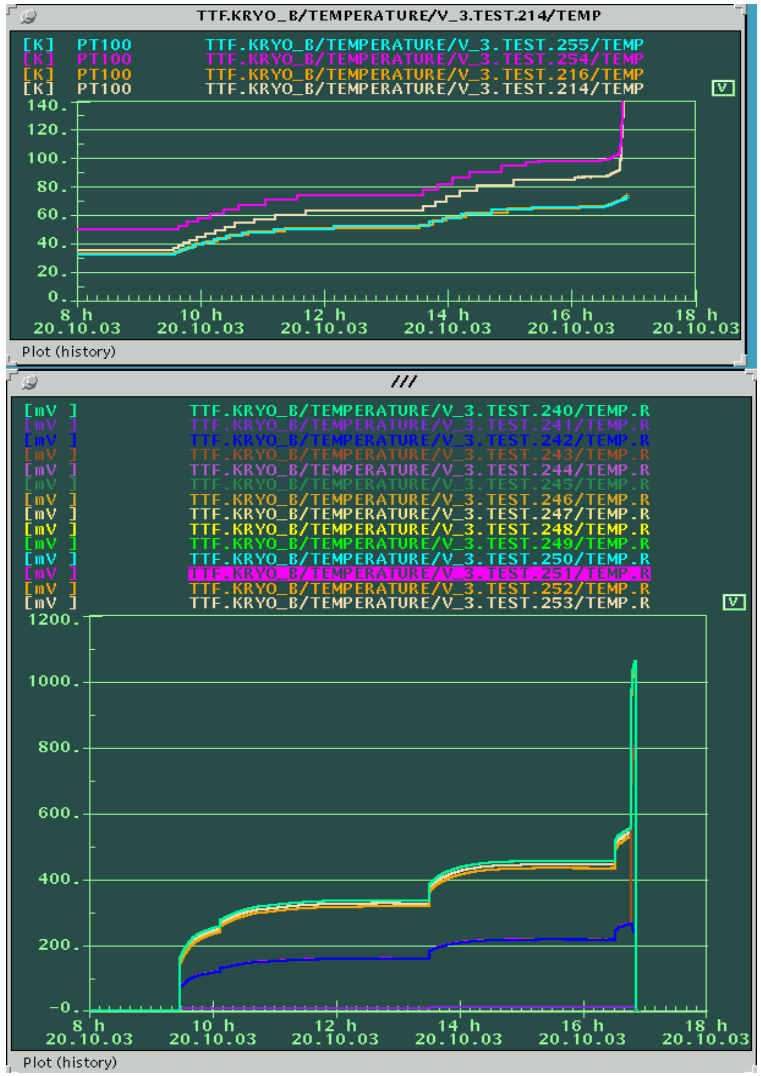
- We want a final test at 2K in one of the TTF modules
- One option seems to be “ACC6”
- Decision needed in order to start the cryostat design and fabrication in Spain
- The package including BPM (without HOM) is a few cm longer than the standard package, but it can probably handeled

# Summary

- The magnet is being produced now in Spain
- It is scheduled to arrive at DESY in April for
  - testing in a vertical cryostat
  - and warm field measurement
- Feedthroughs and HTc lead were successfully tested
- Missing:
  - Final lead design
  - He container design for horizontal testing in Chechia and at TTF

# Voltages and Tempeatures 30A to 90A

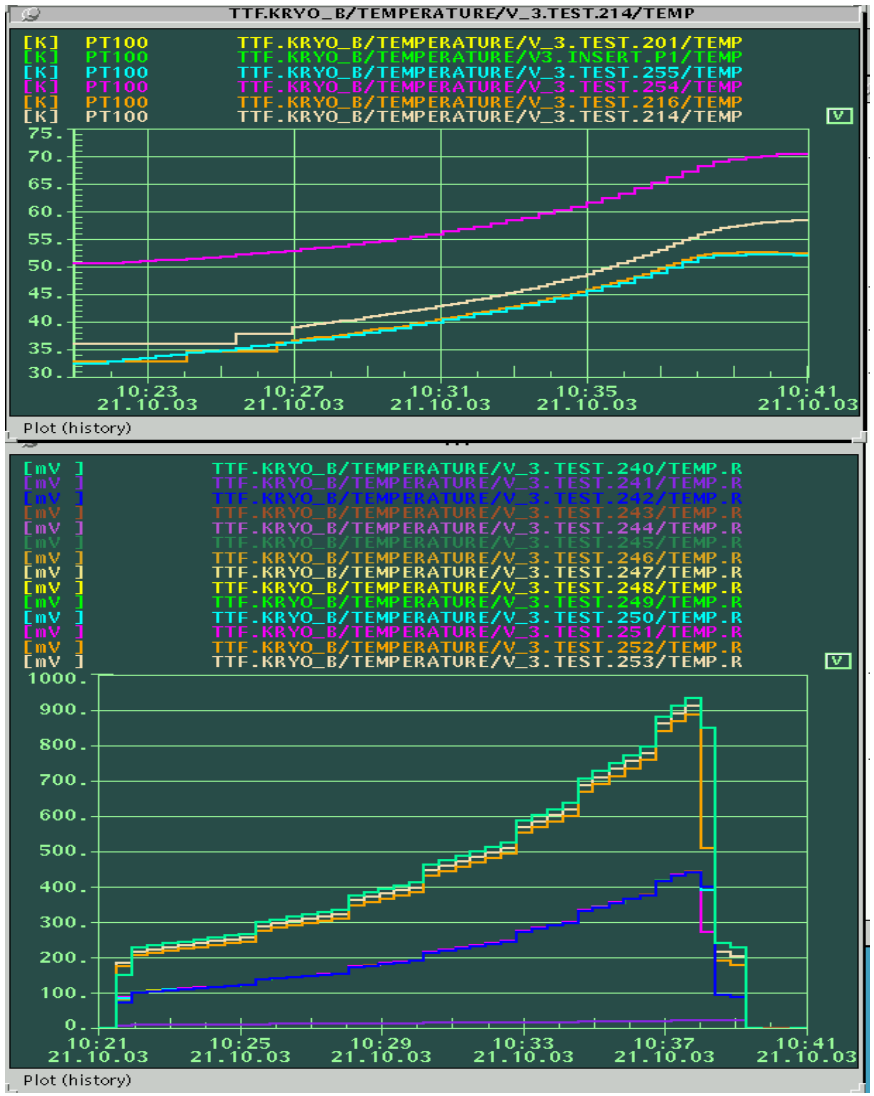



32A 40A 50A 60A 70A 80A 90A

**Unwanted Switch off at 90A**

# Voltages and Tempeatures 90A to 160A

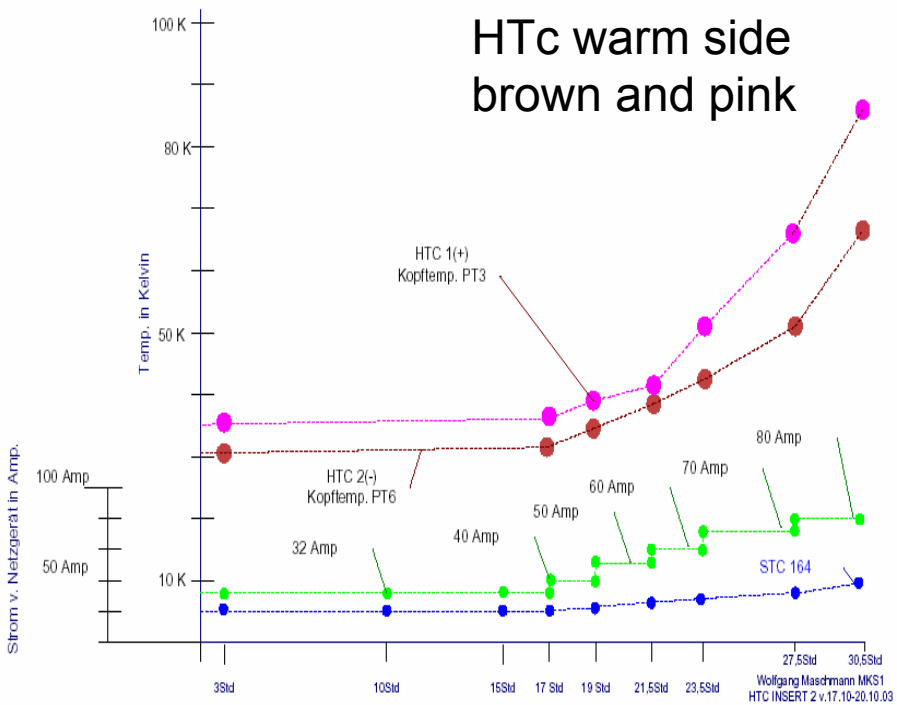



90A 100A 110A 120A 130A 140A 150A 160A

- Due to warming up of copper cables no wait for stable signals
- At 160A a short in the connection (“warm side) appeared

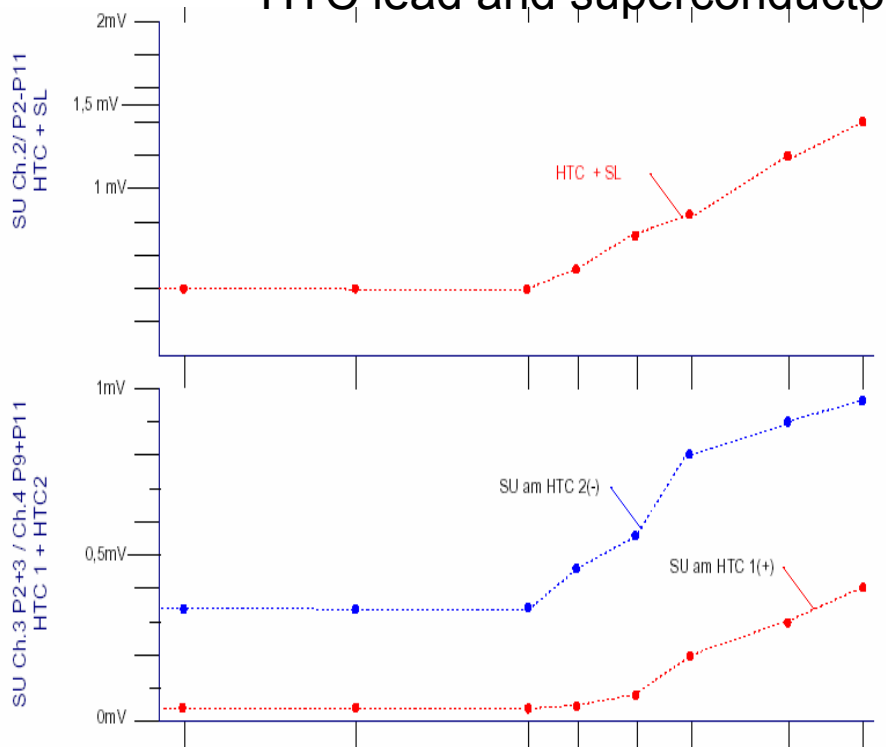
# Lead Test 30 – 80A

HTc warm side
brown and pink




Current green curve

Voltage drop
HTC lead and superconductor




Voltage drop each HTc
(blue curve offset)!

# Current Leads

- HTc leads designed for 100A
- Operated up to 160A
  - Limited by cables connected on the warm side of the lead
  - 160A not limited by the HTc part

# XFEL Magnet Package

- info by R. Brinkmann
  - Quadrupoles: integrated gradient **5.6T**
  - Correction Dipole
    - Vertical and horizontal bending
    - Integrated field **.006Tm**
  - Quads placed at the end of a module (still open for discussions)