On line monitoring of the TTF cryostats cold mass with wire position monitors

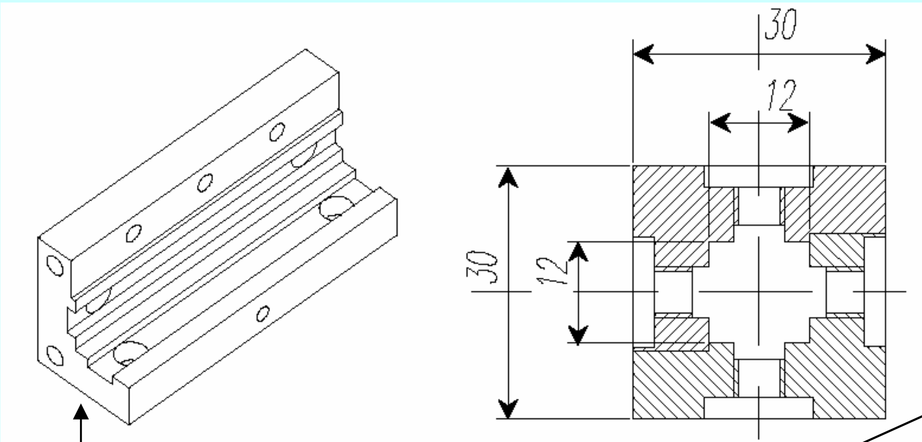
A. Bosotti M. Bonezzi C. Pagani
(INFN Milano - LASA)

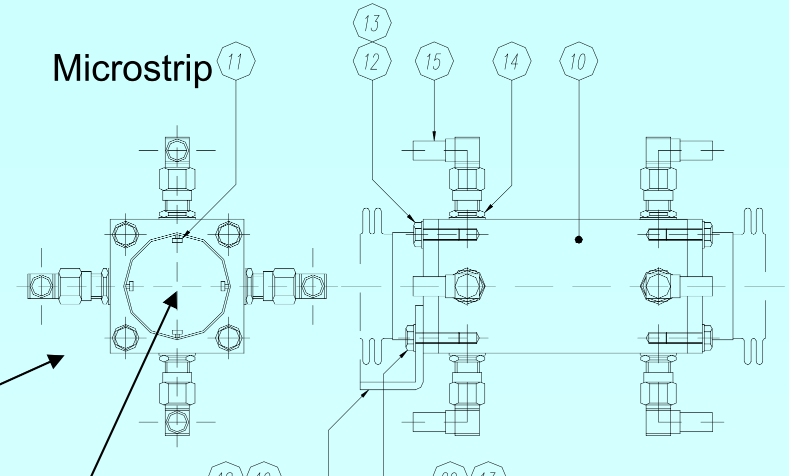
R. De Monte – M. Ferianis
(Sincrotrone Trieste)

WPM Main Features And Evolution

- A Wire Position Monitor (WPM) system has been developed for on-line monitoring of the cold mass during cooldown and operation. The analysis of the WPM measurements allows checking the alignment reproducibility between successive cooldown cycles.
- A WPM is a sort of microstrip four channel directional coupler. A 140 MHz RF is applied on a stretched wire placed (nominally) in the center of the monitor bore.
- The first cryomodule (1997 – 1998) was equipped with two sets of 18 WPMs, fixed along two straight sections inside the cryostat of square cross section and 12 mm aperture.
- The module # 2 (1998 – 1999) was equipped with only one chain of 9 monitors of circular cross section of 28 mm diameter.
- The modules # 4 & # 5 (and # 6) are equipped with a chain of 7 monitors (starting from 2003).

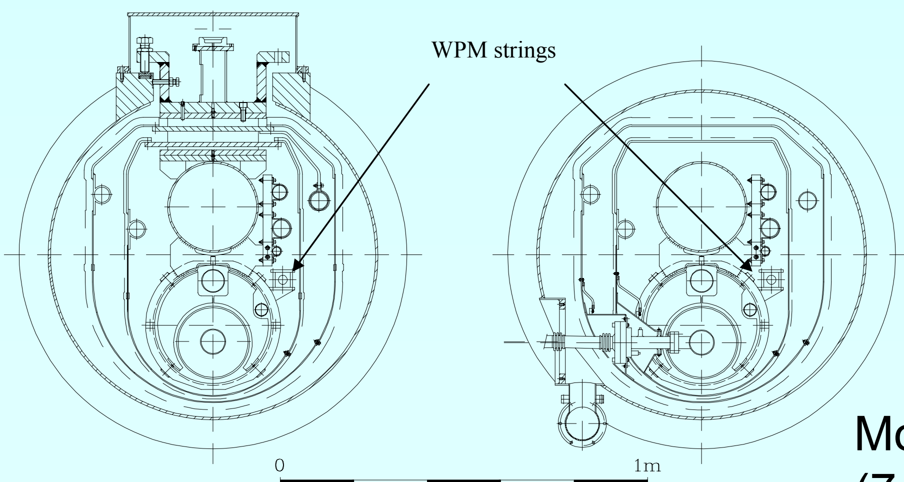
WPM Details



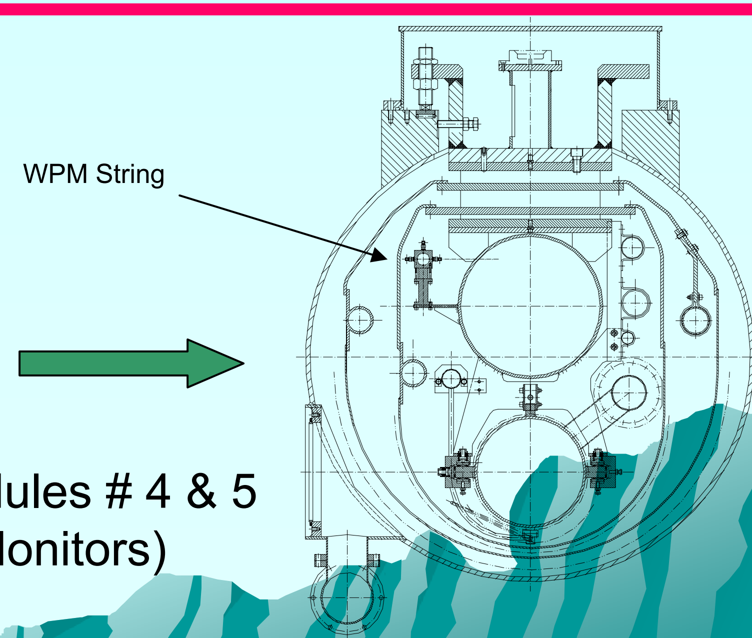


Internal Cylindrical structure
Old version: square

Larger bore (higher linearity, more clearance)
Machined from one piece

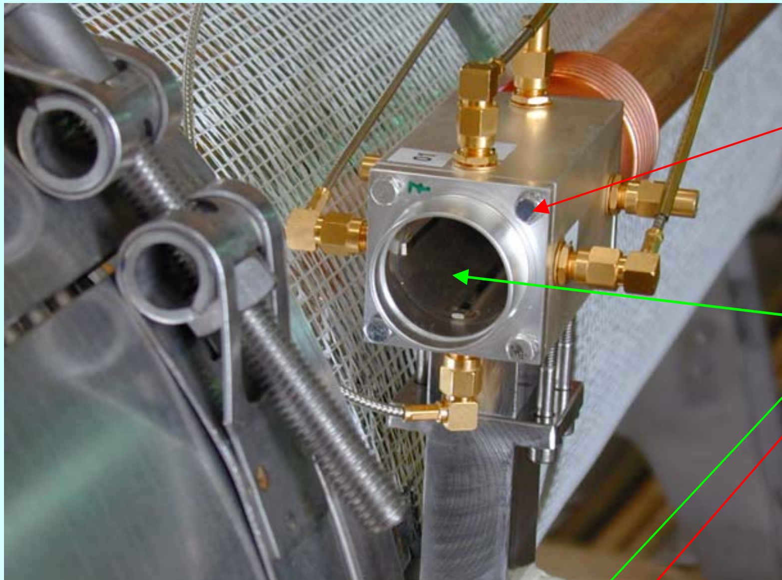


Module # 2 (9 Monitors)



Modules # 4 & 5
(7 Monitors)

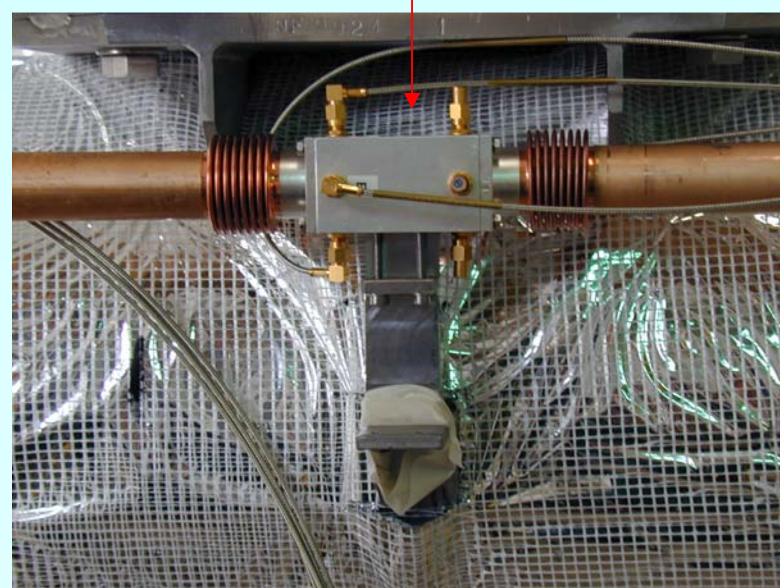
WPMs Assembled Into The Modules



WPM during assembly at ZANON

The stretched wire for the 140 MHz RF signal transmission is inserted here

WPM assembled on cryomodule 4



WPM Calibration

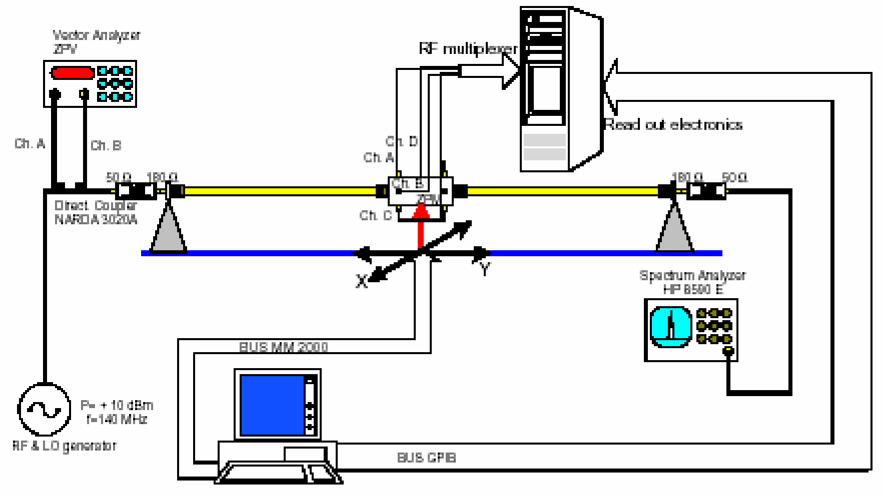
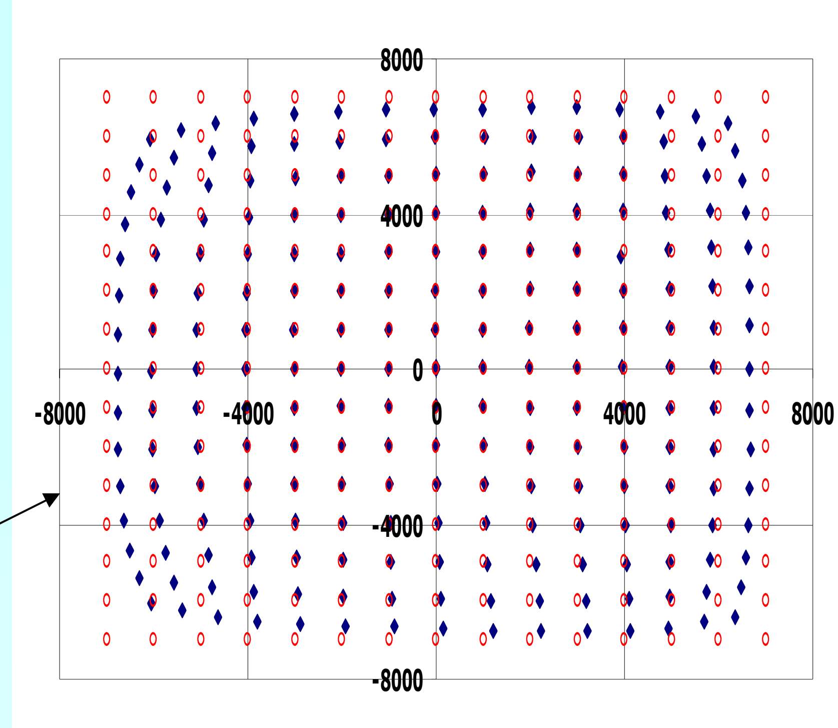


FIG. 11: Block diagram of the WPM mapping system.

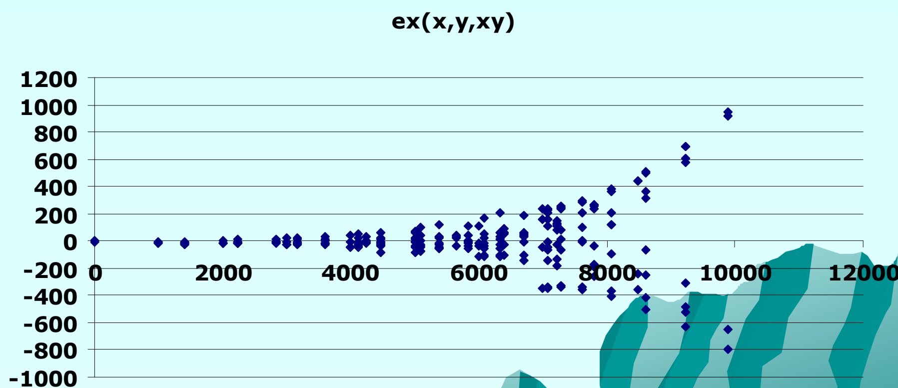


WPM "map" (X & Y [μm])
+ = actual wire position
O = position read

$$x = a_{10} D_x + a_{30} D_x^3 + a_{12} D_x D_y^2$$

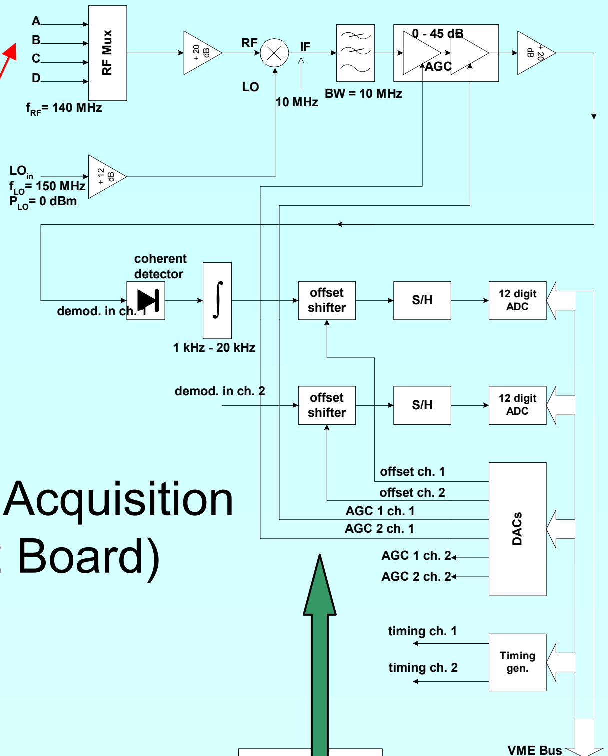
$$y = a_{01} D_y + a_{03} D_y^3 + a_{21} D_x^2 D_y$$

2-D Polynomial Internpolation

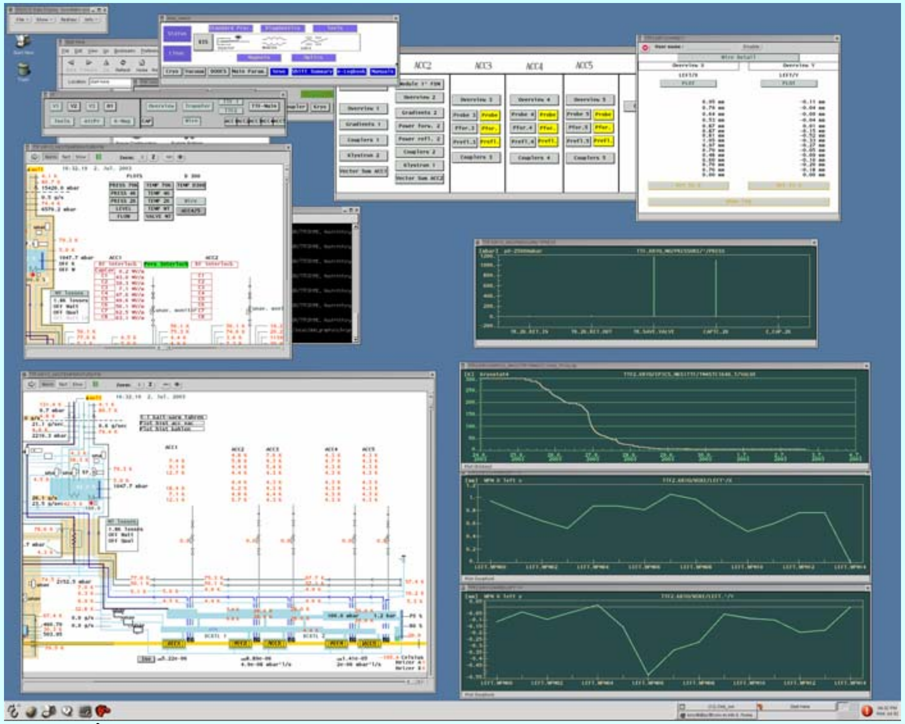


Error [μm] in Position Vs Bore Radius [μm]

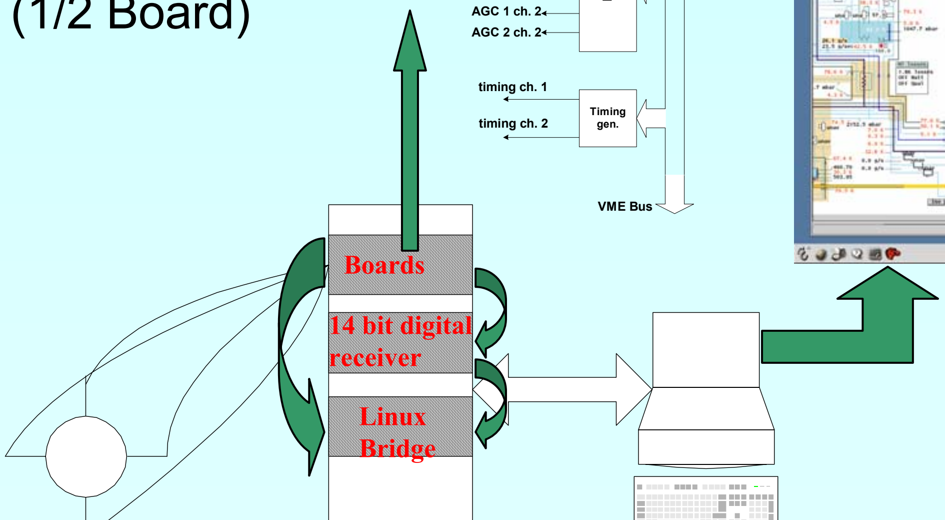
Control Electronics



4 Channels Acquisition Section (1/2 Board)



TTF Console “Screen Capture”



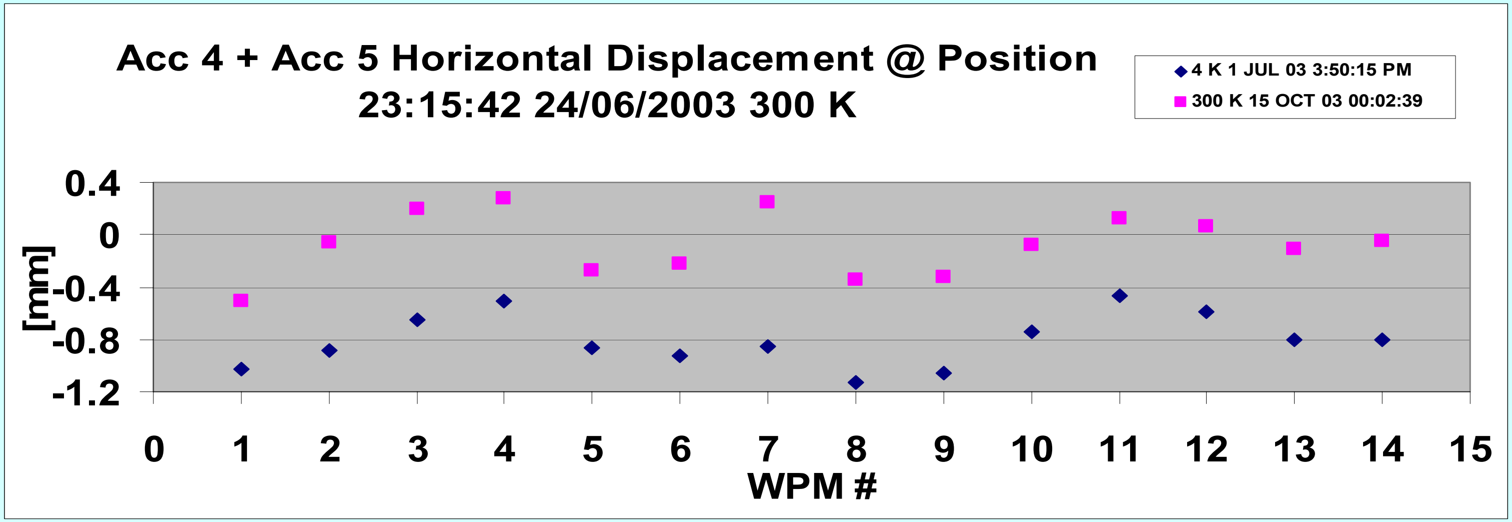
WPM Chain

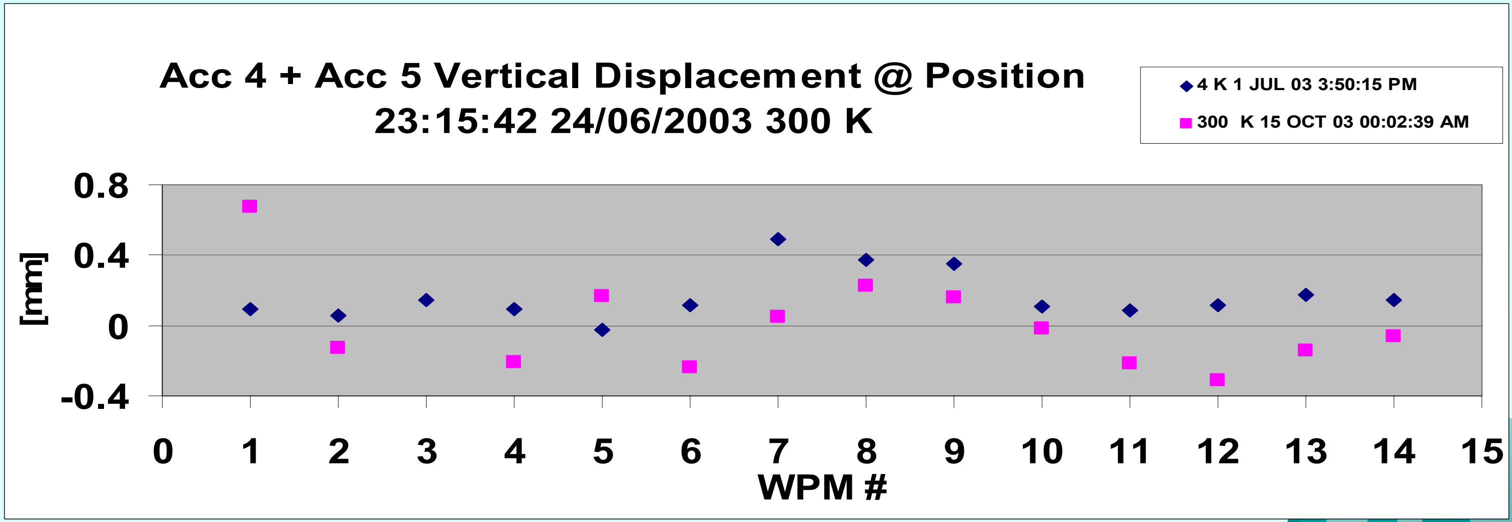
Control Electronics

TTF Console (terminal)

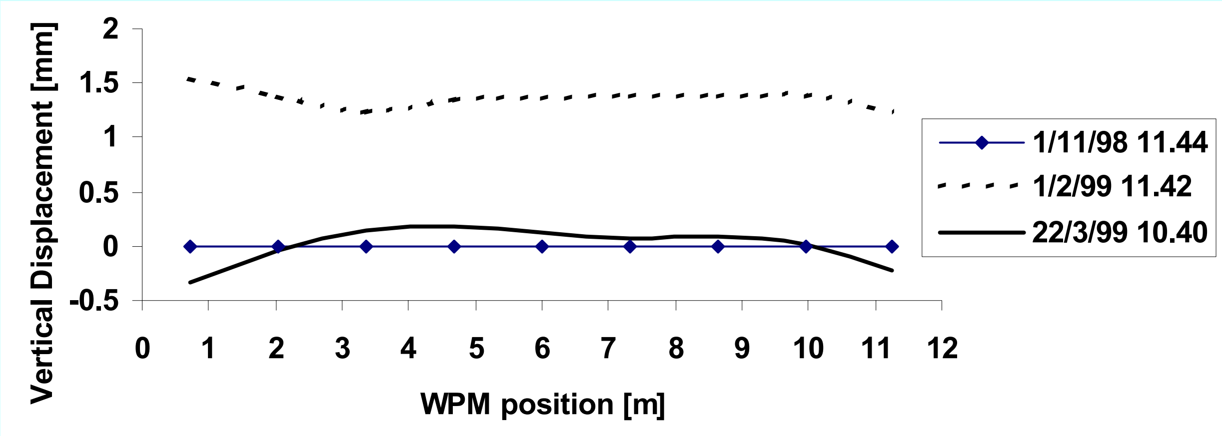
Control Electronics Block Diagrams

Modules 4 & 5 (7 WPMs)

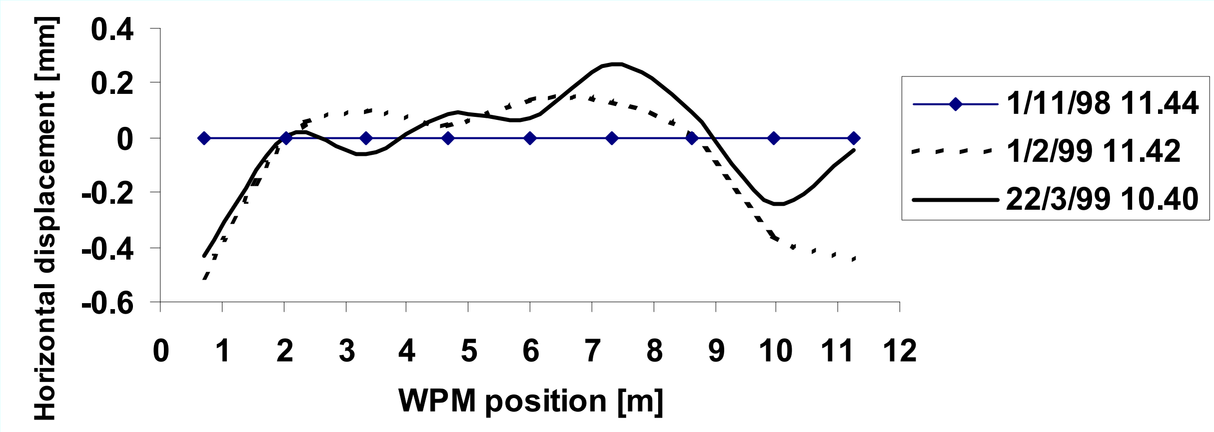




Module 2 (9 WPMs)



Maximum vertical displacement of the cavity string during cooldown (1/2/99) and warmup (22/3/99) referred to the stable position (1/11/98).



Maximum horizontal displacement of the cavity string during cooldown (1/2/99) and warmup (22/3/99) referred to the stable position (1/11/98).

Module 1 1st & 2nd complete thermal cycles

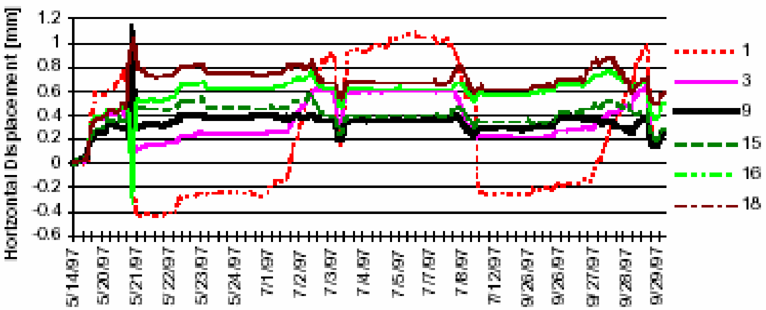


FIG. 16: Historical graph of the horizontal displacement of the first TTF cryomodule cold mass during the first two cooldown and warm up operations.

Historical Graphs

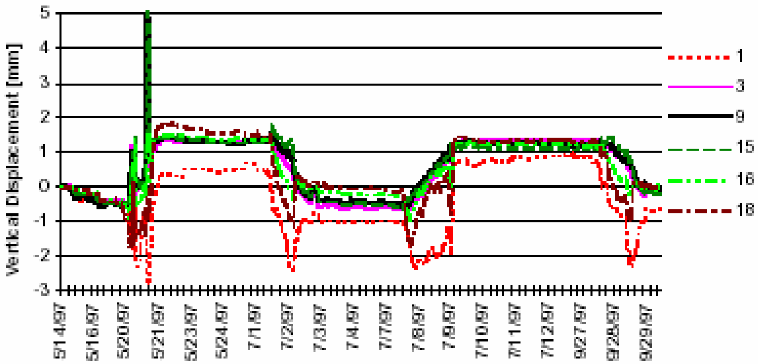


FIG. 17: Historical graph of the vertical displacement of the first TTF cryomodule cold mass during the first two cooldown and warm up operations.

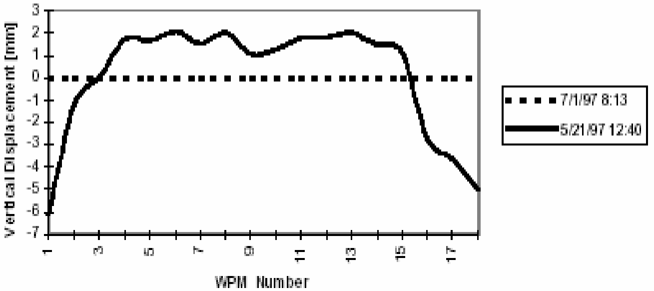


FIG. 18: Taking as a vertical reference the stable cold position after the first cooldown (7/1/97), the solid line (5/21/97) shows the maximum vertical bending of the cavity string during the fast cool down.

Module 1 1st & 2nd complete thermal cycles

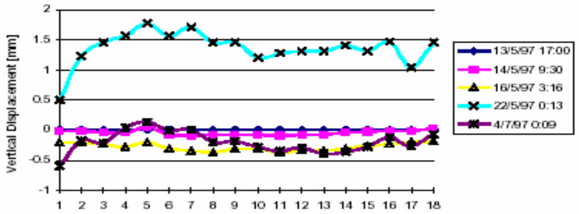


FIG. 20: Vertical displacements related to stable positions during the first complete thermal cycle.

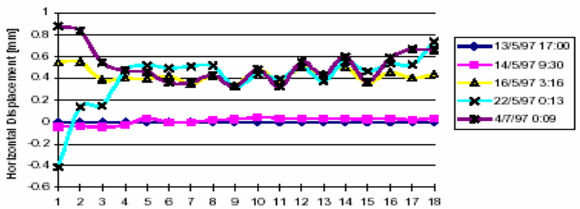


FIG. 21: Horizontal displacements related to stable positions during the first complete thermal cycle.

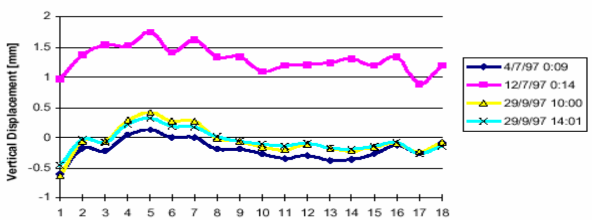


FIG. 22: Vertical displacements related to stable positions during the second complete thermal cycle.

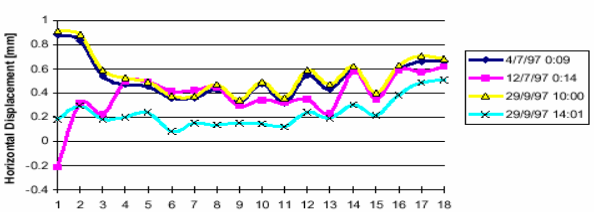


FIG. 23: Horizontal displacements related to stable positions during the second complete thermal cycle.

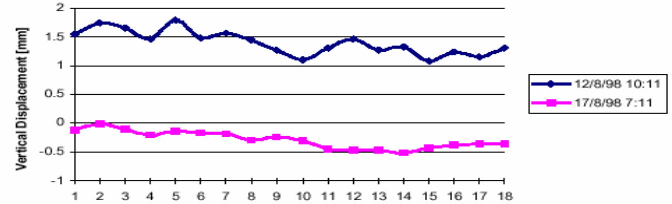


FIG. 24: Vertical displacements related to stable positions 23/11/98 during the third complete thermal cycle.

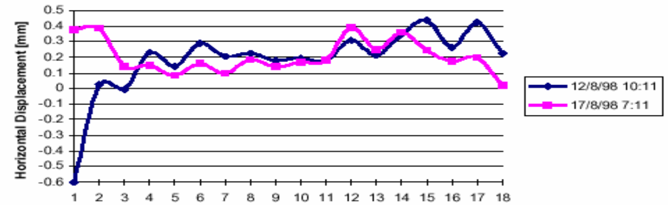
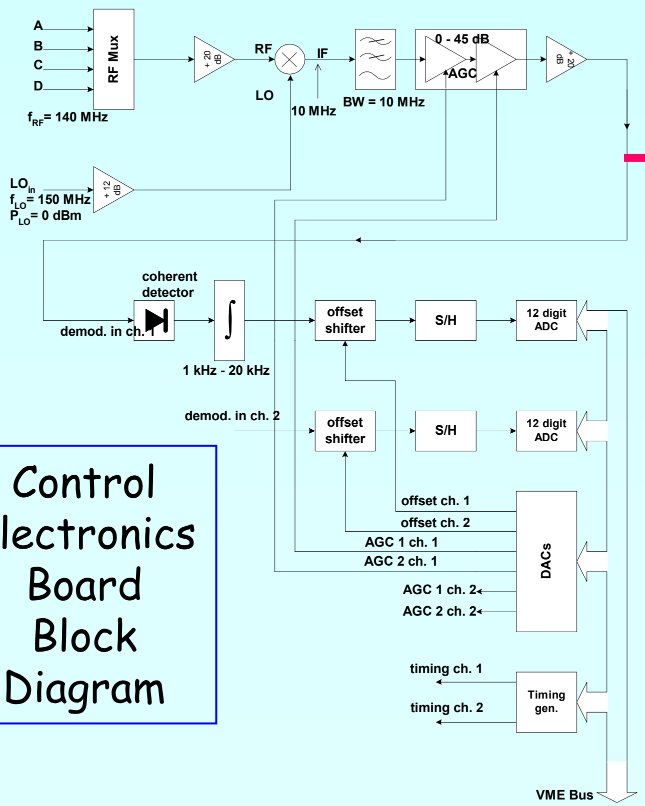


FIG. 25: Horizontal displacements related to stable positions 23/11/98 during the third complete thermal cycle.

- 14/5/97 h 9:30 Starting of the vacuum pumping.
- 16/5/97 3:16 Pressure = 0.1 mb; T = 300K.
- 22/5/97 0:13 Stable cold position after first cooldown operation.
- 4/7/97 0:09 Stable position after warm up; pressure = 0.1 mb.
- 12/7/97 0:14 Stable position after second cooldown.
- 29/9/97 10:00 Stable position after second warm up; pressure = 0.1mb.
- 29/9/97 14:01 Stable position after second warm up; pressure = 1000 mb.

WPM (Wire Position Monitor) as sensors for vibrations

- New ADC (digital receivers) boards under way: increased sensibility and precision: 14 bits, 30MHz input bandwith (65 Mbs).
- Increased bandwidth: now the system is able to read “real time” frequencies higher then 100 Hz.
- Possibility to use WPMs as sensors for cold mass vibrations.



Control Electronics Board Block Diagram

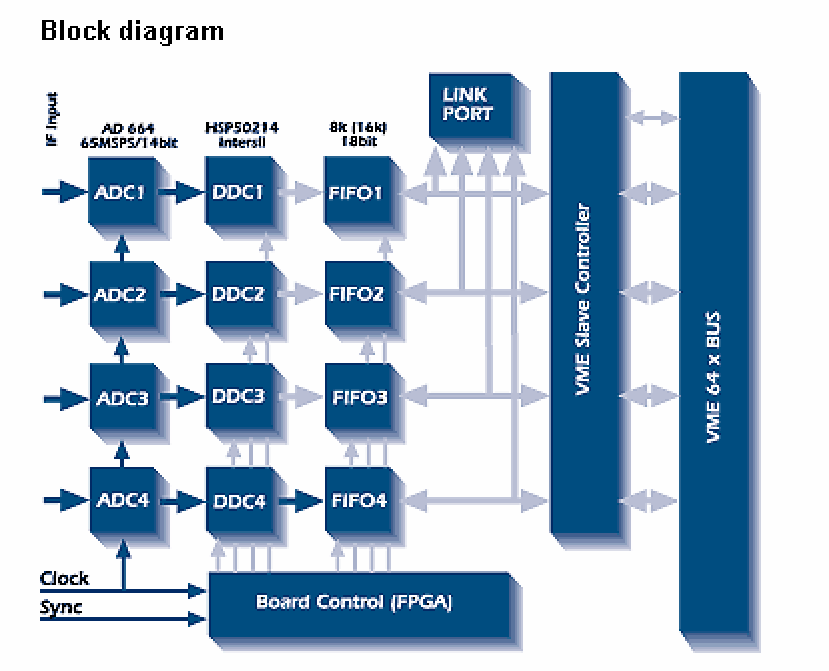
10 MHz IF Signal

Digital receiver

Low Frequency Vibrations

QDR – Quad Digital Receiver

from Instrumentation Technologies



- **QDR (Four 14 bit ADCs) Features**:
- 4 independent channels with simultaneous sampling
- Analog to digital converter (ADC) and a programmable down-converter on each channel
- ADCs are mounted on mezzanine boards to allow flexibility
- Up to 255-tap programmable FIR
- Overall decimation ranging from 4 to 16384
- Cartesian to Polar converter and frequency discriminator
- Suitable for CW or pulsed applications
- Real time or batch (gated) processing
- On board FPGAs add flexibility for user-specified functionality
- VME 64x compatible