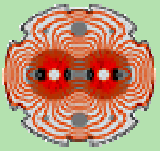
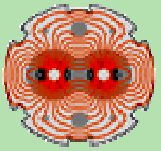


IRRADIATION TESTS of VACUUM EQUIPMENT

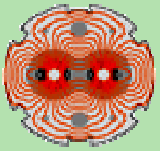
J-C. BILLY, R. GAVAGGIO, W. KOELEMEIJER
LHC Vacuum Group

Contents



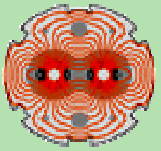
- Vacuum Equipment in the LHC arcs
- Irradiation Tests: Why, What?
- Tests 2000
- Tests 2001
- Conclusion
- Additional Tests in 2002

Vacuum Equipment in the LHC Arcs



- **4 Vacuum Systems !**
  - 2 Independent Beams Vacuum
  - Insulation Vacuum for the Cryo Line (QRL)
  - Insulation Vacuum for the Magnet Cryostats

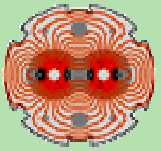
Vacuum Equipment in the LHC Arcs



- **Vacuum Equipment (Q7-Q7)**
  - 1136 Gauges (Pirani, Penning, Piezo, Full Range,...)
  - 184 Pumping Groups (incl. 552 Valves, 368 Pumps,...)
  - 368 Valves (on Vacuum Barriers)
  - 880 (?) Ion Pumps

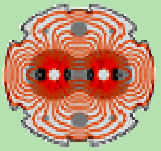
- **Pumps & Gauges located near the Quadrupoles**
- **Controllers & P. Supplies under the magnets**

Vacuum Equipment in the LHC Arcs



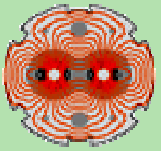
- Goal : Reduce the cabling COSTS !
- How ?
  - Power Supplies & Controllers as near as possible to the equipment (Ion Pumps, Turbomolecular Pumps, ...)
  - Use equipment with integrated electronics (Gauges,...)
  - Use local PLCs and Fieldbus
- ==> Electronics in the Tunnel !

Irradiation Tests
Why ?



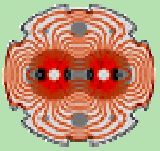
- To qualify vacuum equipment.
- No previous experience.
- No available information from the manufacturers.
- To freeze the local architecture of the vacuum control system in the tunnel.

Irradiation Tests
What ?



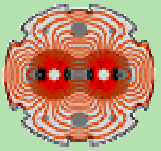
- PLCs & Profibus devices (repeaters, term.,...)
- "Compact" Gauges (with integrated electronics)
- Ion Pump Power Supplies
- Turbomolecular Pump Controllers

Tests 2000 Summary



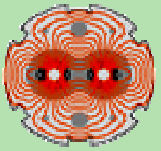
- **PLC Siemens S7/200 & Profibus devices**
  - Negative results: Severe Single Event Effects; Complete failure after 10-20 Gy
- **5 "Compact" Gauges (Balzers & Edwards)**
  - Encouraging results
- **1 Ion Pump Power Supply (Cern design)**
  - Very good results for the HV part
- **1 Turbomolecular Pump Controller (Alcatel)**
  - S.E.E. affect remote control. Complete failure after a cumulated dose 20-50 Gy

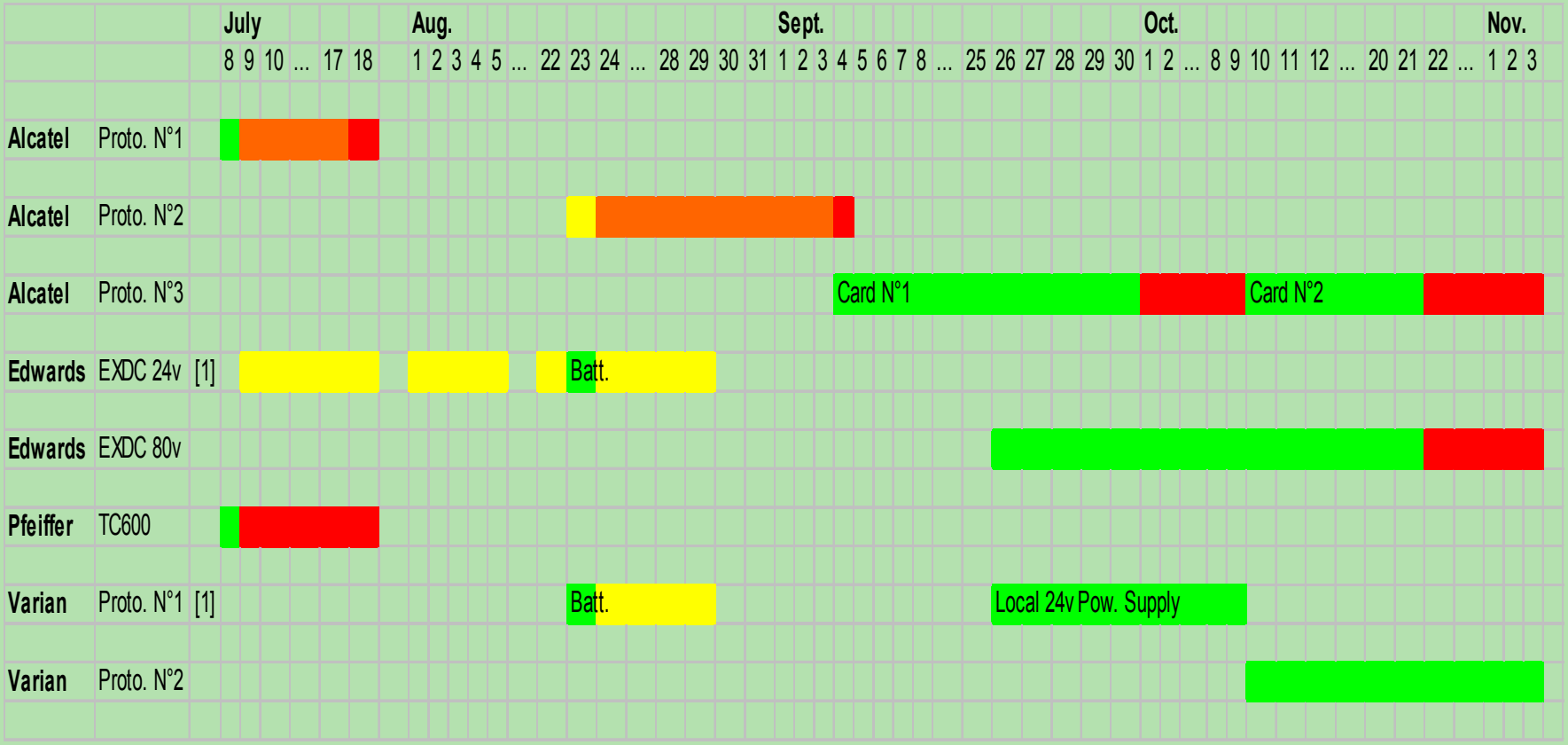
Tests 2001



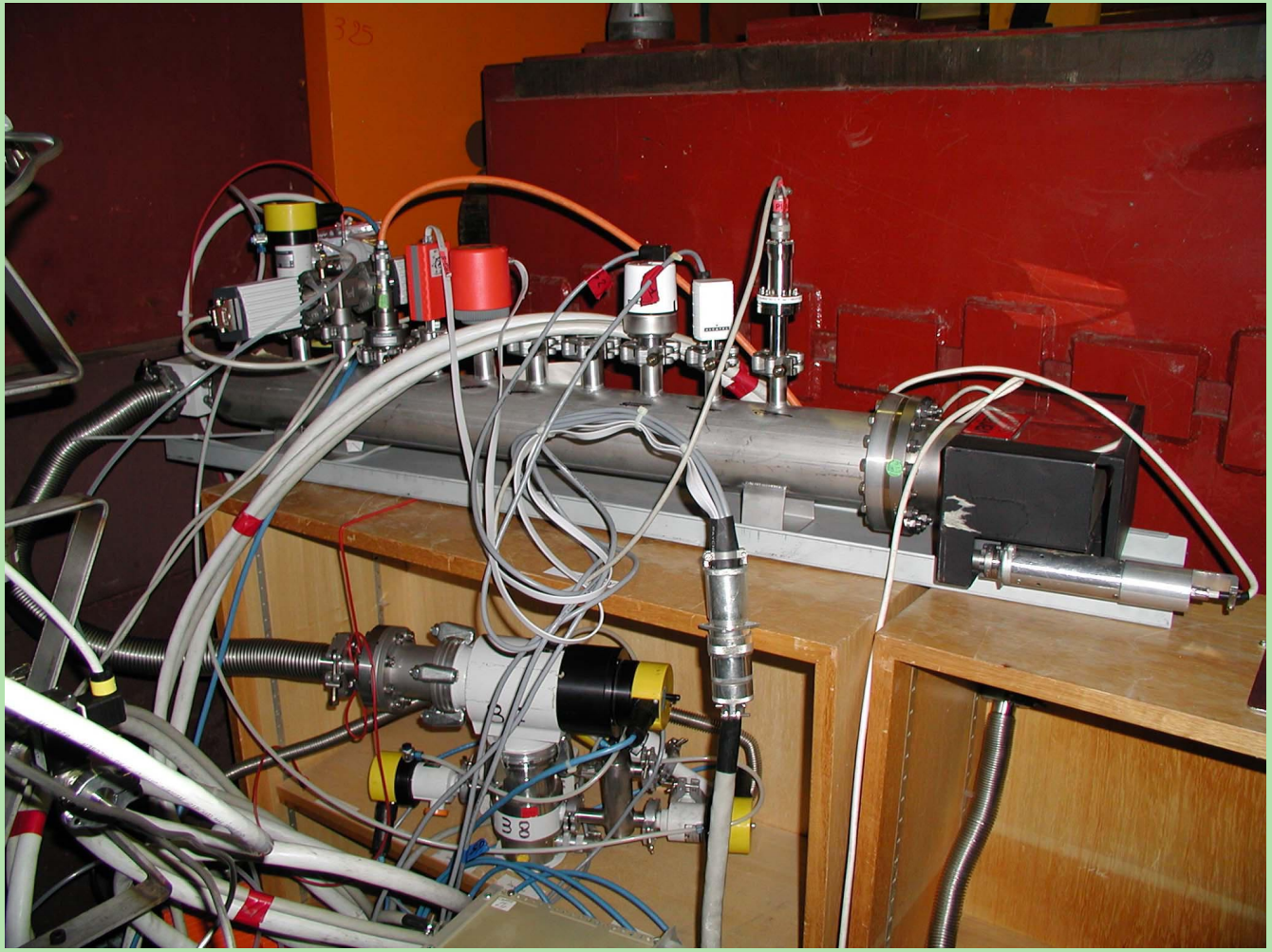
- **Equipment tested:**
  - 8 "Compact" Gauges Full-Range, Penning, Pirani, Piezo (Alcatel, Balzers & Edwards)
  - 1 Ion Pump Power Supply (Cern design)
  - 8 Turbomolecular Pump Controllers (Alcatel, Edwards, Pfeiffer, Varian)
  - 1 Linear 5v Power Supply (Cern design)

Tests 2001

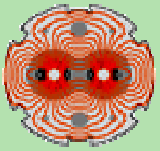



July
Aug.
Sept.
Oct.
Nov.
8 9 10 ... 17 18
1 2 3 4 5 ... 22 23 24 ... 28 29 30 31 1 2 3 4 5 6 7 8 ... 25 26 27 28 29 30 1 2 ... 8 9 10 11 12 ... 20 21 22 ... 1 2 3
Alcatel Proto. N°1
Alcatel Proto. N°2
Alcatel Proto. N°3
Card N°1
Card N°2
Edwards EXDC 24v [1]
Batt.
Edwards EXDC 80v
Pfeiffer TC600
Varian Proto. N°1 [1]
Batt.
Local 24v Pow. Supply
Varian Proto. N°2

Tests 2001
Gauges Set-Up

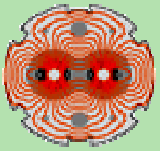


Tests 2001
Gauges Results



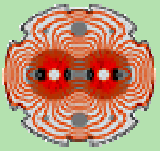
- **BALZERS, 3 "Full Range" PKR251**
  - G1: OK up to 372-594 Gy
  - G2: OK up to 178-355 Gy
  - G3: OK up to 300 Gy (Penning OK up to 800Gy)
  - (2 gauges tested in 2000 ==> 290 ~ 430 Gy)
- **ALCATEL, 1 "Full Range"**
  - OK up to 400 Gy

Tests 2001
Gauges Results



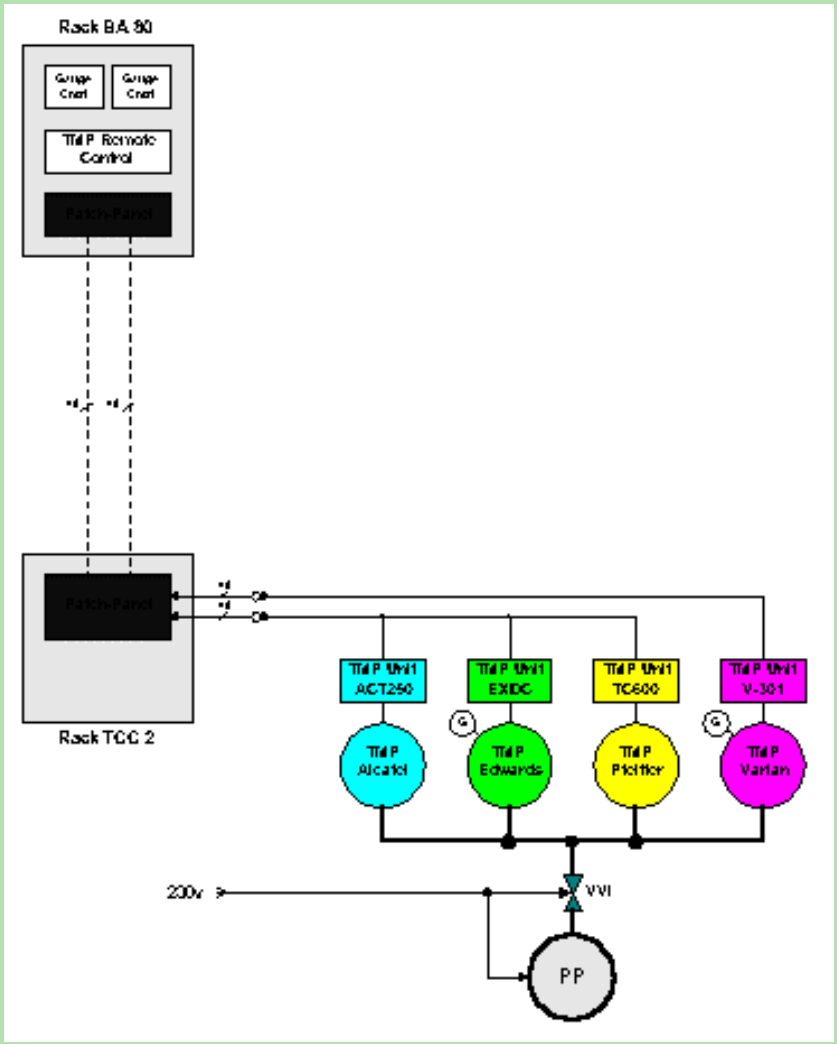
- **ALCATEL, 2 Pirani AP 1004**
  - G1: OK up to 800 Gy (450 Gy Off)
  - G2: OK up to 450 Gy
- **EDWARDS, 3 Gauges**
  - Penning AIM-X OK up to 300 Gy (50 Gy in 2000)
  - Pirani APGM OK up to 220 Gy
  - Pirani-Piezo ASG 2000 OK (err 10%) up to 150 Gy

Tests 2001
IP Power Supply

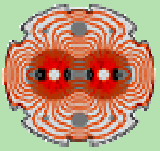


- **Ion Pump Power Supply, CERN design (W.K.)**
  - HV part: Always OK after 1053 Gy (2000) + 950 Gy (2001)
  - Control section: OK up to 200 Gy
  - Identification of broken components

Tests 2001
TMP Set-Up

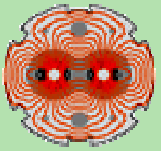


Tests 2001
TMP Controllers



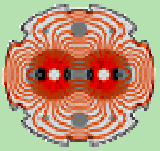
- **ALCATEL type ACT250**
  - Prototypes N°1 & 2 not OK (SEE & Mosfets failure)
  - Prototype N°3 OK up to 645-1488 Gy
    - Interface card N°1 OK up to 315-1048 Gy
    - Interface card N°2 OK up to 361-717 Gy

Tests 2001
TMP Controllers



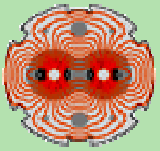
- **EDWARDS type EXDC**
  - Standard Unit '24v' not ok after few Gy (rem. control problems)
    - But OK again after 157-504 Gy !
  - Standard Unit '80v' OK up to 441-743 Gy
- **PFEIFFER type TC600**
  - Standard Unit not ok (SEE & failure after few Gy)

Tests 2001
TMP Controllers



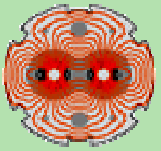
- **VARIAN type V301**
  - Prototype N°1 always OK after 181-356 Gy
    - with switch-mode power supply
  - Prototype N°2 always OK after 304-495 Gy
    - with linear power supply

Tests 2001
Linear 5v Power Supply



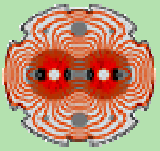
- **CERN design**
  - **Always OK after 364-580 Gy**

Tests 2001 Conclusion



- Coherence with campaign 2000 results
  - Simplest Equipment ==> Best results
  - Too few identical equipment tested ==> Be careful with figures !
- Results good enough to install equipment in Q12-Q12 part of the LHC arcs (lifetime of 10 years)
- Compare individual results, Rad. doses, precise position, costs, etc, to decide to install or not equipment in the Q7-Q11-LSS parts

Tests 2002



- Tests of TM Pump Controllers ("final" version)
- New types of gauges
- Other equipment ?