



Status of CERN Activities

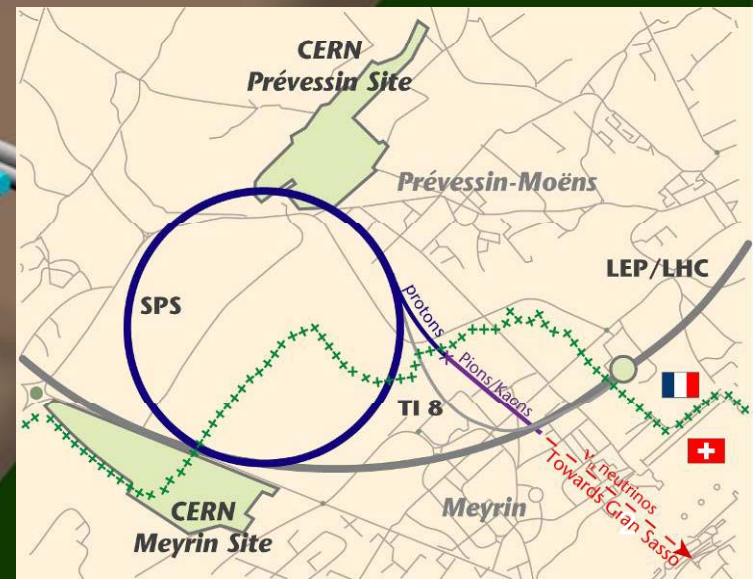
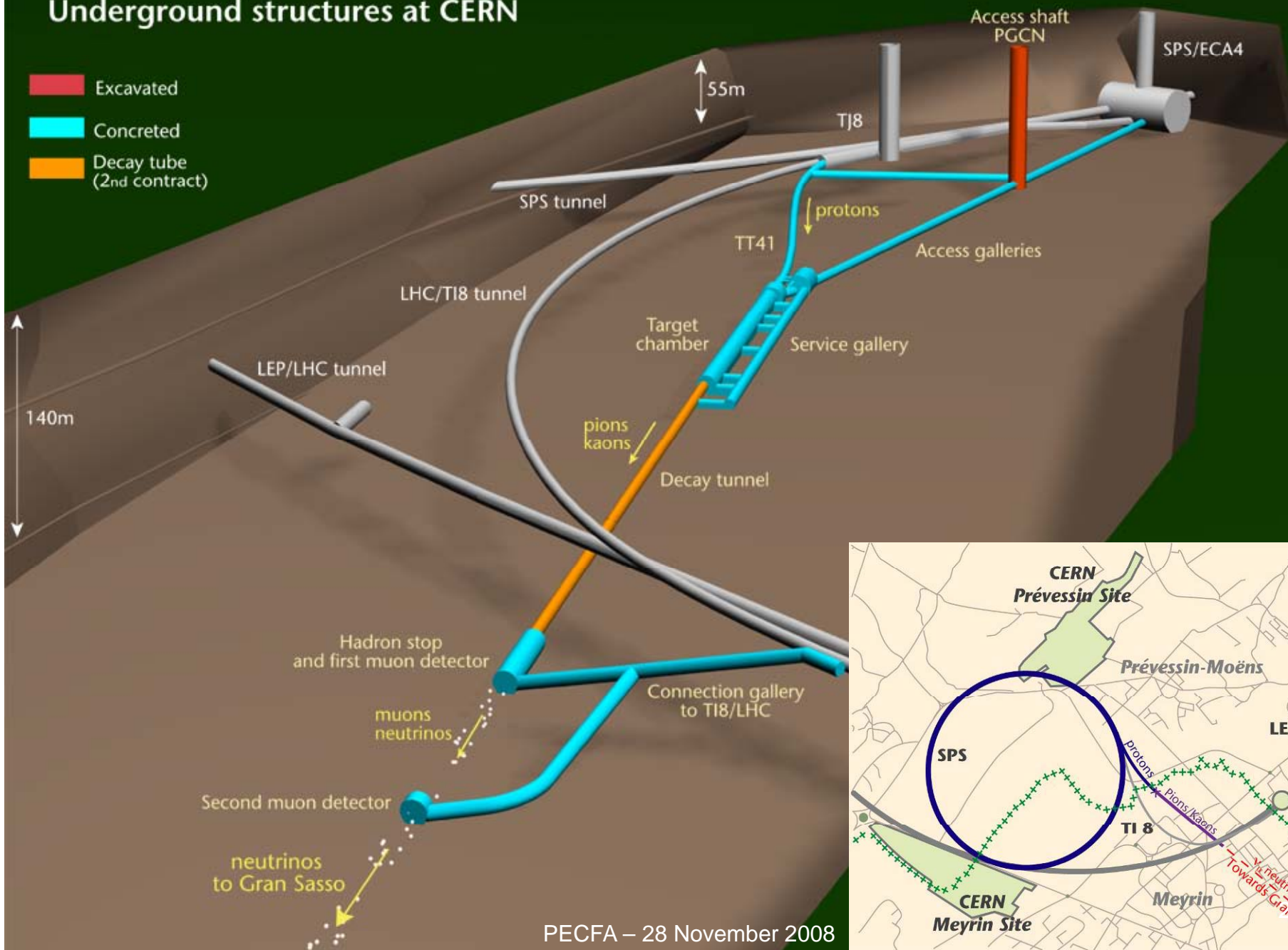
Robert Aymar

28 November 2008

CERN NEUTRINOS TO GRAN SASSO

Underground structures at CERN

- █ Excavated
- █ Concreted
- █ Decay tube (2nd contract)



CNGS – shutdown work 2007/08 address radiation issues on electronics



New remotely controlled shielding plugs



- ❑ Huge collective effort to complete all modifications and allow timely restart of CNGS
- ❑ Beam was extracted to CNGS on **June 18th**
 - ❑ three weeks delay from the foreseen schedule

Ventilation cubicals in the TSG4 service gallery

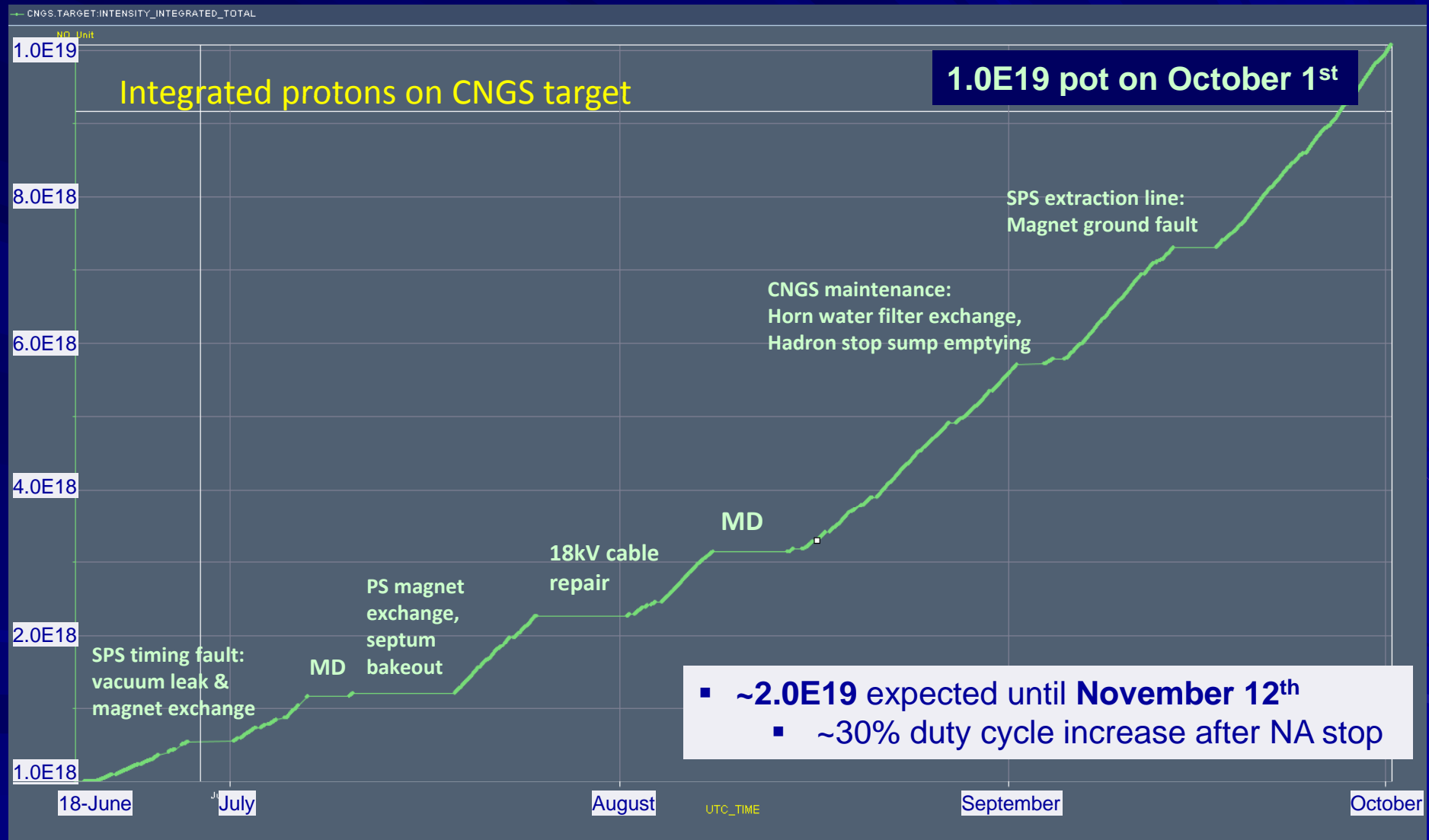


Shielding in TSG41 tunnel
Towards the target chamber



PECFA – 28 November 2008

CNGS – operation in 2008



n_TOF Facility Restart



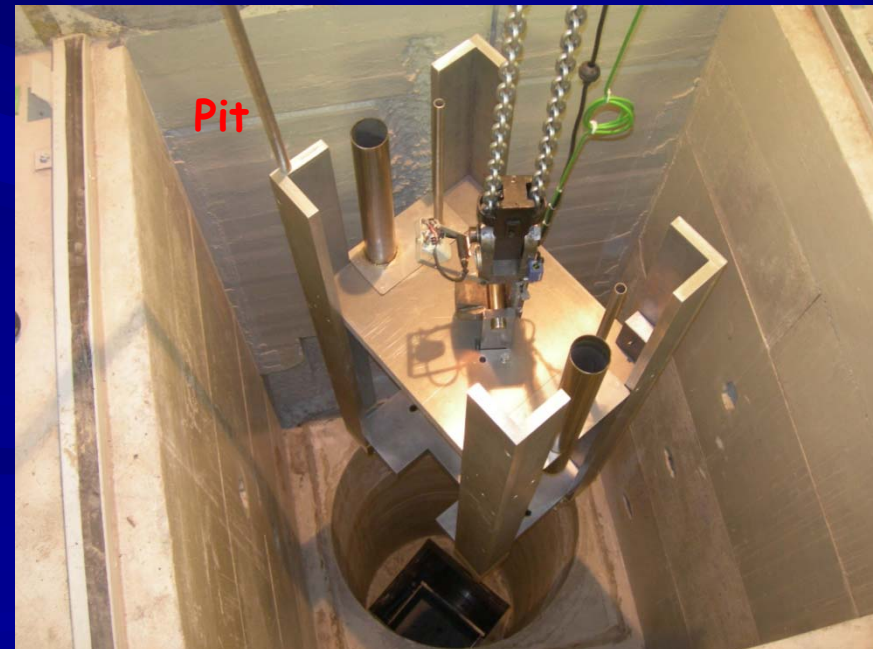
- Facility stopped in 2004 for contamination of cooling water circuit from corrosion of lead target;
- In Dec. 2007 it has been decided to proceed with the design of a new lead target to cope with all the safety requirements concerning contamination of water cooling station and ventilation of the target area;
- A huge collaborative effort among AB/ATB, TS/MME, TS/CV and TS/CE launched to fulfill the challenging goal of having beam already in 2008. SC/RP accompanied the project with their know-how and services for the difficult decisions to be taken under high pressure from the tight schedule. AT/MCS provided know-how for the remote machining of radioactive water containment vessel;
- Test-Beam, without ventilation and with preliminary cooling plant, is indeed scheduled to be sent on the target for commissioning from 3 to 12 Nov. 2008;

n_TOF Facility Restart



- ☐ Target Vessel Commissioning
20.10.08
- ☐ Target Installation in the pit
27.10.08

- ☐ Target Cooling Commissioning
27.10.08
- ☐ TEST-BEAM on TARGET
03.11.08

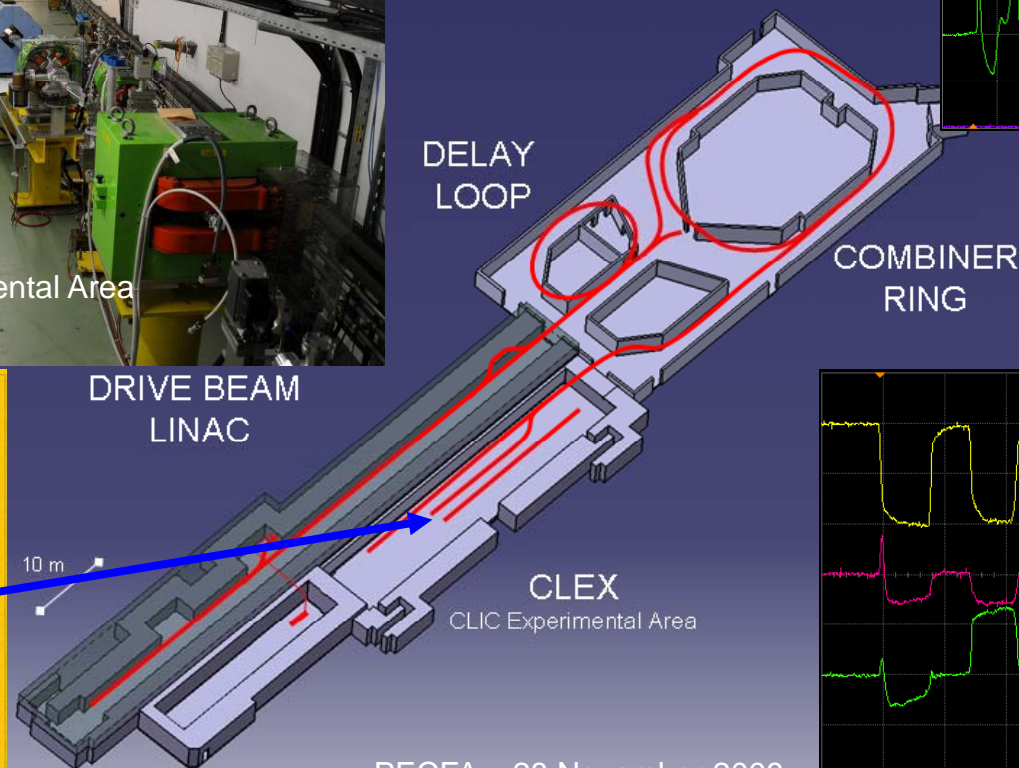
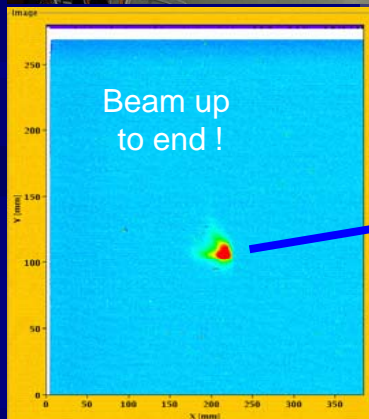


CLIC Test Facility (CTF3)



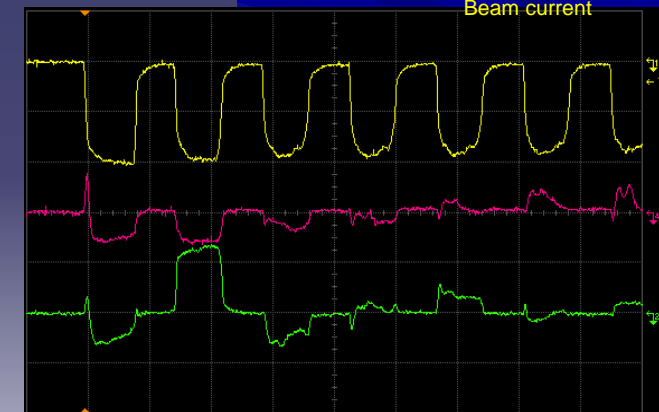
Well on schedule to address all major CLIC technology issues to be published in a Conceptual Design Report (CDR) by 2010.

- All major components installed (Test Beam Line to be completed in 2009-10)
- CR vertical instability solved by new damped deflectors
- **Beam up to end!**



BPM signals showing vertical instability

BPM signals with damped deflectors installed, no instability



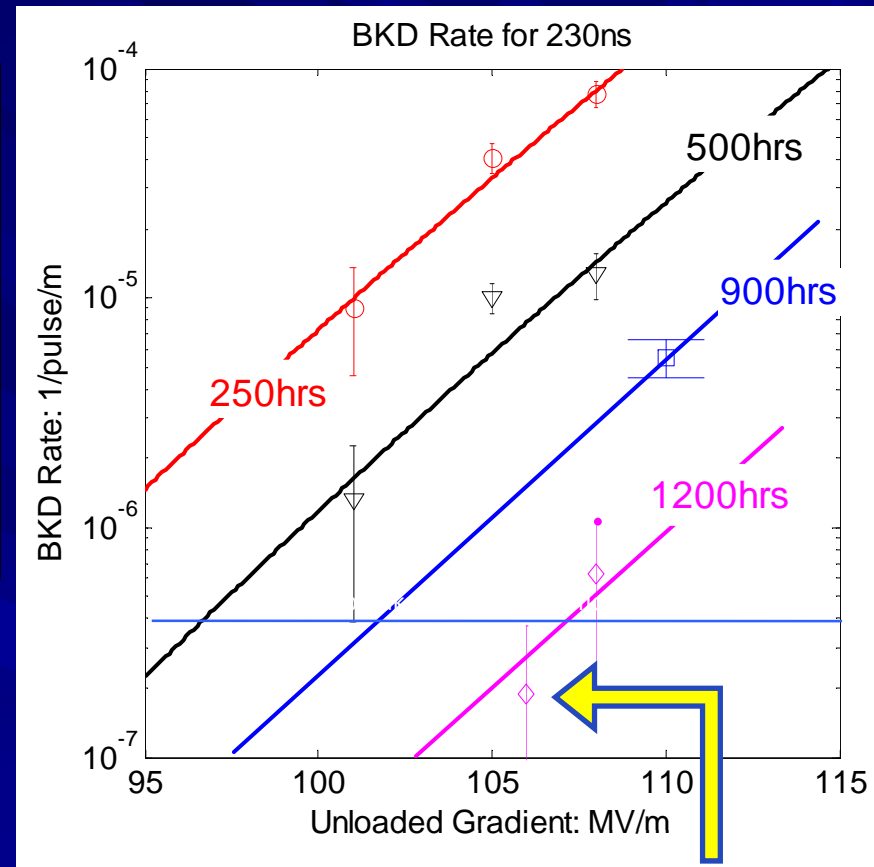
T18 – Successful fabrication and test of the first CLIC X-band test structure designed for 100 MV/m, low breakdown rate operation.



For the connoisseur– 18 undamped cells, 29 cm long, 2.6 to 1% tapered group velocity and manufactured by diamond turning and diffusion bonding.

Excellent and fruitful collaboration:

- designed by CERN,
- manufactured by KEK,
- bonded and tested by SLAC.



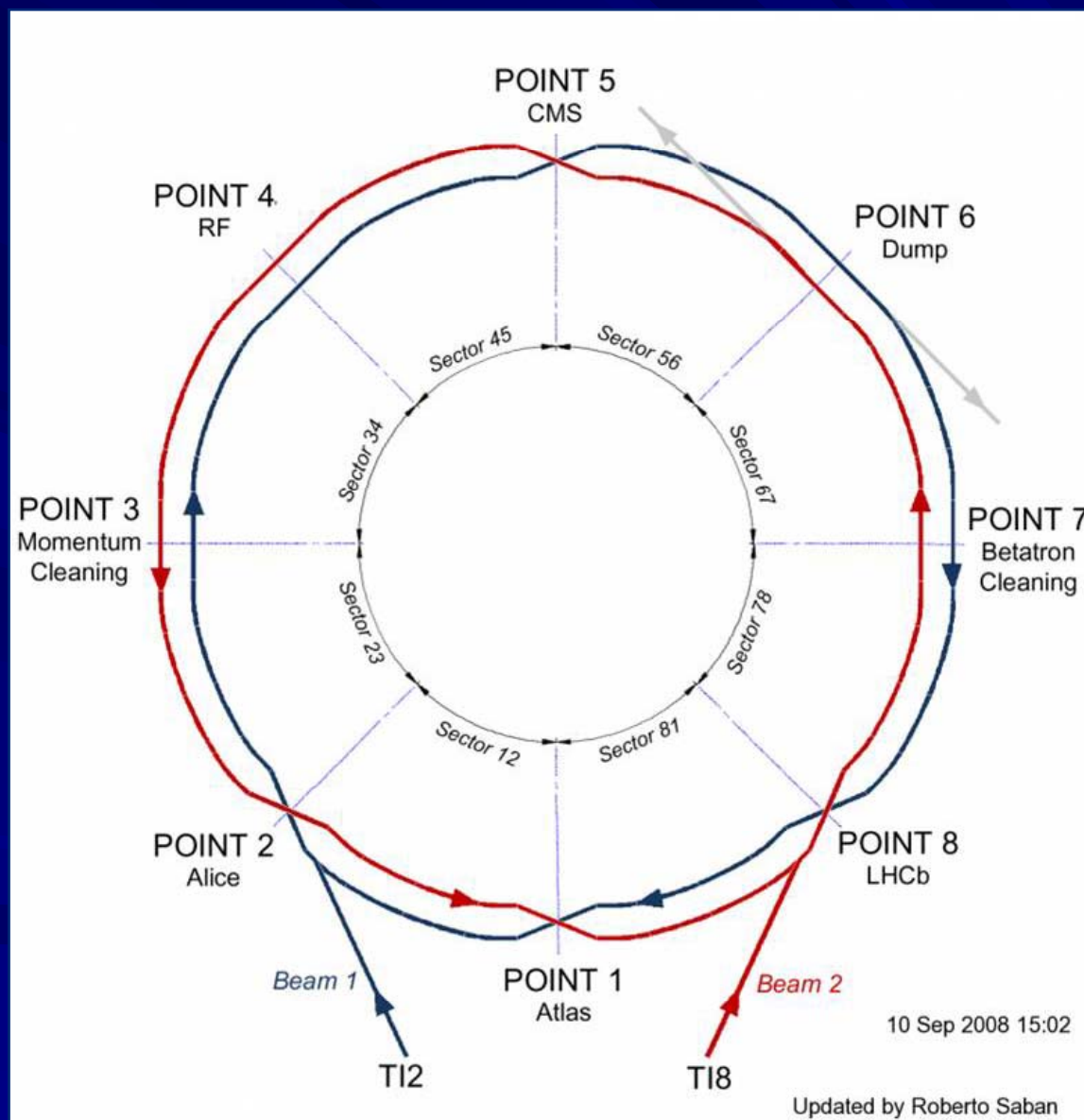
The result – After steady improvement, operation below the 4×10^{-7} CLIC breakdown rate specification with above 105 MV/m unloaded gradient.

LHC Start of Operations

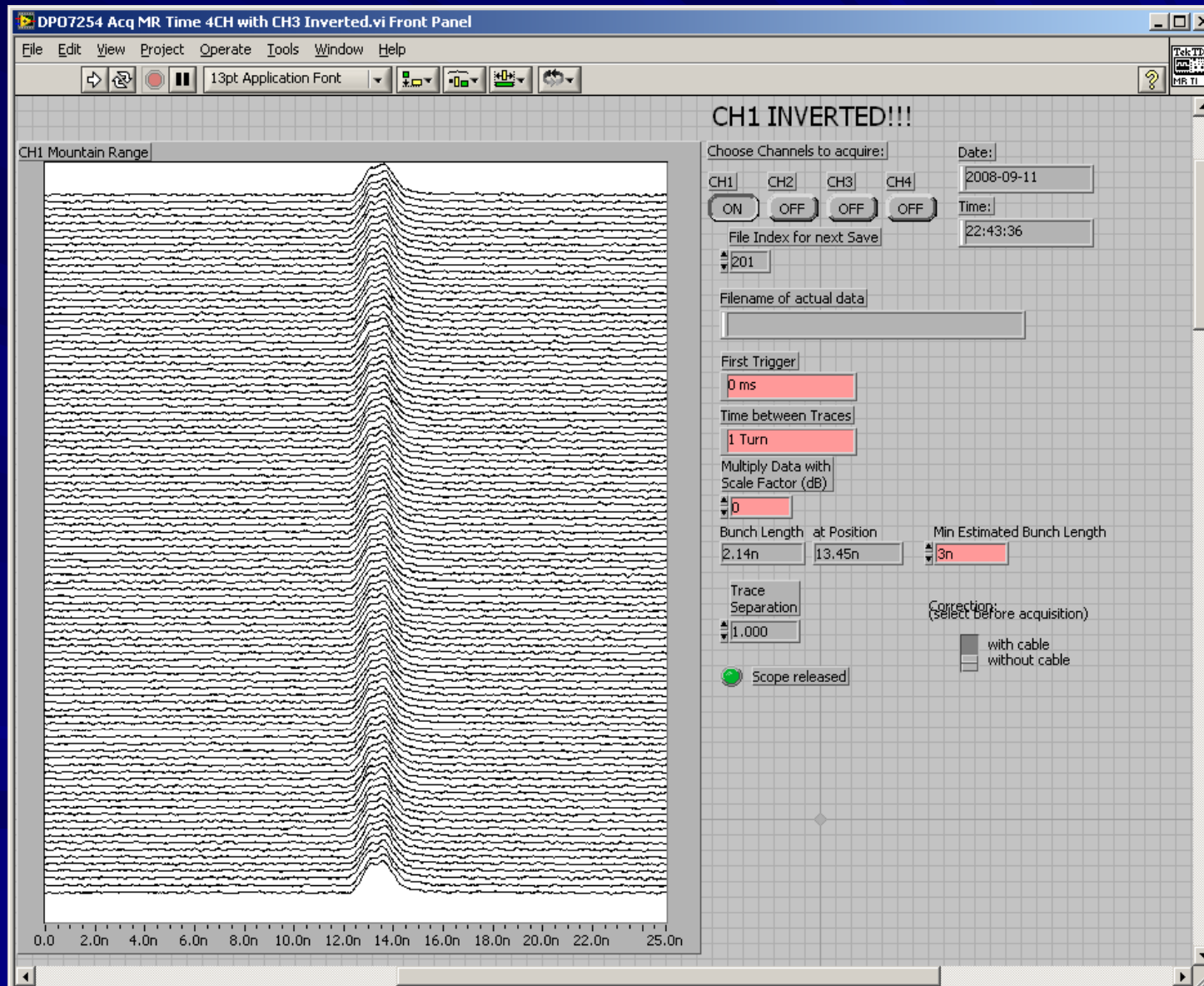


The Large Hadron Collider project saw a wonderful start of operations on September 10, 2008:

- LINAC, Booster, PS, SPS were accelerating beam to 450 GeV for injection into the LHC
- The injection lines (TI8, TI2) transported the beam to the LHC
- The injection kickers sent the beam(s) into the LHC
- **Circulating beams**, in both apertures, were established for the first time, with the whole world looking over our shoulders, in a matter of hours
- The **LHC experiments** were ready and operational as planned and recorded beam related (timing!) data immediately
- The Worldwide **LHC Computing Grid** was up and running
- **The success of the LHC's first operation with beam is a testimony for years of painstaking preparation and the skill of the teams involved in building and running CERN's accelerator complex**
- **Everyone in the field has been "impressed with the speedy control of the beam trajectory, a testimony of the quality of the software and the previous simulation"**



Capture with optimum injection phasing, correct reference



Summary Report on the analysis of the 19th September 2008 incident at the LHC

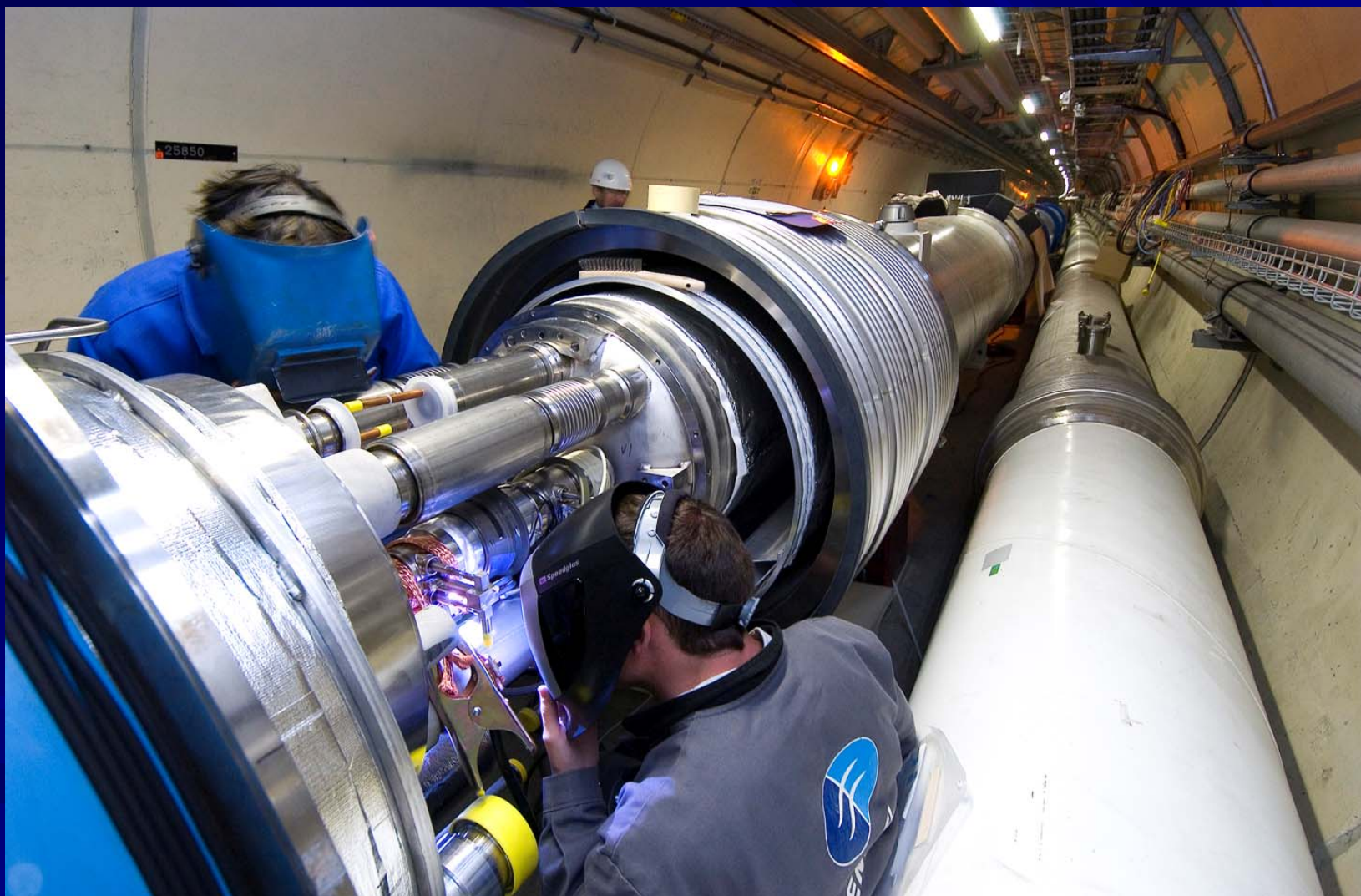


Incident during powering

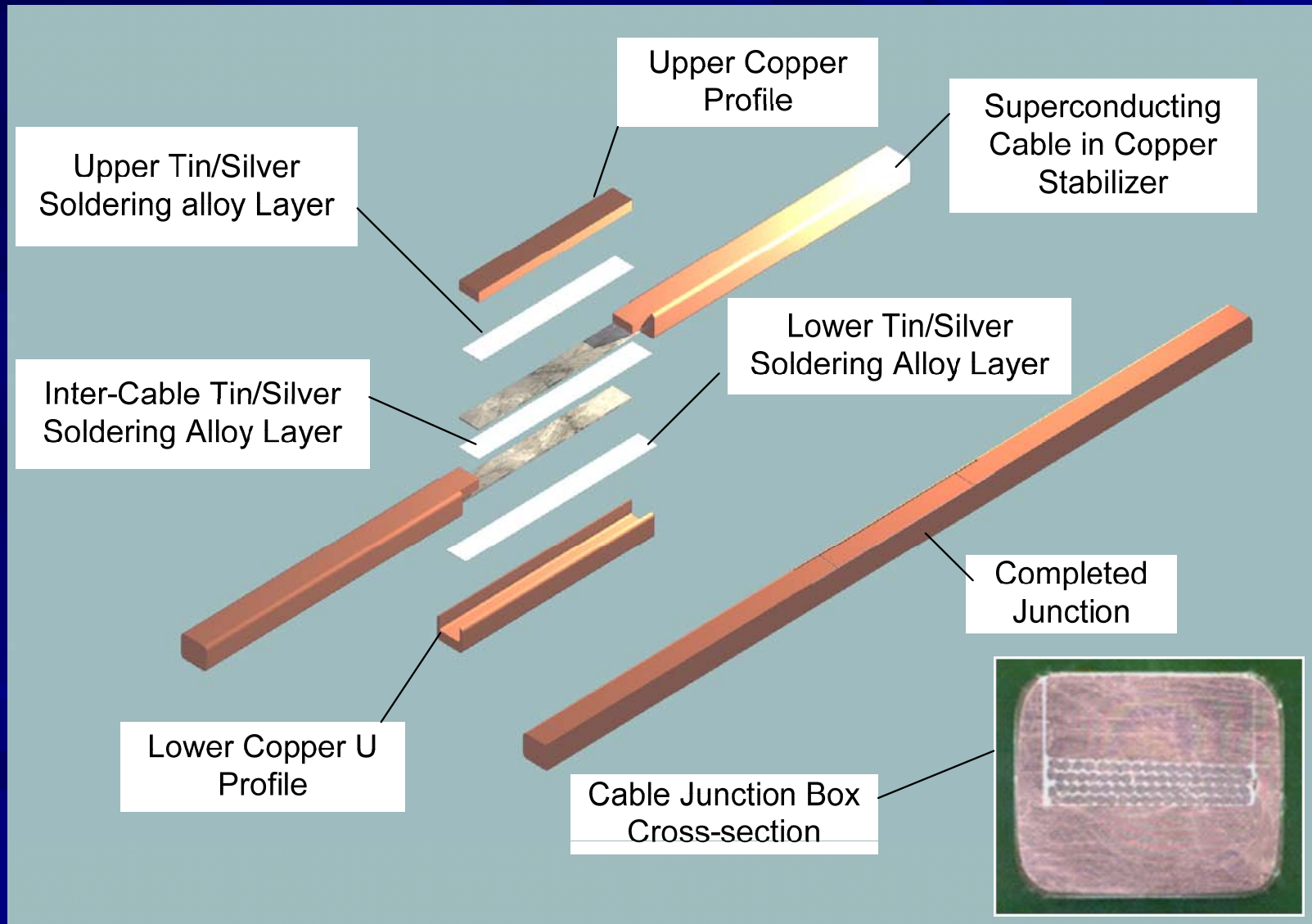
The magnet circuits in the seven other sectors of the LHC had been fully commissioned to their nominal currents (corresponding to beam energy of 5.5 TeV) before the first beam injection on 10 September 2008. For the main dipole circuit, this meant a powering in stages up to a current of 9.3 kA. The dipole circuit of sector 3-4, the last one to be commissioned, had only been powered to 7 kA prior to 10 September 2008. After the successful injection and circulation of the first beams at 0.45 TeV, commissioning of this sector up to the 5.5 TeV beam energy level was resumed as planned and according to established procedures.

On 19 September 2008 morning, the current was being ramped up to 9.3 kA in the main dipole circuit at the nominal rate of 10 A/s, when at a value of 8.7 kA, a resistive zone developed in the electrical bus in the region between dipole C24 and quadrupole Q24. No resistive voltage appeared on the dipoles of the circuit, so that the quench of any magnet can be excluded as initial event. In less than 1s, when the resistive voltage had grown to 1 V and the power converter, unable to maintain the current ramp, tripped off, the energy discharge switch opened, inserting dump resistors in the circuit to produce a fast power abort. In this sequence of events, the quench detection, power converter and energy discharge systems behaved as expected.

Interconnects



Busbar splice



Summary Report on the analysis of the 19th September 2008 incident at the LHC



Sequence of events and consequences

Within the first second, an electrical arc developed and punctured the helium enclosure, leading to release of helium into the insulation vacuum of the cryostat.

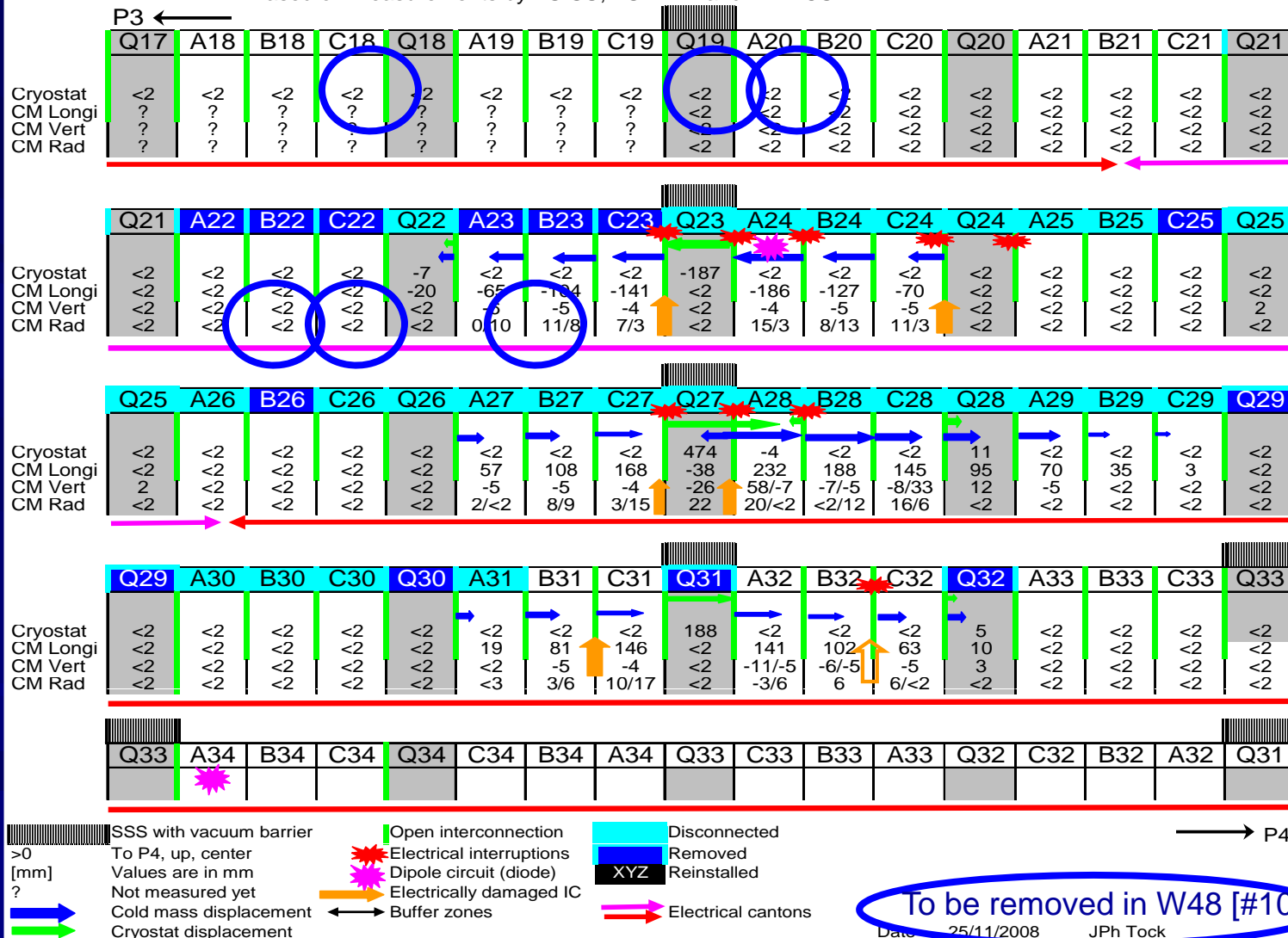
The spring-loaded relief discs on the vacuum enclosure opened when the pressure exceeded atmospheric, thus relieving the helium to the tunnel. They were however unable to contain the pressure rise below the nominal 0.15 MPa absolute in the vacuum enclosures of subsector 23-25, thus resulting in large pressure forces acting on the vacuum barriers separating neighboring subsectors, which most probably damaged them. These forces displaced dipoles in the subsectors affected from their cold internal supports, and knocked the Short Straight Section cryostats housing the quadrupoles and vacuum barriers from their external support jacks at positions Q23, Q27 and Q31, in some locations breaking their anchors in the concrete floor of the tunnel. The displacement of the Short Straight Section cryostats also damaged the “jumper” connections to the cryogenic distribution line, but without rupture of the transverse vacuum barriers equipping these jumper connections, so that the insulation vacuum in the cryogenic line did not degrade.

Sector 3-4 recovery + 25/11/2008 / AT-MCS



Displacements status in sector 3-4 (From Q17R3 to Q31L4)

Based on measurements by TS-SU, TS-MME and AT-MCS



Q27R3





Summary Report on the analysis of the 19th September 2008 incident at the LHC



Inspection and diagnostics

The number of magnets to be repaired is at maximum of 5 quadrupoles (in Short Straight Sections) and 24 dipoles, but more (42 dipoles and 15 quadrupoles) will have to be removed from the tunnel for cleaning and exchange of multilayer insulation.

Spare magnets and spare components are available in adequate types and sufficient quantities for allowing replacement of the damaged ones.

The extent of contamination to the beam vacuum pipes is not yet fully mapped, but known to be limited; in situ cleaning is being considered to keep to a minimum the number of magnets to be removed.

The plan for removing/reinstallation, transport and repair of magnets in sector 3-4 is being established and integrated with the maintenance and consolidation work to be performed during the winter shutdown.

It should be available for the next Council meeting in December.

The corresponding manpower resources have been secured.

Summary Report on the analysis of the 19th September 2008 incident at the LHC



Follow-up actions (preliminary)

Two different goals, namely to prevent any other occurrence of this type of initial event, and to mitigate its consequences should it however reproduce accidentally. Precursors of the incident in sector 3-4 are being scrutinized in the electrical and calorimetric data recorded on all sectors, which remain cold, in order to spot any other problem of the same nature in the machine.

- An improvement of the quench detection system is currently tested, before being implemented.
- The relief devices on the cryostat vacuum vessels will be increased in discharge capacity and in number.
- The external anchoring of the cryostats at the locations of the vacuum barriers will be reinforced to guarantee mechanical stability.

Until now, no other interconnection resistance has been identified as above specification, but two (?) connections inside the cold masses (which have been tested successfully to 9T) have been measured higher than specified.

Schedule of Experiments



- The incident on 19th September is undoubtedly a psychological blow but I have no doubt that we will overcome this setback with same degree of rigor and application
- We have received quite many messages of sympathy and support, in particular from US laboratories (Fermi and BNL), from Japanese KEK and Russian BNIP, ready to help, and from industry contractors like Air Liquide
- The LHC will restart operation in the next spring. Maintenance of CERN infrastructure in North Area will start immediately (on 6th October) in order to restart the accelerator complex as usual in April (and not in June as planned)
- The experiments will now go into 'long shutdown' mode, to be ready again in early Spring 2009: a more precise date will be agreed with them as soon as this is possible
- Most experiments have identified a useful and/or necessary program of work of 4 – 5 months: repairs, refurbishments, improvements, additional installation work

New Activities 2008-2011

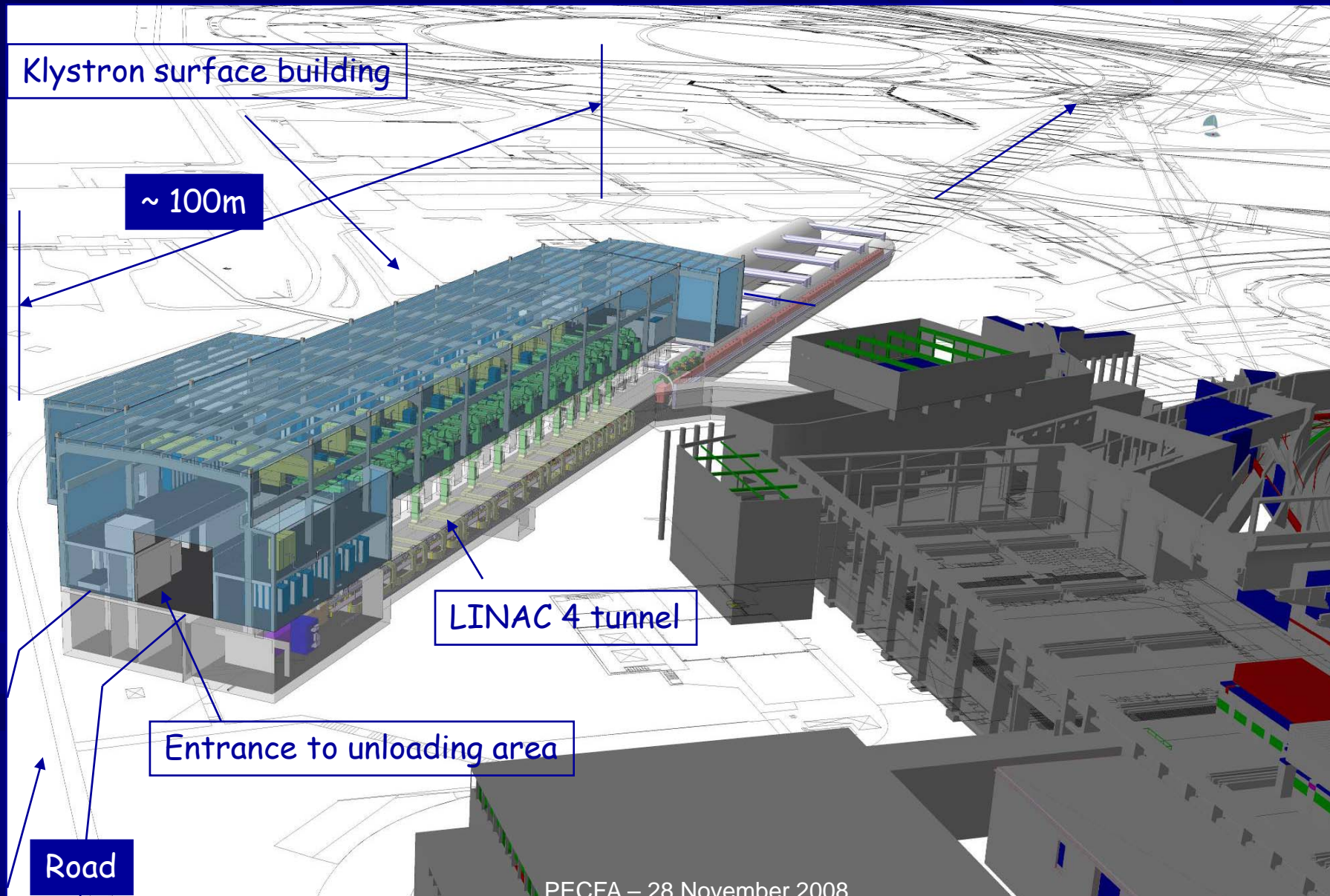


- Follows the directions of the « European Strategy for Particle Physics » approved by the Council at Lisbon in July 2006
- Plan structured in 3 + 1 themes
- First theme: « *to fully exploit the physics potential of LHC* »
 - Final implementation of the four experiments
 - Enhanced capacity for physics data analysis
 - Consolidation/improvements to enhance luminosity in the short term
 - *New inner triplets: upgrade of the LHC insertions « Phase I »*
- Second theme: « *renovate the injector complex to improve reliability* »
 - Design of PS2 and SPL
 - Build LINAC4 as new front-end injector
- Third theme: « *accelerator and detector R&D for LHC luminosity upgrade, high-intensity ν facility and CLIC technology qualification* »
 - Superconducting magnet R&D: high-field and fast-cycled
 - Improved RF capture systems in SPS and LHC
 - Detector development for LHC and CLIC
 - Enhanced CLIC qualification programme with CTF3

Layout Linac4-SPL-PS2



Linac 4 Building and Tunnel



Upgrade of the LHC insertions: “Phase I”



Goal of “Phase I” upgrade:

Enable focusing of the beams to $\beta^* = 0.25$ m in IP1 and IP5, and reliable operation of the LHC at $2 \cdot 10^{34} \text{ cm}^{-2}\text{s}^{-1}$ on the horizon of the physics run in 2013.

Scope of “Phase I” upgrade:

1. Upgrade of ATLAS and CMS experimental insertions. The interfaces between the LHC and the experiments remain unchanged at ± 19 m.
2. Replace the present triplets with wide aperture quadrupoles based on the LHC dipole cables (Nb-Ti) cooled at 1.9 K.
3. Upgrade the D1 separation dipole, TAS and other beam-line equipment so as to be compatible with the inner triplet aperture.
4. The cooling capacity of the cryogenic system and other main infrastructure elements remain unchanged.
5. Modifications of other insertion magnets (e.g. D2-Q4) and introduction of other equipment in the insertions to the extent of available resources.