Preliminary View on the LHeC Experimental Vacuum Chambers

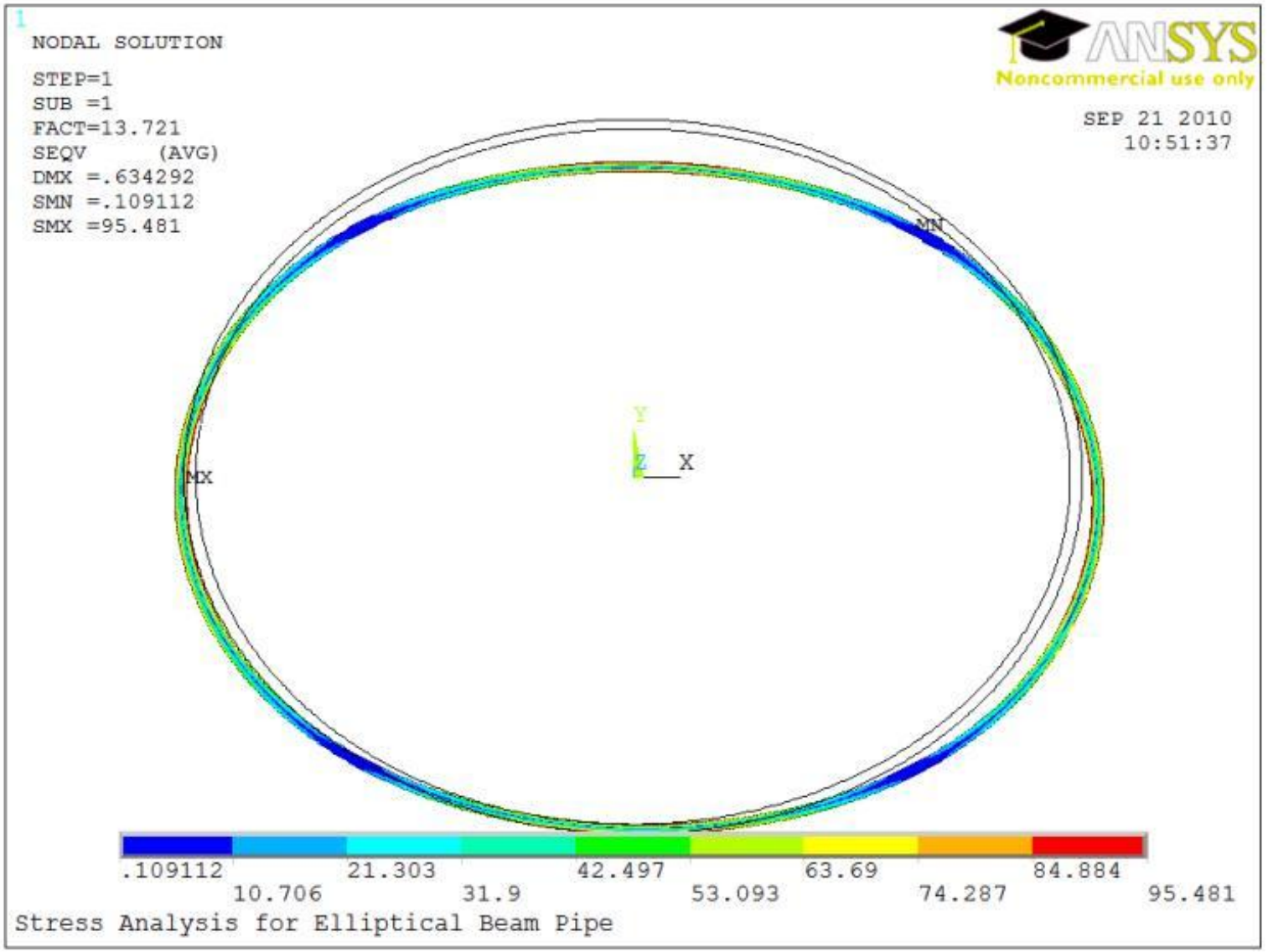
Jonathan Bosch and Ray Veness / TE-VSC

LHC Experimental Vacuum Requirements

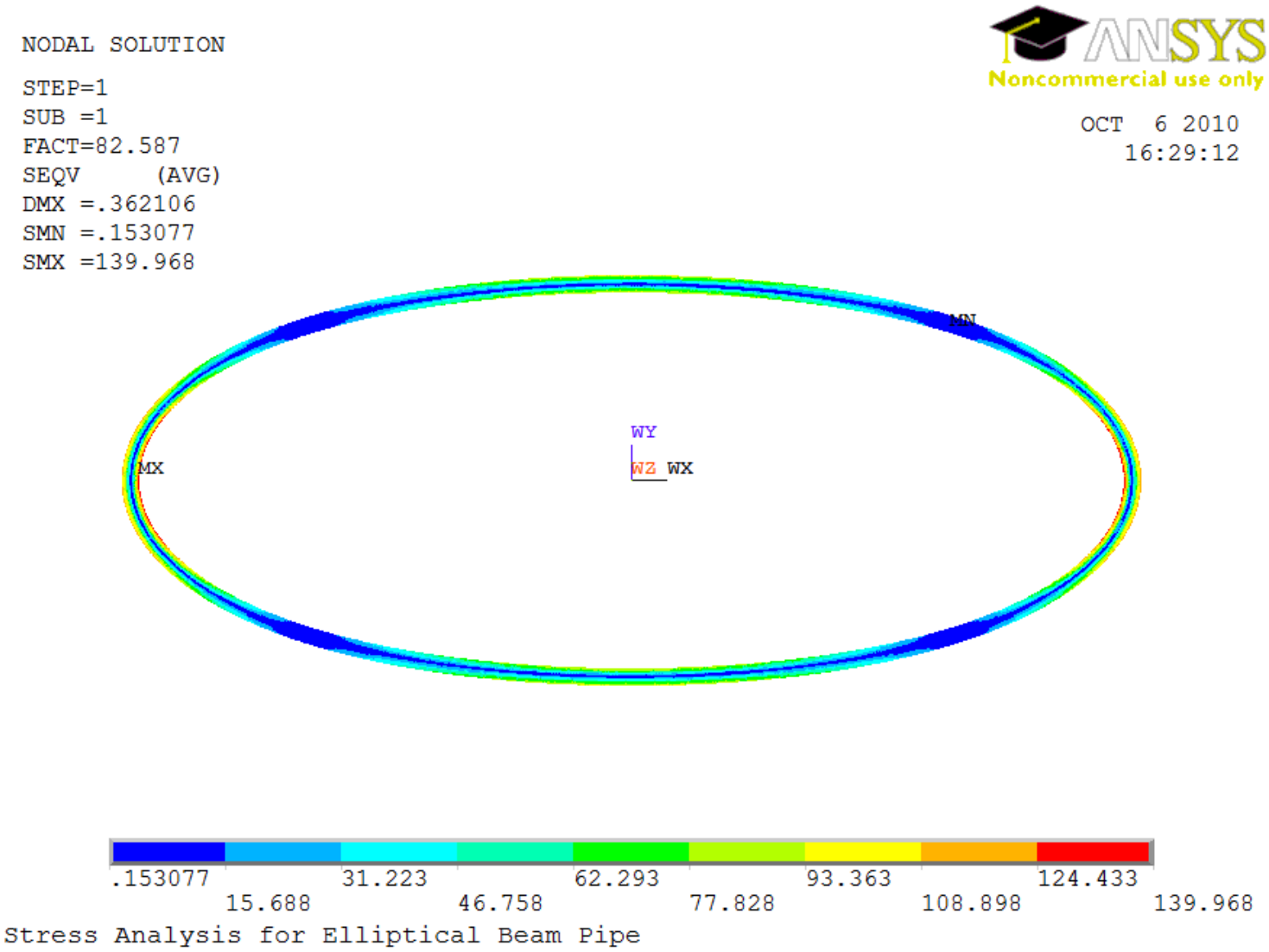
- Machine requirements
  - The LHC beam vacuum system design requires control of a number of dynamic vacuum issues
    - Ion induced desorption, electron stimulated desorption & electron cloud, photon stimulated desorption
  - The primary factor in this control is low desorption yields from vacuum chamber surfaces
- Experimental Vacuum requirements
  - LHC (and LHeC) experimental chambers require low Z materials
  - Low Z, ultra-high vacuum compatible materials (eg, aluminium, beryllium) have high desorption yields
    - Titanium would be a possible exception
  - LHC overcame this by using thin-film TiZrV NEG coatings, but these require activation by heating the chamber to 180~220°C
- Radiation
  - LHC experimental interaction chambers are designed for doses in the order of 1 MGy per year (at nominal luminosity), mainly from collisions
    - Will this be true for LHeC?
  - This places additional limitations on choice of material

Preliminary Analysis

- Beampipe material choice
  - This combination of temperature resistance, radiation resistance, UHV compatibility, plus mechanical requirements resulted in the choice of NEG coated beryllium and/or aluminium for the critical central parts of LHC detector beampipes
  - Sandwich structure or composite pipes have been considered at the design stage, but rejected due to limitations in the bonded assemblies
  - Long-term R&D on carbon-carbon composite chambers is under way in VSC which may give an alternative.
- Preliminary calculations
  - Finite element analysis using ANSYS
  - Infinitely long chamber of constant cross-section
  - Eigen value buckling plus stress analysis



72mm x 58mm ellipse, 1 mm thick beryllium. Deformed shape plus equivalent stress distribution



120mm x 50mm ellipse, 2mm thick beryllium. Undeformed geometry plus equivalent stress distribution

Summary

- LHC requirements
  - The combined requirements of LHC machine and experiments (of which not all have been considered here) place a serious limit on the choice of materials and forms for beampipes
- Preliminary analysis
  - Preliminary calculations have been made for simple ‘solid’ geometries made from aluminium, titanium and beryllium
  - In beryllium, thickness in the order of 1 mm (for 72x58mm) and 2 mm (for 120x50mm) appear feasible