Vacuum Systems for Diamond

Design of the Vacuum Systems for Diamond
The UK 3rd Generation Light Source

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Vacuum Systems for Diamond
What is Diamond?

- a 3rd generation synchrotron light source
  - an electron storage ring (3GeV, 300 mA, 2.7 nm-rad)
  - injector train
    - linac (100 MeV)
    - booster synchrotron (3GeV)
    - transfer lines
  - experimental beam lines
Vacuum Systems for Diamond Project Organisation

- Diamond will be owned and operated by a joint venture company, Diamond Light Source, Ltd. (DLS)
  - UK Government (86%)
    - Through Office of Science and Technology
      - Nominated shareholder CLRC
  - Wellcome Trust (14%)
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Where is Diamond?

- Diamond (RAL)
- ASTeC (DL)
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The Building

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Pictures courtesy of JacobsGIBB Ltd/Crispin Wride Architectural Design Studio.)
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General Layout
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Project Timescales

• Design Study completed            March 2002
• Building work starts              March 2003
• Machine build starts              September 2004
• Machine complete for commissioning January 2006
• Beam for users – 7 beam lines     January 2007
• Build up approx 4 Beam Lines per annum thereafter
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Basic Vacuum Parameters

• **Injector**
  - \(~10^{-8}\) mbar

• **Storage Ring and Front Ends**
  - **Base Pressure**: \(~10^{-10}\) mbar
  - **Operational Pressure**: \(~10^{-9}\) mbar (300mA)
  - **Gas Scattering Lifetime**: \(~35\)h
  - **Overall Lifetime**: \(~24\)h

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Vacuum Design Objectives

• To obtain minimum lifetime of 10 hours after 100 Ah conditioning
  ▪ $10^{-9}$ mbar at 300 mA
  ▪ No *in situ* bakeout
• To use proven (conventional) materials, design methods, techniques
• To achieve as much modularity as possible
• To use, wherever possible, standard, commercially available vacuum equipment
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Evolution of the Design

- Originally
  - Lumped Photon Stops with close coupled pumping
- Finally
  - Crotch absorbers with high pumping
  - Distributed absorbers
  - No true distributed pumping
Vacuum Systems for Diamond Materials

• **Stainless Steel**
  - Most vessels fabricated
    - Economical
    - Well understood
    - Familiar to UK and European industry
    - ? 304L; 304LN; 316L; 316LN

• **Aluminium**
  - Extruded narrow gap ID vessels
    - Critical Tolerances
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To bake or not to bake?

After 25 years operating experience of the SRS
• Useable lifetimes after modest beam conditioning
  ▪ Comparable to time spent carrying out a bake
• Good lifetimes after about 100 Ah conditioning
  ▪ Even following substantial machine rebuilds with many new components.
• Current practice at other light sources divided
Vacuum Systems for Diamond Technology

- **Pumping**
  - Ion Pumps, probably differential diodes
  - TSPs – good experience
  - Lumped NEG
  - Sputtered NEG for narrow gap ID’s
  - Clean roughing
- **Gauging**
  - Pirani
  - Inverted Magnetron
  - RGA
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Vacuum flow diagram of an arc
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Calculated Pressure Profile

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Vacuum Systems for Diamond Girder Arrangement

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Vacuum 16
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Vacuum String

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Vacuum Systems for Diamond Dipole Vacuum Chamber

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Vacuum Systems for Diamond Tapers

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Vacuum Systems for Diamond
Typical Beam Line Layout
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Beam line front end vacuum design

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• Day 1
  ▪ Four *in vacuo* permanent magnet undulators
    ◆ Three 0.7T, 2m length, 7mm nominal gap, 1.7kW
    ◆ One 0.8T, 2m length, 7mm nominal gap, 2.2kW
• Adopt ESRF Design
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The Team

The work summarised here is heavily reliant on

The ASTeC Vacuum Science Group

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and the

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