

Vacuum Science and Technology in Accelerators (2010 version 2)

This course will provide the basic background to enable an accelerator scientist to understand why vacuum is required in accelerators and how to obtain it. It will not cover the whole field of vacuum science and technology, but will largely be concerned with high vacuum and ultra high vacuum. The course will include some basic vacuum science, the production and measurement of low pressures, materials properties which affect vacuum and some of the peculiarities of designing vacuum systems for accelerators. The basic approach will be descriptive although there will be formulae where necessary.

Session 1 (18 Jan)

The vacuum requirements of accelerators.

Brief review of different classes of accelerators and why vacuum levels differ. Beam-vacuum interactions. Introduction to the vacuum design of accelerators

Session 2 (18 Jan)

Basic principles of vacuum

Kinetic theory; gas laws. Basic concepts – mean free path, pressure, impingement rate. Gas flow regimes. Conductances. Pumping speeds. Pressure regimes.

Session 3 (25 Jan)

The measurement of vacuum

Direct and indirect gauges for total pressure. What is actually measured? Gauge effects. Calibration. Partial pressure measurement (residual gas analysis)

Session 4 (25 Jan)

The production of low pressures

Pumping mechanisms. Displacement pumps: Rotary pumps, dry roughing pumps, turbo-molecular pumps. Capture pumps: Getter Ion pumps, sublimation pumps, non evaporable getter pumps. Cryogenic pumps.

Session 5 (1 Feb)

Materials properties related to vacuum.

Relevant mechanical properties. Outgassing and desorption phenomena. Selection of materials for vacuum

Session 6 (8 Feb)

Components, construction and processing techniques for vacuum components and systems

Flanges and joints. Welding and brazing. Valves, bellows, windows, feedthroughs. Moving devices in vacuum. Cleaning; degassing; bakeout.

Session 7 (8 Feb)

Basic vacuum design of accelerators I

Approaching the specifications. Putting it all together.

Session 8 (15 Feb)

Basic vacuum design of accelerators II

Practical aspects and some common pitfalls. Quality control techniques for vacuum

Session 9 (15 Feb)

Calculations to support the design

Pumping speeds. Pressure distributions. Software packages.

Session 10 (22 Feb)

Examples and Review

Discussion of some accelerator projects. Review of the course.