ILC Beam Dumps and Fast Extraction Line

Related Experience

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- Physics
- Engineering
- Technology
Challenges

- Power density
- Pulsed power effects (Cavitation, shock)
- Window design
- Safety (off-normal operation)
- Radiation damage
- Induced activity
- Total power
ILC Beam Dumps

Water Dump: Overall Scheme

- sand
- normal cooling water
- exhaust / chimney?
- enclosure
- air treatment
- water-system
- water-dump
- dump shielding
- spent beam, tilted ≈15mrad
- emergency/comm. beam tilted ≈15mrad
Requirements

• Simulation
  Beam Transport, Heat deposition, activation, secondary particles

• Shielding

• Materials
  Radiation damage, high thermal and stress loads

• Engineering
  Thermal analysis, CFD, Stress analysis, remote handling

• Radioactive discharges, waste
  Solid, Liquid, Gaseous
Codes available:

- Beam Transport
- GEANT, FLUKA, MCNPX, CINDER90
  - Electromagnetic cascade
  - Neutron transport
  - Deposited Heat
  - Radionuclide production
  - Induced activity
Codes: MCNPX, FLUKA, GEANT

Beam-Line #7  90.8 degrees with respect to the proton beam direction

JSNS Shielding Design
ILC Beam Dumps - Engineering

Expertise

- Spallation Targets
- Active Water Cooling Circuits
- Fully Remote Handling
- Vacuum
- Analysis: Thermal, Stress, CFD (ANSYS, CFX)
- Design – CAD 2D and 3D
- Electrical engineering
- Controls
Available Data

• Proton and Neutron damage data available for almost all useful materials

• Status of high energy electron and photon damage data??

• Assessment of component lifetimes from radiation damage data is problematic.
Solid, Liquid and Gaseous waste generated in operation and decommissioning

- Quantities well within what ISIS has to deal with currently
- Disposal arrangements are very site dependent
- Activation calculations – codes available
- Predicted dose rates on components ~ 100mSv/h require fully remote handling
ILC Beam Dumps – ISIS Spallation Source

Target

Remote Handling Cell

Proton Beam 160 kW

Shielding Services Area
‘High Power’ Targets

- ISIS 250 kW
- SNS Mercury 2 MW
- SNS Mercury 2 MW
- Neutrino Factory 4 MW
- PSI 1 MW
Spallation Targets – Water Cooling

3 Active Water loops
- ~9 TBq/m³ Tritium
- IOX cleanup
- Filters
- Maintenance
- Monitoring
Remote Handling

- Fully remote handling
- Master-slave manipulators
- Special tooling
- Handling complex assemblies
Remote Handling - Seals

Adaptation of commercial seals for remote handling

Pneumatic boltless seals
SNS Proton Beam Window
5 x 10^{-6} torr l/s leak rate
Off normal events may well drive the design

- Failure of beam expander system – how long before the window fails?
- Failure of gas recombiner systems
- Major leak of water/gas (gas more difficult)
- Instrumentation problems
- Interlock design
A great deal of useful experience exists in CCLRC outside the ILC community

Relevant experience in CCLRC exists in most areas (Neutron source, Neutrino factory as well as ILC teams)

Areas where the knowledge is relatively weak
  • Radiation damage
  • High pulsed power effects
  • Gas recombiners

New ideas may well be needed
  • Rotating metal (AL) target in the water bath?
  • Flowing liquid metal (e.g. Gallium) beam dump?