



Workshop on Materials for Collimators and Beam Absorbers



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3-5 September 2007

CERN



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This workshop will focus on collimators and beam absorbers for High Energy Hadron Accelerators, with the energy stored in the beams far above damage limit. The objective of the workshop is a better understanding of the technological limits imposed by mechanisms related to beam impact on materials. The issues to be addressed at the workshop are listed below.

Dates: from 03 September 2007 14:00 to 05 September 2007 18:15

Location: CERN
Geneva, Switzerland
Room: **40-S2-D01**

Chairs: **Ralph W. ASSMANN (CERN) - ORGANIZING COMMITTEE**
Wim WETERINGS (CERN) - ORGANIZING COMMITTEE
Nikolai V. MOKHOV (Fermilab) - ORGANIZING COMMITTEE
Alessandro BERTARELLI (CERN) - ORGANIZING COMMITTEE
Peter SPILLER (GSI) - ORGANIZING COMMITTEE
Rudiger SCHMIDT (CERN) - Chairman
Malgorzata MACUDA (CERN) - Workshop Secretary
Caroline CAZENOVES (CERN) - Workshop Secretary

Thanks to all members of organisation committee for the preparation of this event
Thanks to all participants for their interest



Introduction

The idea to organise this workshop came up last year during

ICFA-HB2006

39th ICFA Advanced Beam Dynamics Workshop

High Intensity High Brightness Hadron Beams

May 29 - June 2, 2006

Tsukuba, Japan

This workshop will mainly focus on **collimators and beam absorbers for (mainly) High Energy Hadron Accelerators**, with the **energy stored in the beams far above damage limit**. The objective of the workshop is a better understanding of the limits imposed by mechanisms related to beam impact on materials.



Motivation

The event is **driven by the LHC challenge**, with more than **360 MJoule** stored in each proton beam. The beam interacts with LHC collimators and beam absorbers, and with the LHC beam dump blocks.

However, collimators and beam absorbers are also in the interest for other labs and accelerators, for example

- CERN: for the CNGS target, for SPS beam absorbers (extraction protection) and transfer line protection collimators
- GSI: Super-FRS target, HED experiments, Antiproton target, etc. ...
- Fermilab: Tevatron and Main Injector collimation systems; neutrino production targets (MINOS, SNuMI, NOVA); antiproton production targets; ILC: positron production targets, beam absorbers and collimators; pion production targets and beam absorbers for neutrino factories and muon colliders.
- ILC: Collimators for beam delivery systems

Introduction – collimators and beam absorbers for different accelerators (Session 1)

- The problems encountered for systems used in different accelerators and solutions adopted
- What materials are being used?
- What led to the choice of these materials?
- What are the limits of the present solutions?
- Why will more robust devices be needed in the future?
- What is the perspective in the framework of new or upgraded machines?
- The relevant parameters for beam impact on the material will be discussed, such as deposited beam energy, beam power and time structure of the beam impact.

New Materials / New Ideas for collimators and beam absorbers (Session 2)

- What material parameters are relevant, such as specific heat capacity, enthalpy, Young's modulus, yield stress, coefficient of thermal expansion, thermal conductivity?
- What are the relevant figures of merit? Are the bulk or microscopic parameters the relevant ones, particularly for composite and anisotropic materials?
- What materials are most suitable, e.g. robust and with low electrical resistance? Other parameters such as anisotropy of materials and secondary electron yield? Are there new materials on the horizon?
- Material requirements for special concepts or locations, e.g. collimators and absorbers at cold or at intermediate temperature, collimators with superimposed magnetic fields, ...



Tuesday afternoon

Experimental results and future tests / test station (Session 3)

Discussion on plans and opportunities for studies and tests at CERN and elsewhere (Session 4)

- What tests of materials are possible?
- What to test and where to test? Test bench at SPS?
- How to analyse test results?
- What R&D is being done or is in the pipeline for investigating devices with special locations and concepts?

Codes and simulations results (Session 5)

- What happens in case of shock impact / continuous impact?
- What are the relevant physics effects to be considered?
- What happens to the material beyond melting / vaporisation temperature? (example: beam tunneling through materials)
- What is the design limit based on, e.g., maximum temperature?
- What is the status of the codes for energy deposition calculations? When do calculations for shock impact with mechanical engineering codes (e.g., ANSYS, AUTODYN, LS-DYNA) break down?
- What are the limits of the domain of application of the classical thermoelastic / plastic theory with respect to the Hydrodynamic theory of Shock Waves?
- What are the domains of validity for simulation?
- How to compare the results from different codes, possibly for some (simple) test cases to be defined?
- What experimental evidence and experience with benchmarking exists?
- How to formulate an equation of state for materials in advanced codes?
- When do we require renewable/disposable/sacrificial devices?



Tuesday and Wednesday

Radiation effects (Session 3 and Session 5)

- What are the short- and long-term effects of radiation? What is the effect of the total dose on material properties, and on equation of state?
- Is there an effect of the dose rate?
- DPA (displacements per atom) is a measure of the material irradiation. Is this a universal measure for different radiation fields?
- Is there a temperature dependence during radiation?
- What about annealing?
- Can this be used to 'repair' devices?



Some of my wishes for the outcome....

For me as a non-expert: very rich physics when discussing interaction of high energy high intensity beam with real world objects: get the experts together and try to come to a common understanding, or at least agree on most relevant questions

- Better understanding of (new) materials for collimators and beam absorbers
- There are several codes: what code is best to address what question?
- Test and experiments: what can be done, where can we collaborate?

Machine Protection GEuro question: What is the minimum length of a disposable absorber for the full non-diluted LHC beam (360 MJoule, $\sigma = 0.3$ mm) without causing too much collateral damage?

A lot of work is being done on high power targetry

3rd High-Power Targetry Workshop, September 10 – 14, 2007, Bad Zurzach, Switzerland, organised by PSI <http://asq.web.psi.ch/hptrgts/index.html>

This workshop should be complementary to workshops on high power targetry. After this workshop, common issues should become more clear.



Plus one more wish for all of you....

**Have a good
workshop**

And a good time in Geneva