Phase 2 Work at SLAC and CERN

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CWG - 2.5.5
Introduction

Phase 1 collimation system is estimated to bring us to ~40% of nominal intensity! This would be an outstanding success: 100 times more stored energy than in TEVATRON!

If you take a factor 4 as uncertainty in complicated predictions: We might also arrive at 10% of nominal intensity! The LHC will tell us!

No time to sit on our achievements: It is now time to prepare nominal and ultimate performance!

– All preliminary views...

– Feedback and input is very welcome to work out the best plan...

– Phase 2 R&D budget is now officially approved by the LHC project office...
“Phase” Philosophy

• All locations have been frozen: Phase 2 places known and reserved!

• Plan: Install as much infrastructure for phase 2 as possible before machine start-up (minimize dose to personnel)!

• **Phase 1 collimators will not be replaced in the LHC:**
  
  – used initially for injection (larger gaps), ramp (shrinking gaps) and physics (smallest gaps).

  – very robust: best learning experience (no or little damage with wrong manipulations).

  – high impedance (C-C) and lower efficiency than 1-m long Cu jaws (though same efficiency as old Al/Cu system)!

  – in phase 2: still use phase 1 collimators for injection and ramp (rocky parts of operation), however, do not close for physics!
Phase 2 Requirements

• Goals:
  – Reduce impedance: Metal facing the beam!
  – Improve efficiency: High Z layer for first mm’s facing the beam!
  – Robustness: Sufficient robustness for regular and irregular operation

• Contradiction in above requirements:
  – High robustness: Low Z
  – Improved efficiency: High Z
  – High accuracy: Excellent flatness and control for nominal $\beta^*$!

➔ Advanced technology needed to cope with expected damages in highly radioactive environment (self-repair, in-situ replacement, ...!)
➔ Used only in stable physics (stable conditions) to minimize risk!

• Phase 2 is advanced technology!
  – Start R&D early on (2005) to be ready for phase 2 installation 2009/10!
  – Aim for nominal & ultimate performance (simulations).
Possible Mis-understanding

- **Phase 2 is ONLY for secondary collimators! Assume same primary collimators!**
- **New technology for primary collimators (e.g. crystals) is very interesting but is only useful for cleaning under these conditions:**
  - High robustness of materials.
  - Acceptable tolerances for stable operational usage (not more demanding than collimators).
  - Functionality assured during the full operational cycle (e.g. problem if channeling breaks down).
  - Improved cleaning efficiency.
  - Secondary collimators can be opened to reduce their effective impedance!
  - Extracted energy is safely deposited.
- **Even if found not useful for proton collimation, these technologies might be useful for background reduction, ions, ...**
To make it clear...

- Crystals will not help for maximum stored intensity if they require the phase 1 collimator system at nominal settings!

- Non-linear collimation is also studied and similar remarks apply.

- This should not stop R&D on these technologies to exploit their other potential benefits for the LHC!
Tentative Phase 2 Schedule

- **2005:** Start of technical R&D towards phase 2.
- **end 2007:** Phase 2 prototypes ready for machine installation.
- **end 2008:** LHC beam tests for several phase 2 concepts.
- **1/2009:** Decision on phase 2 technology
  (required at all? what is the real problem: impedance or efficiency or accuracy? what is the best solution for the LHC?)
- **2009:** Phase 2 production.
- **3/2010:** Phase 2 installation.
- **2010:** Phase 2 commissioning.
- **2011:** Ready for nominal LHC performance.
Phase 2 Competition

• **Phase 2 technology is very demanding. “Crazy” concepts accepted!**

• Chance for real improvement but also for failure in R&D, prototyping and beam tests!

• Follow *diverse solutions and select the best technology* based on tests with LHC beam!

  ➔ “Phase 2 collimation competition”

• Work and experience from US-labs is very important.

• Do not reproduce US technology but instead develop other or complementary technology!

• Re-usage of parts of phase 1 technology is very useful, if feasible!
SLAC Effort

• Impressive progress reported at last US-LARP meeting!
• Slides at: http://www.agsrhichome.bnl.gov/LARP/050406_danfords/
• They do now commit on continuing...
• Excellent news for CERN!
Overall Plan:
FY 2004: Introduction to project
FY 2005: Phase II CDR and set up of a collimator lab at SLAC
FY 2006: Tests of RC0, Design and construction of RC1
FY 2007: Tests of RC1 (two rounds), design and construction of RC2
FY 2008: Non-Beam Tests of RC2
FY 2009: RC2 beam tests & final drawing package for CERN
FY 2010: Await production & installation by CERN
FY 2011: Commissioning support
FY 2007 Goals
RC1 Testing - Design & Build RC2

RC1 Tests
- Test RC1 inner mechanism in air
- Test RC1 under vacuum
- Test RC1 under heat load in vacuum
- Iterate tests as needed

Design, Build and Test “RC2”, a beam-test capable prototype with exotic materials

Design RC2
- Adapt to exotic materials
  - Be, Cu loaded Carbon, AlbuMet, Gum Metal,
- Control system capability
- External Mover system
- Alignment system
- External BPM system
- Cooling channels
- Remote Instrumentation & Control

Build RC2
- Parts: BPMs, Movers, Bellows, I&C Hardware
- Fabrication
- Assembly
FY2008 Goals

RC2 Non-Beam Tests
- Air test of RC2
- Vacuum Tests of RC2

Preparation for Beam tests of RC2
- Transport to beam facility
- Installation
- Alignment
- In-situ tests without beam
FY2009-11 Goals

2009 Goals: RC2 beam tests & Final drawing package

Beam Tests of RC2 in Fall 2008
Design and produce complete drawing package for industry-produced collimators
As close to RC2 as possible
Not thought to need a prototype unless RC2 shows need for substantial design modifications

2010 Goals: Production Support
Support the industrial production of the required number (5-10) of collimators, presumably by CERN unless it is decided otherwise at a later date.

2011 Goals: Installation & Commissioning support
Participate in installation and commissioning of final collimators
## Phase II Collimator Budget Summary

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Work at CERN

• No detailed plans exist yet...

• **Same goals and boundary conditions as work at SLAC, however, no rotary collimator!**

• Procedure:
  
  – Agree on **basic ideas, goals and procedure** (this presentation and following discussions).
  
  – Agreement AB/TS on phase 2 work: **TS would lead a work package on phase 2 R&D!?**
  
  – R&D work must be **complemented and preceded by brainstorming and wide discussion of advanced ideas and concepts** (coordinated by AB and CWG). Include all CERN expertise and outside ideas!
  
  – Lots of supporting **simulation** in beam tracking and energy deposition to be done in AB (together and shared with SLAC): ABP, ATB(FLUKA).
  
  – Start of conceptual design work before Summer to give feedback to brainstorming (what has a chance to work in engineering)?
  
  – Start of detailed design work after end of phase 1 work!
Possible Schedule for 1st Year R&D

• June 2005:
  – Collaboration meeting at SLAC on phase 2.

• September 2005:
  – Special and wide phase 2 brain-storming meetings at CERN.
  – Start of conceptual design work in TS.
  – Engineering work for including crystals into tanks of LHC scrapers (one-sided and short collimators)?

• January 2006:
  – Start of detailed phase 2 design work.

• June 2006:
  – Start of prototyping and laboratory tests?
New Mandate for TS Could Include…

- Include crystals into scraper design.
- Work package for:
  - conceptual and detailed engineering design of one or several phase 2 technologies.
  - prototyping of phase 2 secondary collimators.
  - laboratory tests of phase 2 collimators.
  - preparation of series production for phase 2 collimators.
- Similar share of work as for successful phase 1 work. TS work package complemented by AB work package on:
  - infrastructure.
  - simulation and system performance.
  - materials and series production.
- Needless to say: Same excellent collaborative and open spirit as for phase 1 is a key for success!

➤ Effective after special designs for phase 2 have been completed (2-beam design and scrapers). This was covered in 2003 mandate!