Phase 2 Work at SLAC and CERN

R. Assmann

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 β^*!

  ➔ 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!

From FY05 Task Sheet

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

LAB	FY	Labor	M&S	Shop	Total
FNAL	2005	$27,000			$27,000
	2006	$27,000			$27,000
FNAL Total		$54,000			$54,000
SLAC	2004		$11,000		$11,000
	2005	$196,000	$89,000	$7,000	$292,000
	2006	$427,000	$139,000	$179,000	$745,000
	2007	$462,000	$204,000	$321,000	$987,000
	2008	$603,000	$50,000	$95,000	$748,000
	2009	$621,000	$65,000	$32,000	$718,000
	2010	$245,000	$26,000		$271,000
	2011	$381,000	$81,000		$462,000
SLAC Total		$2,935,000	$665,000	$634,000	$4,234,000
Grand Total		$2,989,000	$665,000	$634,000	$4,288,000

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!