DOE review homework answers

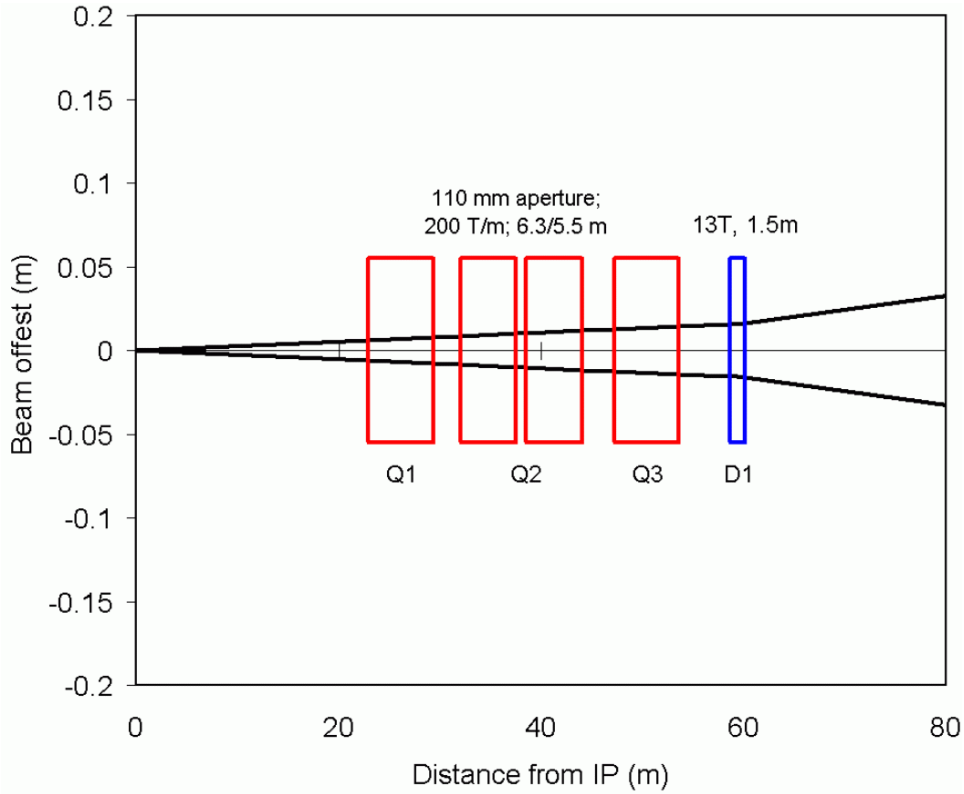
Monday questions 2, 3, 4, 5 & 6

Steve Peggs

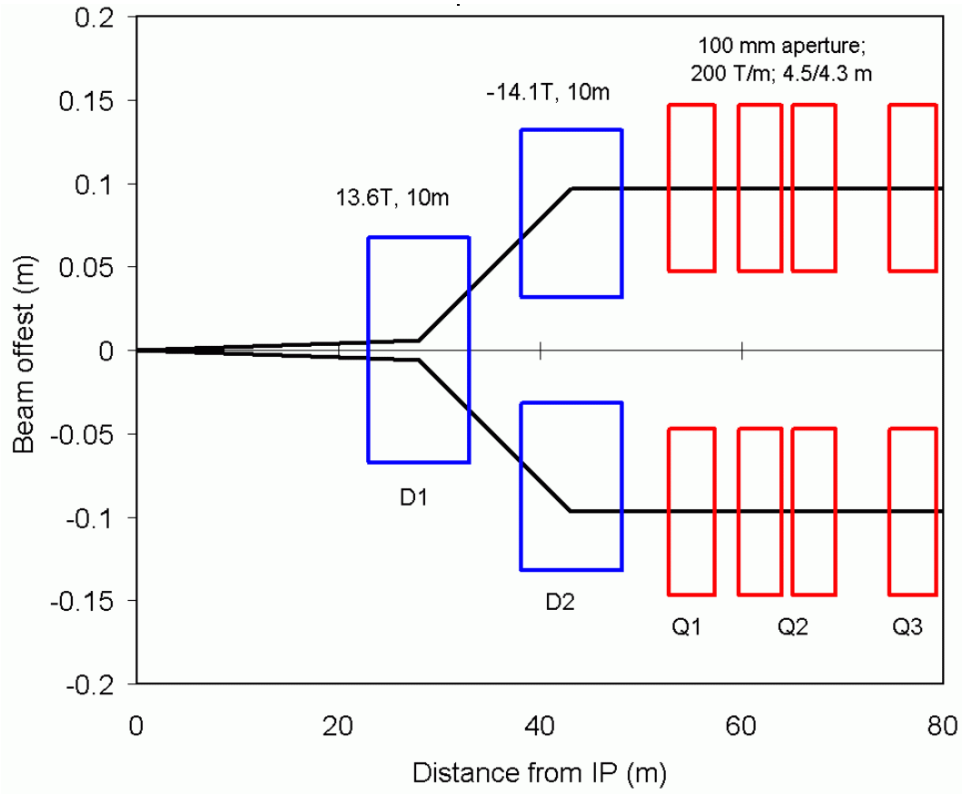
1. Show how you are going to spend the accelerator physics (Systems) budget for the remainder of the fiscal year. Show specific actions. [Shiltsev]

2. Show the benefit analysis for the choice of the quad first IR design.

Quad first



Dipole first



The distance of the "triplet quad center of gravity" (red boxes) from the collision point is about

$$L^* \approx 40 \ [\mathrm{m}]$$ Quad first scenario

$$L^* \approx 70 \ [\mathrm{m}]$$ Dipole first

Maximize the angular beam size (minimize the size)

Engineering

$$L = F_{coll} \left(\frac{N_1 N_2}{4\pi \sigma^2} \right)$$

Protons/bunch in beams 1 & 2

Collision frequency

Beam size (round)

Physics

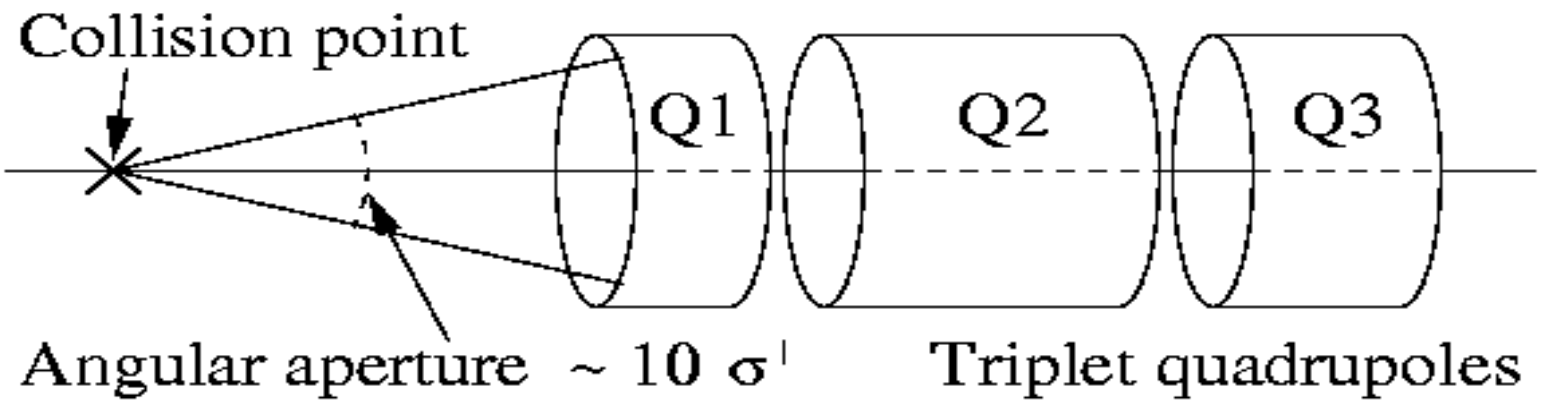
Number of bunches

Angular beam size

$$L = M \, (\xi_1 \xi_2) \, \sigma'^2 \times \left(\frac{4\pi\gamma^2}{r_p^2} \right) F_{rev}$$

Beam-beam parameters

Triplet quads



Angular beam size scales with angular aperture, so

$$L \sim (\sigma')^2 \sim (A/L^*)^2$$

Therefore:

1) enlarge A the quad aperture
2) reduce L*
   - bring the quads closer to the IP)
   - make them shorter (stronger)

Suggests the quadrupole first scenario ... unless there are compelling reasons (long range beam-beam)

Quadrupole first layout
(with a small crossing angle)

Both beams go through a single bore of a quadrupole triplet in this layout, which is the nominal implementation of the LHC as it will first be run.

Stronger quadrupoles would allow the focusing center to move closer to the interaction point (IP), allowing a smaller beta* and more luminosity for a given number of bunches, and bunch intensities, et cetera.

Or, larger bore quadrupoles with the same gradient would hold the slot lengths constant, allowing a quadrupole-by-quadrupole progressive upgrade.

In either case the beams will suffer a relatively large number of parasitic long range beam-beam interactions, until the beam reach the first beam separation dipole, approximately 60~meters from the IP.

Dipole first layout

Separates the beams into separate triplet quadrupole bores.

This scheme has the advantage of eliminating the long range beam-beam collisions beyond about 23 meters from the IP.

It has the optical disadvantage of moving the triplet focusing center further from the IP.

The question of where and how to absorb the many kilowatts of luminosity debris power is a significant challenge in all scenarios.

One suggestion is to use magnetized absorbers in the middle of the IR optics.

The dipole first layout has the simultaneous advantage and disadvantage of not needing magnetic absorbers, since the first dipole will absorb much of the debris power.

3. Show how the yearly task sheets morph to a year to year (total task) basis

Summer is Task Sheet preparation season, focused on FY07.

We have upgraded the web based mechanics. Now is also a natural time to re-tune Task Sheet specifications.

Task Sheets:

1) focus on a single fiscal year (eg FY07), with all the analysis (milestones, technical description, human resources and financial) that can be included in a readable 2 pages.

2) include a reasonable analysis of the out years, especially (but not just) the following year (eg FY08).

3) include an extrapolation beyond the next 2 years, throughout the entire expected trajectory of the Task.

Of necessity, the program (not project) Tasks necessarily evolve from year-to-year. Consider TQ, for example. Only in some cases (eg luminometer) is there a true “total task” basis.

4. Discuss the budget if any for new initiatives.

As you have seen, there are many proposed new initiatives, mostly with rough budget estimates, NONE with WBS numbers.

The next step is for the proponents to finish constructing Task Sheets (new initiatives + established tasks) , so that we can construct a “Blue Sky” budget (> $11M).

Then some hard decisions will need to be made, setting priorities, trimming tasks, rejecting/deferring proposed new initiatives.

This trimming is (ideally) mostly performed by the L2's and their L1, within approximately fixed Accelerator Systems and Magnet R&D total budgets.

With my help where necessary, we achieve a $11M budget.

“In a collaboration, everybody suffers.”

Not all of the proposed new initiatives will get a WBS number.

5. Discuss how you are going to projectize hard deliverables

"Hard deliverables" is loose argot for Tasks that:

- are crucial to LHC performance
- where "plan B" is weak or non-existent
- need special protection in the face of a budget shortfall.

1) Luminosity Monitors & 2) Tune Feedback instrumentation
Their progress is on track, and delivery is "imminent" (reviewers are happy). Little or no need to tune the mechanisms already in hand. "It ain't broke - don't fix it."

3) Beam and Instrumentation Commissioning.
Vital to CERN & LARP, but not "hard" in the sense of being projectizable. A current concern – see next question/answer.

4) Rotatable Collimators.
This is a longer time scale item, that is worth further discussion. Recall that LARP (which does only R&D) plans to demonstrate a prototype, NOT build a production series.

LARP

6. What are the plans for energizing commissioners and the training of young physicists? Note that the committee felt that Mike Syphers was running late with respect to recruiting. Need to get people in there early. Match up with mentors.

(This answer is IMHO: it needs input from Syphers & Shiltsev.)

1) Centralize funding and the organization/monitoring mandate for all long term (> 3 months?) Accelerator Systems personnel under the L2 for Commissioning (Syphers).

2) Establish a clear set of rules and tables which mesh with those of CERN, and are applied with observable lab neutrality, to write down a prioritized and complete (initial) set of individuals, and their attributes

3) Take the 10 year perspective. Identify (in consultation with CERN) excellent individuals to head hunt

4) Have the new system in place (Tasks etc) by Oct 1 06

5) Expect a long term maintenance and development workload.