Towards a Proposal for the LTC on June 25th

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Coll WG 30/5/03

Goals for LTC on June 25th

Make a proposal that offers:

Immediate start of collimator design and construction (have a system installed in 2007 for commissioning and early running, 50% intensity)

A simple first phase with maximum robustness for early LHC/injection/ramp (best prospect for success, easiest commissioning, maximum robustness during injection/ramp, minimum cost start-up system, reduced luminosity reach of the LHC, triplet protection and cleaning)

A more delicate second phase for nominal/ultimate performance (less robust, only used with squeezed optics at top energy, good efficiency, low impedance, install after first run)

Proposal will be: Compatible with LHC schedule.
Compatible with 10-20% of nominal luminosity (factor 2 from reduced intensity included)
With reduced initial cost and reasonable extrapolation from LEP.
Not the best imaginable solution and not the cheapest.

To move now is mandatory in order to achieve compatibility with LHC schedule!

Present status of material studies

Impact scenario: 8 bunches at 7 TeV (irregular dump)

1 full batch at injection
- TL coll as proposed by HB at 5 sigma gives 7.5 σ osc
- plus 1 sigma injection jitter
- 8 sigma oscillations are possible (elliptical collimators)
- collimators at 6/7 sigma (or closer?) can be hit

All nominal not ultimate, no safety margins for FLUKA

FLUKA/ANSYS: (dyn)	Fiber reinforced carbon	0.2 m OK, even for ultimate 1.0 m at limit
	Beryllium	0.02 m OK not OK above, 10 x worse than C-C?
	Higher Z	not OK

Ions, Cu doped C, e-cloud still missing…

Slow case: (4e11p/s)	C-C OK. Be OK. Up to 0.2 m Al OK? Unclear above! C-C temperature increase ~ 300 deg K! OK for 10 s?

What could it be - Phase 1 (my view based on seen results):

Best robustness: Fiber reinforced graphite jaws in a LEP type assembly
"Conservative" mechanical design (rely on LEP design if possible)
0.2 m primary, 1.0 m secondary jaw length

Reduce impedance: Remove 1 primary and 5 secondary jaws (betatron cleaning)
Impedance 3.5 times too high (half intensity):

Inj/ramp: OK up to nominal at least

Physics: Coll gap times 1.5 (10.5 sig) for half intensity
Reduce beta* and luminosity reach by less than factor 2!
Recover at least partly with tertiary collimators!

Full intensity physics:
Learn with feedback!? Open coll gaps to 13 sigma?
Best: Rely on hybrid secondaries (second phase)

Efficiency: Roughly the same (5.4e-3) as Al/Cu system (4.9e-3)
Need less efficiency for half intensity (physics) and full intensity (injection and top of ramp):
Reduce lengths further if we are sure of second phase?

Sufficient for injection/ramping up to nominal (ultimate?). Good for initial years with reduced intensity (/2) and increase beta* (x2 or smaller with tertiary collimators).

Original Al/Cu based system:

```
# 1=icoll 2=nimp 3=nabs 4=imp_av 5=imp_sig
            1       349812       141465   0.2203277E-04   0.4661210E-04
            2       339719       134663   0.1483048E-04   0.5270702E-04
            3       209849        84913   0.4642261E-05   0.4466848E-04
            4         8173         3343   0.7646820E-04   0.1653837E-03
            5       129947       125678   0.3464030E-03   0.2884151E-03
            6         6564         6309   0.2106378E-03   0.2919616E-03
            7         9349         8957   0.2276610E-03   0.2074276E-03
            8         9530         9184   0.4714330E-03   0.5078924E-03
            9         9069         8712   0.4811211E-03   0.5027627E-03
           10        11883        11307   0.3091312E-03   0.4073619E-03
           11         5579         5358   0.3153129E-03   0.3701968E-03
           12         7274         7036   0.3910403E-03   0.4127230E-03
           13         3784         3614   0.2329447E-03   0.2346956E-03
           14         6591         6311   0.5100991E-03   0.5295932E-03
           15         2301         2199   0.1694481E-03   0.1720415E-03
           16         1465         1402   0.5310451E-04   0.8539220E-04
           17         4581         4395   0.1629725E-03   0.2062690E-03
           18         6234         5958   0.1579979E-03   0.1745482E-03
           19        10153         9763   0.1347180E-03   0.2721763E-03
           20         1248         1162   0.4944291E-04   0.1930840E-03
```

Worry: Large absorption at first secondary jaw (coming from horizontal and skew halo). Flatly distributed for vertical halo!

Full C-C based system (0.2 m / 1.0 m):

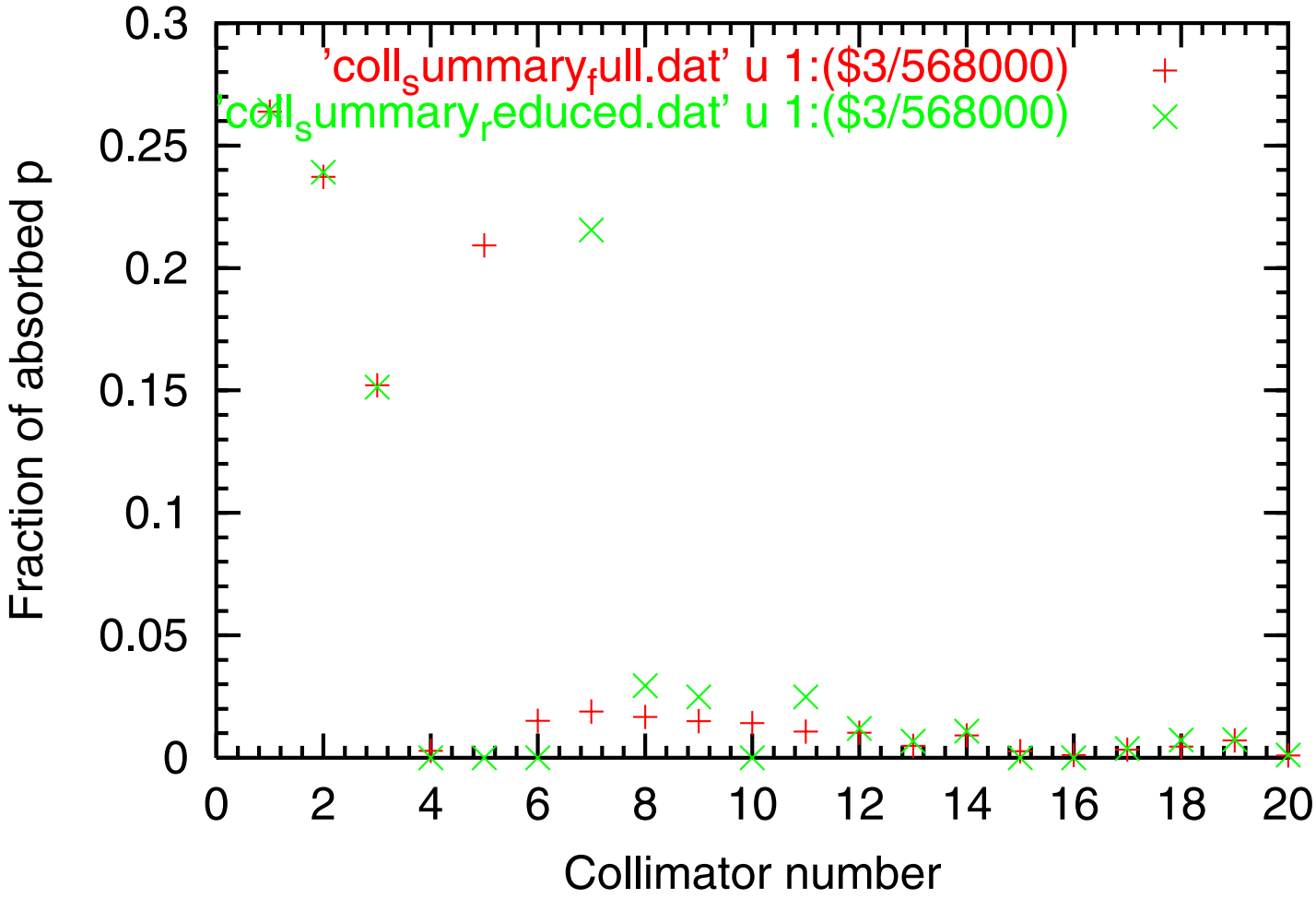
```
# 1=icoll 2=nimp 3=nabs 4=imp_av 5=imp_sig
            1       358250       149865   0.1572481E-04   0.3903942E-04
            2       331497       134748   0.8952920E-05   0.5625700E-04
            3       204956        86368   0.2911112E-05   0.3550392E-04
            4         3808         1636   0.8295298E-04   0.2658282E-03
            5       126483       118836   0.3691113E-03   0.3171209E-03
            6         9364         8586   0.2482761E-03   0.3459143E-03
            7        11497        10699   0.2789619E-03   0.2325119E-03
            8        10195         9476   0.5787740E-03   0.6059679E-03
            9         9039         8450   0.5744193E-03   0.5717996E-03
           10         8747         8069   0.4627821E-03   0.5089441E-03
           11         6610         6096   0.3813241E-03   0.4492533E-03
           12         6294         5849   0.4893519E-03   0.5430213E-03
           13         2992         2787   0.3178015E-03   0.3150745E-03
           14         5571         5154   0.6423902E-03   0.6126353E-03
           15         1586         1485   0.2106760E-03   0.2165461E-03
           16          699          643   0.6522988E-04   0.1319627E-03
           17         1954         1835   0.2043085E-03   0.2858049E-03
           18         2797         2599   0.2035629E-03   0.2604951E-03
           19         4310         3986   0.1749204E-03   0.4004148E-03
           20          645          557   0.8254451E-04   0.3179066E-03
```

Reduced C-C based system:

# 1=icoll	2=nimp	3=nabs	4=imp_av	5=imp_sig
1	359831	150223	0.1607647E-04	0.3993418E-04
2	333205	135784	0.9787740E-05	0.6345569E-04
3	205149	85920	0.3191720E-05	0.4652284E-04
4	0	0	0.0000000E+00	0.0000000E+00
5	0	0	0.0000000E+00	0.0000000E+00
6	0	0	0.0000000E+00	0.0000000E+00
7	130434	122418	0.5723306E-03	0.3707995E-03
8	17874	16668	0.8687356E-03	0.9635576E-03
9	15134	14132	0.9593772E-03	0.9630210E-03
10	0	0	0.0000000E+00	0.0000000E+00
11	15085	14081	0.7953587E-03	0.9192368E-03
12	7347	6828	0.5359980E-03	0.7798476E-03
13	4152	3837	0.2809822E-03	0.3838139E-03
14	6718	6183	0.5978610E-03	0.6753473E-03
15	0	0	0.0000000E+00	0.0000000E+00
16	0	0	0.0000000E+00	0.0000000E+00
17	2337	2163	0.2906717E-03	0.5149586E-03
18	4406	4084	0.2614256E-03	0.3620094E-03
19	4509	4182	0.1924059E-03	0.4092635E-03
20	675	583	0.8946527E-04	0.2742920E-03

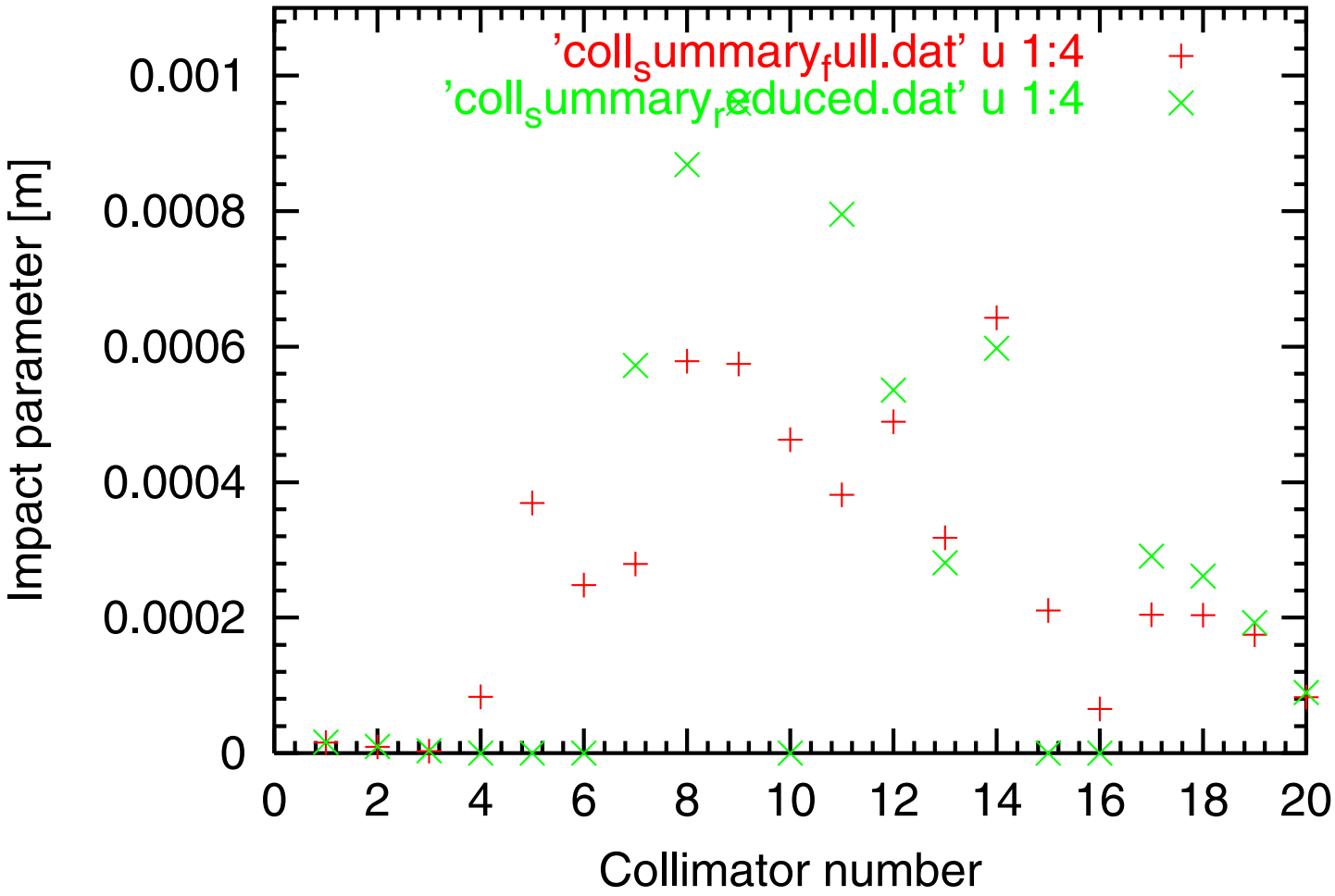
Collimators 4, 5, 6, 10, 15, 16 have been eliminated! Gain 5.2 m out of 16.8 m!

Loss map of primary protons:



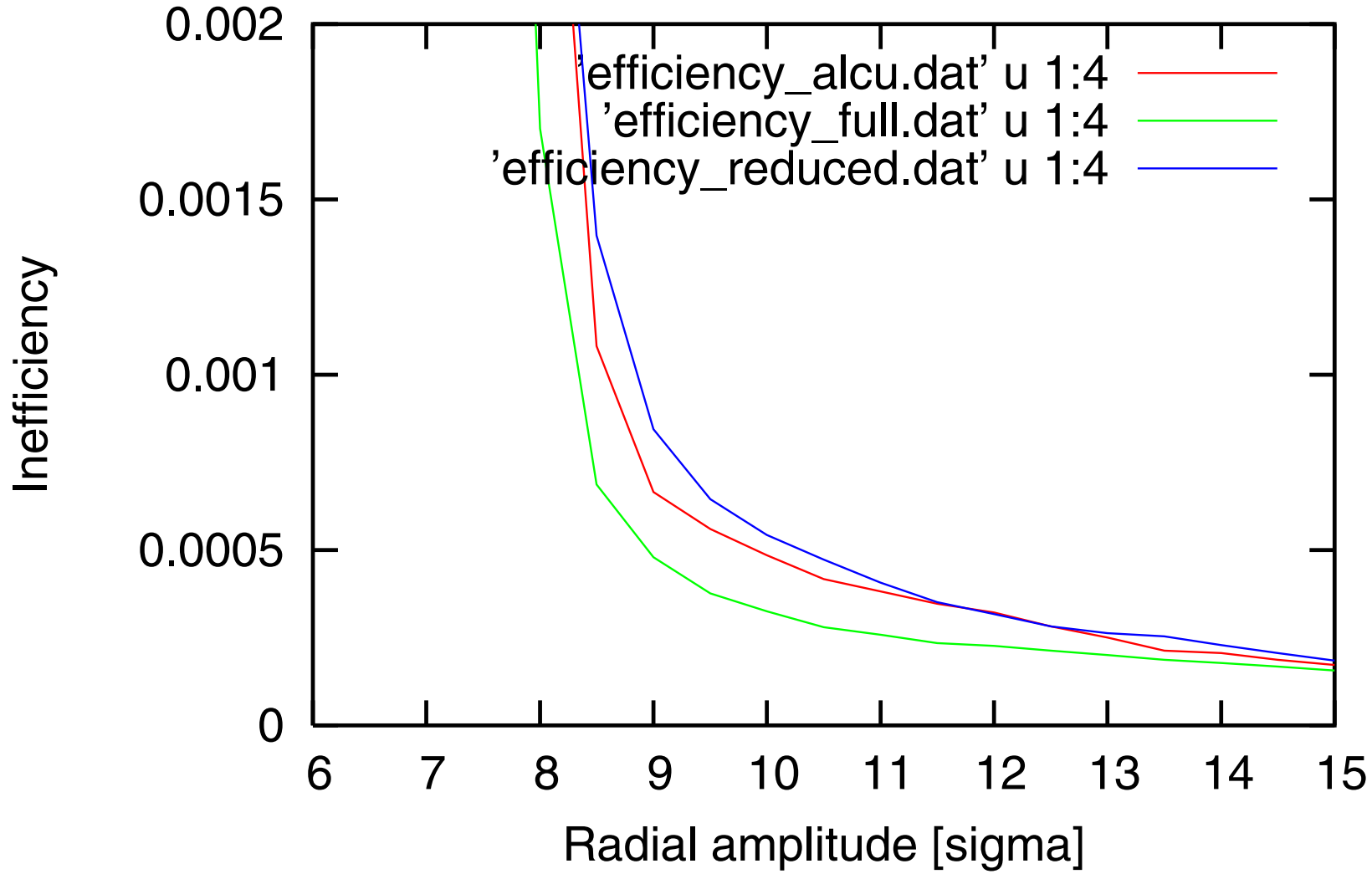
Reduced system concentrates losses in fewer collimators!

Impact parameter at different collimators:



Impact parameters on secondary jaws are bigger (factor 2) or the same as before for the reduced system: Better stability against beam-jaw tilts!

Efficiency for different solutions:



Efficiency at 10 sigma (7 TeV) roughly the same as with the Al/Cu system!

Further work to be done:

Finalize optimization of number/length of collimators

Predict loss rates at tertiary collimators and TCDQ

Predict cleaning efficiency of three-stage system

Propose solution for hybrid phase compatible with slow losses:
Cu not OK? C nose on Cu? Be as hybrid phase, not to be destroyed?

Estimate budget

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