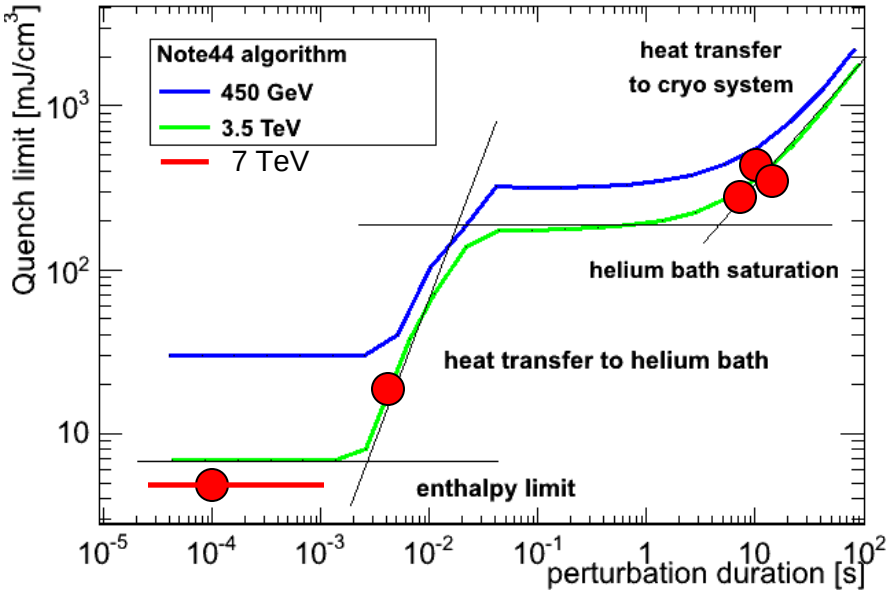
Almost final planning of beam induced quench tests at the end of 2013 run

Mariusz Sapinski BE/BI
for Quench Test Strategy WG

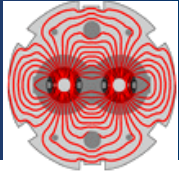
LHC Machine Committee, 2013/01/30

General remarks

1. We were asked to investigate collimation limits due to quench and UFO-timescale quench limit
2. Five tests are proposed:
    - 3 addressing quench limit at steady state (two collimation tests and steady-state with orbital bump test)
    - One addressing UFO
    - One addressing ultra-fast losses (e.g. asynchronous dump)
3. All tests on B2.
4. MPP and QTSWG: collimation proton test and fast losses with ADT tests have the highest priority.



Status of MPP documents

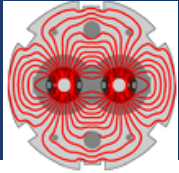


Test name	Status
ADT Fast Losses	Draft for discussion: EDMS 1263345
Ion collimation tests	Draft for discussion: send to EDMS
Proton collimation test	Draft for discussion: send to EDMS
Steady state with orbital bump	Draft for discussion: EDMS 1263798
Q6 injection	Draft for discussion: EDMS 1263797

What needs to be done before tests

1. ~~**ADT and instrumentation setting for very low intensity beam**~~ In the machine now
   - ~~For ADT fast losses~~
2. **Installation of scope in 12L6**
   - For ADT fast losses and steady-state with orbital bump tests
   - Need 2 hours access in IP6 (tunel)
   - Expert not here next week!
   - Concerns about radiation to the scope
   - Proposed time: this week or Sunday 10/2?
3. **Betatron loss maps for extra-relaxed collimator settings (when doing other loss maps)**
4. Installation of scope in IR8
   - Need 0.5 h access to QPS rack – installation easier than scope in 12L6
   - Can be done during quench test period (recovery from quench)
5. Calibration of constant loss rate with ADT (can be done as a part of loss maps)
6. Probably short access (IR8) to change power converter limit for Q6 magnet

Fast losses with ADT (for UFO losses)

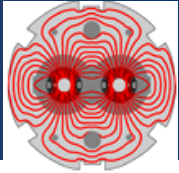


1. Need to estimate quench limit in UFO timescale
2. Basic algorithm:
    - Inject 10 pilot bunches (Single scheme), ramp
    - Make orbital bump in Q12L6
    - Scrape 1st bunch using ADT vertical excitation
    - Measure intensity with AGM
    - When reached the demanded intensity (a few 1e8) stop scraping
    - Excite with ADT in horizontal plane
    - Repeat procedure for next bunch
3. Collimators: open horizontal
4. Loss:

Duration	Loss MQ12L6 [charges]
1-10 ms	1.e8-5.e9

5. Beam screen issue: conservative estimations by A.Lechner: Tmax< 145 K, more realistic: 55 K

Collimation test with protons



1. Exploring the limits of the collimation
2. Impossible to quench with tight collimation settings so:
3. Use extra relaxed settings (like in 2011, with additional retraction of TCS by 1 sigma)
4. Validation of settings needed: betattron loss maps and async beam dump
5. Loss maps well before test – need a couple of days to prepare and discuss BLM thresholds
6. First ramp with 3 bunches to calibrate ADT, then several ramps.
7. Plan minimum: 500kW loss (as in 2011) but time 10 s (it was 1 s) and worse cleaning
8. FLUKA simulations ongoing, maybe try 1 MW losses.

9. Beam:

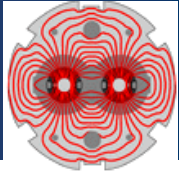
ch/bunch	bunch/train	Nb. trains	total int [charges]
1.2e11	144	1-3	1.7-5.2e13

10. Loss:

Duration[s]	Peak Power Loss [kW]	Peak Loss Q8 [charges/s]
10	500	3e9

5-10 MJ over a few seconds – regular losses during ramp/squeeze

Collimation test with ions



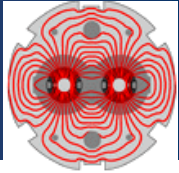
1. Do the same as for protons but for a very specific ion loss pattern
2. Use nominal collimation settings – cleaning efficiency factor 100 worse than for protons
3. Considerations:
   - no more ions in the oven
   - high probability to quench
4. Beam:
   - 3 bunches for ADT setup (for constant loss rate, as for protons)
   - 1-2 fills for quenching:

ch/bunch	Ions/bunch	bunch/train	Nb. trains	total int [charges]	total int [ions]
1.23e10	1.5e8	24	3	8.7e11	1.1e10

1. Loss:

Peak Loss TCP [charges/s]	Duration[s]	Peak Power Loss [kW]	Peak Loss Q9/Q11/Q15 [charges/s]
1.8e11	5	112	1.8e9

Q6 test at injection



1. It probes very fast loss timescale (quench limit without helium contribution)
2. Well defined loss pattern – high precision test – a lot of simsulations done recently
3. It is done with magnet current corresponding to ~7 TeV (commissioned in 2008)
4. Beam:
    - Injection and dump mode, NO RAMP
    - Shooting on closed TCLIB collimator in front of Q6L8

ch/injection
Up to 1e11

5. Collimators: close all to be sure no beam circulating
6. Rather short test (3-5 hours), fast recovery of standalone magnet.

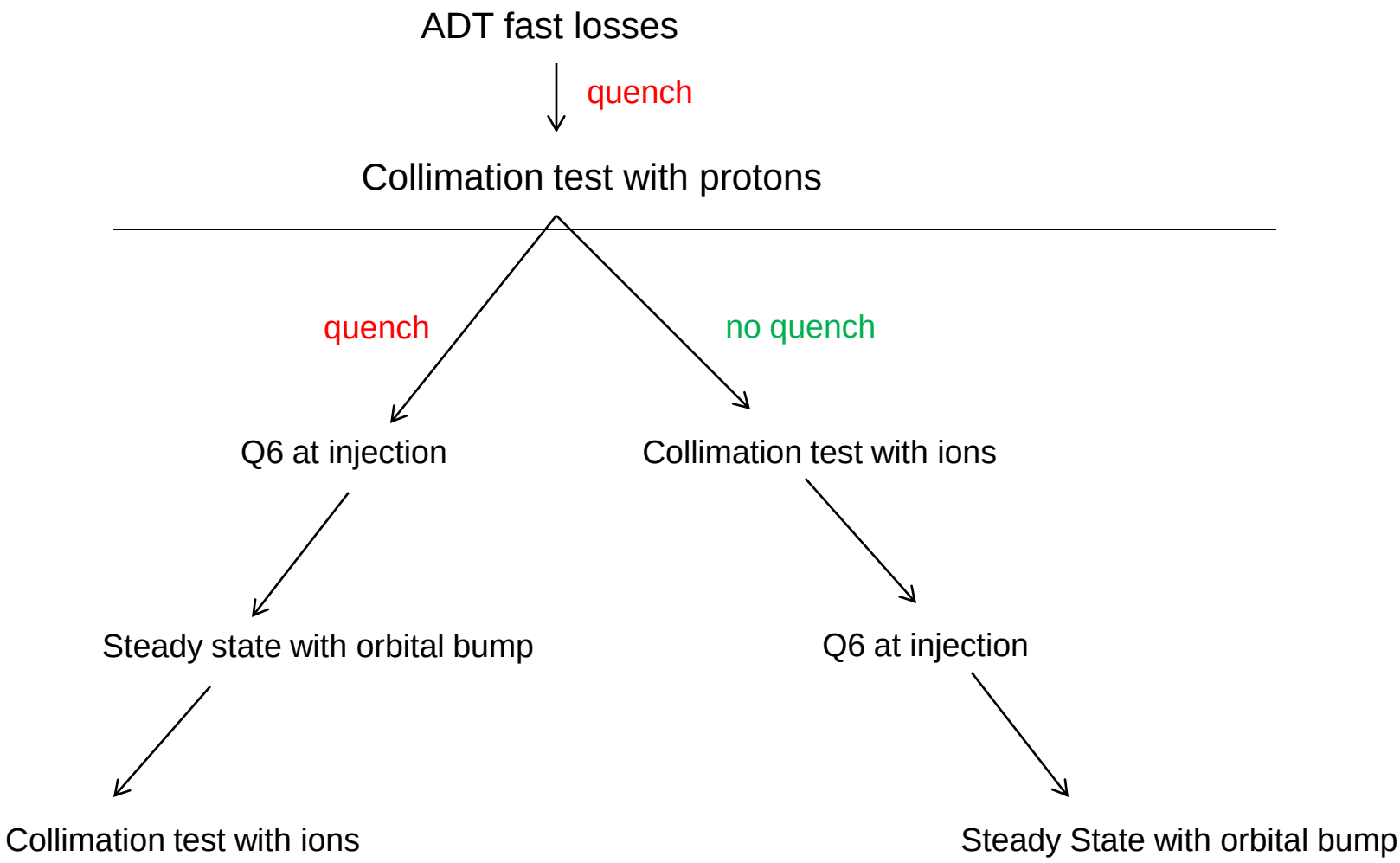
Steady-state with orbital bump

1. Steady-state test aiming for precision (a lot of simulations done)
2. If at the end: fill LHC, shut down the injectors and continue with the test on Wednesday before midday.
3. Beam:

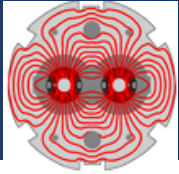
ch/bunch	Nb. bunches	Total Intensity [charges]
1e10	3x12	<3e11

4. Collimators: open horizontal
5. Beam screen temperature during quench test in 2010:

Proposed planning

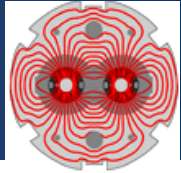


Summary



test	Charges/bunch	No of bunches	Total intensity	Filling scheme
ADT fast	5e9	10	5e10	Single_10b_4_2_4
Coll protons	1.2e11	144	5.4e13	50ns_144b_144bpi
Coll ions	1.2e10	72	2.8e12	200ns_72b_24bpi
Q6	Up to 1e11	1/inj	1e11	injection
Steady-state bump	1e10	3x12	3e11	Single_10b_4_2_4

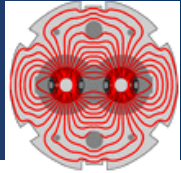
Conclusions



1. We have (asymptotically) agreed on planning:
    - Start with ADT fast losses and Collimation with protons
    - Do the other 3 tests in function of time left and results of the Collimation with protons
2. The **ADT fast loss** calibration done – looks OK
3. MPP documents in the system – for comments
4. Still needed loss maps, accesses, we try to fit it in current schedule.

Spare slides

Collimation test with protons



Relaxed settings+ opening of secondaires by 1 sigma (wrt 2011)

factor 3 for losses in the magnet (DS)

Min set of validation (1 fill):
- betatron loss map
- async dump

500 kW – baseline, more – to be seen later (FLUKA) – up to extra factor 2.

Loss pattern: as in 2011 + loss map to be done during one of validation fills during species change or maybe today (needed for BLM threshold adjustment)

First fill:
one fill with 3 bunches for ADT setup (safe beam flag) – end with async dump
Followed by 2-3 fills with one train with 144 bunches, later maybe 2-3 trains (as an option, discussed by MPP).

5-10 MJ over a few seconds – regular losses seen during ramp/squeeze