Early 2011 needs from the expts

- Lumi production beam conditions
  - all parameters, roman pots, B-fields, probe bunches, etc.
- Conditions for the 1.38TeV run
  - ref orbit, intensities, vdm , velo, roman pots…
- Lumi calibration measurements
  - defining the envelope
  - application software

Lumi production conditions

- Target parameters
- Polarities (reversal), fields off...
- Roman Pots
- Scan procedures

Target parameter set for lumi production 3.5 TeV

- N = 1.15x10^{11} protons per bunch
- ε_N = 2.5 um

} initial values, adiabatically push up N/ ε_N (after reaching ~ 900b?)

external!

Parameter	Value at 450 GeV	Value at top energy
Energy [GeV]	450	3500
Beta* IP1/5 [m]	11.0	1.5
Beta* IP8 [m]	10.0	3.0
Beta* IP2 [m]	10.0	10.0#
Parallel separation [mm]	2.0	0.72
Crossing angle IP1/5 [mrad]	0.14	0.12
Crossing angle IP2 [mrad]	*± 0.14*	*± 0.08*
Crossing angle IP8[mrad]	*0.14*	*0.25**
Ramp duration [s]	1400 → 1020	
Squeeze duration [s]	1041 (3.5 m) → 474 (1.5 m)	
Collision BP duration [s]	108 → 60	

less for ions

two TCT settings! (but β*=10m)

assumes a small enough emittance!! LHCb magnet can stay on at full field all the time

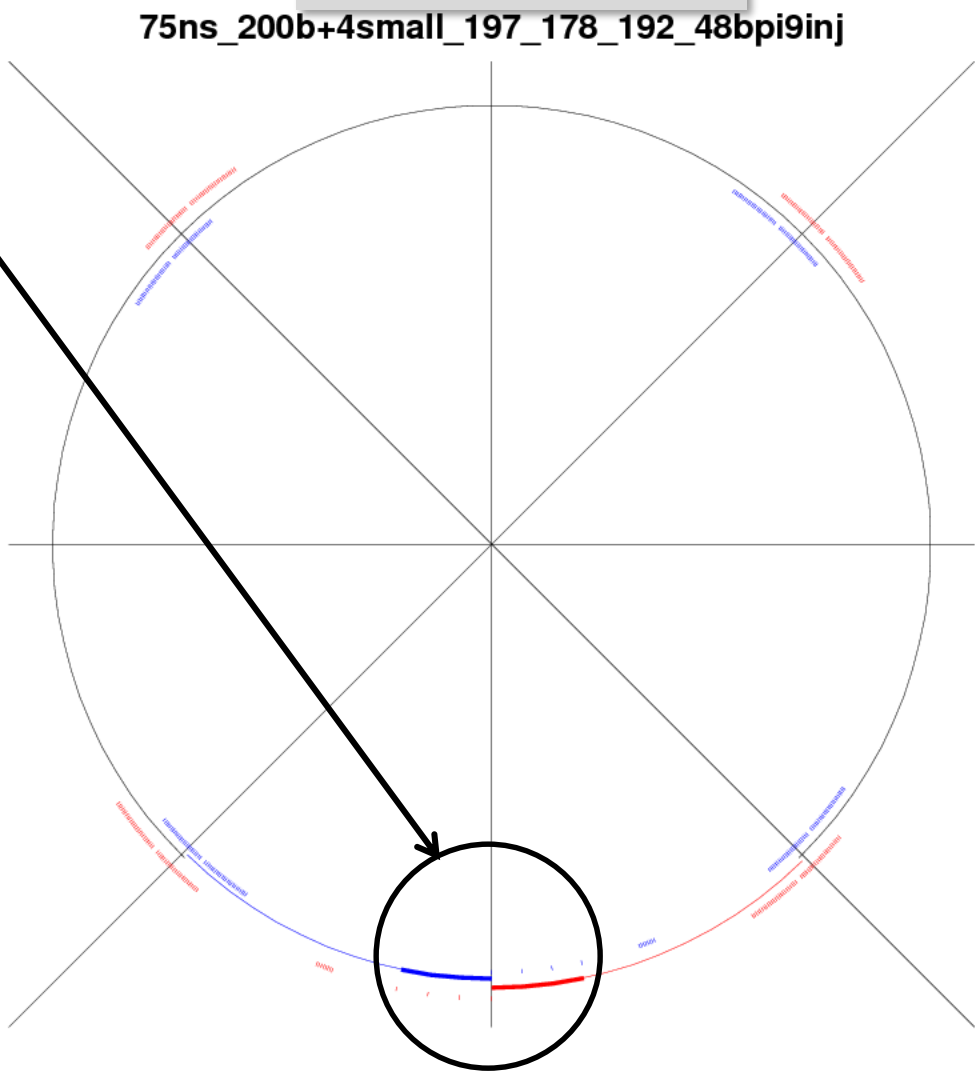
- Operate point 8 with a V separation ~ 0-2$\sigma_{beam,y}$
  - Ref orbit with 1$\sigma_{beam,y}$ V-separation ?
- Operate point 2 with a H separation ~ 3-5$\sigma_{beam,x}$
  - Ref orbit with 4$\sigma_{beam,x}$ H-separation ?

watch out! use a decent guess of beam size!

Adding a few probe bunches

- The idea is to add a few probe bunches at the start of the pattern (~1e10 p/bunch, spaced by ~1us)
- This will allow TOTEM (but also CMS and ATLAS) to collect "parasitically" (no dedicated beam time) with low pile-up
- TOTEM wish to fully profit from the now complete detector system (RPs, T2 and T1). The T1 detectors were successfully installed during the 2010-2011 winter stop.
- TOTEM need: ~10/nb at μ=0.01...0.05
  - i.e. 500h with a single bunch or 125h with four bunches
- It is proposed to do this in normal physics fills as long there is room in the filling pattern for these probe bunches

illsutrative example



Optimization scans & leveling during lumi production fills

- Mini scans / optimisation at start of fill

  Proposed prioritization for 3.5TeV high lumi 2011 conditions

  1. optimize in parallel IP1,5,8 in H
  2. optimize in parallel IP1,2,5 in V and start leveling in IP8-V
  3. start leveling in IP2-H

- Leveling procedure:
  - first manual, later automated
  - rough idea:
    - target average value L_{avge} and measured values L_{meas} are published by LHCb & ALICE
    - re-adjust L_{meas} to $L_{meas}=L_{avge}*(1+\Delta_{thr})$ whenever $\Delta = | 1 - L_{avge}/L_{meas} | > \Delta_{thr}$
    - Δ_{thr} is to be specified (probably around 5 – 10 %, but such that adjustment frequency < 2/hour)
      - if lumi lifetime = 10h , then $e^{-(1h/10h)} = 0.9$, hence Δ_{thr}=10% means 1/hour

MP: Enforce beam displacement limits

- Specification for application being worked on

Reyes Alemany

Lumi leveling

What could happen if too high lumi ?

- put beams head-on by mistake:
  - Max lumi IP8: 3m , ~1400b (2011) => 8e32 Hz/cm^2
  - Max lumi IP2: 10m, ~900b, 1.5e32 Hz/cm^2
- Could it cause damage to ALICE or LHCb, if the beams collide head-on for a few minutes ?

  LHCb: no protection issue

  ALICE: probably no protection issue => to be confirmed by ALICE BISU (but, yes, performance issue)

- For the machine ? (triplets ?): Ok to have high lumi in IR2 and IR8 ?

  BLM protects (TAS-free!) triplets against steady lumi debris

  But: how to avoid spurious dumps ?

  How far will we be from BLM thresholds ?

Roman Pots

- Important that the Roman Pots are set up for lumi production conditions (squeezed PI1 and IP5) **before the start of intensity ramp-up**
  - Opportunity to take data with few probe bunches in front of the trains will be there at the beginning while less than 900 bunches (75ns)
- Status: controls being validated (not finished)
  - prerequisite to setting up
  - document results of intlk tests (see MP procedures)
- Detailed plan of RP beam-based alignment ?
  - how much time ? (24 Totem + 8 Alfa)
- What will be procedure to define the nominal allowed RP positions in lumi production fills ?
  - I heard it could be $12\sigma_{beam,@RP}$, but what does the final decision depend on ?
- Totem request a couple of hours at very small distance (~$5\sigma_{beam,@RP}$)
  - Huge gain in acceptance for small scattering angles
  - What intensity limits ? In what conditions can we allow that ?

some delays here will likely slip

Ralph & collimation team

For MPP ?
What consequences for magnets if beam goes through RP edge ? => Ingwe: shower simulations
What could happen to vacuum ? => TOTEM

Changing polarity

- Start with these spectrometer polarities
  - LHCb: POSITIVE , ALICE: NEGATIVE (both solenoid and dipole)
- External angle defined by LHC (see Jorg, LPC 21-2-2011)
- Wish to flip approximately 1/month
- IR2: two TCT settings required
  - first set up for the above polarity, other polarity could be staged to the first reversal
  - Note: β^* IR2 = 10m , in shadow of arcs => can the settings be just derived from the first polarity settings (validation by “fait accompli”, looking at losses in normal physics fills ?)

Various requests for spectrometer fields off

For alignment

All desired to be done as soon as possible

- ALICE: ~8h with solenoid & dipole off at >100 kHz interaction rate
  - limit on pile-up ?
- ATLAS: 4/pb at 3.5TeV
- CMS: ??/pb at 3.5TeV

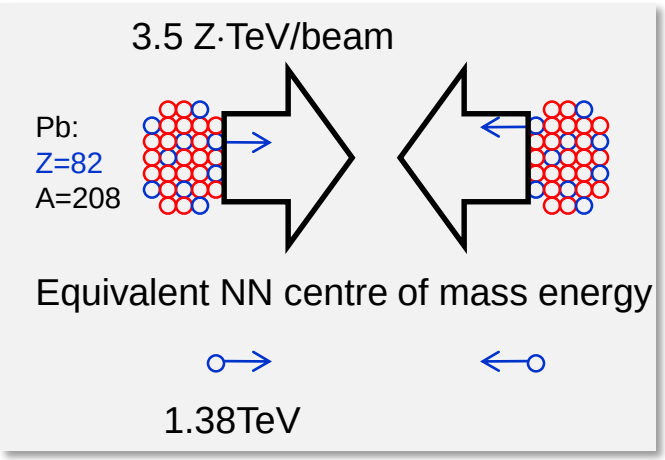
minimize cycles on/off => just before/after the TS+scrub

- LHCb: ~1M events (500s at 2kHz), sometime while beam luminosity still low <2e32
  - limit on pile-up ?

E = 1.38 TeV run

Intermediate energy proton run E=1.38TeV/beam

CHAMONIX 2011



Requestor: ALICE

- 50 M events to tape

Conditions:

- R = 3…10 kHz inelastic interaction rate
- β* = 10 m IP2/8 (11 m IP1/5)
  - NB: All expts want to take data
- Pile-up: μ < 0.05
  - $R = f\, n_b\, \mu \Rightarrow n_b = (3…10\text{kHz})/(11\text{kHz}\ 0.05) = 5…18$ b
  - $\varepsilon = 2\text{um}$: $N = (0.05\ \ 4\pi\ 10\text{m}\ 1.36\text{nm}/55\text{mb})^{1/2} = 4\text{e}10$ p/b
- Needed: ~35 h of stable beams
- Setup time: 3 shifts (Mike Lamont)

Details:

- One polarity
  - ALICE: any
  - LHCb: one polarity gives larger net angle, to be decided
- VdM scans during one of the fills (<10% lumi accuracy)

proposed:
24b equalitarian scheme
16 collisions at each IP
=> 200kJ
i.e. like 4 nominal bunches at 3.5 TeV

Rising interest… 1.38TeV run

To put it in context: 50x1e11, 2um, 11m 35h and factor 0.7 for lumi decay => 260 nb^{-1}

- CMS: as much luminosity as possible (but no extra time cost) >300 nb^{-1}
- ATLAS: both maxlumi (priority, > ~100/nb^{-1}) and low μ (small sample)
  - use probe bunch ?
- LHCb: wish to collect >25 nb^{-1} (but no extra time cost)
  - wish to take data with both polarities (if no extra time cost)

=> QUESTION: What is the maximum intensity ? (without extra setup cost)
  - Can we do 50 ? 100 ? 150?

- NB1: ALICE requested μ < 0.05 , hence
  - if $N/\varepsilon = 10^{11}/2um$ => we must use 2-3$\sigma_{x,beam}$ separation in IP2 or
  - no separation, limit of 4e10 at 2um for IR2 => 0.15 x reduced lumi for IP1/5
- NB2: All experiments a priori interested in VdM scans (in physics fills, no extra setup cost)
  - what scan range allowed ? watch out impact from IR2 separation

LHCb VELO closing at 1.38 TeV

- Closing the VELO at 1.38 TeV:
  - LHCb/VELO had so far assumed keeping it open by 5mm w.r.t. fully closed position
  - Some loss in physics (acceptance)
- What is reasonably safe ?
- Massimo Giovannozzi performed calculations of the expected aperture in LSS8 (Q7 to Q7)
- Compare 1.38 TeV @10m versus 3.5 TeV @3m

Conditions for aperture computations

Massimo Giovannozzi BE-ABP

1. Closed orbit tolerance: 3 mm
2. Beta-beating: 20%
3. Spectrometer angle:
   1. ~685 μrad for 1.38 TeV
   2. 270 μrad for 3.5 TeV
4. External crossing angle:
   1. 170 μrad for 1.38 TeV
   2. 250 μrad for 3.5 TeV
5. Beta*:
   1. 10 m for 1.38 TeV
   2. 3 m for 3.5 TeV

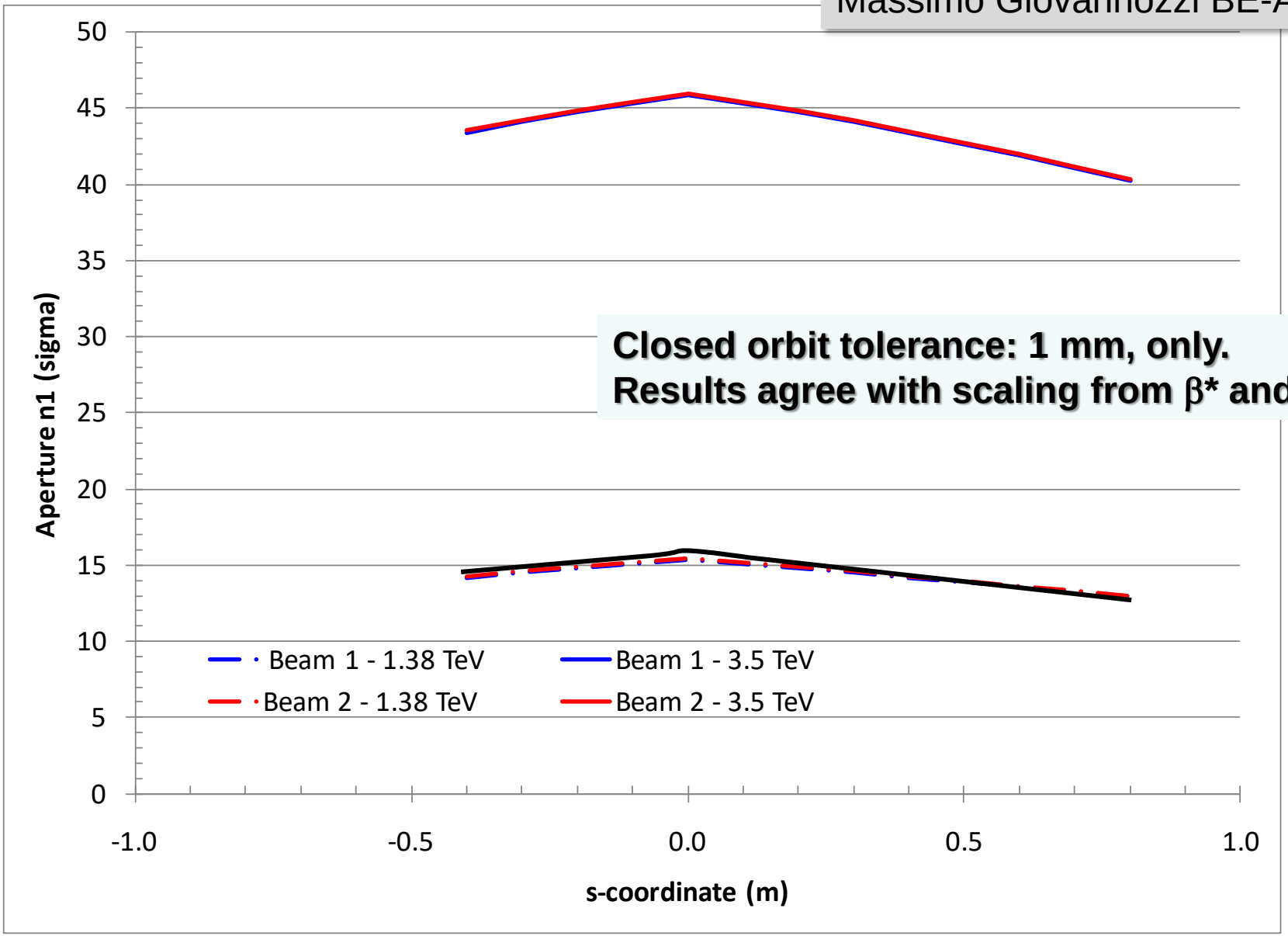
all half-angles

Net crossing angle
- 855 μrad for 1.38 TeV
- 520 μrad for 3.5 TeV

nominal emittance 3.75 um

VELO aperture

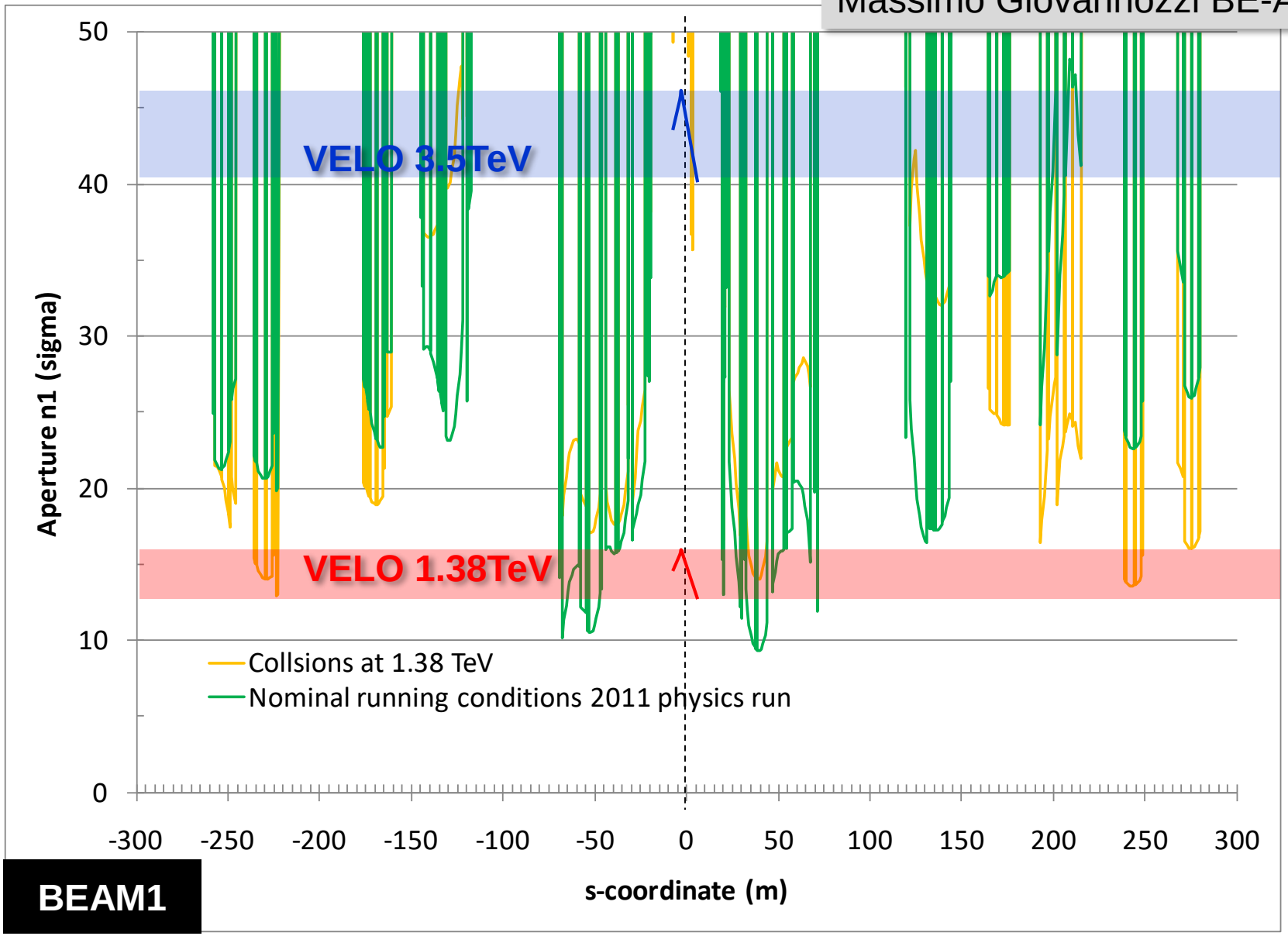
Massimo Giovannozzi BE-ABP



Closed orbit tolerance: 1 mm, only.
Results agree with scaling from β* and γ

Comparison of aperture in collision – Q7 L/R

Massimo Giovannozzi BE-ABP



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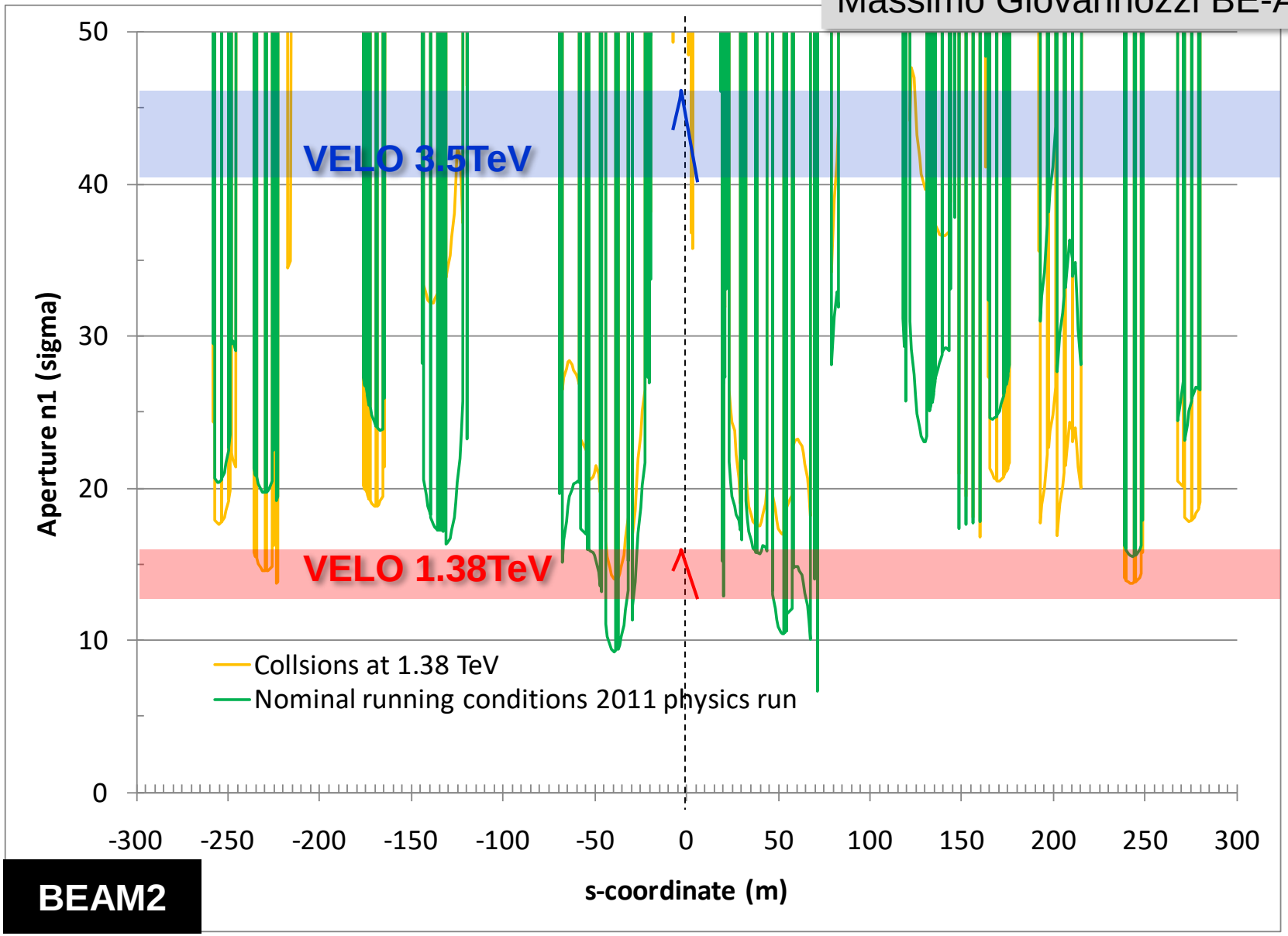


Roman pots at 1.38 TeV ?

No formal request so far, but informally...

- Certainly, will not request extra setup time just for that run
- But may want to profit as well from these extra physics
- Will depend on status of "experience" with Roman Pots at the time of E=1.38TeV run
- May have to define "acceptable settings" for that particular run, based on status of roman pots, interlocks, experience with it, etc.

Lumi calibration measurements

- Defining the scan envelope for lumi calibration measurements
  - In chronological order (i.e. in order of urgency!)
- Wishes related to the lumi scan application

Chronological order

- VdM scans at E=3.5 TeV in lumi production — next week ?
  - β^* = 1.5 - 10 - 1.5 - 3m
  - repeated scans, acquire experience with VdM (systematics) , during intensity ramp-up
    - beam intensity will be 30 to 200 nominal bunches (possibly including a few small bunches)
- VdM scans at E=1.38 TeV — March-April !
  - β^* = 10 & 11m, ε_N = 2 um (2 … 4 um ?)
  - will be done in one (or two) of the lumi production fills
    - beam intensity could be as high as reasonably acceptable without extra setup time (50x1e11 ? 100x1e11 ? 150x1e11 ?)
    - does the VdM scan request put a limit on the intensity ?
- VdM scans at E=3.5 TeV in special fills — 2nd half 2011
  - β^* = not squeezed or physics values
  - 1 or 2 fills to shoot for the best possible accuracy (2% ??)
    - beam intensity will be ~20 isolated bunches
- VdM scans at E=3.5 TeV special β^* = 90 m — 2nd half 2011
  - 1 or 2 fills — Under discussion
    - beam intensity will be several isolated bunches (large spacing >0.5us)

General needs

- VdM scans generally come with a length scale calibration

- Requested scan range:

  beam separation of at least +/-6σ_{beam} in V and H
  - displacement of each beam individually by +3 to -3σ_{beam} w.r.t. to ref
  - for the length scale calibration, an extended range is profitable
    say +4 to -4σ_{beam}

- If reference orbit includes a separation offset of 2σ_{beam} , can the scan still be performed with a separation of at least +/-6σ_{beam} ?
  - displacement of each beam individually by +2 to -4σ_{beam} w.r.t. to ref

Scan range: defining the envelope

Ralph & collimation team (+MPP?)

- Please specify the allowed scan range separately for the 2 cases
  - (a) fixed TCTs and
  - (b) co-moving TCTs

when will this be usable ?

- Keep in mind special case of separated offset in the reference orbit!

Lumi scan application

Simon, Reyes, Fabio

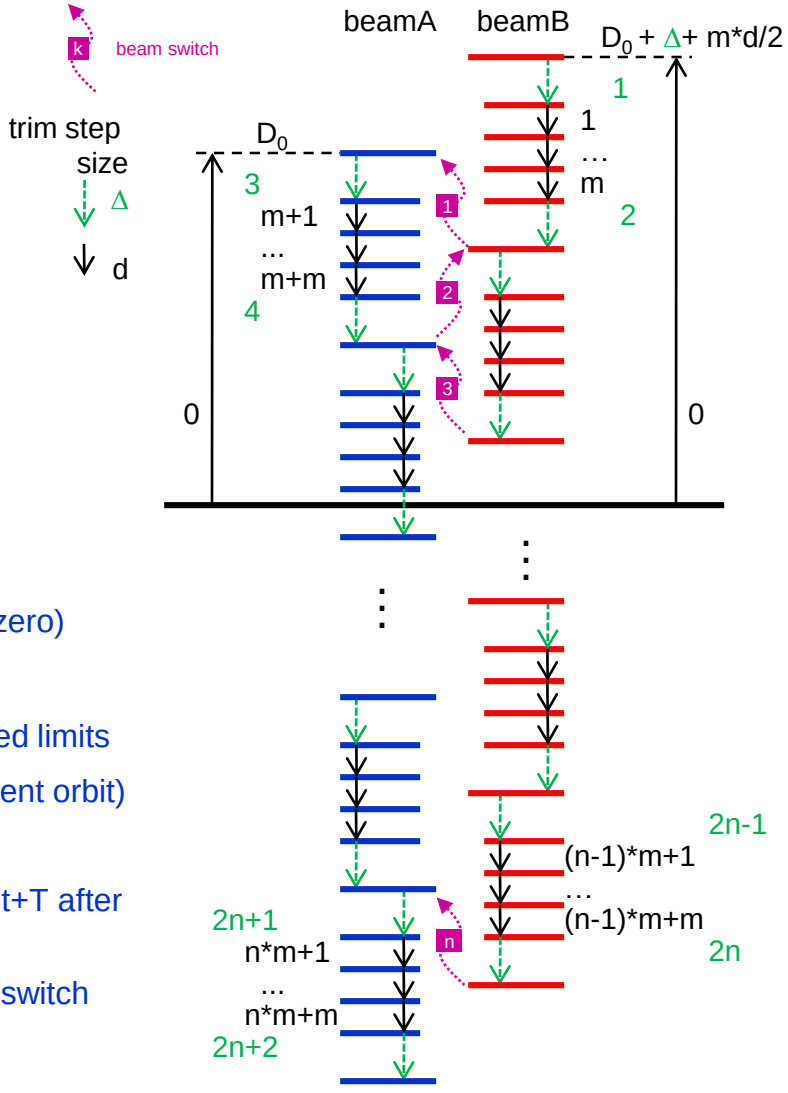
- Urgently needed (for scans at 1.38 TeV and possibly at 3.5TeV) :
  small modification of the lengths scale calib scan protocol

- Less urgent but much desired:
  overall upgrade (re-thinking ?) of IR steering application(s)
  Example:
  - make the scan sequence file-driven (more flexibility, one scan protocol covers all use cases)
  - make (test) scans (or steering) at different IP in parallel
    => DIP publishing must be compatible with this functionality
  - publish over DIP the beams positions and angles at IP at any time, update “on change” whenever doing an IR trajectory adjustment (not only for the lumi scan application)
    => Lumi scan application goes a layer above the “IR steering”
    => “IR steering” is used for any IR trajectory change

New scan protocol for length scale calib

"urgent"

- Input parameters:
  - plane, IP, beamA=beam1 or beam2 (here A=1)
  - D_0 = first offset for beamA (signed value)
  - d = trim step size 1 (signed value)
  - Δ = trim step size 2 (same sign as d)
  - m = number of d-trims before switching beam
  - n = number of active beam switchings
  - t = settle time after any trim that is followed by data acquisition
  - T = data acquisition time after settle time
  - Daq flags:
    - Vladik flag: acquire data only after Δ-trims n=0,4,8,…
  - (option: allow loop scan, no large steps, like the 0 and the return to zero)
- Procedure:
  - Application checks (before start) that beams never go beyond allowed limits
  - BeamA is brought to D_0 and beamB to D_0+Δ+ m*d/2 (relative to current orbit)
  - BeamB is active
  - Make 1Δ step, m * d steps, and 1Δ step with active beam, wait time t+T after selected daq trim steps (as of daq flags) ,
  - Switch active beam n times and repeat the previous line after every switch
  - Bring back both beams to original orbit
  - Note: if one of the two step size is set to zero, skip the associated steps



still under discussion, to be finalized very soon.

Current status on this new scan protocol

- A simple modification of the code would allow to carry out the new scan protocol in steps (each beam switch = one VdM scan)
  - modification: option to **not** execute the "return-to-ref" statement after a VdM scan
  - how to make this safe enough ? (know where the beams are at the end of the scan session)
- This would still not allow the full scan protocol in one go
  - after each beam switch, start a new scan with the new active beam
- If such a modification is not made, some experiments may request to do the "time-consuming" length scale calibration as was done by ATLAS (fill 1393), using the standard IR steering for one beam and VdM scans for the beam (across the displaced beam)
- In the long term, if the file-driven protocol is impolemented, the "new scan protocol" will be automatically possible.

VdM: a last minute wish...

- Dry runs with lumi scan application are higly desirable a few days before the first VdM scans, to check the communication protocol, etc.
- Simon White had foreseen (and used in 2010) a simulation mode to do this, even with beams in the machine*, which however needs to be carefully evaluated

  * the test mode does not send the trims to the machine, but executes the scan loop as if.

- When and how should such dry runs be made ?
  - with/without beam ?
  - during ramp down / precycle ?
  - during access ?

to be defined
=> JorgW ? MPP or rMPP ?