Experiments expectations

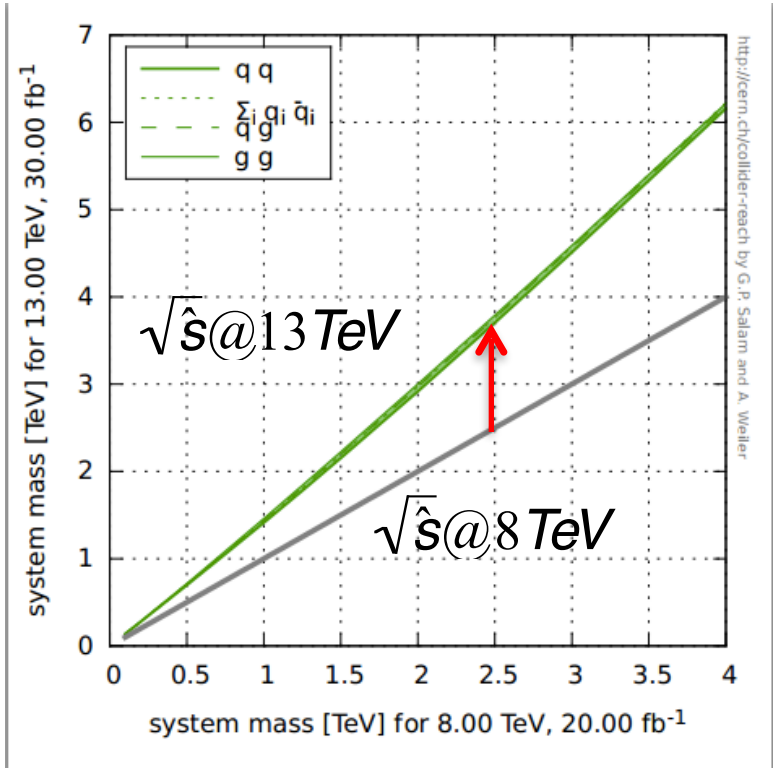
BASELINE RUNNING CONDITIONS

Maximizing physics reach (stating the obvious….)

- Peak instantaneous luminosity isn't all
  - Should not aim for higher values at the expense of stability
- Not even delivered integrated luminosity
  - Physics selection efficiency and background rejection depend on experiment resolution as a function of the physics and the pileup
  - Same delivered luminosity could result in different usable luminosity at different running conditions
- Effective (i.e. usable for physics) luminosity is a key parameter
- Effective integrated luminosity is the ultimate goal
  - Can be different for different analyses depending on type of final state and complexity
  - Challenge is to find the proper instantaneous luminosity and trigger as the best compromise for all analyses
  - Whichever mode of operation we chose, it has to be the one which maximizes it

Discoveries could come early!

30 fb^{-1} @ 13 TeV



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Courtesy of Gavin Salam

- Discovery potential comparison: 20 fb^{-1} @8TeV vs X fb^{-1} @13 TeV
  - Parton-parton system mass at which we get the same number of events
    - Caveat: only scaling of partonic luminosities taken into account
    - Any other effect is assumed equal between the two beam energies

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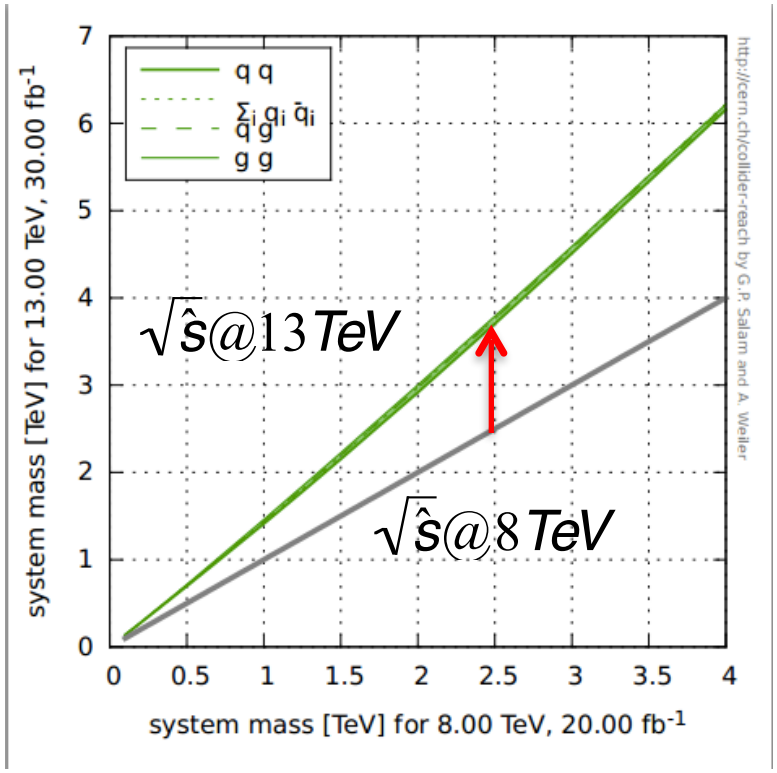
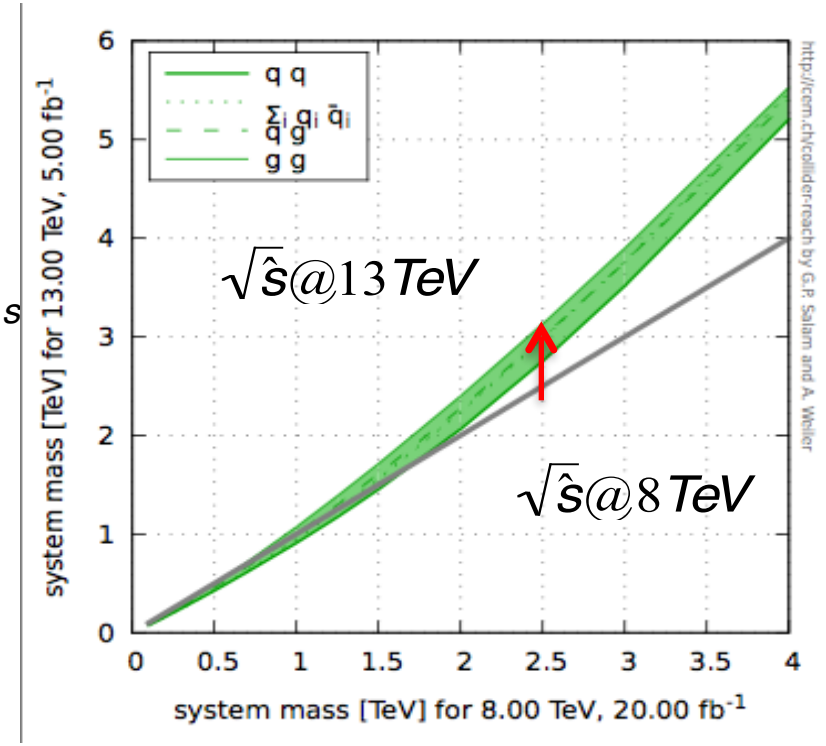


5 fb^{-1} @ 13 TeV



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Views on beam energy

- The positive:
  - At the mass scale of 1 TeV the cross section for production of new particles is ~10 times higher at 13 TeV relative to 8 TeV
- The challenge:
  - Minimum-bias cross-section increases by O(15%)
  - Expected overall multiplicity increases O(10%) at $|\eta|<2.4$, O(20%) in LHCb
  - At equivalent number of bunches and luminosity, events get O(25%) more busy in ATLAS/CMS and up to O(40%) in LHCb
    - Naturally more challenging reconstruction
- Target energy value for 2015
  - Obviously higher energy implies higher reach but this has to be weighted against the need of fixing the energy early enough to allow MC production
    - Ideally by end of summer… though not in phase with machine quench tests
  - The suggested scenario would be to fix the energy by or earlier than Chamonix to a conservative value (13 TeV?) so that we can start production
    - We accept the risk that results from late quench tests could force to run at lower energy
    - *Longer term comment*: small intermediate step increases (< ~250GeV) towards ultimate beam energy should be avoided

Effects of Pileup and bunch spacing

- Obvious: 50ns gives twice the in-time pileup for the same luminosity
- Higher pileup has several negative implications on:
  - Detector
    - E.g. event size and bandwidth limitations in inner detectors readout
  - Trigger efficiency
    - Higher fake rates make it difficult to keep current thresholds
  - Online and offline CPU resource requirements
  - Reconstruction & Analysis efficiency
  - Increased systematic uncertainties
- Not a sharp threshold but rather a constant degradation with pileup
  - Moreover the pileup effects are analysis-dependent
- A maximum pileup of ~50 is considered to be acceptable
  - For higher values a levelling mechanism should be considered
  - It is important to note though that physics with μ=50 is challenging and in the case of levelling to a constant value we should aim for a lower value
    - Ideally in the 30-40 range

Recap of 25ns vs 50ns

- Running at 25ns is considered of paramount importance by all experiments to maximise ultimate physics reach

⇓

- 50ns for luminosity production should only be considered in case of major showstoppers
  - Leveling would be needed in IP1&5
  - We feel that it is premature and not appropriate to discuss criteria that would suggest to fallback to the 50ns scheme

- Experiments understand that 50ns commissioning will be needed but they would ask to keep it to the absolute minimum required for machine setup and to establish readiness for 25ns
  - Assuming a delivered luminosity ≤1 fb^{-1} @ 50 ns
  - Not to be forgotten: some colliding bunches for ALICE (2011-like) during 50ns
- We do not request any optimisation at 50ns
  - Except if needed to speedup 25ns commissioning
- It is accepted that running at 25ns could result in lower delivered luminosity in 2015 compared to a 50ns scenario
  - Longer commissioning plus longer scrubbing period

Bunch Length, Luminous Region, Crossing angles etc.

- The critical parameter is the luminous region rather than the bunch length
  - Naturally smaller in 2015 because of larger crossing angles
- A short luminous region gives more 'merged vertices'
  - i.e. more difficult to reconstruct the primary event vertex
  - In general it is safe to say that the "pileup density" is the key physics parameter for tracker detectors
- A longer luminous region would benefit ATLAS and CMS tracking and vertex reconstruction at high pile up but:
  - For excessive values it will reduce track reconstruction efficiency
  - CMS: it would also worsen the mass resolution in the H->gg analysis
  - LHCb: despite VELO being ~1m, already some loss of "long-lived" B's….
- Thus we would like to keep a luminous region close to the current one
- Even more importantly:
  - Luminous region length should be kept as stable as possible from fill to fill over the full running period
  - Value should be known in advance for correct generation of MC samples

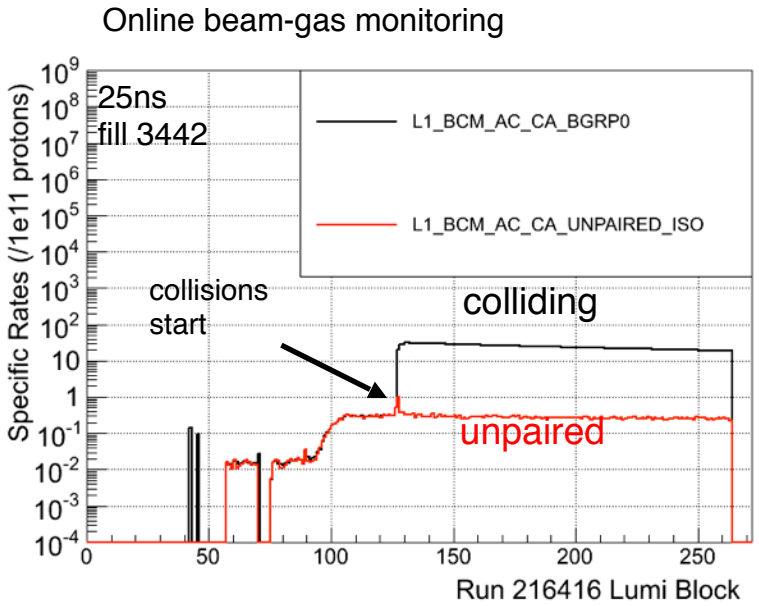
Views on optics options

- Injecting at lower β* is generally agreed to be OK
  - Special optics will be required anyway for VdM scan (see later)
- Very preliminary thinking about flat beam have not indicated an evident showstopper
  - Final decision will depend on accurate study based on actual value of β_x/β_y ratio
    - Should we assume 2-3?
  - In any case a decision should be taken as early as possible to take it into account MC production

Filling schemes

- Several fill schemes prepared for 2015
  - 25ns_2748b_2736_2452_2524 (standard booster extraction)
  - 25ns_2508b_2496_2108_2204 (BCMS / 5 PS trains per SPS batch)
  - 25ns_2604b_2592_2288_2396 (BCMS / 6 PC trains per SPS batch)
  - 25ns_1968b_1960_1163_1868 (e-cloud moderating scheme, 8b+4e)

- Beware that all schemes have 12 initial bunches not colliding in IP1&5
  - These are of paramount importance for background studies
  - Eliminating them would leave the experiments “blind” to beam-gas

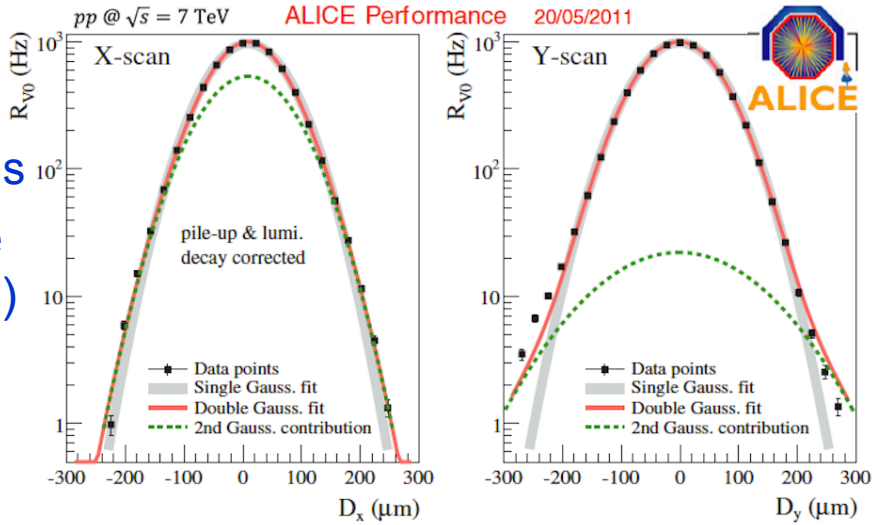


Levelling and crossing in LHCb

- Currently no hard proof of an improvement with tilted crossing in IP8
  - No request for tilting in 2015 (for now), but difference between angles in UP/DOWN should be minimised
- Will require regular polarity swaps as in the past for reduction of systematic error in precision measurements
  - Every ~100 pb^{-1} collected
- Levelling to 4-6x10^{32} $cm^{-2}s^{-1}$ will be needed
  - Minimum $\beta^* = 3m$
  - We suggest to setup levelling by a combination of separation and β^*
    - Max $\beta^*>10m$ to keep separation not larger than 1σ
      - Advantage for machine stability (Landau damping)?
  - There's no particular advantage for LHCb w.r.t separation only, but it would serve as a continuous test bed for β^* levelling
    - Supported baseline mechanism for future levelling needs
  - Assuming no significant impact on physics time
    - Otherwise we should return to "standard" separation-only approach

ALICE running conditions in p-p

- ALICE plans to run in minimum-bias conditions
  - Luminosity range $5x10^{29}$ - $2x10^{30}$ $s^{-1}cm^{-2}$
  - Actual set point depending on final running conditions
    - TDI vacuum and beam-gas background level as well as ALICE final triggering scheme
- Luminosity reduction must be obtained by separation only
  - No main-satellite scenario available for 25ns
  - Data from 2011 VdM show a drop of rate of only about 300 (Y-scan) to10^3 (X-scan) at the limit of VdM separation range (~5-6 sigmas?)



- Points to be addressed:
  - What lumi fluctuations can we expect at those separations?
  - We need to setup a proper operational strategy to avoid risks of beam dump at removal of the separation bump in P4?
    - Estimated present value of BCM dump threshold is ~6 10^{31} $s^{-1}cm^{-2}$ (see MPP 91)
    - Lower limit may be needed to protect detector in stable beams conditions

Quick view on Heavy Ion Operations in 2015

- **4 weeks** of HI operations allocated in 2015

- Baseline program: Pb-Pb operation at 5.1 TeV
  - Expect Luminosity ~ 10^{27} $cm^{-2}s^{-1}$
  - Levelling in ALICE required (operate at 8 kHz rate)
- A reference pp sample at equivalent energy will be required
  - Usual formula: $\int Ldt\ (pp) = 3\text{-}4\ 10^4 \times \int Ldt\ (PbPb)$

Views on commissioning and early beam

- Experiments express no concern with the initial commissioning plan, in particular the plan and schedule of checkout and sector test.
  - Important: schedule dry run to test VdM scan application
  - Sector test 78 in week 47 should include “TED shots” for LHCb (alignment) and system tests including BIS (injection and beam)
- Both ATLAS and CMS explicitly request ~20 beam splash per beam (other detectors are probably interested too)
  - At the moment no request for scraping beams but we should keep the option open
- Stable colliding beams, with pilots, as early as possible are paramount to commission detectors and trigger systems that have undergone major maintenance or upgrades in LS1
- Dedicated very low-pileup data (μ~0.01) is very important but for the moment dedicated runs are not requested
  - For IP1 and 5 LHCf data taking period may provide needed data
- Some time in stable beams during initial low intensity commissioning should be regularly allocated
- Unsqueeze for VdM and LHCf should be part of initial commissioning
  - See detailed discussion later
- Consider performing ALFA and TOTEM commissioning (alignment and loss maps) as part of the initial commissioning

SPECIAL RUNS / SPECIAL OPTICS

Overview of special runs in 2015

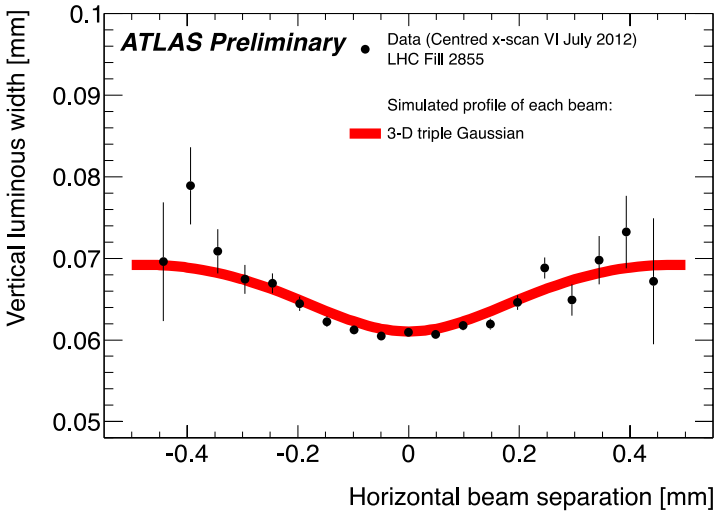
- Only few exceptions to standard p-p conditions are considered
  - Low pileup and unsqueezed optics for LHCf
  - Run at high beta (90m) for TOTEM/ALFA
  - VdM scan(s)

LHCf run

- Ideal beam conditions:
  - β* = 19m (same as for VdM)
  - 40 very low intensity bunches (~$1x10^{10}$ p per bunch) with some non-colliding (no trains)
    - Luminosity ~$5x10^{28}$ $cm^{-2}s^{-1}$
  - Half crossing angle 145 μrad needed
  - Target integrated luminosity: 5-20 nb^{-1}
    - 2-4 good fills
  - *LHCf request to take data at 3.5 and 7 TeV as well (to test √s scaling) does not fit in current schedule*
- Constraints:
  - The run must be taken before 500 pb-1 of delivered luminosity in IP1
    - Beyond that LHCf will suffer from radiation damage even if it is kept in garage position
  - One pilot run should ideally be scheduled 1 week before main run

Luminosity Calibration: VdM scans

- 2012 campaign showed that the non-linear x-y beam correlations are a dominant source of uncertainty in the luminosity calibration
  - Non-factorization @ IP 1, 5,8 can be studied quantitatively only by fitting the evolution of the beamspot position & luminous width during scans
    - Possible only if the vertex resolution does not dominate the luminous width
  - The problem:
    - σ_b scales like $\sqrt{(\beta^*/E_b)}$ ⇒ naturally smaller beamspot in 2015
    - The vertex resolution won't get any better!



- Hence VdM scans cannot be performed at injection optics
  - Dedicated conditions:
    - β*~19 m in IP1&5, 30-40 m in IP8
    - ε~3 μm
    - ~7×10^{10} protons per bunch
    - Gaussian beams in the injectors

LHCf and VdM schedule

- Both LHCf run and first VdM need to be scheduled within the first days of p-p running
  - Beware that experiments require a minimum initial exposure of their luminosity detectors (order of $10pb^{-1}$ for detector conditioning and/or calibration of luminometers) before VdM
- For efficiency use same optics for both to combine commissioning
  - This implies that the first VdM will have $\theta_{1/2xing}$ = 145 μrad
- Combining part of the runs would be a plus (i.e. take data for LHCf during scans in other points than IP1)
  - But LHCf requires ~7 times lower pileup than VdM conditions
    - Can we separate IP1 (~4 σs) during scans in other IPs?
  - Can we define proper filling scheme to provide enough collisions to LHCf during IP2 & IP8 scans?
    - Cannot put too many bunches to stay in proper DCCT range
- A second “precision” VdM is foreseen for the second part of the program
  - No θ_{xing} for this one

High β* runs

- Both ALFA and TOTEM are interested in a run at β*=90m for diffractive physics
- TOTEM specific requests:
  - Strategy: small bunches (7×10^{10}) ⇒ low pileup (μ ~ 5%)
  - Fill with 1000 bunches for L~10^{31} $s^{-1}cm^{-2}$
    - Need to develop enhanced setup with crossing-angle
  - Collect ~10 pb^{-1} events of central diffraction
    - Ideally at least 2 weeks of data taking (possibly in two separate slots)
    - Not yet clear how to fit this in 2015 shortened schedule
- Low β* insertion (in conjunction with CMS/PPS) is also important
  - Need to schedule end of fill tests of insertion

… we are looking forward for a 2015 of challenges and renewed success

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Thank you for your attention