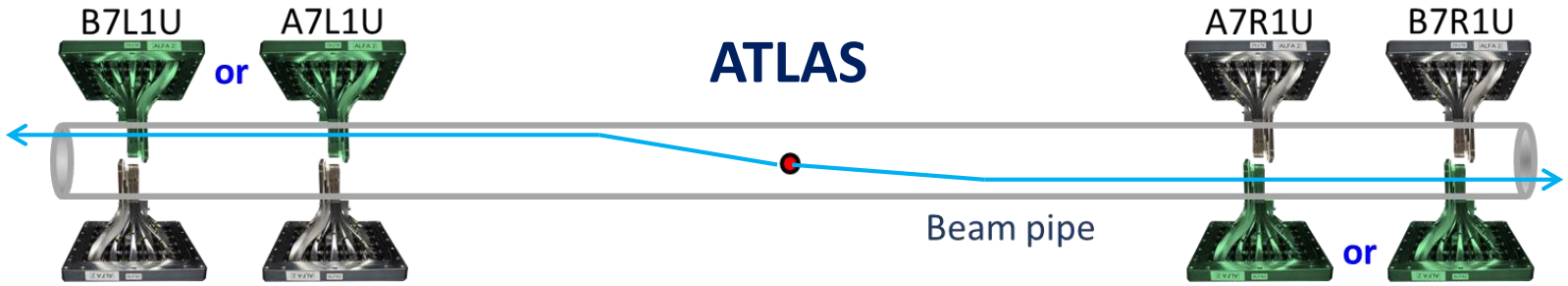
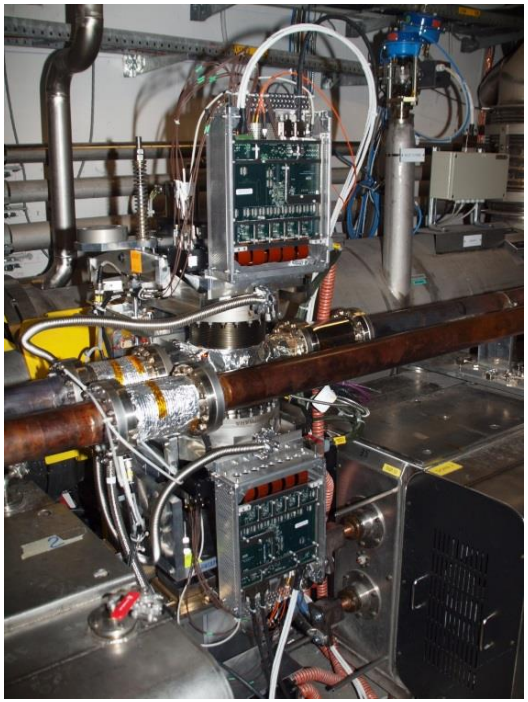
ALFA
From LS1 to 2016

P.Fassnacht on behalf of ATLAS/ALFA

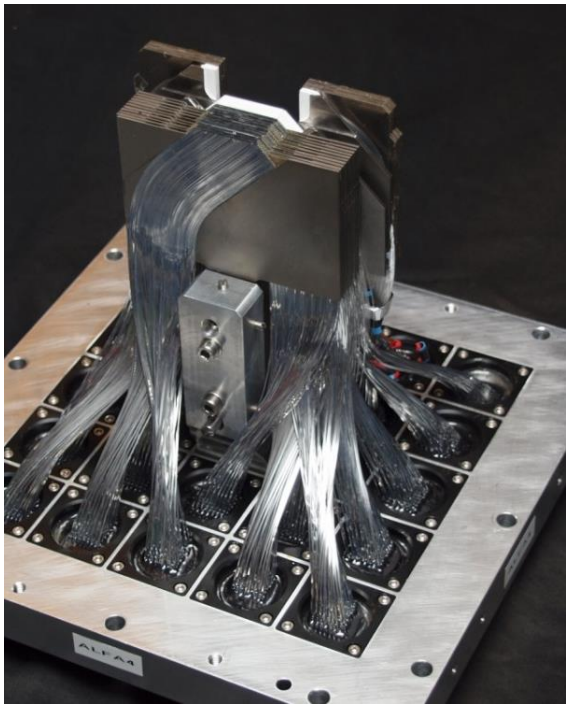
- Detector readiness
- Status of physics analyses (short)
- Plans for 2016

The ALFA detector





- 2 x 2 stations
  ~ 240 m from ATLAS IP
- 8 fiber detectors with
  2 x 10 layers of 0.5 mm
  quadratic fibers
- Movable in vertical direction
- Resolution ~ 35 µm

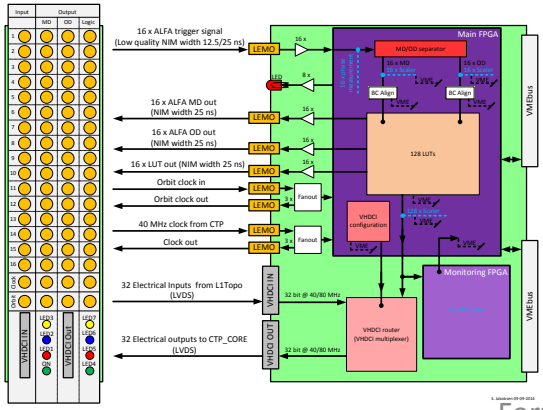


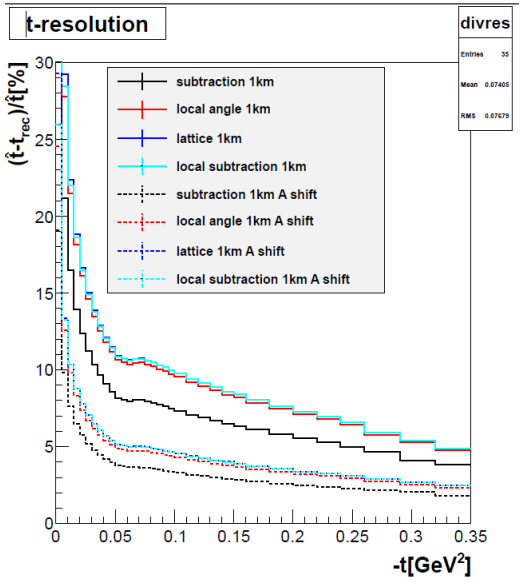
Long list of LS1 upgrades …

- All 4 station moved from tunnel to surface, complete disassembling
- Replacement of detector ALFA2 → ALFA10
- Alternate pre-vacuum pumping with remote controlled spare pump
- Reduced dead time of trigger electronics to handle up to ~ 700 bunches
- Upgrade of movement system: PXI, FESA etc.
- Upgrade of DCS and TDAQ along with ATLAS stream
- Vital: heat protection to avoid damage of detectors
- New laser survey in tunnel
- Special trigger board to stay within ATLAS latency budget

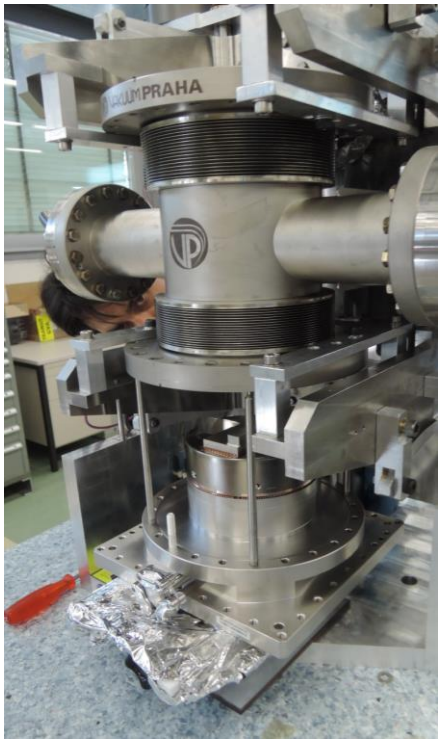
- Move both far stations to new positions to enlarge distance 4m → 8m,
  → improve t-resolution by factor 2

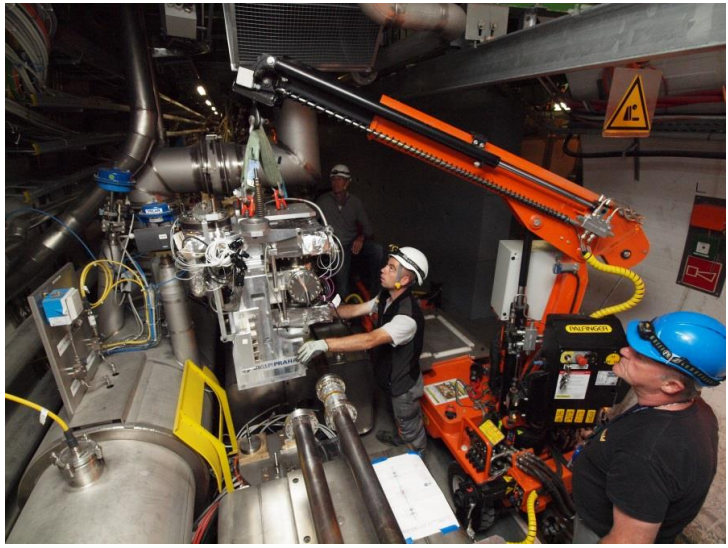
- New code for reconstruction software



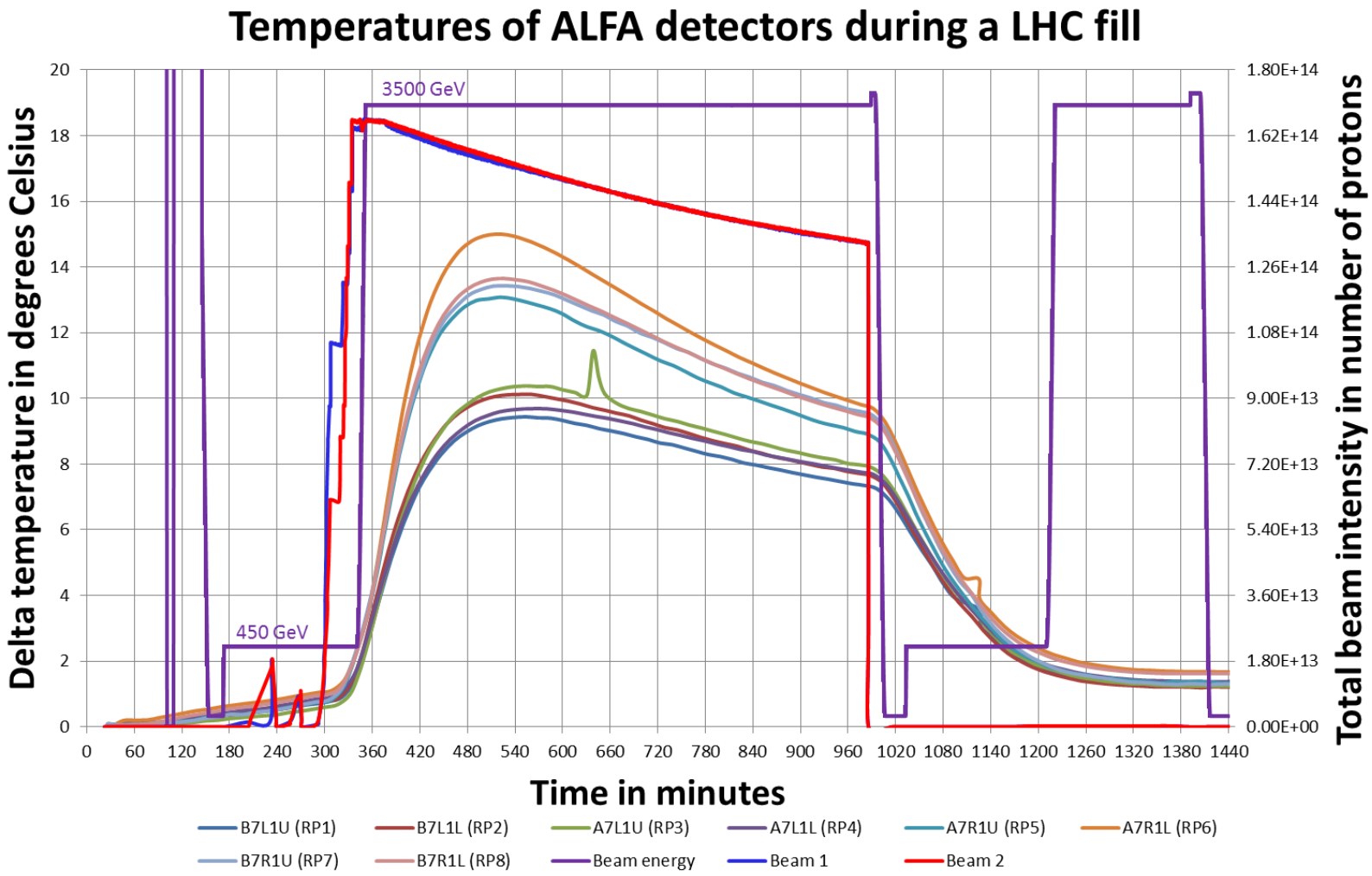


From tunnel to surface and back





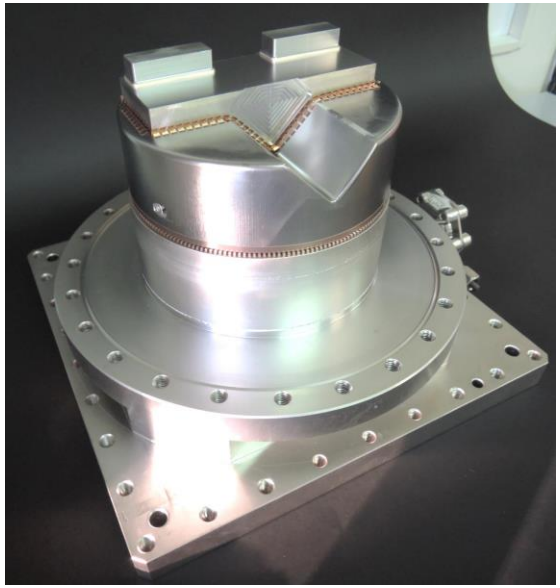
Heating in Run1

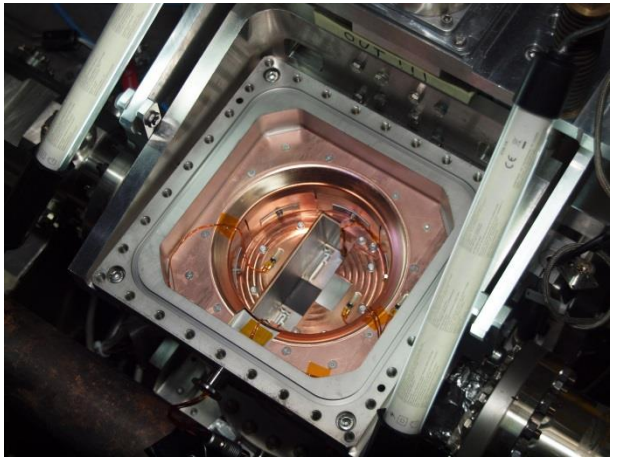


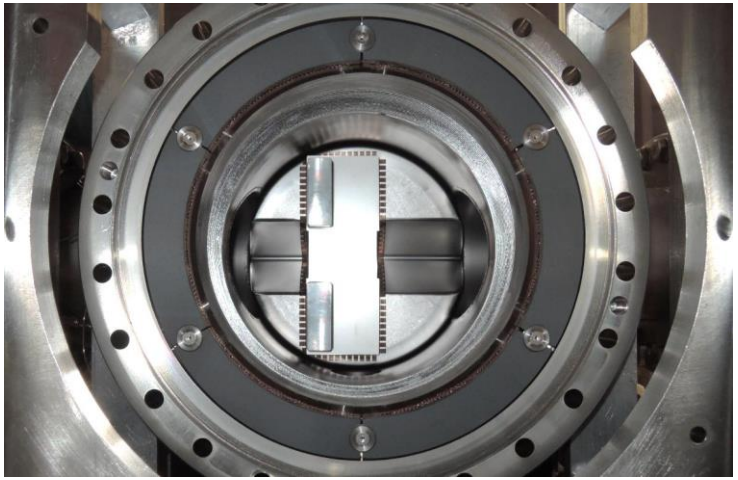
- Max increase ~ 20 degrees observed
- Danger: destroy structure of fiber detector

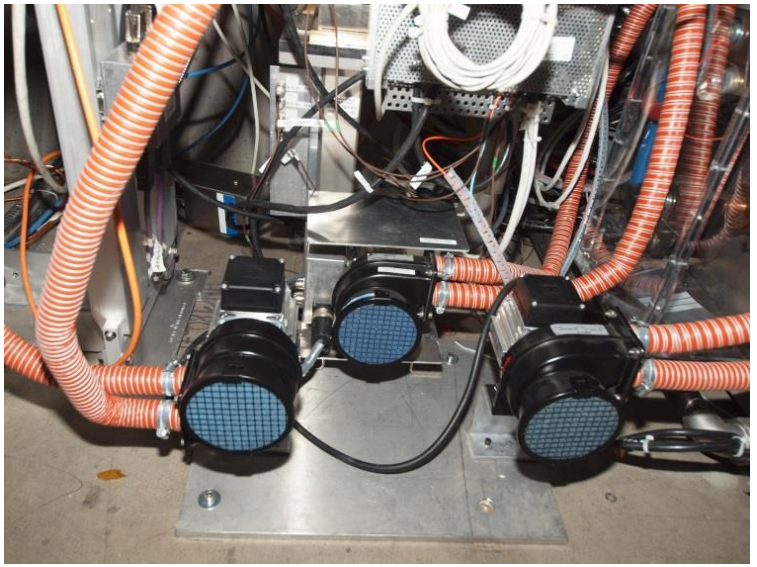
4 Measures against heating

RP Filler, ferrites, air cooling, heat distribution

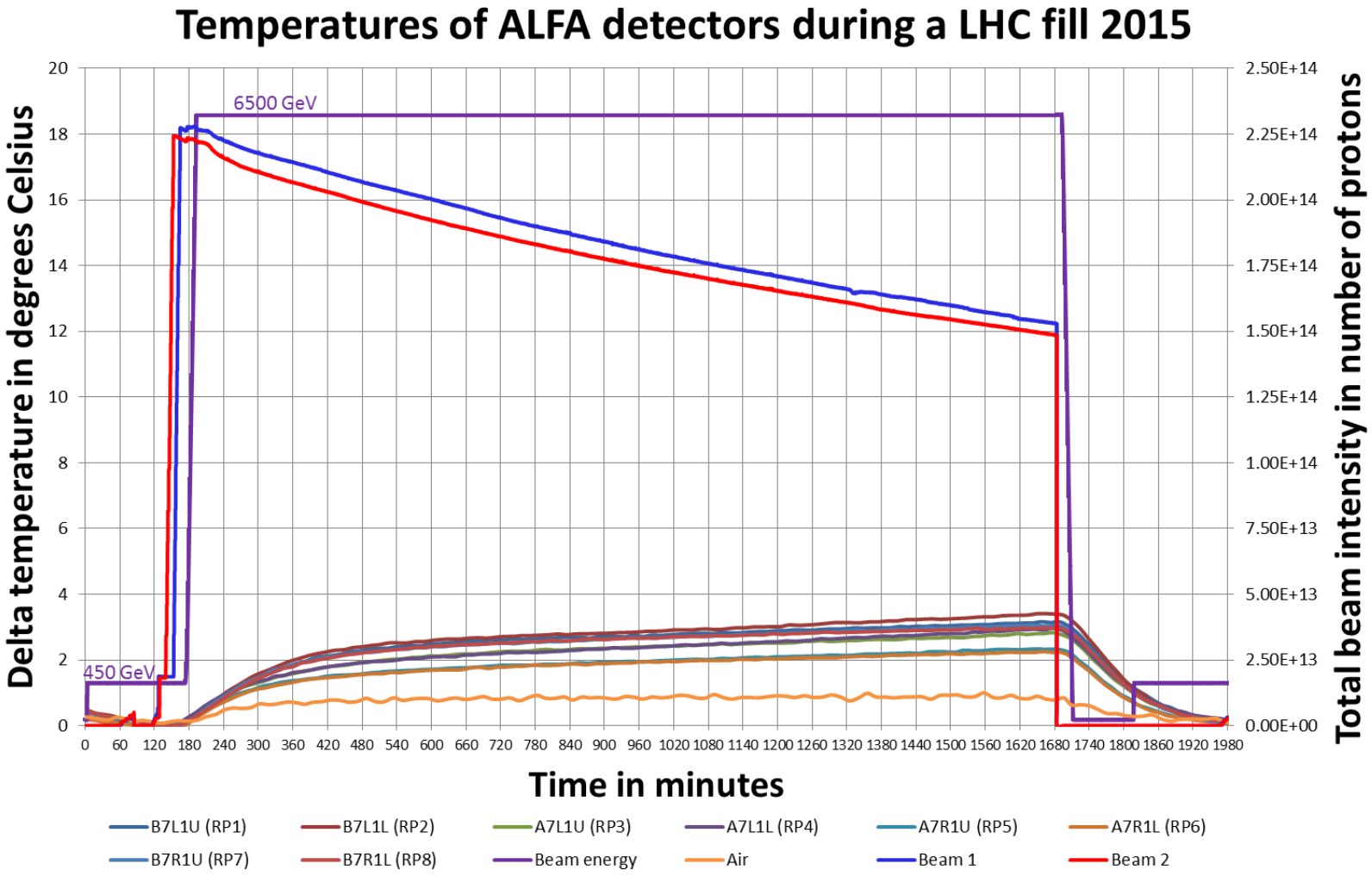








Heating in Run2



➔ Small increase by ~ 3 degrees, save for Run2

Data taking in Run2: beta* 90m

Optics
Fill#2

Scraping &
Elastics#1

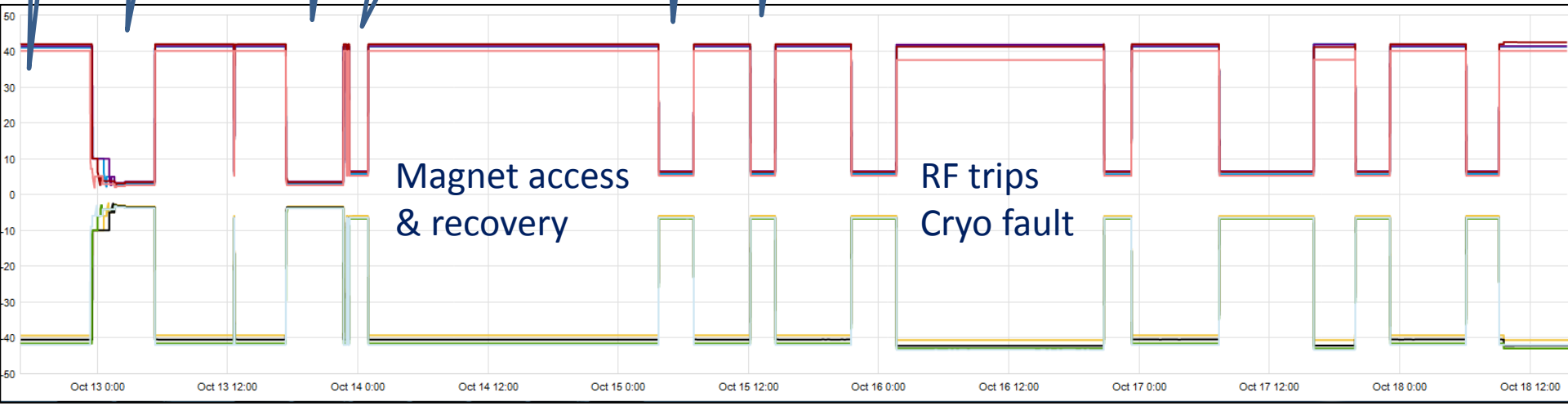
Elastics#2
Xing = 0

Loss maps
10 sigma

Diffractive
Fill 54b

Diffractive
Fill 252b

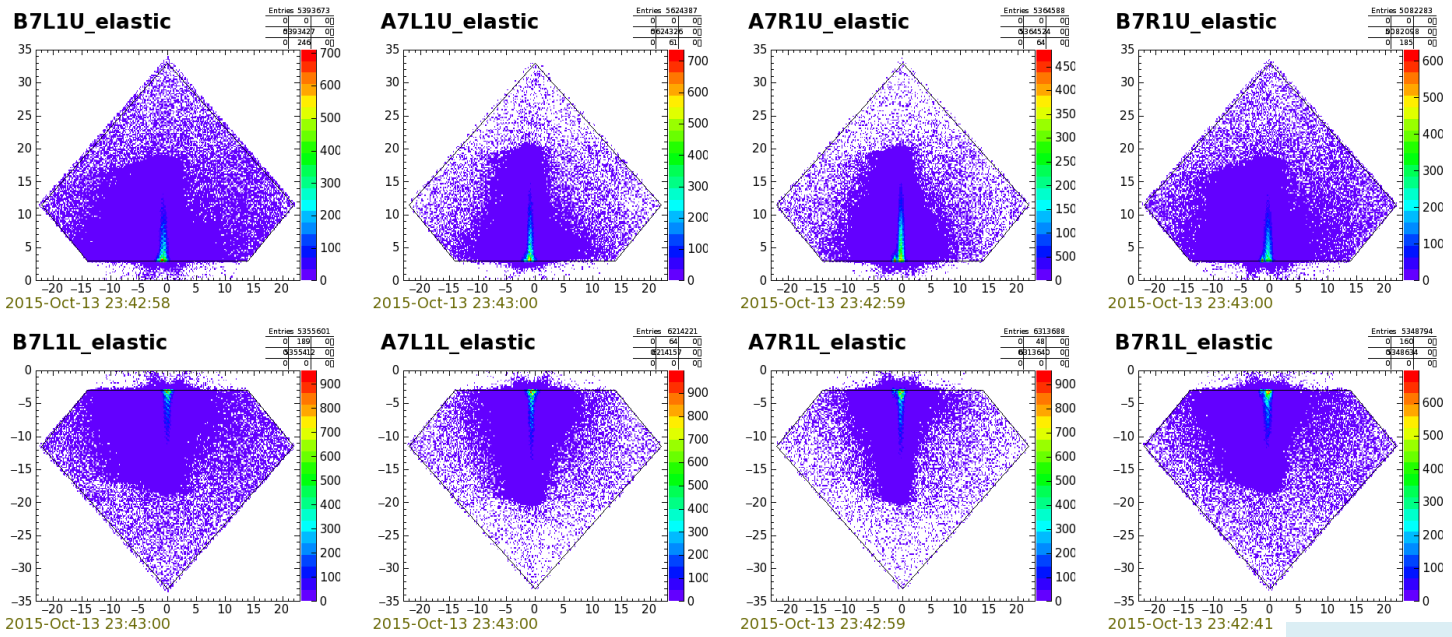
5 diffractive runs with Fills 685b



Monday 8:00 → **Sunday 12:00**

Elastic scattering

- Refill LHC with 3 bunches ~ 8E10 plus up to 10 pilot bunches ~ 1E10
- Move the Roman Pots again to 5.5 $\sigma_{nominal}$
- Follow data recording by farm processing for various groups of trigger items
- Now w/o IBL in readout to allow higher trigger and storage rates

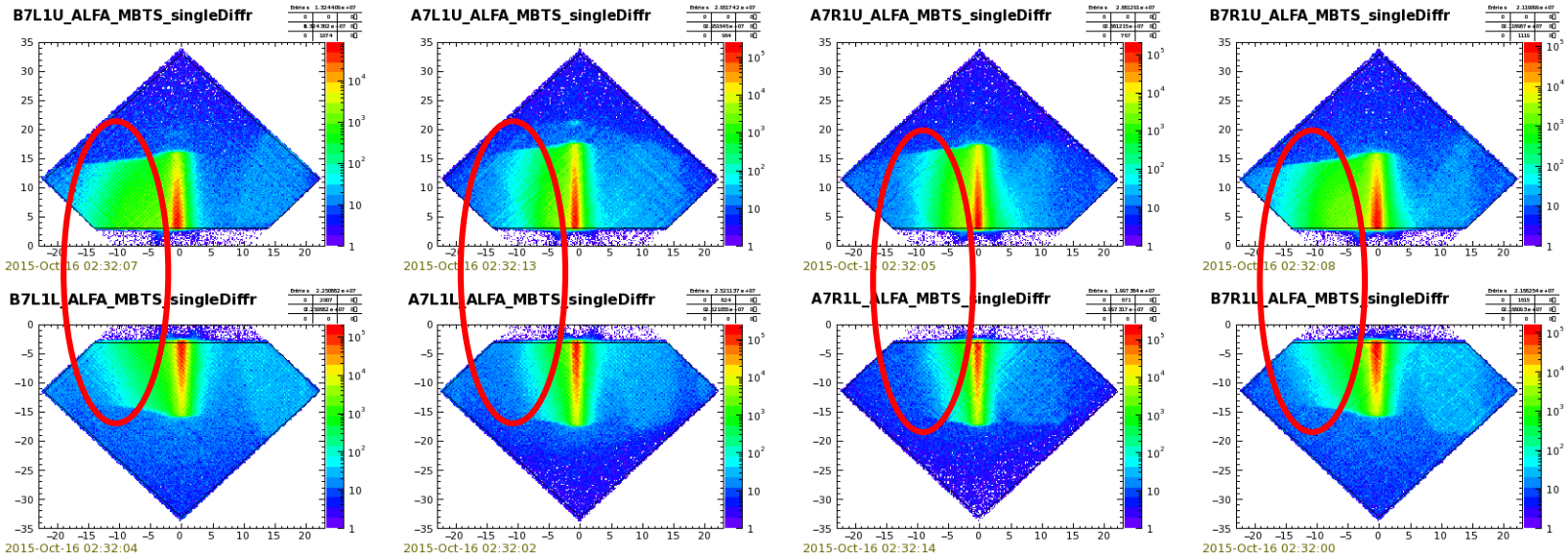


K.Korcyl

- After about 4.5 hours beam was dumped by operator !!!
- Collected: 40 million physics, 11 million elastic, 450 million calibration triggers
- Data w/o crossing angle for standard elastics analysis
- Qualification by loss map tests for Roman Pots at 10 σ successful, originally 12 σ

Diffractive scattering

- Due to ALFA dead time min bunch spacing 100 nsec, allows max 700 bunches
- Unusual filling scheme, never before tested …
- Strategy for intensity ramp: 50 → 250 → 700 bunches
- Move all Roman Pots to 10 $\sigma_{nominal}$ (5-7 mm)
- Example: Online plots for single diffractive events combining ALFA & MBTS



K.Korcyl

Integrating over all 7 fills:

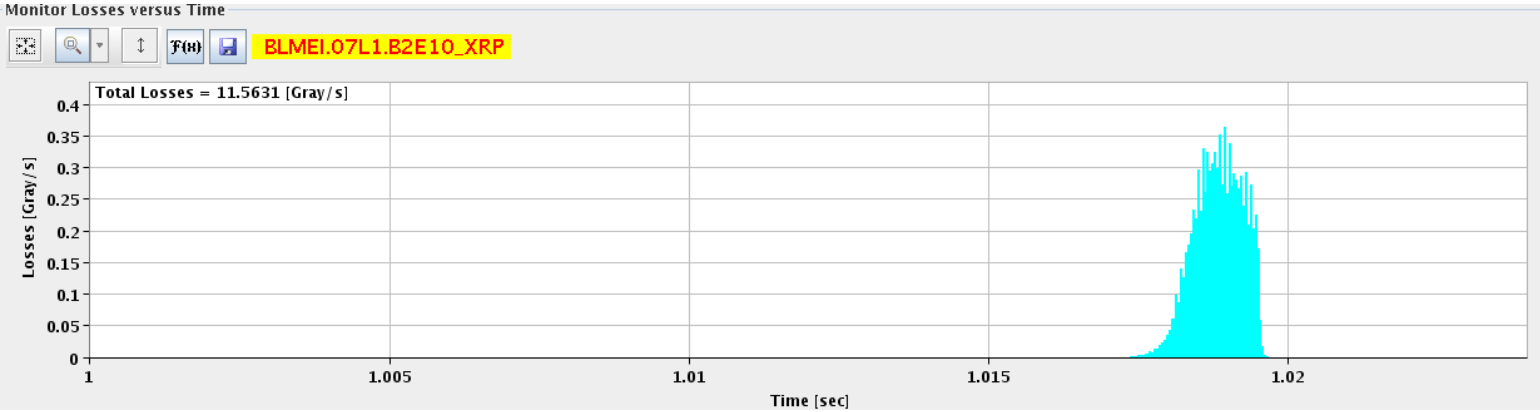
- LHC delivered: 735 nb-1
- ATLAS+ALFA in position recorded: 652 nb-1
- ATLAS+ALFA optimal: ~600 nb-1 (~82 % efficiency)

List of YETS 2015 upgrades …

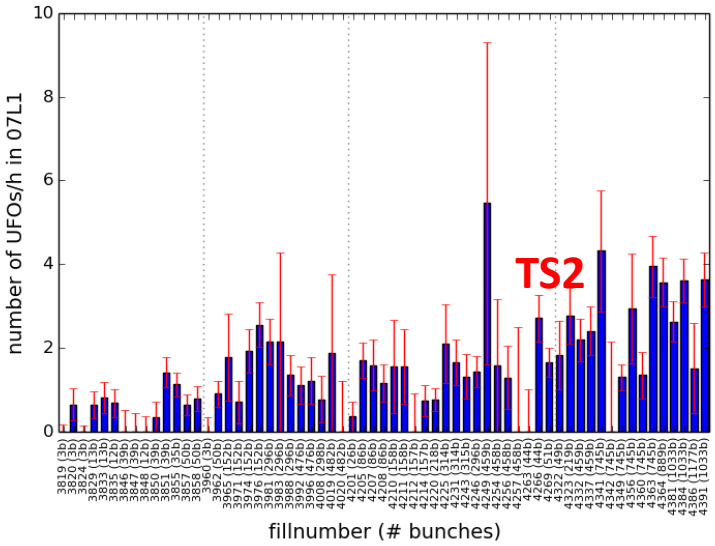
- Vacuum pumps & fans
- Replacement of noisy LVDT
- Modification of Radmons for higher doses
- Upgrade of movement system. Interlock validation started
- Changes in DCS and TDAQ along with ATLAS
- Measures against the UFO issue
- Long-pending installation of new magnet cables

UFO issue and measures (1)

Beam dump in an ALICE/LHCb vdM run by a BLM signal close to station A7L1



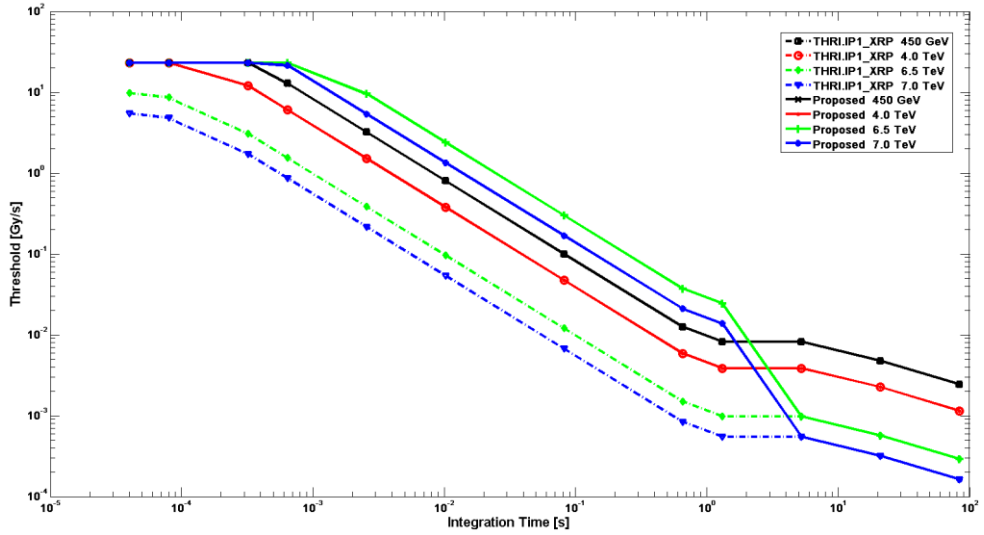
Measure#1: multiple movement repetitions in TS2

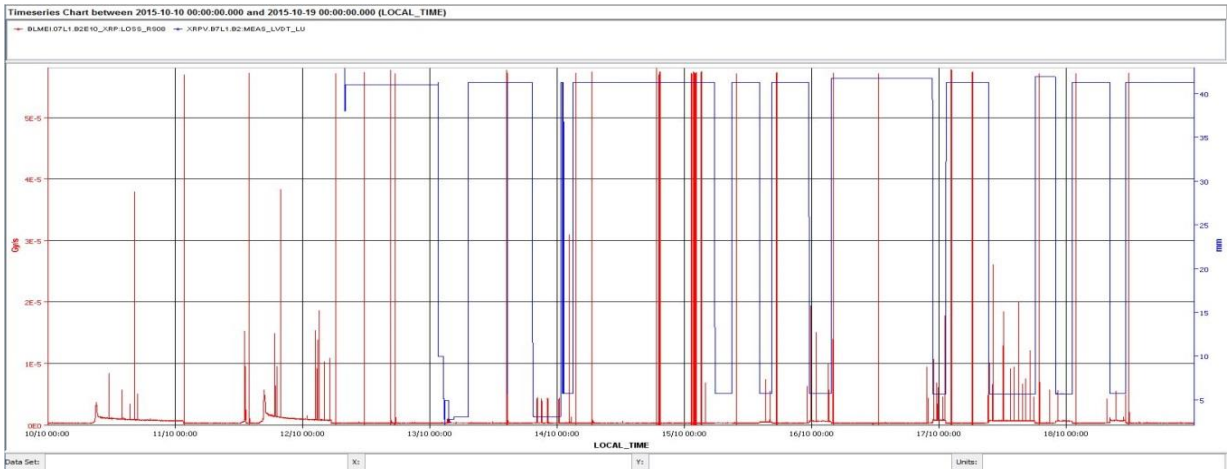


No clear effect
UFO rate scales with beam intensity
All signals below dump threshold

UFO issue and measures (2)

Measure#2: increase dump threshold from machine side, more coherent with TOTEM
Increase by factor ~25 should rule out UFO amplitudes above the threshold over Run2



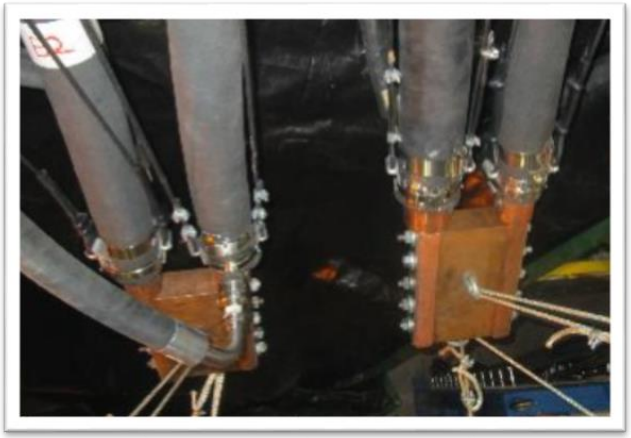


Beta* 90m, Oct 10-19, 2015
BLM signals versus RP mvt

→ No indication
of correlation seen.

Magnet cables for Q4

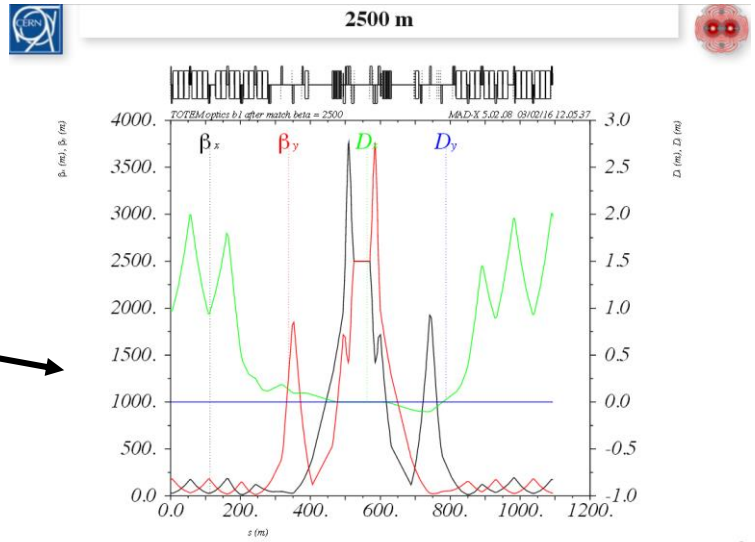
Cables installed - to satisfy optics requirements very asymmetric powering of Q4 needed for the 2 beams. Not possible with the past powering schema – Like for TOTEM new cables installed during YETS



Cables: 24h Short Circuit Test

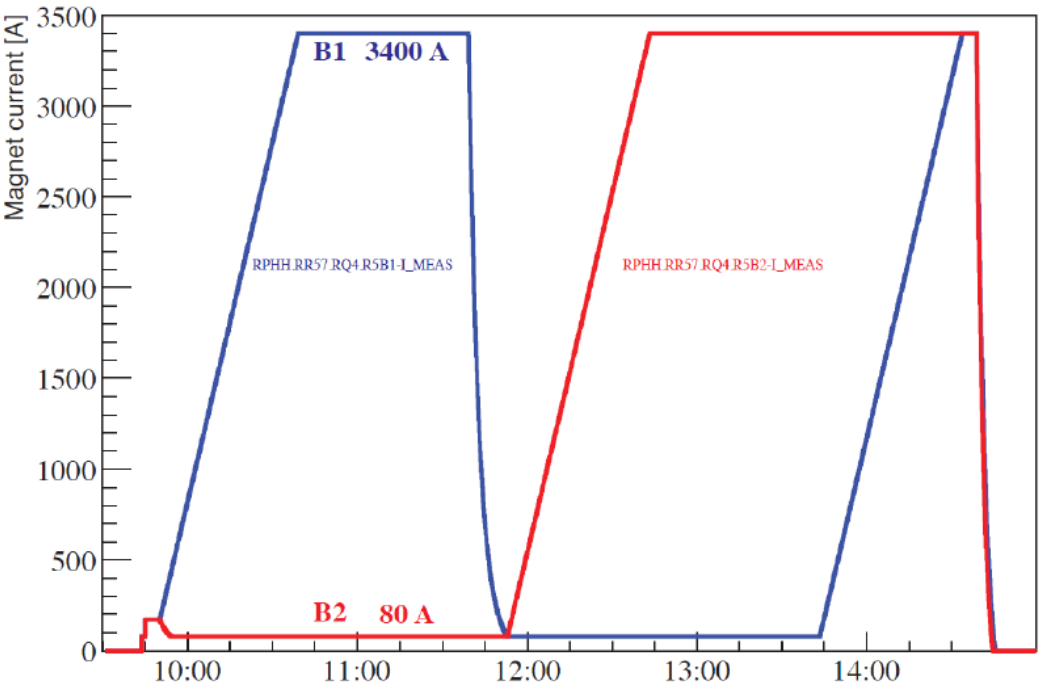
Optics:

- Starting point : 1000 m optics of 2012.
- No more Beam1 / Beam2 ratio constraint on Q4.
- Phase advances: 90deg in vertical (ok) and away 180deg in horizontal (not yet fully there…).
- Preliminary file available.



Steps to highest beta*

Powering tests of Q4.R5 on the 2015.02.14 results (TOTEM)



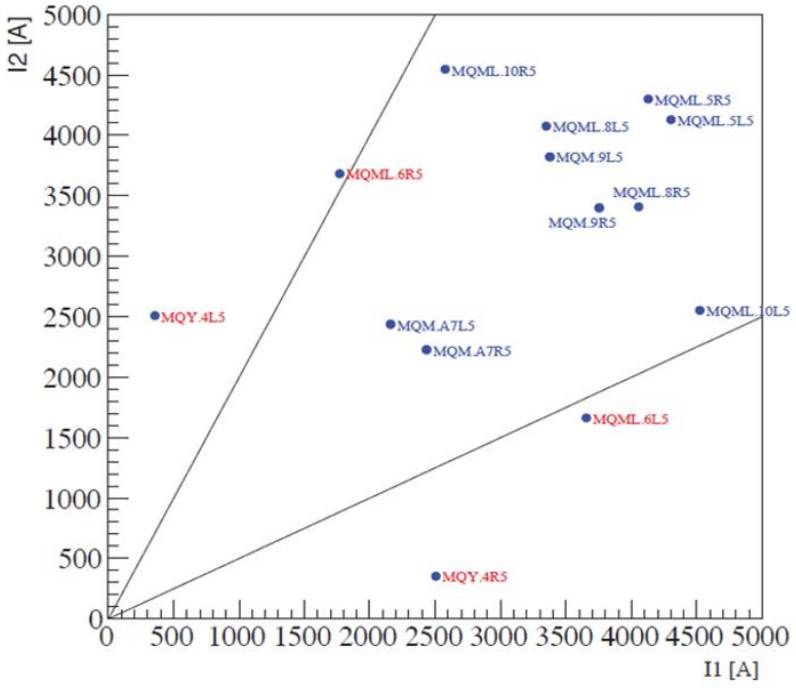


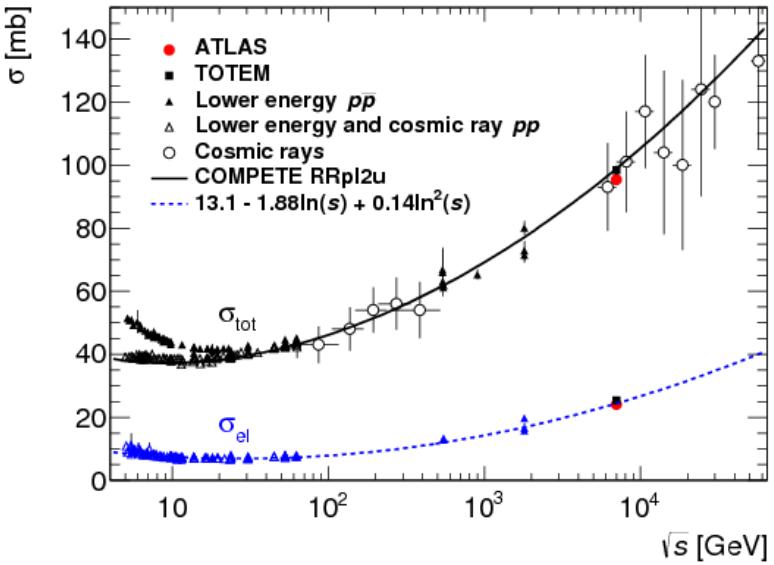
Figure 3 – current ratio between the 2 apertures in IR5

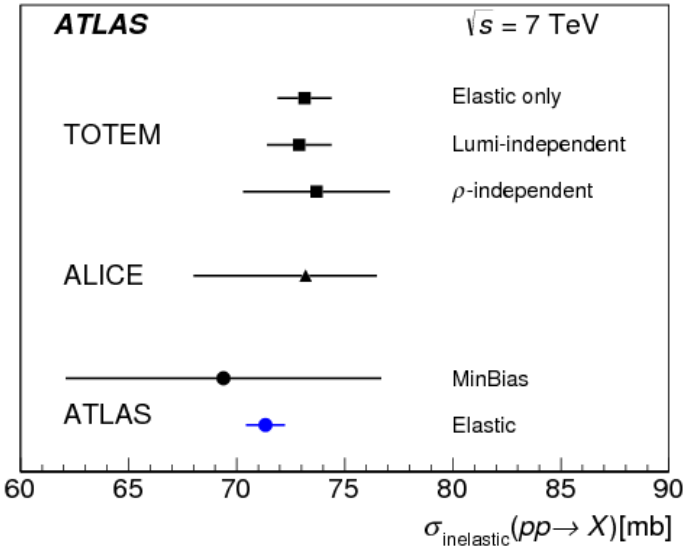
De-coupling of beam1 and beam2 allows to design optics with less constraints

Status of physics analyses

Elastic scattering:

- Total/elastic cross section at 7TeV (beta* 90m) published
- Analysis 8TeV / 90m in final stage. Internal reviewing started.
- Analysis 8TeV / 1km first iteration done, checking consistency with 90m results
- Data 13 TeV/ 90m first inspection done, on hold until 8 TeV results published





Diffractive processes:

- 7 + 8 TeV – exclusive pions: close to being finalized
- 13 TeV – inclusive and exclusive analysis started
- ALFA+LHCf – combined data, mostly pp + π^0

Standard elastics program

Measurement of luminosity and total cross section by elastic scattering at very low t

In dependence on t-range two options:

1. Only nuclear scattering and luminosity from ATLAS → σ_{tot}

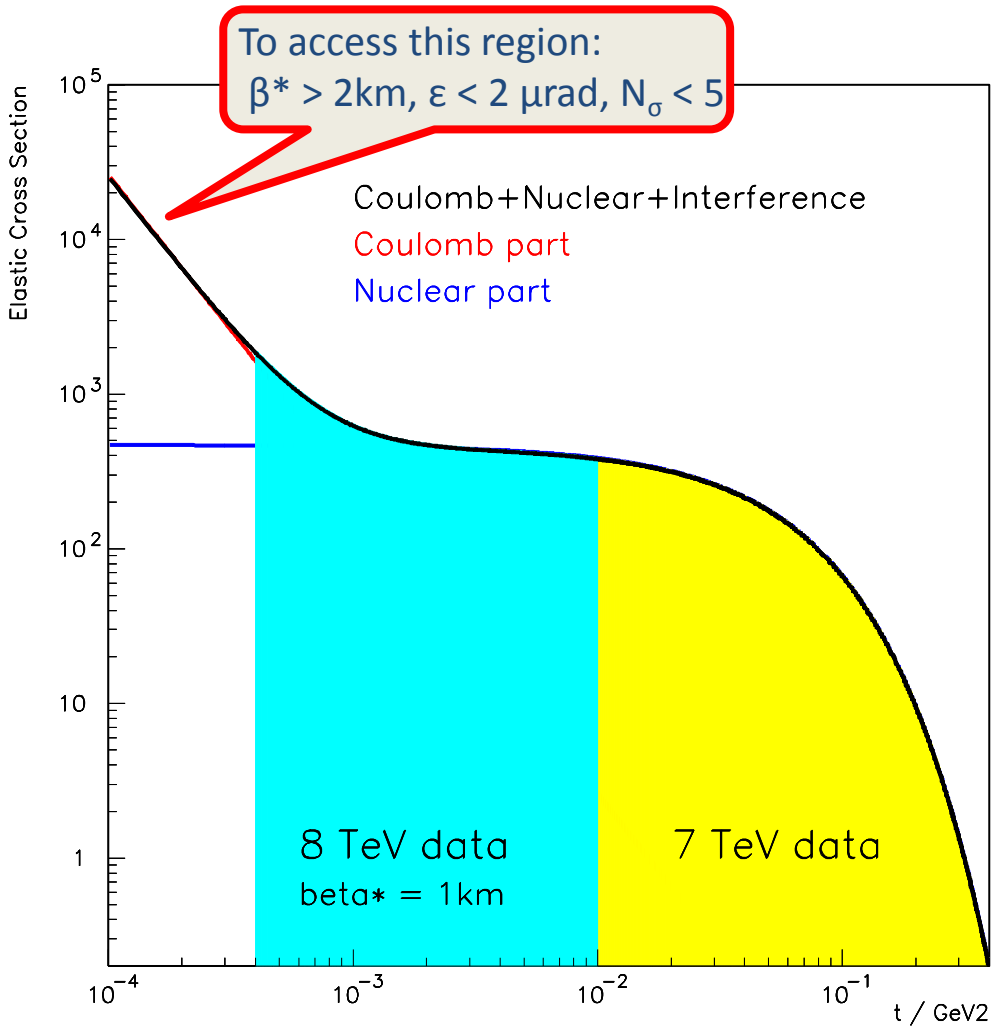
$$\frac{d\sigma}{dt} = \frac{1+\rho^2}{16\pi(\hbar c)^2}\sigma_{tot}^2 \exp(-Bt)$$

2. Coulomb + nuclear scattering:
   → Luminosity and σ_{tot}

$$\frac{dN}{dt} = L\pi|f_C + f_N|^2 \approx L\pi\left|-\frac{2\alpha}{|t|} + \frac{\sigma_{tot}}{4\pi}(i+\rho)e^{-b|t|/2}\right|^2$$

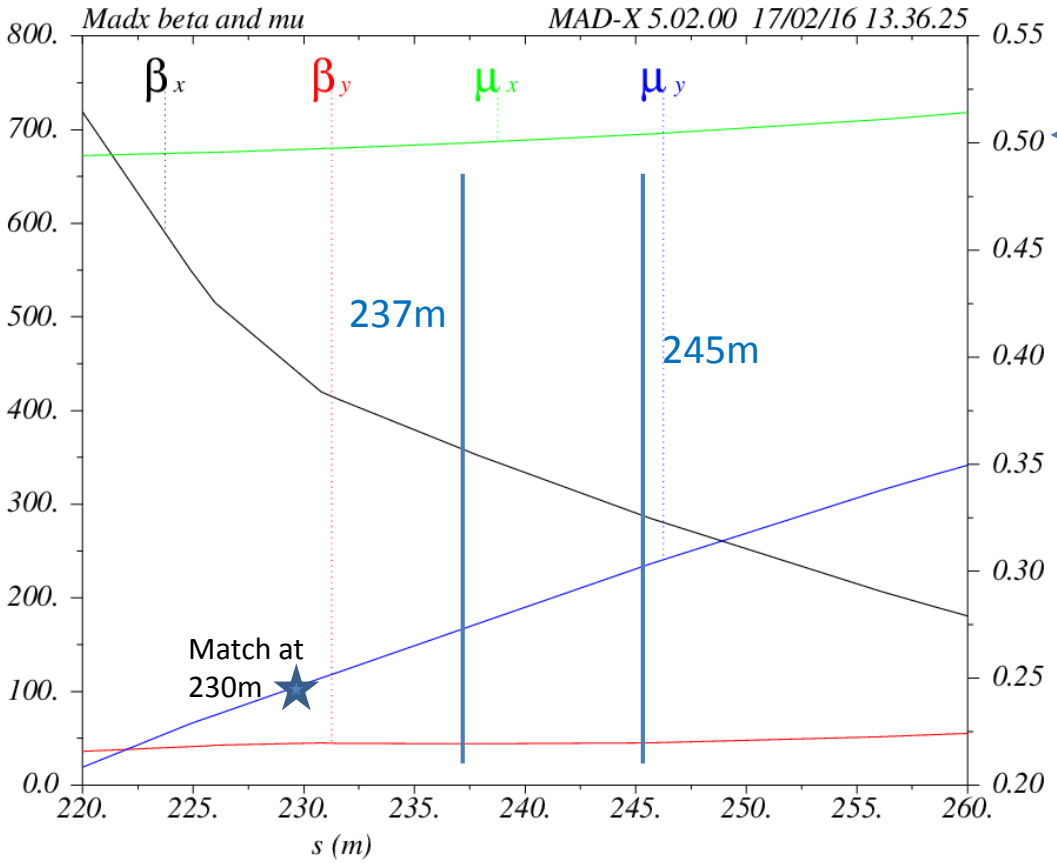
Key parameter: small t_{min} requires small emittance ε_N, close distance N_σ and large β*

$$t_{\min} = m_p \quad p\frac{\varepsilon_N N_\sigma^2}{\beta^*}$$



On the way to highest beta*

H.Burkhardt: first attempt for beta* 2-3 km



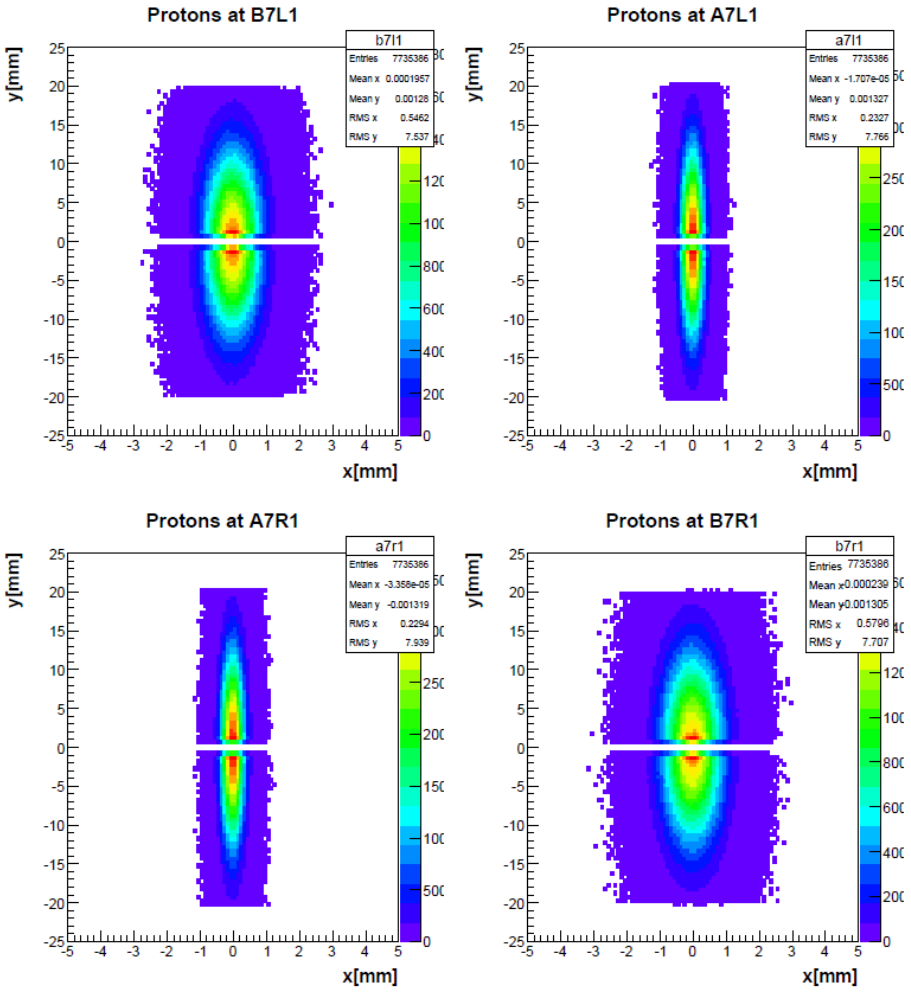
← 180 deg!!

Problematic phase advance in horizontal plane

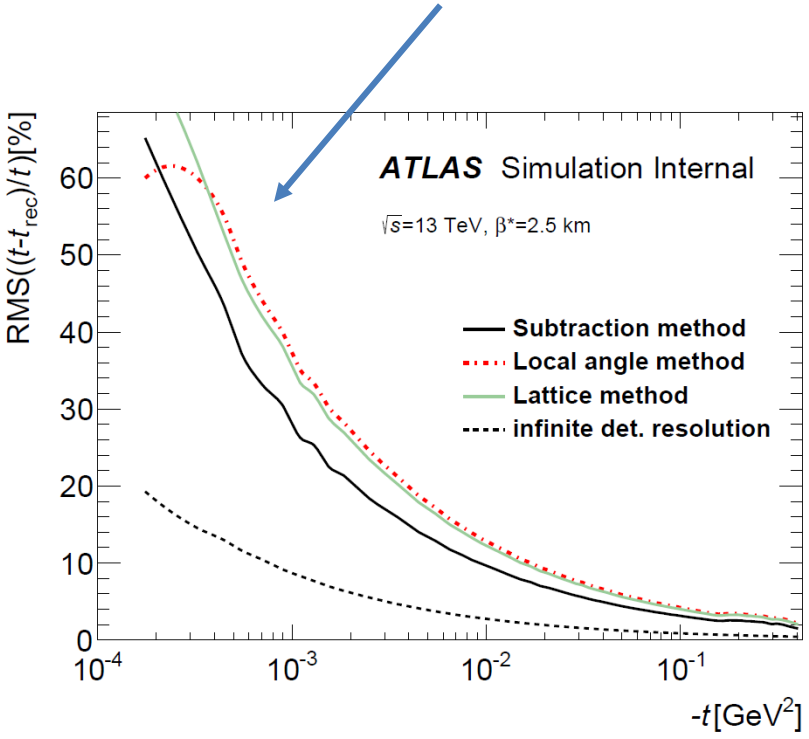
→ M12x ~ sin μ_x ~ 0

B1	βx	φx	M12x	βy	φy	M12y
237m	357m	180.035	-0.58m	43.95m	98.53	328
245m	285m	181.52	-22.4m	45.41	109.2	318

Hit maps & resolution from fast simulation



At small t, t-resolution mainly limited by poor lever arm, in particular in x ($M12_x$)



H.Stenzel

t_min, how much into CNI?

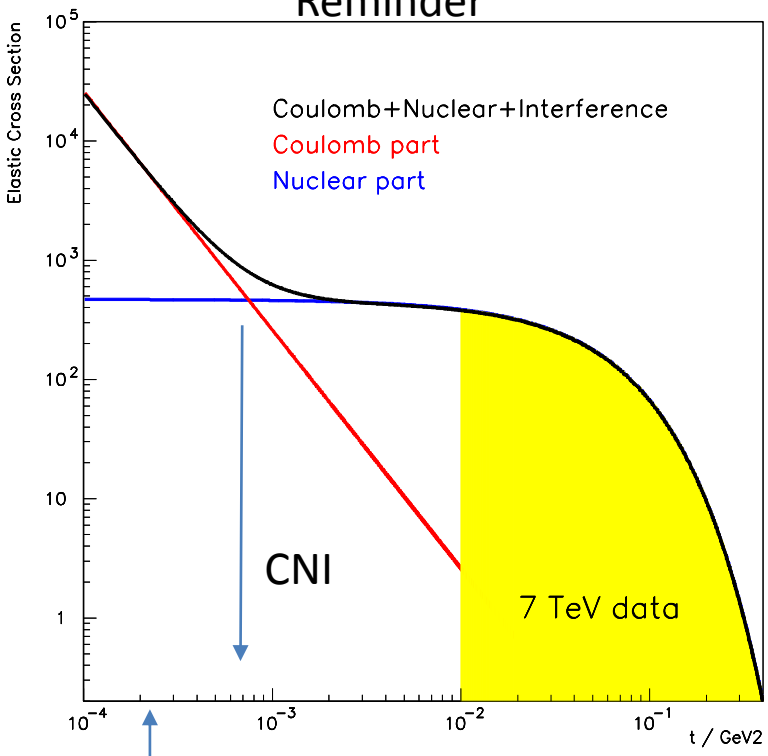
Mechanical limitation to RP positions:
AC switch
Approx. 800-900 μm per gap.

$$t\_min = p^2 * y_d^2 / (\beta_y * \beta^*)$$

y_d=800 μm (half gap + wall + d_{d_w})
β_y(240m) = 45m, β^*=2500m
p=6.5TeV/c

==> t_min = $2.4 * 10^{-4}$ GeV^2

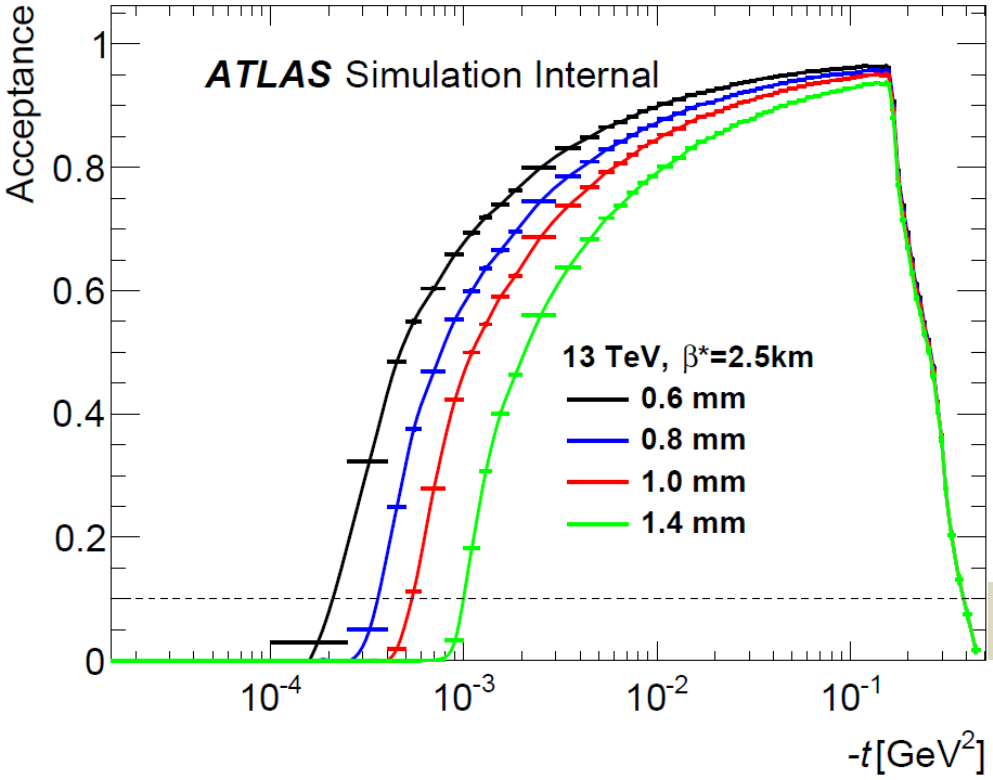
Reminder



"Only" freedom: maximise $\beta_y * \beta^*$!

Acceptance versus detector positions

- For data in CNI region with acceptance > 10% detectors at 1mm to beam
- Taking into account ~ 0.4mm dead space due to window+gap RPs at 0.6mm



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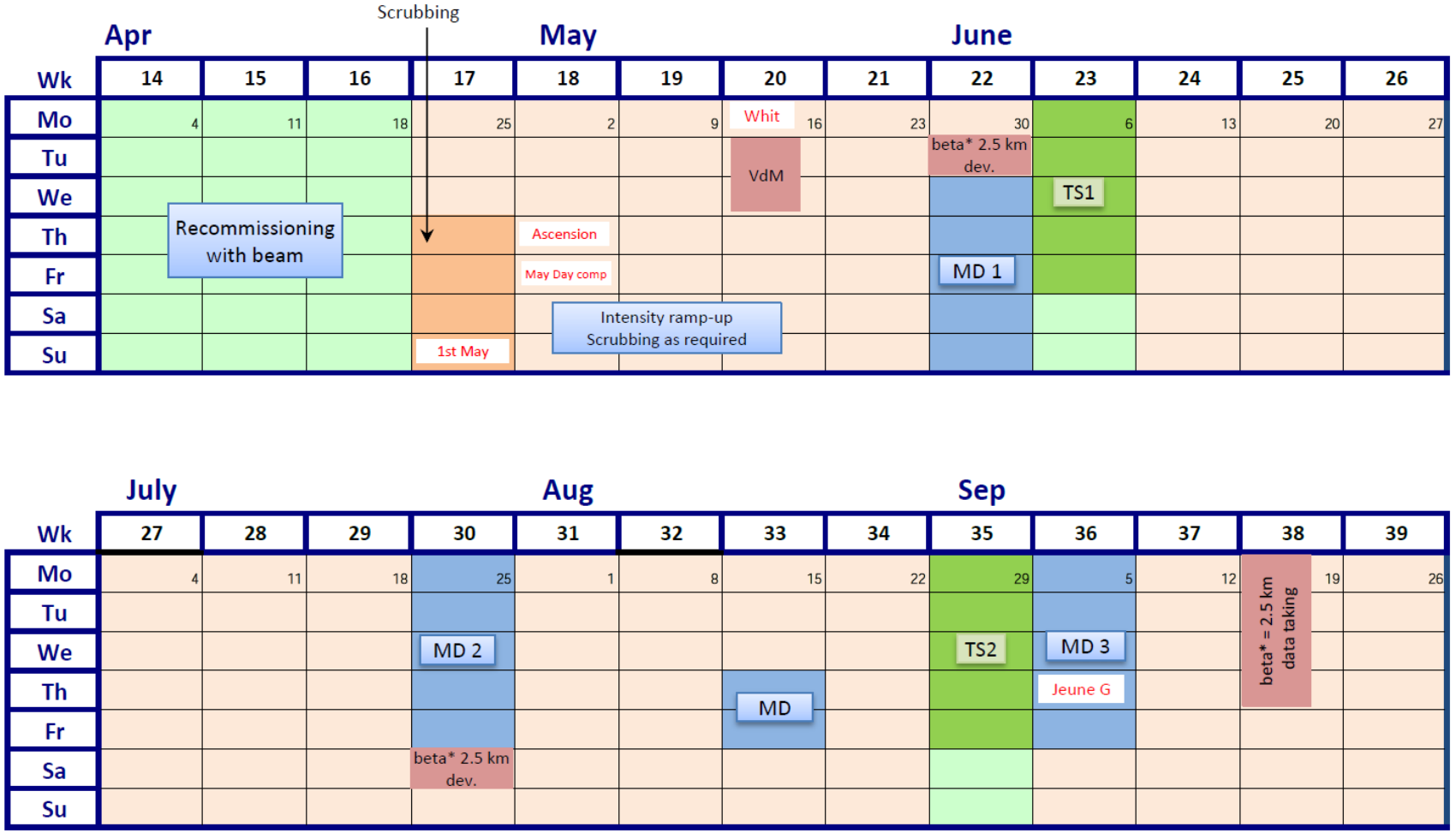
Acceptance (10%) and t-resolution limits range for physics analysis to at best t > 2.10^{-4} GeV^2

Schedule for 2016

- Two slots to implement and measure optics: end of May, July
- A period of 3-4 days for data taking late September , together with TOTEM. Needs final confirmation




Ready for β*=2.5km
Thank you for your attention