

# Overview of Drive Beam Operation

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for the CTF3 operations team



# Programme



- ◆ Beam for experiments
  - Two beam acceleration with Two Beam Module
  - The Dogleg Experiment (BDR in presence of beam)
  - Deceleration in Test Beam Line
  - Phase Feed Forward
  - Pulse shaping
  
- ◆ Drive Beam performance optimization
  - Quest for factor 8 combined beam emittance reduction
  - Minimization of losses
  - Minimization of satellite content
  - Stability & Reproducibility
  - Procedures & Lessons for CLIC



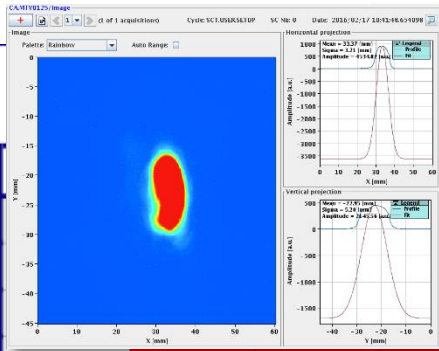
# 3 phases



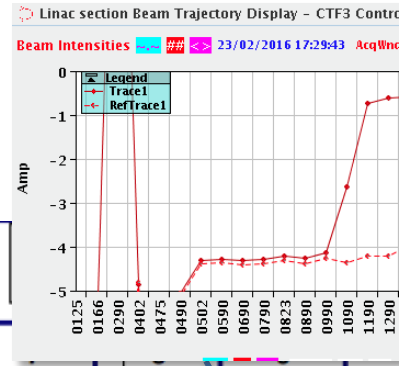
- ◆ Phase 1: Recover last year performance
  - How: start from last archives & references, (hopefully) small adjustments
  - Goal: verify repeatability, hardware checks, "come-back point", document status
  - Duration: 4 weeks -> Mid to late March
  
- ◆ Phase 2: Full optimization
  - How: systematic approach, start-to-end
  - Goal: Improve beam performance, demonstrate emittance/b. length control, prepare ultimate beam(s) for experiments
  - Duration: 8 weeks -> Mid to end May
  
- ◆ From the moment usable beam was achieved interleaving periods of drive beam optimizations with experiments
  
- ◆ Phase 3: Exploitation
  - How: use ultimate beam(s)
  - Goal: Fully exploit beam performance to complete experiments (TBM, TBL, FF, Diags, ...)
  - Duration: until December 2016 (6 months?)
  
- ◆ Dog-Leg runs through some weeks and many weekends

# CTF3 Schedule 2016 & milestones

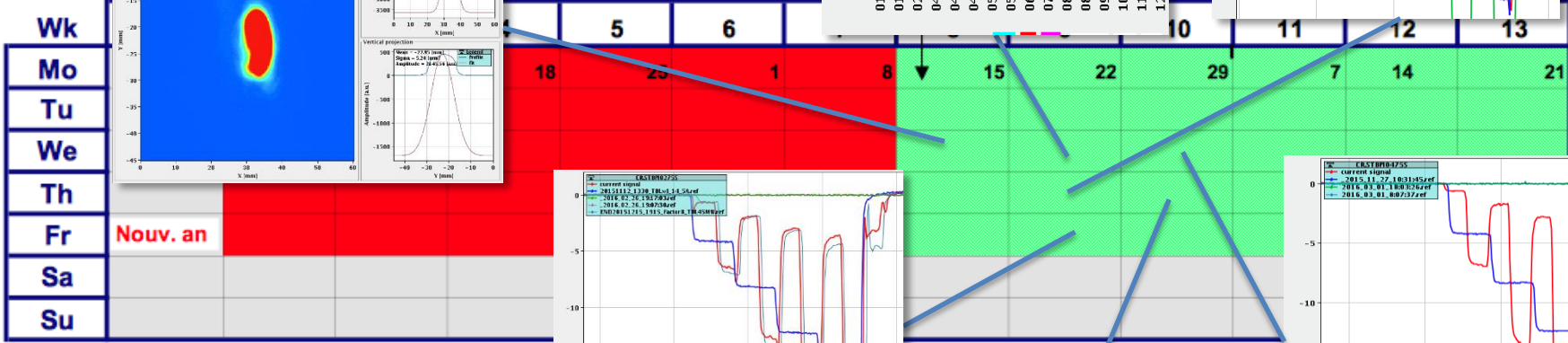
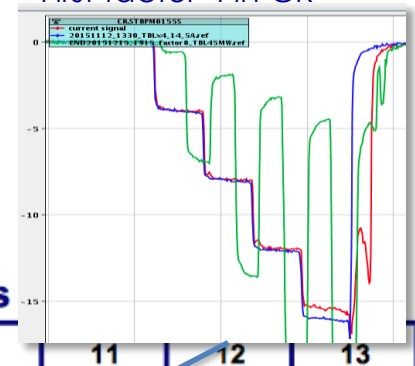
17 Feb  
First CALIFES Beam



24 Feb  
DB in linac  
(girders 10)



25 Feb  
First factor 4 in CR

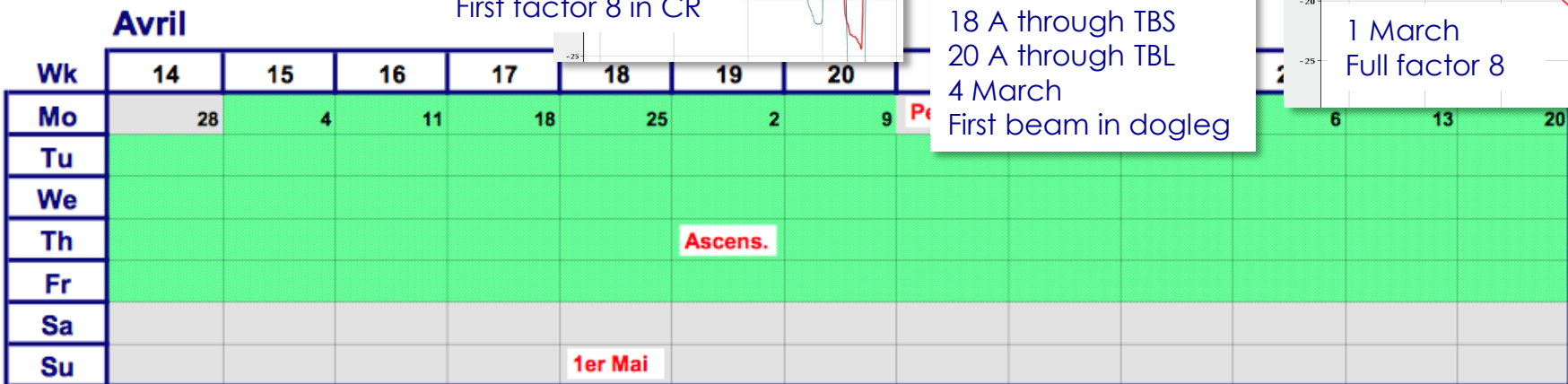
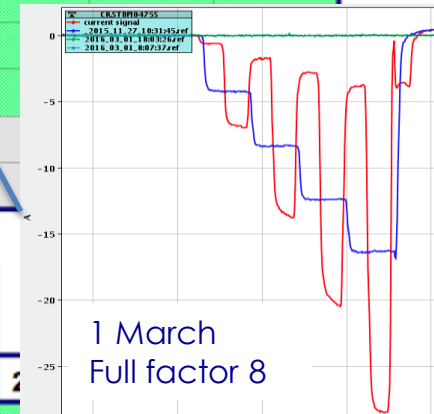


26 Feb  
First factor 8 in CR



3 March  
18 A through TBS  
20 A through TBL  
4 March  
First beam in dogleg

1 March  
Full factor 8





# The main technical problems



- ◆ RF window in klystron MKS12 broken twice
  - Repair and conditioning took 1 month
  - With no RF present the beam was decelerated in 2 ACSs
  - Lowered the beam current to achieve the same final beam energy
  
- ◆ TWT issue disabled 1.5GHz beam for 3 months (July-Sept)
  
- ◆ Unstable septa power supplies
  - Noise from the grid transferred to the magnet
    - ◆ 30 years old 1kA supplies
  - In CR the effect was acceptable thanks to favorable optics
    - ◆ The resulting orbit jitter within the beam pipe aperture limits
  - In DL was much more pronounced spoiling the beam stability



# Performance Targets



- ◆ Factor 4 combined beam
  - Already in past years achieved target performances
    - ◆ Lossless recombination in the Ring, below 5% loss in transport to CLEX
    - ◆ Emittance below 150 mm·mrad
    - ◆  $5 \cdot 10^{-3}$  current stability
  
- ◆ Factor 8 combined beam
  - Previous years achieved
    - ◆ 28 A in the Ring, 24 A in CLEX
    - ◆ 350 mm·mrad horizontal emittance, routinely rather closer to 600
    - ◆ 170 mm·mrad vertical emittance
    - ◆  $5 \cdot 10^{-3}$  stability, routinely couple of %
  - More difficult because
    - ◆ Needs 3 additional bunching cavities to produce 1.5 GHz bunch spacing
    - ◆ Phase switches
    - ◆ The two above give higher energy spread, which leads to emittance growth
    - ◆ Uses delay loop, which turned out to be very tricky to setup
  - Much less experience due to repeating issues with 1.5 GHz sources during all the past runs
  
- ◆ The 2016 target was to maximize performance of factor 8 beam



# Delay Loop



## Why it was problematic

- ◆ Delay Loop has only 40m
  - Very short spacing between bends
- ◆ At the same time needs to be Isochronous and Achromatic
  - Strong optics → sensitive to imperfections
    - ◆ NB: No flexibility in optics choice
  - Reduced energy acceptance → off momentum particles make the transverse emittance growth
- ◆ All magnets reused from past projects
  - Magnetic field quality, let's say, not the best one
  - Septa with 2cm vertical aperture
- ◆ Powering in series
- ◆ Limited number of orbit correctors and of BPMs
- ◆ Position dependent droop in BPMs
  
- ◆ In CLIC
  - Omega shape with no space constraints
  - Dedicated large momentum acceptance Chassman-Green cell