

Beam Loading Dog-leg experiment status

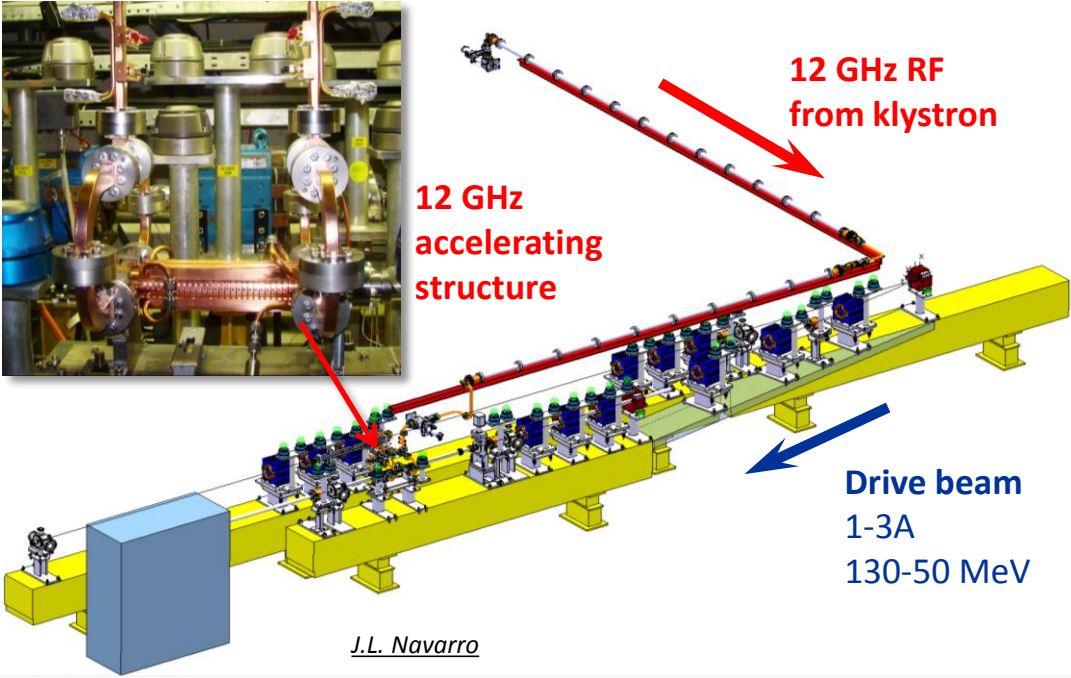
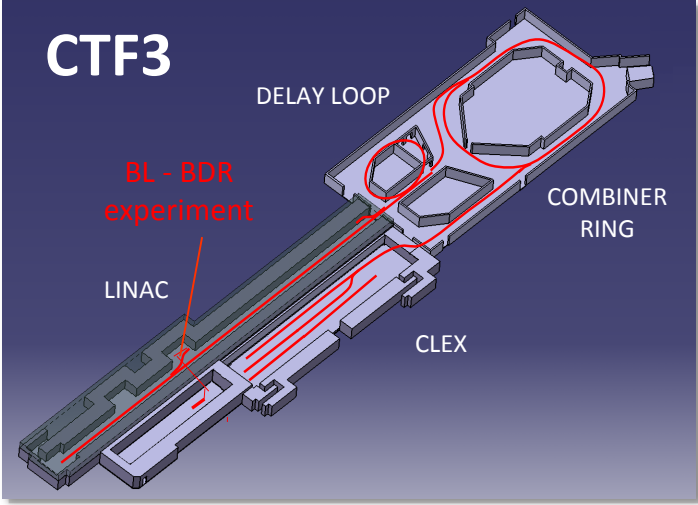
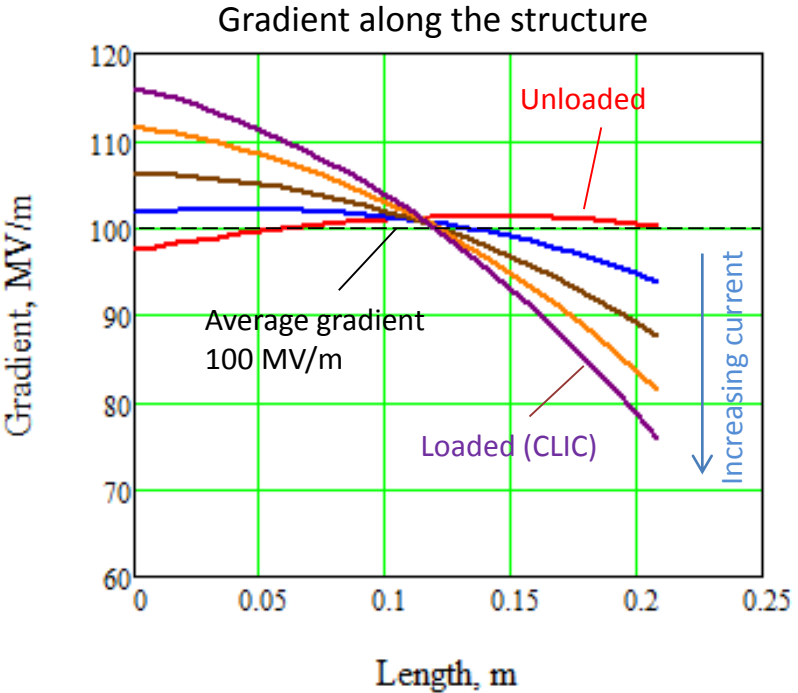
Frank Tecker (BE-OP)
on behalf of the dogleg team

- Introduction
- 2014 Data Analysis
- 2015 Spring Run
- 2015 Autumn Run
- Conclusion

Beam loading changes the field distribution for the same average gradient
 ⇒ how is the break-down rate affected?



- Reactivated an old beam line (**dogleg**)
- ~1.2 A DB current (like CLIC Main Beam)
- Measure BDR with/without beam for a direct comparison



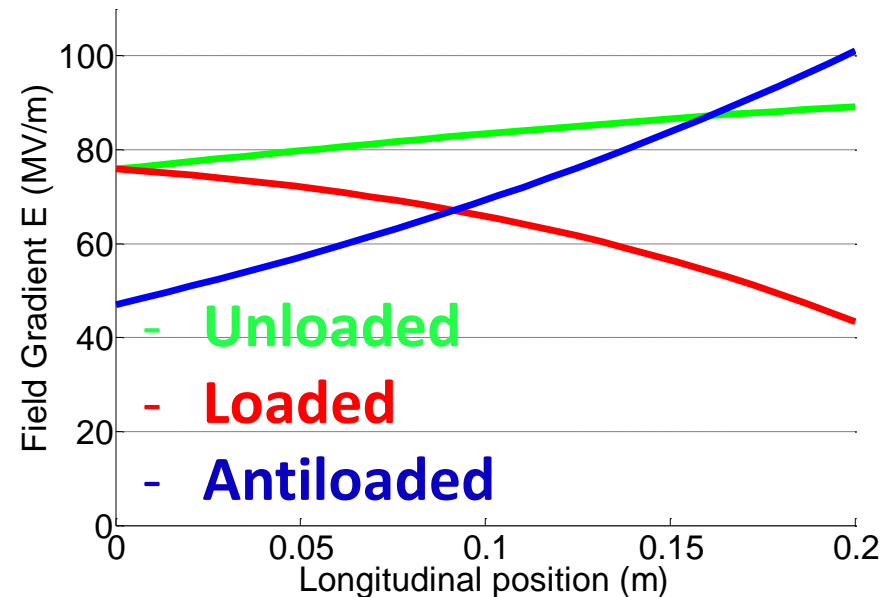
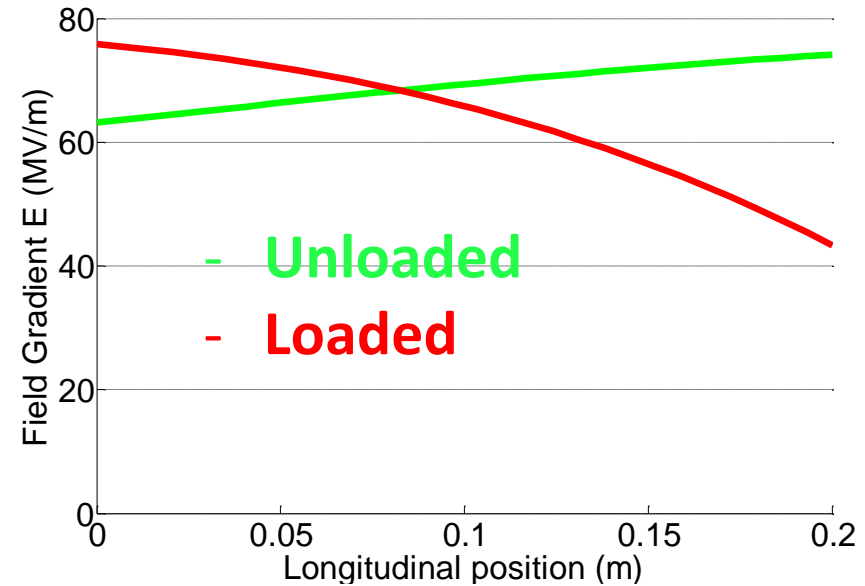
- Final goal:
measure BDR

- loaded
- unloaded

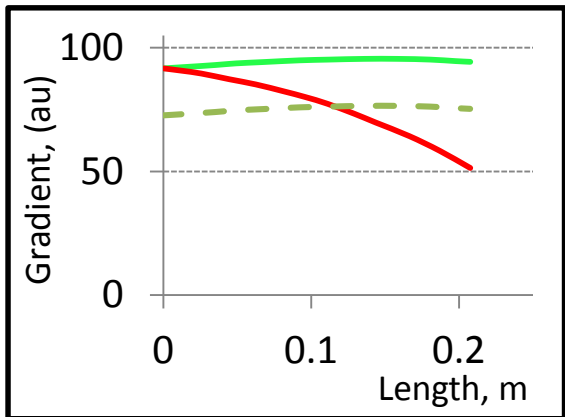
for the **same average gradient**

- Alternative: measure BDR for constant input power (when power limited)
=> BDR decreases?

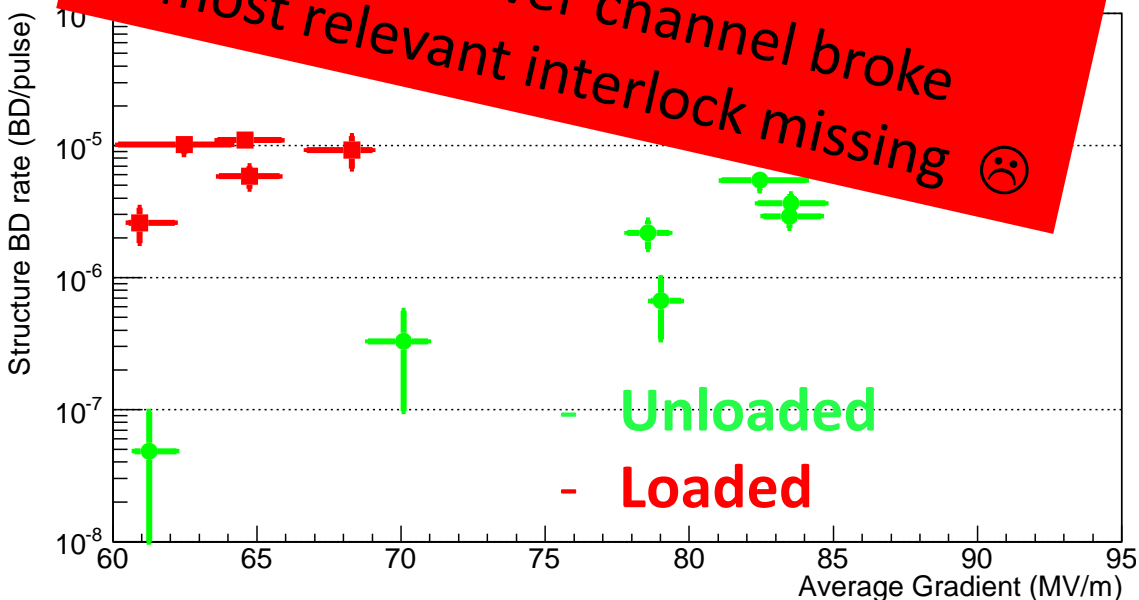
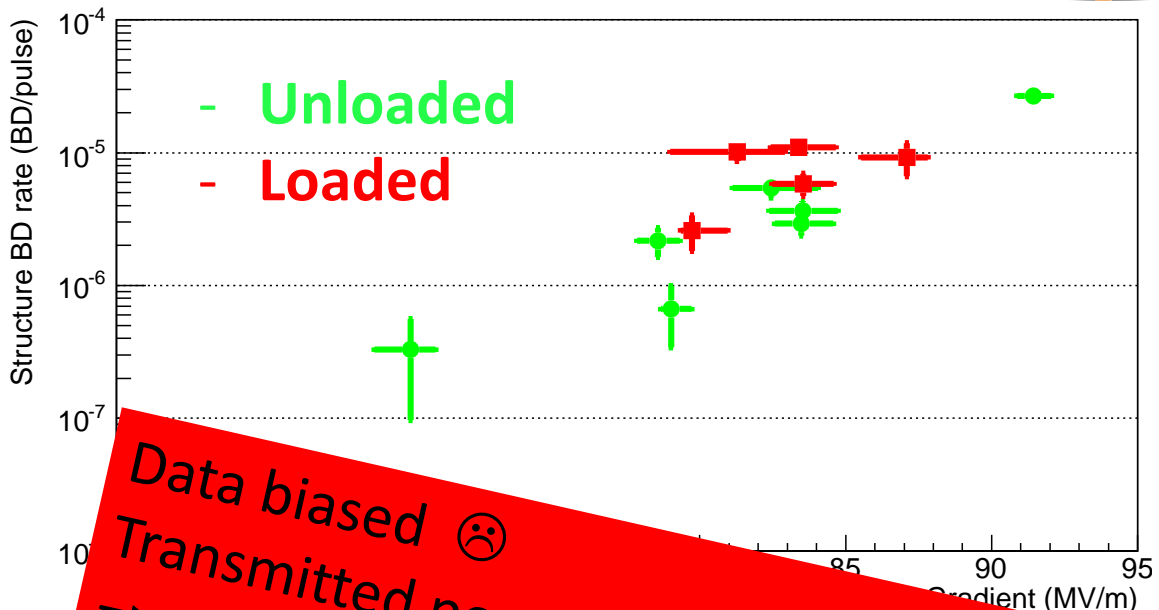
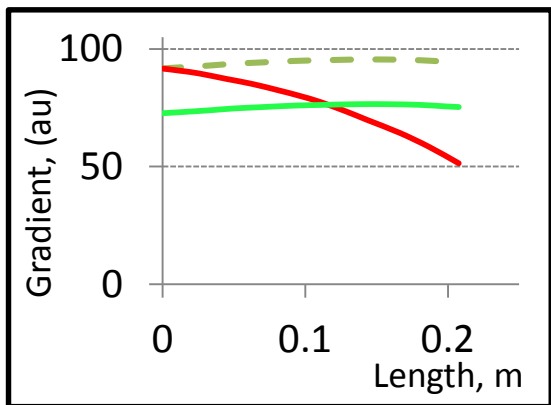
- even decelerate the beam
=> antiloading



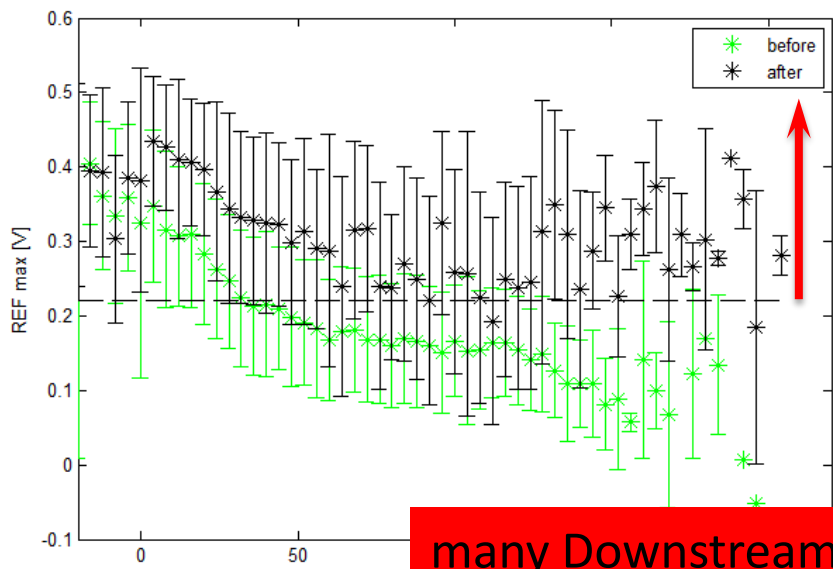
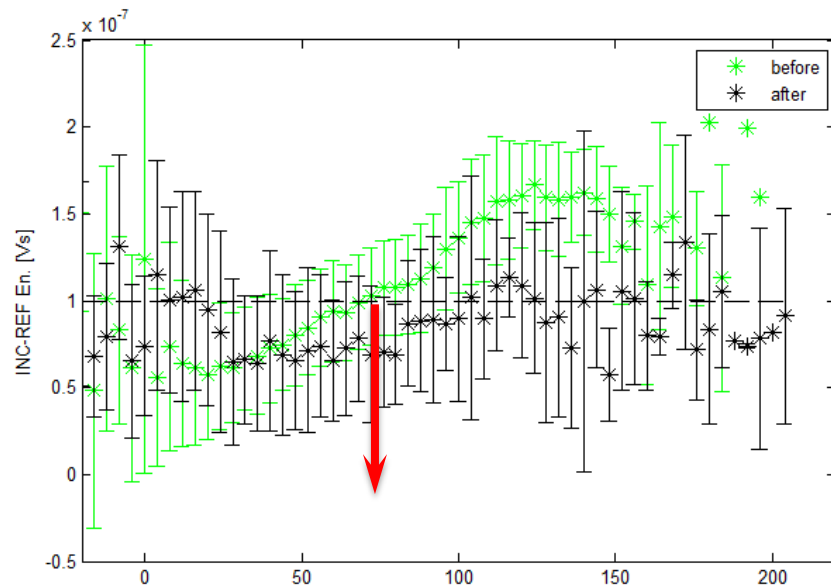
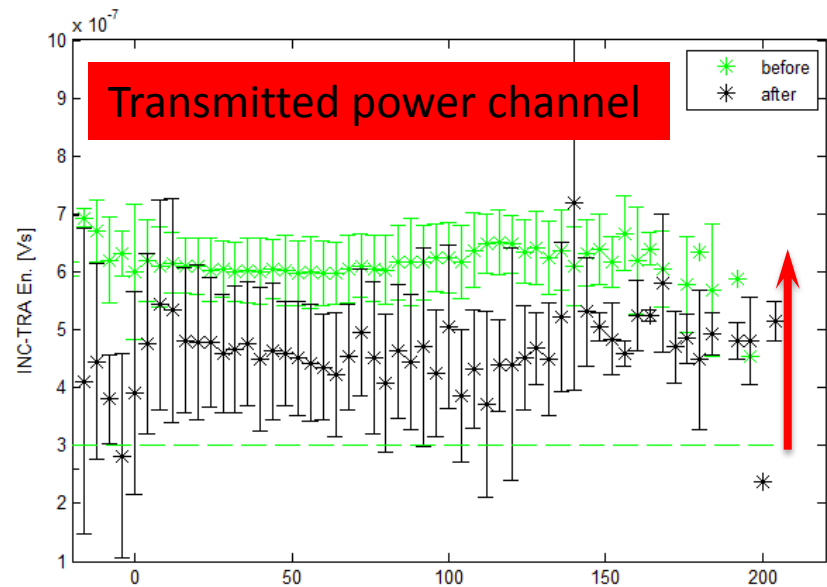
Constant input power



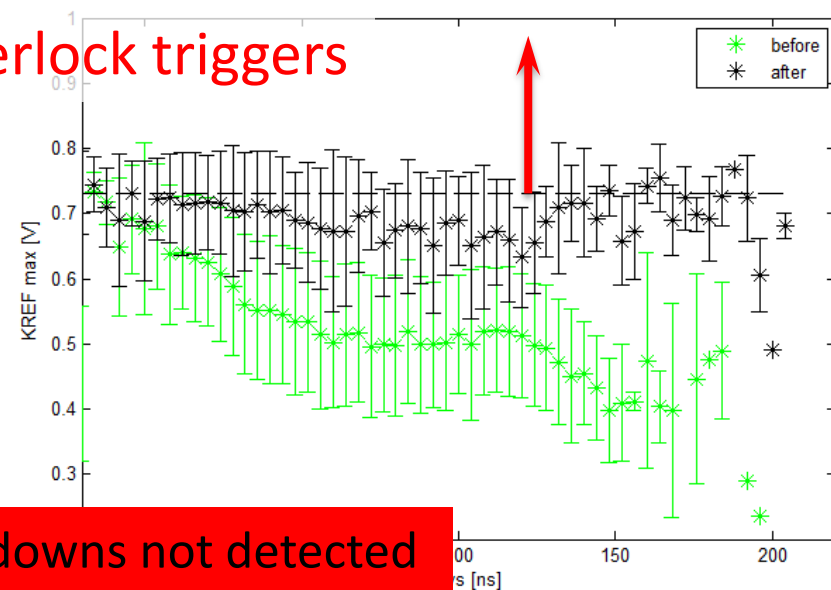
Constant average gradient



Before: From (YMD) 2014 7 15 to (YMD) 2014 8 30; N. events= 6253
After: From (YMD) 2014 9 18 to (YMD) 2014 12 15; N. events= 2282

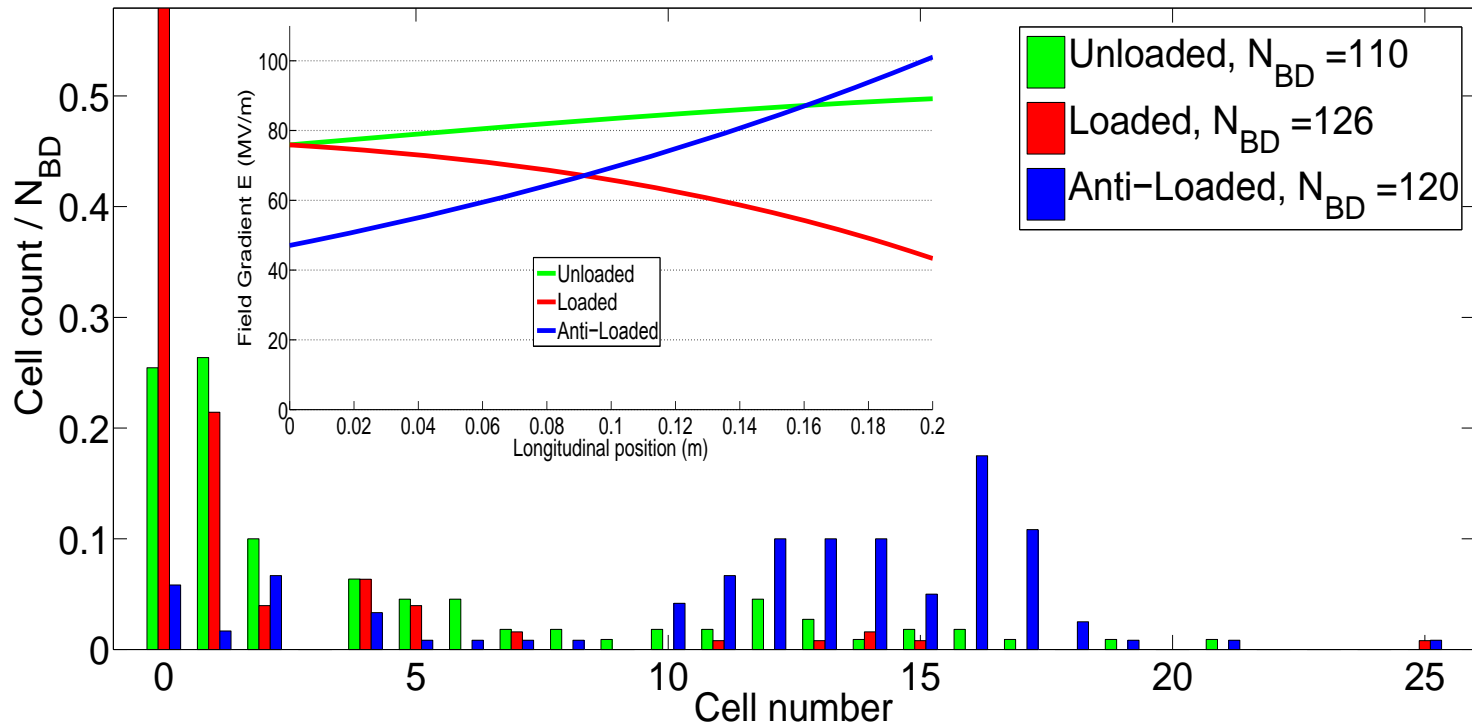
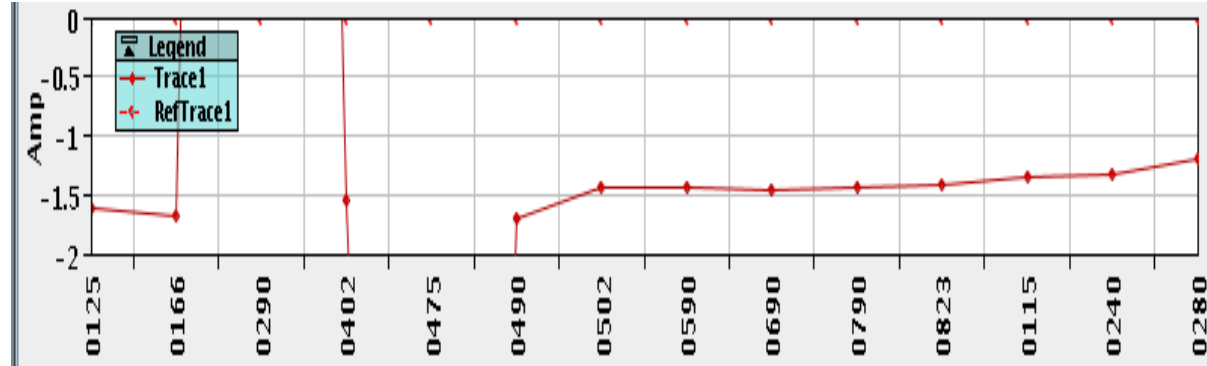


Interlock triggers

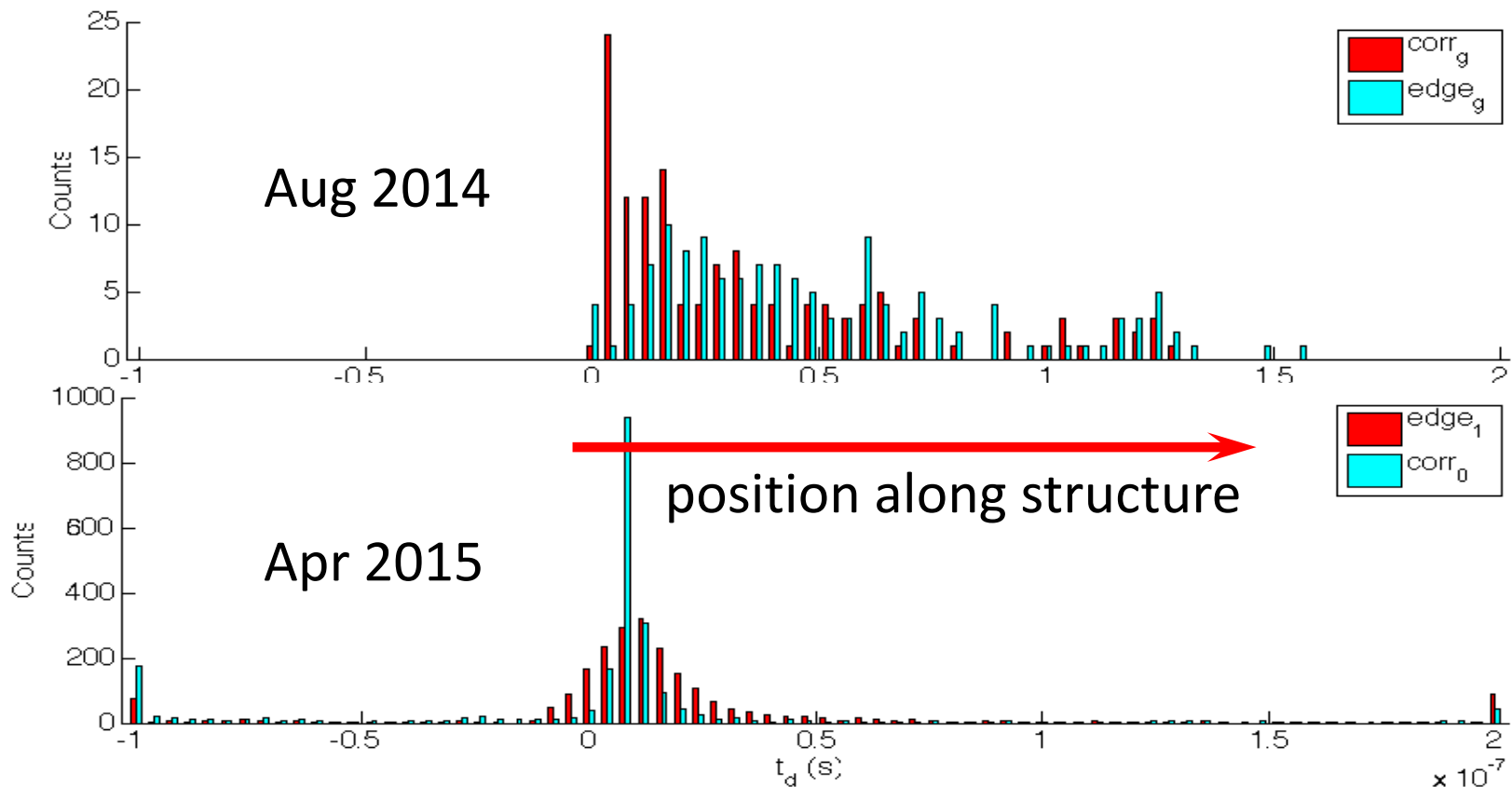


many Downstream Breakdowns not detected

- Xbox RF acquisition fixed (broken transmitted channel)
- Beam quickly set up
- BDR measurements
 - unloaded (26 MW)
 - loaded (26 MW)
 - anti-loaded (10 MW)

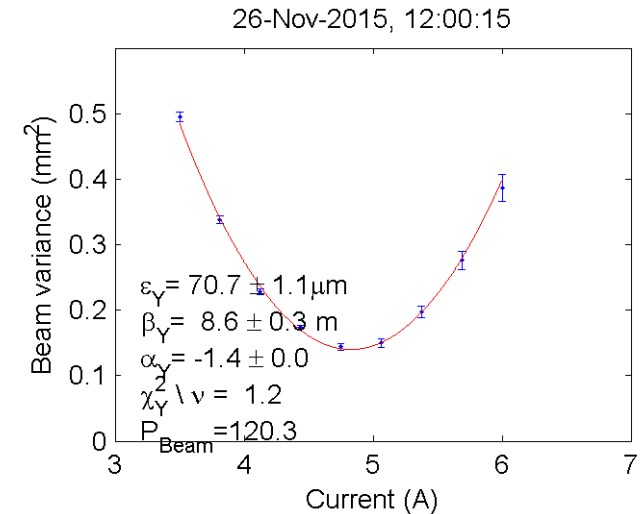
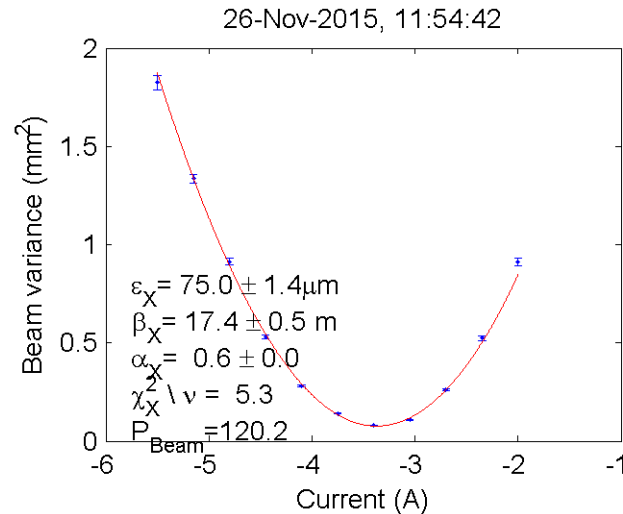
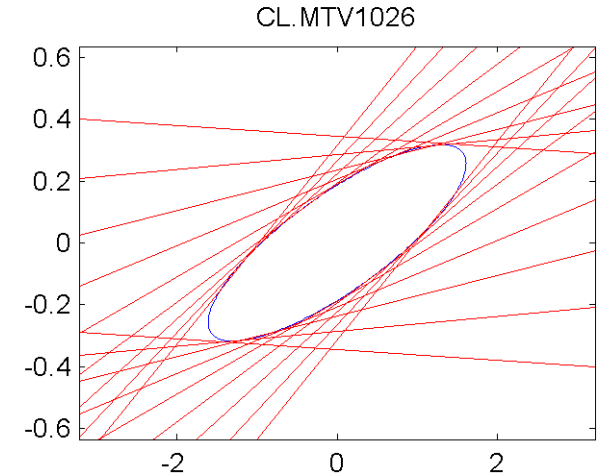
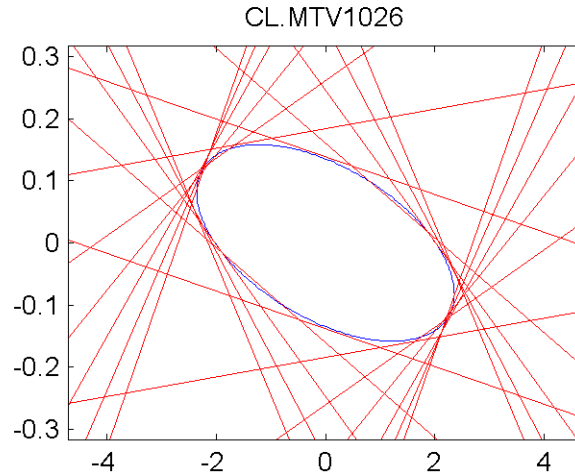


- Initially: breakdown distribution inside structure as expected 😊
- Later: breakdowns mostly detected at beginning of structure 😞
- => **hot spot** for breakdowns had developed there
- **structure unusable** for beam-loading experiment => changed

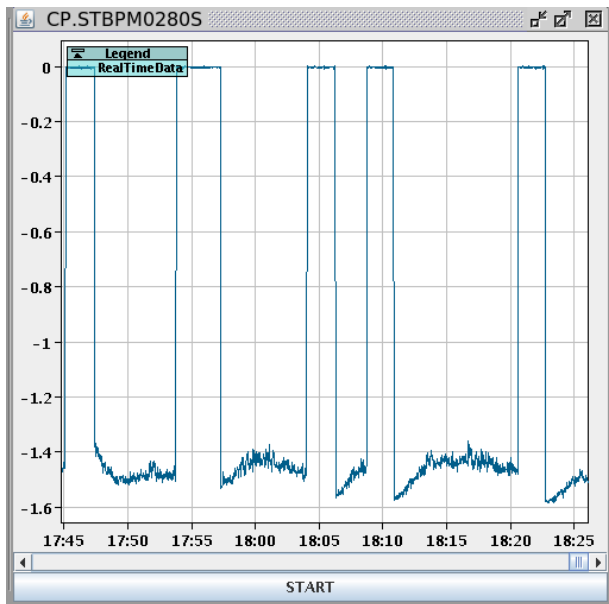


- T24 structure was changed in shadow of the access system change in May against a TD26CC that had been previously in CTF2
- pulse compressor breaking down, backlash => taken out => limited in RF power
- June: **Realignment** of the 8mm-diameter **collimator** (2mm off)
- several unavailability periods with
 - Xbox klystron solenoid power supplies
 - drive beam gun
 - pulse compressor installation (6-12 August)
 - drive beam priorities for other users
- restarted drive beam RF for dogleg on 14 Oct., RF setup completed but no beam due to dogleg line magnet problem
- finally restarted on 25/26 Nov

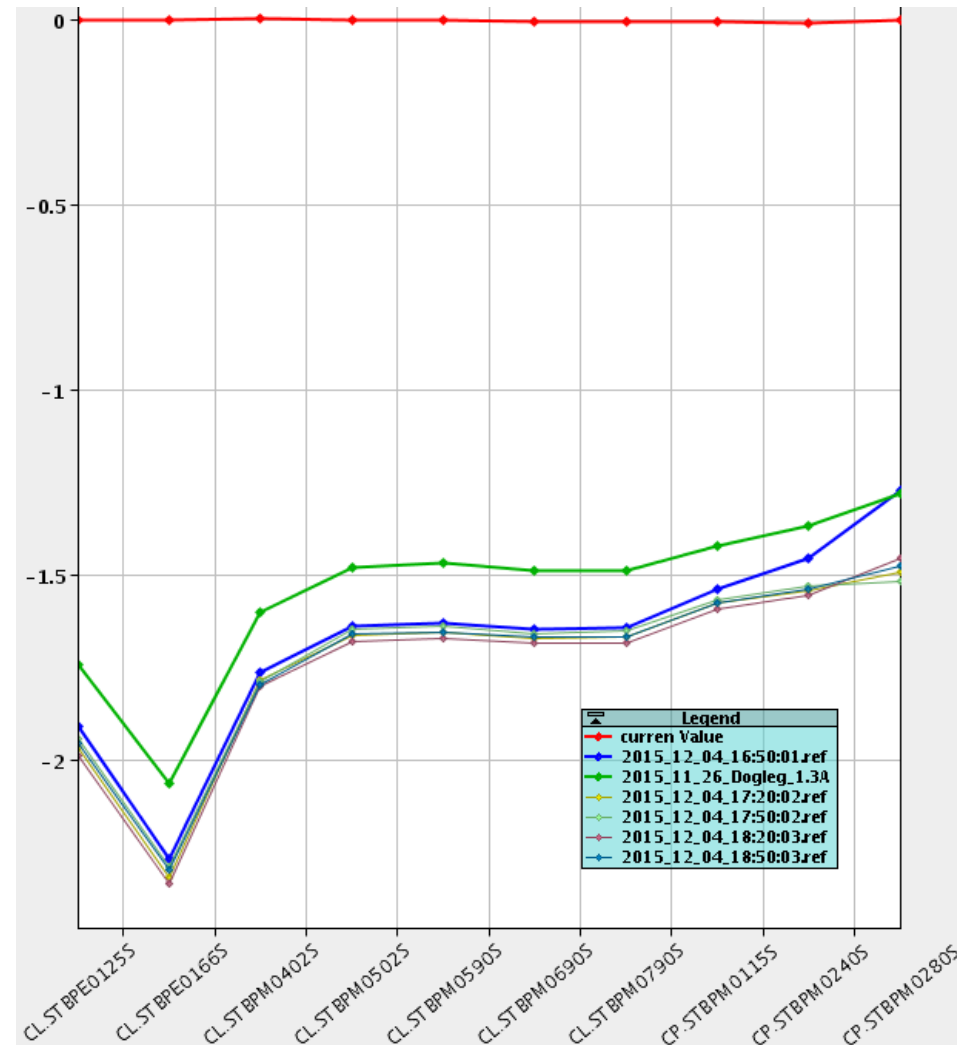
- Dogleg optics initially rematched based on quad scans in girder 10
- followed by empirical optimisation



- Gradually improving transmission
- no big corrector kicks any more
- still small losses through the accelerating structure
- intensity varying over time
- => need to improve still

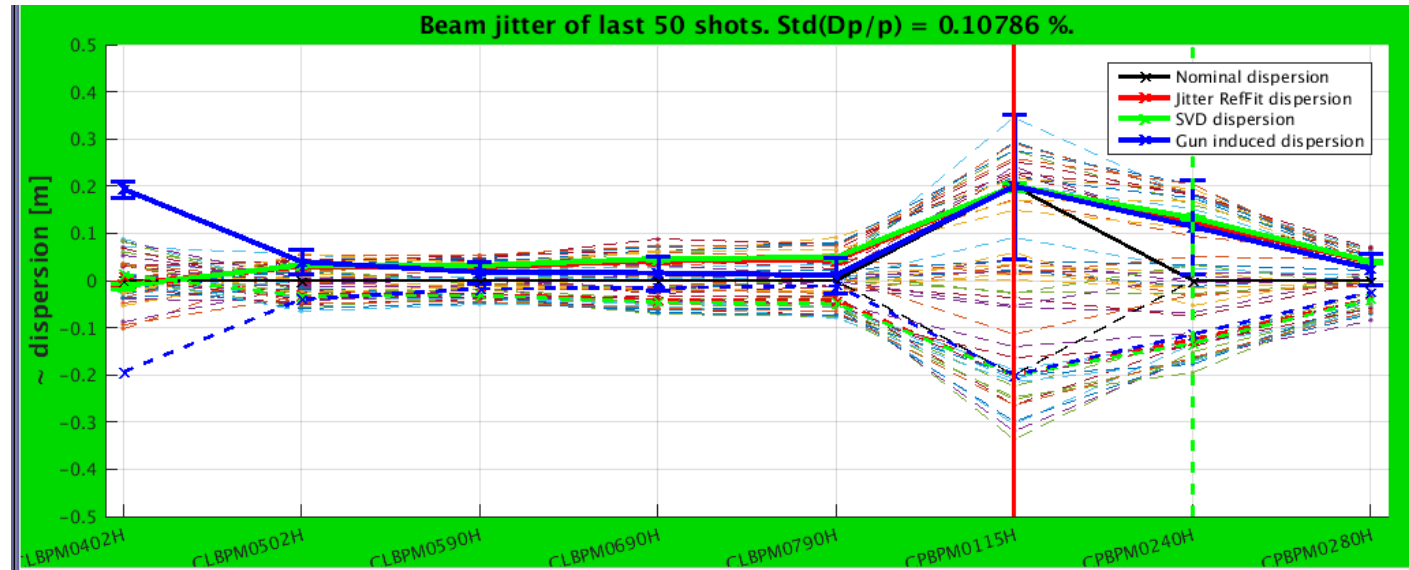


Frank Tecker

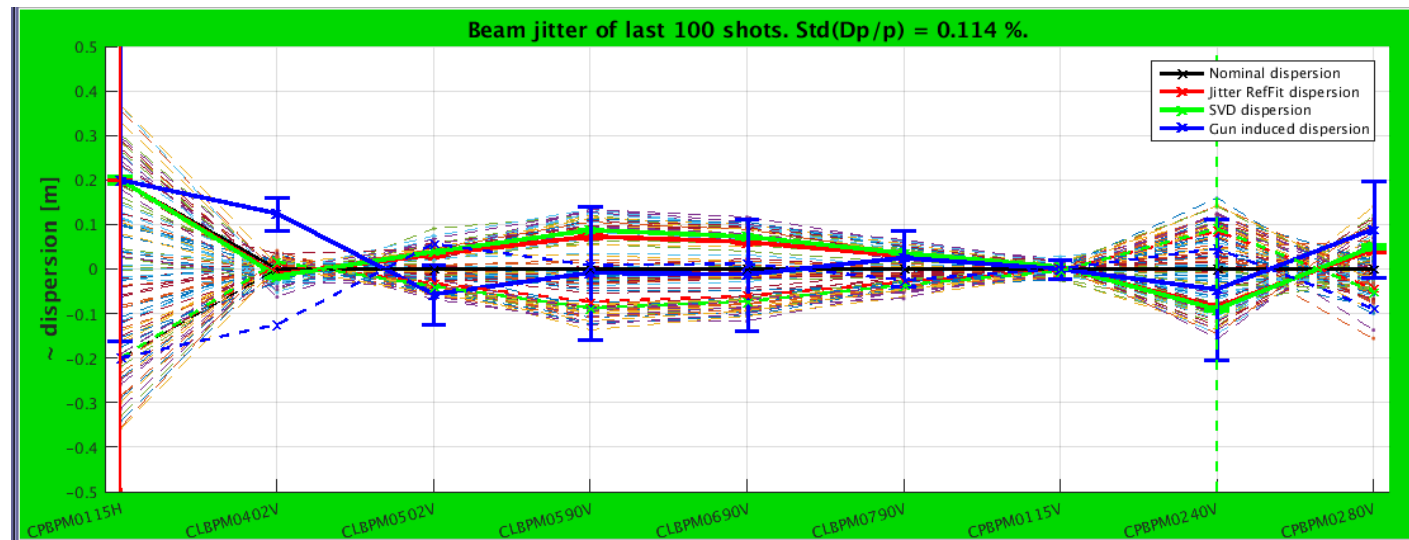


Beam Loading Dog-leg experiment status

horizontal dispersion not fully closed

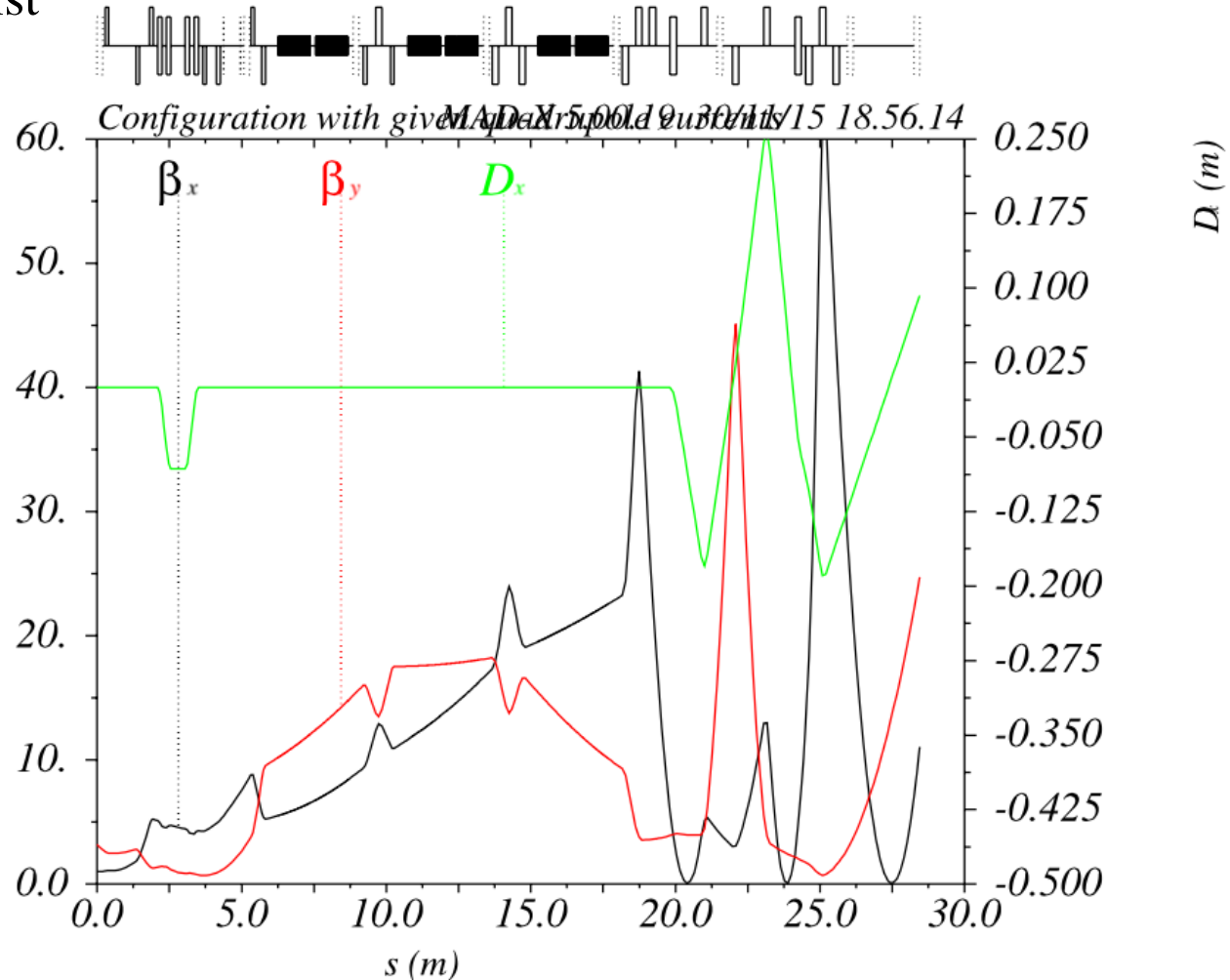


vertical dispersion can still be improved

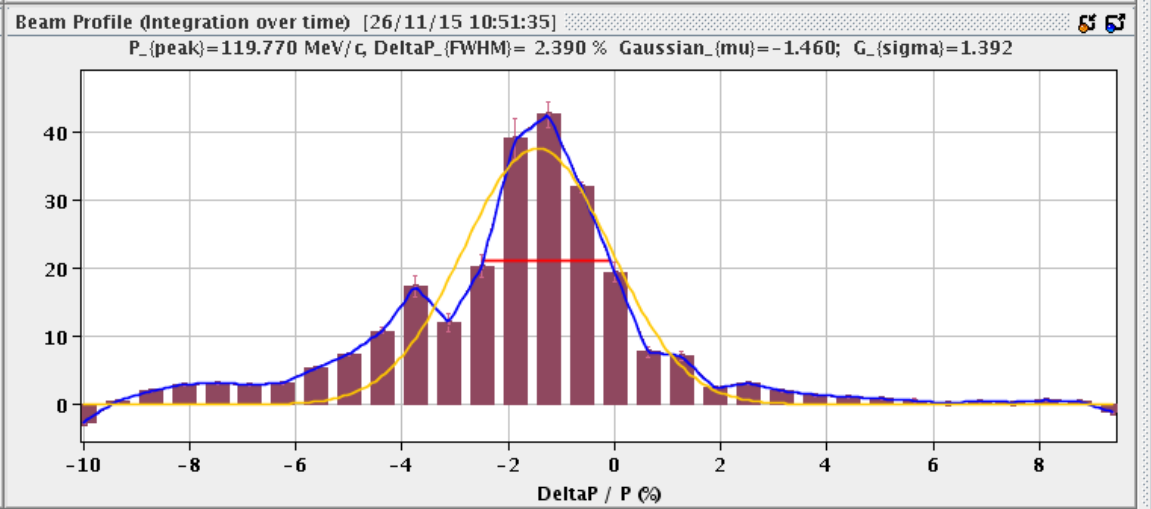
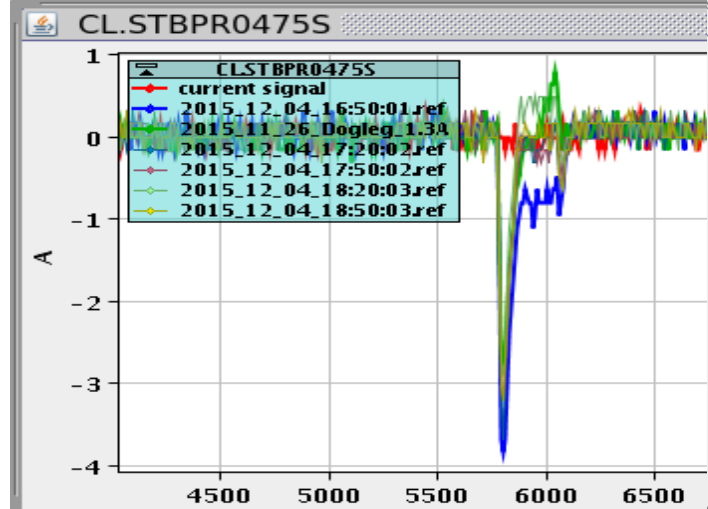
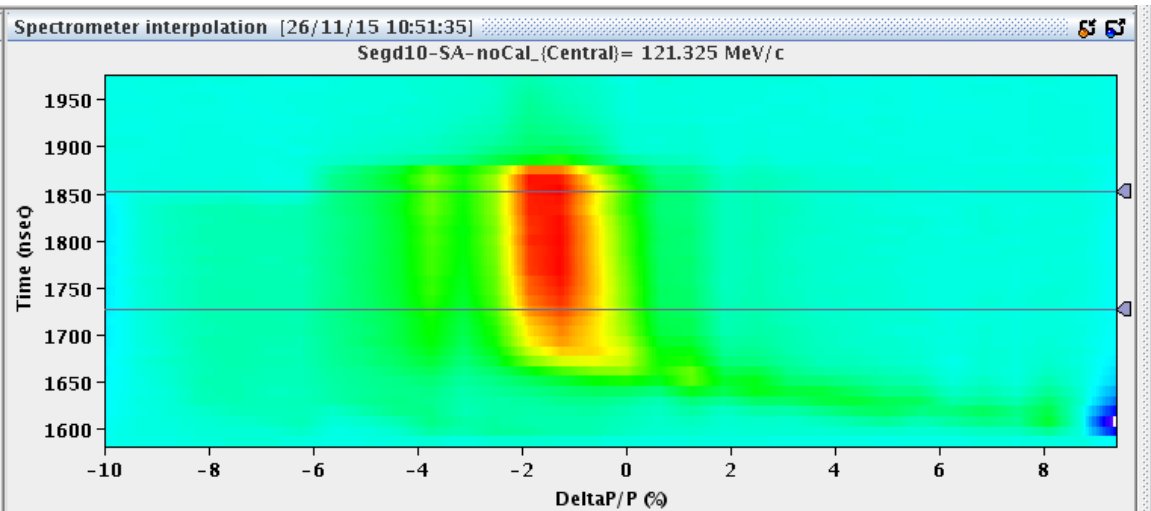
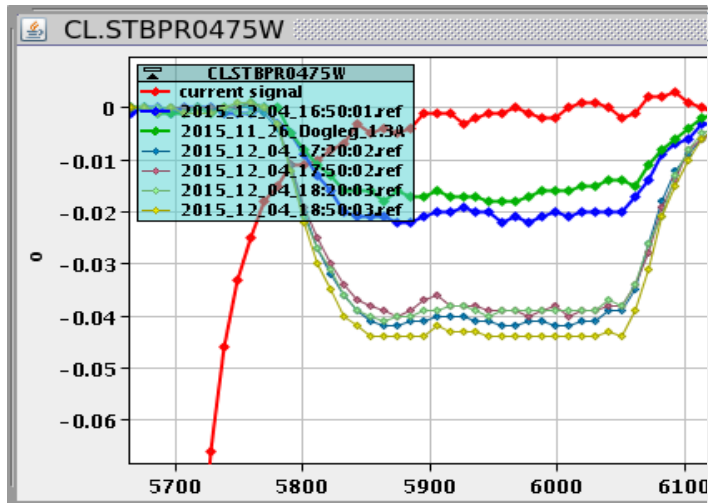


- Empirical optics found for best transmission has
 - non-closed dispersion
 - small horizontal waist

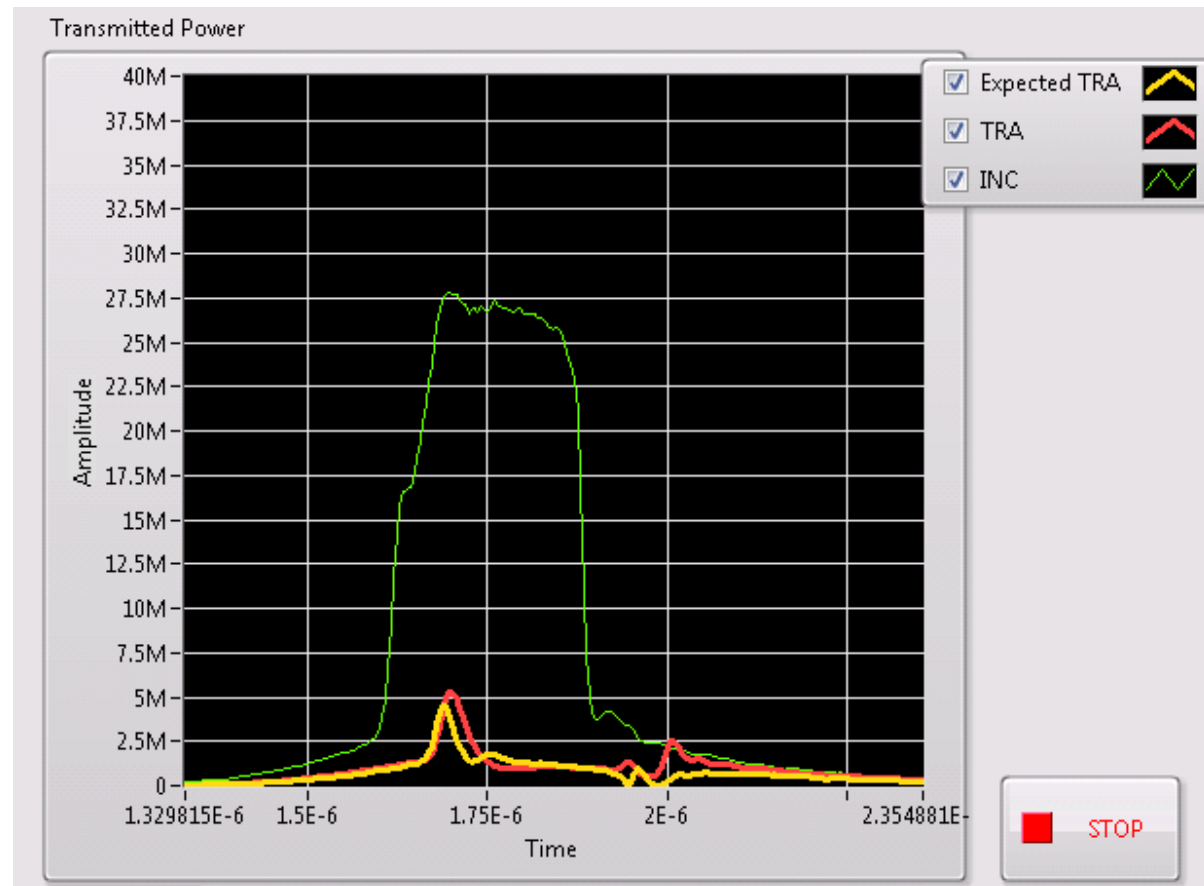
=> need to improve dispersion correction



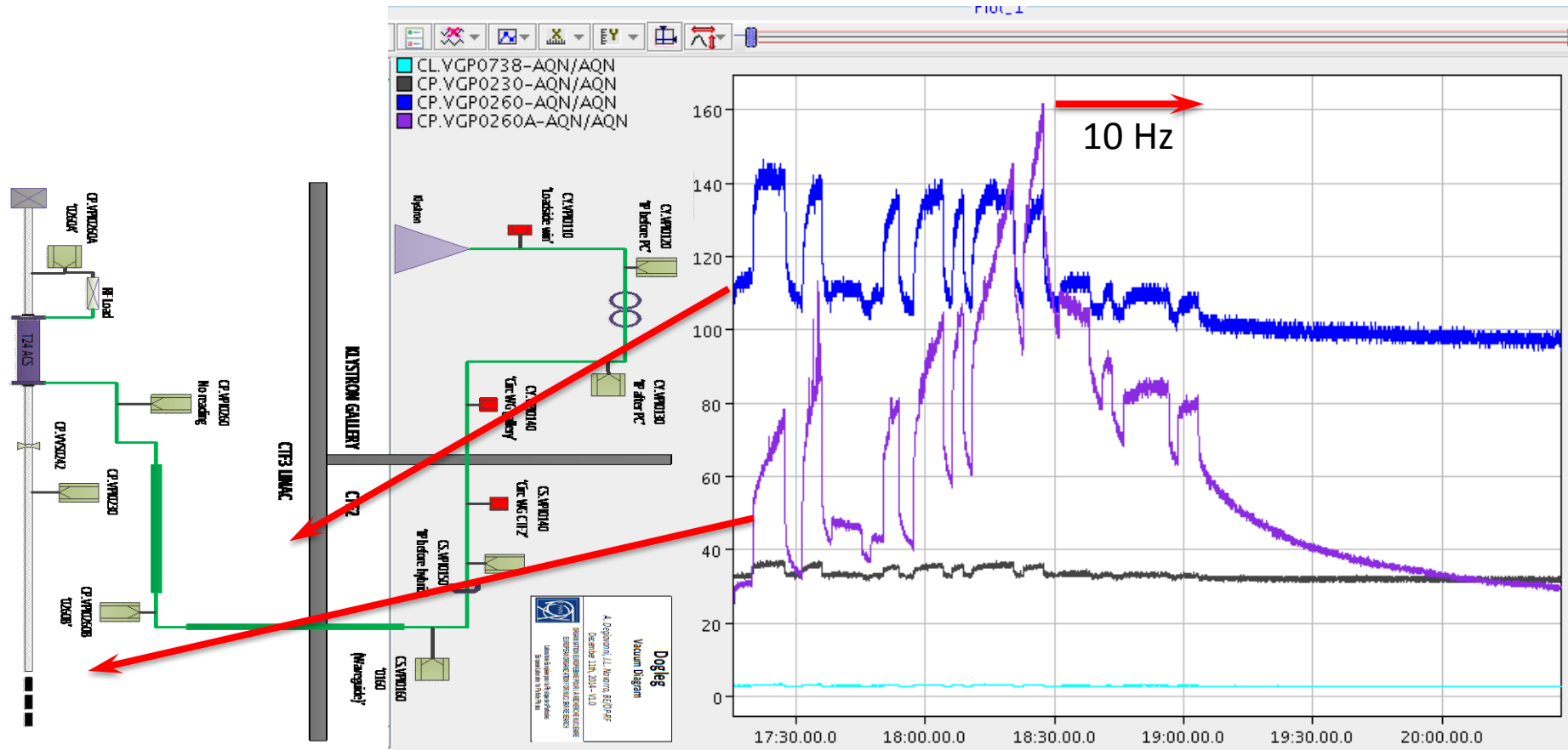
- BPR0475W (bunch length) + energy nicely flat along the pulse
- beam phase constant after transient



- Beam phase and RF phase have to match to assure constant loading along the pulse
- Beam and RF setup OK and output power matches expectations

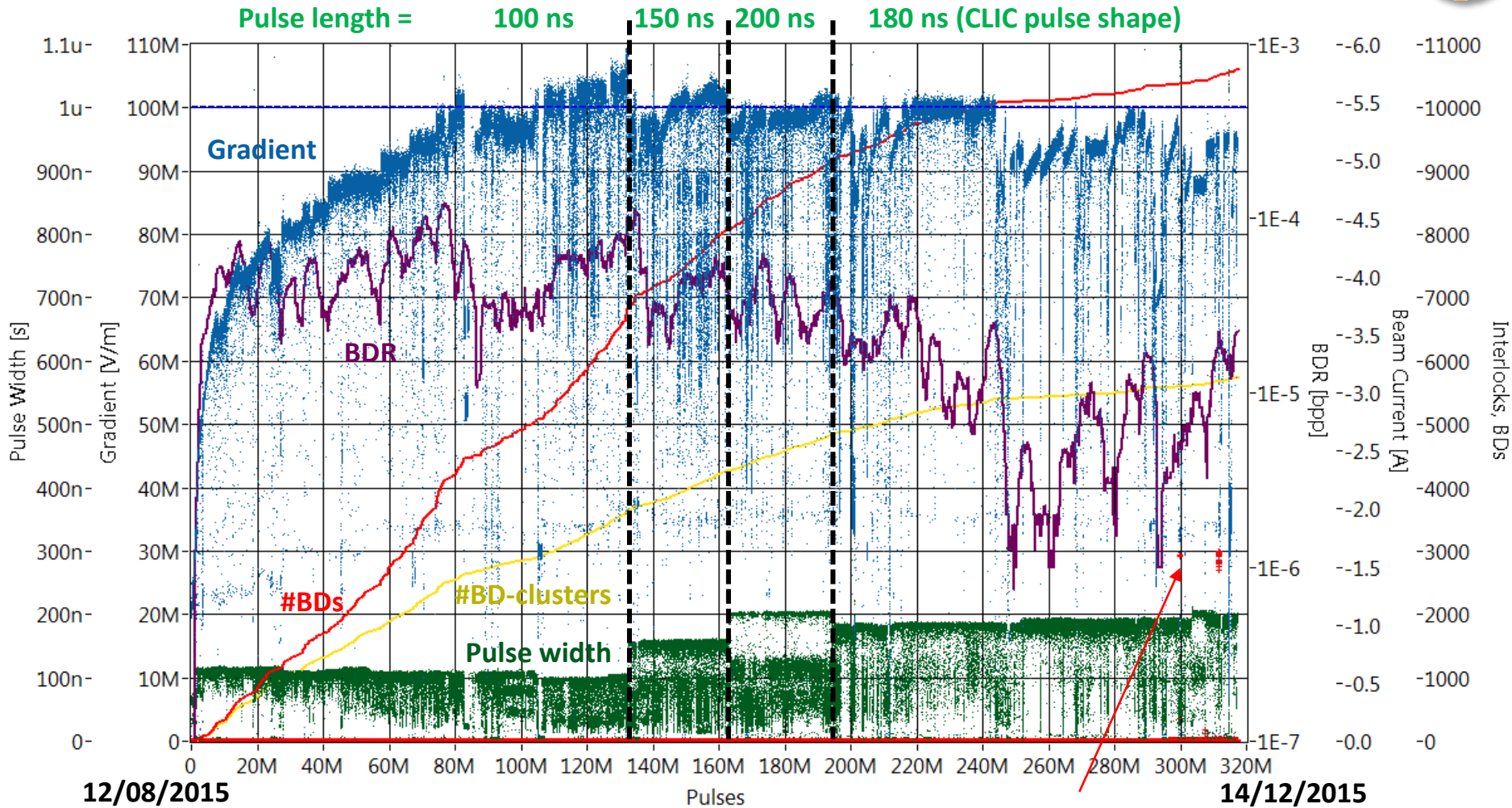


- Vacuum on dump side increased when going to 25 Hz beam frequency
- Stabilized at 10 Hz
- Losses limiting operation?





Full history of the TD26CC-N1 structure



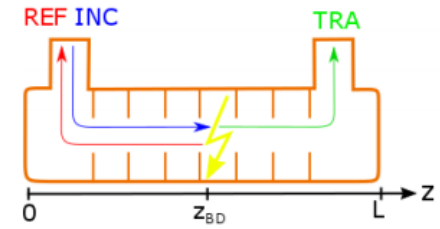
First measurements with beam ~1.5 A

Jorge Giner Navarro

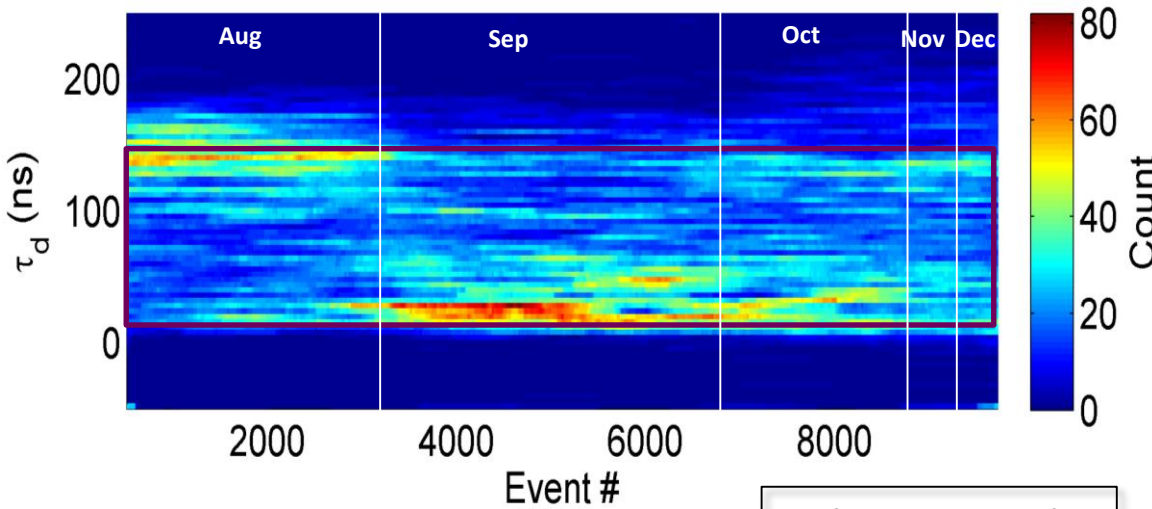
# Pulses	317.2M	Equip hours	1762	Up-time	59.4 %
# BDs	10610	Cluster BDs	5743	Mean BDR	3.35E-5

See Jorge Giner Navarro's talk: "High-gradient structure performances" on Monday afternoon

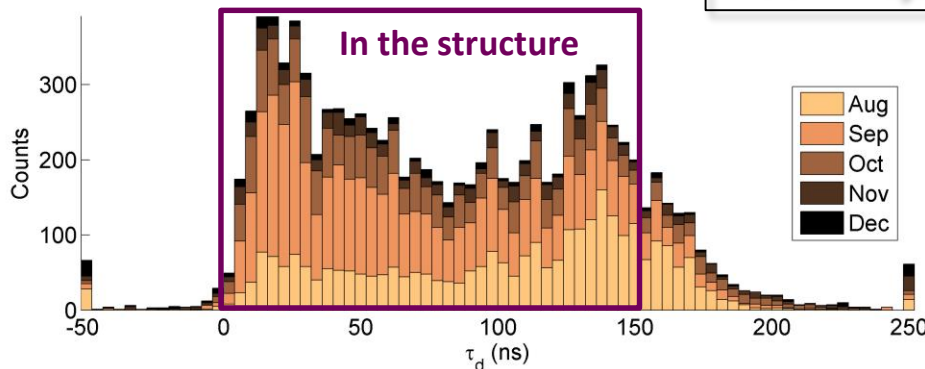
- Initially BD more at downstream end
- Later at the beginning
- Now uniformly distributed



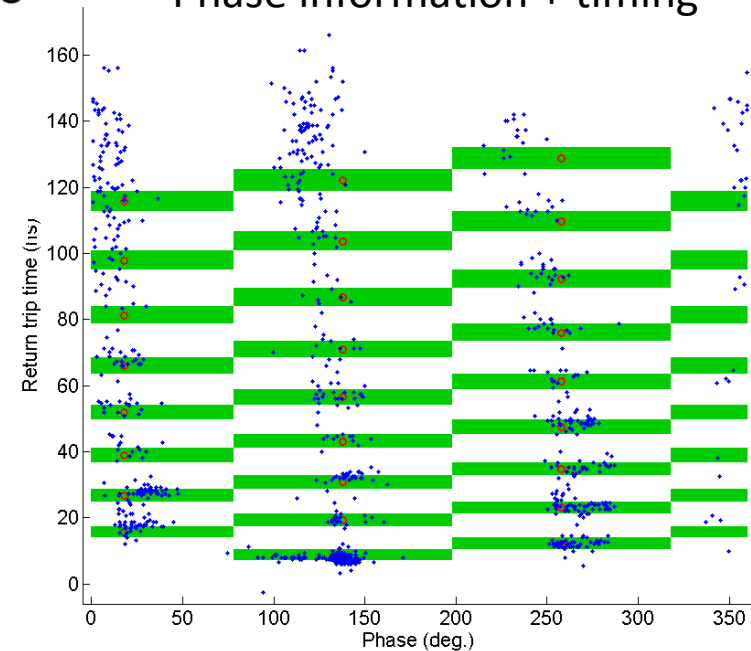
See Robin Rajamäki's talk:
"Breakdown positioning"
on Tuesday afternoon



Robin Rajamäki



Phase information + timing



- Structure conditioned to ~ 95 MV/m @ CLIC pulse 180ns with $\sim 10^{-5}$ BD per pulse
- pulse compressor presently limits significant increase in power
- \Rightarrow compare unloaded and loaded operation at constant power
back off in input power to have same unloaded gradient as loaded
- 100 BDs with 10^{-5} BDR \Rightarrow 111h = 4.6 days @ 25 Hz
(longer! if we are limited by vacuum to 10 Hz)
- \Rightarrow we need to
 - schedule some days to improve beam quality and transmission
 - plan routine running week-ends (+ nights)
- after some results we can think of pulse compressor replacement

- 2014 relevant data compromised
- Good stable running April/March but structure with hot spot
- Difficulties: Pulse compressor replacement, klystron solenoid power converters, drive beam unavailability and priorities
- Pulse compressor easier to operate but still power limiting
=> replacement in 2-3 month?
- last weeks 2015: finally **restart** with **beam**
 - almost full transmission achieved
 - orbit without strong corrector kicks
 - 12 GHz RF interlocks set up
- 2015 run time very limited, need much more in 2016
- consolidate beam setup => ready to go for data taking
- **A BIG Thank You** to everyone involved!



Acknowledgements



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XBOX

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L. Timeo
B. Woolley
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BI

M. Kastriotou
E. Nebot

VAC

A. Bruton
H. Rambeau

SU

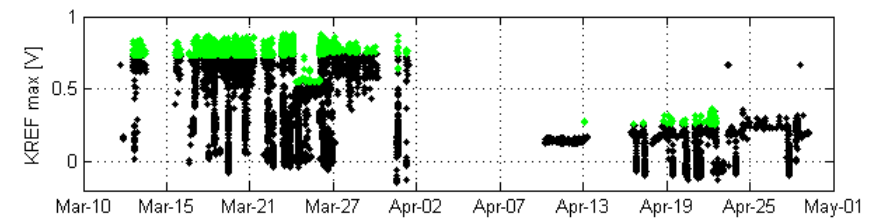
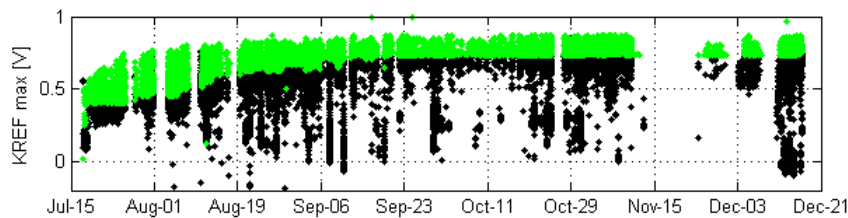
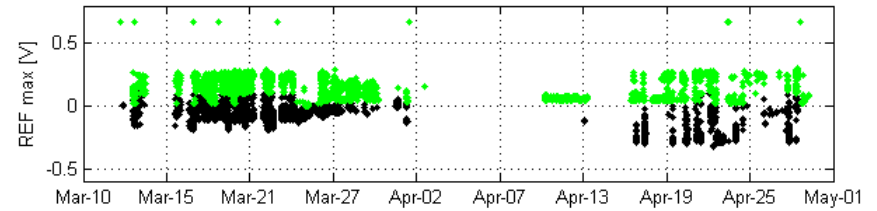
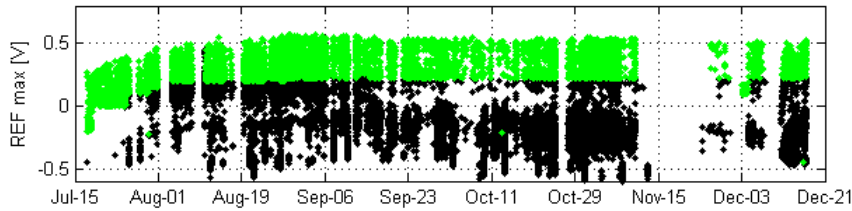
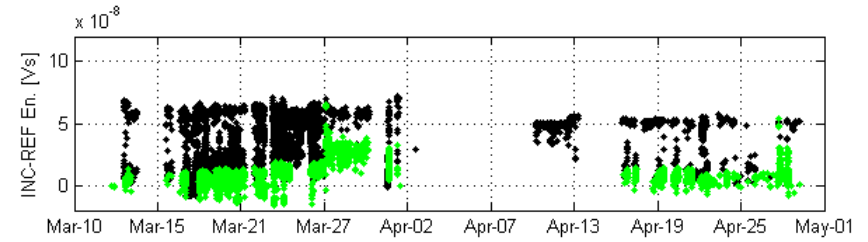
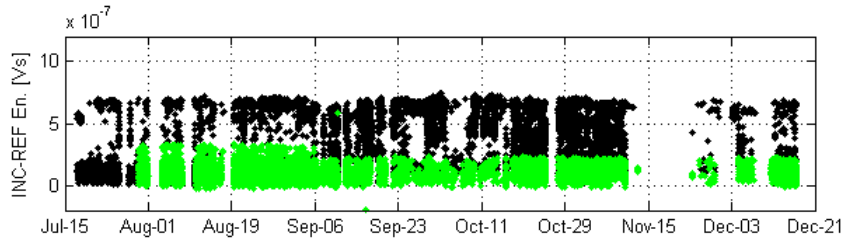
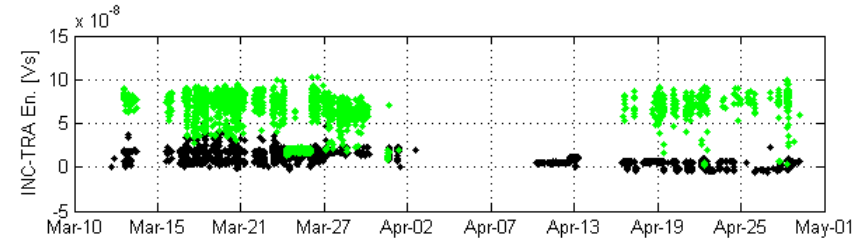
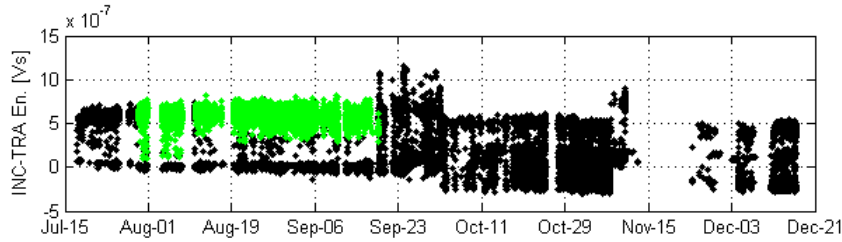
P. Bestmann
T. Dobers
J.F. Fuchs
M. Tortrat



Spare slides

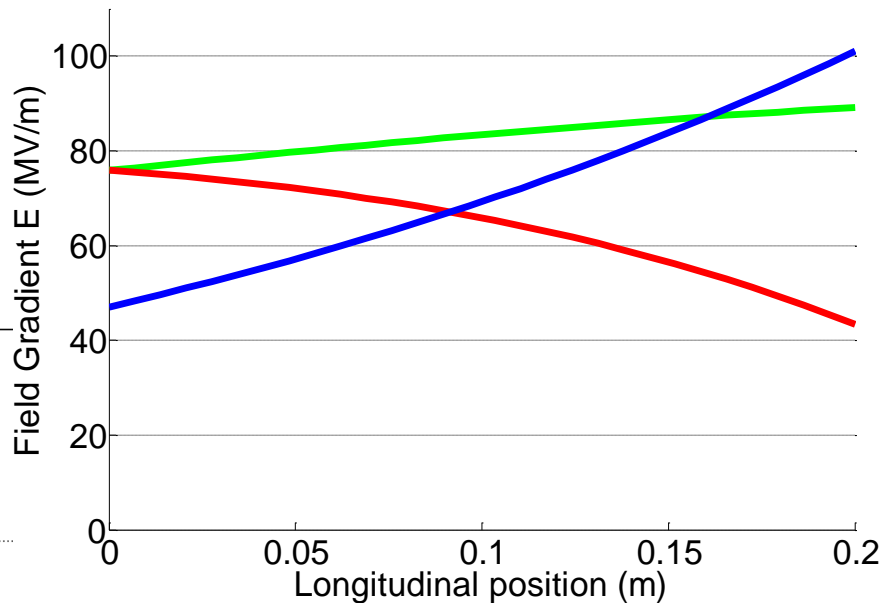
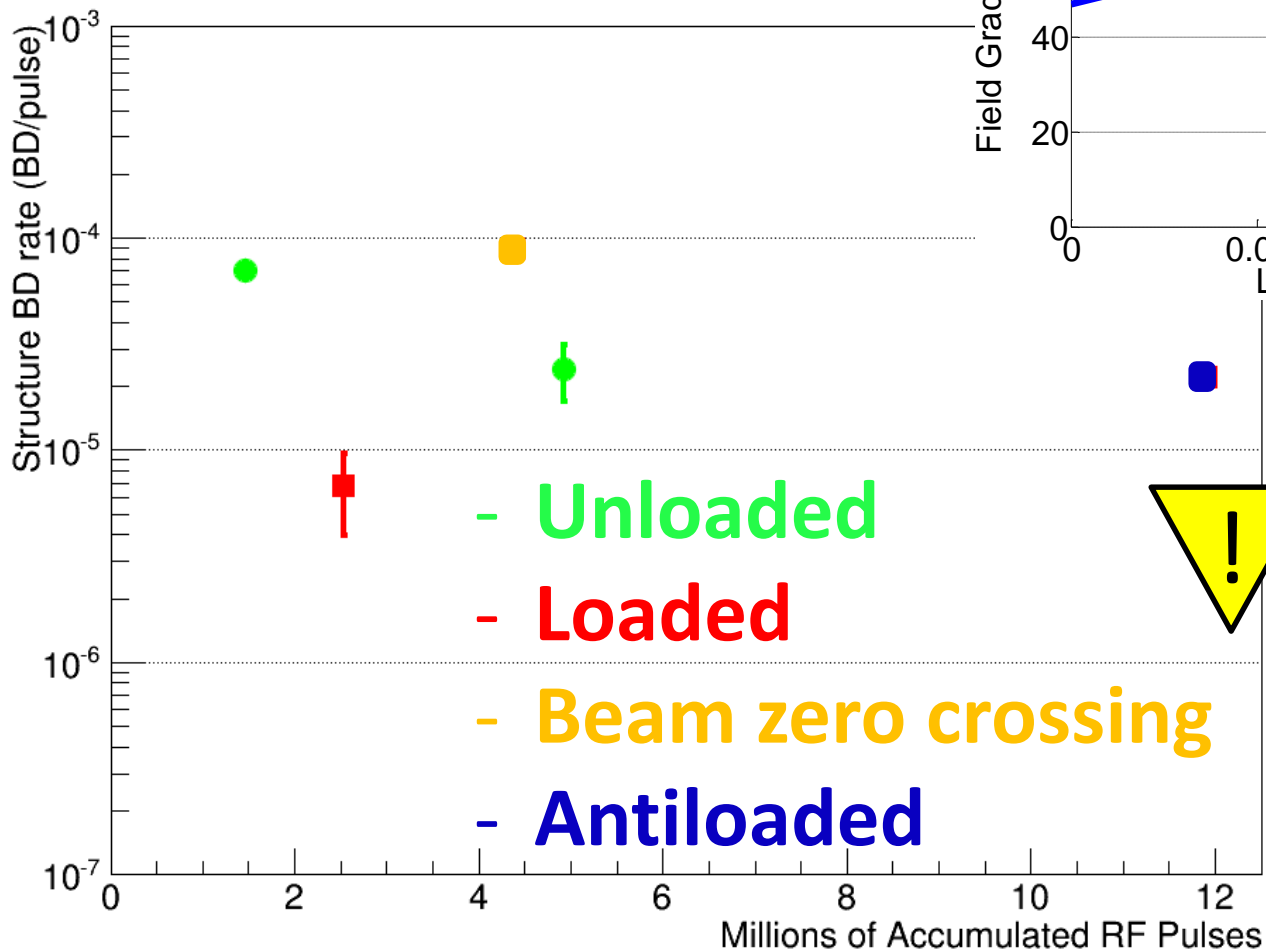


- Xbox RF acquisition fixed (broken transmitted channel), cleanup
- March: machine restart, rapid beam setup and measurements
- May: Accelerating **structure** had to be **replaced** due to hot cell (during access system change)
pulse compressor breaking down, backlash => taken out
- June: **Realignment** of the 8mm-diameter **collimator** (2mm off)
Klystron solenoid power supply problems
- since July: DB gun problems
- 6-12 August: refurbished pulse compressor installed
- 14 Oct: RF setup, no beam (faulty magnet)
- 25/26 Nov: finally beam again
- 4 Dec: beam setup, MKX stopped
- 11 Dec: beam, vacuum crate stopped



We did not observe an increase of breakdown rate with the beam but...

... the beam could have develop a hot-cell.



Only March and April data.

Error bars account only for statistical errors.

Structure with hot cell

Nothing conclusive yet