



Status Ring RF & Long. Dynamics

From the Accelerator Development Group for
ESLS RF Meeting at SOLEIL November 2018

1.5 GeV Ring Delivery

1.5 GeV Ring

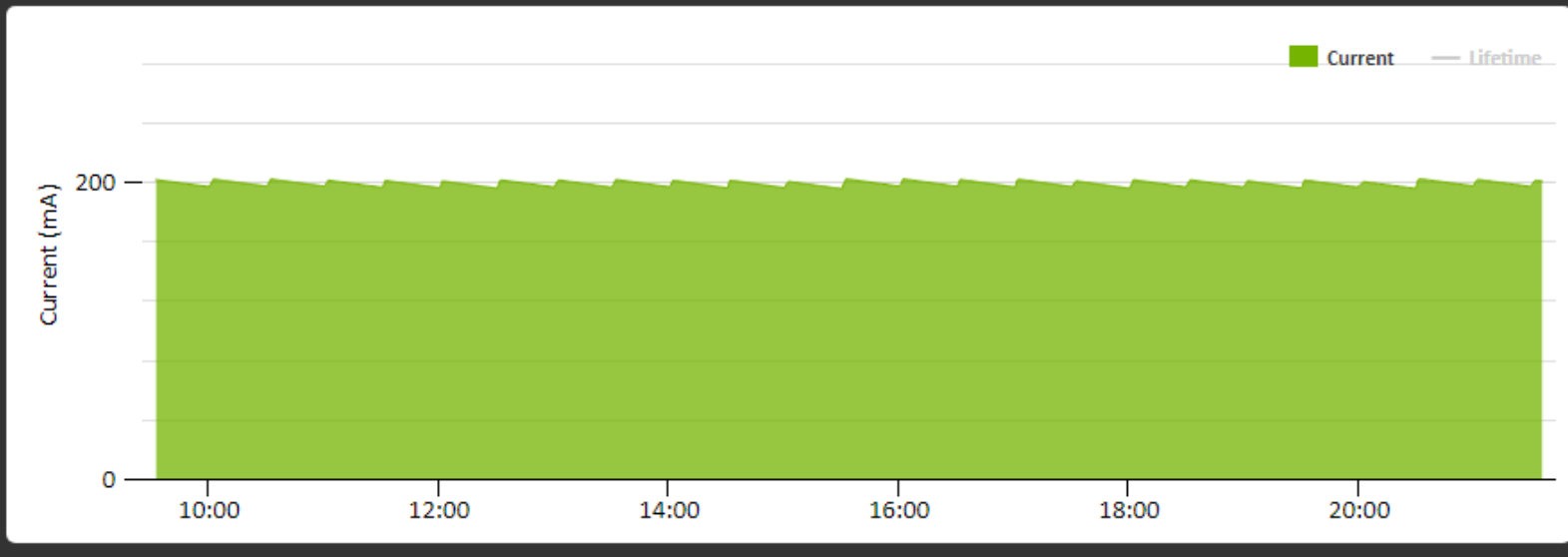
199.81 mA

Delivery: Top-Up

19.07 h

NEXT INJECTION:

2018-11-04 22:00:00



1.5 GeV: RF straight section

240 kV

240 kV

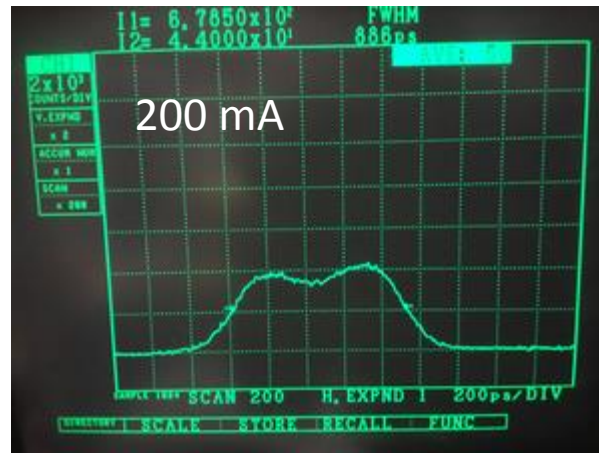
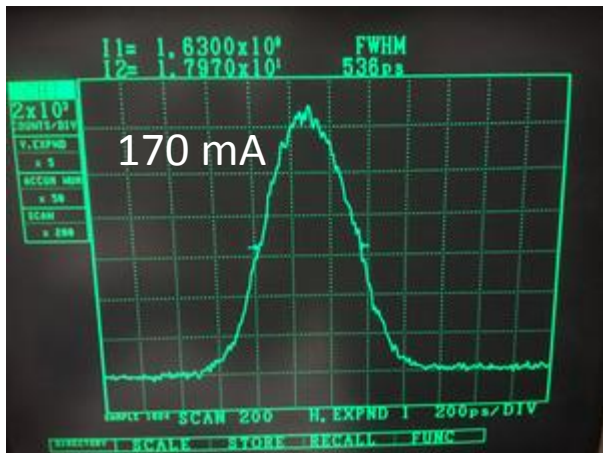
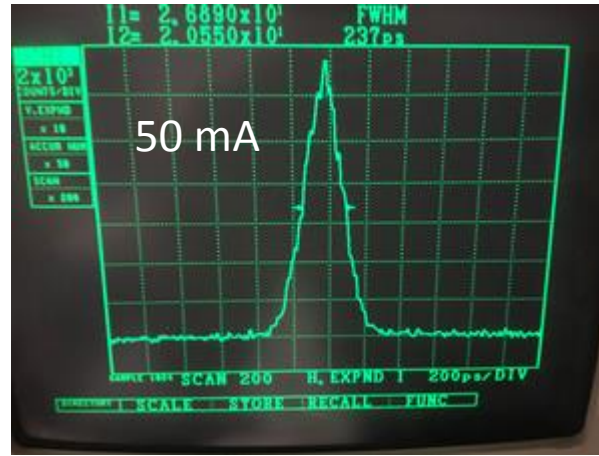
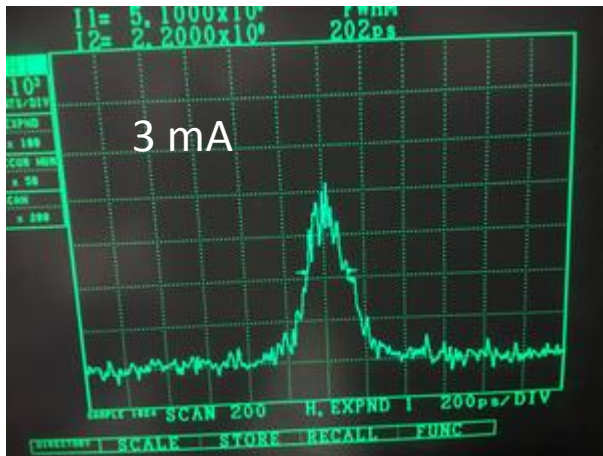
~80 kV

~80 kV



$A_{\varepsilon} = 3.7 \%$
 $f_s = 6.8 \text{ kHz}$

1.5 GeV Ring: Bunch lengthening for fixed HHC detuning



I [mA]	FWHM [ps]
3	202
50	237
170	530
180	680
200	900

Unstable region from 60 to 130 mA.

Theory:
125 ps @ 0 mA
800 ps @ 200mA

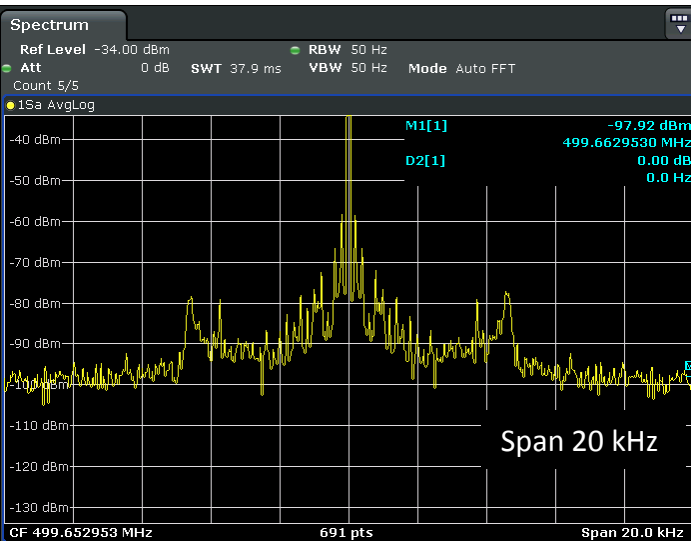
Data by David Olsson and Per Lilja

1.5 GeV Ring: HHC bunch lengthening

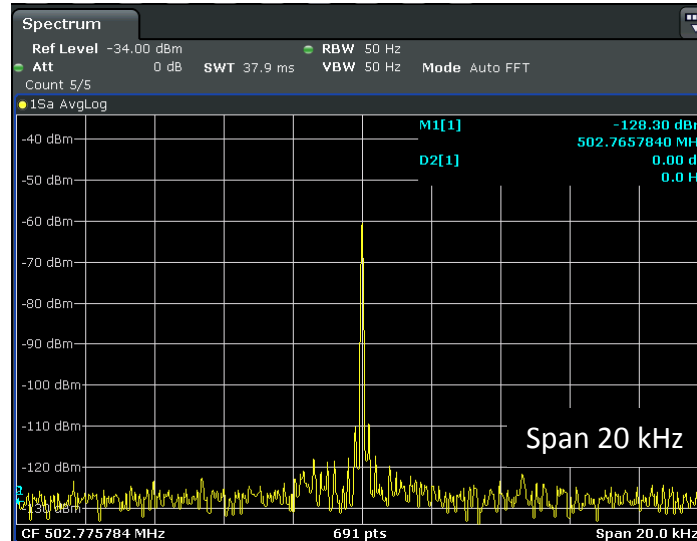
- With HCs an evenly filled bunch train stays stable in all three planes, without the use of the BbB feedback system, from around 130mA and upwards.
- "Auto-tuning" is applied to the HCs, for maintaining the ~ 80 kV, when stacking to higher currents.

Longitudinally stable

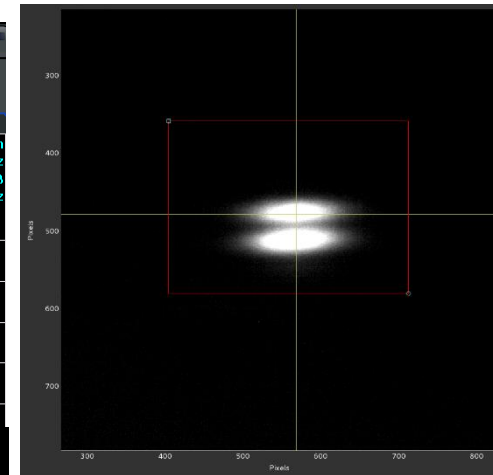
Transversely stable



Mode 0



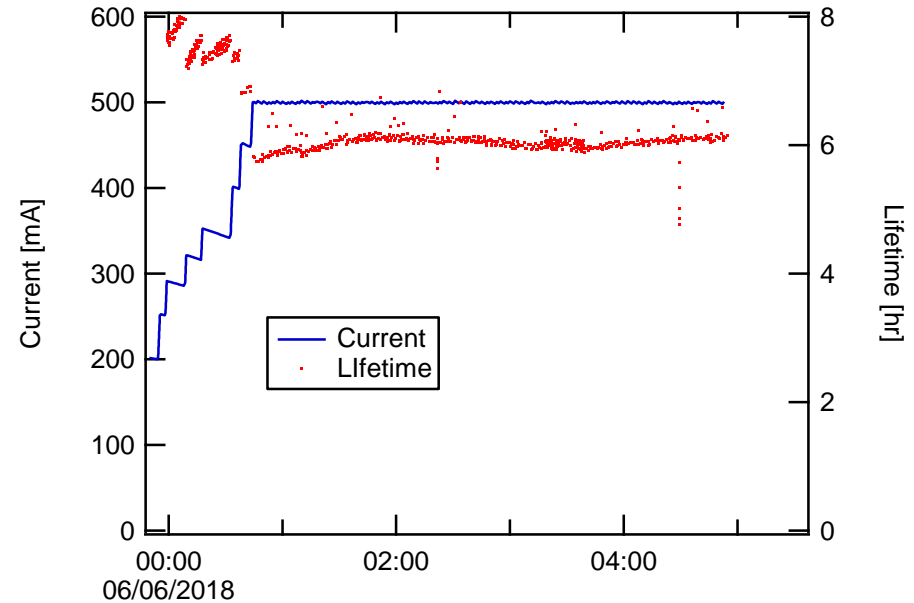
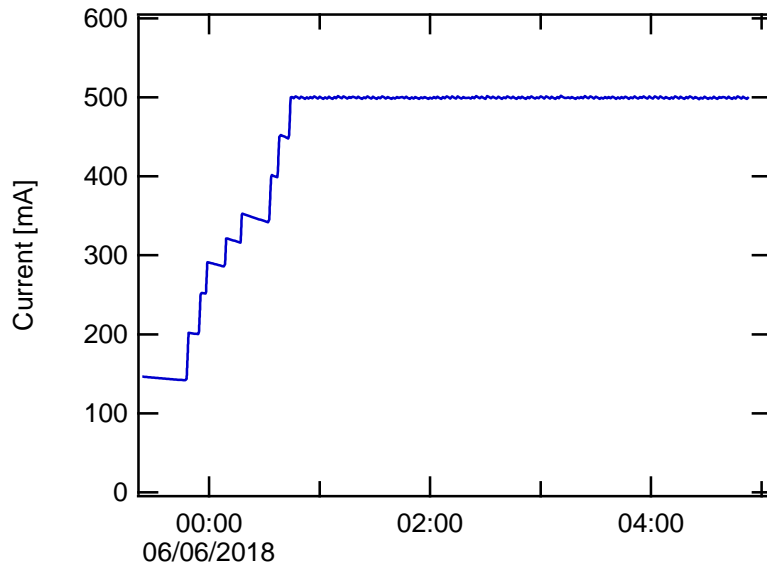
Mode 1 Mode n



Courtesy Robin Svärd & Mathias Brandin

1.5 GeV Ring: Off delivery time

500 mA in top-up mode during acc. dev. shift.



Night Tuesday 5th to Wednesday 6th
of June 2018.

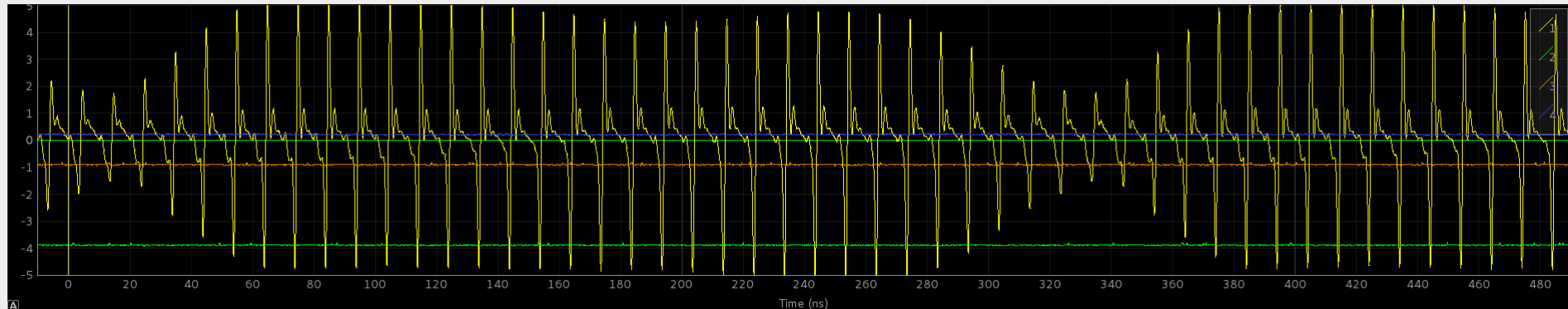
$I * \tau = 3 \text{ Ah @ } 500 \text{ mA}$

(Design is 5 Ah @ 500 mA)

1.5 GeV ring fill pattern @ 500 mA

- Above 350 mA the beam may go unstable vertically, due to an ion instability.
- We counteract by an uneven filling pattern. This, together with the Landau cavities, keep the beam **stable in all three planes up to 500 mA.**

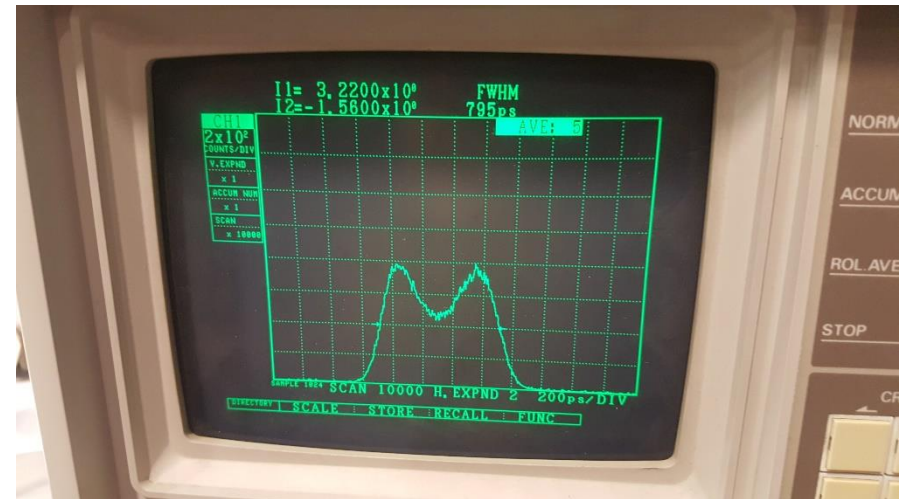
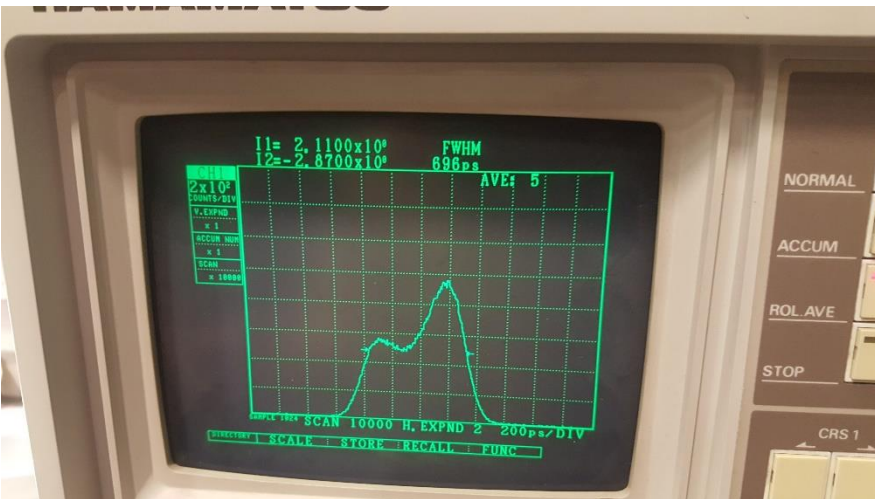
Scope R1-D110210/DIA/OSCA-01



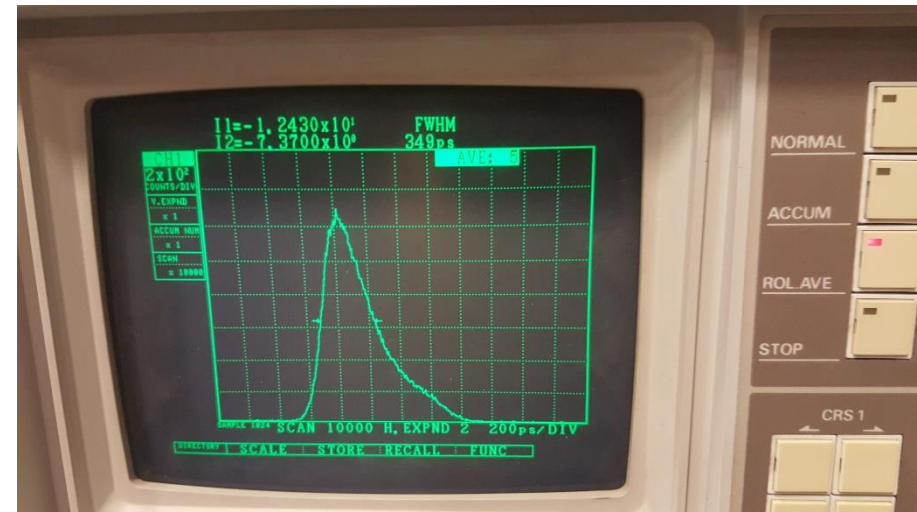
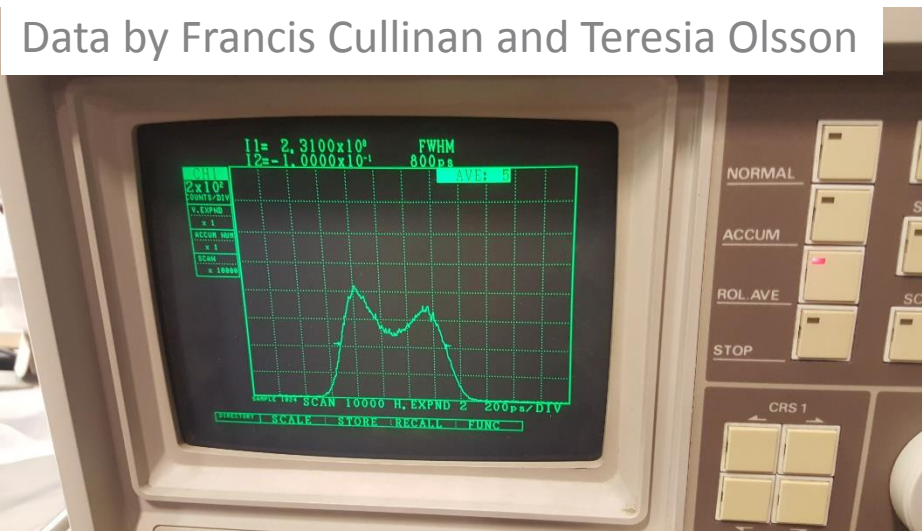
One turn (32 buckets)

- However, it results in **various bunch profiles along the train** →

1.5 GeV bunch profiles along the train @ 500 mA



Data by Francis Cullinan and Teresia Olsson



Teresia Olsson and Francis Cullinan are working on tracking/analytical models describing this.

3 GeV Ring Delivery

- Normal delivery: 150 mA top-up every half hour, $I \cdot \tau \sim 2 \text{ Ah}$

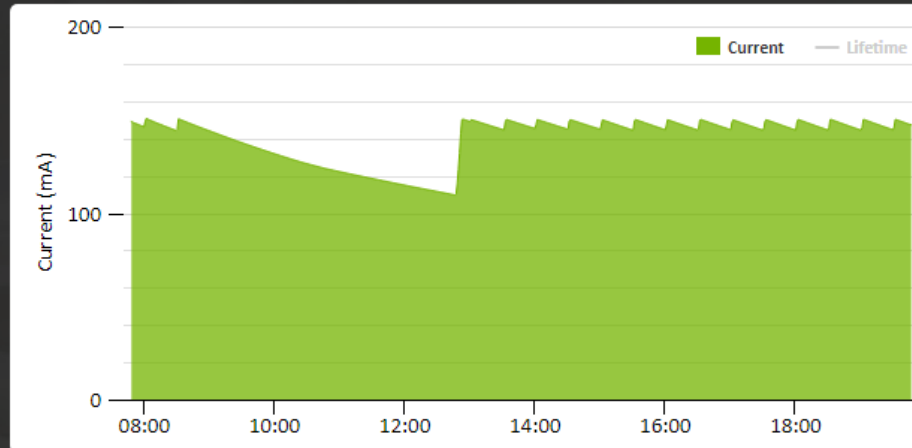
3 GeV Ring

146.77 mA Delivery: Top-Up

13.20 h

NEXT INJECTION:

2018-11-07 20:00:00



BALDER	5.00	CLOSED
BioMAX	25.05	CLOSED
DanMAX		
CoSAXS		
HIPPIE	28.74	OPEN
NanoMAX	8.06	OPEN
SoftiMAX		
VERITAS	150.00	CLOSED

- We deliver **presently** with help of a BbB feedback system acting **longitudinally** against HOM driven Coupled Bunch Instabilities.

3 GeV ring, RF installed in achromats, not in SS

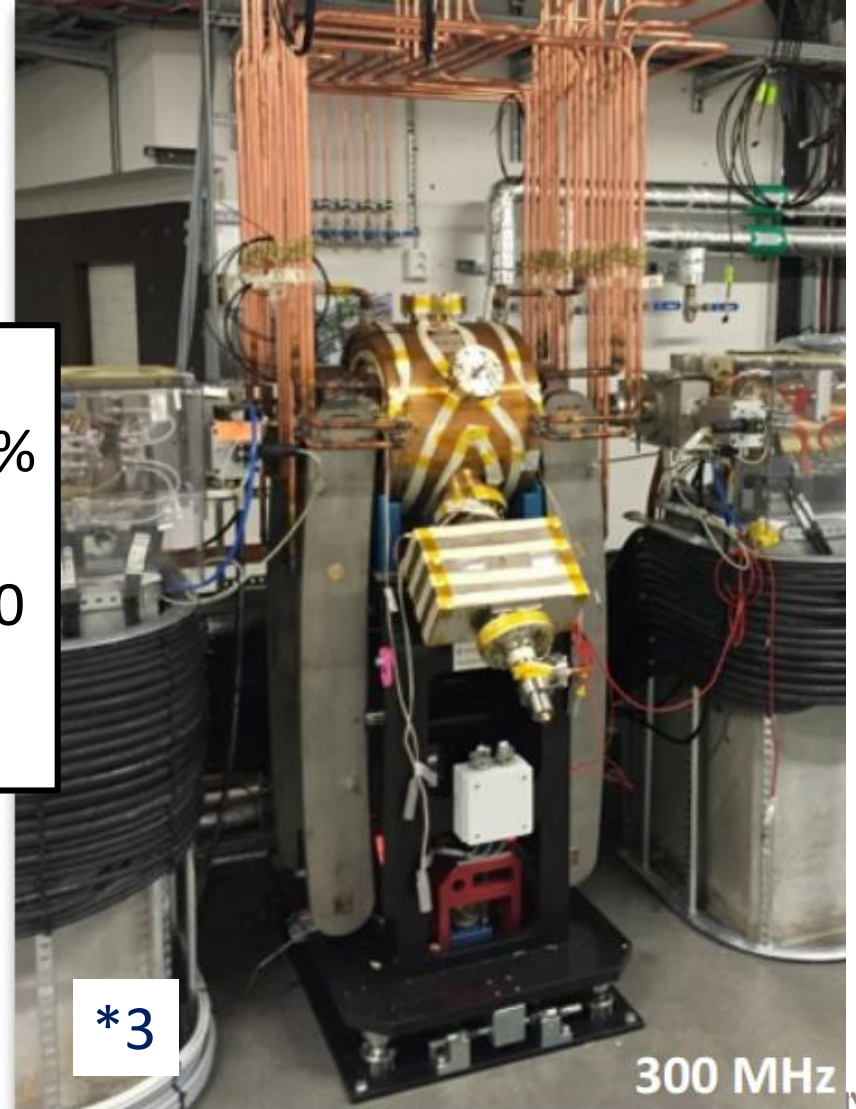
5*250 kV



*5

100 MHz

$A_{\epsilon} =$
5.4 %
 $f_s =$
1050
kHz

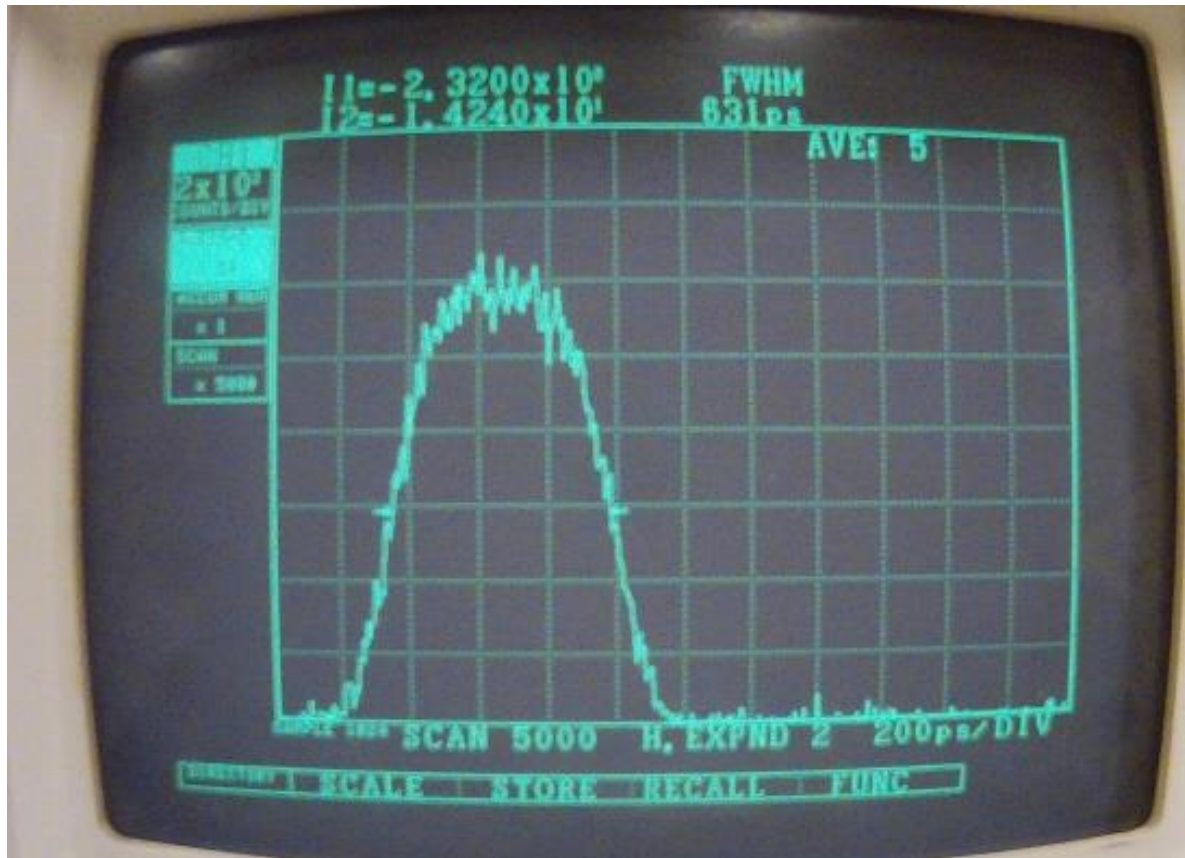


*3

300 MHz

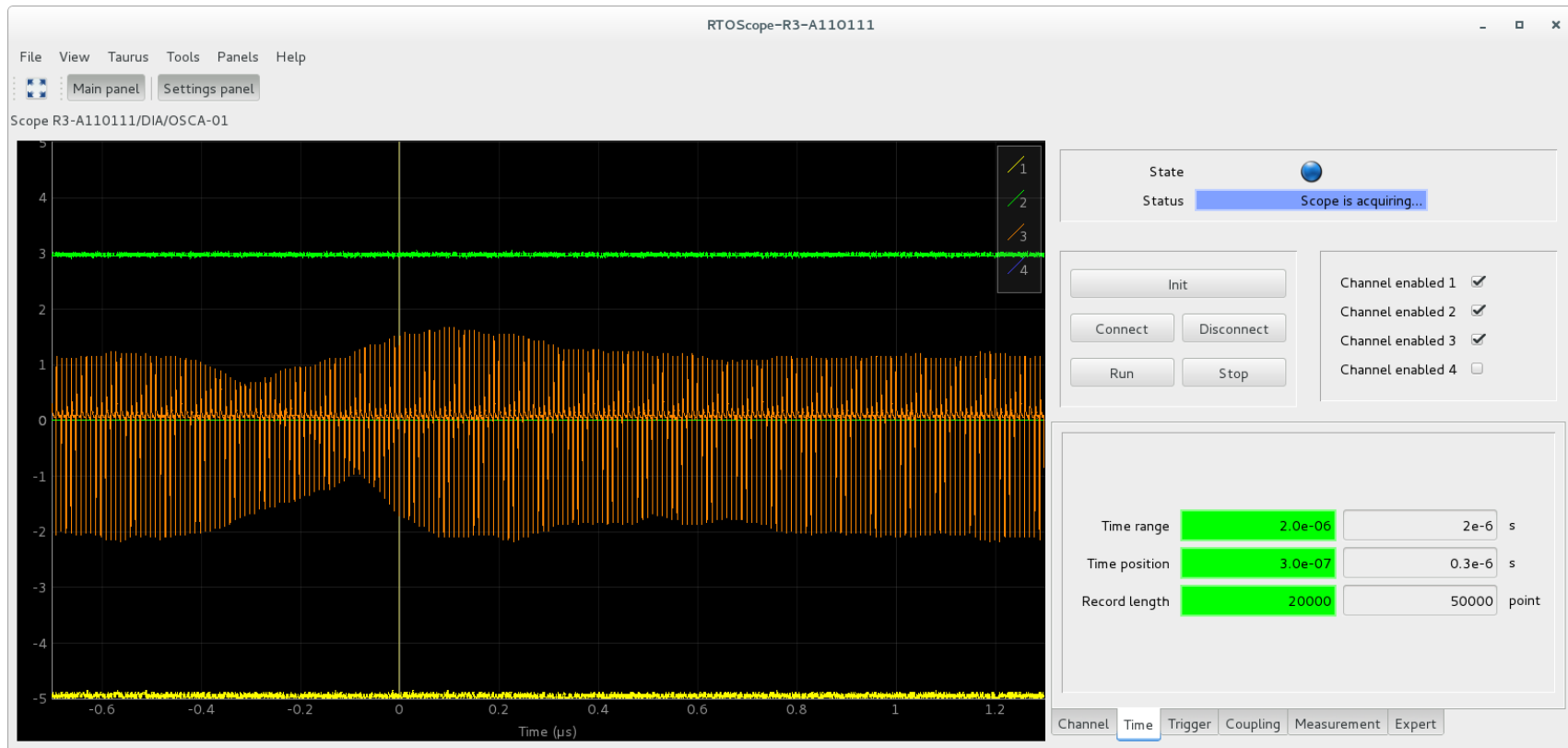
3 GeV Ring: Bunch lengthening at 75 mA

- At this relatively low current and at lower main cavity field, we can demonstrate **the theoretical lengthening of 4.5** along a uniform filling pattern.



3 GeV Ring: Bunch lengthening at 150 mA

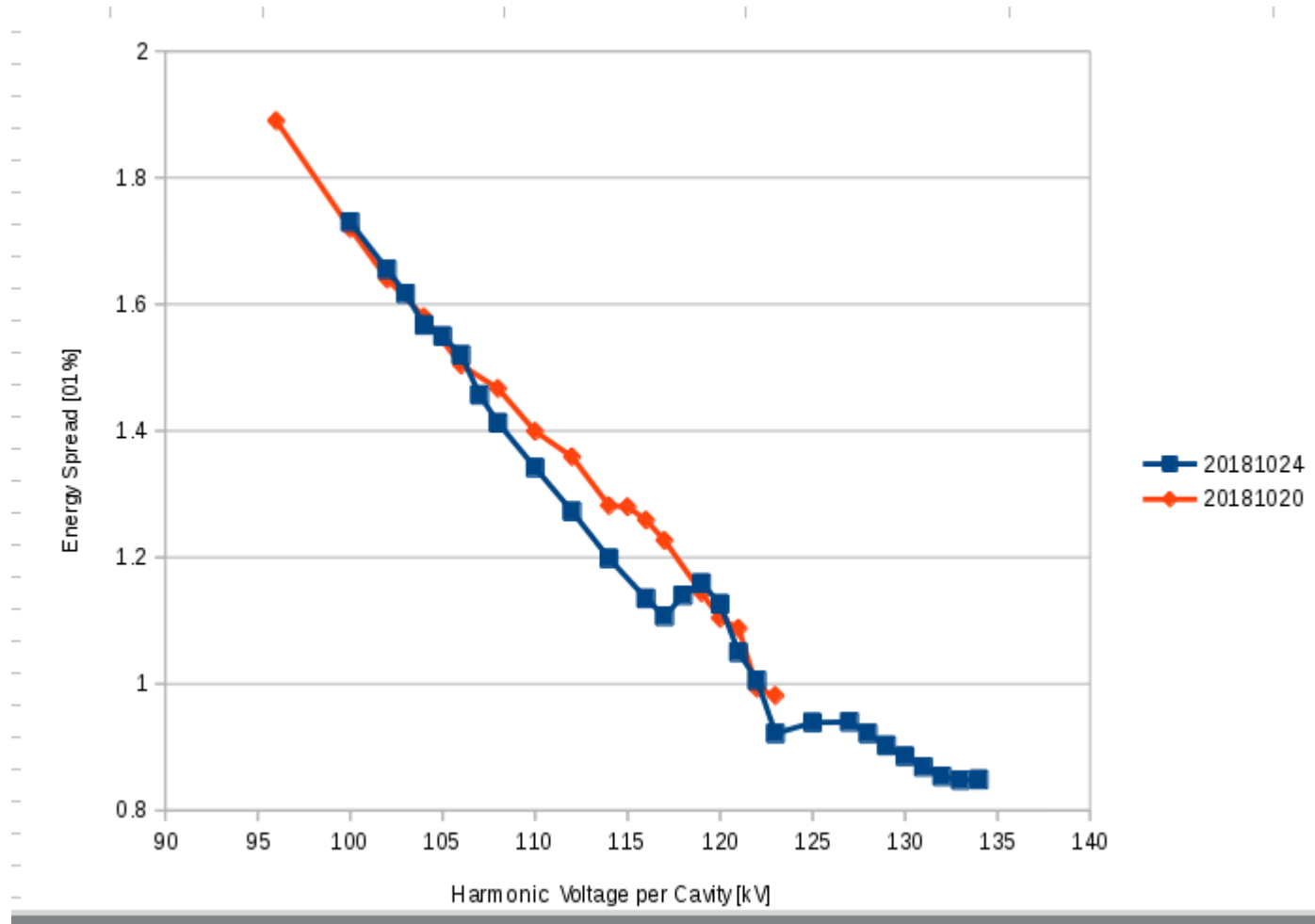
- However, at higher currents we often suffer from a "self-induced" static bunch profile pattern along the circumference.



- The bunch profiles differ along the train, even though the bunch charges are quite similar. Thus, the effective lengthening is less.

3 GeV Ring: Bunch lengthening at 150 mA

- However, the energy spread is approaching the natural one ($0.8e-3$) with increased HHC fields, and the beam is longitudinally stable.



3 GeV Ring probable soon delivery

- Development shift: **150 mA** top-up every half hour, closed IDs, $I \cdot \tau \sim 3 \text{ Ah}$

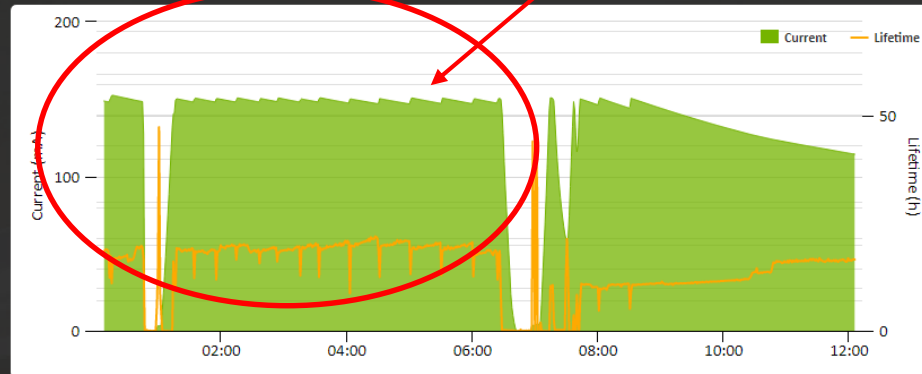
3 GeV Ring

114.01 mA Delivery: Decay

17.29 h

NEXT INJECTION:

2018-11-07 12:30:00



BALDER	5.00	OPEN
BioMAX	4.99	OPEN
DanMAX		
CoSAXS		
HIPPIE	28.74	OPEN
NanoMAX	5.18	OPEN
SoftiMAX		
VERITAS	150.00	CLOSED

- Here we test delivery without help of a BbB feedback, but with a **separate zero-mode feedback (David McGuinnies)** and the **Harmonic Cavities** acting against HOM driven Longitudinal Coupled Bunch Instabilities.
- For stable operation $V_{\text{main}} = 5 \cdot 190 \text{ kV}$ & $V_{\text{HHC}} \sim 3 \cdot 120 \text{ kV}$ ($A_{\epsilon} = 4.6 \%$)