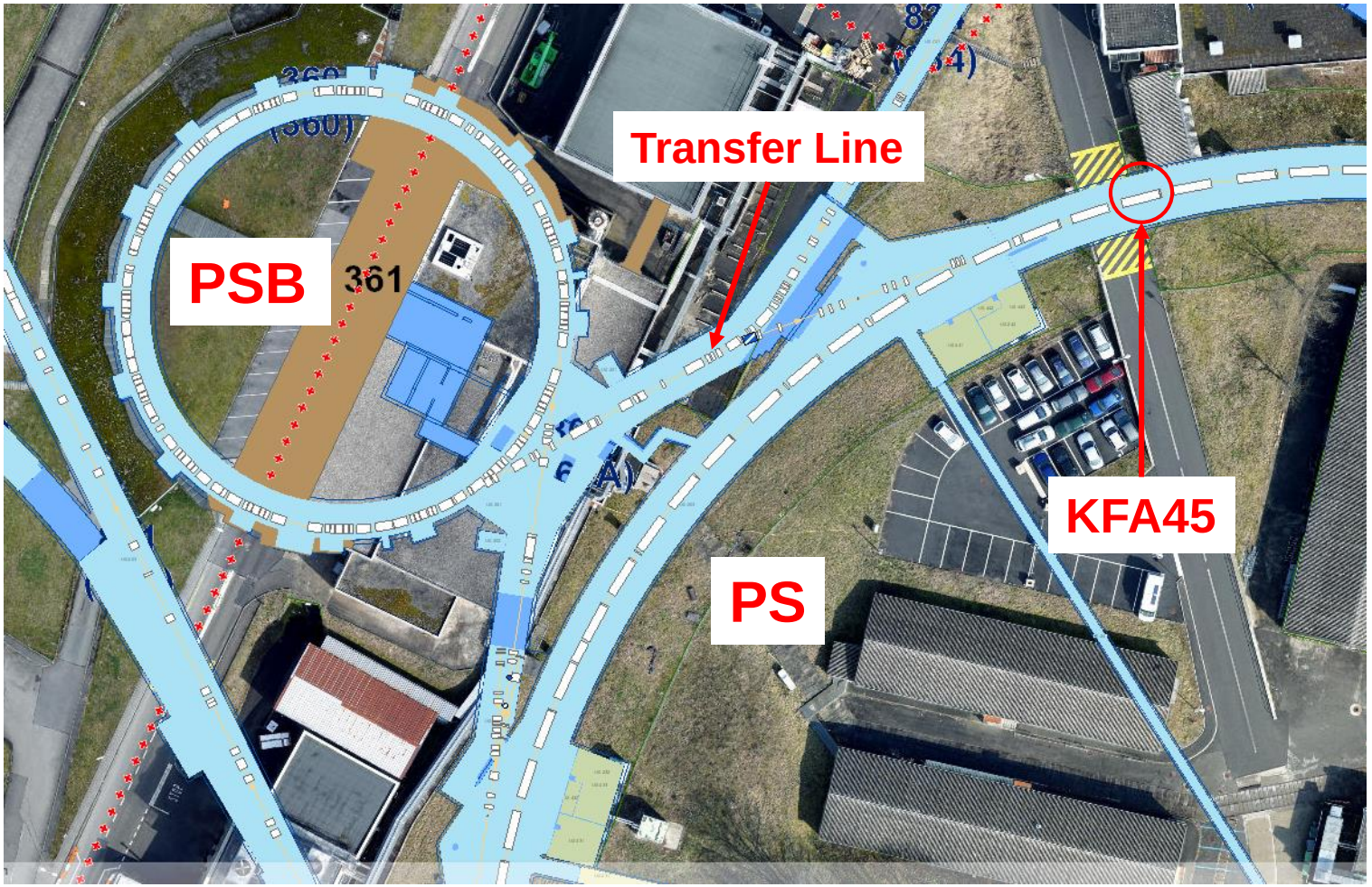
Analysis and results of PI.KFA45 Magnetic measurements

N. Ayala, A. Ferrero, T. Kramer

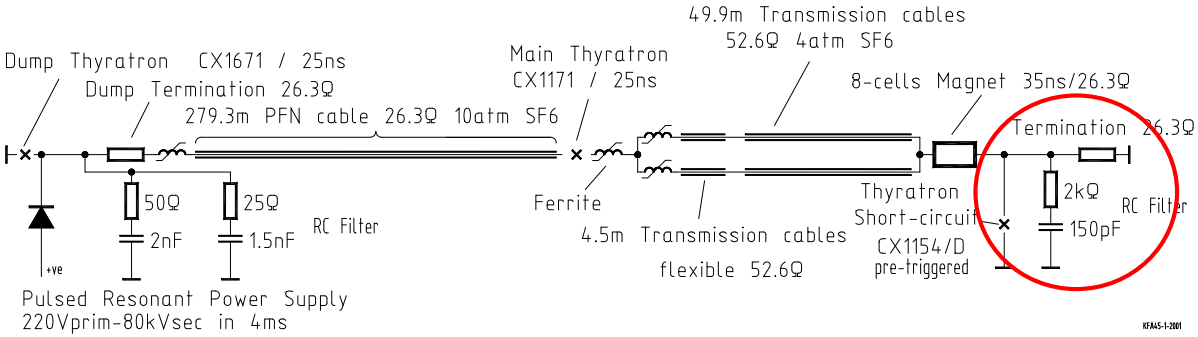
With the support of: F. Pedrosa, J. Bauche, J. Ferreira, L.M. Coralejo, L. Sermeus, N. Thaus, P. Demarest, R. Noulibos, Y. Sillanoli.

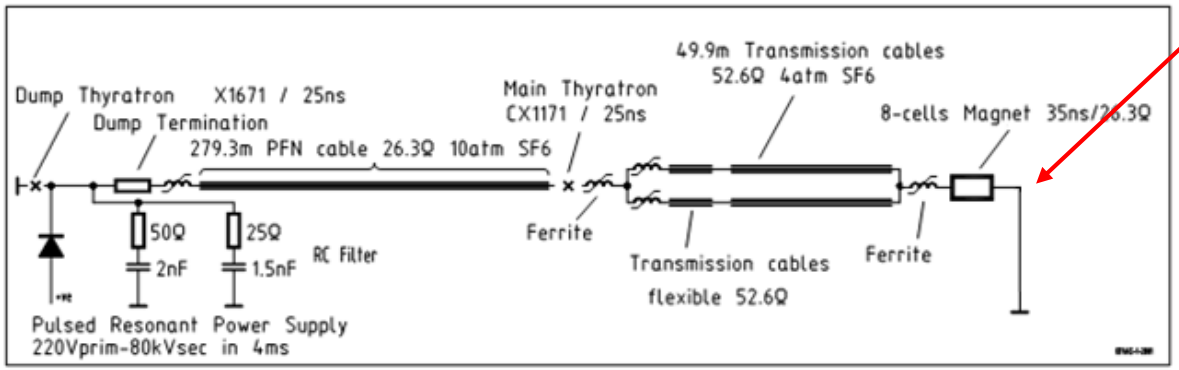
Table of contents

Introduction



Introduction

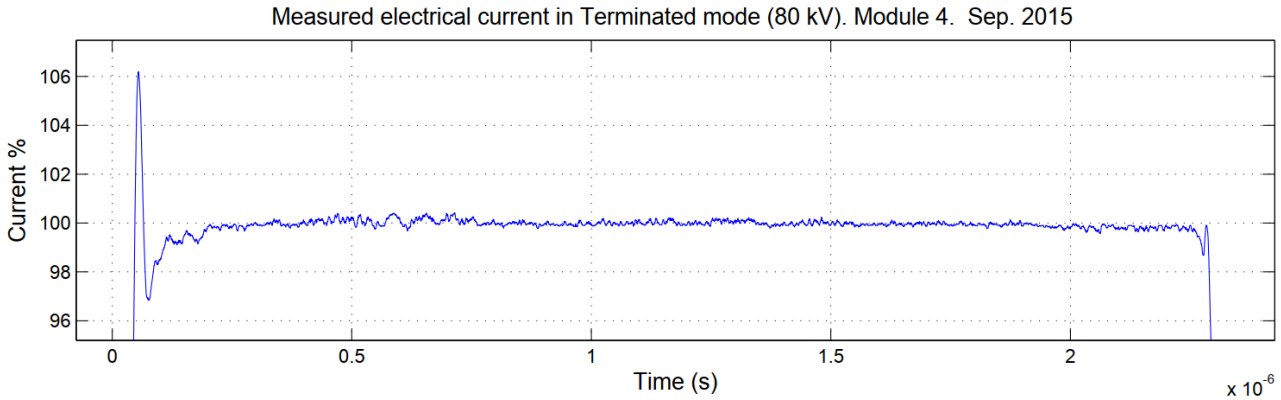


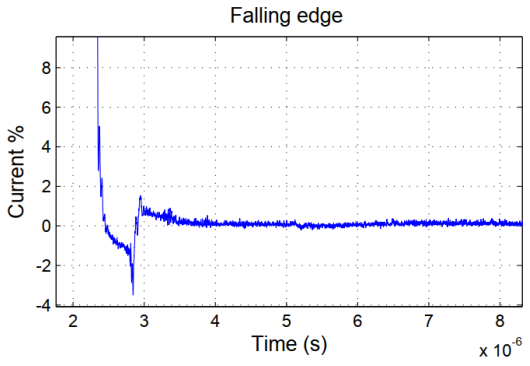


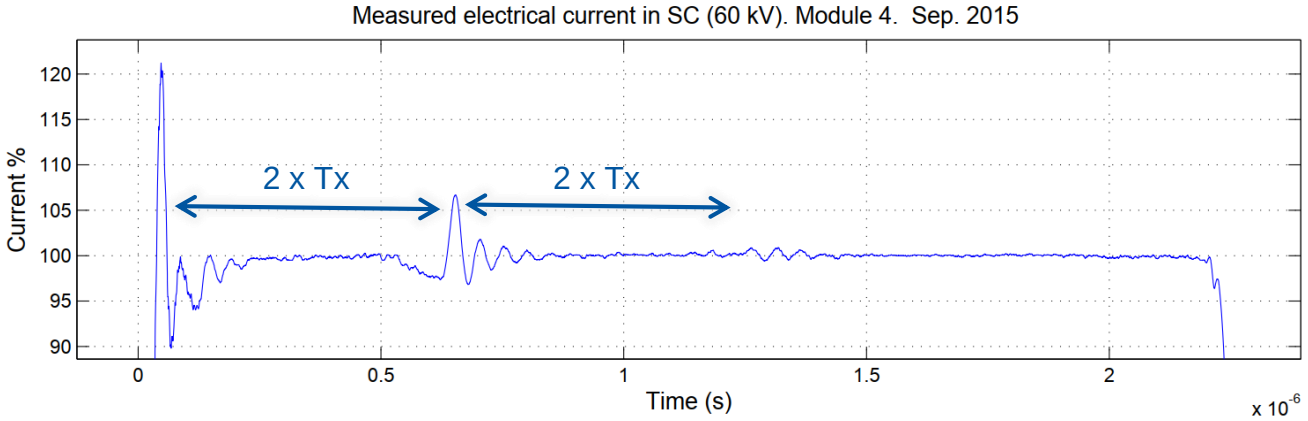
Magnet termination and all associated elements replaced by a direct short circuit (SC)

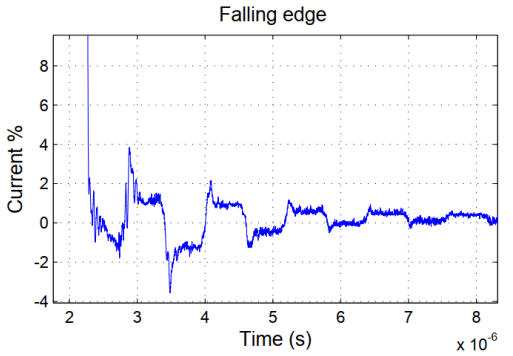
This modification allows to double the kick strength

Introduction





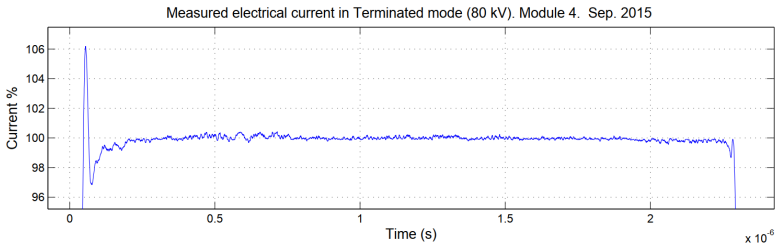




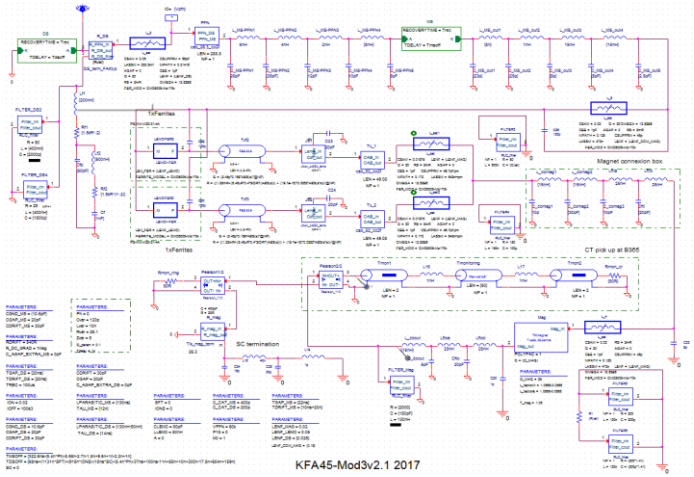
Under SC configuration undesired ripples appear in the pulse

Introduction

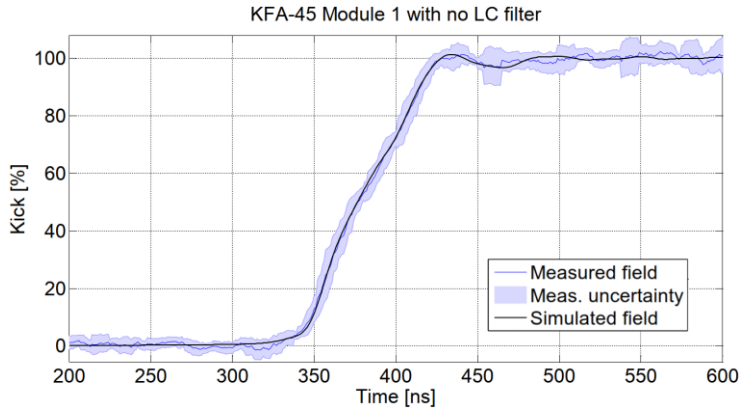
Current measurements



Simulations



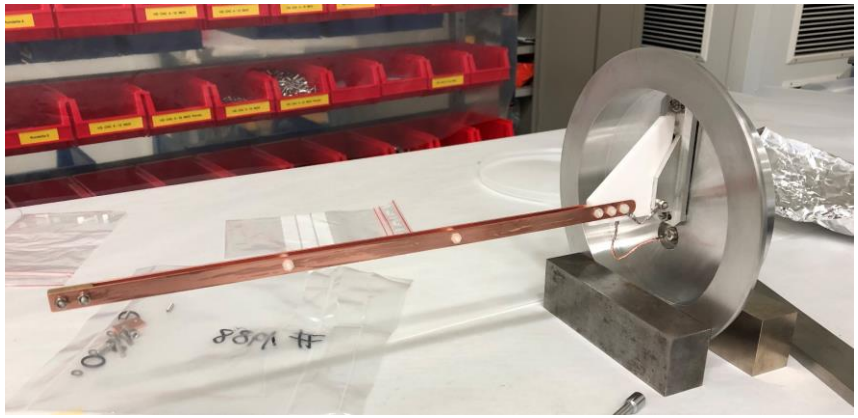
Beam based field measurements

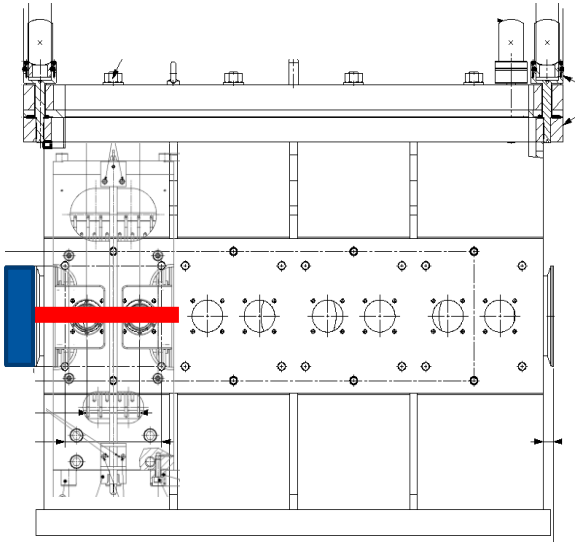


Direct magnetic field measurements needed to validate all previous work

Measurement set-up

A stripline loop was used for measuring the time variation magnetic field in the magnet aperture



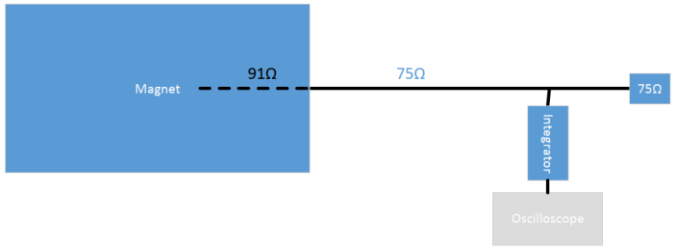


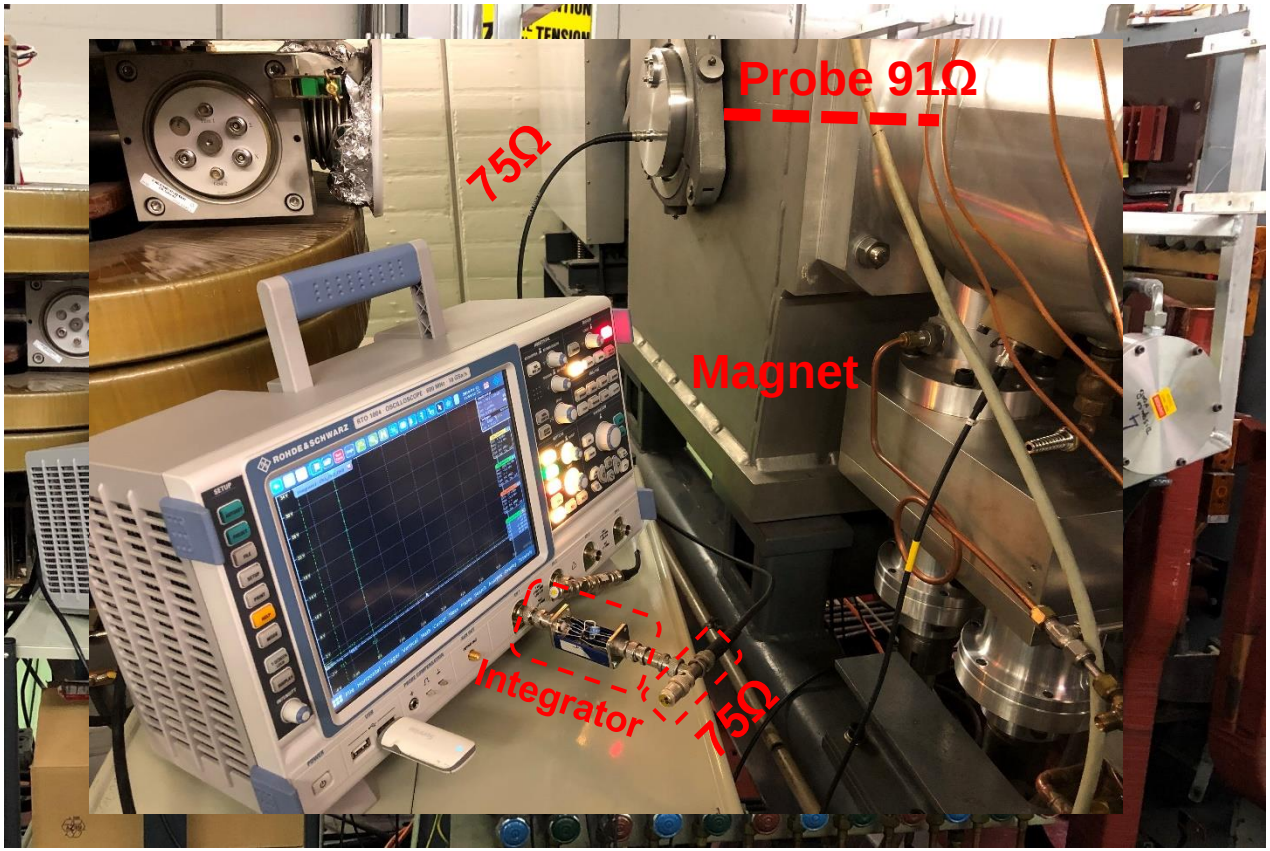
Only one module was measured

$$\nabla \times E = -\frac{\partial B}{\partial t}$$

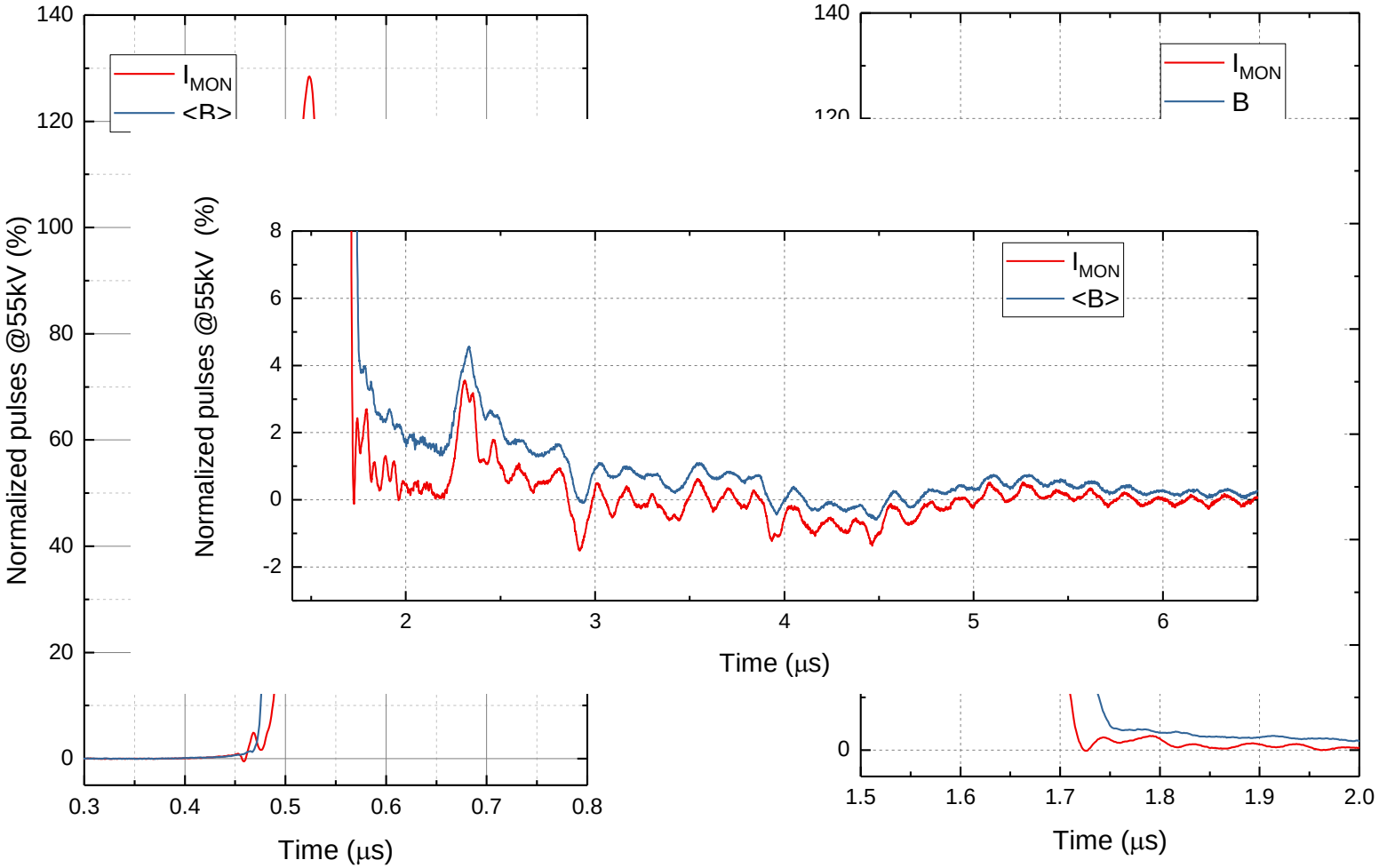
$$M(t) = \int_0^t V_0(t')dt'$$

Measurement set-up





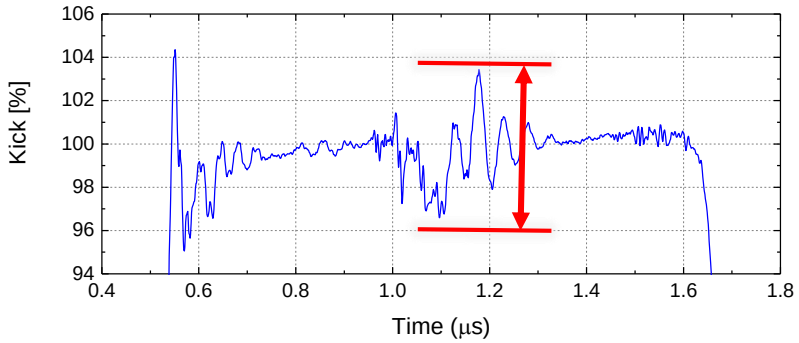
Current vs Magnetic field pulses



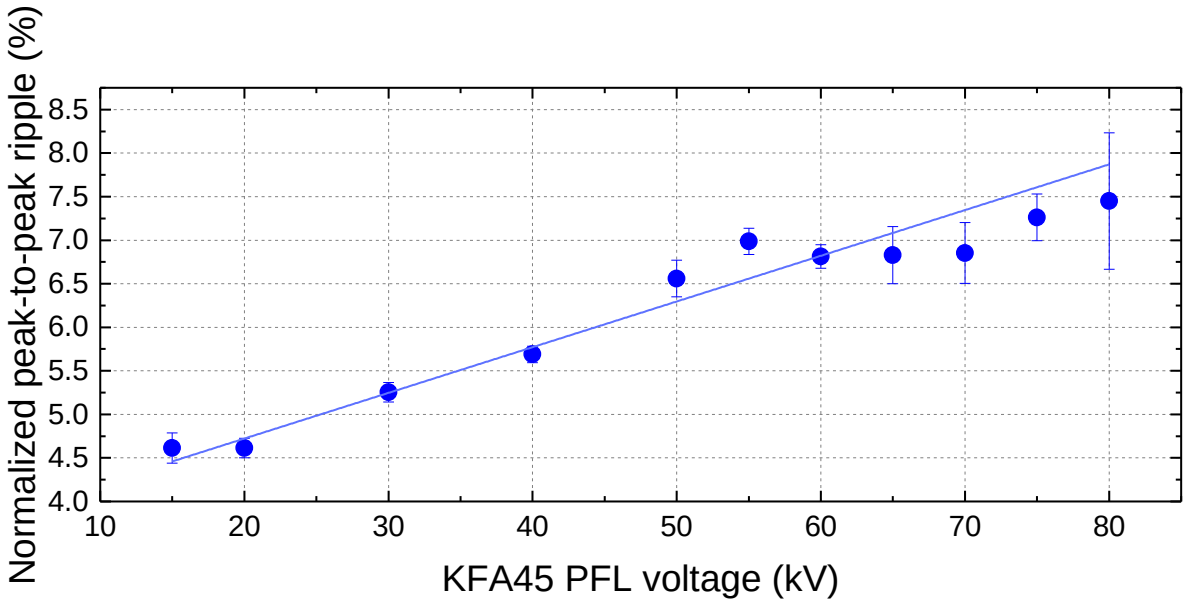
*Field measured on Module 1, January 25th, 2019

Magnetic field dependences w.r.t. PFL voltage

- Flat top ripple measured for different PFL voltages

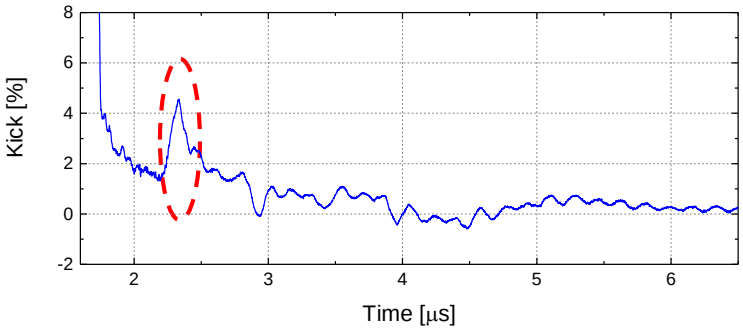


The normalized ripple amplitude on the flat top **increases** with the PFL voltage

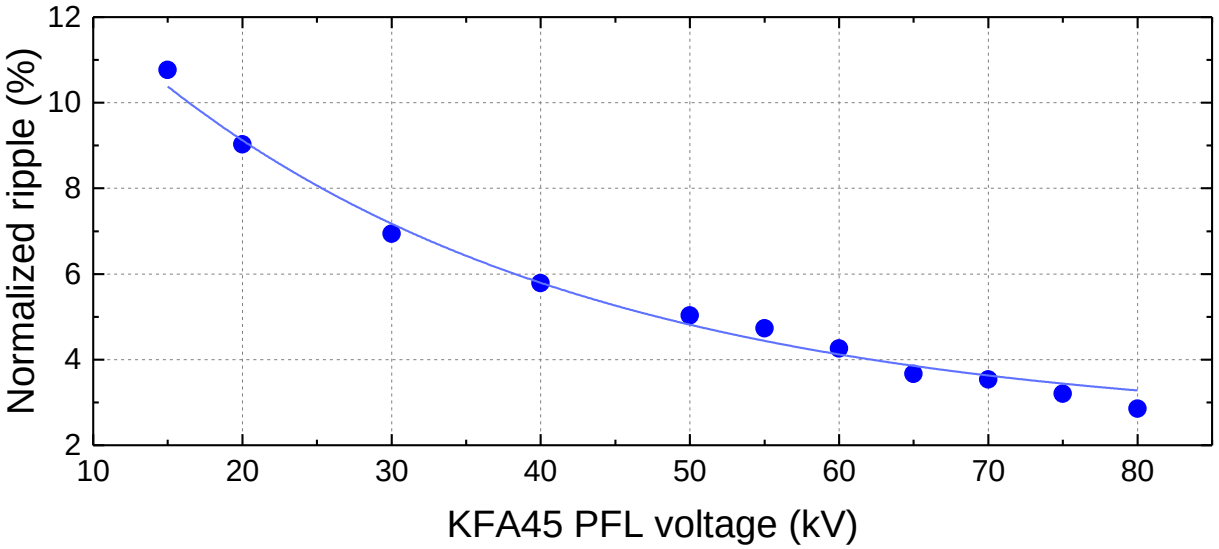


Magnetic field dependences w.r.t. PFL voltage

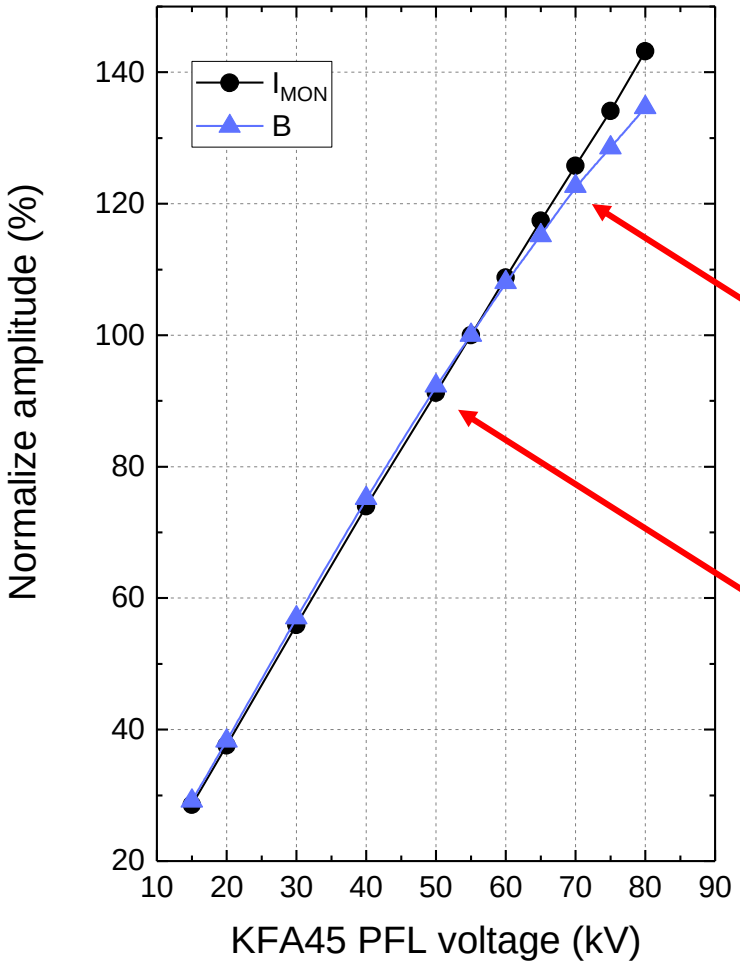
- Post pulse ripple measured for different PFL voltage



The normalized post pulse ripple **decreases** with the PFL voltage

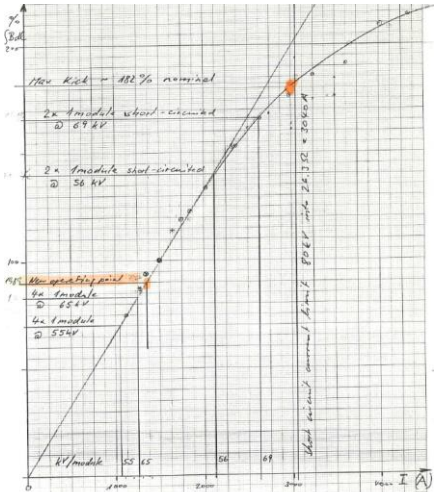


Saturation effects



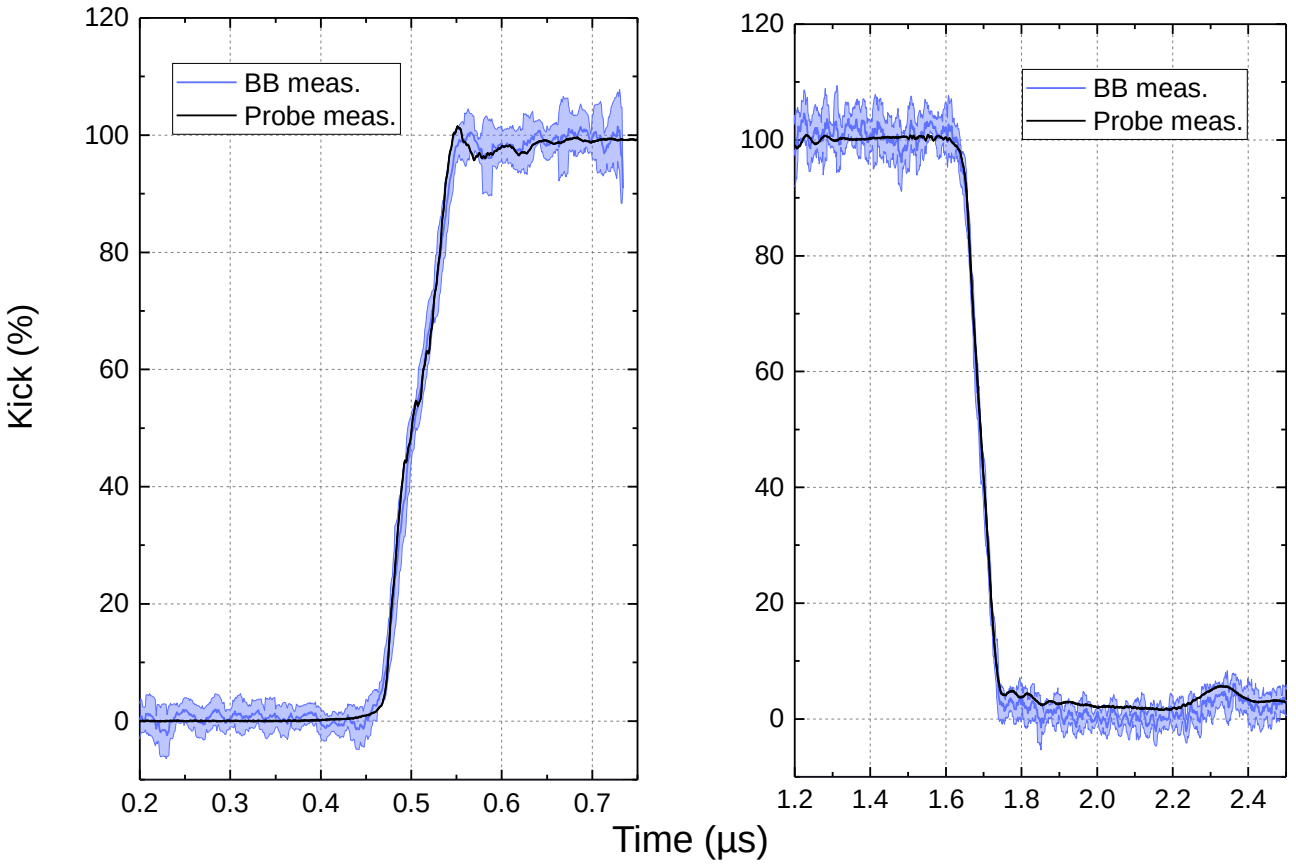
Operational voltage
for 3 modules @2GeV

Operational voltage
for 4 modules @2GeV



*Courtesy L. Sermeus

Beam based meas. vs magnetic field meas.

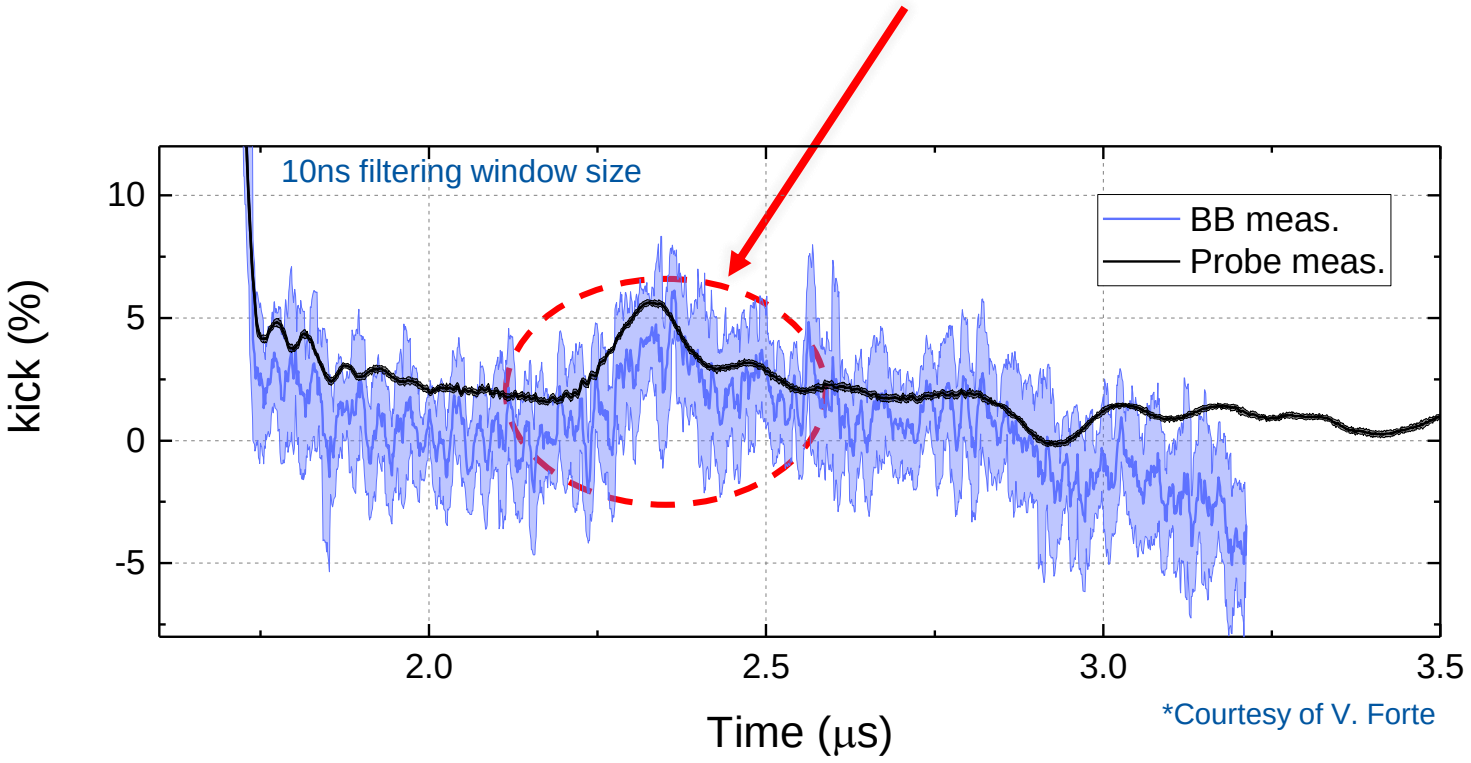


*Courtesy of V. Forte

Good agreement between both methods to measure the rise and fall times

Beam based meas. vs magnetic field meas.

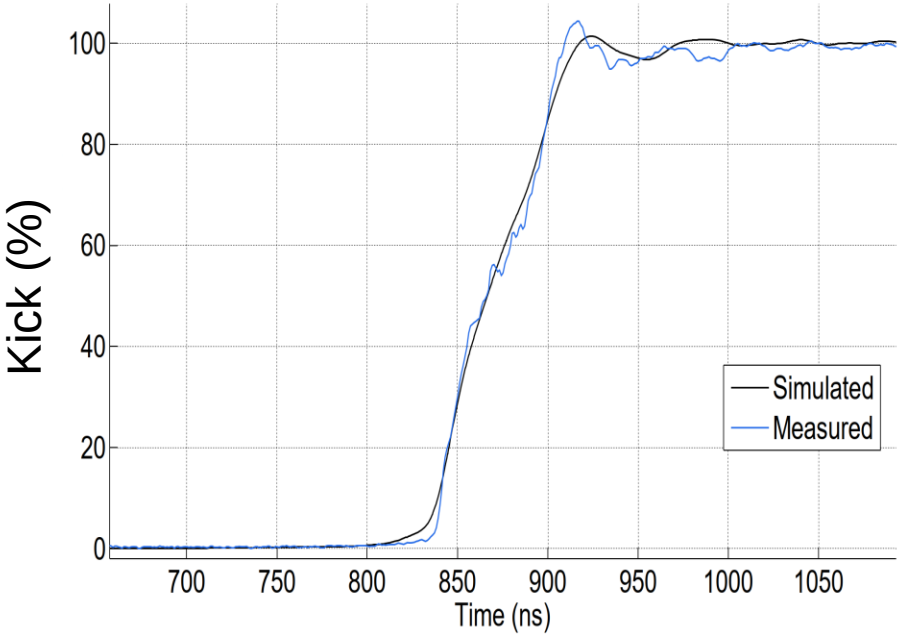
Both methods are able to measure the post pulse ripple



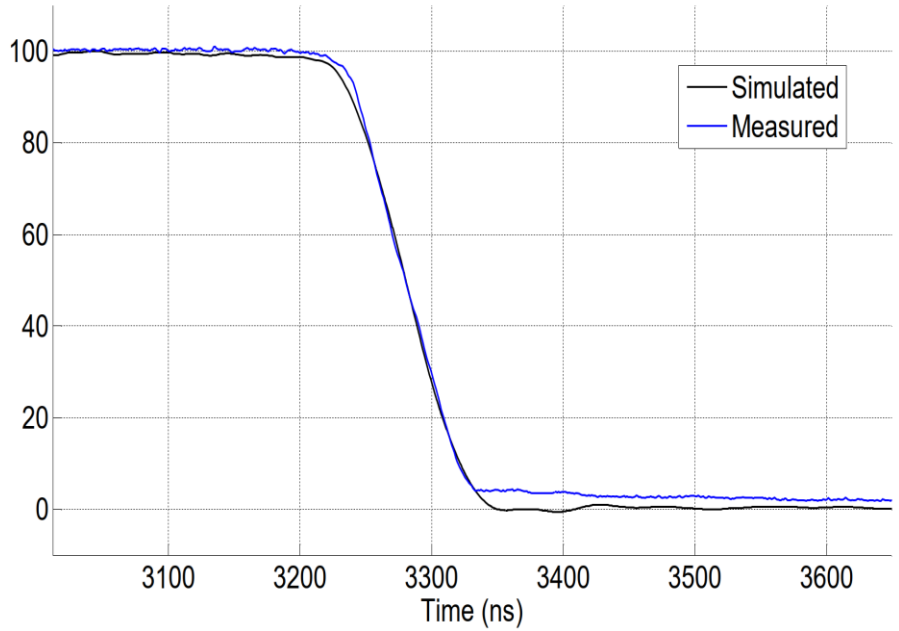
*Courtesy of V. Forte

Magnetic field simulations vs measurements

Rise time



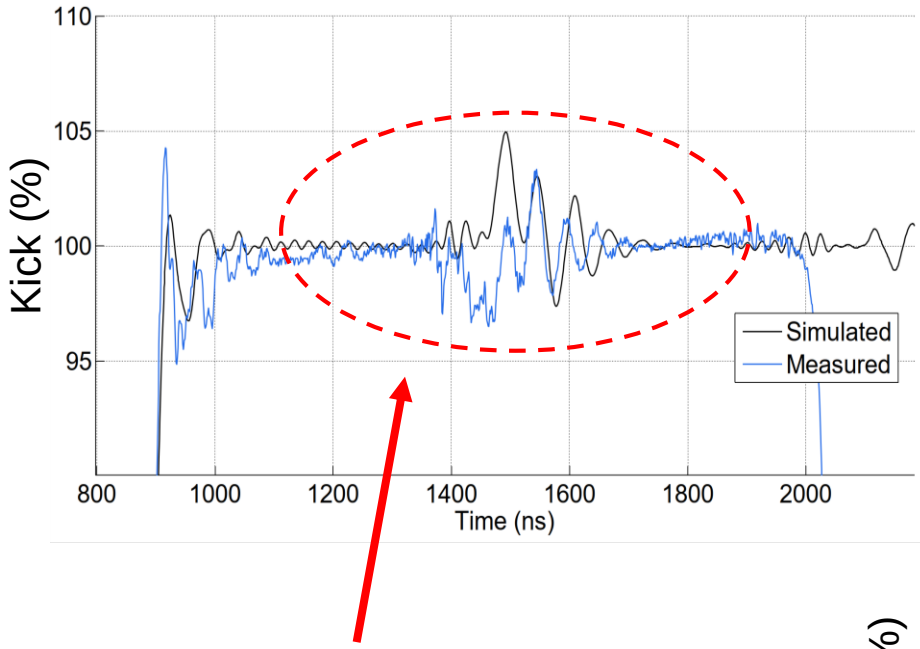
Fall time



*Simulation model: version 2018 (adjusted on BBM, no LC filter)

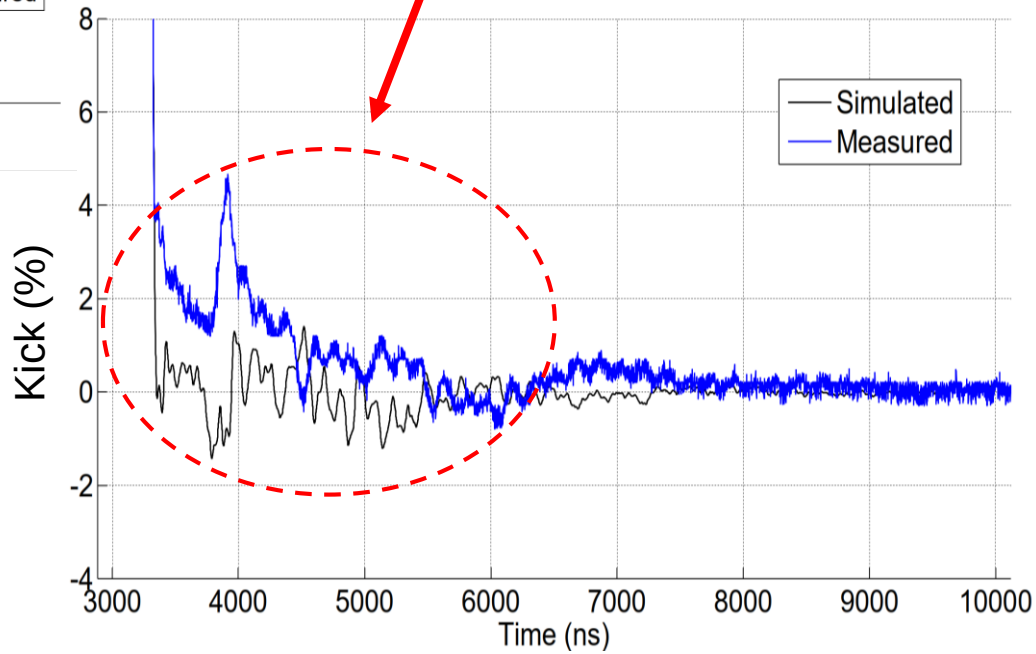
Good agreement of rise and fall times, even the simulation is more pessimistic in the rising edge

Magnetic field simulations vs measurements



Disagreement of flat top ripple

Disagreement in post pulse prediction



Conclusions

- Ripple **increases** on the **flat-top** and **decreases** on the **post pulse** w.r.t PFL voltage.
- Saturation effects observed @70kV and agree with previous measurements done when the magnet was constructed.
- Beam based method agrees with direct magnetic field measurements.
- pSpice model works pretty well, ev. some refinement on the model possible?
- Next steps:
  - New (long) probe
  - Measurement of new LIU magnet
  - Tuning of new connection box filter circuit
  - IPAC'19 paper

References

- T. Kramer *et al.,* “Feasibility study of the PS injection for 2 GeV LIU beams with an upgraded KFA-45 injection kicker system, operating in short circuit mode”, *Proc. of IPAC’16*
- V. Forte *et al.,* “Beam-based waveform measurements of the CERN PS injection Kicker”, *Proc. of IPAC’17*
- V. Forte *et al.,* “CERN PS Kicker for proton injection: From Beam-based waveform measurements to hardware improvements”, *Proc. of IPAC’18*
- A. Michet *et al.,* “A probe for kicker KFA45 Proton Synchrotron Booster”, CERN EDMS: 2065251
- N. Ayala *et al*., “Magnetic Field Waveform Measurements for the PS Injection Kicker Magnet PI.KFA45”, CERN EDMS: 2066720


CERN