

Dynamic Measurements with Static Coils and Hall Probes

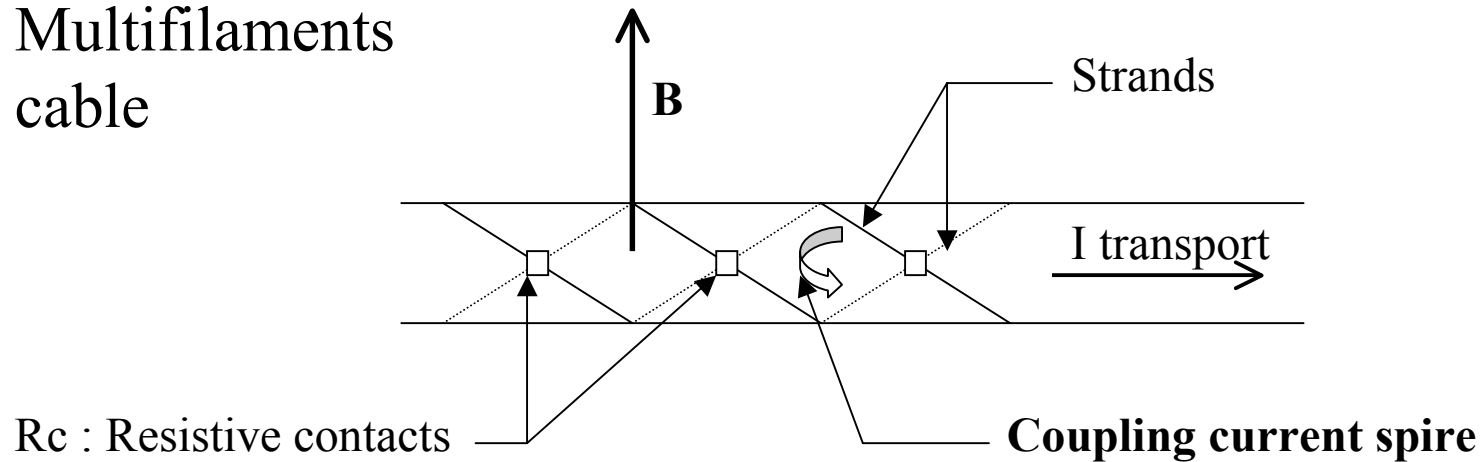
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Summary

- Loss & Field advance
- Principle of measurement
- Different methods of measurement
- Acquisition systems
- FA with PDI : Results
- Comparison between methods

Loss & Field advance

Multifilaments
cable



Interstrand & interfilaments coupling currents depends on :

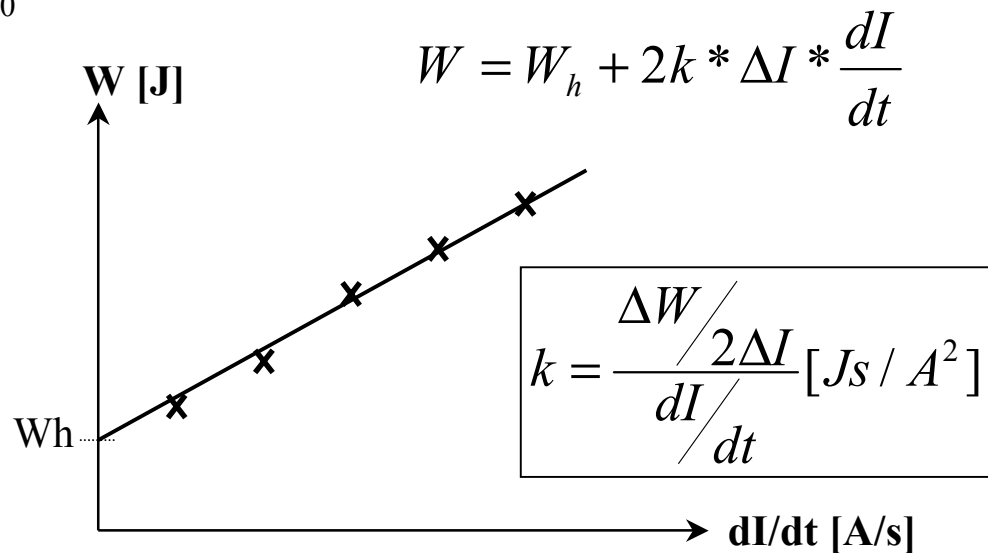
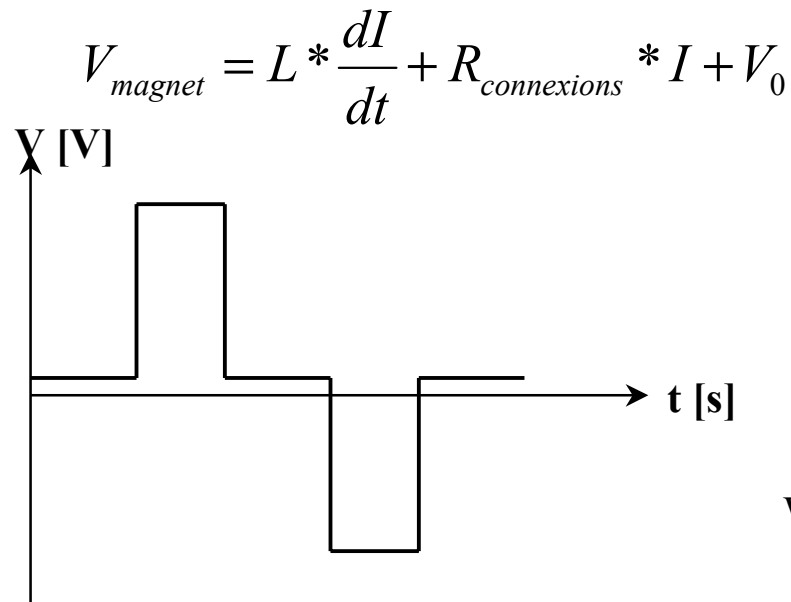
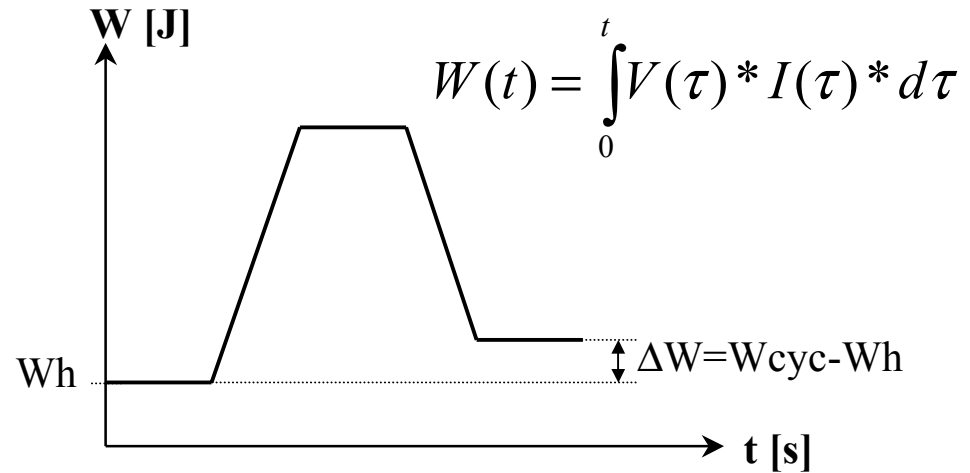
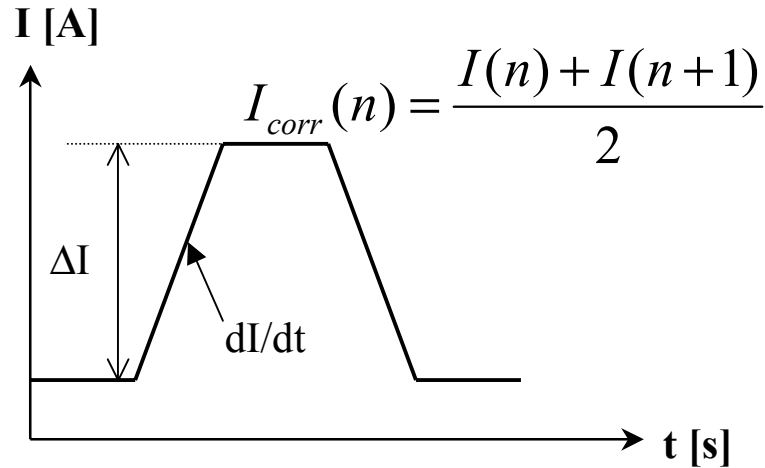
- the cable geometry
- the contact resistance between the strands
- the current ramp rate (linearly)

Loss & Field advance

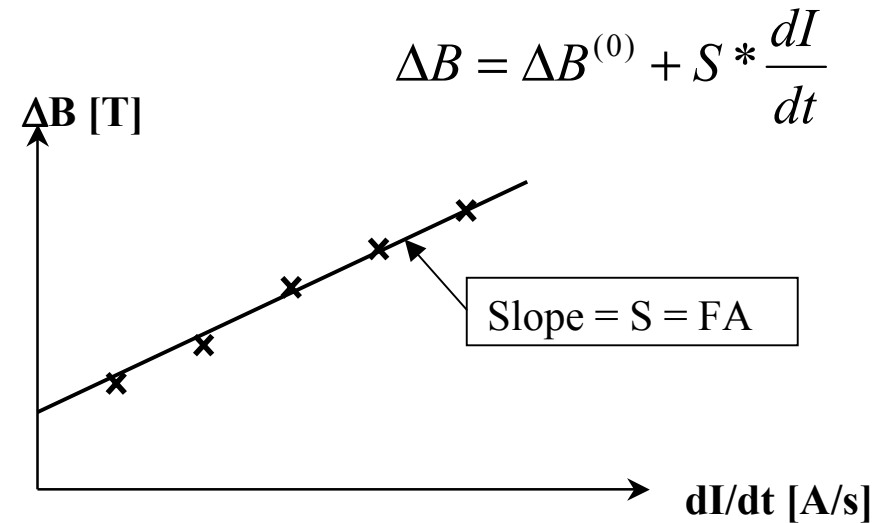
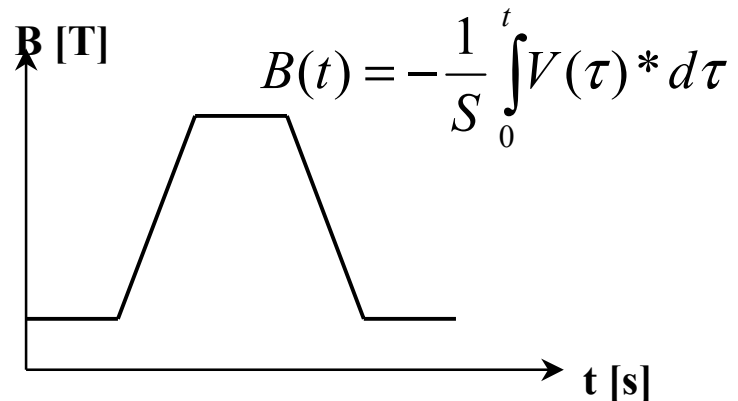
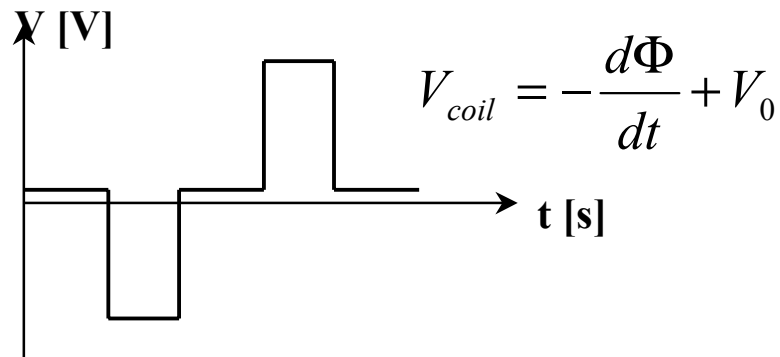
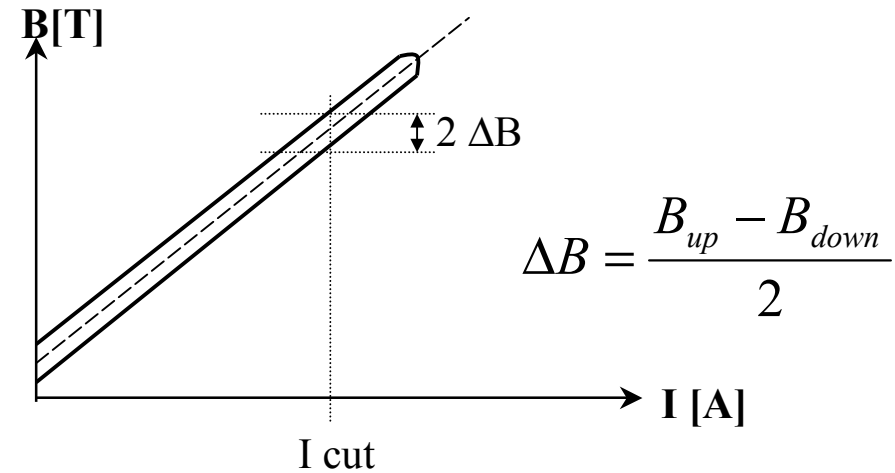
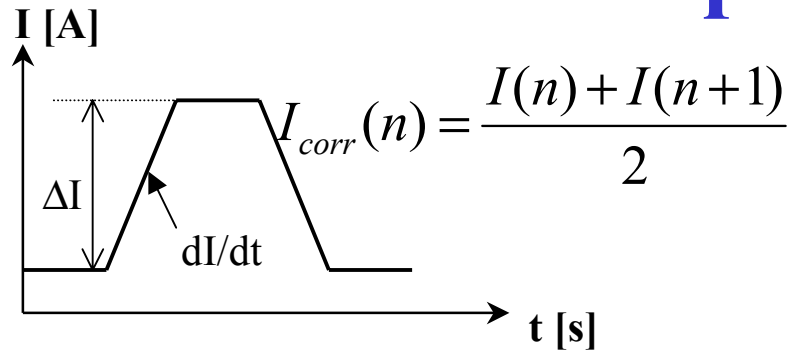
- Interstrand & interfilaments coupling currents
 - ⇒ Losses : energy dissipated in the magnet
 - ⇒ Field advance : distortion of the magnetic field due to eddy current

- Measurement at different current ramp rates
 - ⇒ Loss & FA factors
 - ⇒ resistive contact value (R_c) of cables
 - comparison of R_c get with different methods

Loss : Principle of measurement



FA : Principle of measurement

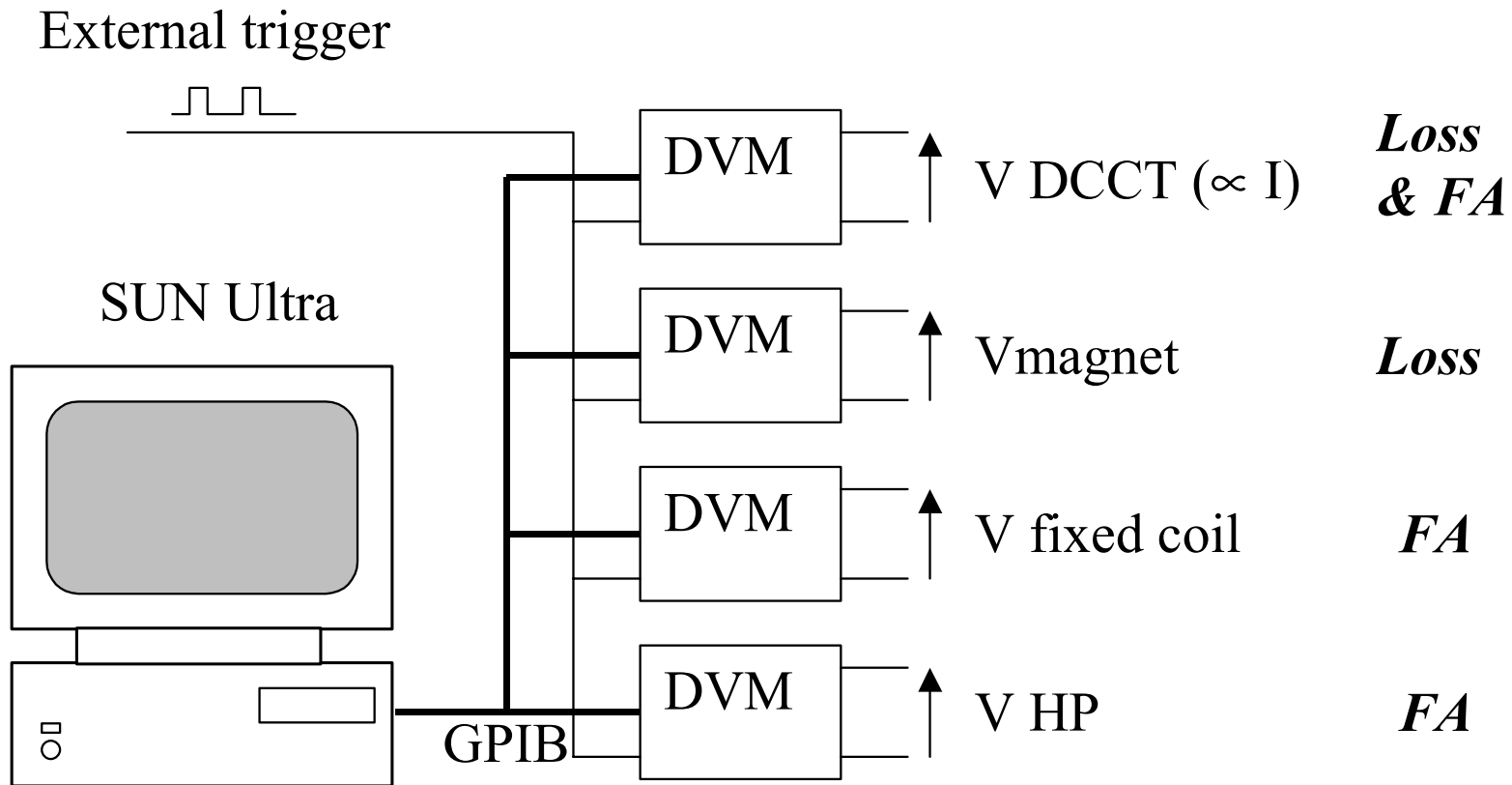


Different methods of measurement

Measure	Pick-up	Measuring instrument	Measurand
Loss	Voltage taps	DVM	Vmagnet
FA	Fixed coils (induction)	DVM	Vcoil
FA	Hall probes	DVM	V HP
FA	Fixed coils (induction)	PDI	$\Delta\psi \equiv \int V_{\text{coil}} * dt$

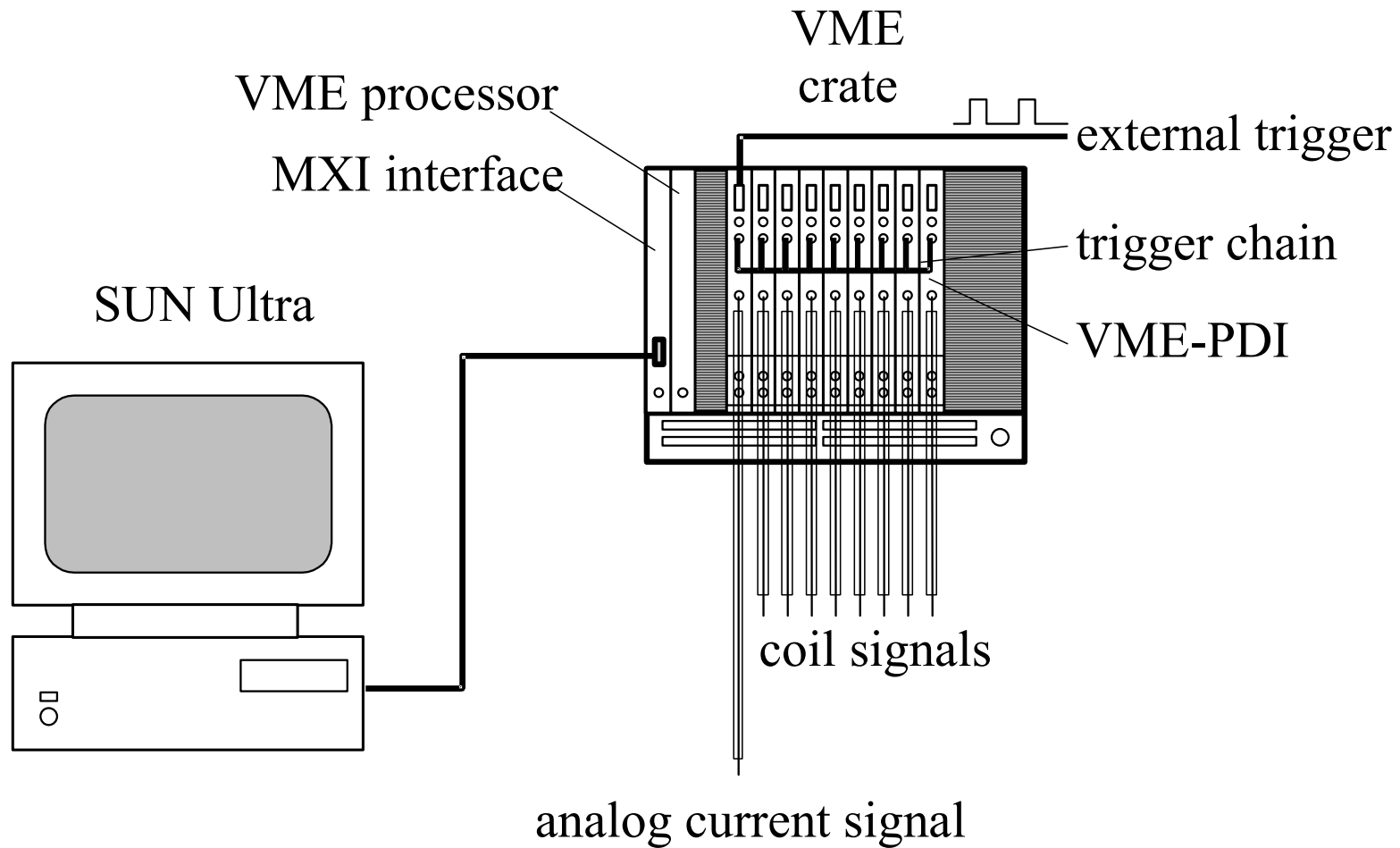
Loss & FA : Acquisition system

→ Using digital voltmeters KEITHLEYS (DVM)

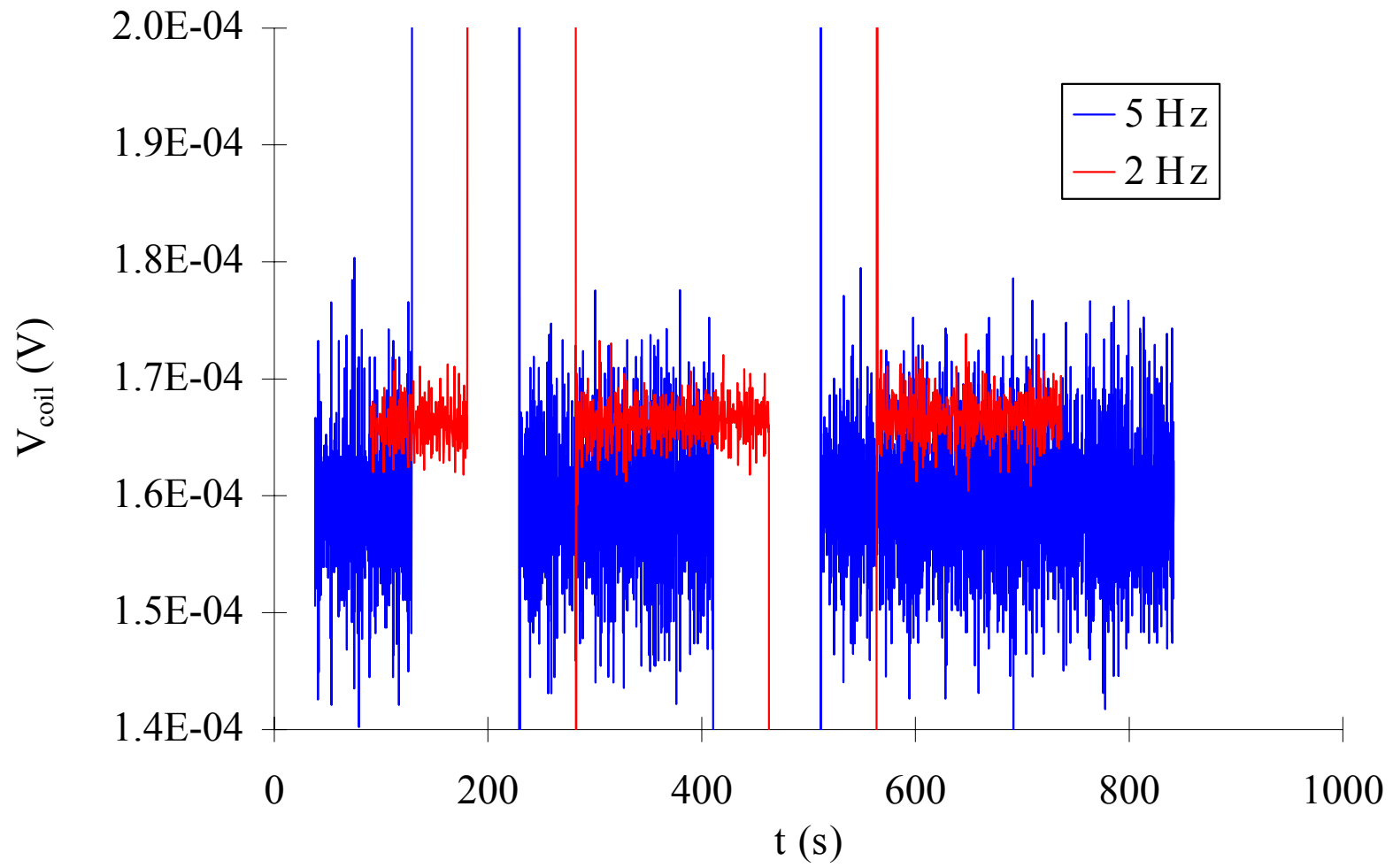


FA : New Acquisition system

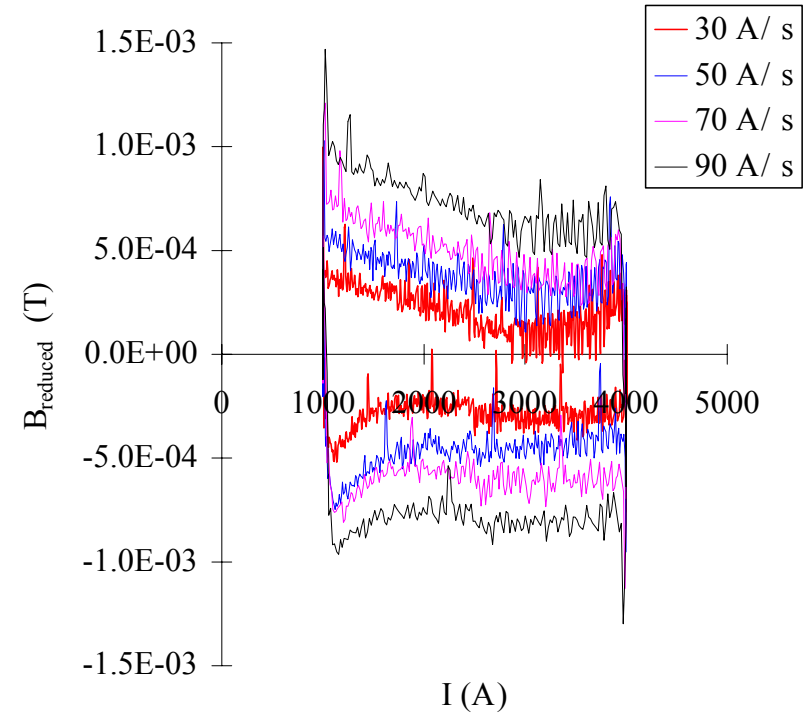
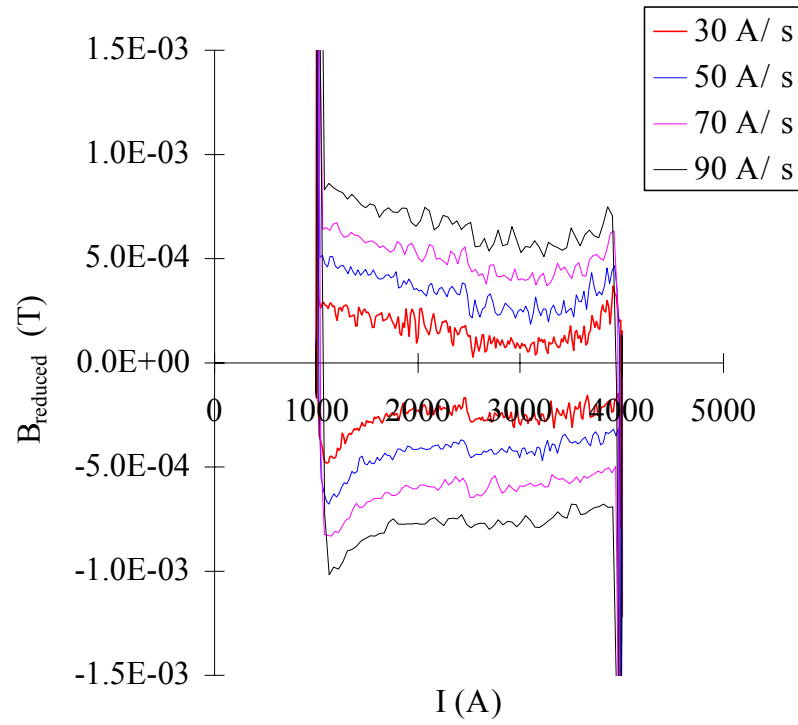
→ Using precision digital integrators (PDI)



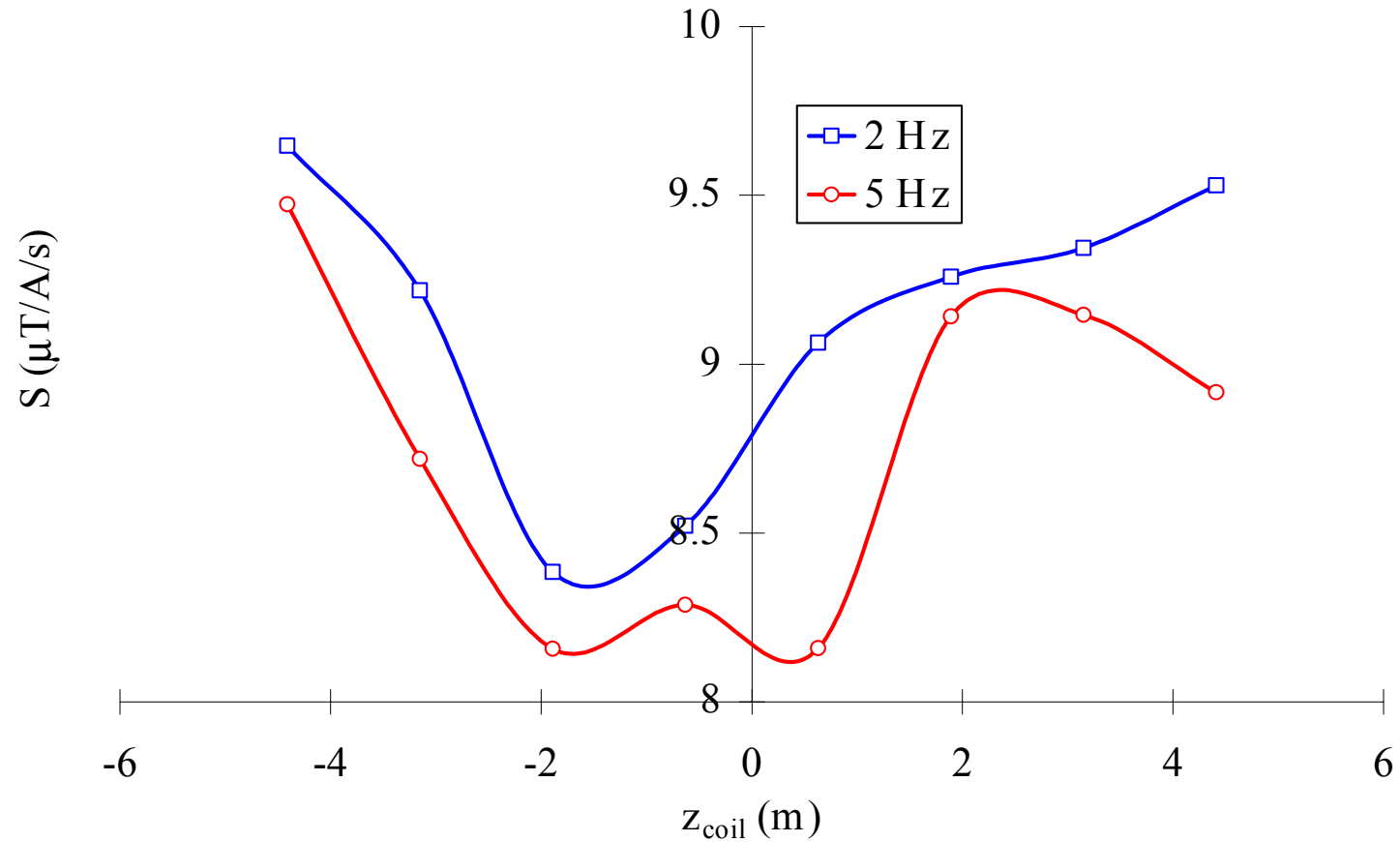
FA with PDI : Results



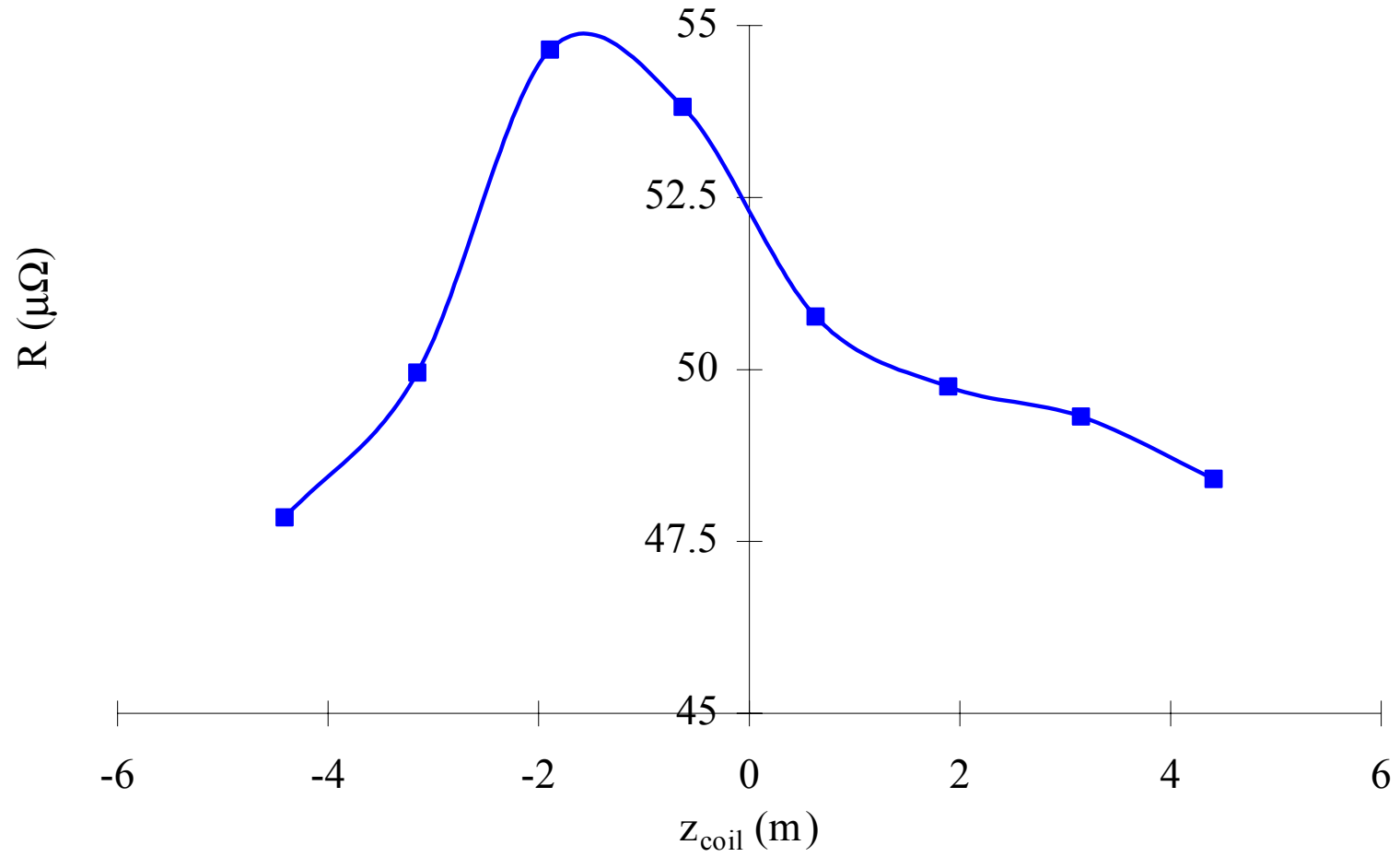
FA with PDI : Results



FA with PDI : Results



FA with PDI : Results



Comparison of the methods

Loss : VT + DVM	FA : Coils +DVM	FA : HP + DVM	FA : Coils + PDI
☺ Integral	☺ Integral (on all the magnet or on each sector)	☹ Local (average on many sensors (...)) ☺Reproducibility(?)	☺ Integral (on all the magnet or on each sector)
☺Magnet symmetry between apertures ☺ Energy dissipated $W=1/2*L*I^2$	☺ Only integral value of FA needed of accelerator control	☺ To study local aspects (Periodic Magnetic Field Pattern, transient effect)	☺ Only integral value of FA needed of accelerator control
☹ Integration $V_o \Rightarrow$ drift on $B(t)$ compensation by a linear regression		☺ No integration ($B=k*V$)	☺ Directly integrated ; data treatment easier
☹ DVM : Dead time -> accurate compensation			
☹ DVM : time dependant voltage offset		☺ less susceptible : short measurement	
☹ Current correction : synchronisation of field & current read-out New mecanism for synchronous current acquisition ?			

Conclusion

- 3 kinds of measurements :
 - Loss : Energy aspect
 - FA with coils : integral value needed for the accelerator performance assessment and control
 - FA with Hall Probes : local aspect
- 2 acquisition systems :
 - Precision digital integrators : coils
 - Digital voltmeters : voltage taps, Hall probes