

Beam instrumentation of the low-energy synchrotron

M. Elisei

J. Galvez

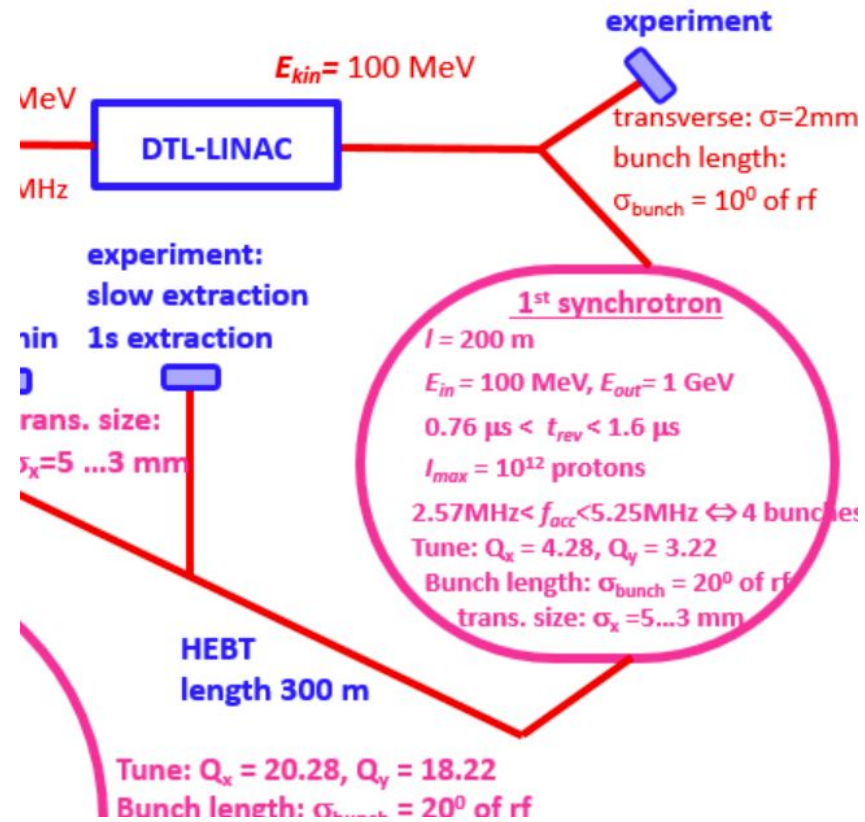
G. Mota

A. Berretta

H. Jaworska

Beam quantity		Synchrotron
Current I	General	Transformer, dc & ac
	Special	Pick-up Signal (relative)
Profile x_{width}	General	Ionization Profile Monitor Wire Scanner, Synchrotron Light Monitor
	Special	
Position x_{cm}	General	Pick-up (BPM)
	Special	
Transverse Emittance ϵ_{tran}	General	Ionization Profile Monitor Wire Scanner
	Special	Transverse Schottky
Bunch Length $\Delta\phi$	General	Pick-up Wall Current Monitor
	Special	Streak Camera Electro-optical laser mod.
Momentum p and Momentum Spread $\Delta p/p$	General	Pick-up (e.g. tomography)
	Special	Schottky Noise Spectrum
Longitudinal Emittance ϵ_{long}	General	
	Special	Pick-up & tomography
Tune and Chromaticity Q, ξ	General	Exciter + Pick-up
	Special	Transverse Schottky Spectrum
Beam Loss r_{loss}	General	Particle Detectors
Polarization P	General	Particle Detectors
	Special	Laser Scattering (Compton scattering)
Luminosity L	General	Particle Detectors

Non-destructive methods Continuous measurements during acceleration



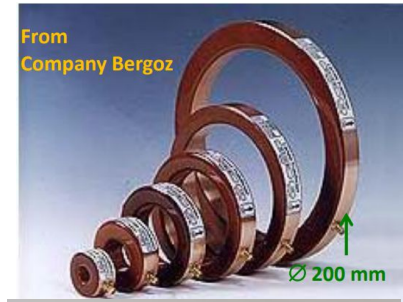
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Current measurement:

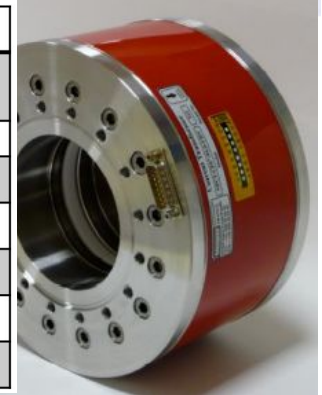
- **FCT**: Beam current, bunch-by-bunch. There is a trick for measuring DC level
- Bunched beam, bunch length of a few ns

$$2.57\text{MHz} < f_{RF} < 5.25\text{MHz}$$

$$44.4\text{ns} > \sigma_{bunch} > 21.1\text{ns}$$



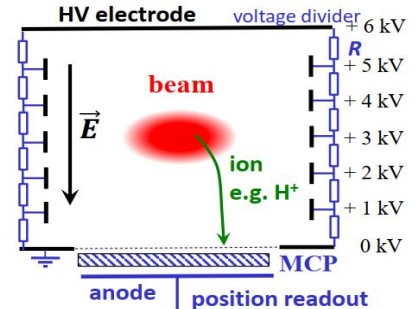
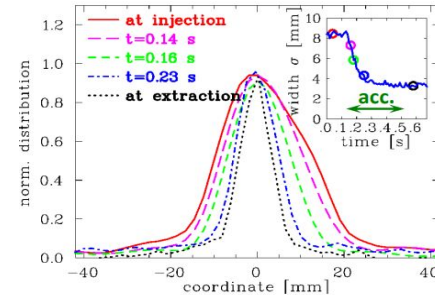
Inner / outer radius	70 / 90 mm
Permeability	$\mu_r \approx 10^5$ for $f < 100\text{kHz}$ $\mu_r \propto 1/f$ above
Windings	10
Sensitivity	4 V/A for $R = 50 \Omega$
Resolution, full BW	30 μA_{rms}
Droop time $\tau_{droop} = L/R$	0.2 ms
Rise time $\tau_{rise} = \sqrt{L_S C_S}$	300 ps
Bandwidth	2 kHz ... 500 MHz



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Transverse profile:

- Wire scanner not suitable
 - Low repetition rate
 - Destructive for low energy.
- Synchrotron light monitor: Requires high synch. rad. emission
- **Ionization profile monitor**
 - Suitable for long time observation during ramp
 - Type choice: **IPM**



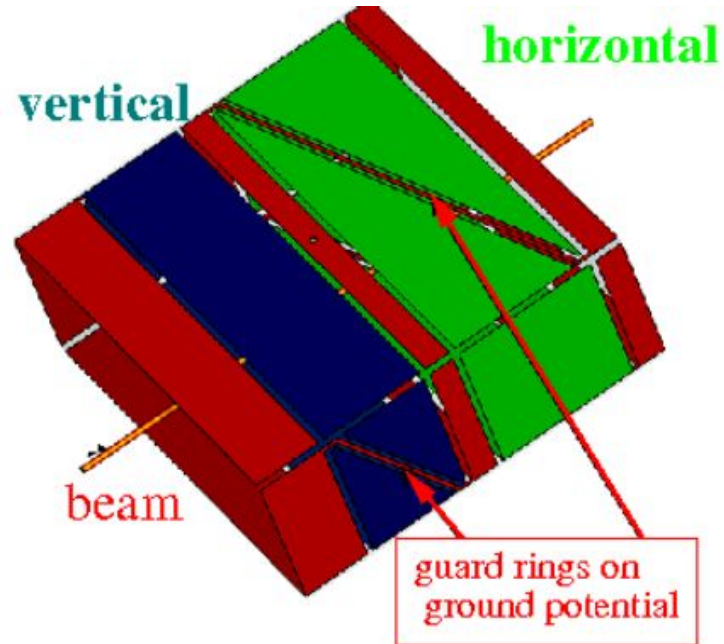
Transverse emittance:

- Wire scanner: not suitable (as explained before)
- **ionization profile monitor:**
 - Already used for profile monitor

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Transverse Position:

- Button BPM: Not suited (f_{cutoff} too high)
- **Pick-ups: Linear-cut BPM**
- 1 device per section, at least



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Bunch length:

- Electro-optical: Requires high synch. rad. emission
- Streak camera
 - destructive, energy too low
- Pick-ups:
 - Low frequency (< 3 GHz)
 - Bunch length \gg Antenna
 - Wall current monitor

Tune and Chromaticity Q, ξ :

- Pick-ups: Linear-cut BPM
 - Excitation of coherent betatron oscillations by exciter

Momentum spread:

- Schottky: only unbunched beam
- Pick-ups (linear-cut): Tomography

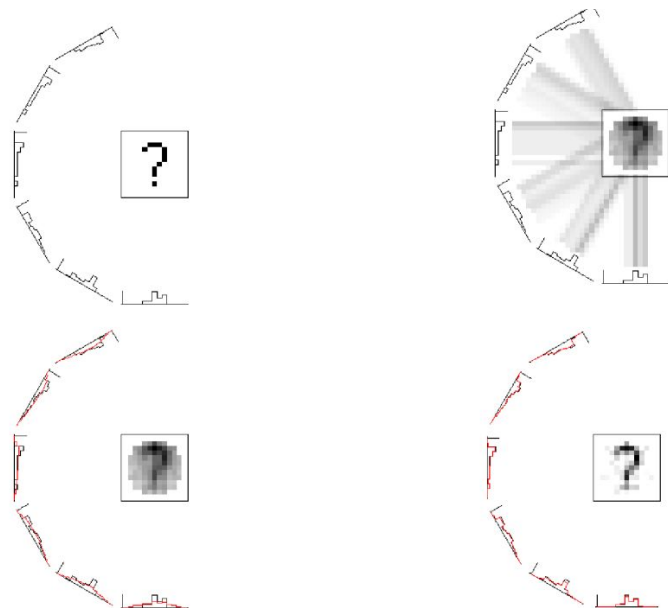
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Longitudinal Emittance:

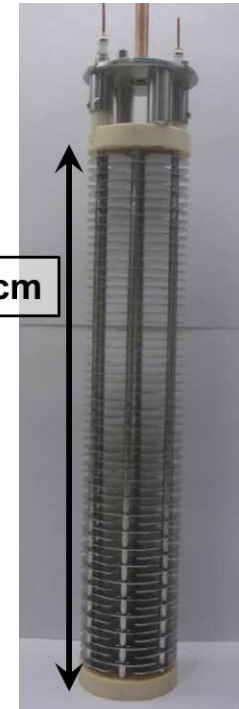
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Beam Loss:

- Ionization Chamber: measure of absolute dose, low gamma



Thank you!