

Development of a Stochastic Cooling System for EDM Experiments at COSY

CERN EDM Kick-Off Meeting

March 13th 2017 | [Bernd Breitkreutz](#), Nikolay Shurkhno, Rolf Stassen, Hans Stockhorst

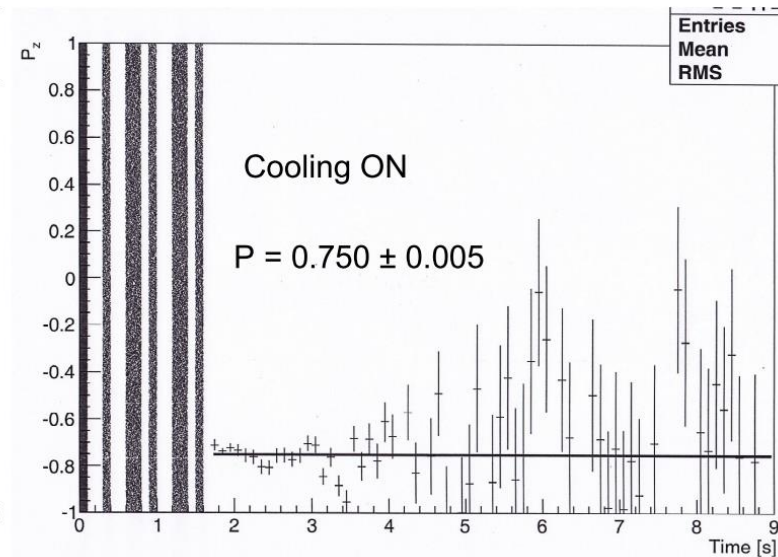
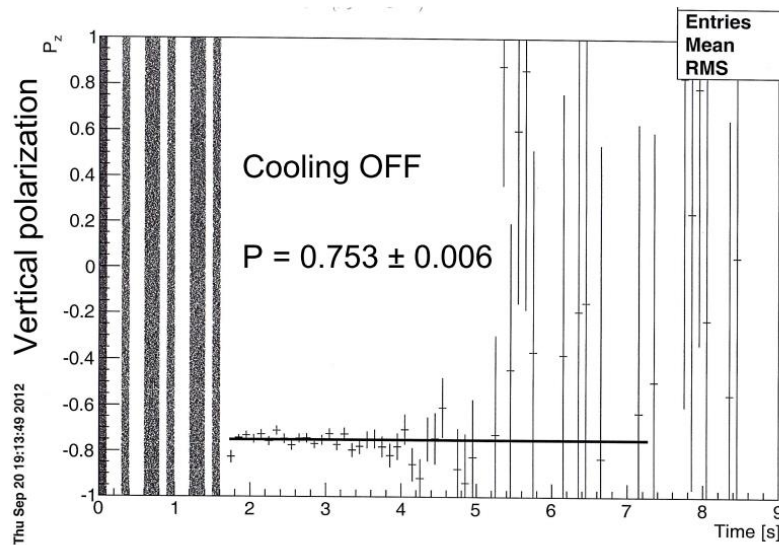
Motivation

- Requirements for EDM experiments at COSY
 - Small momentum spread and emittances for high spin coherence time
- Pre-Cooling is done with 100kV e-Cooler
- E-Cooler has solenoids which may not be perfectly compensated, and therefore can influence the spin
- Pre-cooling, or maybe permanent cooling with a stochastic cooling system would be desirable
- Existing stochastic cooling system not sensitive at low particle velocities

Development of a dedicated stochastic cooling system for EDM experiments

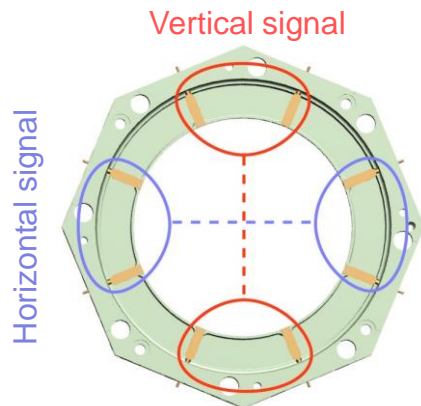
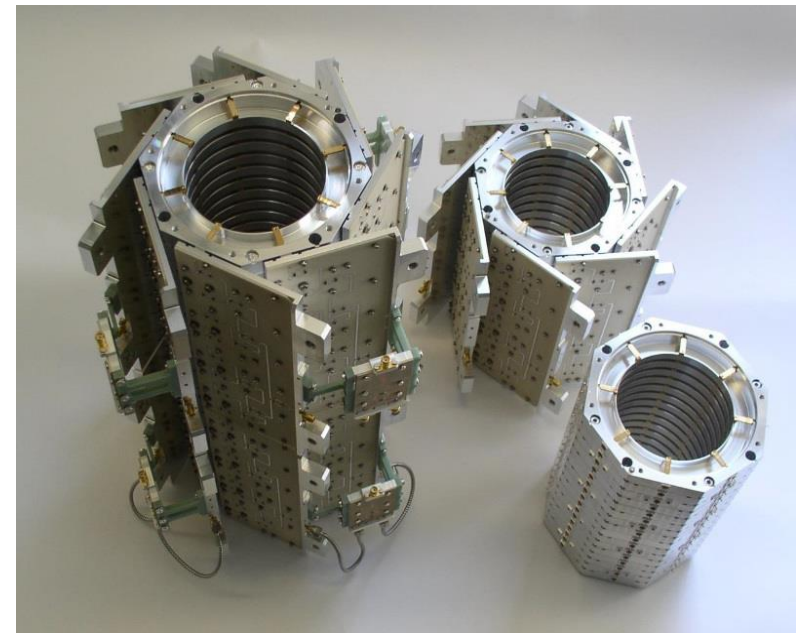
Cooling of Polarized Beams: Proof of Principle

- Is stochastic cooling a source of depolarization?
- Influence of stochastic cooling on beam polarization was investigated at COSY in 2013
 - 1965 MeV/c protons, $N=3 \cdot 10^8$
 - Vertical cooling, to apply horizontal magnetic fields
 - *After 30 minutes no polarization loss has been observed*
- It was shown that Stochastic Cooling of polarized beams is possible at COSY



Pick-up and Kicker for HESR

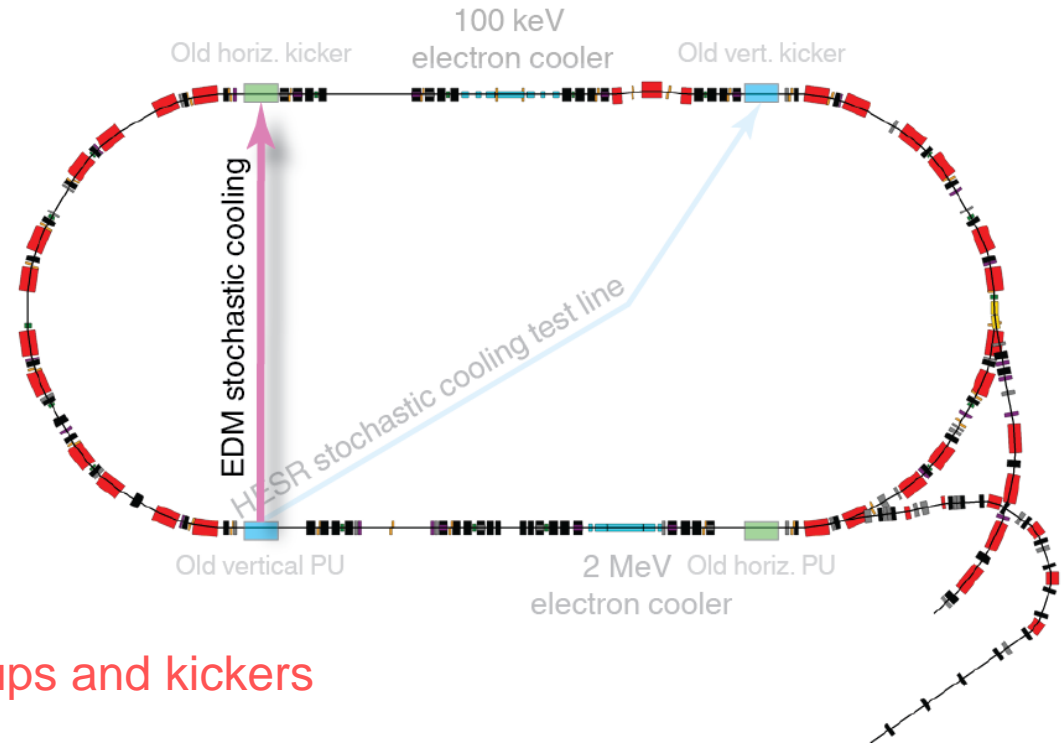
- Ring-slot structures newly developed for HESR
- Currently installed at COSY
- 2-4 GHz cooling band
- Advantages
 - High coupling impedance
 - Simultaneous 3D operation
 - Static aperture



System Considerations

Related parameters:

Circumference	184 m
Ions	d+
Intensity	10^9
Kin. energy	118 MeV/u
β	0.46
δ_{rms}	$2 \cdot 10^{-4}$
η	0.6



New design required for pick-ups and kickers

Cooling band considerations

- Bad mixing above 700 MHz
- PU/KI performance is insufficient above 1GHz

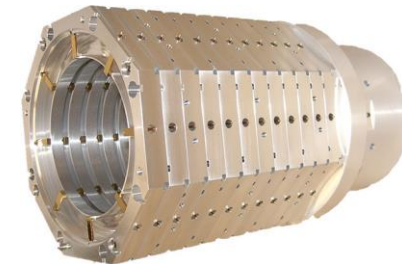
→ Frequency Band: 350 – 700 MHz

Pick-up and Kicker Design for EDM Experiments

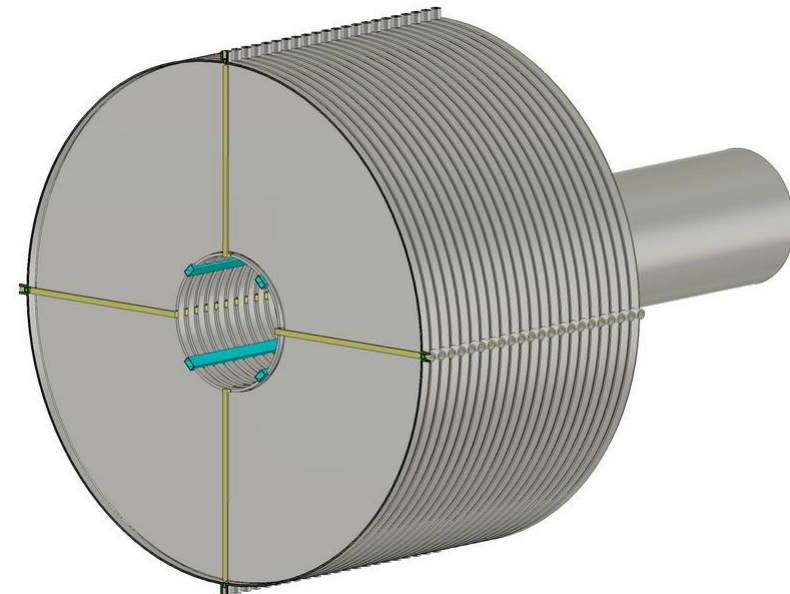
- Based on HESR ring-slot design
- 90 mm aperture
- Frequency tuning: slot width increased from 13mm to 150mm
- Mechanical stiffness: thicker walls, supporting features
- No ferrites needed

$$(f_{c,TE11} = 1.95\text{GHz})$$

- Only 4 electrodes per ring instead of 8
- First test rings are currently under construction



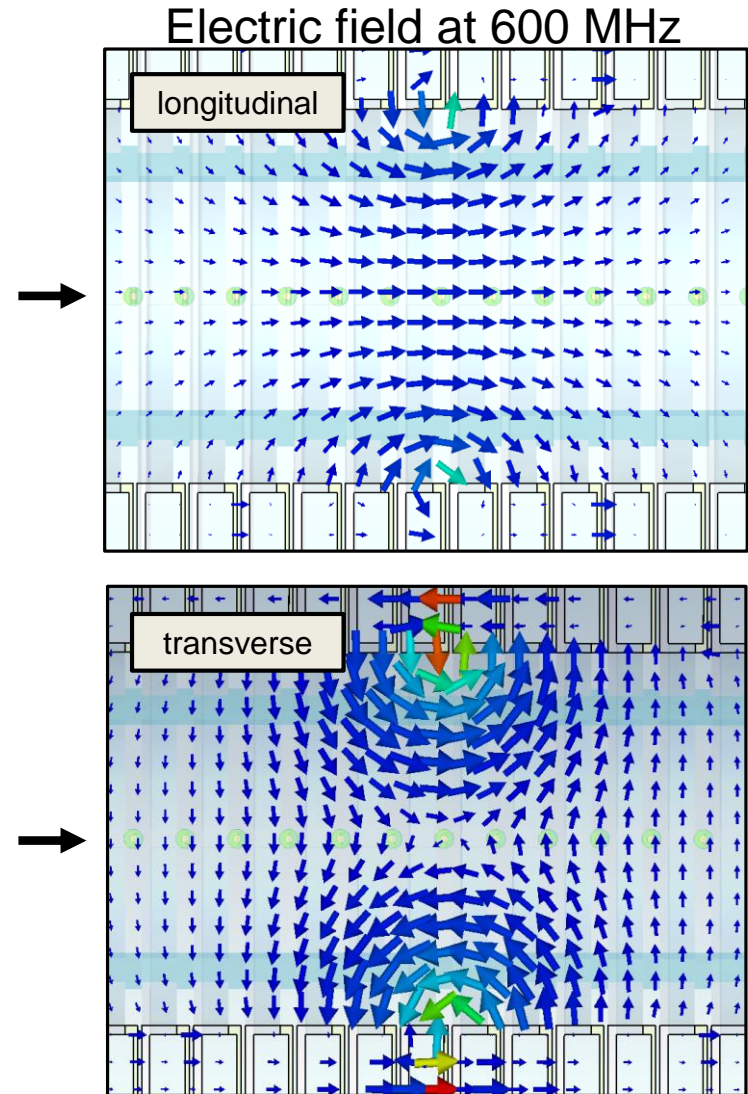
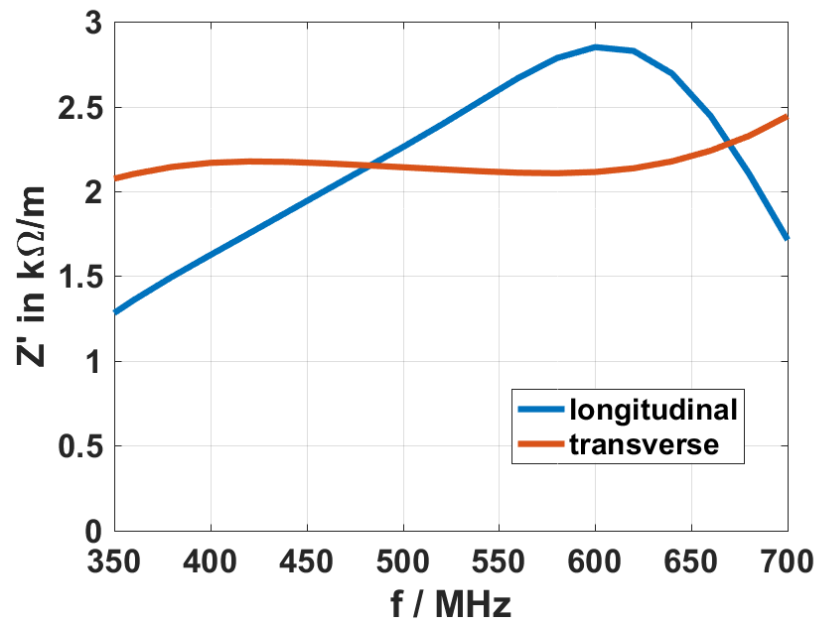
HESR ring-slot coupler



New ring-slot coupler design

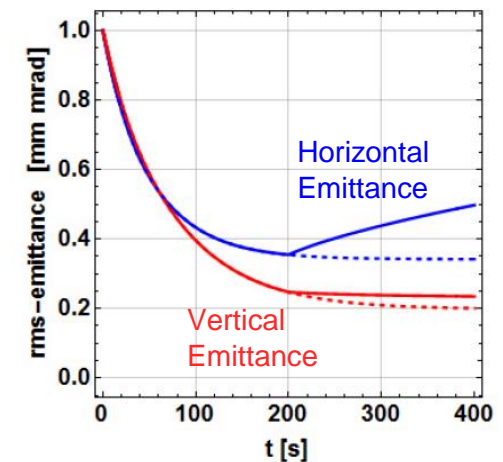
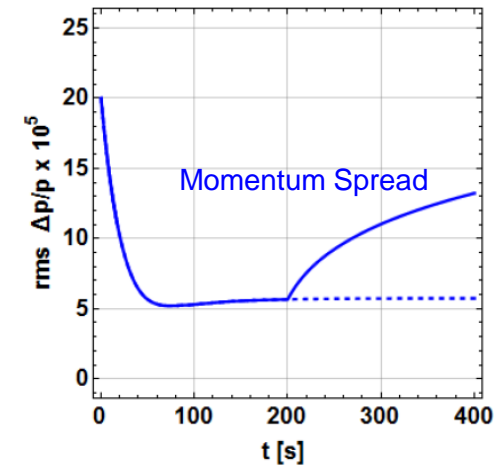
Kicker Performance

- Longitudinal and transverse kicker shunt impedance have been simulated with CST Microwave Studio
- The sensitivity of the EDM kicker is comparable to the HESR kicker.



System Performance (Simulation Results)

- System simulation
 - Cooling of all three planes simultaneously
 - Intra-beam scattering is considered
- Anticipated equilibrium states:
 - $6 \cdot 10^{-5}$ rms momentum spread
 - 0.35 mm mrad horizontal rms emittance
 - 0.2 mm mrad vertical rms emittance
- After switching off cooling: beam blow-up due to intra-beam scattering
 - Permanent cooling would be beneficial
- Microwave power less than 5 W
 - Off-the-shelf power amplifiers perfectly good



Dotted curves: cooling is not switched off

Summary

- A stochastic cooling system for polarized low energy beams at COSY is under development
- Supposed to serve as a replacement for e-cooling, has no solenoids
- Experiments showed that beam depolarization by the system is not to be expected
- A satisfying performance is anticipated
- System of manageable cost
 - Standard power amplifiers sufficient
 - Structures of comparatively low complexity