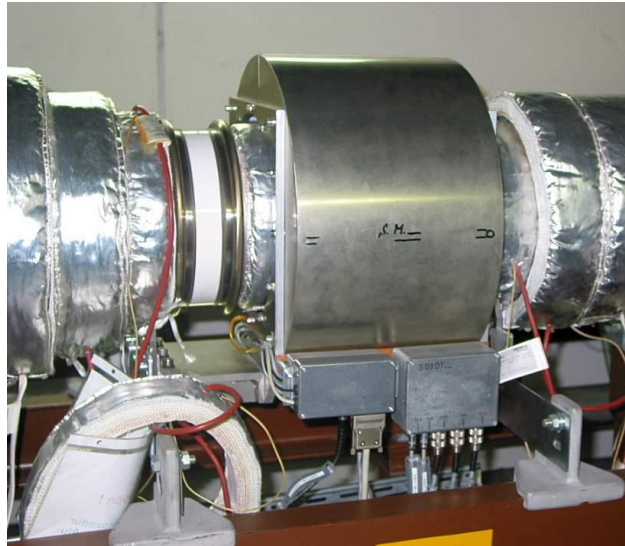


## DCCT **GS09DT-ML**, mounted in the **SIS18** (GSI development)

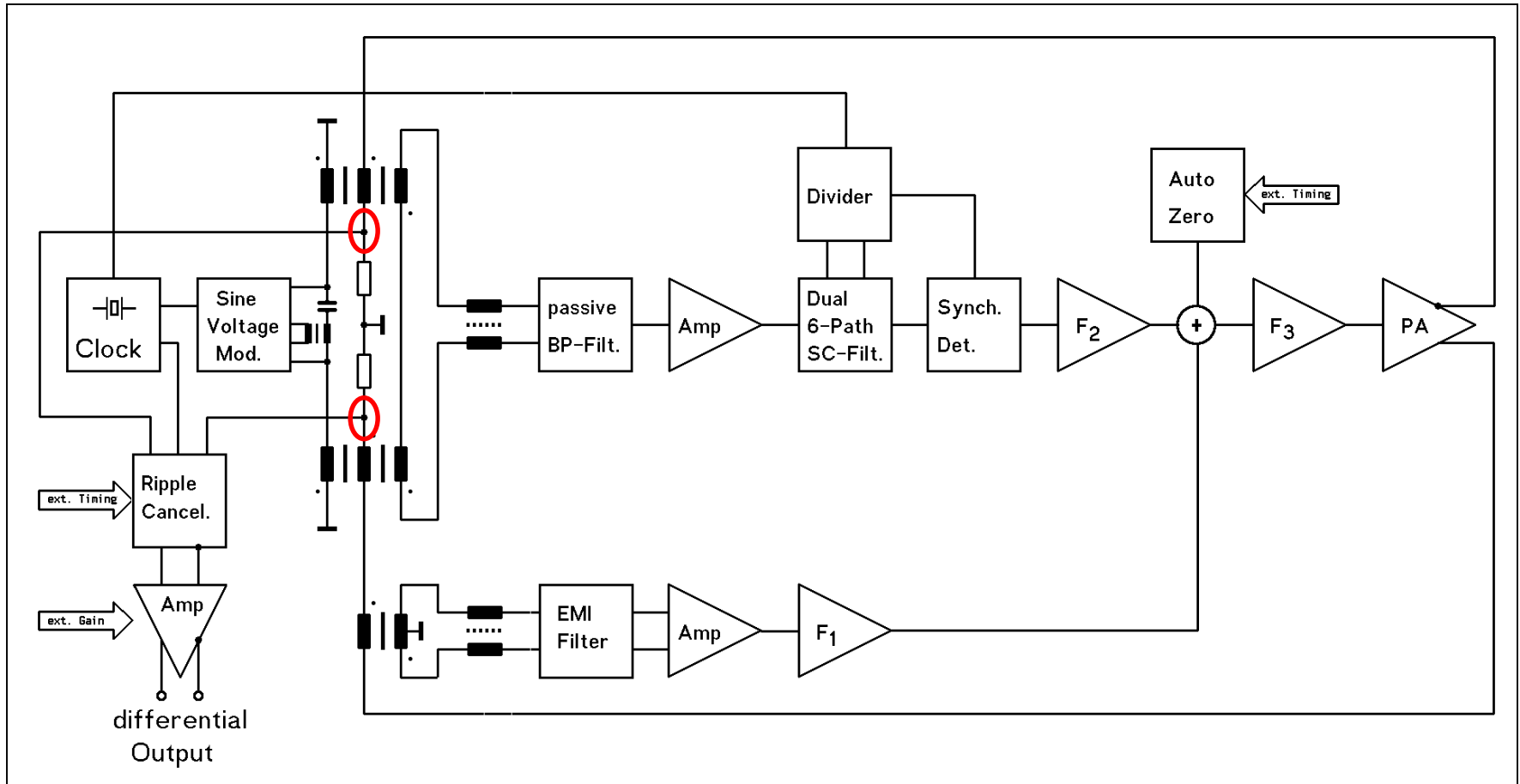


- Chamber for UHV, bakeable upto 300°C
- Aperture: DN200CF
- Length: 600mm
- Al<sub>2</sub>O<sub>3</sub> ceramic gap, resistive coating on inner surface
- Dual-layer Mumetal® magnetic shield



- Remote control / ADC placed outside of tunnel
- Locally mounted 19" front end electronics (see bottom)
- DCCT upgraded with 2 V/f-converter outputs:
  - fixed range 1 MHz f. s. / 60mA beam current
  - 1MHz f.s. for each selected range

# GSI DCCT block diagram



**○** => differential voltage proportional to DC beam current /  $U_{\text{diff}} \sim I_{\text{beam}} \cdot 16.66 \text{ V/A}$ ,  
dynamic range  $\geq 100 \text{ dB}$

## GSI DCCT: A magnetic modulator with the usual 3-core scheme

• <b>Dimensions of toroids:</b>	264 x 284 x 10 mm
• <b>Magnetic ribbons:</b>	VITROVAC® 6025F, t = 25 μm
• <b>Winding schemes:</b>	$N_{loop}=12$ , $N_{DC}=16$ , $N_{AC}=96$ , $N_{mod}=16$
• <b>Main control loop:</b>	Current driven, burden resistance 200 Ω
• <b>Control sub-loops:</b>	Peak modulation current, Auto-Zero
• <b>Modulation characteristics:</b>	Sine voltage, with avalanche capacitor
• <b>Modulation frequency:</b>	987.5 Hz
• <b>Peak excitation field:</b>	~ 20 A/m
• <b>Crossover frequency DC/AC channel:</b>	~ 6 Hz
• <b>Open loop gain at DC:</b>	>120 dB
• <b>Open loop - 0 dB crossing frequency:</b>	~ 0.4 Mhz
• <b>Signal transmission, toroids to front end:</b>	differential, twisted pair lines
• <b>Cable length, toroids to front end:</b>	2.5 m, limited by cable capacitances
• <b>Min. Shunt impedance @ DC:</b>	≥ 2 kΩ, across toroid stack

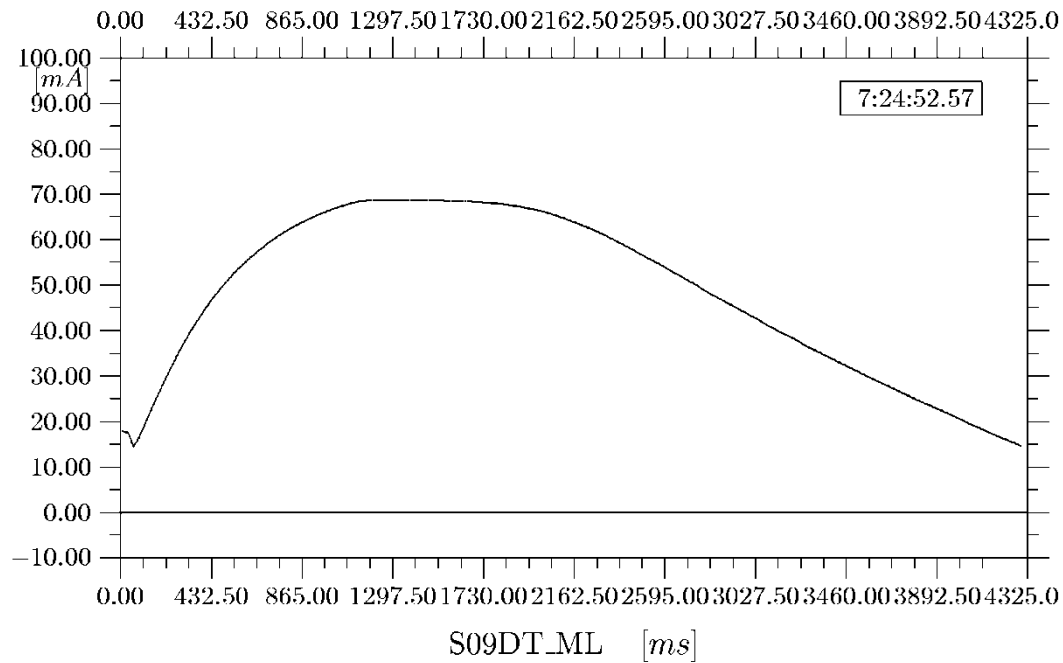
## GSI GS09DT-ML DCCT Specifications

- **8 Current Ranges:**  $\pm 300 \mu\text{A}$  to 1 A DC f. s., (1... 3 ... 10 ...)
- **Bunched Beam Current Limit:**  $\sim 40 - 100 \text{ mA}$ , dependent on bunch frequency / harmonic no.
- **DC Gain error:**  $\leq 0,1 \%$  (for  $I < 50 \text{ mA}$ )
- **DC Linearity error:**  $\leq 0,1 \%$  (for  $I < 50 \text{ mA}$ )
- **1/f-noise corner frequency:**  $\sim 2 \text{ Hz}$
- **Offset Temperature coefficient:**  $\sim 5 \mu\text{A}/^\circ\text{C}$
- **Auto-Zero function:** active during time gap between 2 consecutive acc. cycles
- **Zero error absolute:**  $\pm \sim 2.5 \mu\text{A}$
- **Zero Error due to external mag. fields:**  $\sim 6 \mu\text{A} / \text{T}$  of main dipole field
- **Current resolution:**  $\sim 5 \mu\text{A}_{\text{pp}}$  @ 20 kHz bandwidth ( $\sim 1 \mu\text{Arms}$ ), S/N=1, range 100  $\mu\text{A}$
- **Output bandwidth:** DC ..  $\sim 2 \text{ kHz}$  (small signal; new output sample every  $\sim 506 \mu\text{s}$ )
- **Ripple cancellation:**  $2 * f_{\text{Mod}}$ -synchronous sampling at zero-crossing of output signal
- **Test current:** pulse of 5ms duration and  $\sim 50\%$  f.s. amplitude (matched to the selected current range), injected into a single turn around the toroid
- **Built-in Voltage-to-frequency converters :** TTL 50 $\Omega$  output, Ch1:  $f_{\text{max}} = 1\text{MHz}$  @ 60 mA beam current  
Ch2:  $f_{\text{max}} = 1\text{MHz}$  for each f.s. range

# Typical operation of GSI/SIS18 DCCT at higher beam intensity

HFS S08  $^{40}\text{Ar}^{18+}$  1035.000 MeV/u

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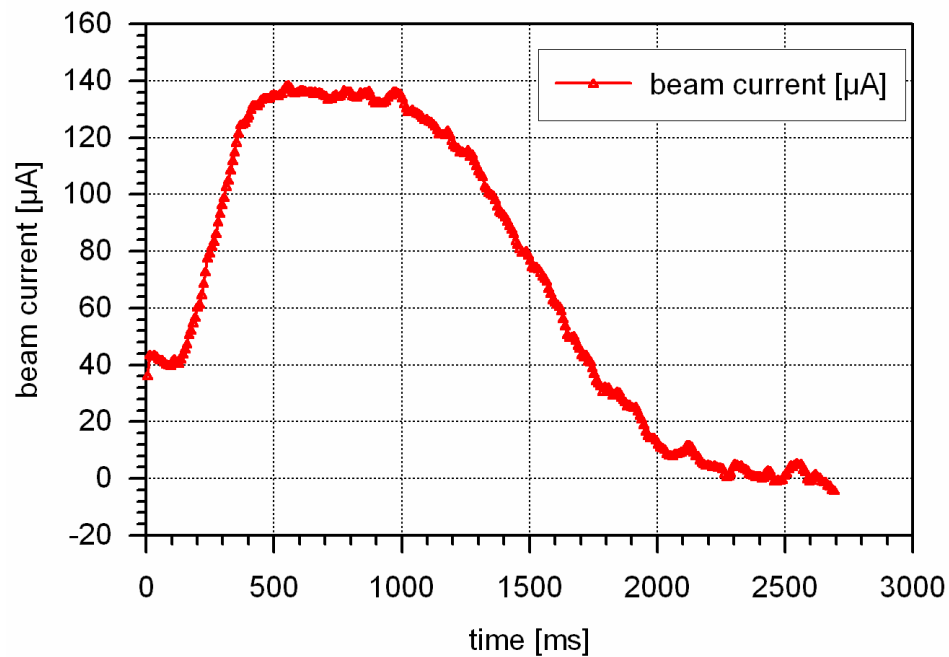


**A beam current cycle in SIS18**

# Typical operation of GSI/SIS18 DCCT at low beam intensity

$^{12}\text{C}^{6+}$  240.650 MeV/u

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A beam current cycle with intensity for tumor treatment