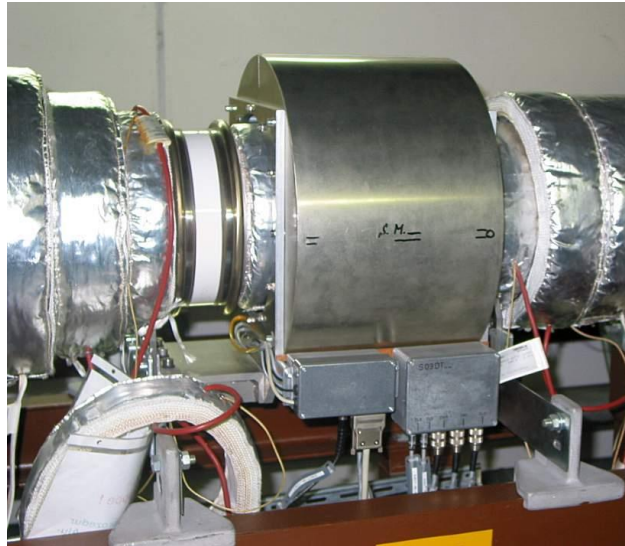


DCCT **GS09DT-ML**, mounted in the **SIS18** (GSI development)

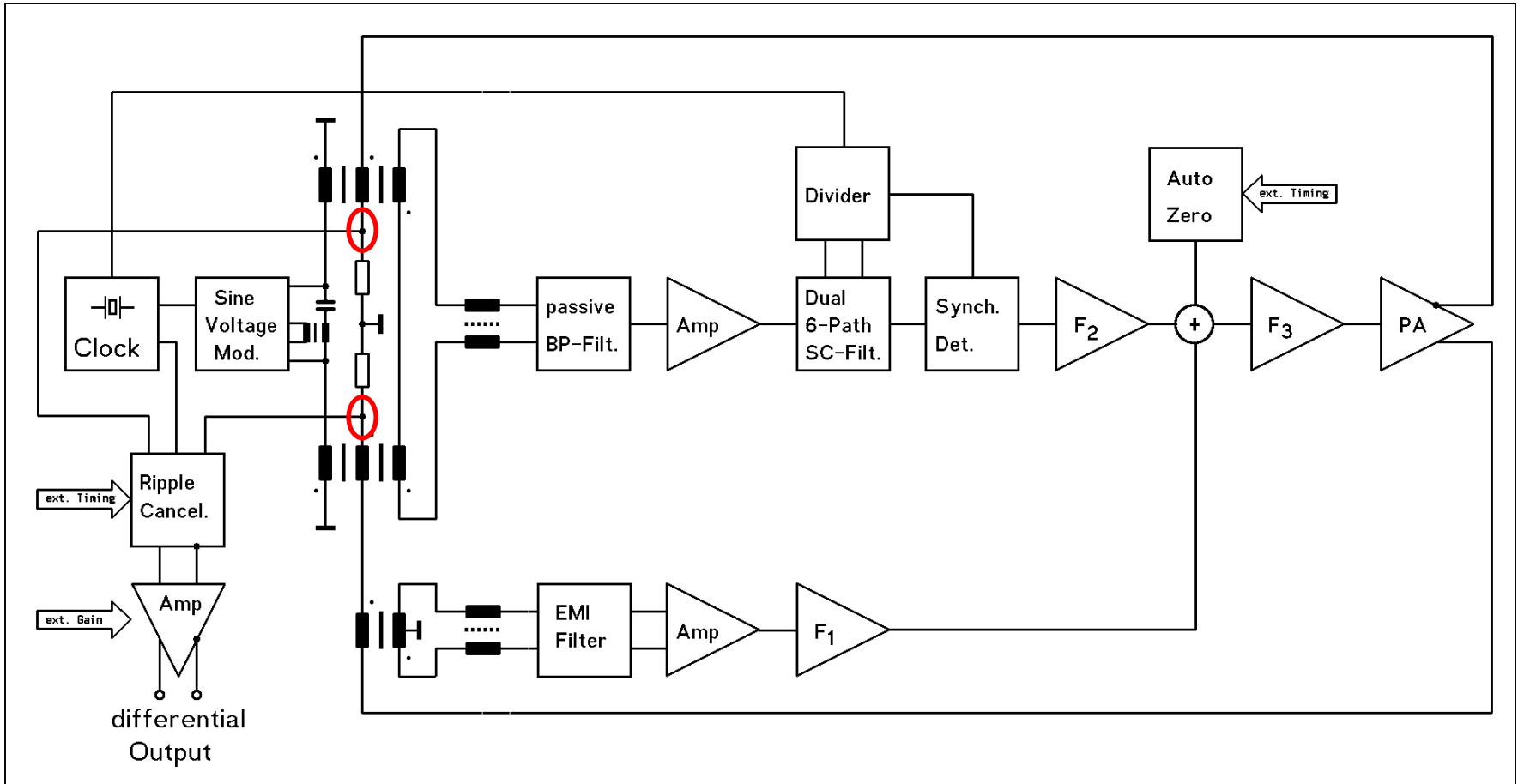


- Chamber for UHV, bakeable upto 300°C
- Aperture: DN200CF
- Length: 600mm
- Al₂O₃ ceramic gap, resistive coating on inner surface
- Dual-layer Mumetal® magnetic shield



- 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

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

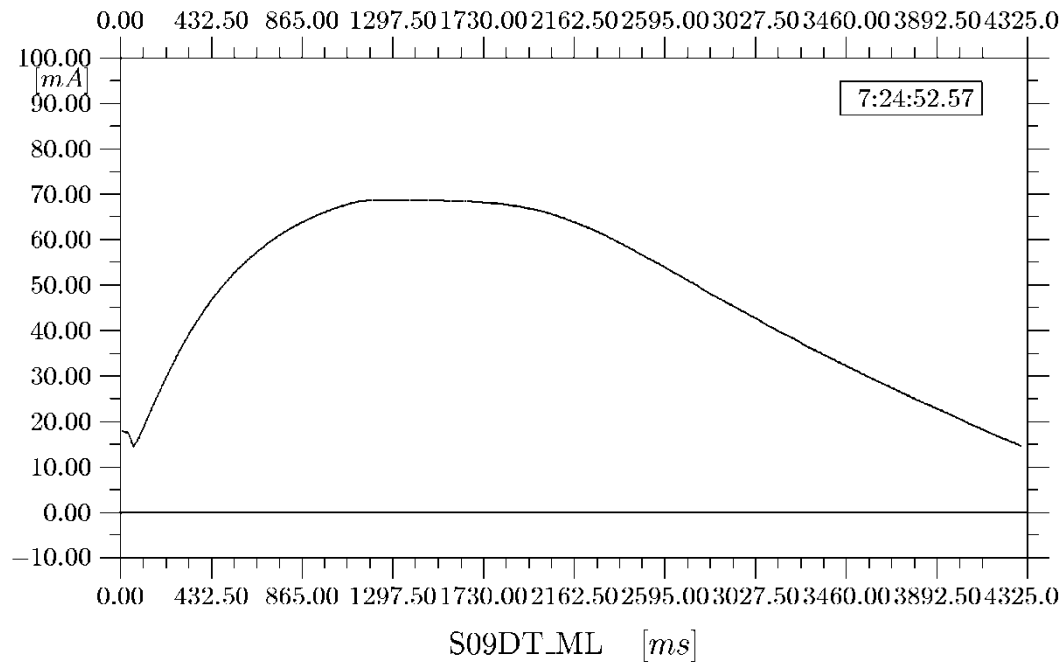
GSI GS09DT-ML DCCT, Specifications

• 8 Current Ranges:	$\pm 300 \mu\text{A} \dots 1 \text{ A}_{\text{DC}}$ f. s., (1... 3 ... 10 ...)
• Bunched Beam Current Limit:	$\sim 40 \dots 100 \text{ mA}$, 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 only during time gap between 2 consecutive acc. cycles
• Zero error, absolute:	$\sim \pm 2.5 \mu\text{A}$
• Zero Error due to external mag. fields:	$\sim 6 \mu\text{A} / T$ of main dipole field
• Output bandwidth:	DC .. $\sim 20 \text{ kHz} / -3\text{dB}$, (1st-order LP characteristics)
• Current resolution:	$\sim 5 \mu\text{A}_{\text{pp}}$ @ 20 kHz bandwidth ($\sim 1 \mu\text{Arms}$), S/N=1, range 100 μA
• Ripple cancellation:	by ADC – DAC chain (AC part of output signal, phase-reverted playback of 1 period of f_{mod})
• 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 stack
• Built-in Voltage-to-frequency converters :	TTL 50 Ω 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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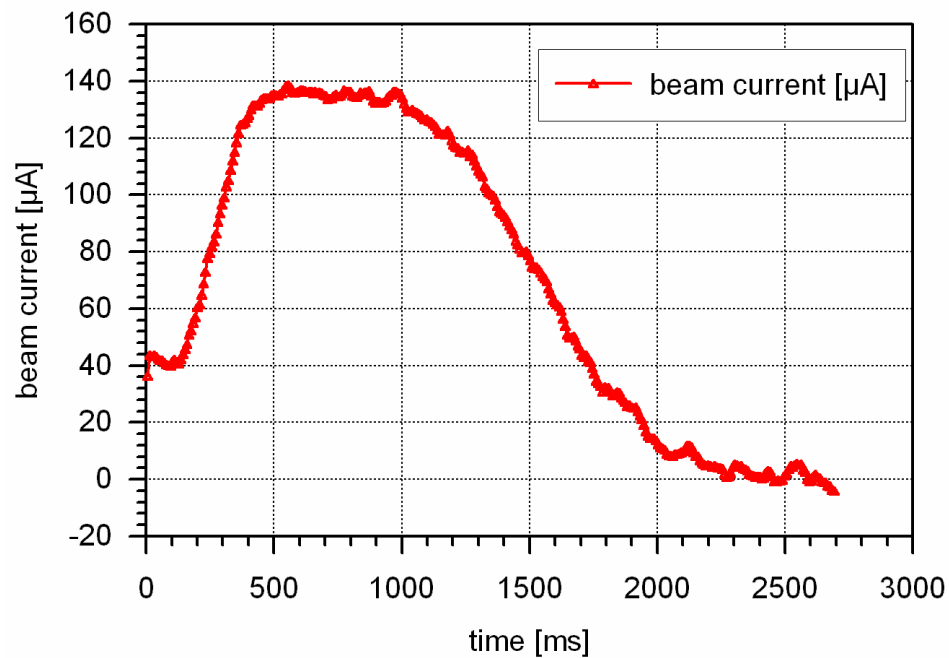


A beam current cycle in SIS18

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