
SNS impedance budget

- **Fedotov et al.**

September 3, 2002

Changes in Impedance Budget



- Impedance due to **EK** was reduced (Davino et al.).
- Impedance due to **RF** was measured (Davino et al.):
 - 2.1 Longitudinal resonances are identified.
 - 2.2 Transverse resonance will be damped by glow-bar.
- Impedance due to **BPM's** was recalculated.
- Impedance due to **Beam-In-Gap (BIG)** and **Tune-Kicker (TK)** were added to the table.

Impedance budget: low frequency approximation (below 10 MHz)



| | Z_ℓ / n [Ω] | Z_T [$k\Omega/m$] |
|--------------------------------------|--|-------------------------------|
| Space charge | -j196 | $j(-5.8+0.45)^1 \times 10^3$ |
| Extraction kicker² | 0.6n+j50 | 33+j125 ³ |
| Injection kicker⁴ | ≈ 0.5 , at w_0 | 17.5 (lowest tune 200 kHz) |
| RF cavity | Resonances: (7.48 MHz, $Q \approx 136$, 4.1 Ω); (12.24, 54, 5.0); (16.88, 71, 8.33); (18.3, 129, 3.94); (20.60, 61, 3.2); (25.50, 38, 3.08); (33.35, 52, 9.5). ⁵ | 9 (at resonance) ⁶ |
| Injection foil assembly | j0.05 ⁷ | j4.5 |
| Resistive wall | (j+1)0.71, at w_0 | (j+1)8.5, at w_0 |
| Broadband | | |
| BPM | j4.0 | j18 |
| BIG and TK | j1.1 | j7 |
| Bellows | j1.3 | j11 |
| Steps | j1.9 | j16 |
| Ports | j0.49 | j4.4 |
| Valves | j0.15 | j1.4 |
| Collimator | j0.22 | j2.0 |
| Total BB | j9 | j60 |

¹ incoherent and coherent part

² 25 Ω termination at PFN

³ measured inside vacuum vessel without feed-through

⁴ ceramic pipe coated with 0.7 μm of Copper and 0.1 μm of TiN of thickness

⁵ all parasitic modes will be removed; active feedback

⁶ resonance is damped with glow-bar at 17.82 MHz, $Q \approx 75$ (peak - 3k Ω/m for one cavity in first harmonic)

⁷ based on MAFFA simulation

Impedance budget: at 50 MHz



| | Z_ℓ / n [Ω] | Z_T [$k\Omega/m$] |
|--|----------------------------|--|
| Space charge | -j196 | $j(-5.8+0.45)^8 \times 10^3$ |
| Extraction kicker, 25 Ω termination | 19.4+j12 | 12.5 + j65⁹ |
| RF cavity | See before | $\cong 0$¹⁰ |
| Injection foil assembly | j0.05 | j4.5¹¹ |
| BPM | 2 + j3.5 | 9+j16 |
| BIG and TK | 0.7+j0¹² | 5.0+j0¹² |
| Broadband | | |
| Bellows | j1.3 | j11 |
| Steps | j1.9 | j16 |
| Ports | j0.49 | j4.4 |
| Valves | j0.15 | j1.4 |
| Collimator | j0.22 | j2.0 |
| Total BB | j4.1 | j35 |

⁸ incoherent and coherent part

⁹ measured inside vacuum vessel without feed-through;

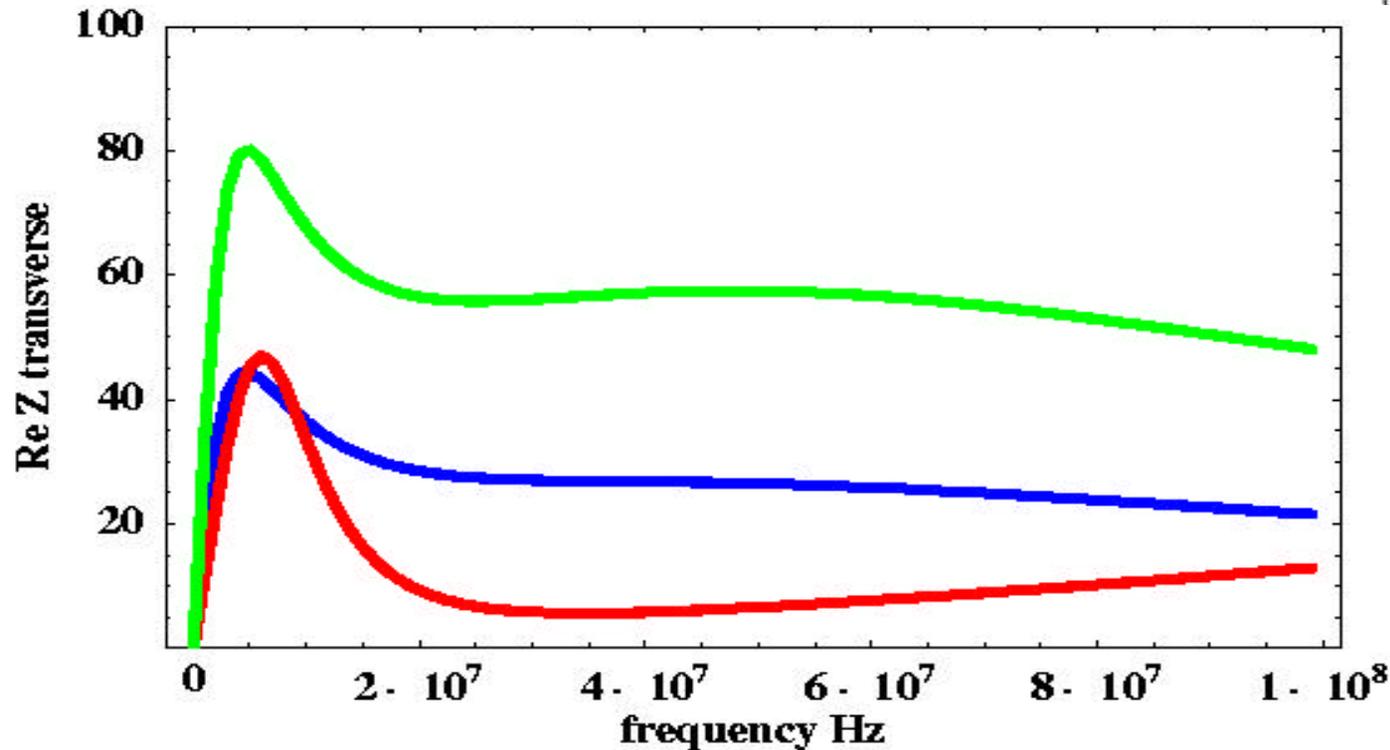
¹⁰ damped resonance (with glow-bars) at 17.82 MHz, $Q \cong 75$.

¹¹ possible higher impedance at res. frequency of about 170 MHz; can be damped with a lossy material

¹² resonant frequency around 50 MHz.

Reduction of Extraction Kicker impedance

(Davino et al.)



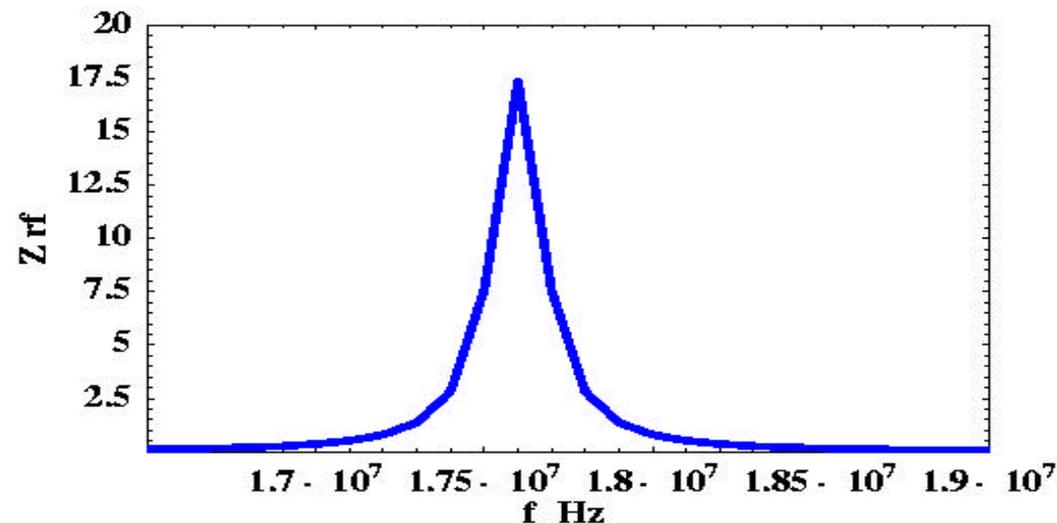
Green – old impedance (Feb. 2002)

Blue – reduced impedance due to increased vertical size

Red – additional reduction due to corrected uncoupled contribution

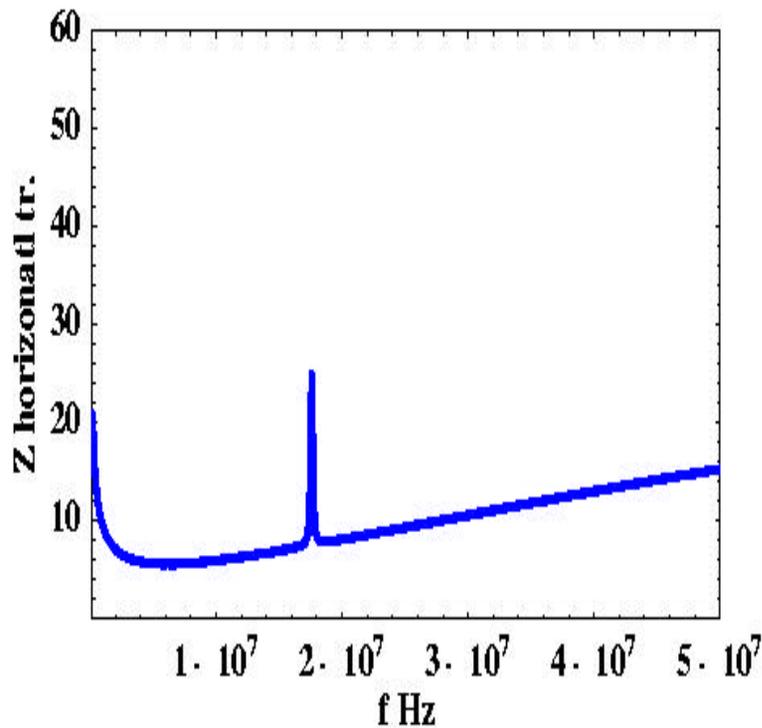
RF impedance

(D. Davino, H. Hahn and M. Blaskiewicz)

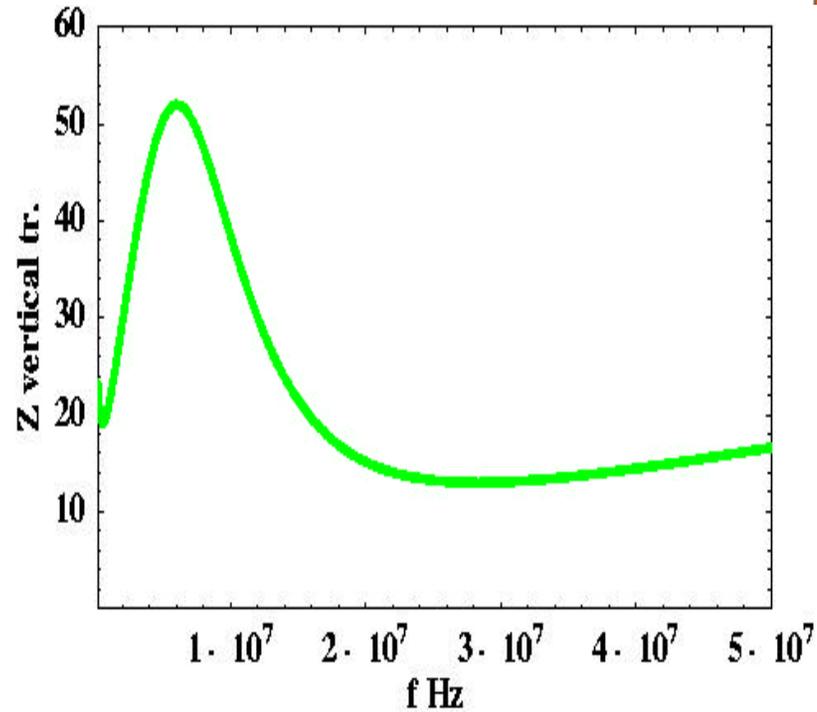


1. **Transverse** resonance is significantly reduced by placing four 40W carborundum rods (glow-bars) on top and bottom of each gap (resonance is damped by factor of 2; undamped res. is shown in Fig.).
2. Major **longitudinal** resonances: ($f=7.48$ MHz, $Q=136$, 4.1W), (12.24, 54, 5.0), (16.88, 71, 8.33), (18.33, 129, 3.94), (20.6, 61, 3.2), (25.5, 38, 3.08), (33.35, 52, 9.5) – high order modes.

Total modeled contribution to $\text{Re}(Z_{\text{transverse}})$: Resistive wall, Ext.Kick. & BPM's {K Om/meter}



Horizontal (RW, RF & BPM)



Vertical (RW, EK & BPM)