# SNS Impedance Budget
# (low frequency (below 10MHz) approximation)

| | $Z_\ell / n$ [W] | $Z_T$ [kW/m] |
|---|---|---|
| **Space charge** | **-j196** | **j(-5.8+0.45)[1] x10[3]** |
| **Extraction kicker[2]** | **35 + j42** | **66+j197[3]** |
| **Injection kicker[4]** | **»1, at $\omega_0$** | **30 (lowest tune 200 kHz)** |
| **RF cavity** | **damped[5]** | **small; under study** |
| **Injection foil assembly** | **j0.05[6]** | **j4.5** |
| **Resistive wall** | **(j+1)0.71, at $\omega_0$** | **(j+1)8.5, at $\omega_0$** |
| **Broadband** | | |
| BPM | **j3.0** | **j15** |
| 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** | **j7.1** | **j50** |

[1] incoherent and coherent part
[2] 25 Ω termination at PFN
[3] measured inside vacuum vessel with feed-through; 2.8n+j280 in the case of open termination at PFN without vessel, 70+j140 in the case of 25 Ohm termination without vessel and feed-through
[4] ceramic pipe coated with 10 μm of TiN of thickness
[5] assuming all parasitic modes removed and the active feedback operates successfully
[6] based on MAFIA simulation

# SNS Impedance Budget
# (at 50MHz frequency)

| | $Z_\ell / n$ [W] | $Z_T$ [kW/m] |
|---|---|---|
| **Space charge** | **-j196** | **j(-5.8+0.45)[7] x10[3]** |
| **Extraction kicker, 25 W termination** | **11 + j0** | **98 + j164[8]** |
| **RF cavity** | **damped[9]** | **small; under study** |
| **Injection foil assembly** | **j0.05** | **j4.5[10]** |
| **BPM** | **1.9 + j3.3** | **27+j48** |
| **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** |

[7] incoherent and coherent part
[8] measured inside vacuum vessel with high value due to feed-through; 56+j140 in the case of open termination without vessel, 21+j140 in the case of 25 Ohm termination without vessel
[9] assuming all parasitic modes removed and the active feedback operates successfully
[10] possible higher impedance at resonance frequency of about 170 MHz; can be damped with a lossy material

# SNS Ring Collective Effects
# (estimates)

| Mechanism | Impedance value/type | Threshold | Comments |
|---|---|---|---|
| **Transverse space charge** | -- | $\Delta\nu_{sc}$~ -0.2 | $\Delta\nu_{sc}$=-0.15 ~ -0.2 spread<br>other impact under study |
| **Longitudinal space charge** | $Z_L/n$=-j196 Ω | | 15 – 20 kV induced voltage comparing with 40+20 kV RF |
| **Longitudinal microwave** | $Z_L/n$= 35 + j42 Ω<br>(extraction kicker) | $\|Z_L/n\|$= 32 Ω | Keil-Schnell-Boussard criteria w/o space charge |
| **Transverse microwave (x =0)** | $Z_T$=(j+1) 19 kΩ/m<br>(resistive wall) | $\|Z_T\|$=1.3 kΩ/m[11];<br>rise time >300 turns | For tunes (6.3, 5.8), at 200 kHz |
| **Transverse microwave (x =-3)** | $Z_T$=(j+1) 19 kΩ/m<br>(resistive wall) | $\|Z_T\|$=100 kΩ/m[11] | For tunes (6.3, 5.8), at 200 kHz |
| **Transverse microwave (x =0~-3)** | $Z_T$=98+j164 kΩ/m<br>(extraction kicker) | $\|Z_T\|$=300~400 kΩ/m[11] | At ~ 50 MHz<br>Not considering space charge |
| **Electron-cloud** | $\|\Delta\nu_{sc}\|$ = 0.15 ~ 0.2 | $\|\Delta\nu_c\|$ ~ 0.2 | At 150 ~ 200 MHz |

[11] For a Lorentzian momentum distribution