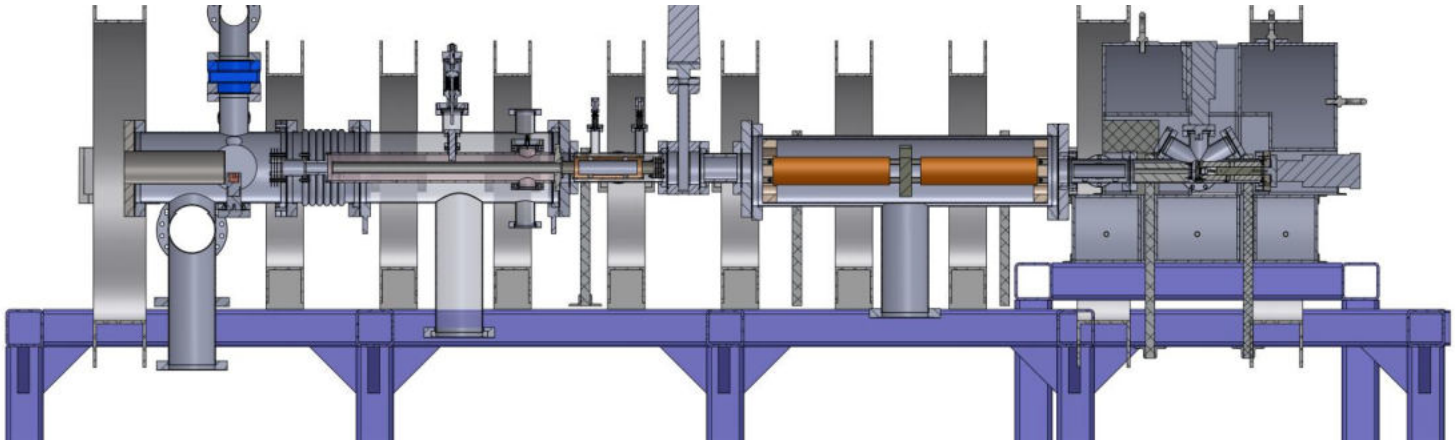
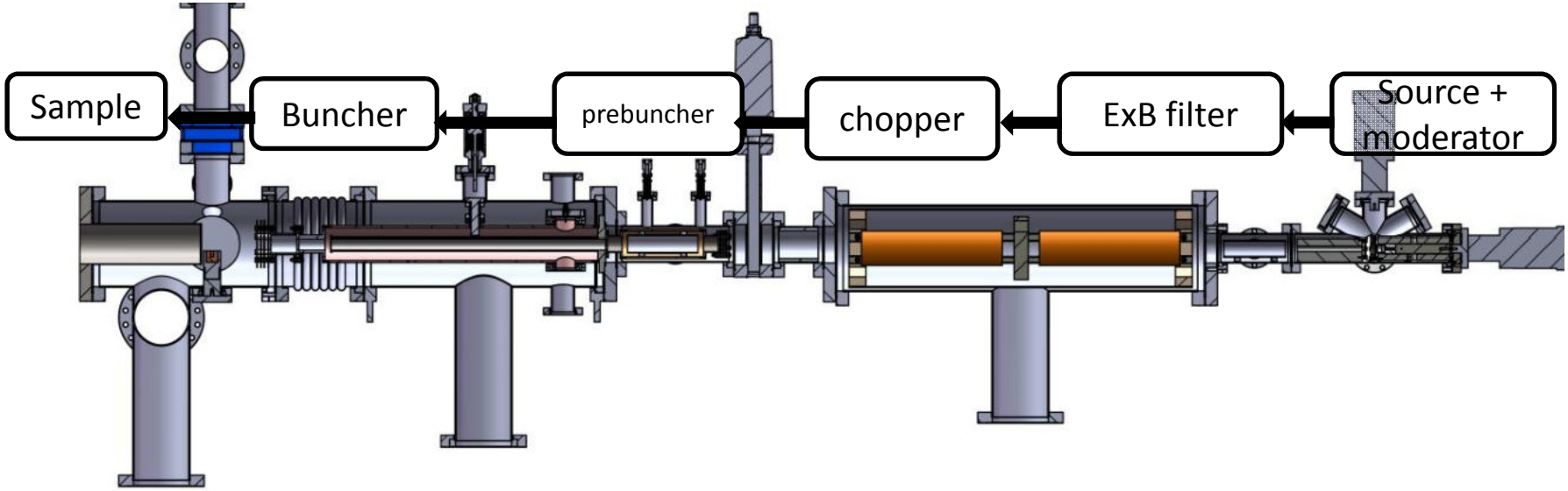
Pulsed positron beamline at BARC, India- preliminary results



Saurabh Mukherjee

LAYOUT of the presentation

1. Overall setup of pulsed beam at BARC
2. RF section
3. Recent results- Silicon and NBR (Nitrile Butadiene Rubber)



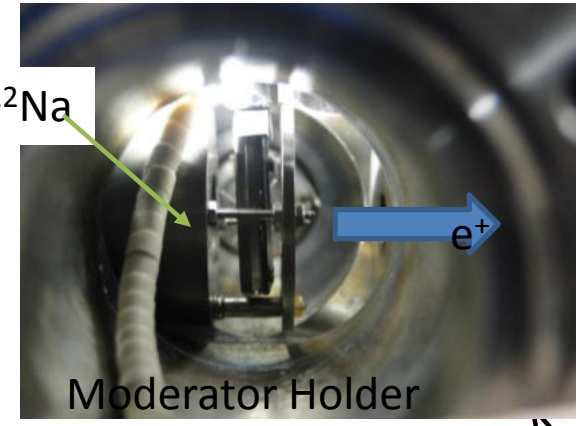
PULSING OF SLOW POSITRONS FOR VARIABLE-ENERGY POSITRON LIFETIME SPECTROSCOPY

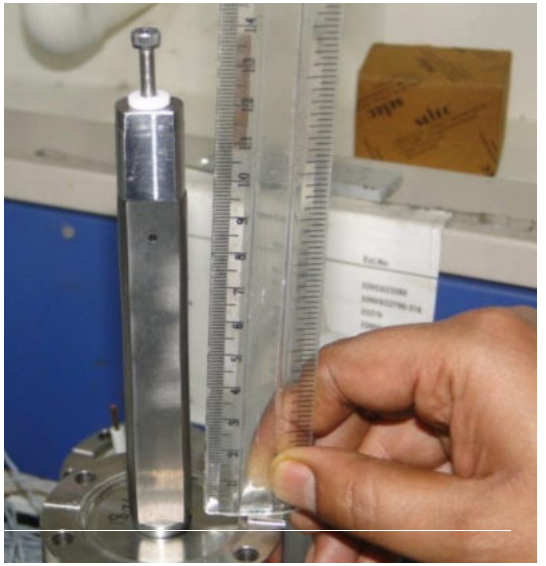
R. Suzuki, Y. Kobayashi*, T. Mikado, H. Ohgaki, M. Chiwaki, T. Yamazaki and T. Tomimasu**

Electrotechnical Laboratory, 1-1-4 Umezono, Tsukuba, Ibaraki 305, Japan
*National Chemical Laboratory for Industry, 1-1 Higashi, Tsukuba, Ibaraki 305, Japan

Solid State Phenomena Vols 28-29 (1992) pp 365-0

SOURCE and MODERATOR




Source Holder


In-situ annealing of moderator

e$^+$

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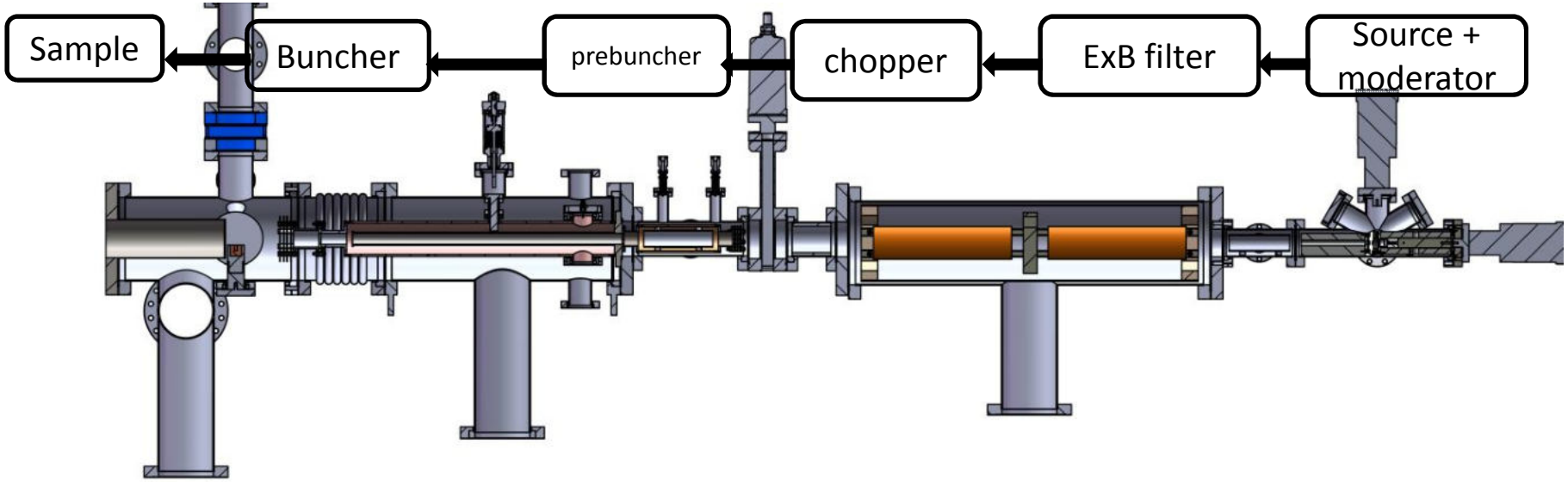

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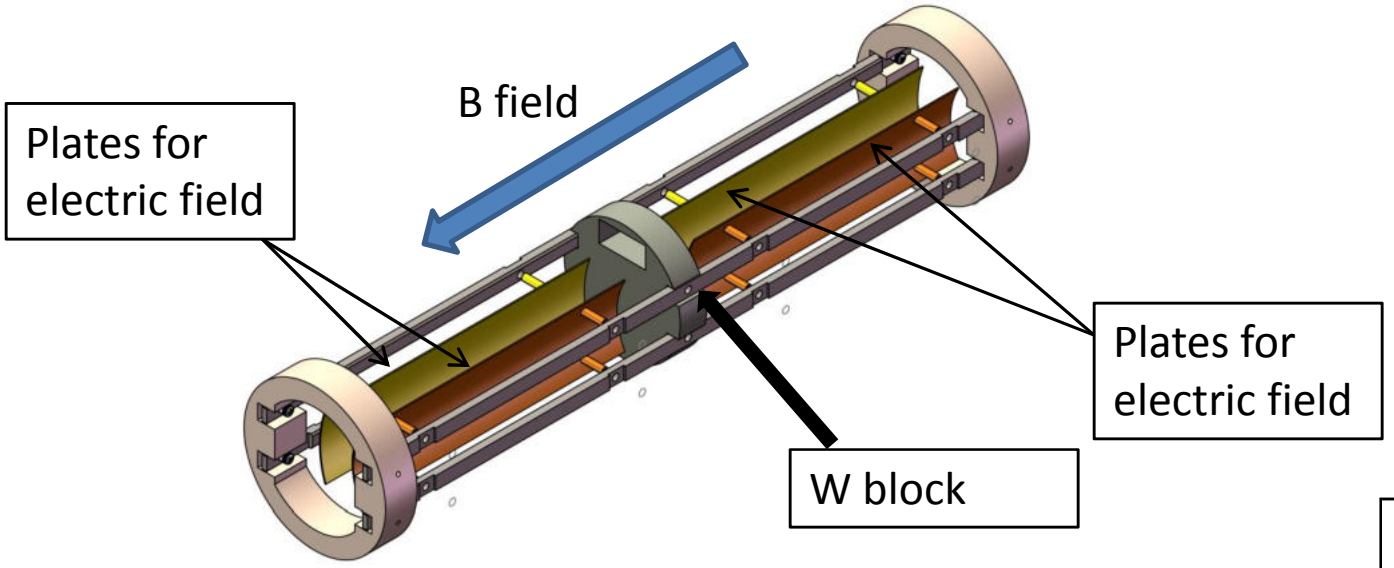
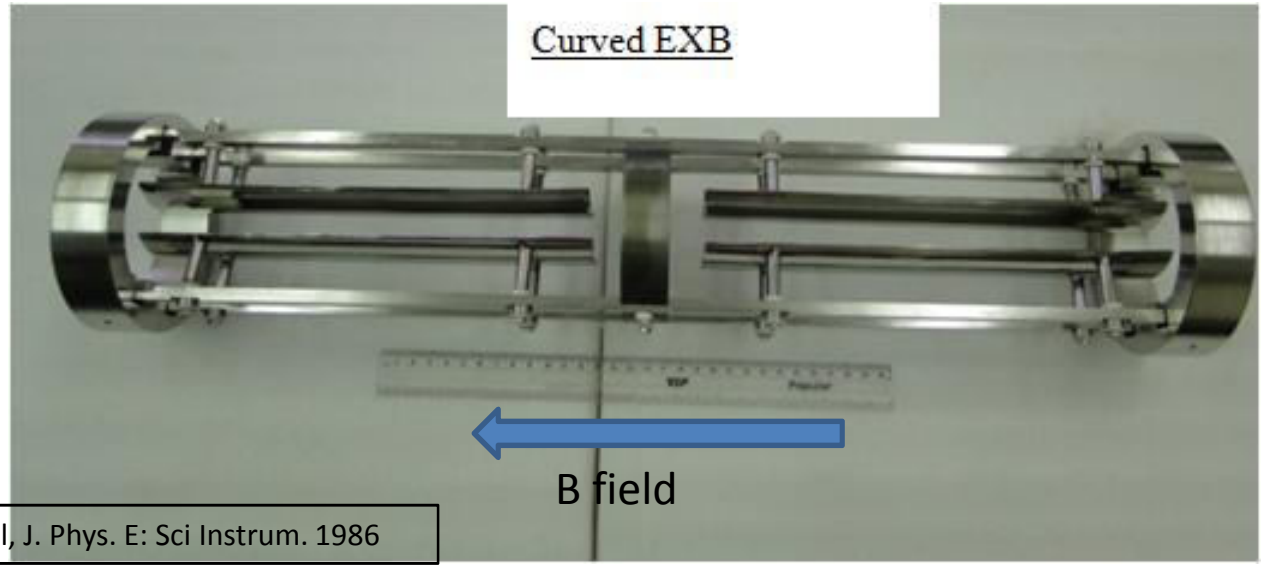
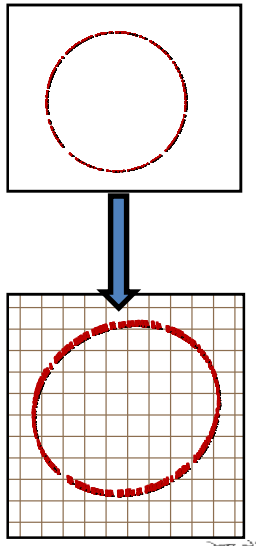
ExB Filter





S. Hutchins et al, J. Phys. E: Sci Instrum. 1986



SIMION simulation of beam cross section after EXB

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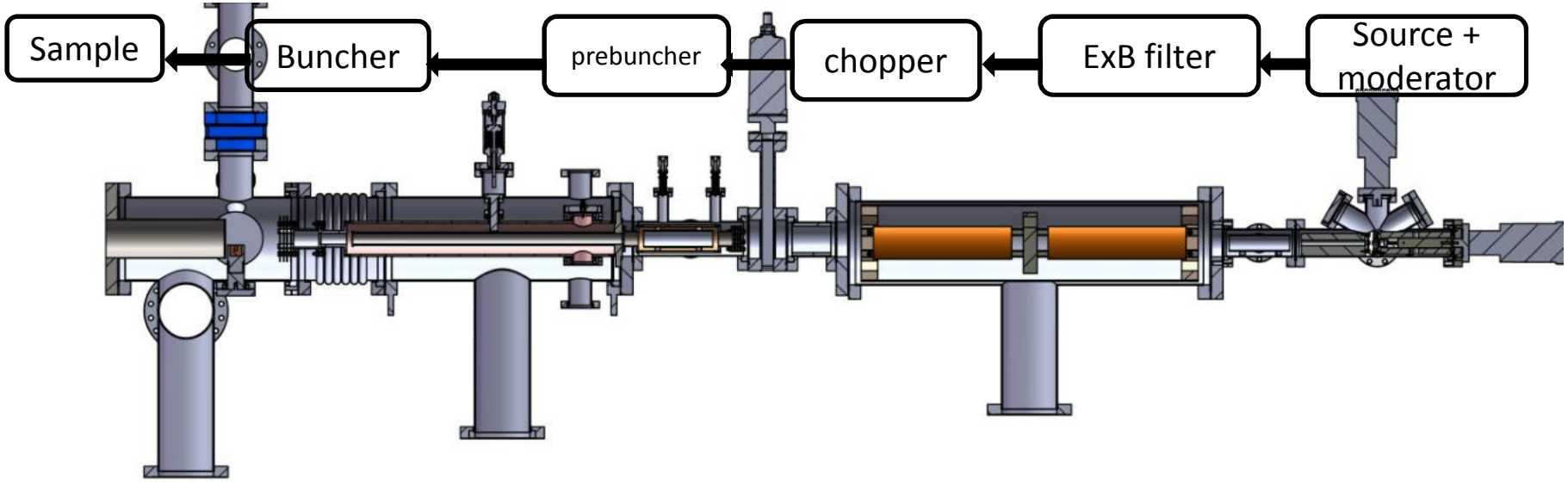

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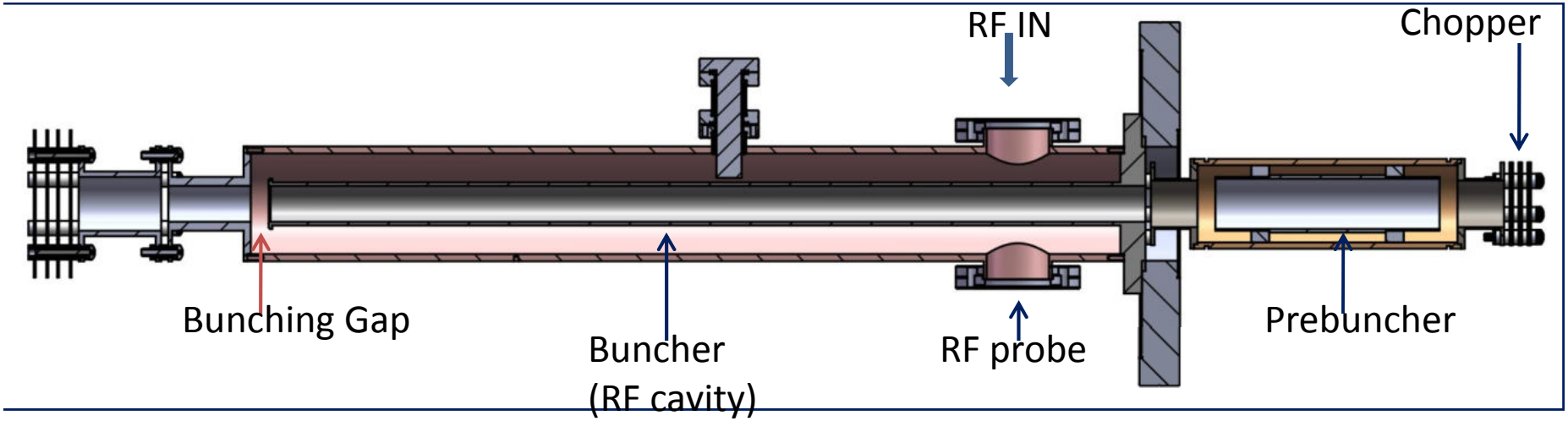
Chopper, prebuncher and Buncher



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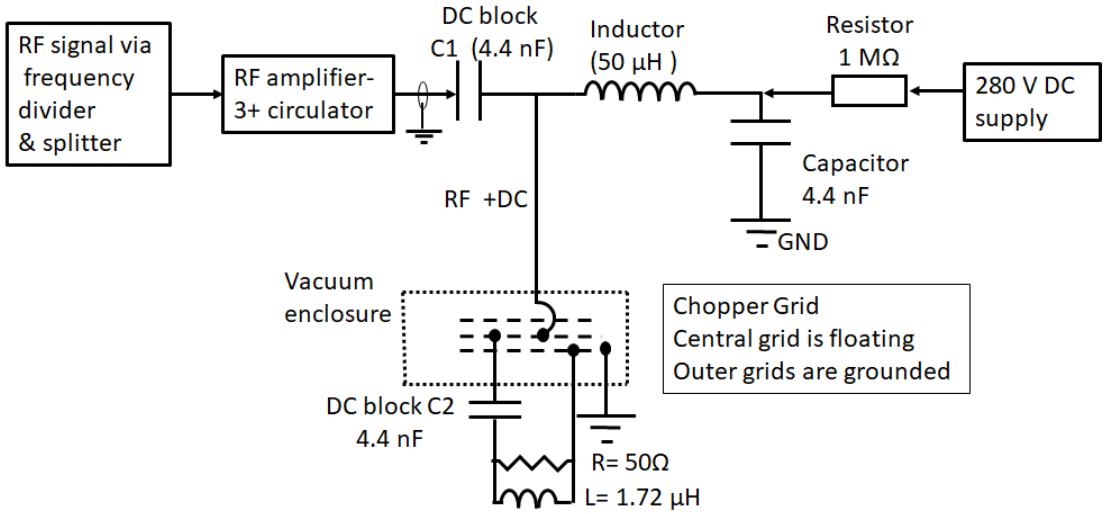
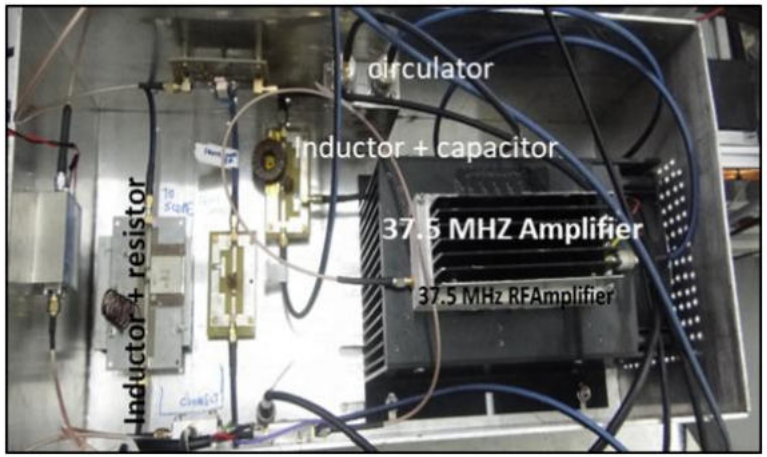
Chopper – circuit for sine wave pulsing





Masaki Maekawa, NIMB, Volume 270, 1 January 2012, Pages 23-27 ; S. Shrotriya , J. Instrumentation, 2021

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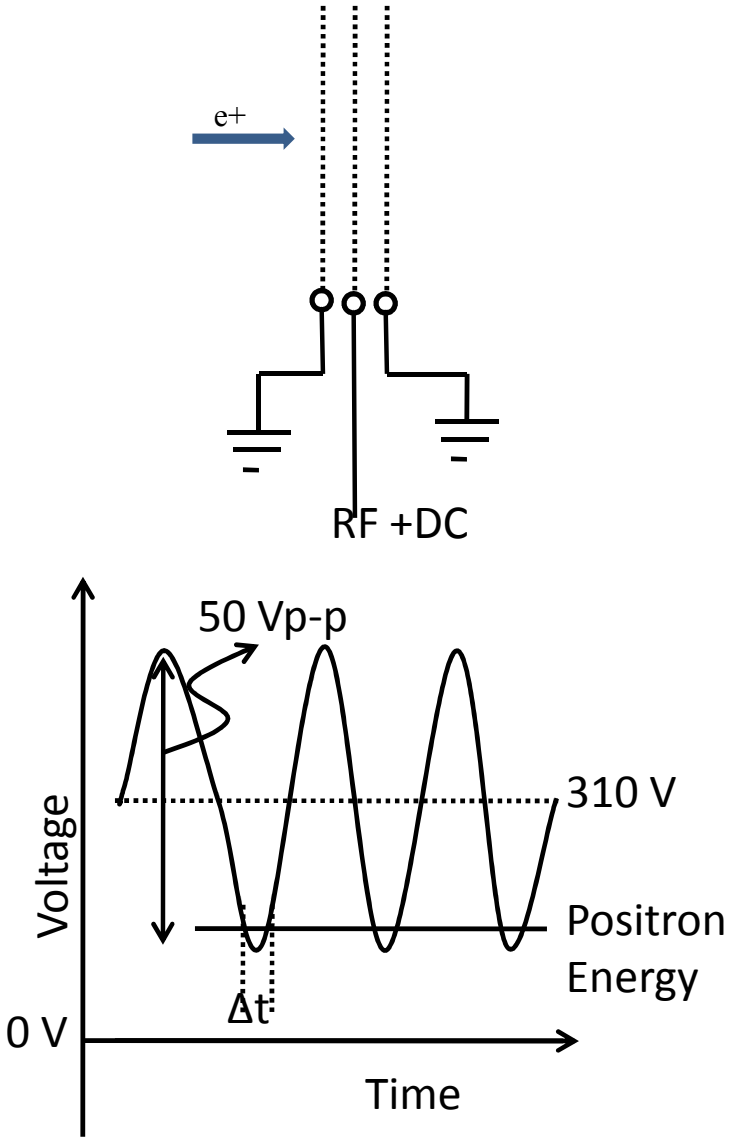
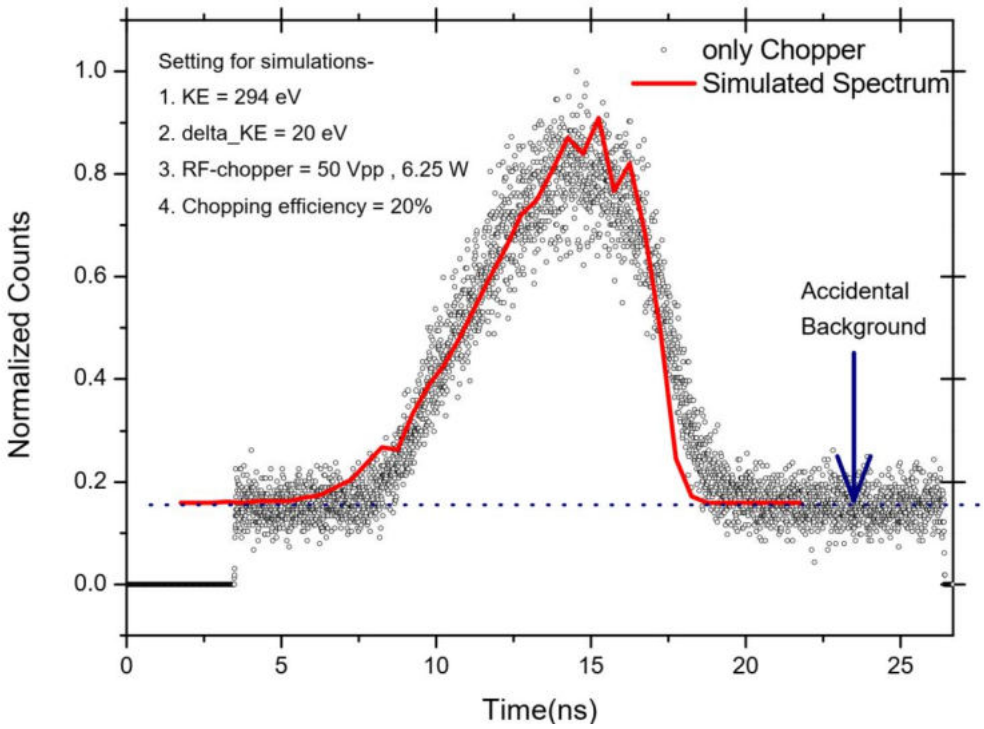
CHOPPER SPECTRUM





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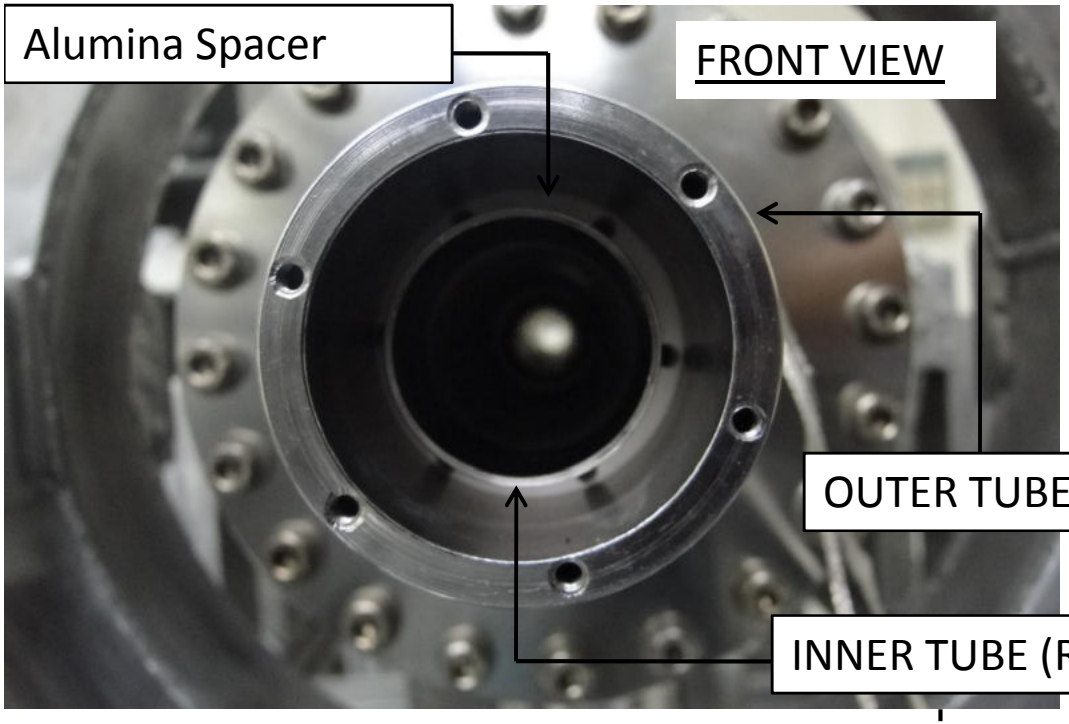
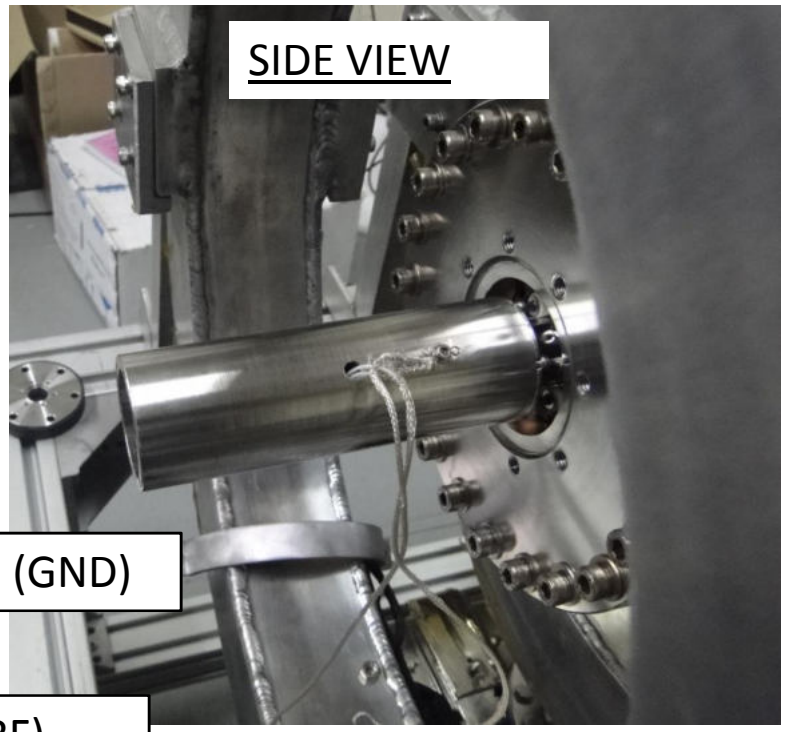
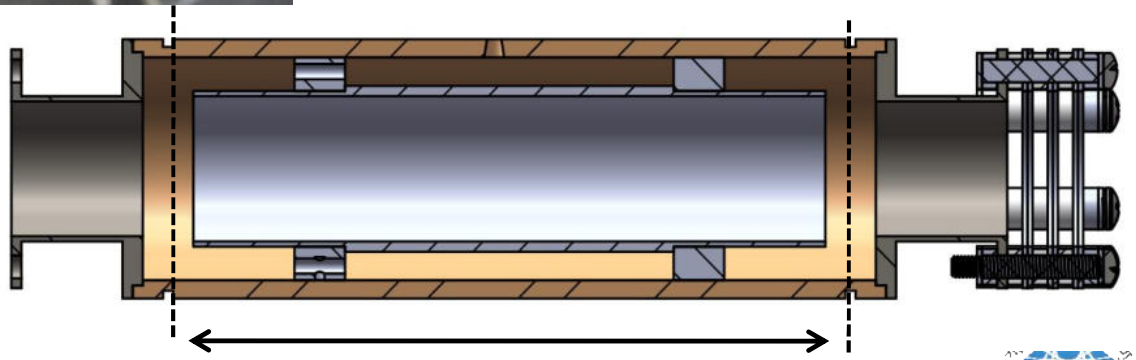
Prebuncher





✓ Length of inner tube is the distance that particles travels in half time period
✓ Driven by 37.5 MHz sine wave
✓Capacitive coupling



$$L = v * T / 2$$

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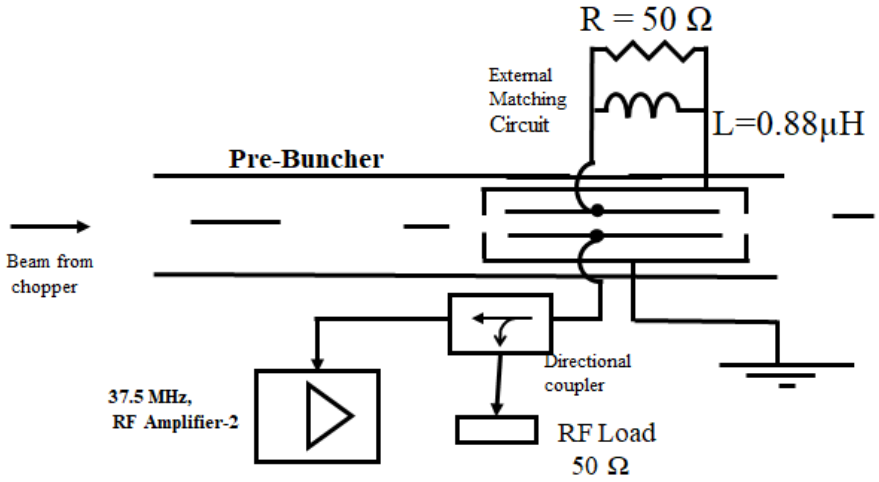
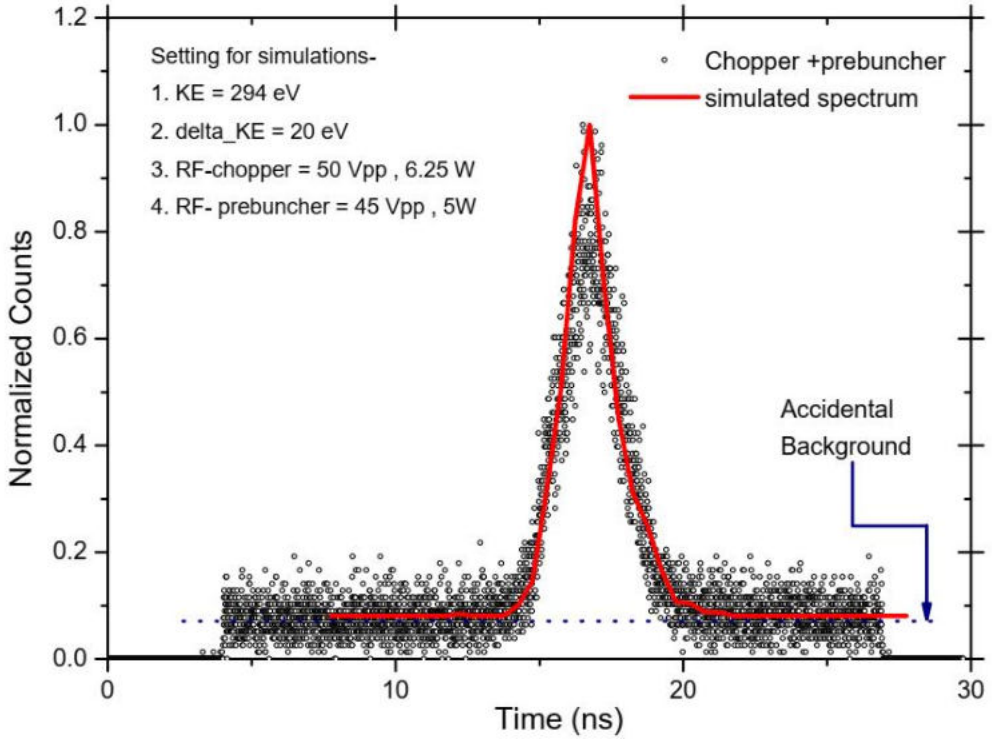
Prebuncher Spectrum





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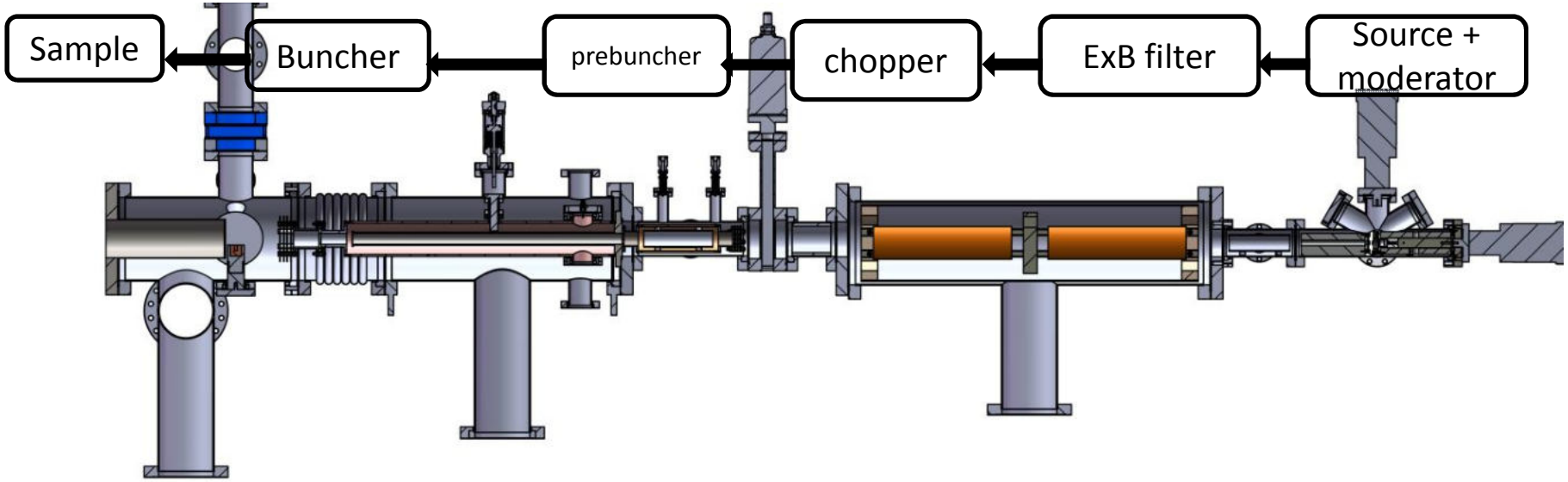

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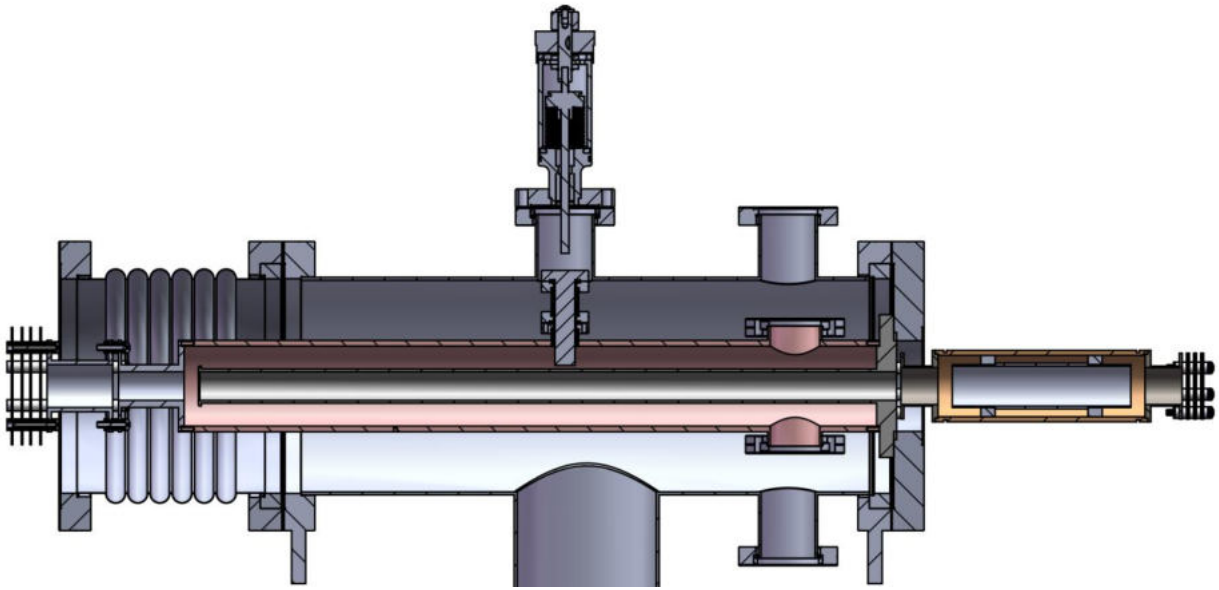
BUNCHER ASSEMBLY INSIDE THE VACUUM CHAMBER



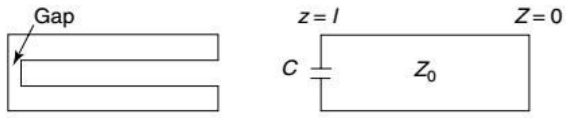


Figure 1.16 Coaxial resonator.

accomplished in practice with a coaxial line that has a gap at one end between the center conductor and the conducting end wall. An electric field suitable for acceleration may exist between the inner conductor and either the end wall or the cylindrical wall. Thus, beam holes can be introduced near the gap, allowing either a radial or an axial trajectory. Resonant modes correspond approximately to the length λ equal to an odd multiple of a quarter wavelength, the lowest mode being a quarter-wave resonator. Design formulas for the quarter-wave

* RF Linear Accelerators, Thomas P. Wangler

DESIGN CONSIDERATIONS-

- Resonant frequency of 150 MHz is used. High frequency is required to produce narrow pulses.
- since λ is = c/f, too small a frequency will result in big structure which are difficult to fabricate. Conventionally, for positrons and ion beams 100-200 MHz is chosen.

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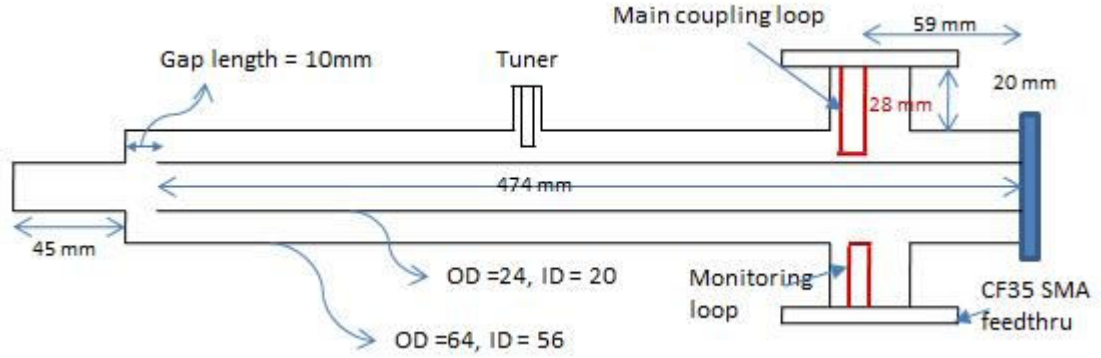
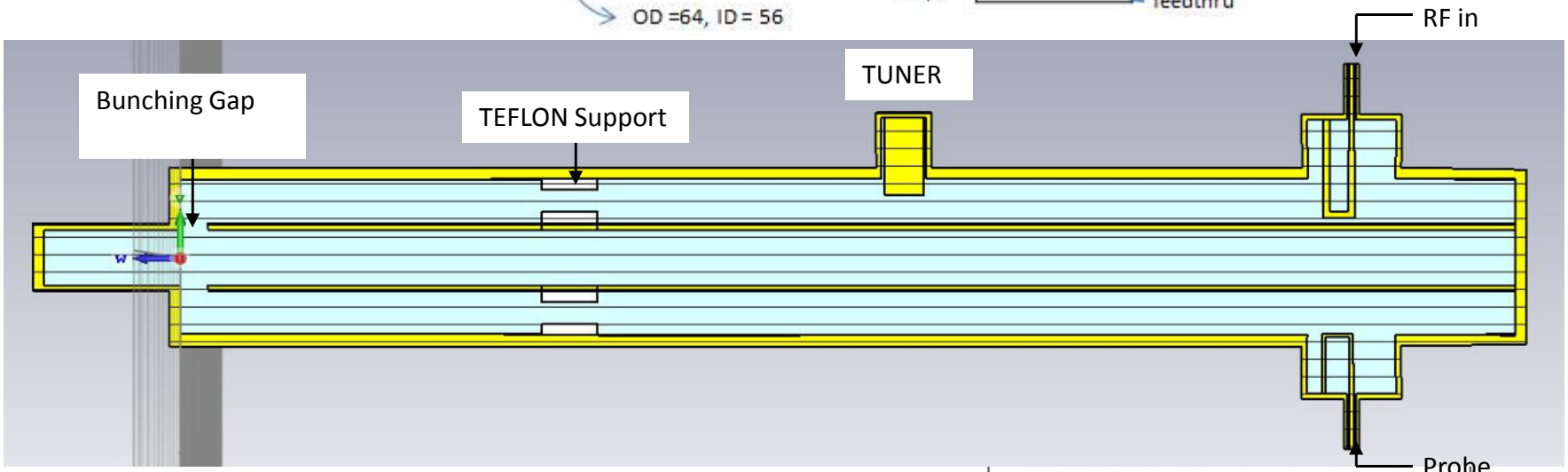
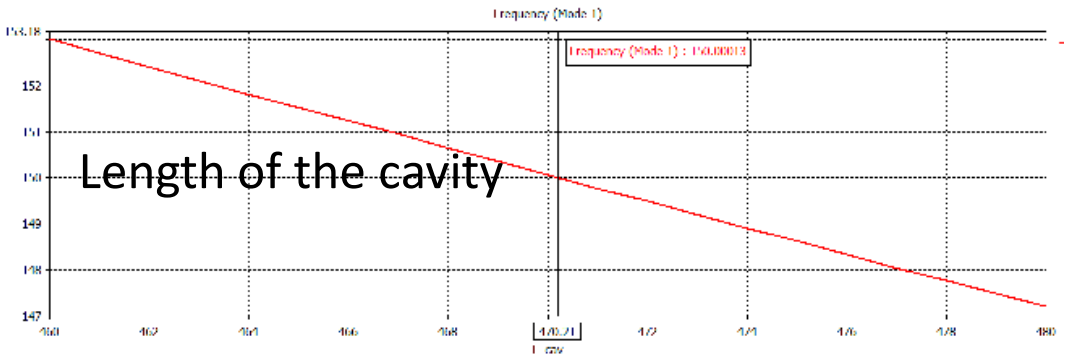
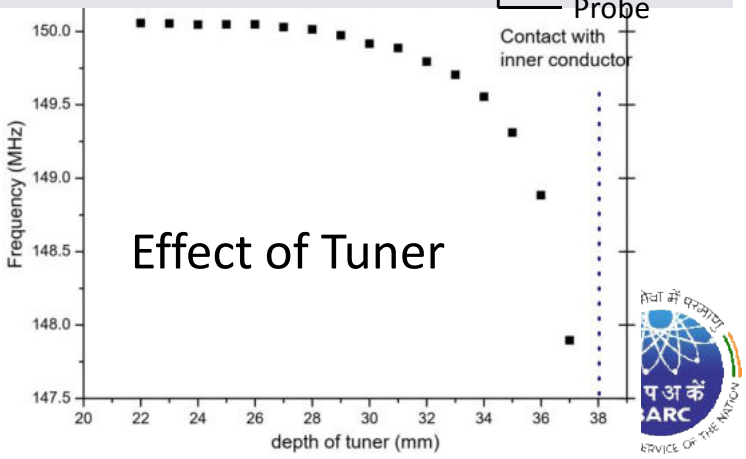
CST simulation of the buncher cavity









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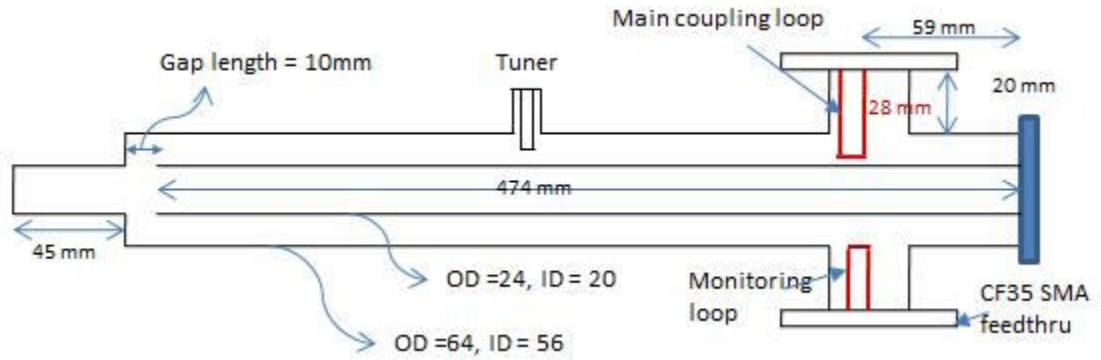
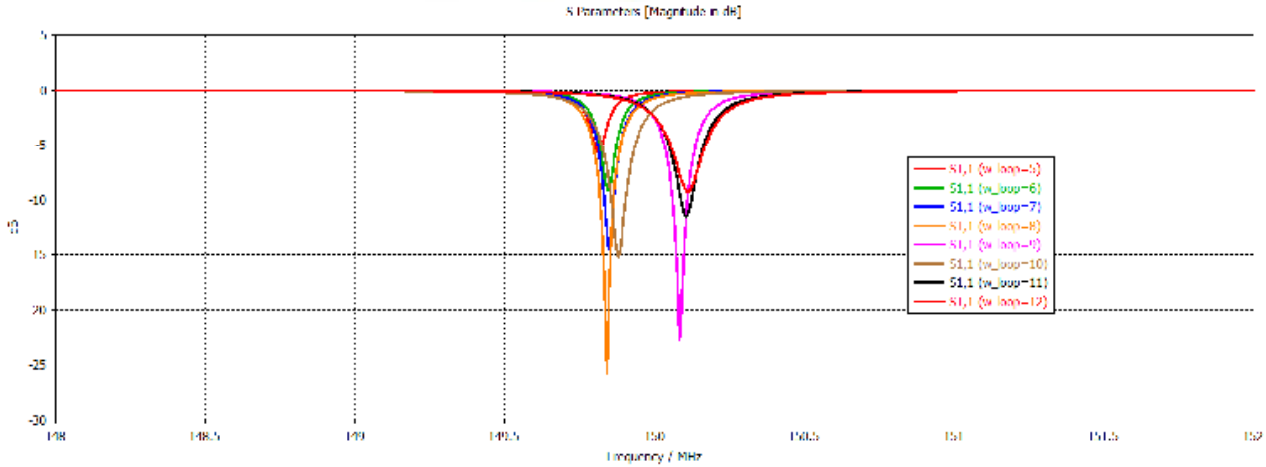
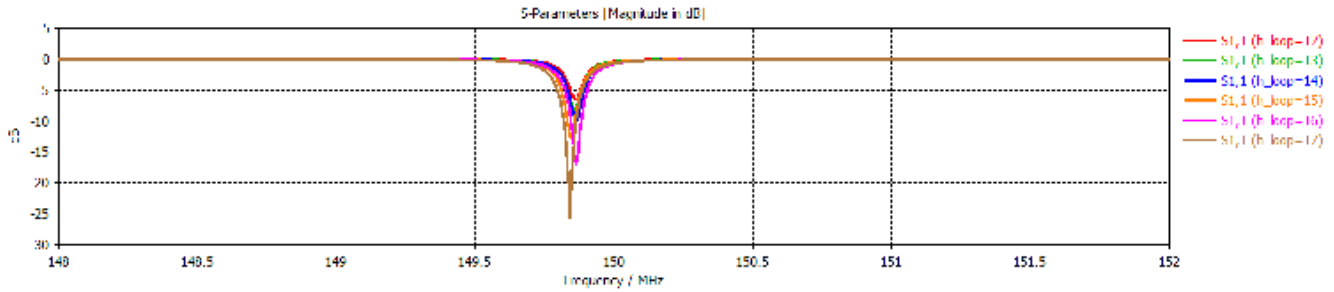
CST simulation - Design of the coupling loop- S parameters







** Shankar Lal, RRCAT, Indore*

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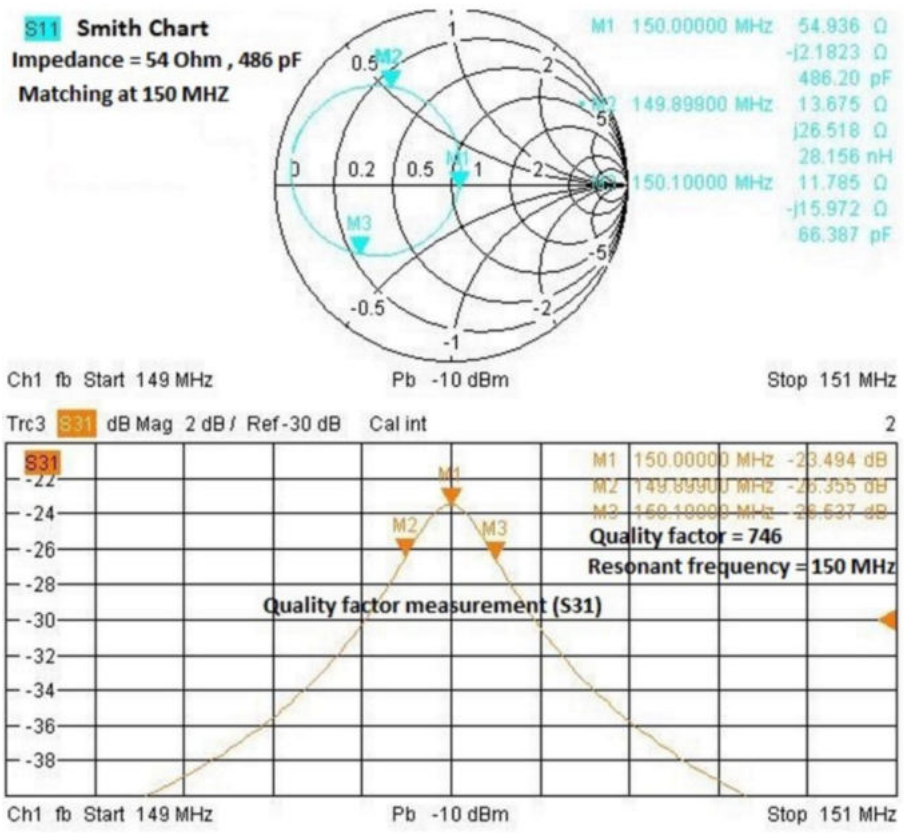
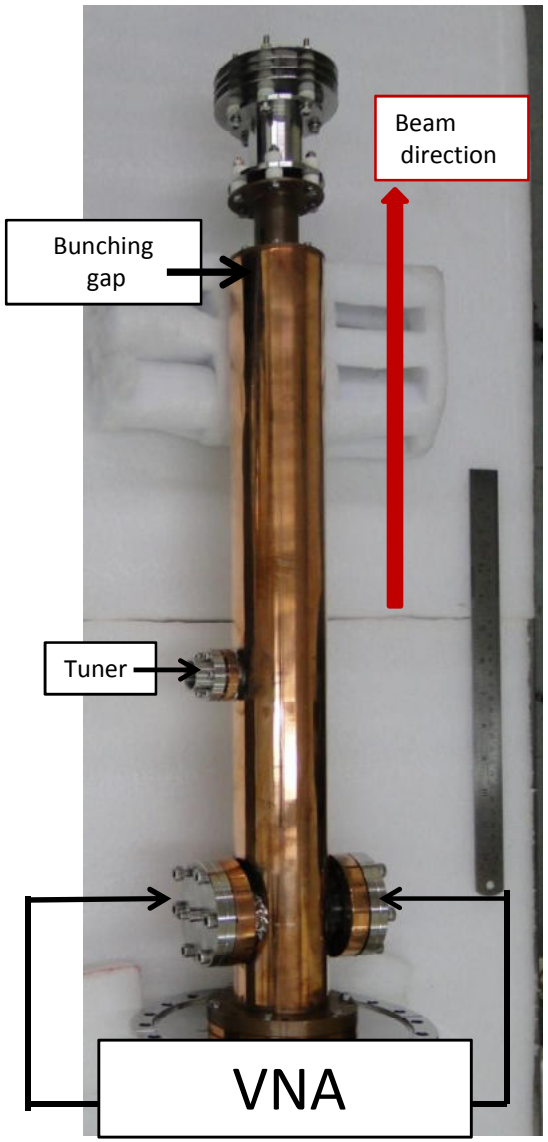
Characterization of Buncher Cavity-1





f_1 & f_2= freq at 3 dB down

$Q\_loaded = 746$

$Q_0 = 2 * Q_{\_loaded} = 1492$

** S.Shrotiya, Journal of Instrumentation, 2021*

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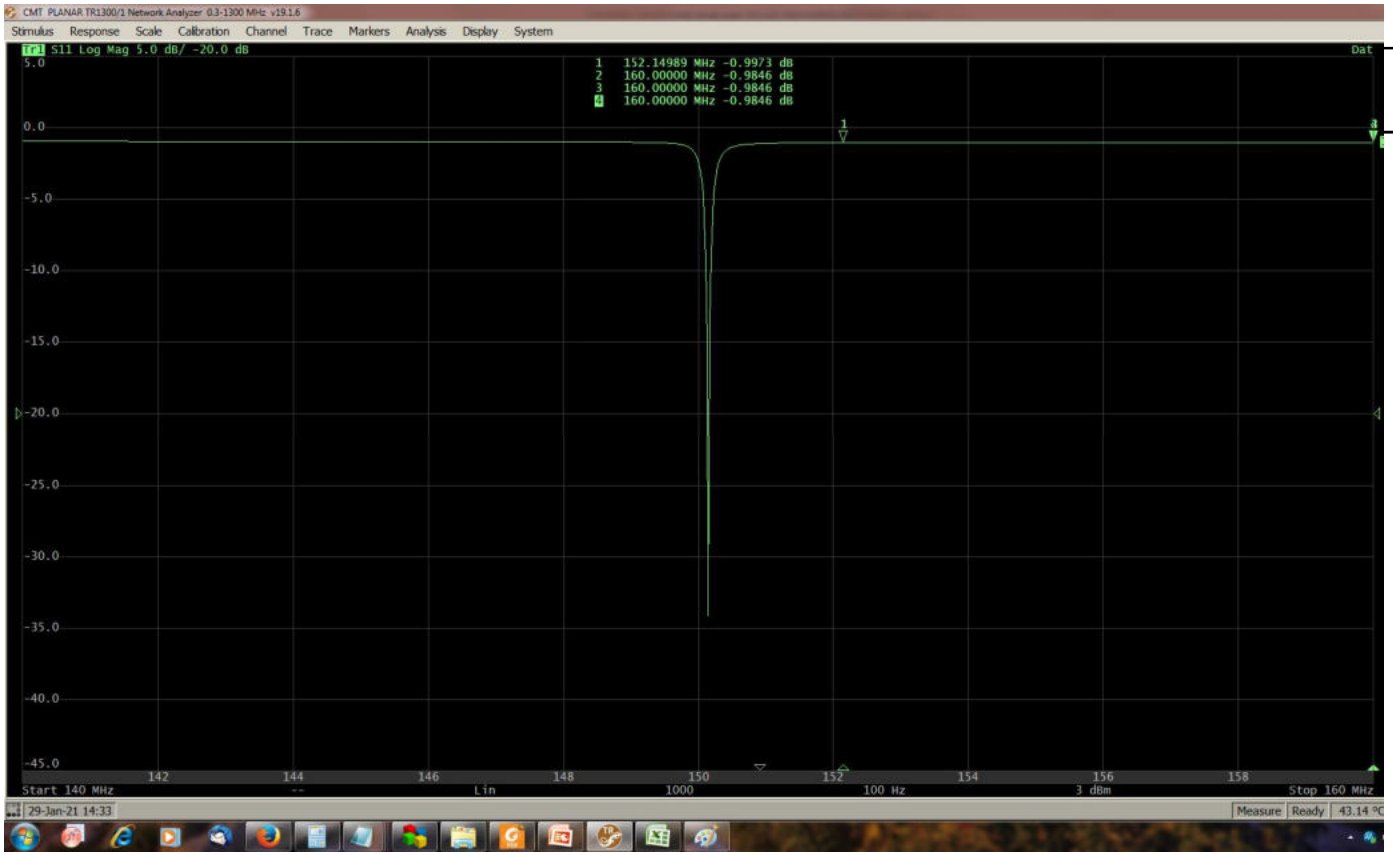
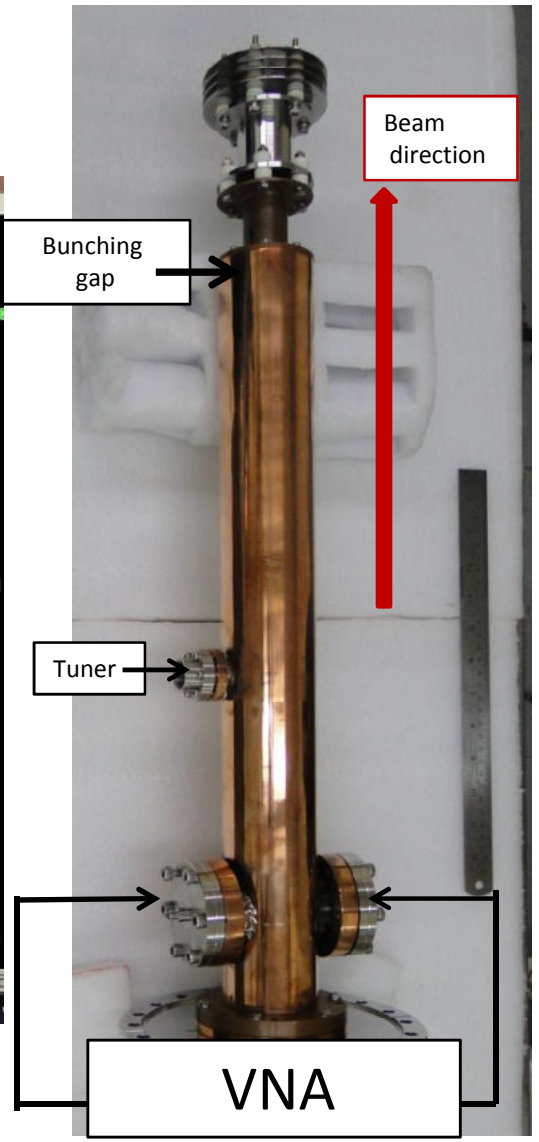
Characterization of Buncher Cavity-2- S11





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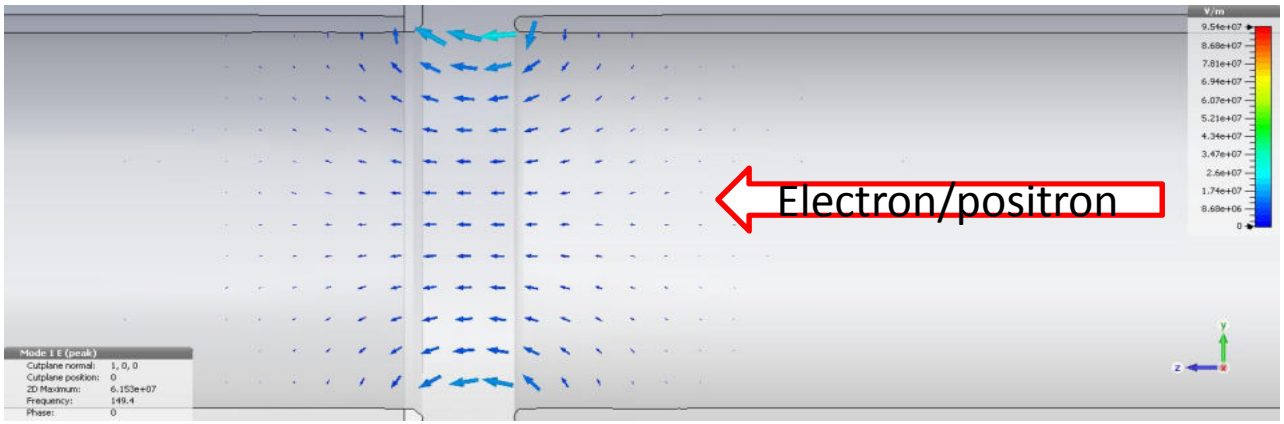
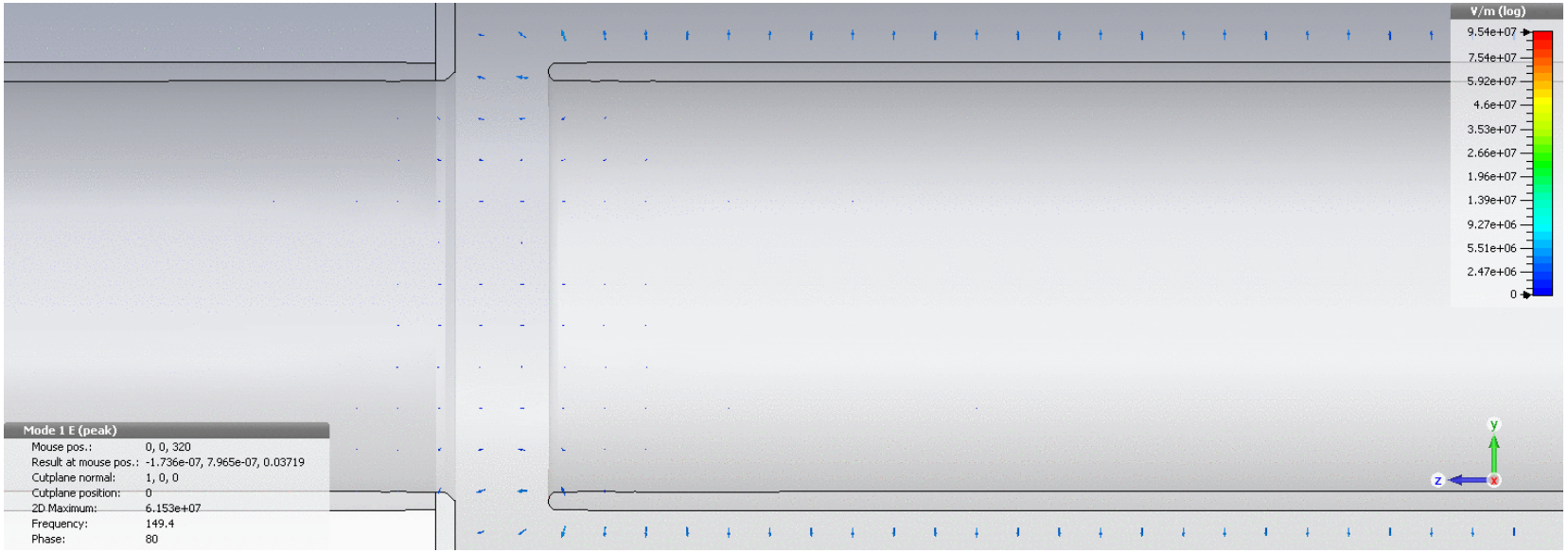
SIMULATION OF ELECTRIC FIELD IN A 150 MHz CAVITY- field at the GAP





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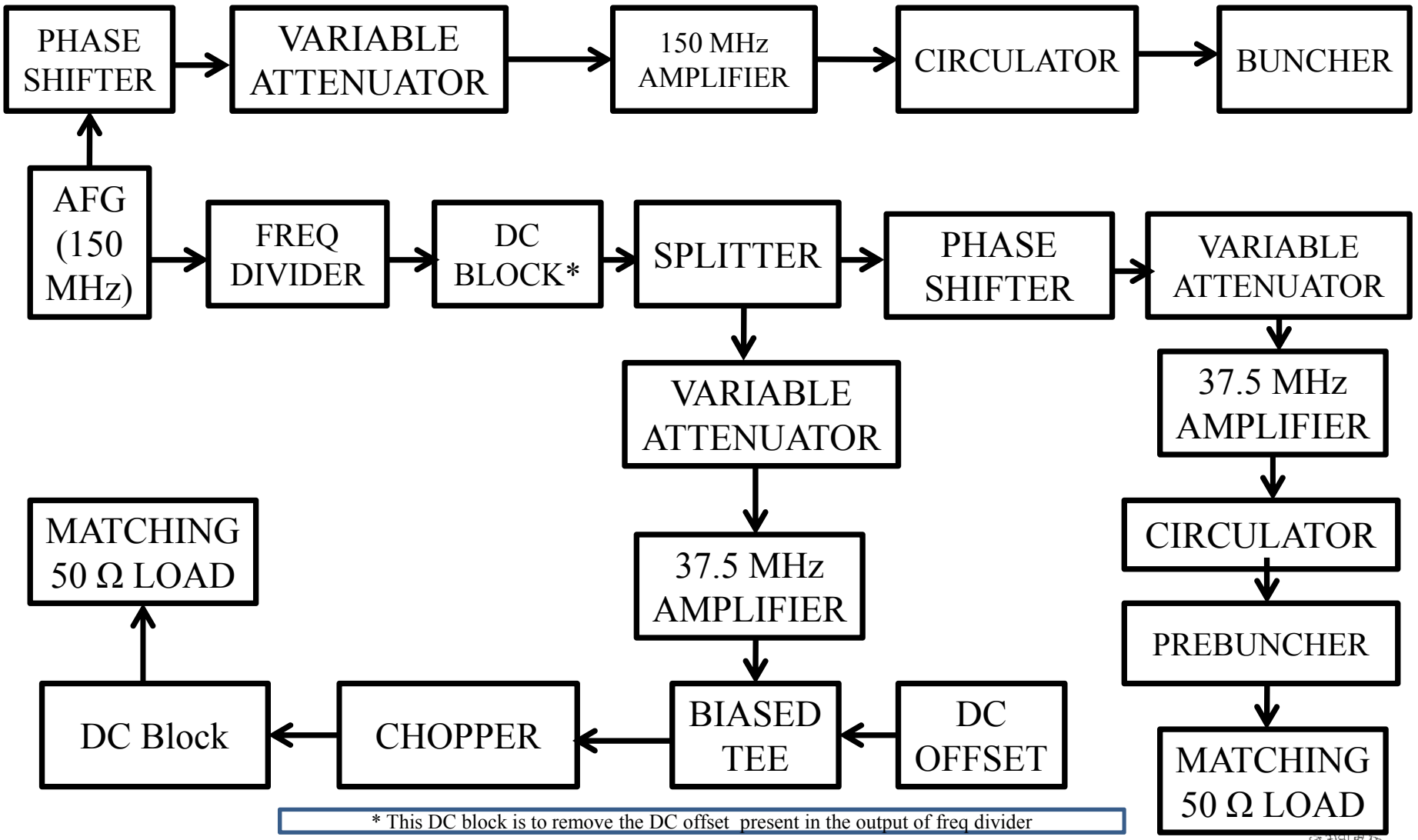
BLOCK DIAGRAM FOR THE RF CIRCUIT



* This DC block is to remove the DC offset present in the output of freq divider

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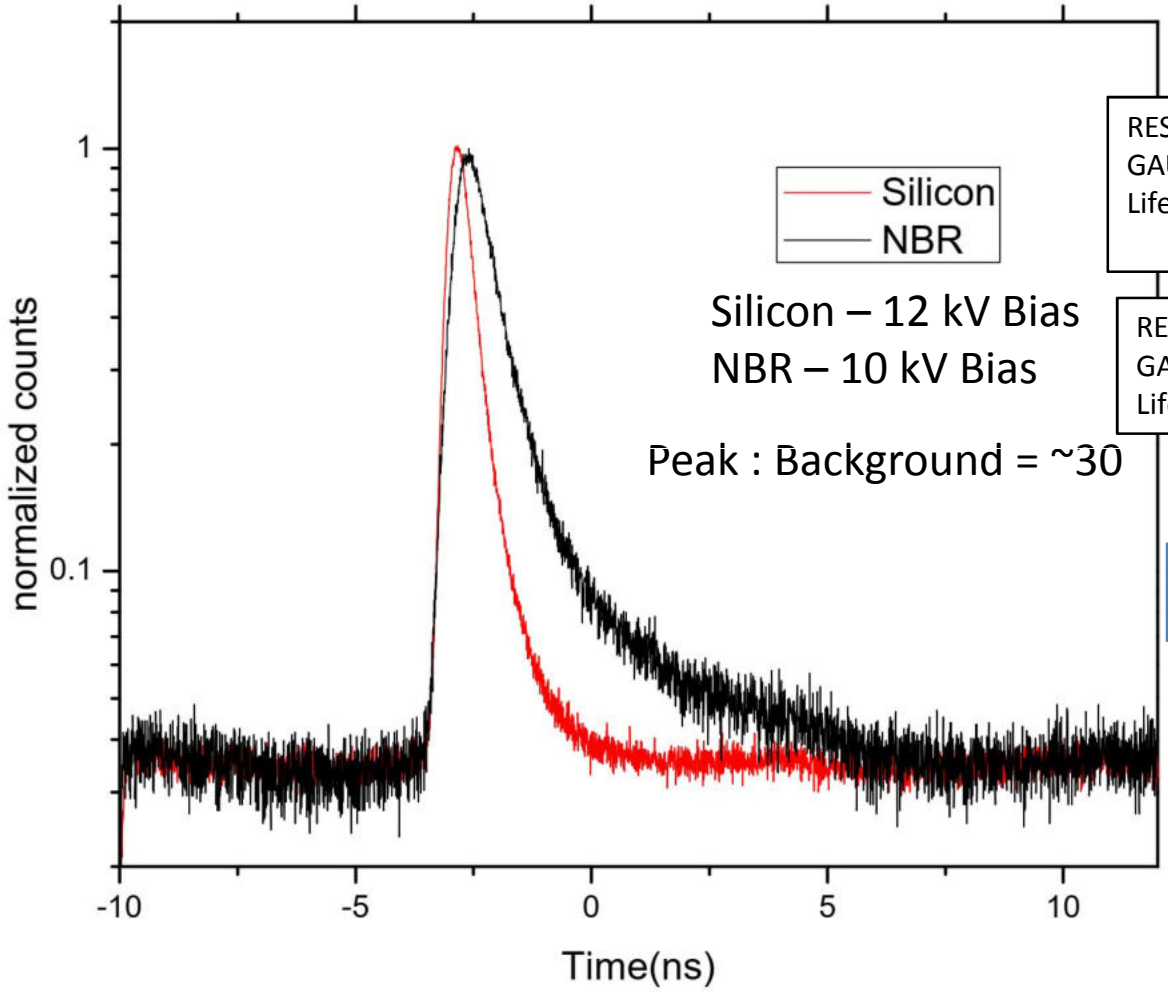
Comparison of Lifetime spectra of Silicon and NBR



RESFIT analysis of Silicon data-
GAUSSIAN (ns) – 0.35 (50%) & 0.45 (50%, shifted)
Lifetime (ns) - 0.202 (54%), 0.545 (45%), 2.84 (2.3%)

RESFIT analysis of NBR data-
GAUSSIAN (ns) – 0.45 (50%), 0.55 (50%, shifted)
Lifetime (ns) - 0.551 (71%), 2.4 (29%)

Bulk PALS analysis of NBR-
LT (ns)= 0.139 (13%), 0.385 (61.4%), 2.13 (25.8%)

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THANK YOU

Fully assembled pulsed positron beam line at RCD

ACKNOWLEDGEMENT-

Sandeep Shrotriya and Manjiri Pande – RF setup

❖ K.G. Bhushan – Electron Gun, Design Inputs

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