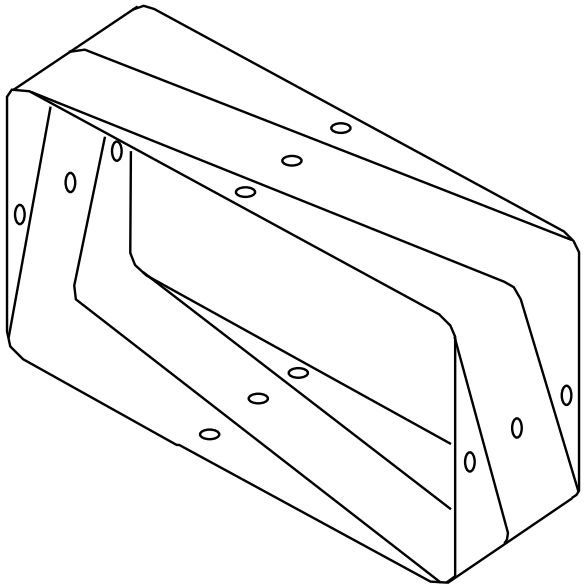
Measuring particle beam trajectories

Pick−Up electrodes

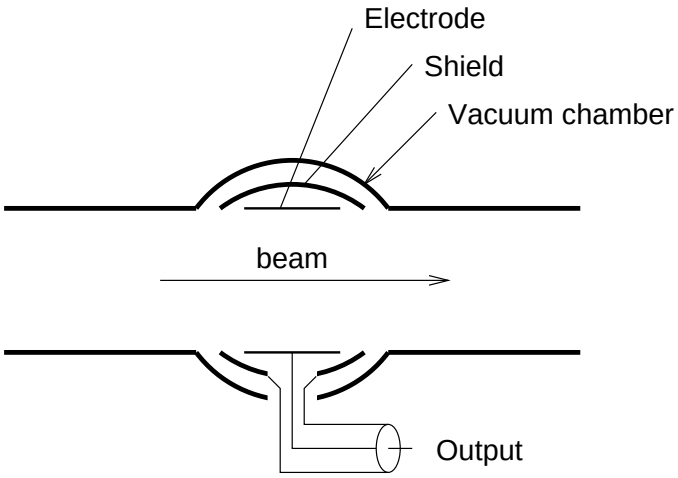
- Length: 62 mm
- Aperture: 166x80 mm
- Capacitance: 100pF
- R_t: $0.52\Omega^*$
- S_x: 174 mm
- S_y: 82 mm

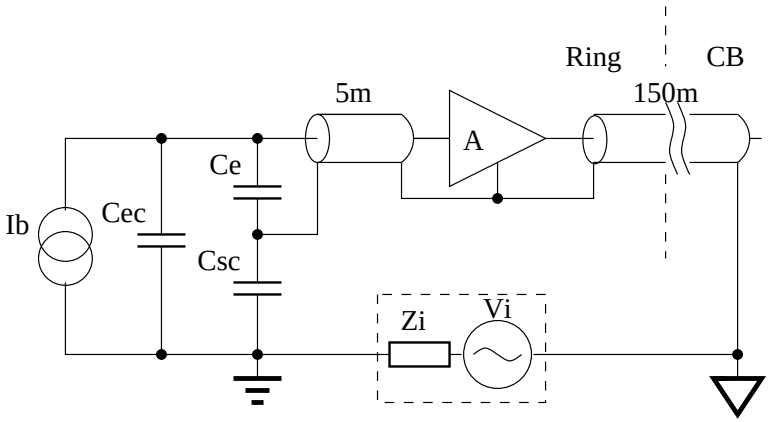


* $For\ \beta = 1, R_t = \frac{l}{c\,C}$

Measuring particle beam trajectories

Equivalent circuit





Interference paths:

- C_{ec}
- Cable leakage

C_{el} = 100pF

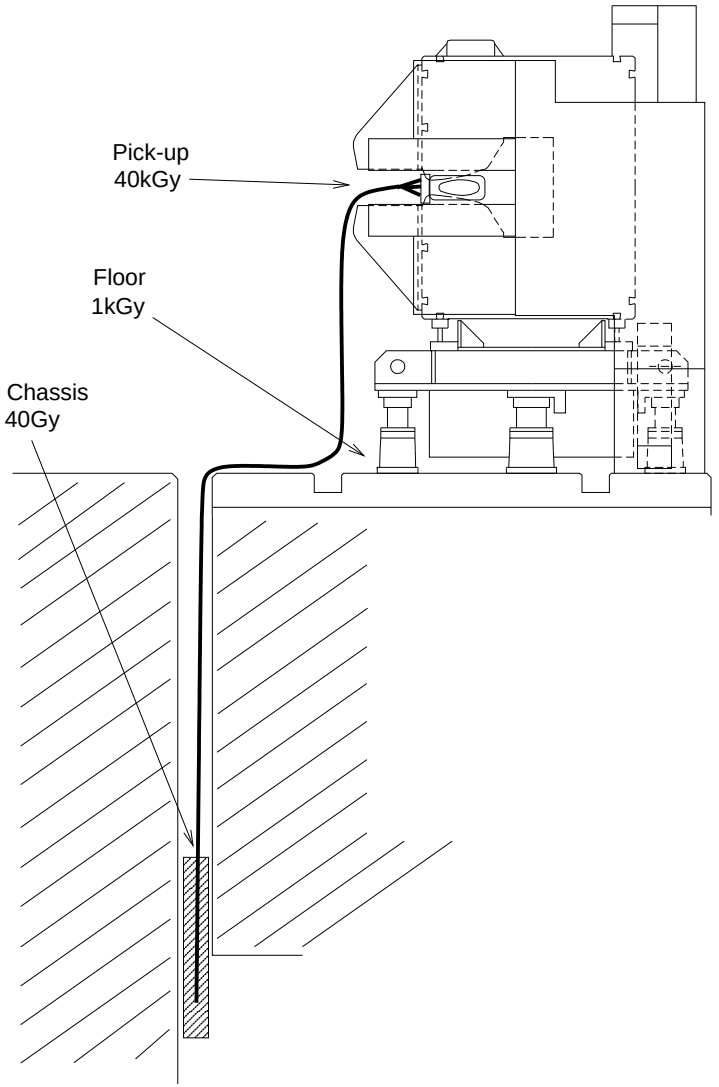
C_{sc} = 1nF

C_{ec} = 0.5pF

Measuring particle beam trajectories

Radiation

Radiation levels
- 40kGy/y at 1.3m
- 1kGy/y on the floor
- 40Gy/y in the gap

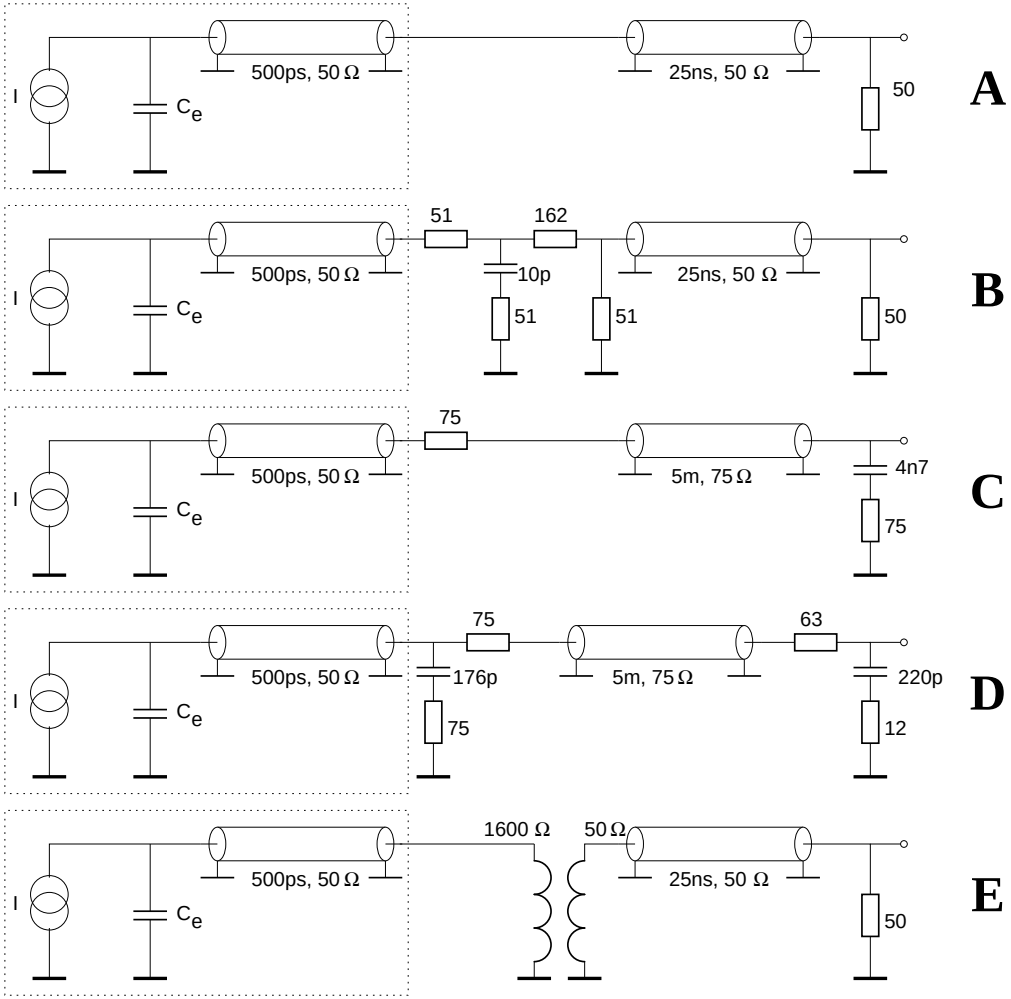


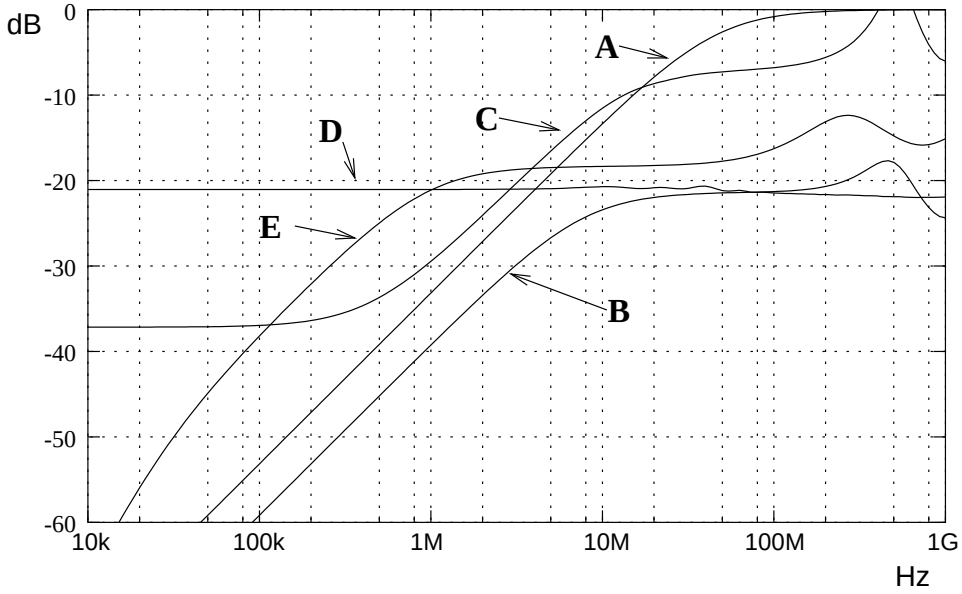
Electronics can take 30 − 300Gy.
Careful choice of components and
careful design can extend that to a few kGy.

Cable length from PU to pre−amp : 5m
Double shielded cable

Measuring particle beam trajectories

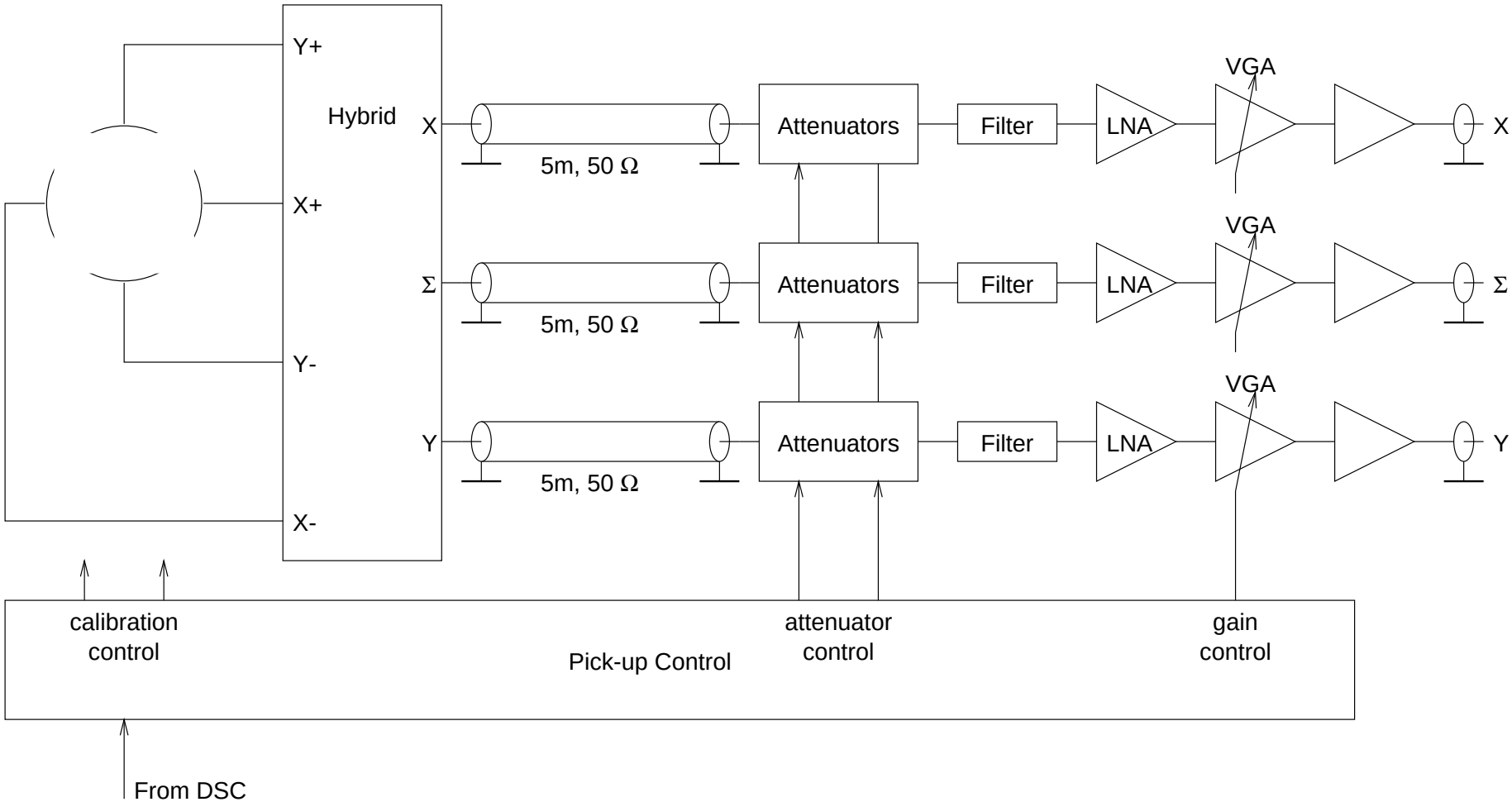
Making the most of the available signal





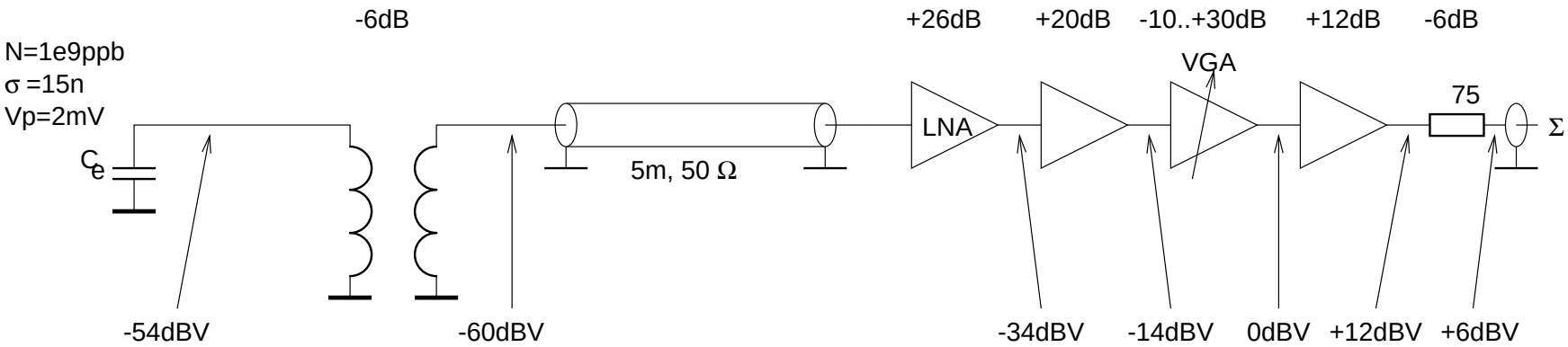
Measuring particle beam trajectories

Amplifier block diagram



Measuring particle beam trajectories

Amplifier chain and gain distribution

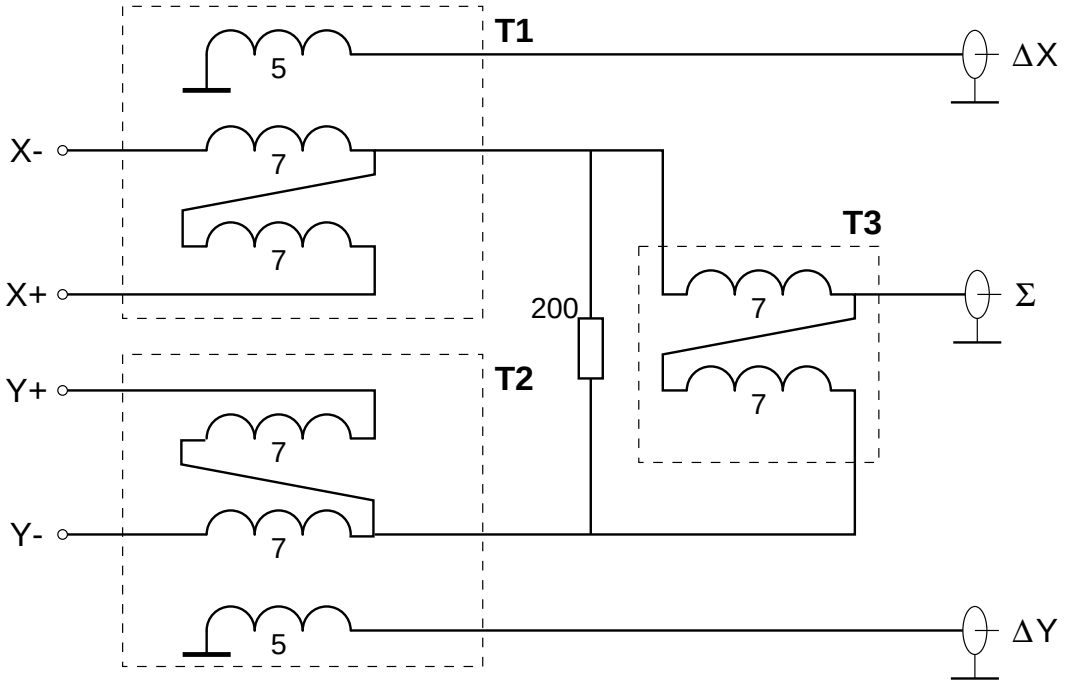


Measuring particle beam trajectories

$\Delta - \Sigma$ separation: Passive hybrid transformers

For $Z_{load}=50\Omega$,

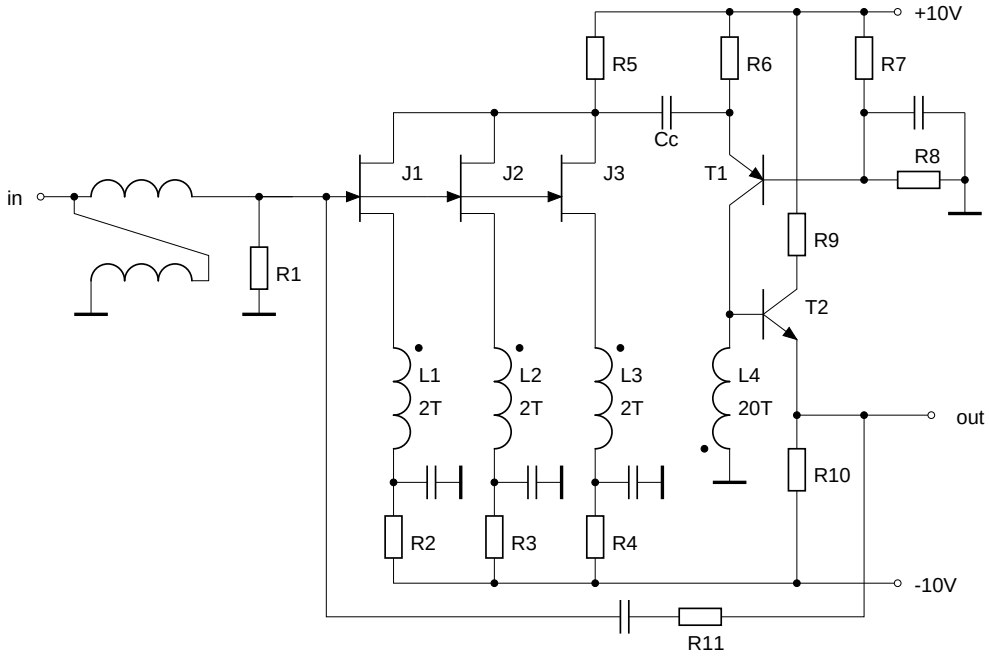
$Z_{in}=200\Omega$



Cores: Vitrovac T60009-E4006-W650

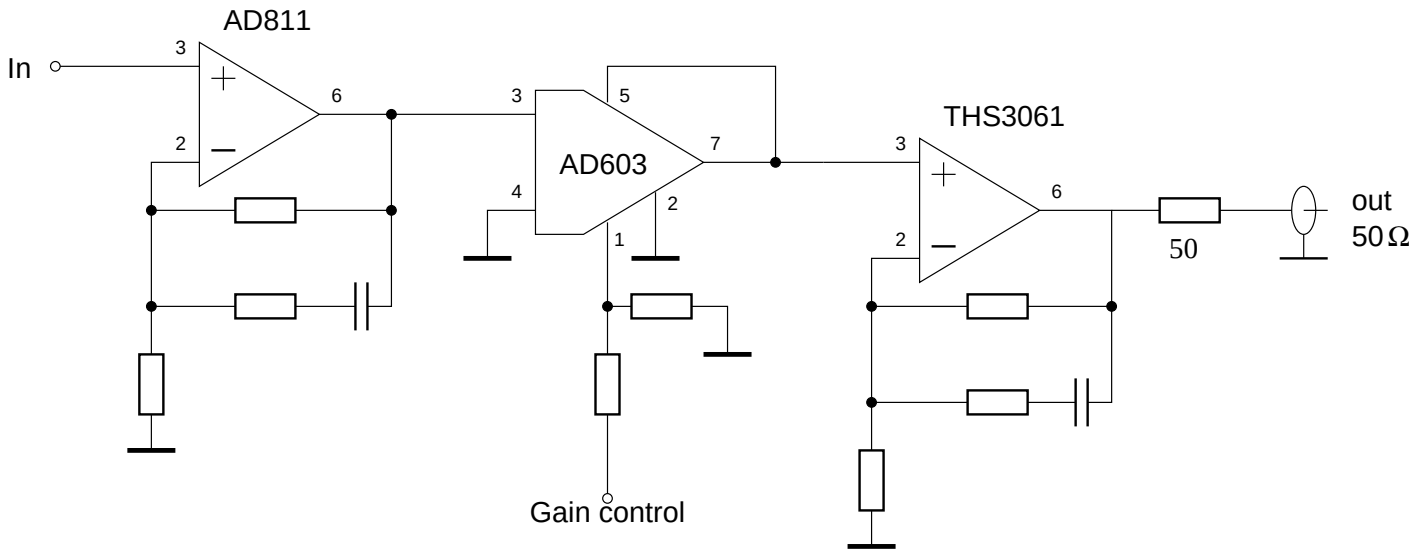
LNA

- Folded cascode
- Transformer feedback sets gain
- Feedback resistor sets Z_{in}
- Input xfrmr for noise match
- Multiple JFETs: lower E_n, higher g_m



BW : 10kHz−75MHz
Gain : 26dB
E_n : 300pV/rtHz
Z_{in} : 50Ω

Variable gain amplifier and frequency compensation

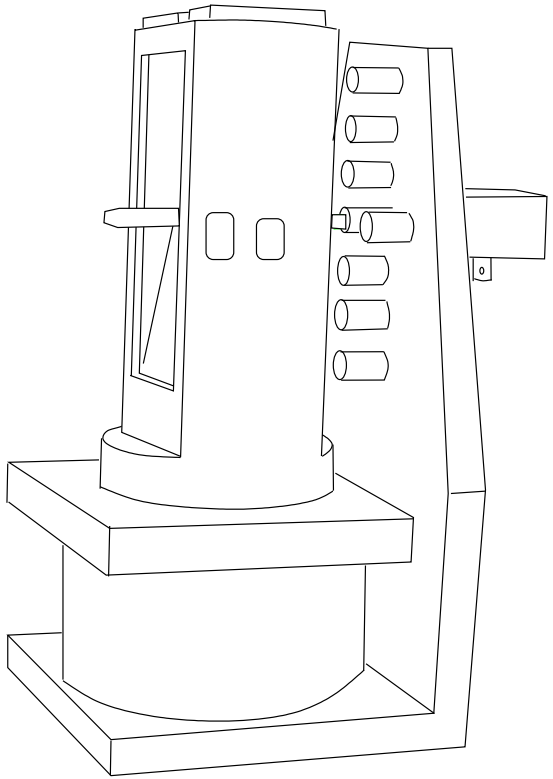


- Gain control range: 40dB
- Frequency compensation distributed over two stages

Calibration

- Step 1:
  Using a carefully positioned antenna rod, measure Δ/Σ at two or three positions.
  This gives displacement sensitivity and electrical zero error.

- For the PS pick−ups, using the shown hybrid,
  S_x =132mm
  S_y =61.7mm

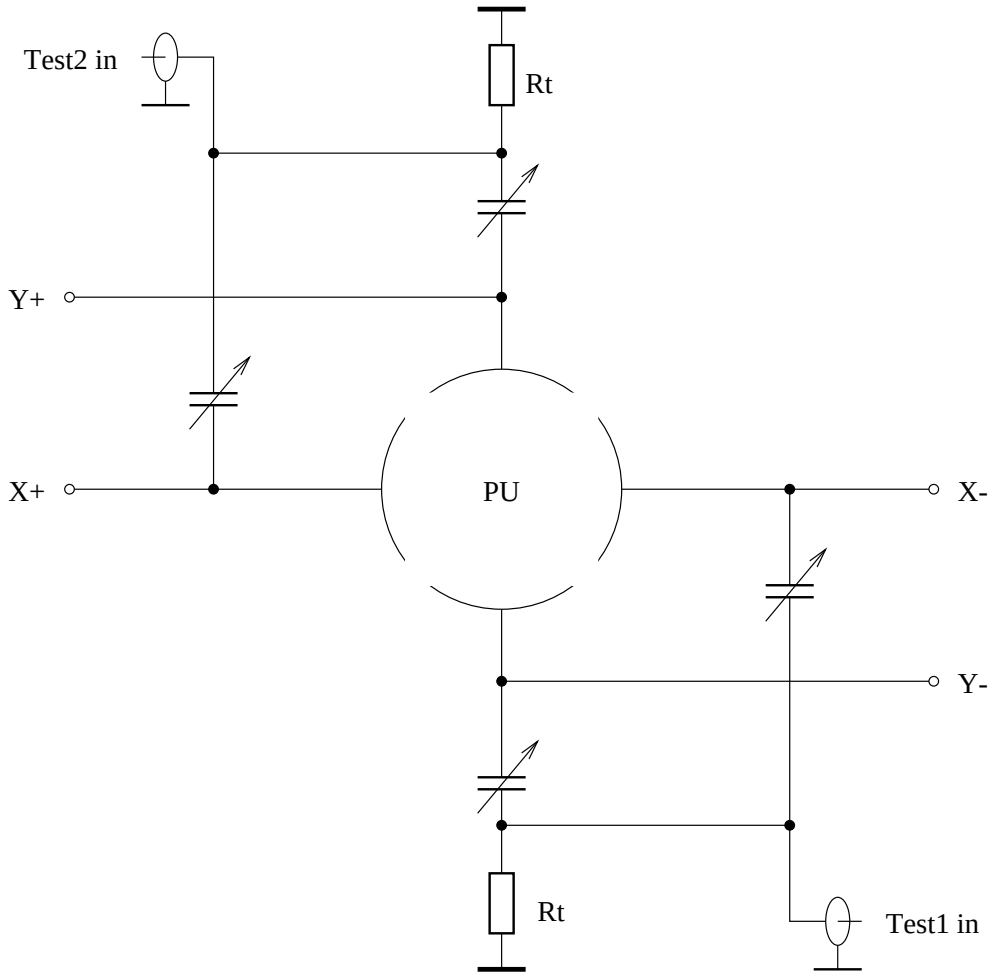


Calibration

- Step 2:
  Apply equal signals via small adjustable capacitors to X^+, Y^+ and then to X^-, Y^- and calculate the simulated positions. Use these as reference positions.

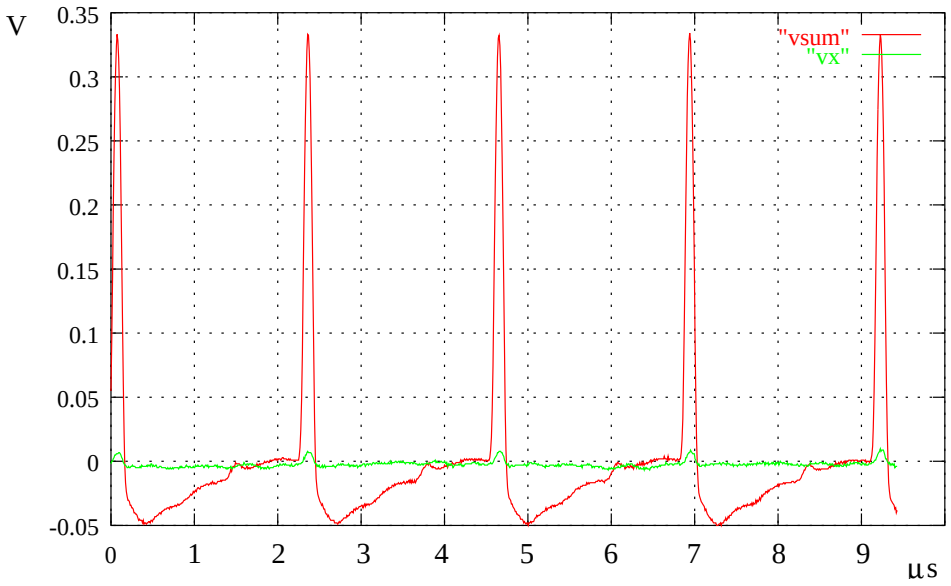
- For our setup, this yields
  X_{cal} = 85mm
  Y_{cal} = 39.6mm

- This is just the PU's size!

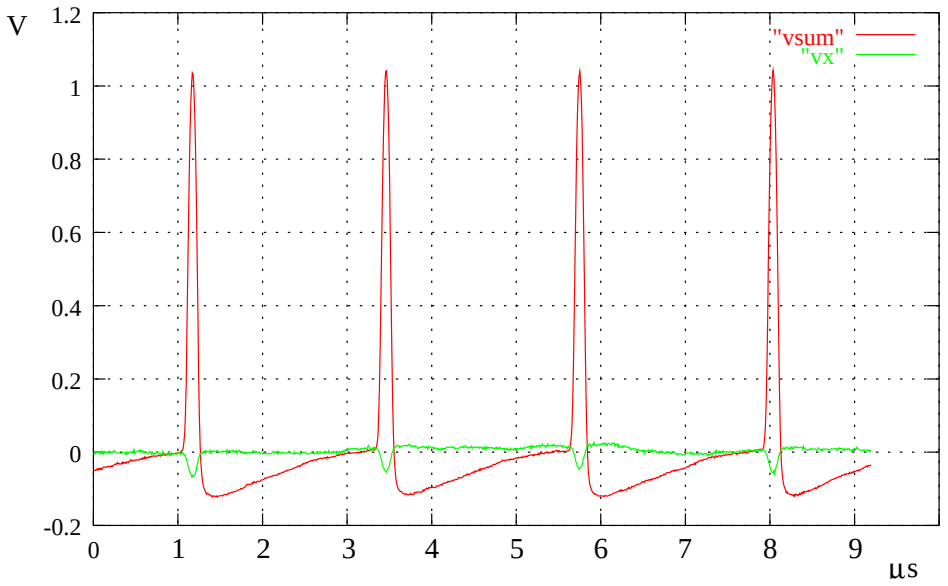


Measuring particle beam trajectories

Some example signals (TOF)



Old (resolution 0.1mm)

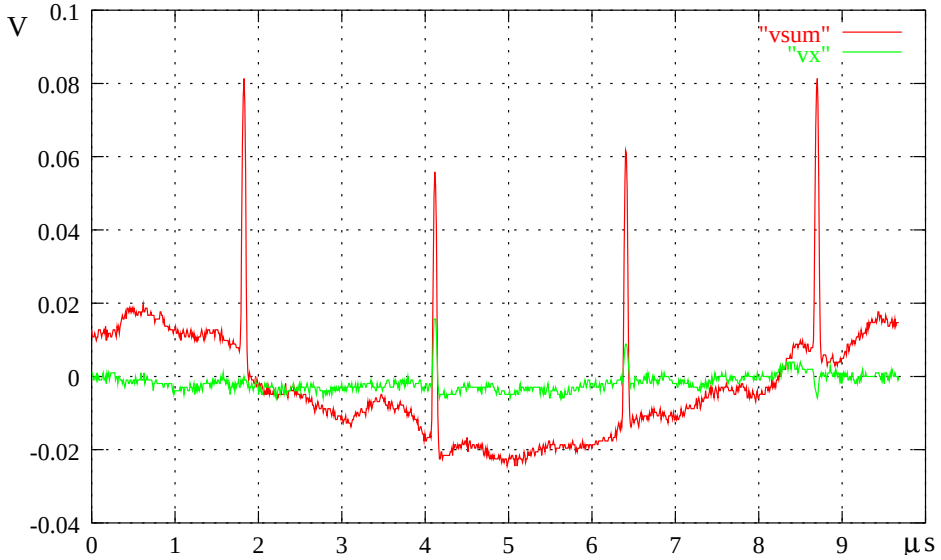


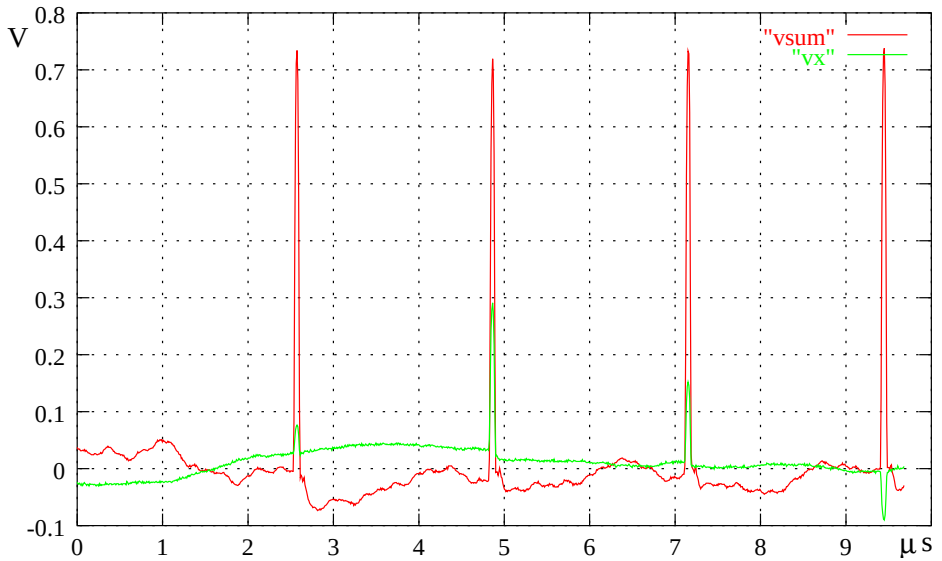
New (resolution 0.1mm)

Harmonic 8, one bunch, $7.2 \cdot 10^{12}$ p^{+}

Measuring particle beam trajectories

Some example signals (MDLHC)





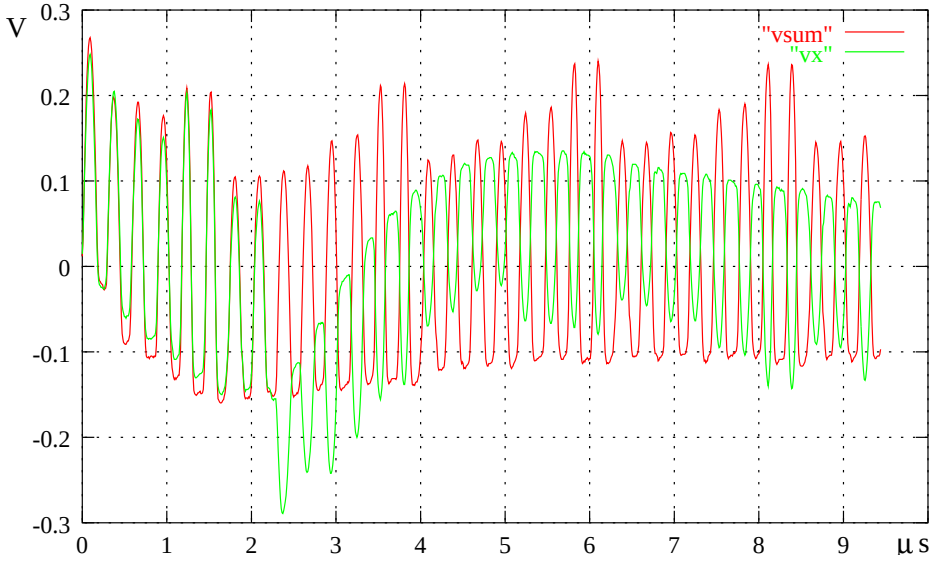
Old (Resolution 1.7mm)

New (resolution 0.5mm)

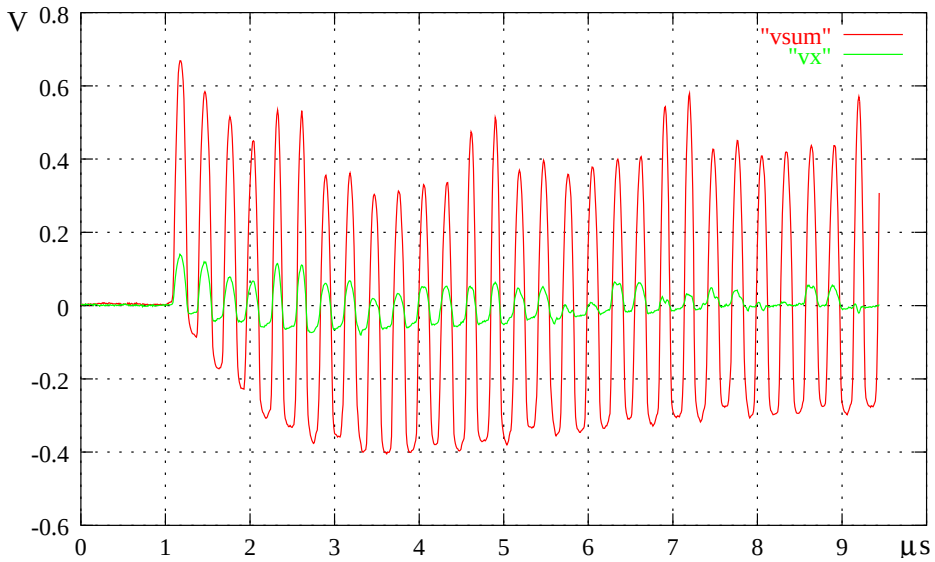
Harmonic 8, one bunch, $6 \cdot 10^9$ p^+

Measuring particle beam trajectories

Some example signals (SFTPRO)



Old



New

Harmonic 8, eight bunches, $2 \cdot 10^{12}$ p^{+}/bunch