2nd DITANET School: Complementary Skills Workshop

Diagnostics for the Ultra-low Energy Storage Ring

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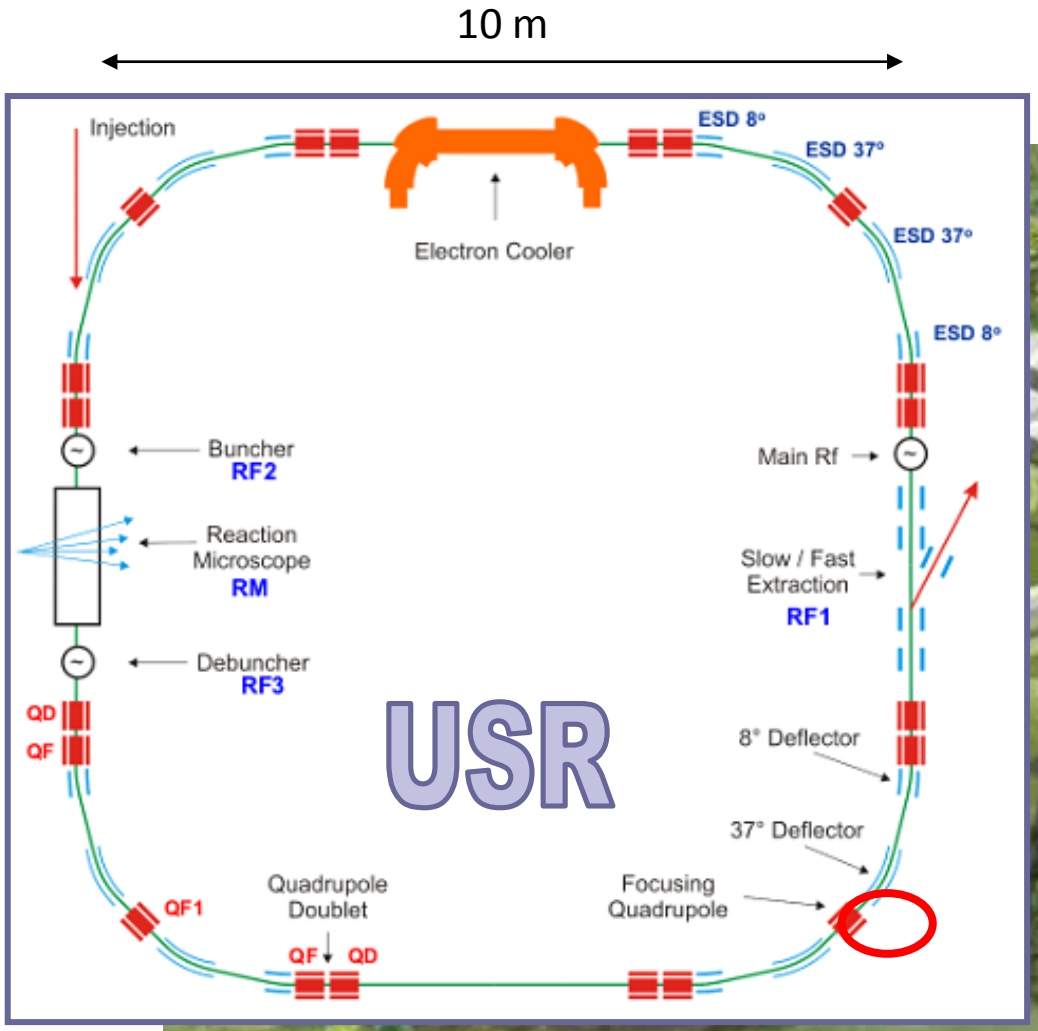
Ultra-low Energy Storage Ring

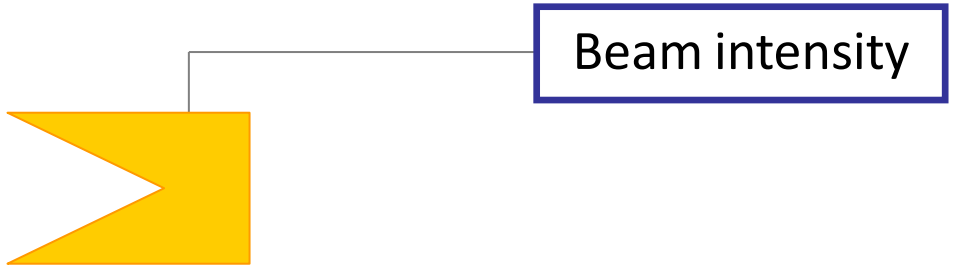


ANTIPROTONS

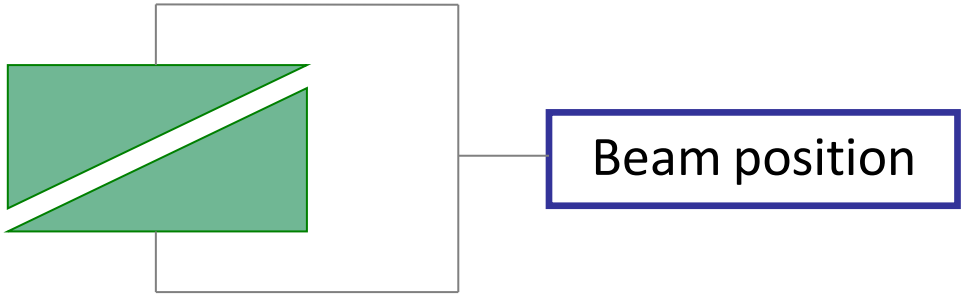
Energy	300 keV → 20 keV
Relativistic beta	0.025 → 0.006
# of particles	~10^8 → ~10^7
Bunch length	1 ns – DC beam
Effective pbar rates for in-ring experiments	10^{10} pps – 10^{12} pps
Average rates of extracted pbars	$5x10^5$ pps – 10^6 pps

Beam Instrumentation

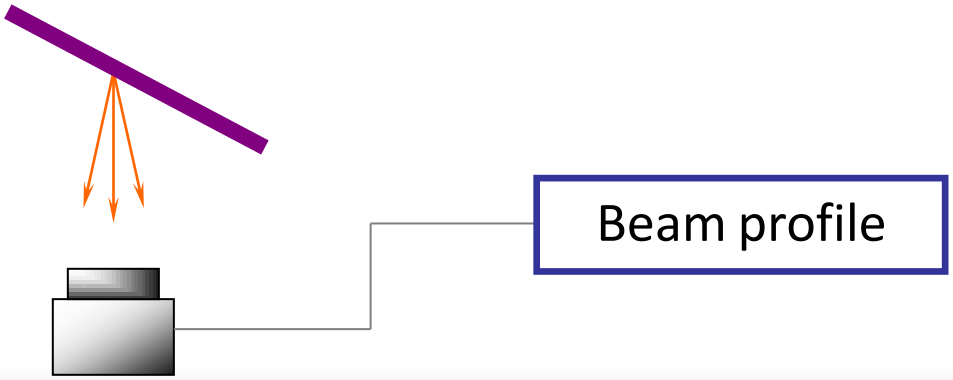
- Faraday Cup



- Capacitive Pick-Up

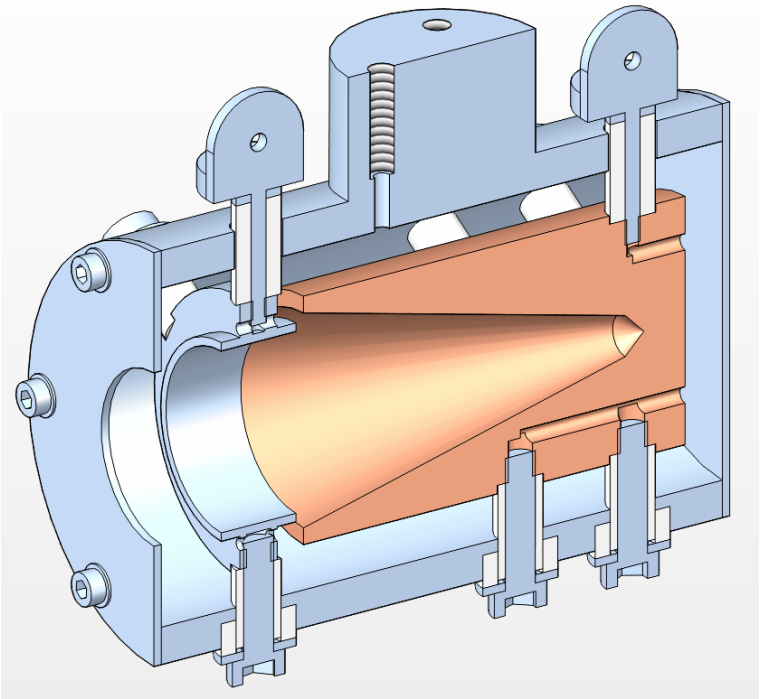


- Scintillating Screen

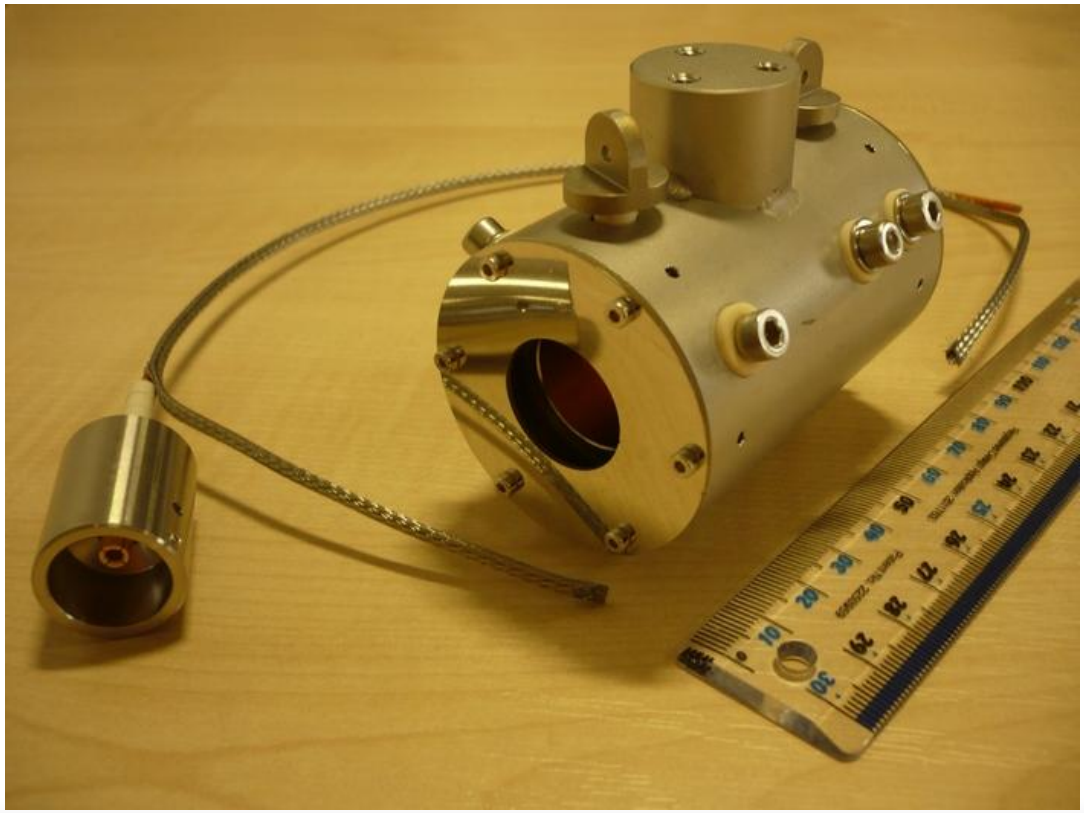


Faraday Cup

- Weak signals:
  - AC mode: ~0.1 μA_{p-p}
  - DC mode: ~0.1 pA
- Ultra-high vacuum:
  - ~10^{-11} mbar

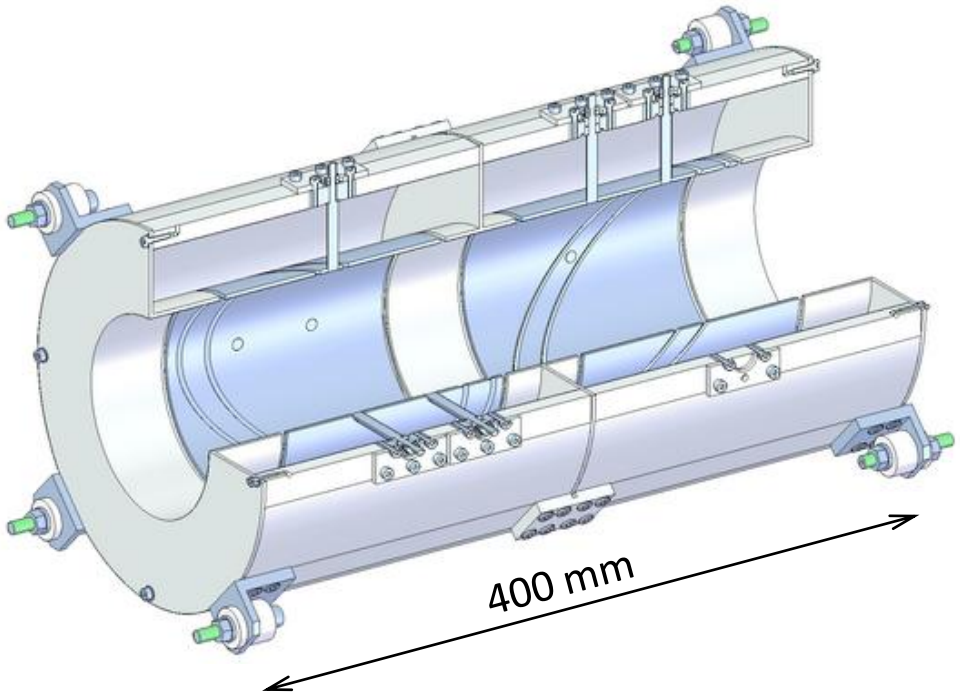


- Variable gain I/U converter
- Narrow bandwidth
- Double shielded cables and special connectors

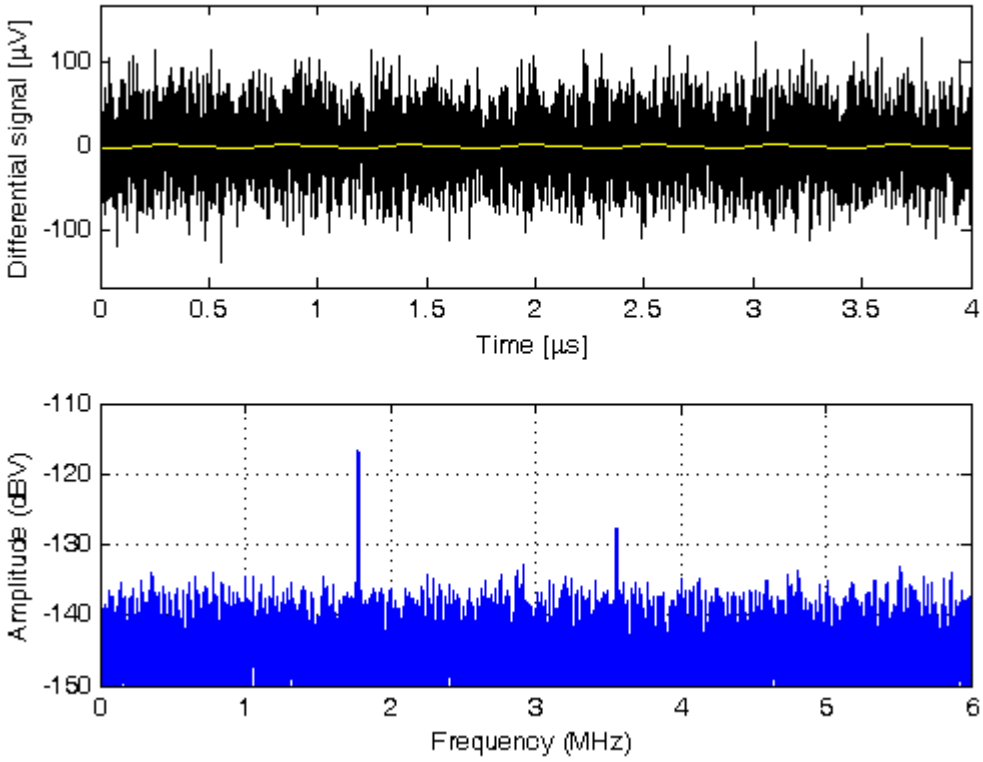


Capacitive Pick-Up

- Weak signals:
  - Sum: ~100 μV_{p-p}
  - Difference: ~1 μV_{p-p} // 1 mm
- Low velocity:
  - $0.006 < \beta < 0.025$



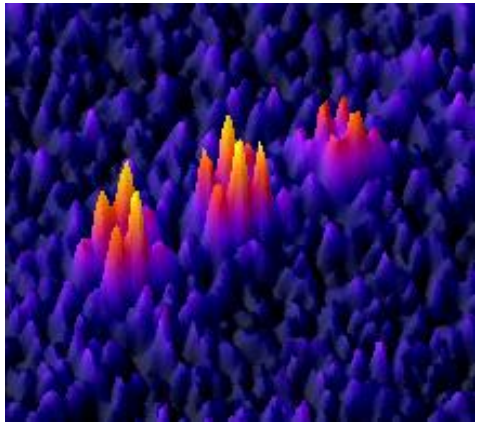
- High input impedance
- Low noise amplifier
- Narrow bandwidth
- Closed orbit measurements



Scintillating Screen

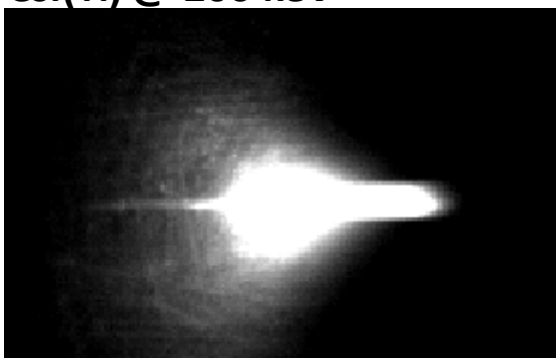
- Low energy:
  - 300 keV – 20 keV
- Low intensities:
  - AC mode: $2 \cdot 10^7$ p in ~5 µs
  - DC mode: $5 \cdot 10^5 – 10^6$ pps
- Large beam spread:
  - diameter up to 20 mm

- Sensitivity and resolution studies:
  - CsI(Tl)
  - YAG(Ce)
  - SFOP



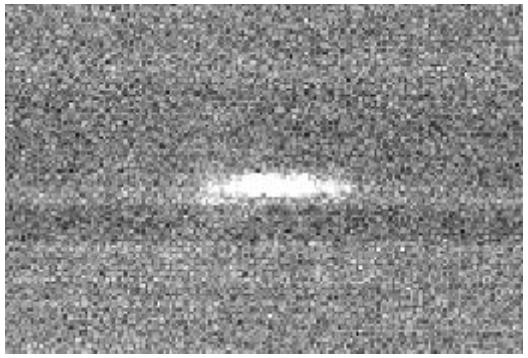
Sub-mm resolution
(example for SFOP @ 50 keV)

CsI(Tl) @ 200 keV



No attenuation: ~10 pA (1s)

20x att.: ~500 fA (1s)



100x att.: ~100 fA (1s)

20x+100x att.: ~5 fA (20s)

Summary

- **Faraday cup**
  - Low current (~0.1 pA) measurements under UHV
- **Capacitive pick-up**
  - Low differential signal (~1 µV for 1 mm)
- **Scintillating screen**
  - Low number of particles (~$5 \cdot 10^5$ pps)
  - Large beam spread (~20 mm^2 – ~100 mm^2)
  - Low energy (20 keV)