Readout system for the P2 tracking detector

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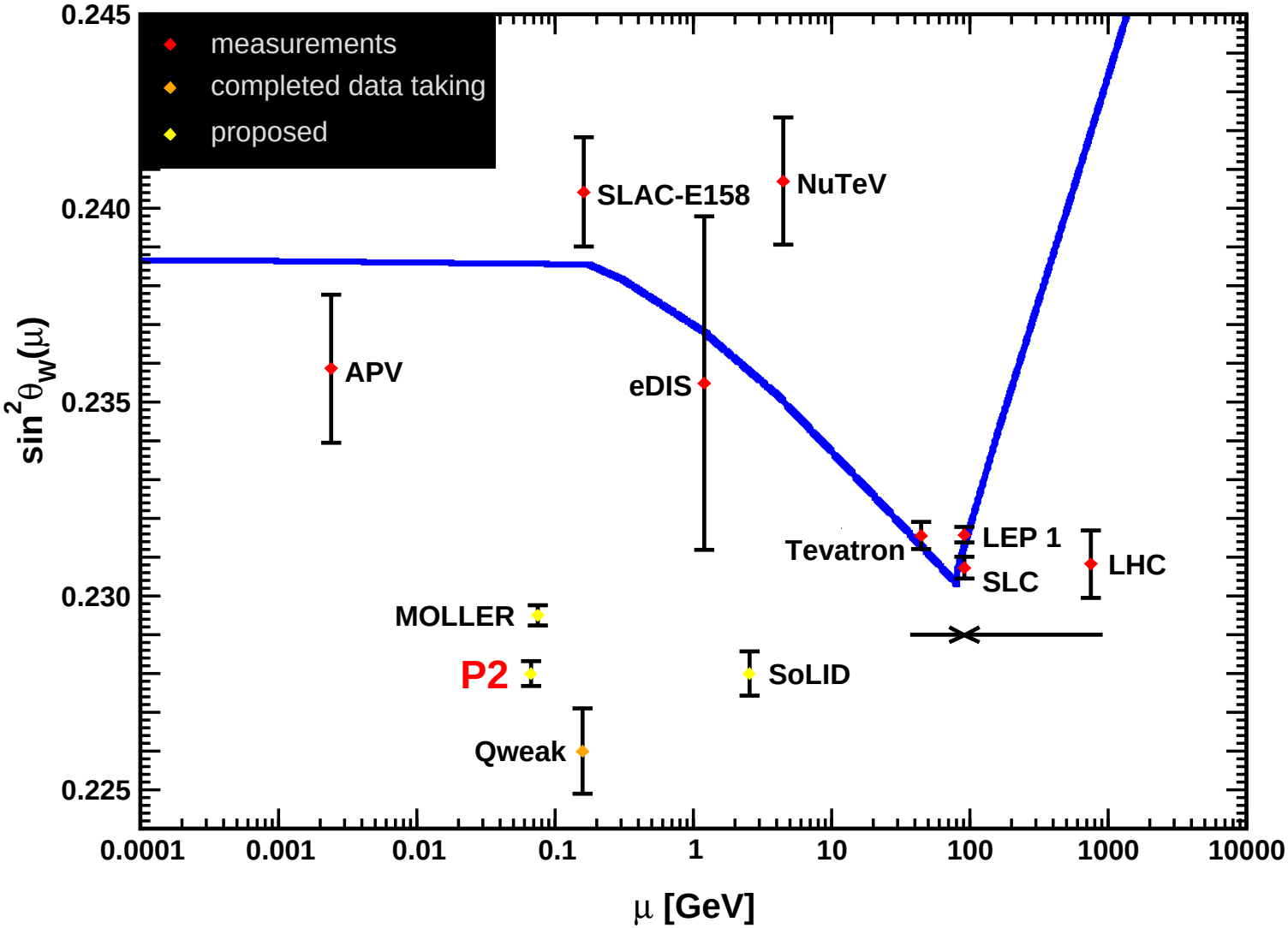
The weak mixing angle

- Fundamental parameter of the Standard Model
- Relation between γ and Z^0

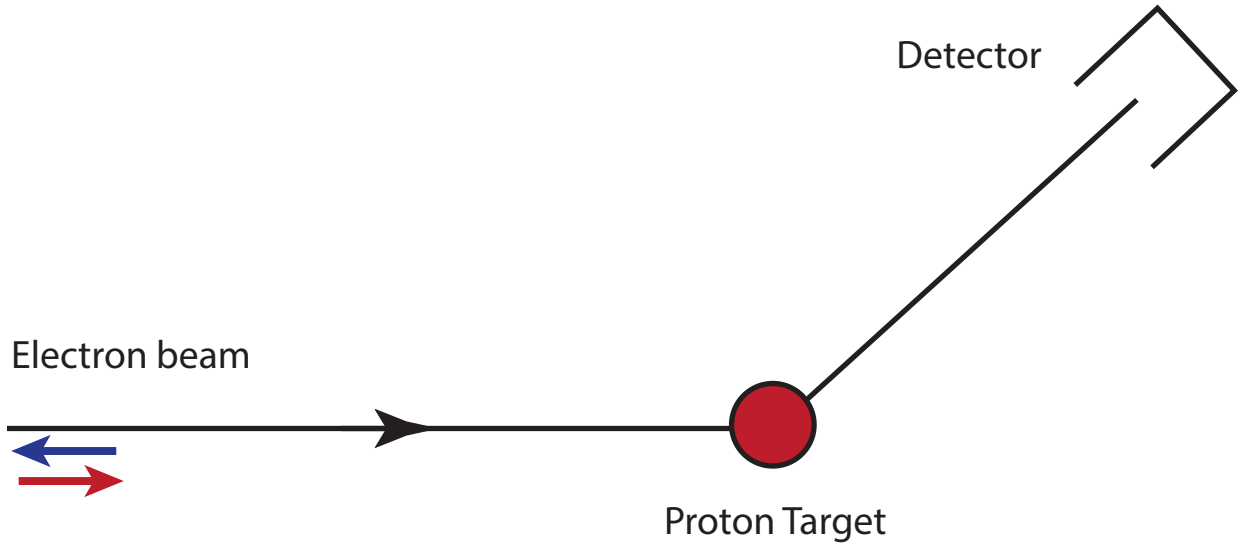
$$\begin{pmatrix} \gamma \\ Z^0 \end{pmatrix} = \begin{pmatrix} \cos\theta_W & \sin\theta_W \\ -\sin\theta_W & \cos\theta_W \end{pmatrix} \begin{pmatrix} B \\ W_3 \end{pmatrix}$$

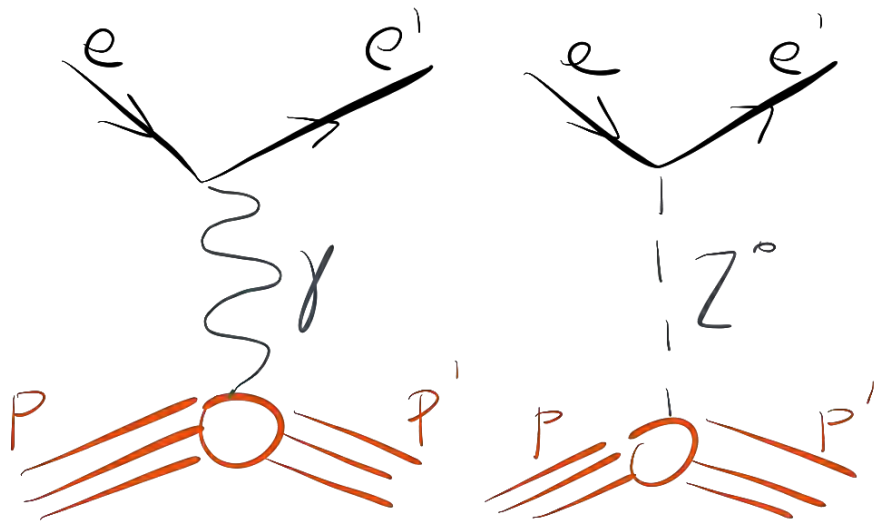
$$\sin^2\theta_W = \frac{{g_e}^2}{{g_W}^2}$$

Running of the weak mixing angle



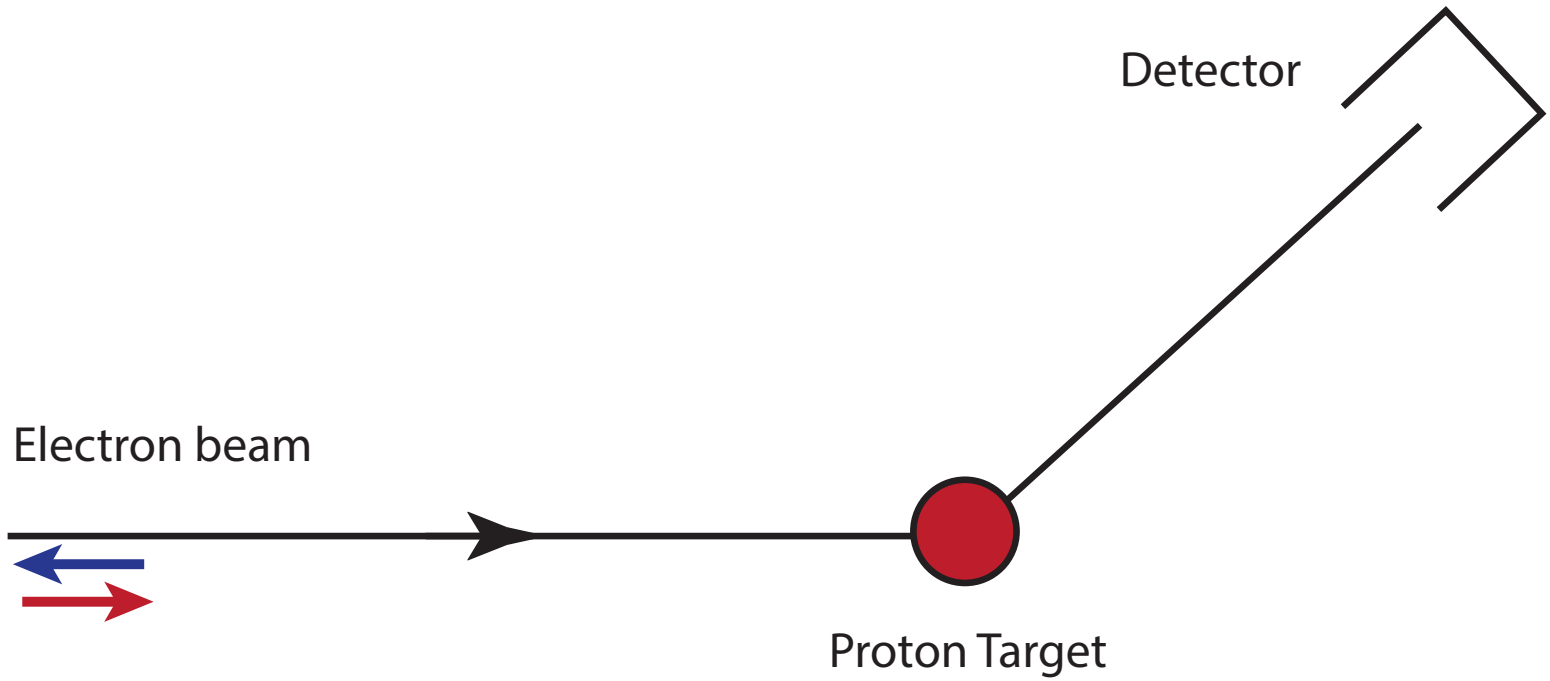
Measure the weak mixing angle





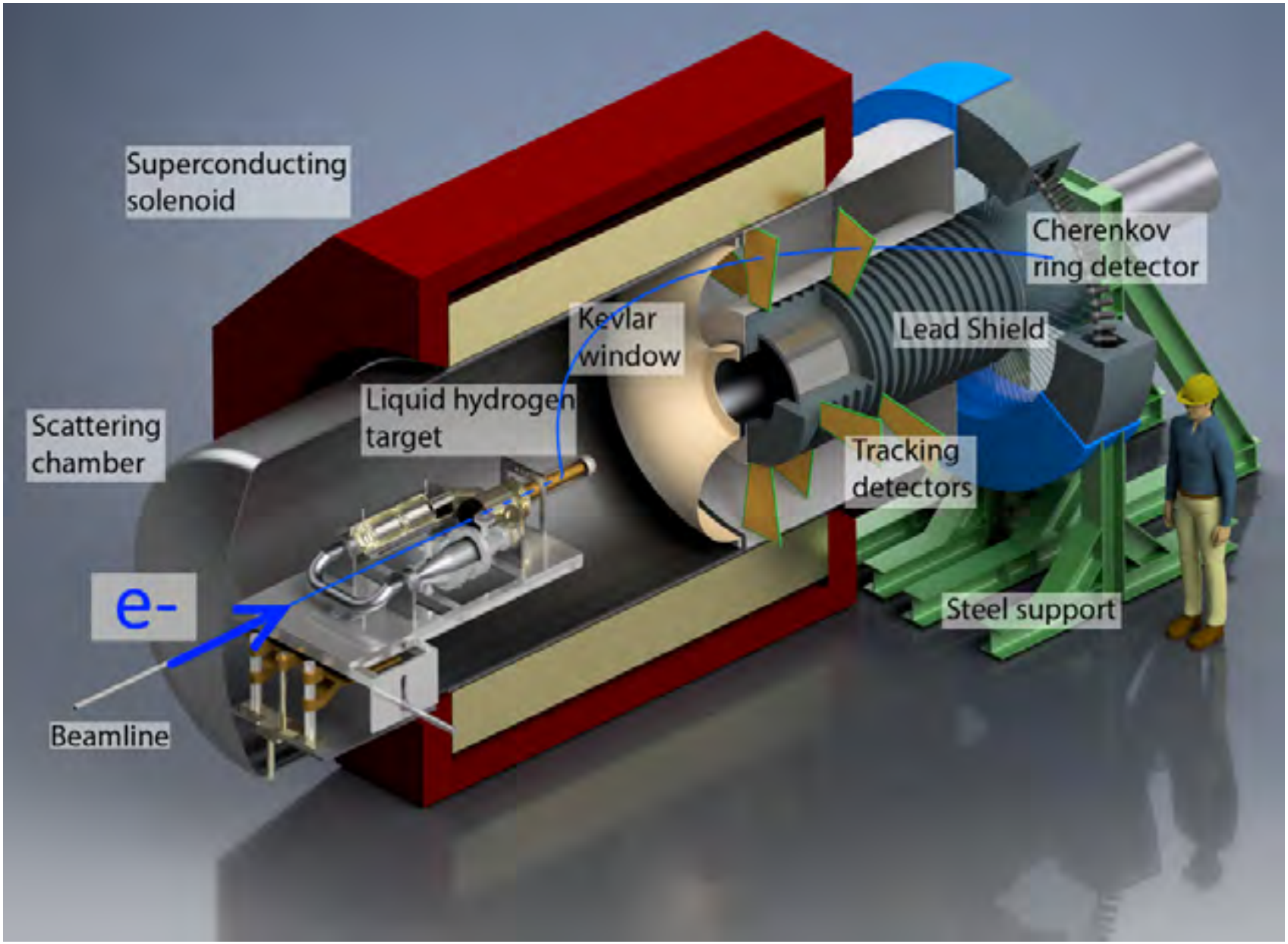
Measure asymmetry

$$A_{PV} = \frac{N_R - N_L}{N_R + N_L} = \frac{G_F Q^2}{4\sqrt{2}\pi\alpha}\left(1 - 4\sin^2\theta_W - F(Q^2)\right) \approx 39 \text{ ppb}$$

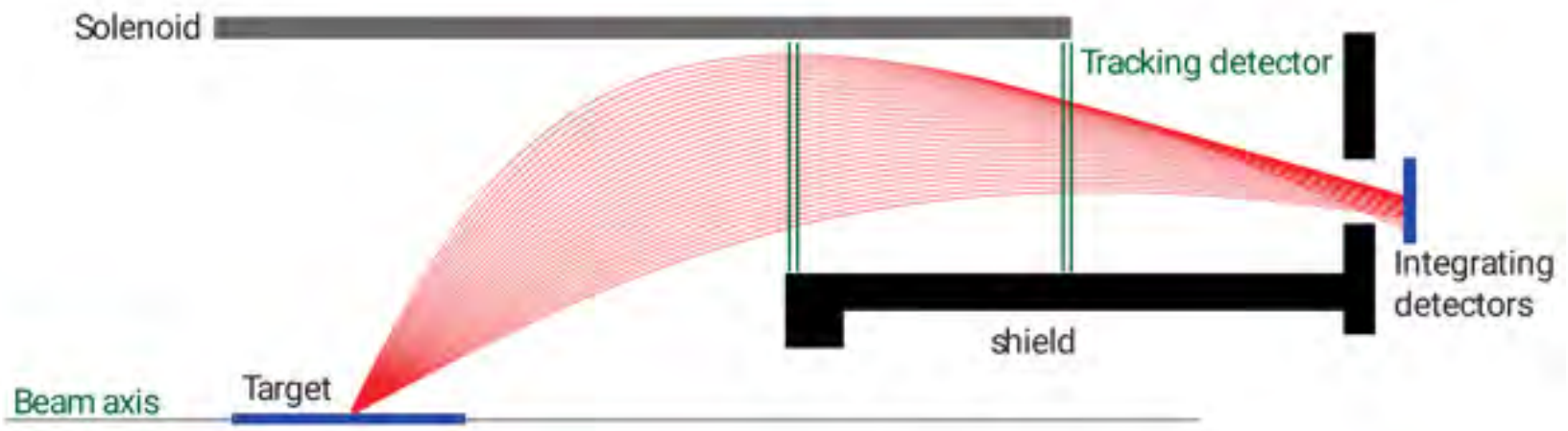


- Measure $\sin^2\theta_W$ to 0.14 % $\Rightarrow 10^{18}$ electrons
- 100 GHz measuring rate

P2 experiment



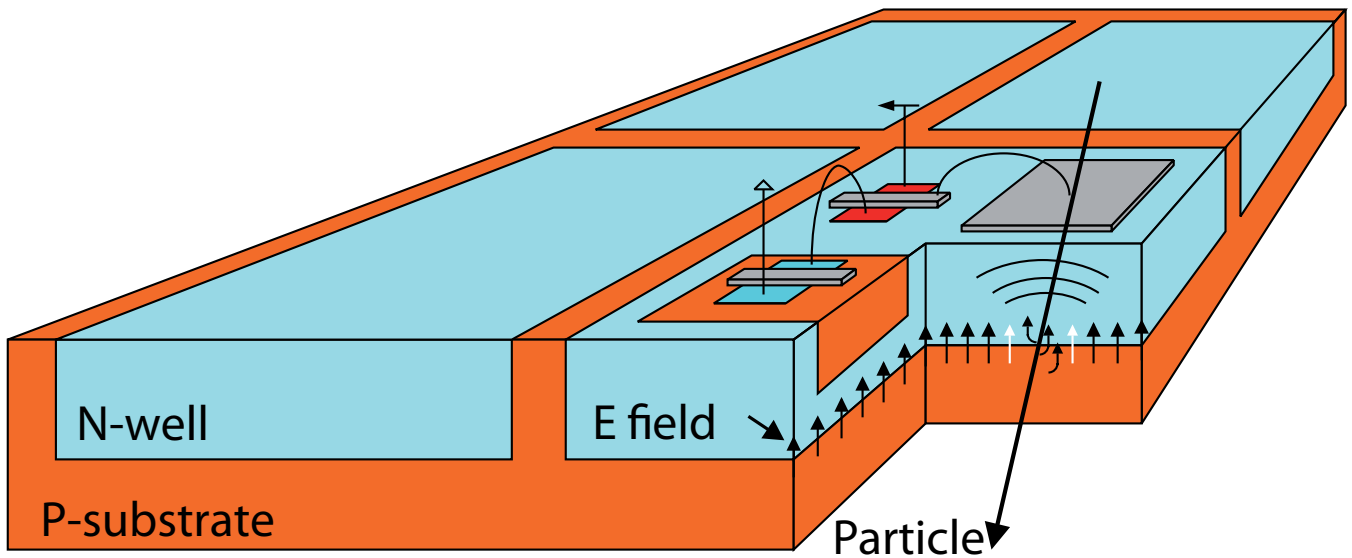
P2 spectrometer and tracking system



- 0.6 T solenoid magnet
- Inhomogenous field in tracking system
- Measure the average Q^2

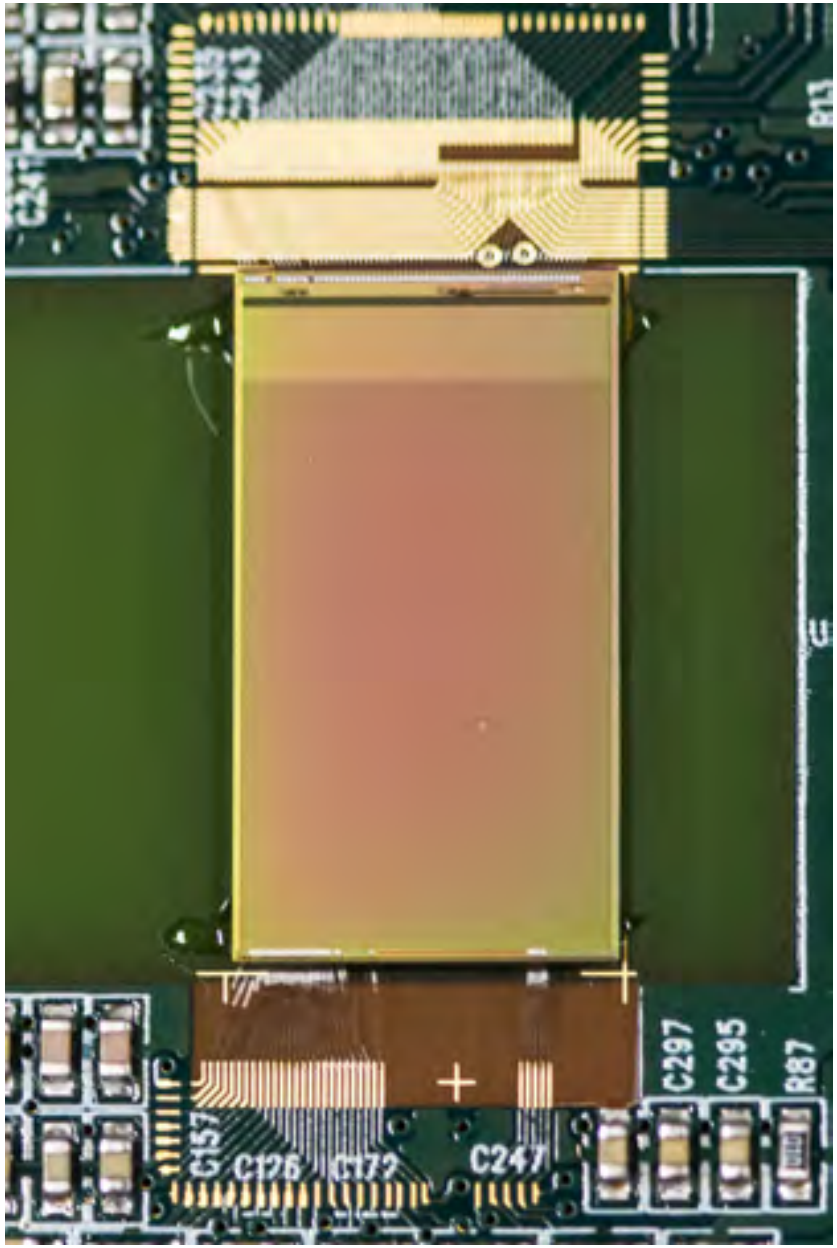
High Voltage Monolithic Active Pixel Sensor - HV-MAPS

- 180 nm HV-CMOS technology
- Reverse biased up to 90 V
- Readout logic on chip
- Thinable down to 50 µm

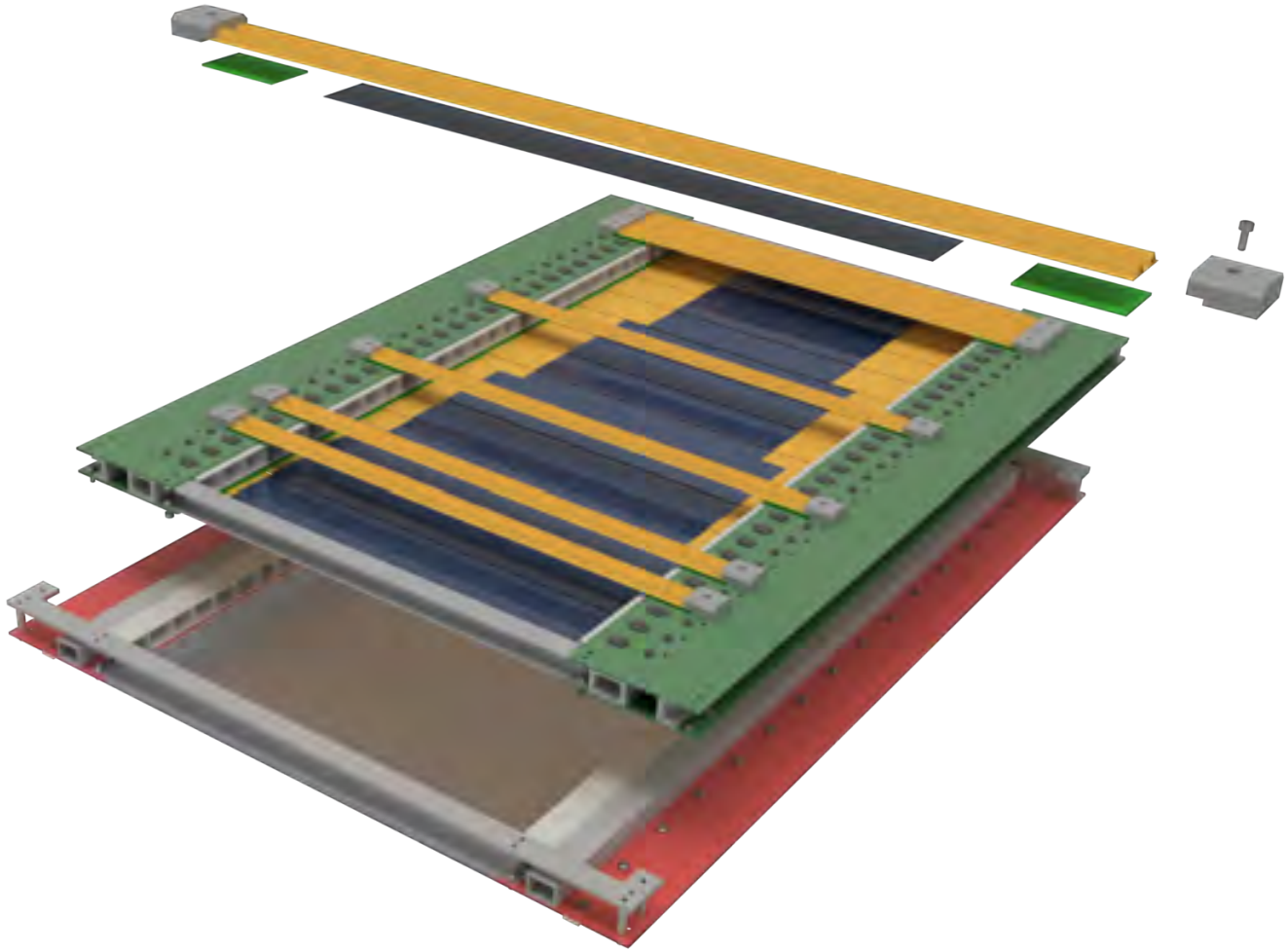


P2 tracking detector - MuPix prototypes

- Mupix8
- Pixel size: $80 \times 81\,\mu m^2$
- Sensor size: $2 \times 1\,cm^2$
- $3 \times 1.25\,Gbit\,s^{-1}$ LVDS data links

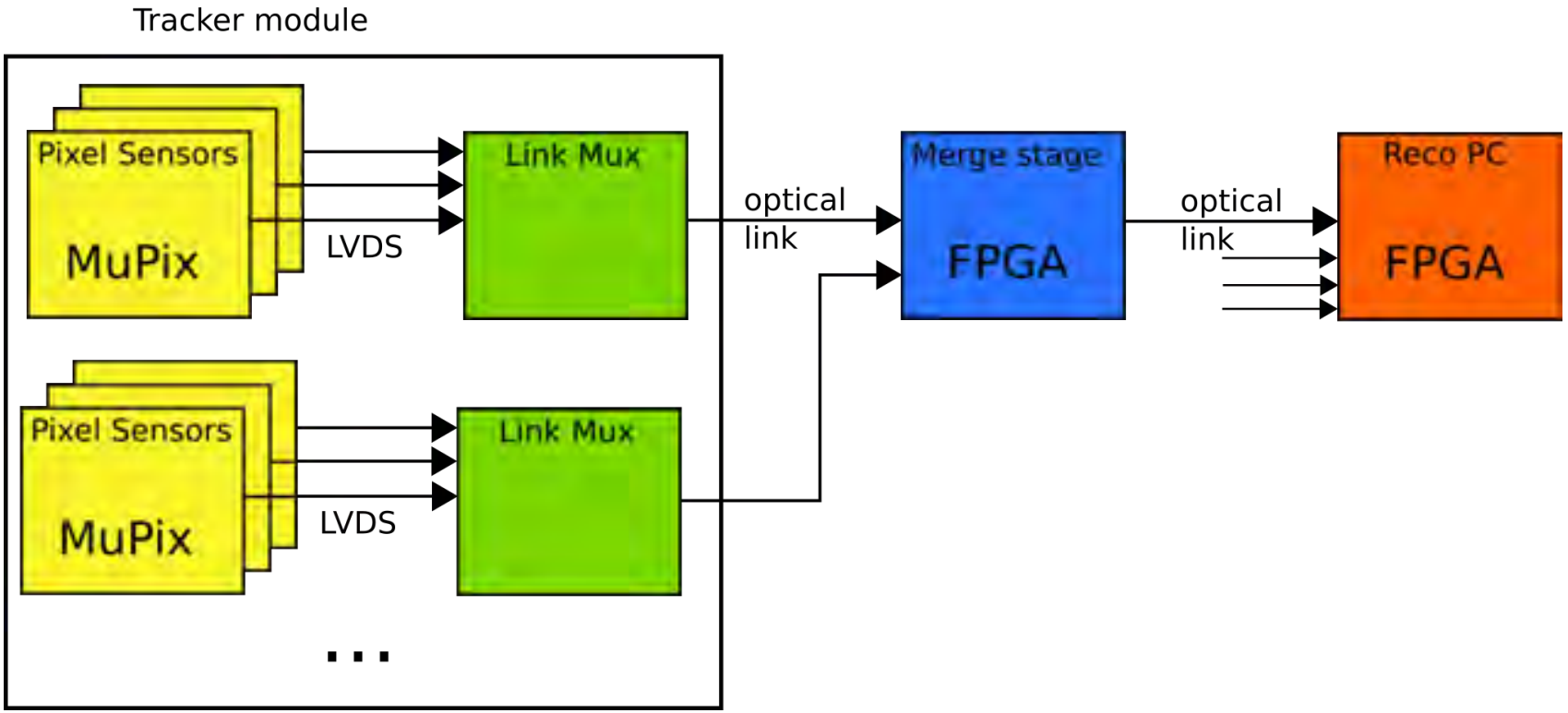


P2 tracking detector - Module readout



- 1.25 Gbit s^{-1} LVDS serial output
- Kapton flexprint
- module mechanics: M.Zimmermann (T 40.8)

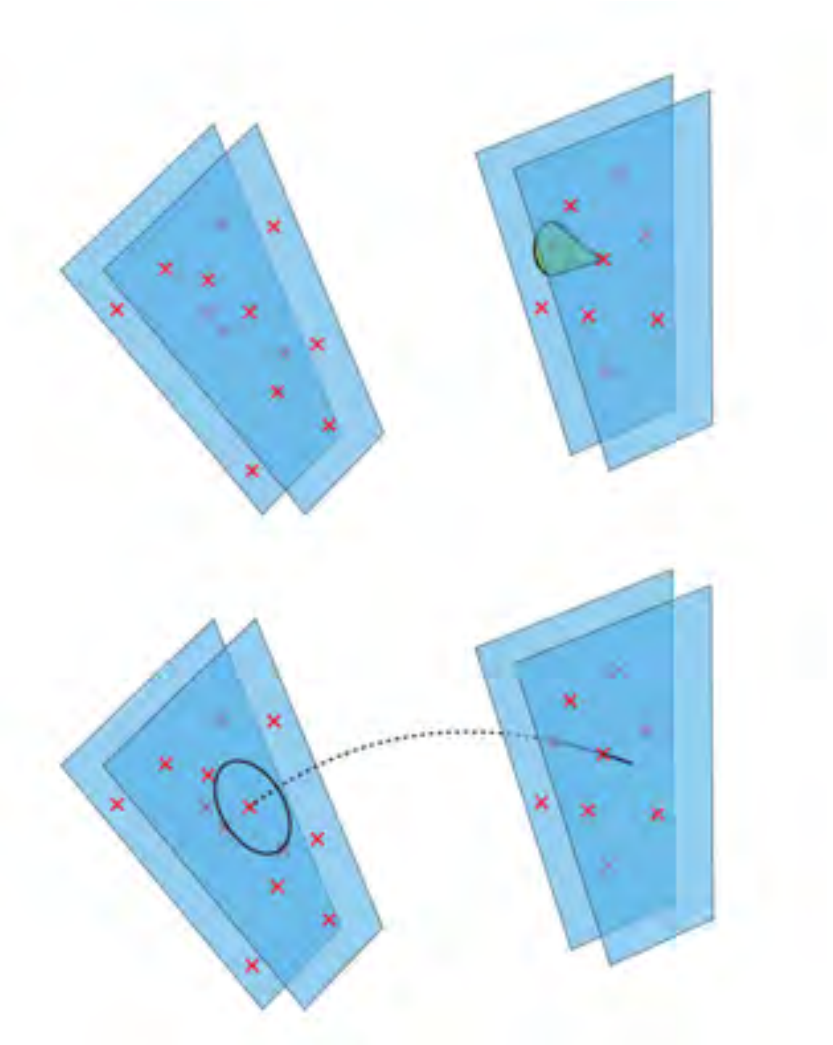
P2 tracking detector - Readout concept



- triggerless, fully digital readout
- 100 GHz measuring rate $\rightarrow$ 10 Tbit s^{-1} data rate

P2 tracking detector - Data rate reduction

- all tracks similar $\rightarrow$ no need to catch all
- gated readout
- highly local track finding



Summary

- P2 measures the weak mixing angle
- Tracking detector to measure average Q^2
- triggerless, gated readout system