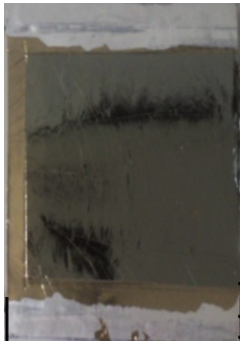
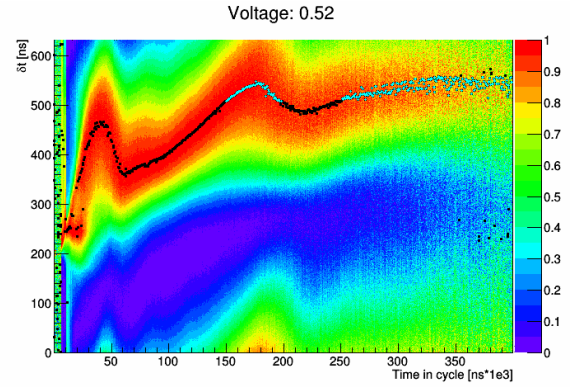
Measuring ADS Foil Thickness





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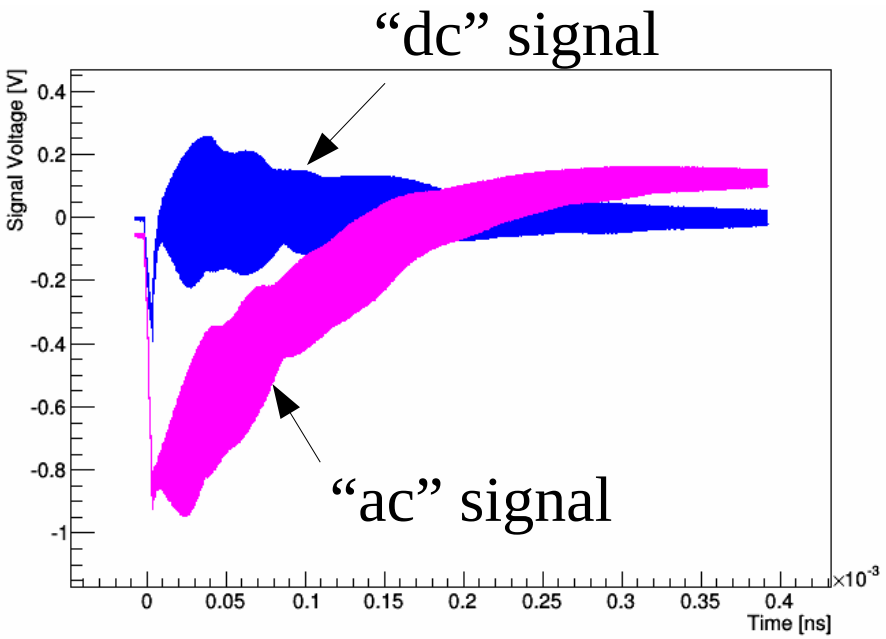
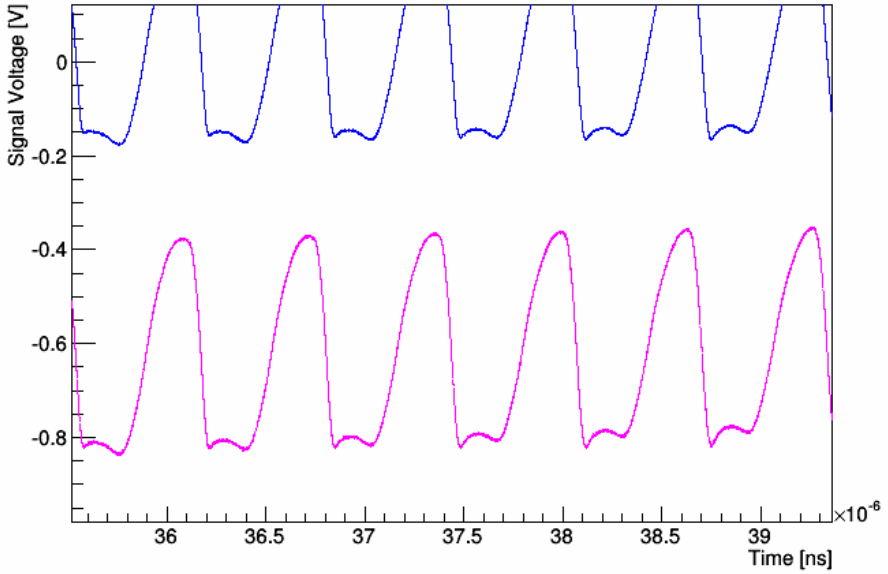
Beam-based of the foil thickness

- Aim to use beam based measurement of foil thickness
- When the RF voltage is too low, no bunch is formed
- Use the voltage dependence of bunch synchronous phase as a cross-check

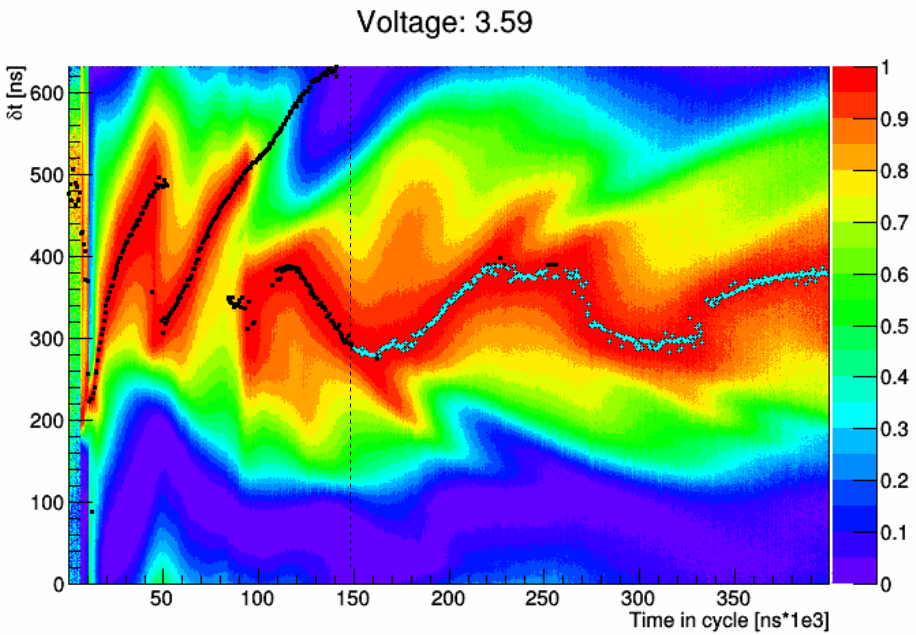
Bunch monitor signal

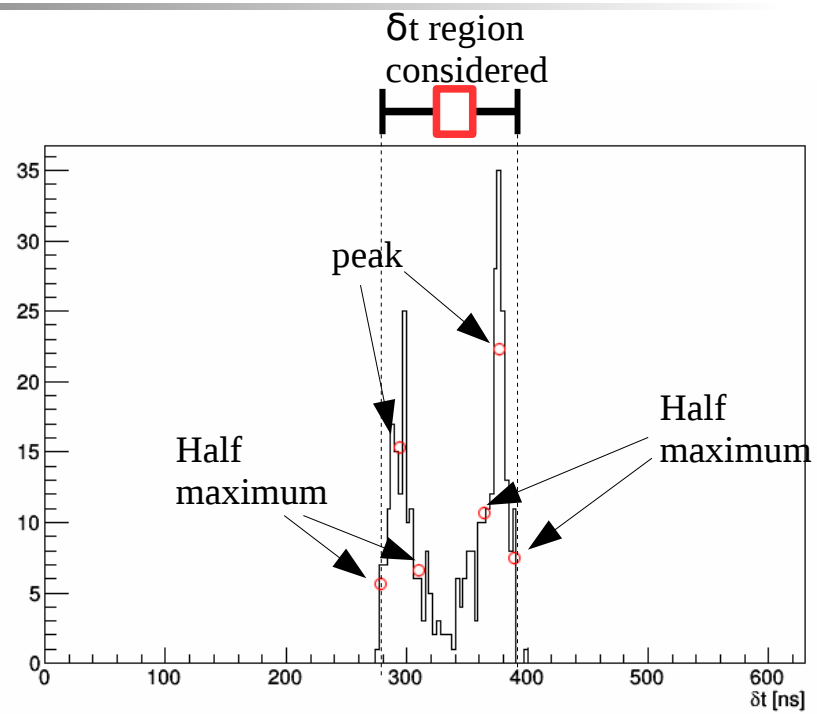




- Use AC bunch monitor signal turn-by-turn
- Calculate position of peaks in the signal relative to peaks in RF signal

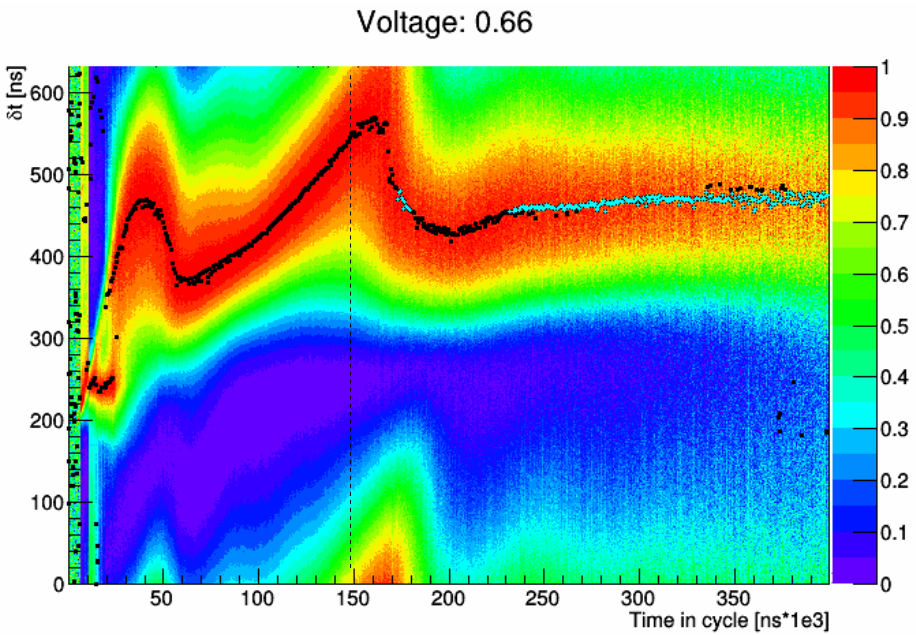
Beam as a function of time – 3.59 V

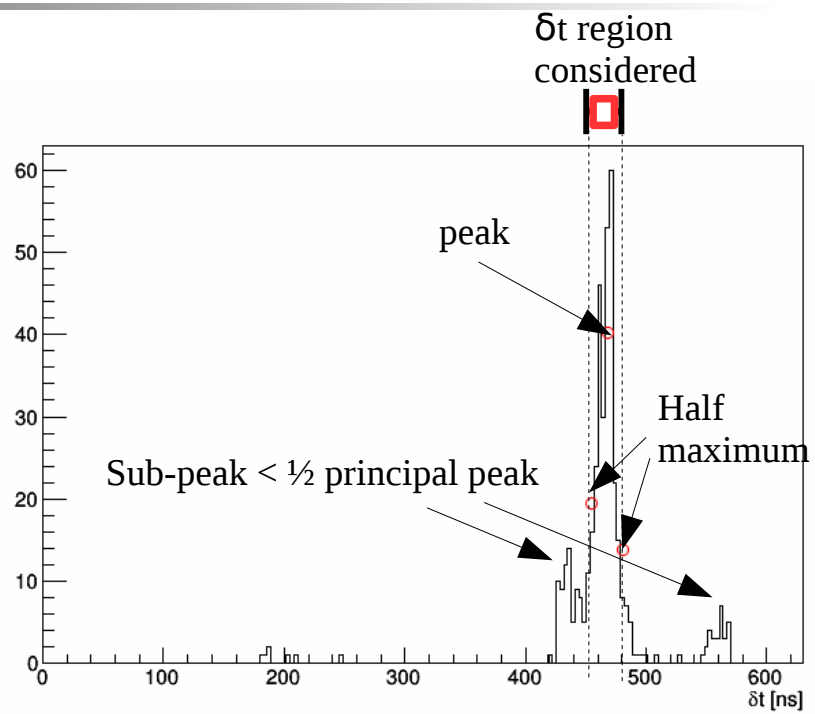




- Consider “ac” signal vs time
  - Contours show beam intensity, normalised in each RF cycle
  - Points show phase of the peaks vs time
- Points coloured blue are considered in RF phase calculation
  - Bounds given by 1D projection of bunch peaks
  - Bunch “phase” boundary is given by “half maximum” points
  - Bunch “phase” is given by the midpoint of the boundary

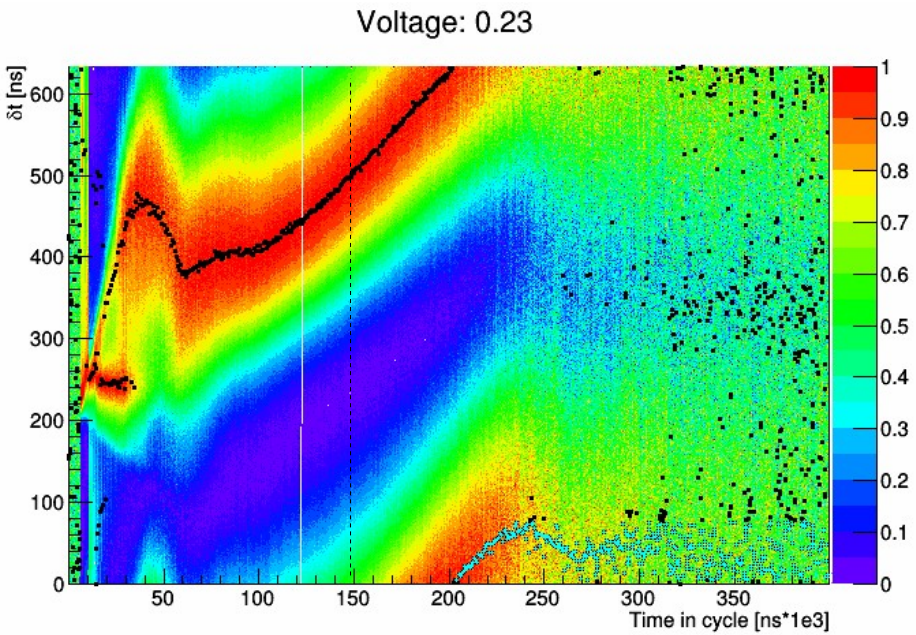
Beam as a function of time – 0.66 V

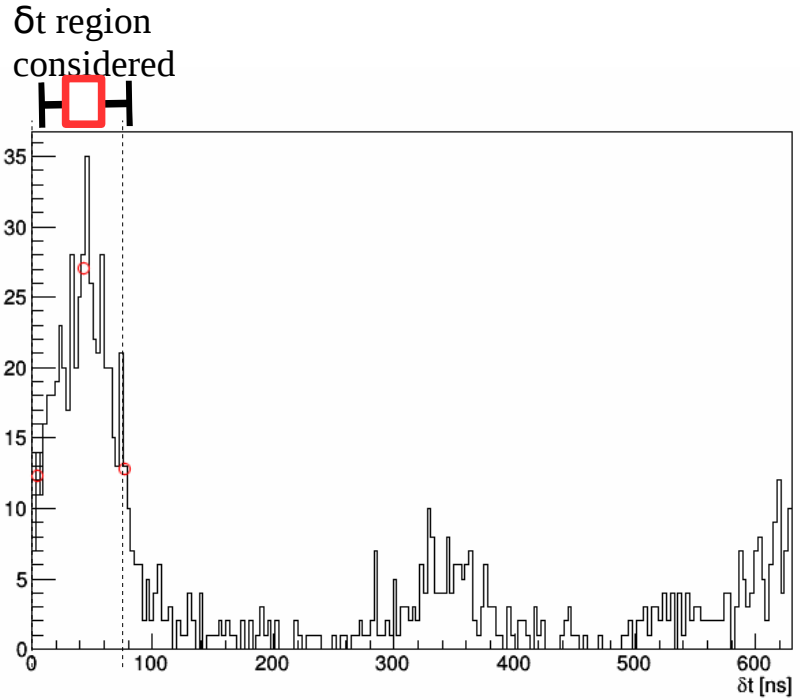




- Looks like beam at 0.66 V is definitely captured
- Note that if there are subpeaks with size < half of the principle peak, these are ignored

Beam as a function of time – 0.23 V

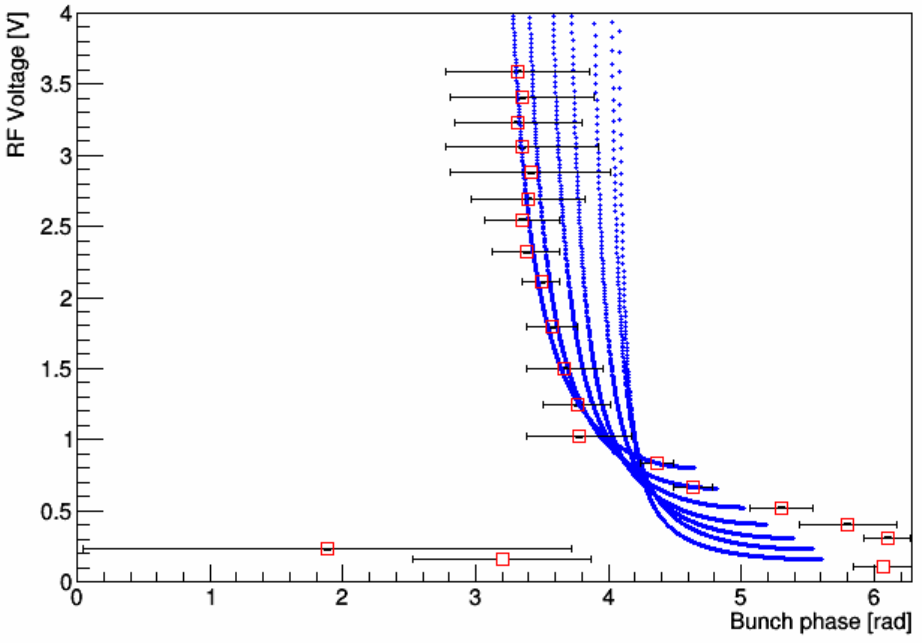




- Looks like beam at 0.23 V is definitely not captured
  - Beam drifts and then is lost

Phase

- Consider estimated bunch phase
  - Phase calculated as per slides 4-6
  - Attempt to fit the curve $\delta W = cV_0 \sin(\varphi_s + d\varphi)$
  - C=1 kV, dφ are calibration constants
- Fitting is very good when we include RF voltages >= 0.66
- Fitting is very poor when we include RF voltages <= 0.42
- Voltages <= 0.42 are not consistent with "bunching" hypothesis



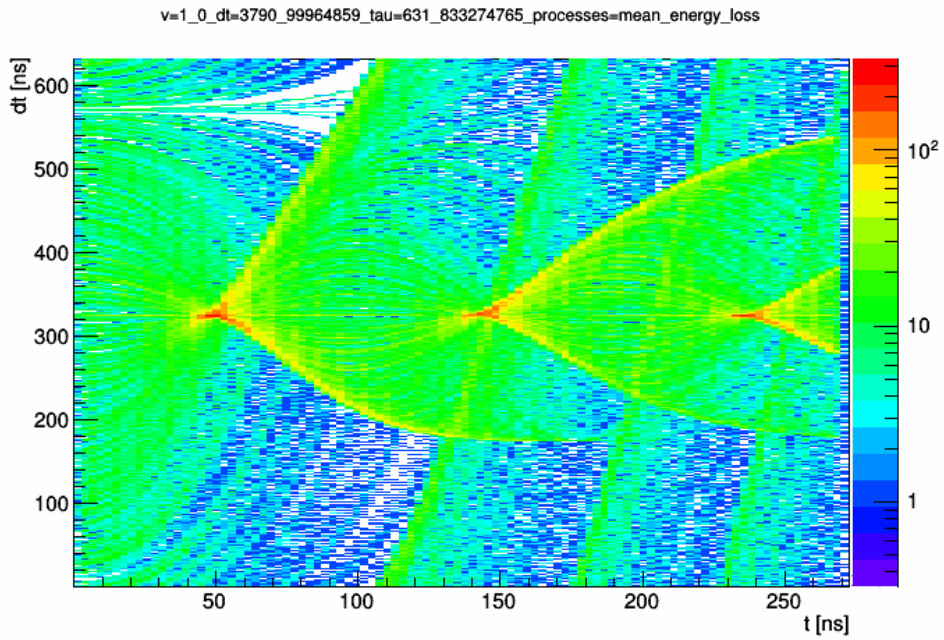
Lowest voltage setting [V]	Fitted voltage [V]	Fitted phase [rad]	Degrees of freedom	$\sum \chi^2$	Probability
0.16	0.16	-4.05	20.0	176.43	0.0
0.23	0.23	-3.96	19.0	143.7	0.0
0.31	0.31	-3.82	18.0	82.07	0.0
0.41	0.41	-3.62	17.0	40.98	0.0
0.52	0.52	-3.45	16.0	16.55	0.42
0.66	0.66	-3.24	15.0	4.33	1.0
0.84	0.8	-3.08	14.0	0.4	1.0

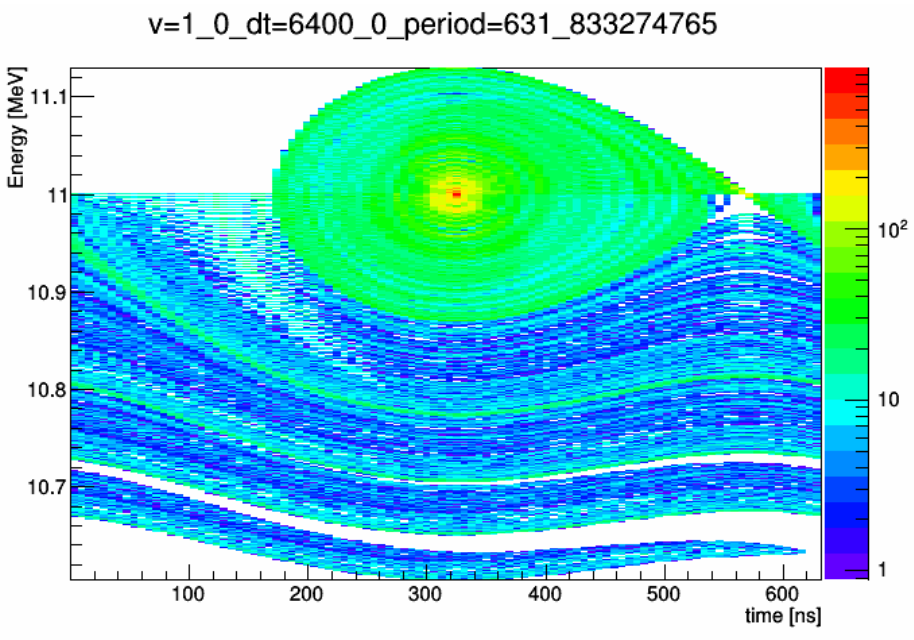
Measured Foil Thickness

	Bethe Bloch	Geant4.9.6p02 QGSP model
Mean stopping power	37.6 MeV cm^2 g	34.0 MeV cm^2 g
By inspection	6.11 - 17.6 μ g/cm^2	6.76 - 19.4 μ g/cm^2
Fit	$>$ 10.9 μ g/cm^2	$>$ 12.1 μ g/cm^2
Combined	10.9 - 17.6 μ g/cm^2	12.1 - 19.4 μ g/cm^2

- Apply Bethe-Bloch model to estimate foil thickness
  - Do we measure beam energy → error?

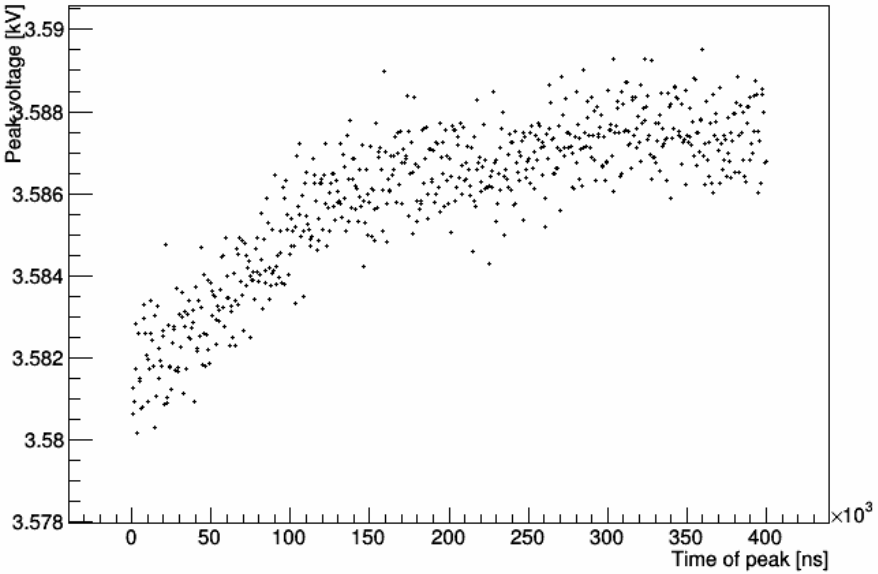
Monte Carlo

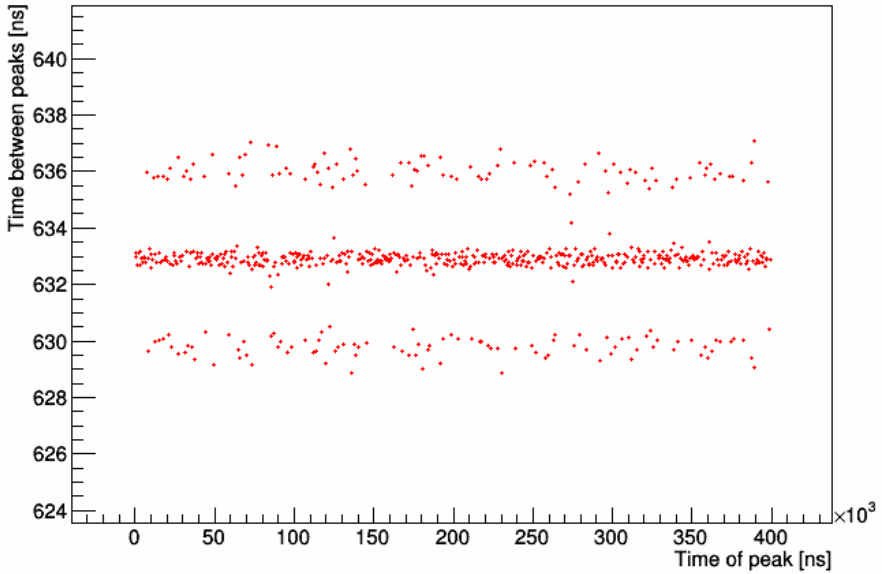




- Note filamentation – compare with e.g. slide 4

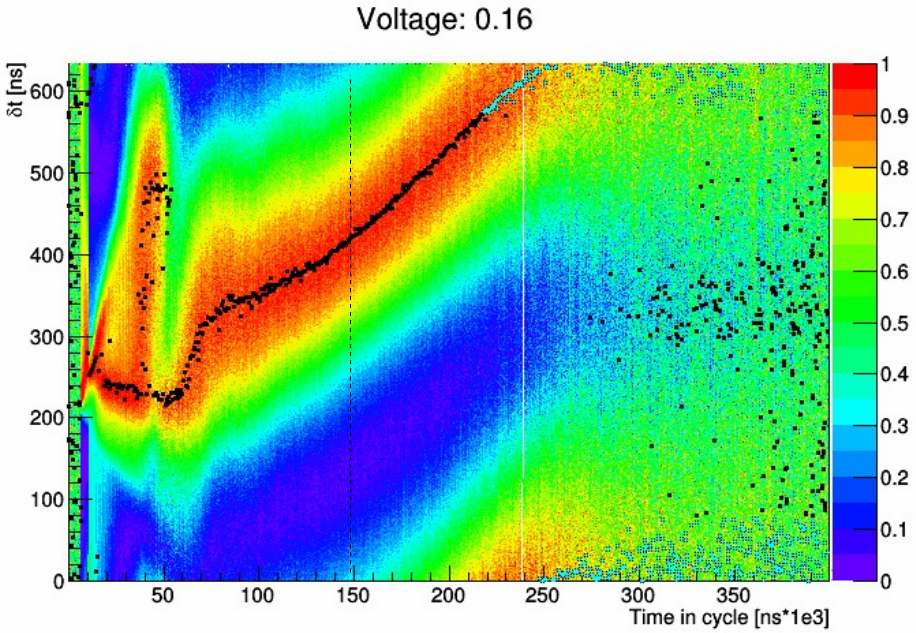
RF signal

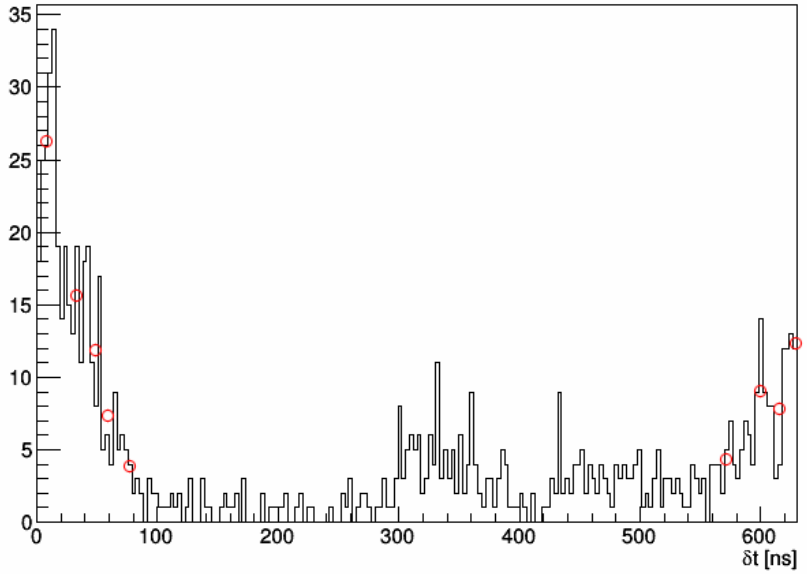




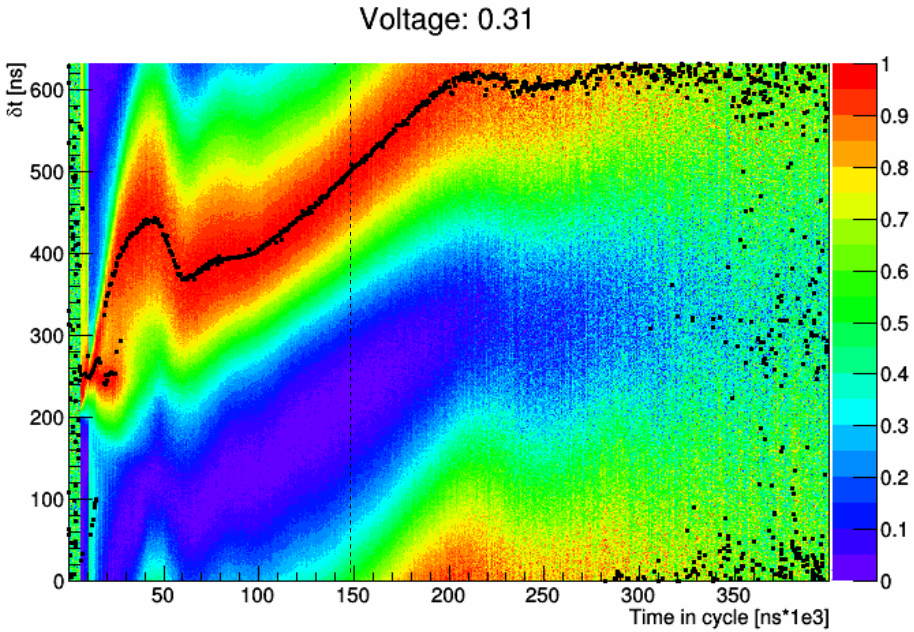
- Calculate position of peaks in the signal relative to peaks in RF signal
- Note RF frequency jitter
  - Is this analysis?
- Note RF peak voltage jitter ~ 0.005 V level
  - It's okay

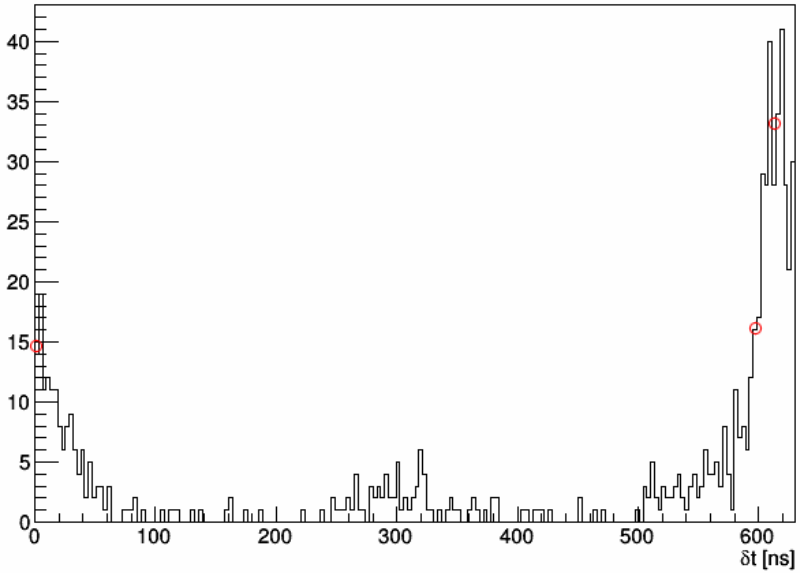
Beam as a function of time



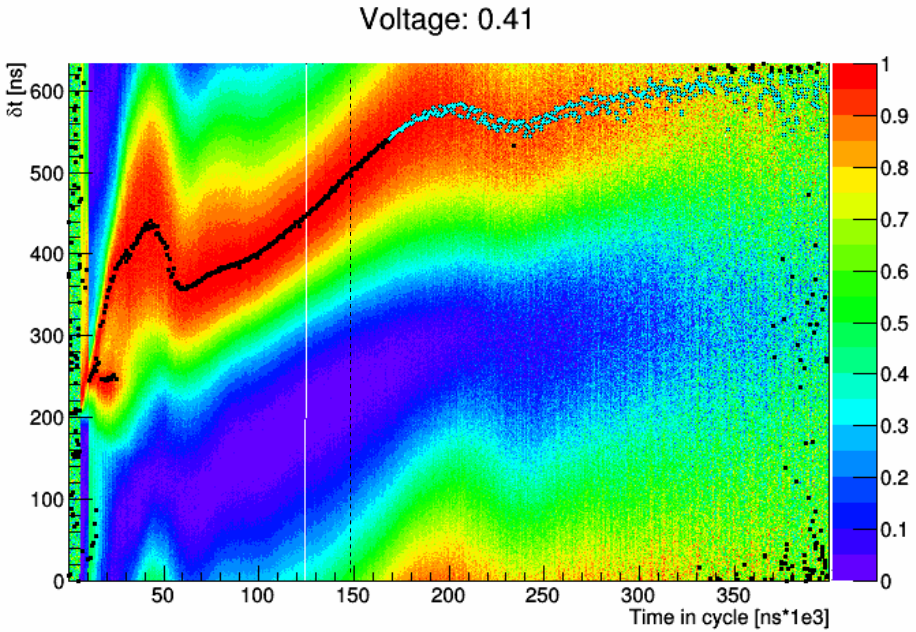


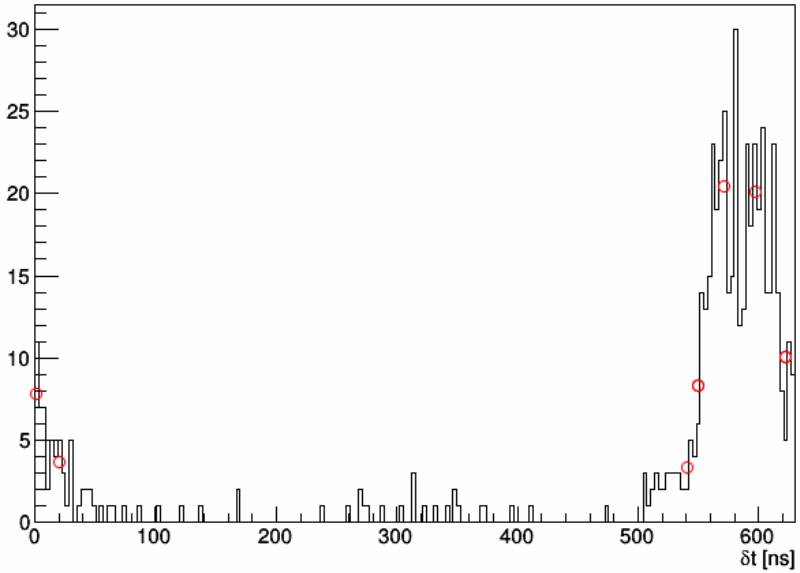
Beam as a function of time



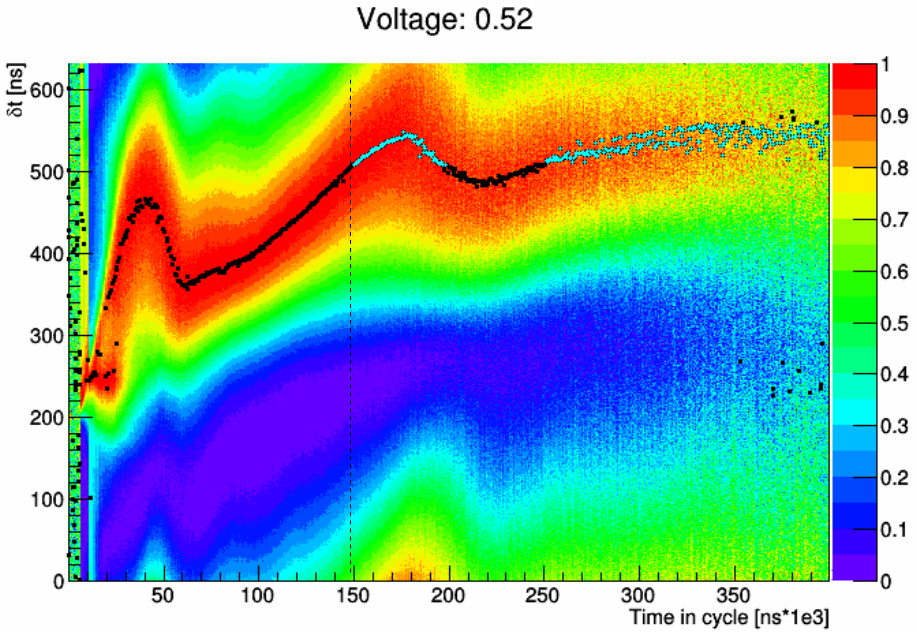


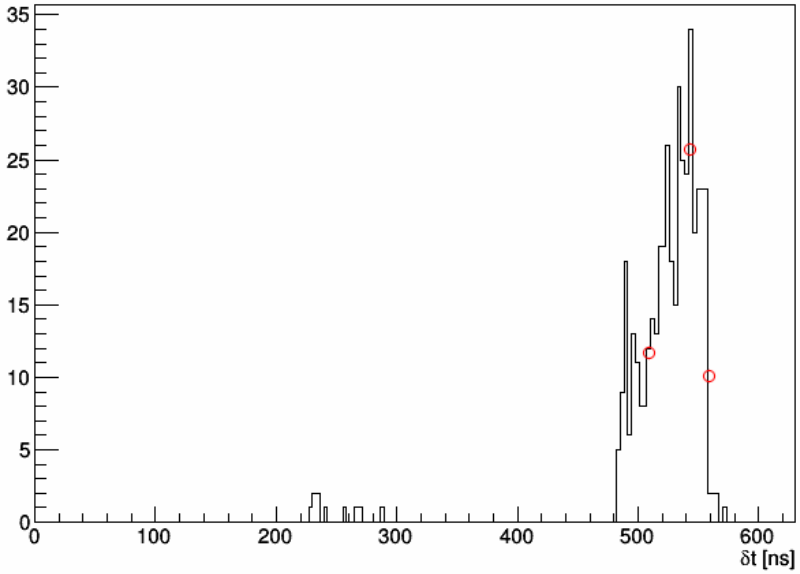
Beam as a function of time





Beam as a function of time





Beam as a function of time