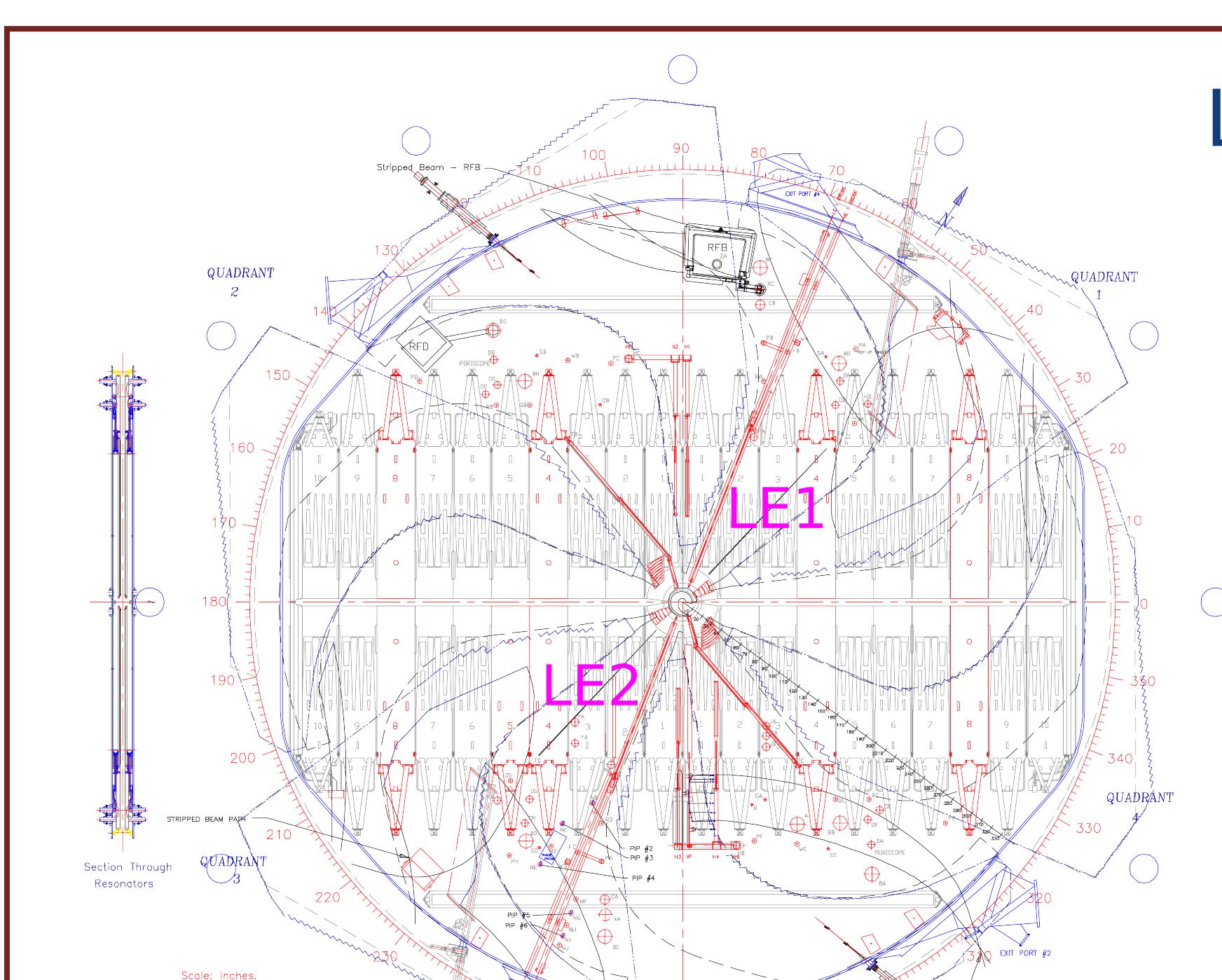


# Measurement of turn structure in the central region of TRIUMF cyclotron

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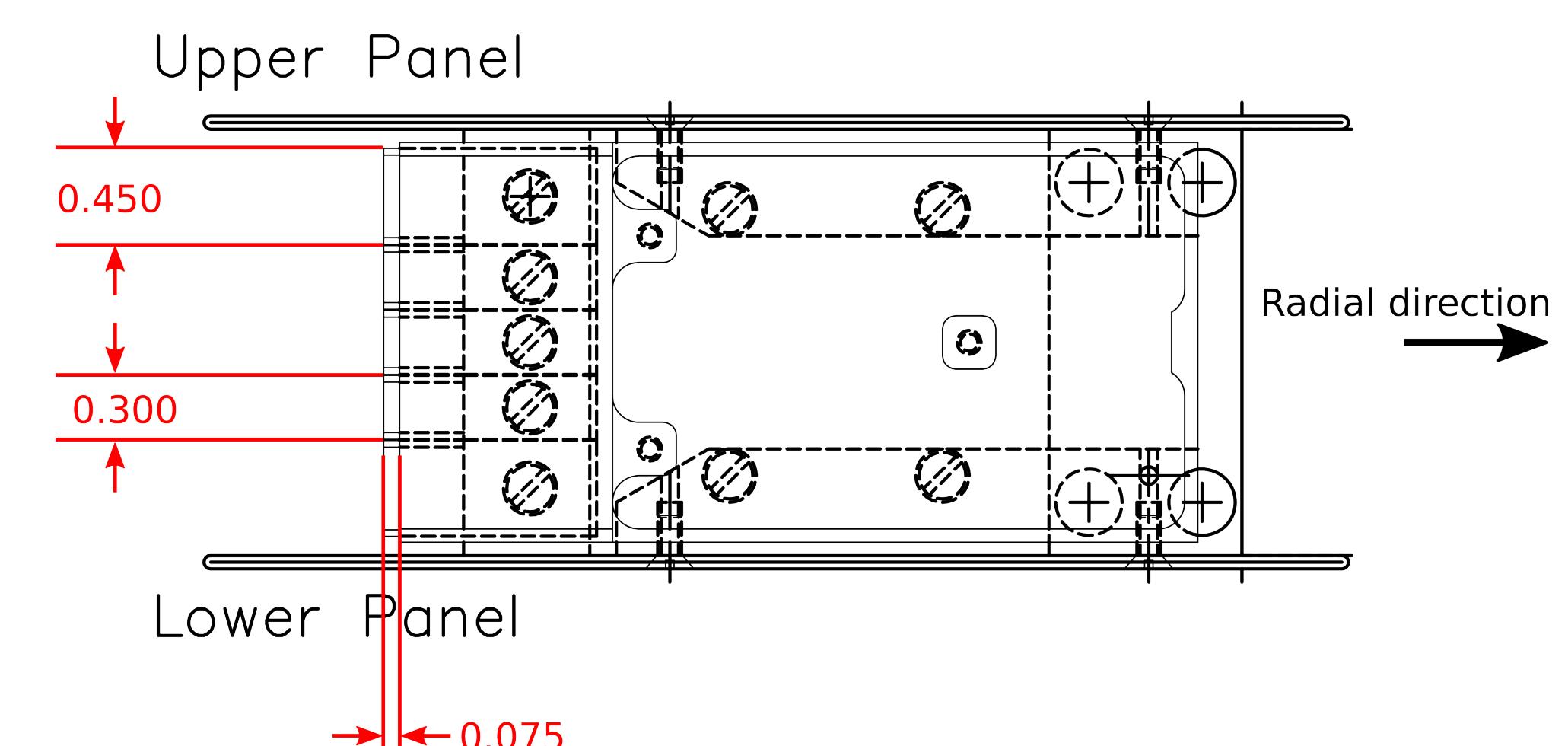
## Abstract

To get the most out of the existing beam diagnostics in the TRIUMF cyclotron, we started in 2011 to develop new data processing and visualization tools. The main advantage of these Matlab®-based tools, compared with old VMS-based tools, is that they can benefit from a much larger library of modern data processing and visualization algorithms. This effort has already shown itself very useful to highlight essential features of the beam dynamics which remained unnoticed before. In this paper we present measurement results displaying beam dynamics processes taking place in the central region of the TRIUMF 500 MeV cyclotron.

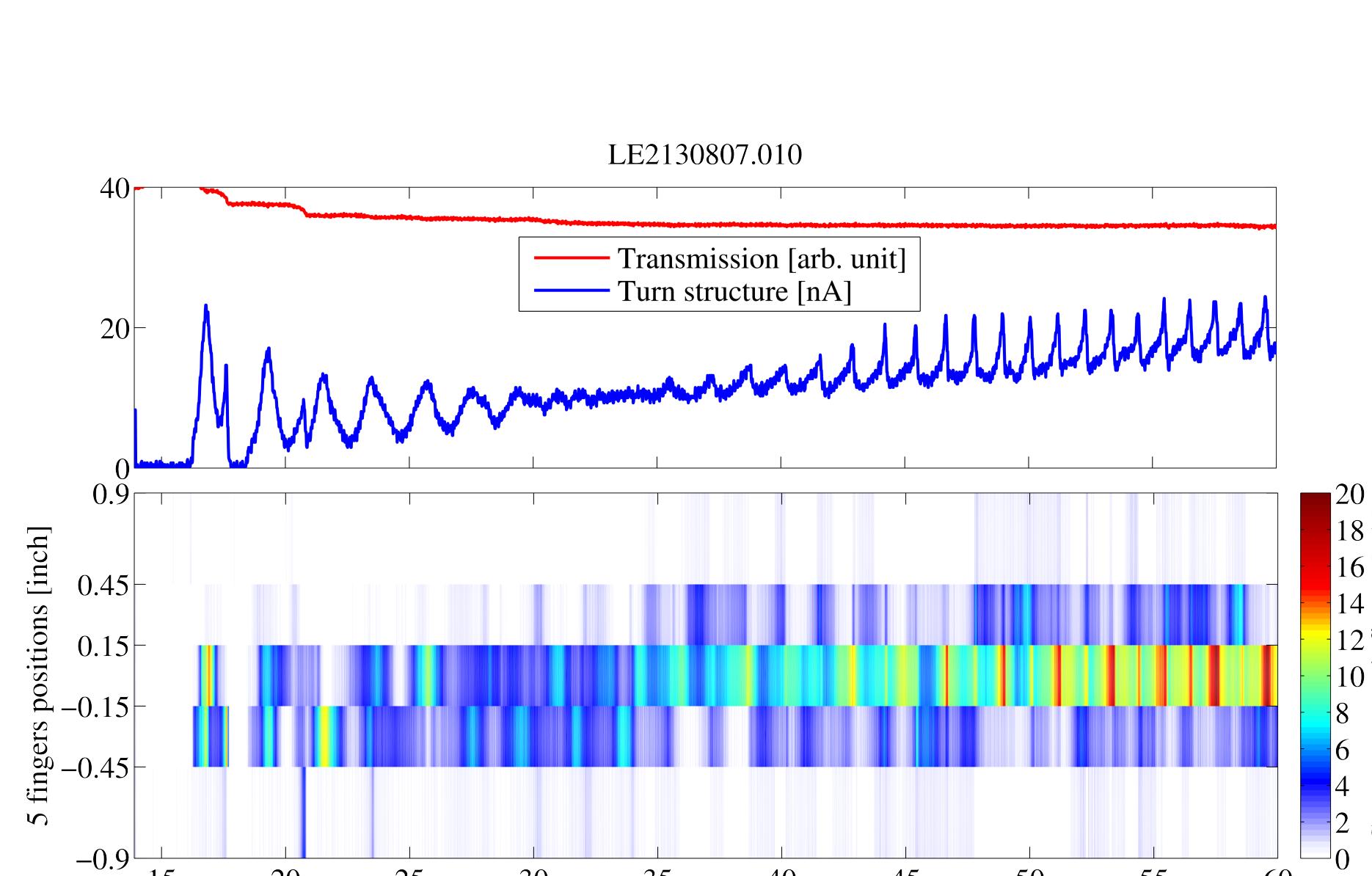


**Fig. 1:** Schematic view of the TRIUMF cyclotron. The two low energy probes are indicated in magenta.

## LE probes

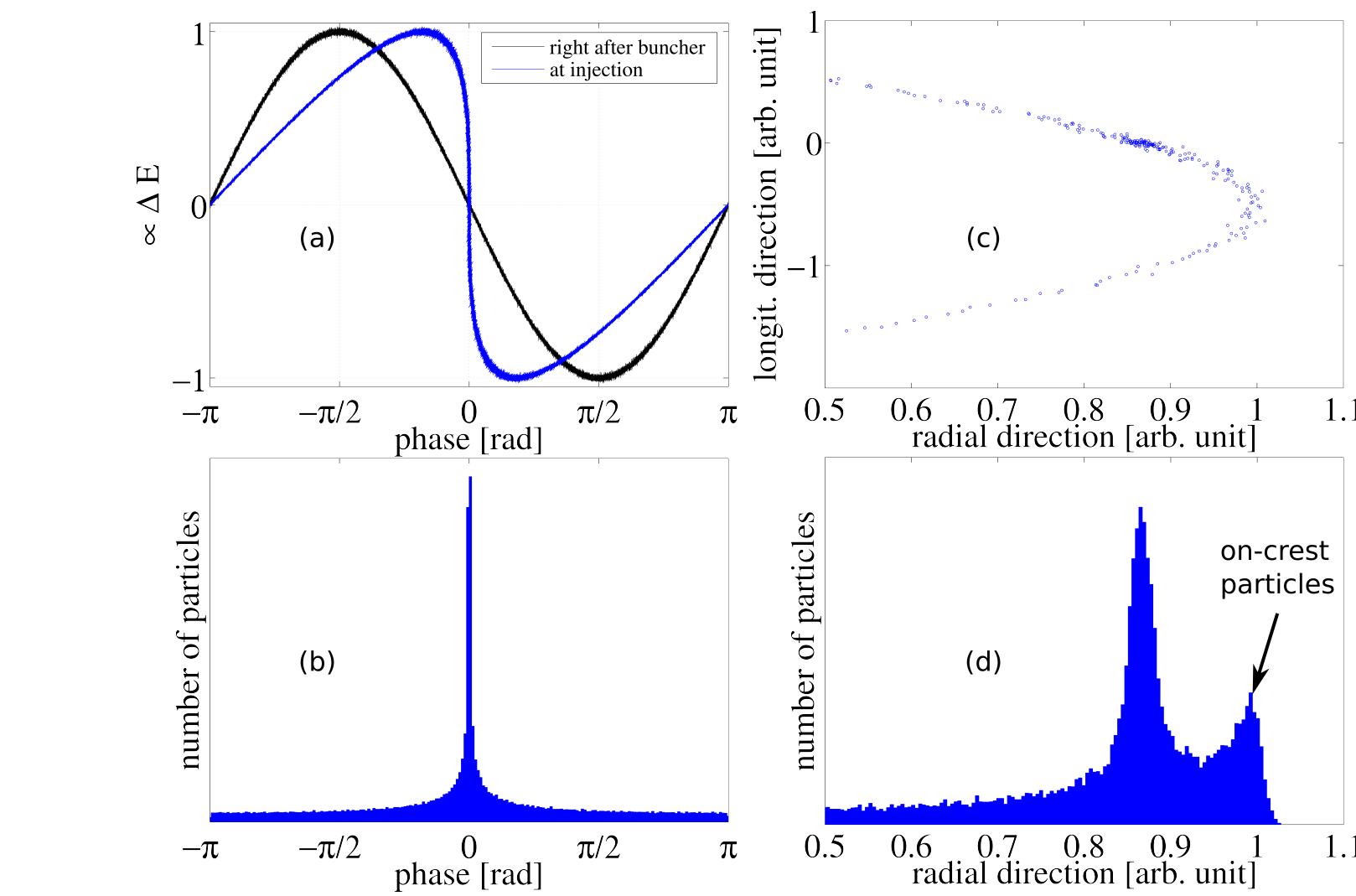


**Fig. 2:** Schematic drawing of the low energy probe head. Dimensions are given in inch.

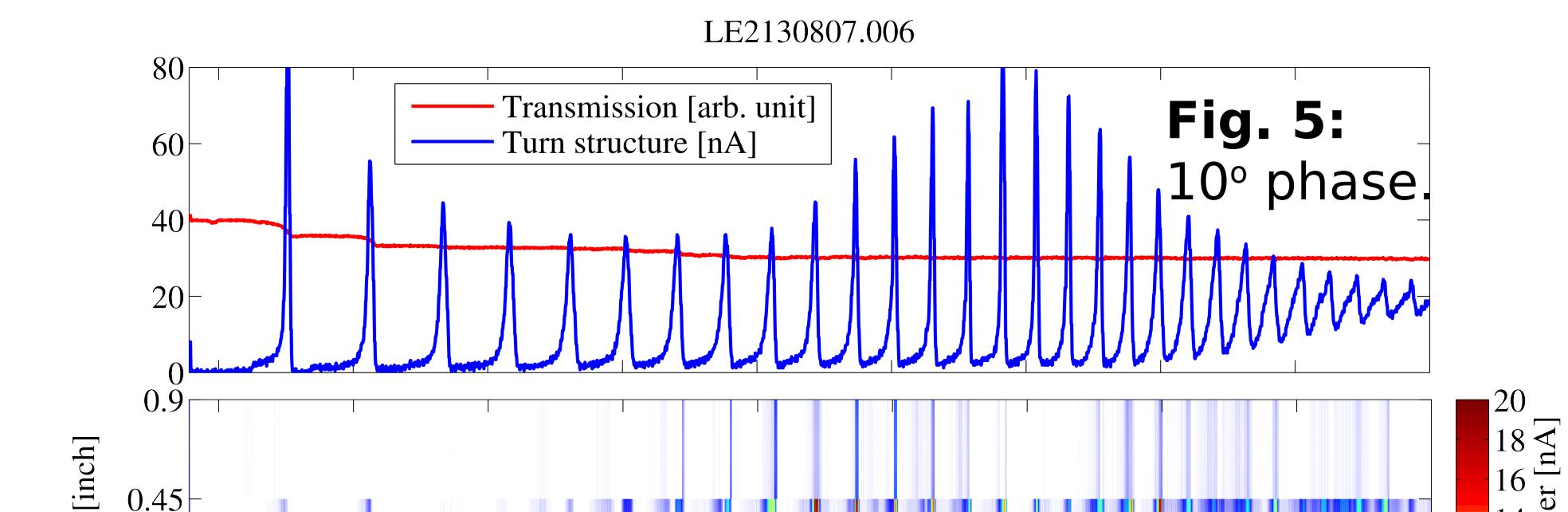


**Fig. 4:** Measurement results from LE2 probe scan when injecting short bunches  $30^\circ$  off crest on the falling side of the rf wave. **Top:** the blue line shows beam current intercepted on the first 0.075 inch of the probe head; the red line shows the total current on the probe (arbitrary scale). **Bottom:** current read back on each of the five horizontal fingers.

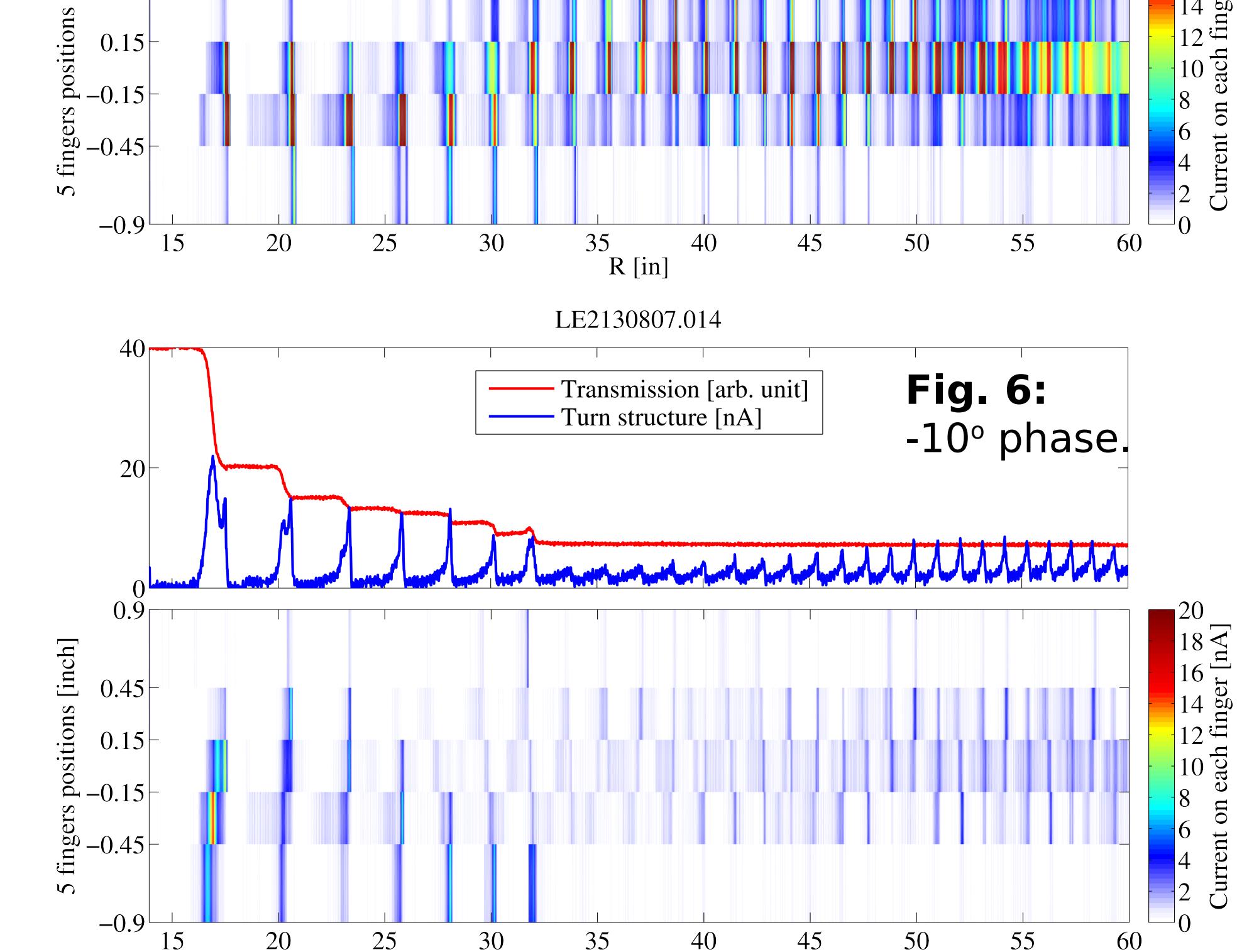
## Phase-dependent dynamics



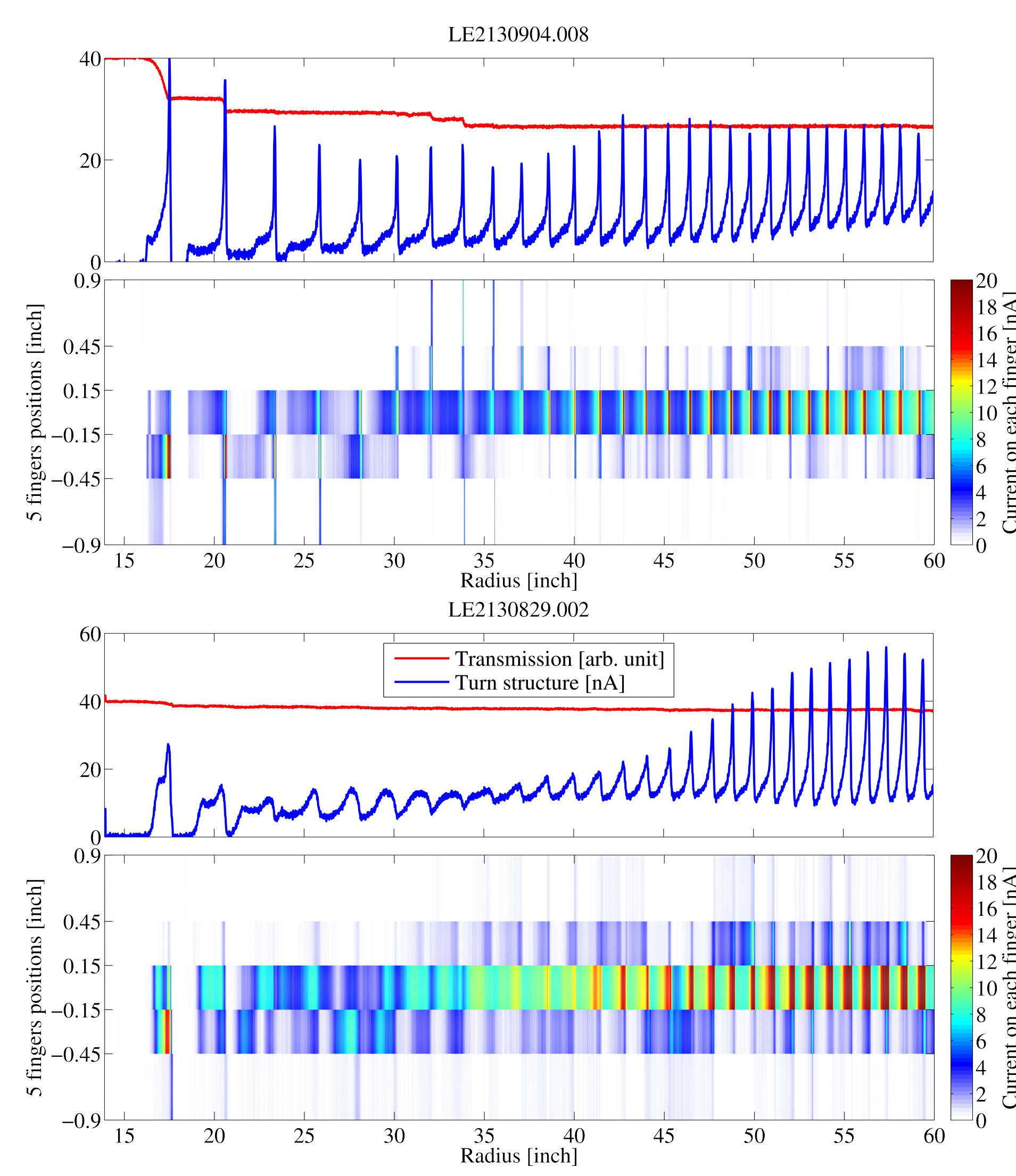
**Fig. 3:** Macroparticle simulation of injection of short bunches: (a) longitudinal phase space right after the first harmonic buncher (black) and right before injection into the cyclotron (blue), in the absence of space charge; (b) phase distribution within the same beam before injection. The same particles, after crossing cyclotron acceleration gap, are shown in 'top view' (c), and in radial projection (d).



**Fig. 5:**  $10^\circ$  phase.



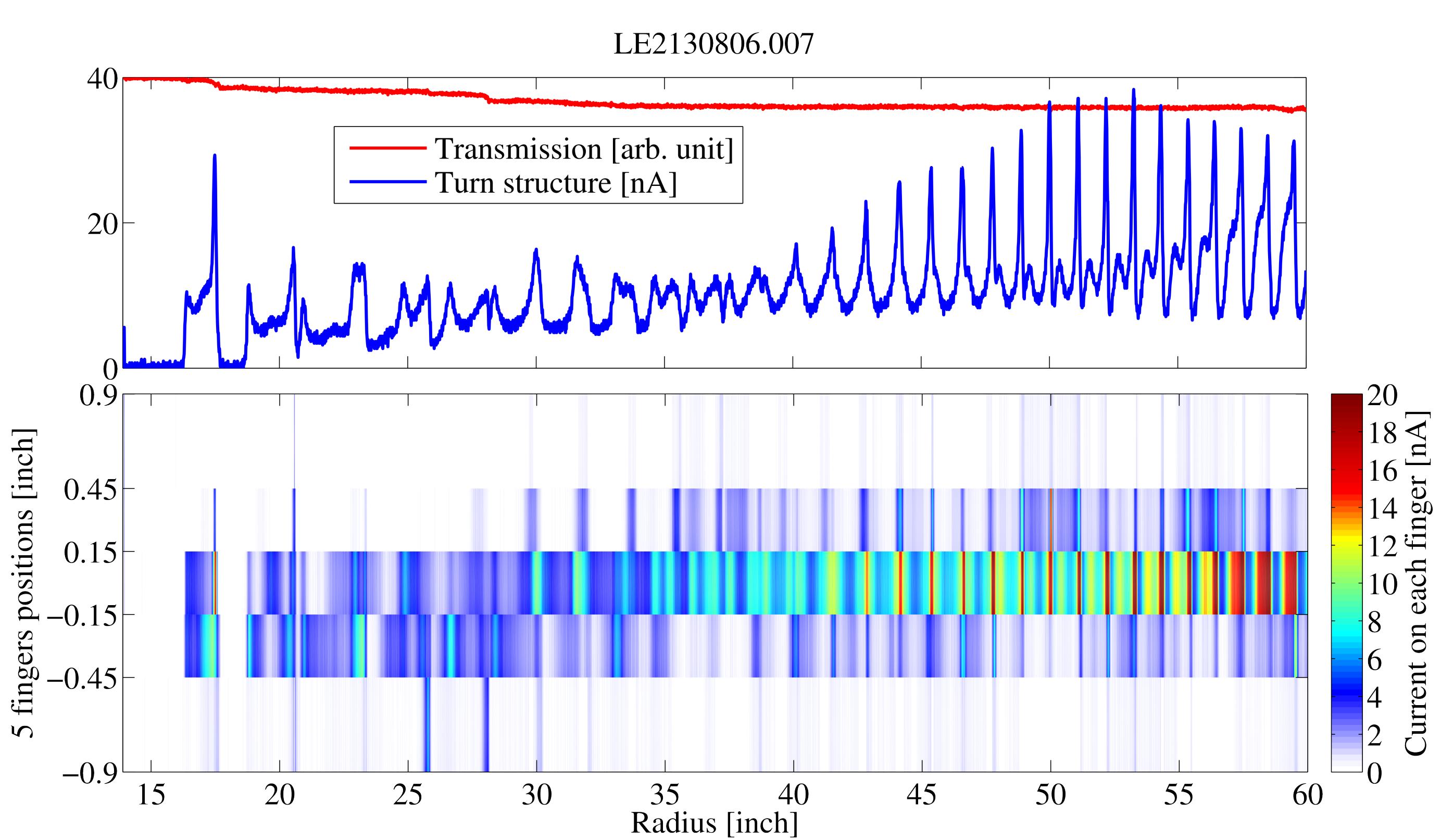
**Fig. 6:**  $-10^\circ$  phase.



## Space-charge-dependent dynamics

**Fig. 7:**  
Bunchers off.

**Fig. 8:**  
LE2 scan at normal  $210\mu\text{A}$  operating conditions.



**Fig. 9:** LE2 scan at normal  $290\mu\text{A}$  operating conditions.