Supplementary Information

Frequency and Amplitude Control of Cortical Oscillations by Phosphoinositide Waves

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Supplementary Figure 1. Patterns of other F-BAR proteins and lipid enzymes.
(a) Image and kymograph of cells expressing mCherry-CIP4 and FBP17-EGFP (n=2 cells, 2 experiments). (b) Image and kymograph of cells expressing 5-phosphatase GFP-SHIP2 and mCherry-CIP4 (n=20 cells, 4 experiments). (c) Image and kymograph showing that GFP-Synaptotagmin1 is punctate but did not display apparent correlation with mCherry-CIP4 waves (n=10 cells, 2 experiments). (d) Image and kymograph showing uniform GFP-PTEN distribution in cells with mCherry-CIP4 waves (n=53 cells, 5 experiments). For TIRF images, scale bar 5 μm; for kymographs, scale bar= 1 min (horizontal bar), 5 μm (vertical bar).
Supplementary Figure 2. RNA-Seq analysis to assess expression of lipid phosphatase and PI3K genes in RBL-2H3.

Gene expression levels are interpreted in read per kilobase per million mapped expression (RPKM) (n=2 total RNA samples; error bar: s.e.m. N.D: not detected).
Supplementary Figure 3. Effect of the rapid recruitment of 5-phosphatase domain of INPP5E.

(a) Intensity profiles of mCherry-CRY2-5ptase\textsubscript{INPP5E} and iRFP-\textsc{PLCδ}, monitoring levels of PtdIns(4,5)P\textsubscript{2}. Sustained decrease of PtdIns(4,5)P\textsubscript{2} could be induced by a train of laser pulses with indicated blue light power and pulse intervals (n=6 cells from 2 experiments). (b) Intensity profiles of mCherry-CRY2-5ptase\textsubscript{INPP5E} and iRFP-\textsc{Akt}, monitoring levels of PtdIns(3,4)P\textsubscript{2} and PtdIns(3,4,5)P\textsubscript{3} levels (n=8 cells from 2 experiments). (c) Intensity profile of mCherry-CRY2-5ptase\textsubscript{INPP5E} and FBP17-iRFP shows reduced amplitude of FBP17 waves with membrane recruitment of CRY2-5ptase\textsubscript{INPP5E} (n=3 cells from 2 experiments).
Supplementary Figure 4. Effects of PI3K inhibitor wortmannin on lipid levels.

The concurrent decrease of PtdIns(3,4)P2 (monitored by RFP-PH<sub>Tap1</sub>, n=5 cells from 4 experiments) and PtdIns(3,4,5)P3 levels (monitored by mCherry-PH<sub>Grp1</sub>, n=12 cells from 5 experiments) are shown. PtdIns(4,5)P2 (iRFP-PH<sub>PLCδ</sub>) level on the plasma membrane was not affected (n=6 cells from 3 experiments). The gray/pseudocolor scale kymographs are made from a movie. The dash-line indicates the timepoint when 10 μM (high dose) wortmannin was added. Scale bar= 1 min (horizontal bar), 5 μm (vertical bar).
Supplementary Figure 5. Characterization of the optogenetic method employed for acute PI3K activation.
(a) Quantification of mCherry-CRY2-iSH2, PtdIns(3,4,5)P3 (monitored by iRFP-PHGrp1) and PtdIns(3,4)P2 (monitored by iRFP-PHTapp1) recruitment to the plasma membrane by different laser power (n=9 cells from 6 experiments). (b) Effect of activation conditions on the levels of PtdIns(3,4,5)P3 (n=28 cells from 6 experiments).
Supplementary Figure 6. Patterns of FBP17 and PI3Kδ.
(a) Image and kymograph showing PI3Kδ-mCherry waves in cells with FBP17-EGFP waves (n=10 cells, 4 experiments). (b) Image and kymograph showing uniform PI3Kδ-mCherry distribution in cells with FBP17-EGFP waves (n=4 cells, 4 experiments). For TIRF images, scale bar=5 μm; for kymographs, scale bar= 1 min (horizontal bar), 5 μm (vertical bar).
Supplementary Figure 7. Additional PtdIns(3,4)P₂ sensor and effect of PtdIns(3,4)P₂ sequestering on waves.
(a) Kymographs and intensity profile of FBP17-EGFP and PX₉₅₅-mCherry (n=5 cells from 2 experiments). (b) Quantification shows GFP-PH₅₅₅₅-PH₅₅₅₅ overexpression could inhibit mCherry-CIP4 waves (n=74 cells from 3 experiments). Scale bar= 1 min (horizontal bar), 5 μm (vertical bar).
**Supplementary Figure 8.** Full gel image of Figure 1b. Dashed box indicates the cropped portion.