Closed-Loop Precision Animal Agriculture for Global Sustainability

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https://web.ics.purdue.edu/~rvoyles/research.animalAg.html

RUMENSoft   RumenSense   RumenScope   RumenComm   RumenStealth   RumenNet
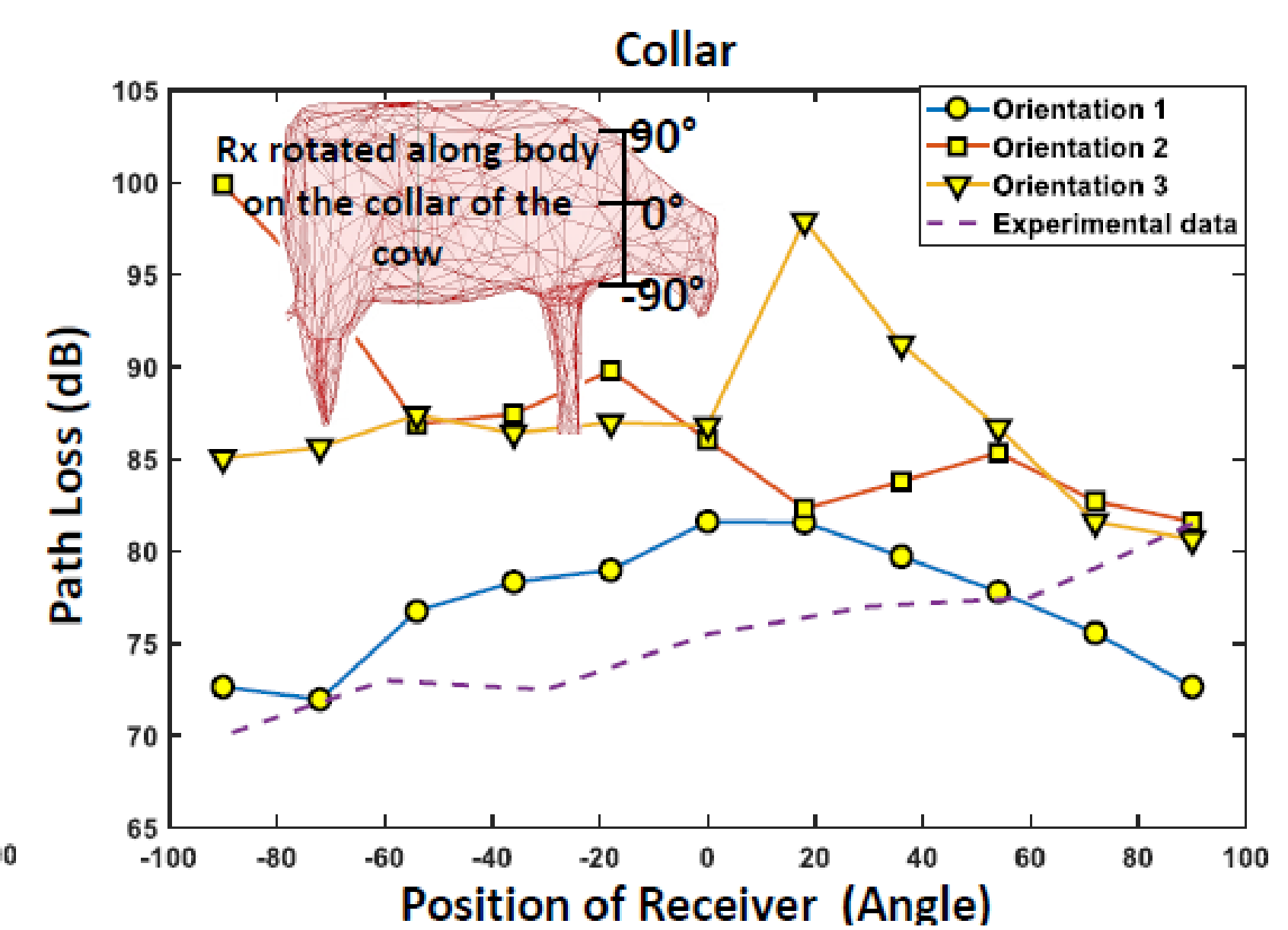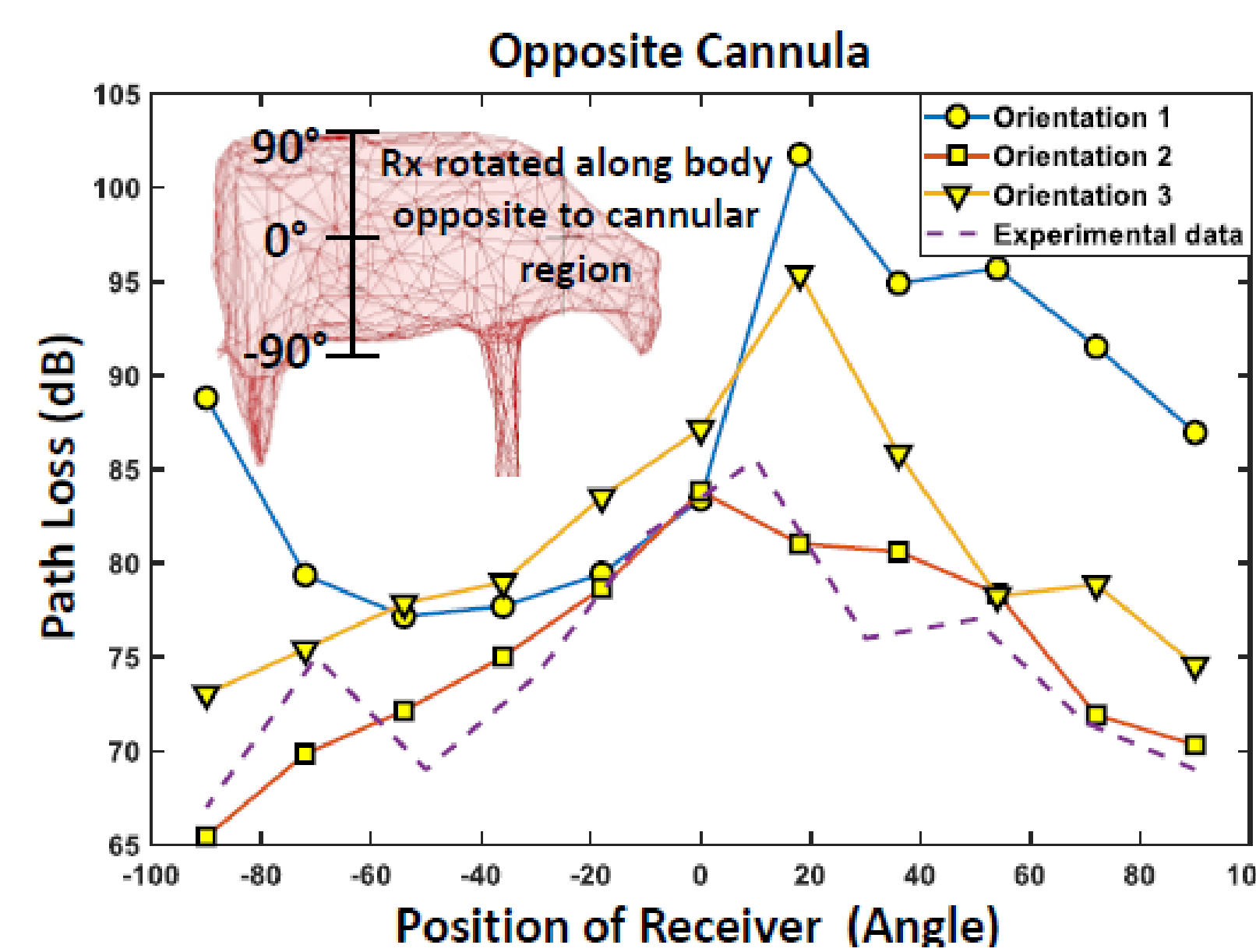
CHALLENGES

- RumenSense: New biosafe **pH, NH3, VFA, histamine** sensors for animal health and welfare monitoring and GHG reduction

- RumenScope: Novel modeling and dataset of electro-magnetic attenuation characteristics and 3-D contractions

- RumenStealth: CPS reference architecture for **Authentication-Free** security with malware detection
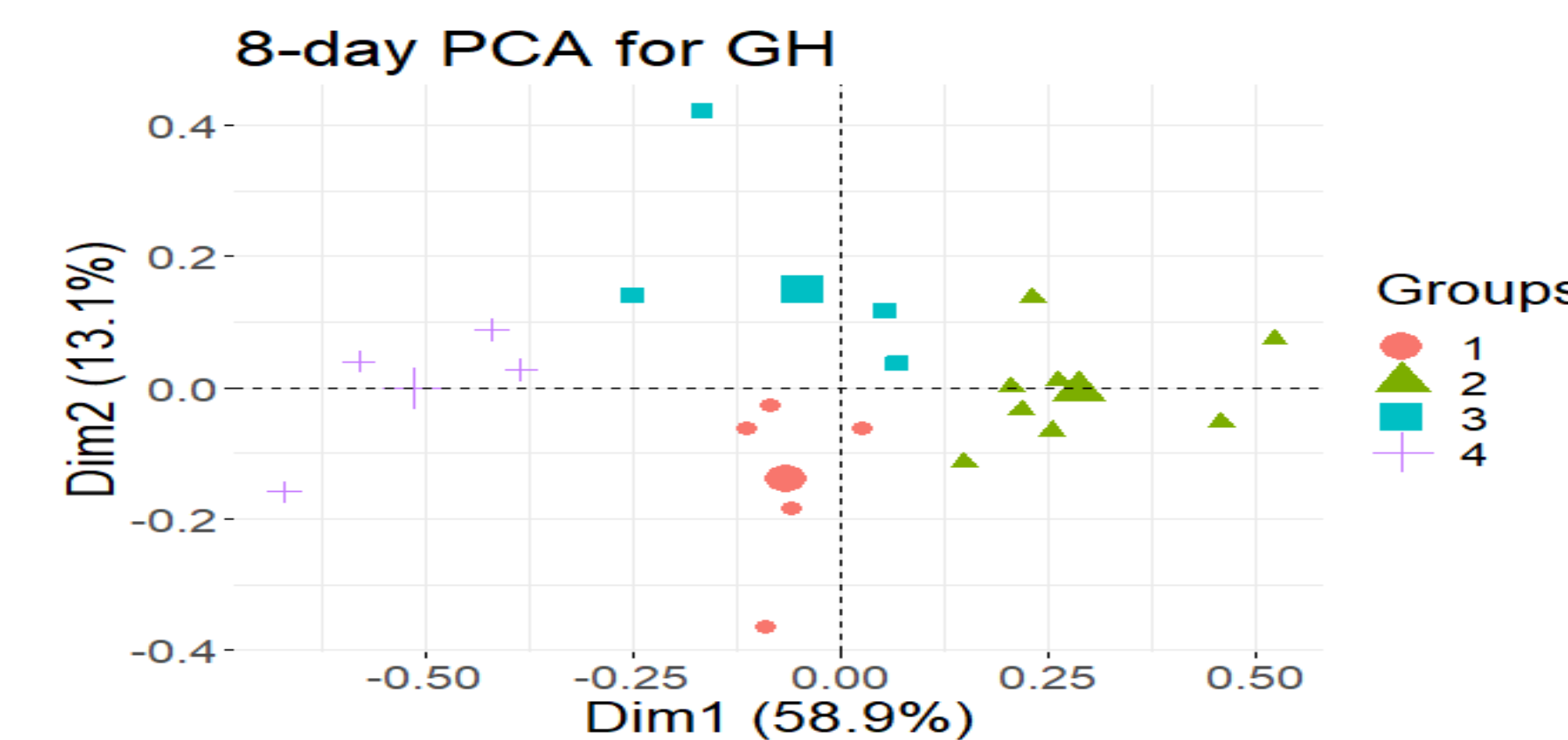
SOLUTIONS

RumenComm examines RF and non-RF-based communications from in vivo active sensors to the external network using electro-quasi-static galvanic coupling for low-radiation power.

RumenStealth employs unsupervised and semi-supervised learning to detect malware prior to execution.

400 MHz RF for Interim Communications

Opposite Cannula — Path Loss (dB) vs Position of Receiver (Angle); Orientation 1, Orientation 2, Orientation 3, Experimental data. Rx rotated along body opposite to cannular region.

Collar — Path Loss (dB) vs Position of Receiver (Angle); Orientation 1, Orientation 2, Orientation 3, Experimental data. Rx rotated along body on the collar of the cow.

Feed Regimens Show Need for Individual Care

8-day PCA for GH — Dim2 (13.1%) vs Dim1 (58.9%); Groups 1, 2, 3, 4.

Advanced estimation techniques begin to yield new clues on cow vs. herd health, wellness and climate.

Broader Impacts – Society

- Demand for food increasing 70% by 2050; Animal protein rich in methane

- Demand for animal protein is increasing faster than the rate of population growth; Neither the US nor globe is becoming net vegetarian

Broader Impacts – Education

- New class on *Cyber-Animal Systems*

  Cross-listed between Animal Science & Engineering Technology; Novel cross-teaching paradigm for Lifelong Learners plus "Lifelong Teachers"

- New professional certificate coming

Broader Impacts – Quantified

- 3-layer network topology with layer-specific edge to cloud analytics will translate to other CPS applications

- Sustainability of food supply can be improved through reduced methane production and animal welfare gains