

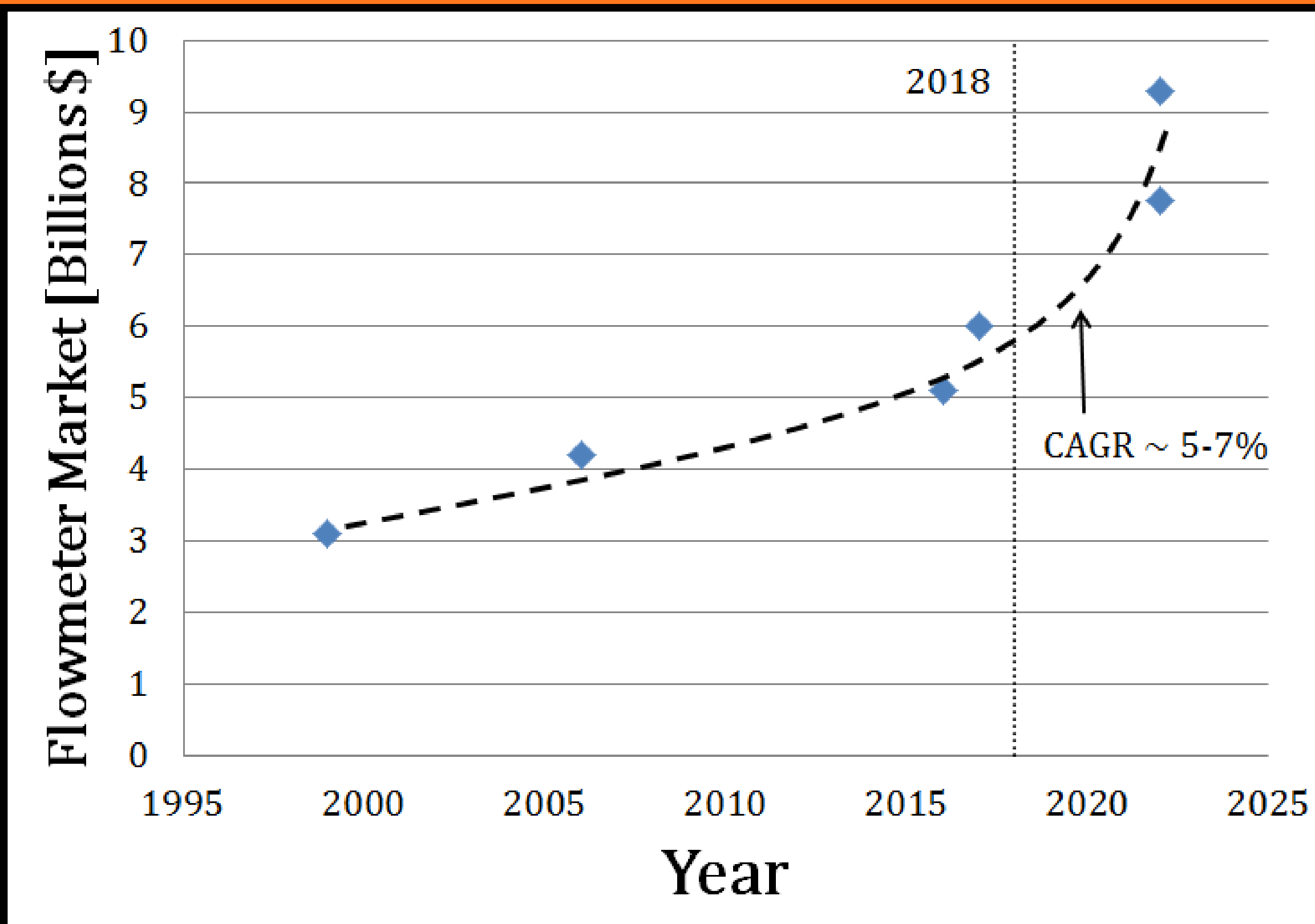
# The Future of Flowmeters: Non-Contact, Non-Invasive, Calibrationless



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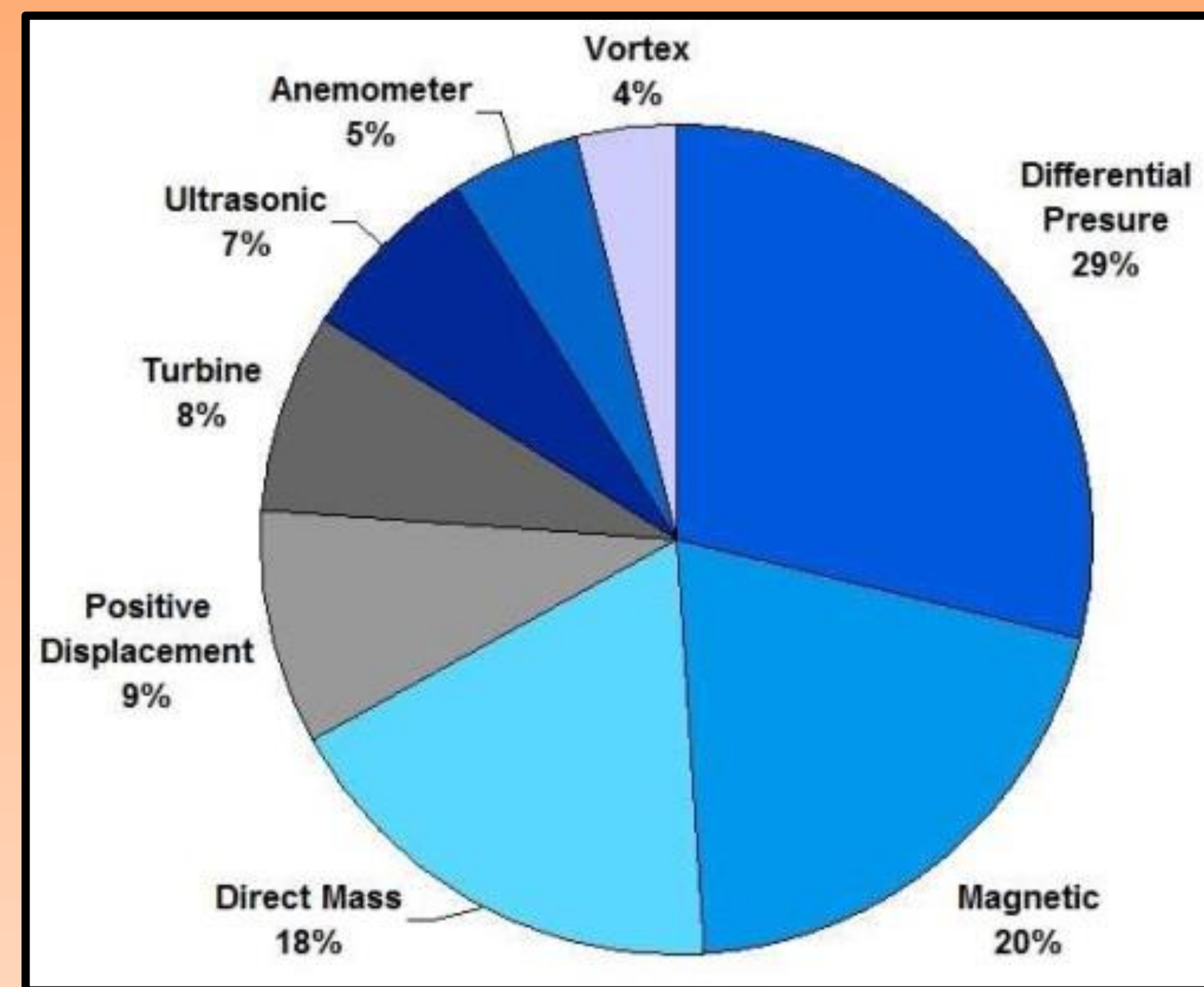


## The Growing Flowmeter Industry:



Projected growth of 24-29% in North America, Europe, and Asia Pacific during the next four years<sup>1-5</sup>.

## Market Penetration By Type<sup>6,7</sup>:



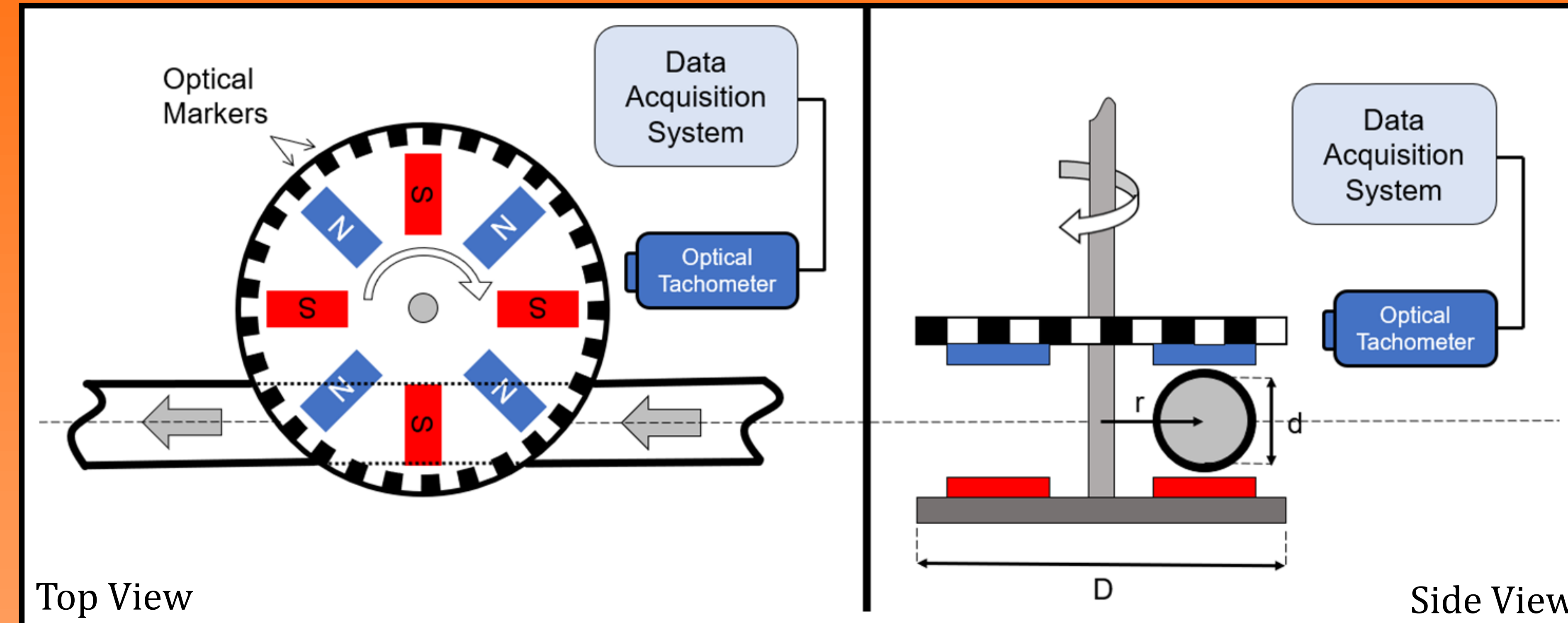
## Traditional Flowmeters:

- Inline Installation
- Invasive
- Full Contact
- Limited Temperature
- Non-Reversible
- Expensive!



Traditional Flowmeter (Vortex<sup>8</sup>)  
\$1,000 – \$20,000 +

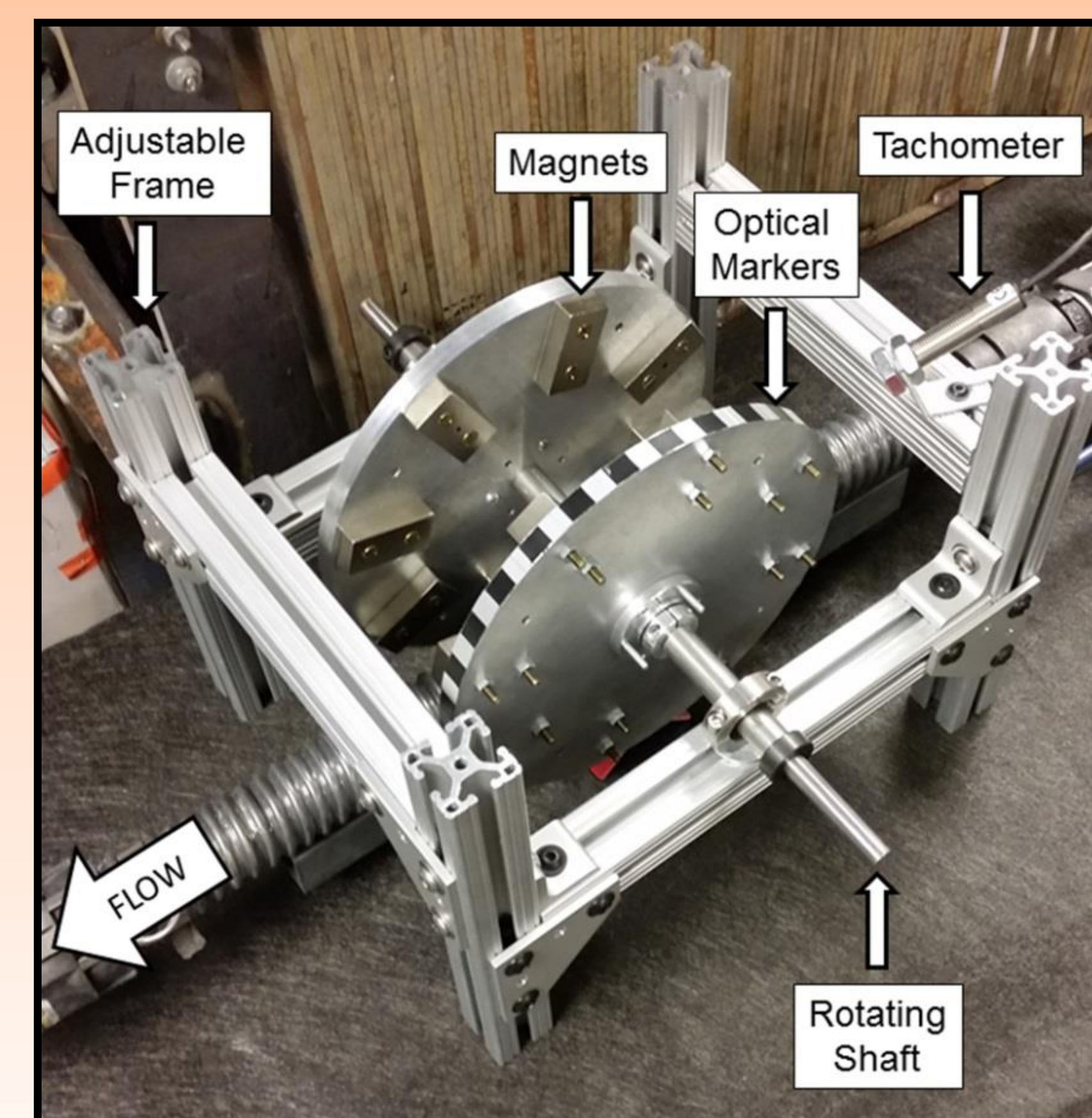
## Rotating Lorentz-Force Flowmeter (RLFF):



### RLFF Benefits:

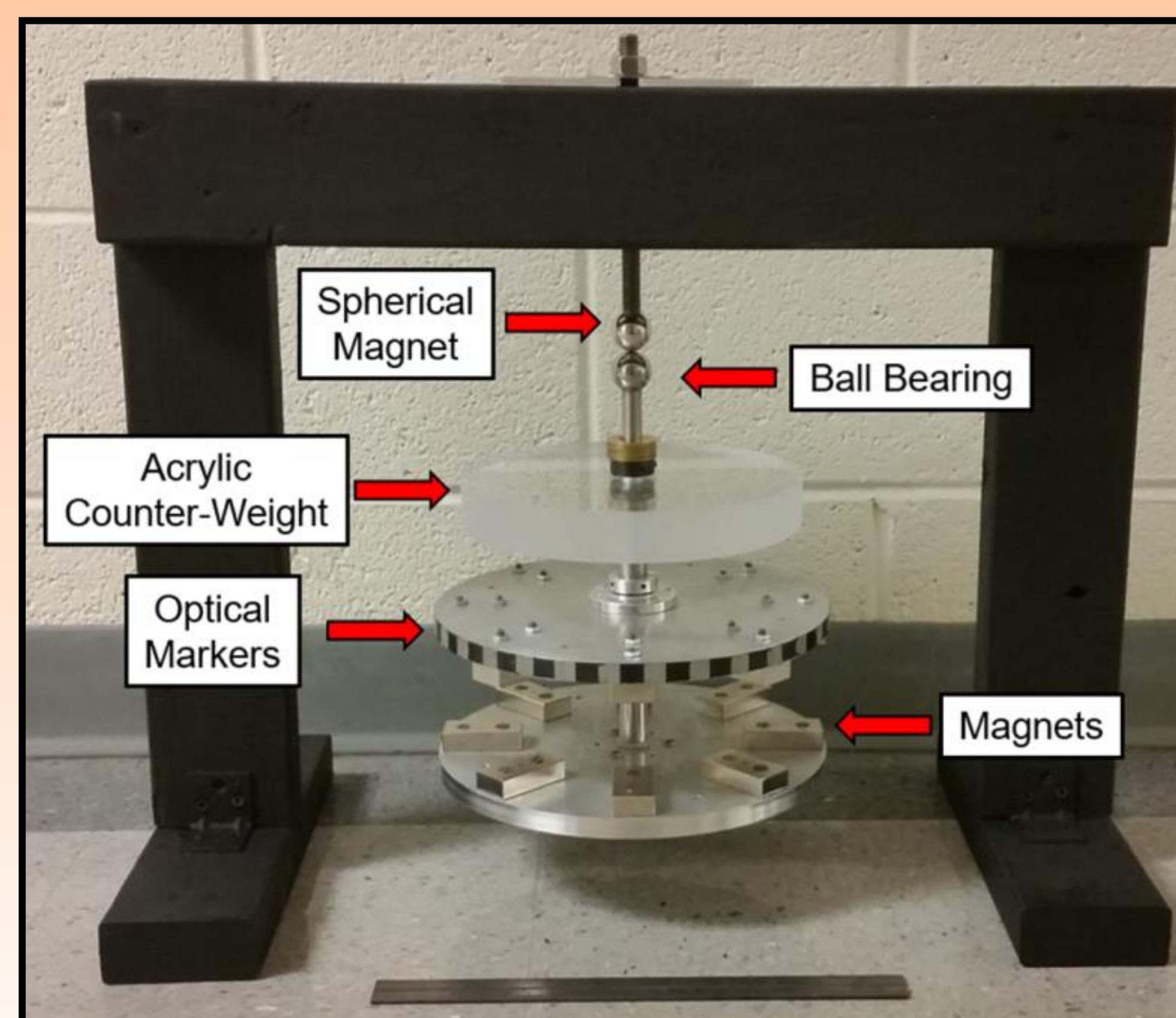
- Non-contact & non-invasive
- No moving parts or extra seals in contact with the fluid
- Ideal for high-temp, corrosive, or dangerous applications
- External installation (no shutdown or loss of productivity)
- Independent of fluid properties
- Reversible operation
- Can work with any electrically conductive fluid

### Conventional Bearings:



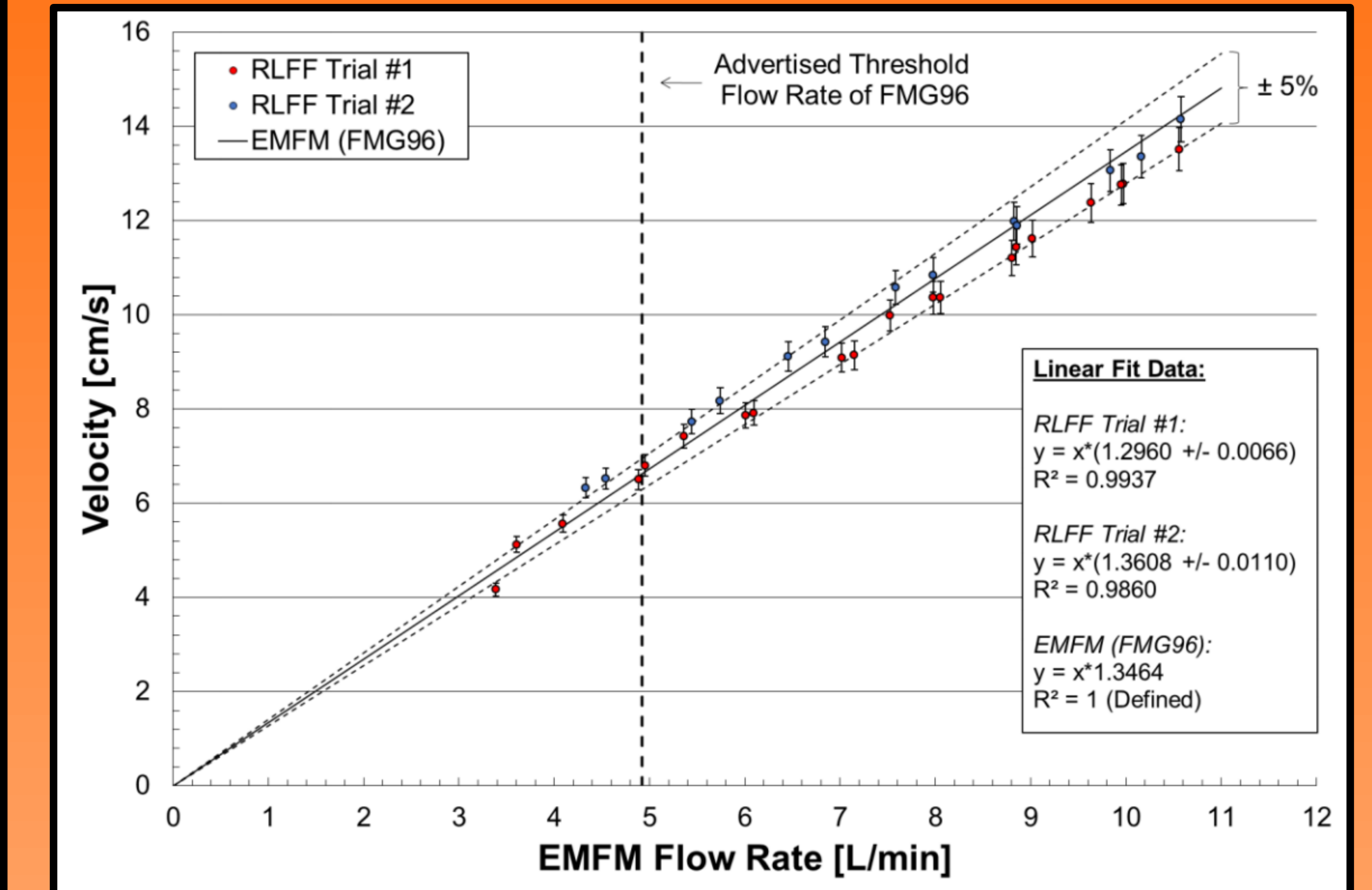
An RLFF with roller bearings.

### Weighted Magnetic Bearing:



An RLFF with a weighted magnetic bearing.

## Low-Friction Bearing Performance:



M G Hvasta *et al* 2018 *Meas. Sci. Technol.* **29** 075303<sup>9</sup>

Torque balance on the flowmeter:

$$\sum \tau = \tau_L [v_0 - \omega r] + \tau_F [\omega] = I \alpha$$

No friction ( $\tau_F = 0$ ) and steady-state ( $\alpha = 0$ ):

$$v_0 = \omega r$$

- Better sensitivity at low-flow rates
- Faster response time
- No calibration required
- Fully demonstrated for \$600

## Industries That Will Benefit:

- Concentrated Solar Power
- Nuclear Energy
- Pharmaceutical / Chemical Production
- Water & Waste Treatment

## Future Work:

- Demonstrate operation with different fluids
- Develop "Electromagnetic Bearing"
- Improve transient performance

[1] Markets and Markets, "Flow Meters Market by Type, End-use Industry (Water & Wastewater, Oil & Gas, Chemicals, Power Generation, Pulp & Paper, Food & Beverages) - Global Forecast to 2022," 2017. <https://www.marketsandmarkets.com/Market-Reports/flow-meters-market-1191.html> [2] "Flow Meter Market: Global Industry Trends, Share, Size, Growth, Opportunity and Forecast 2017-2022," [https://www.researchandmarkets.com/research/2m2dgs/flow\\_meter](https://www.researchandmarkets.com/research/2m2dgs/flow_meter) [3] "GLOBAL FLOWMETER MARKET TO REACH \$5.1 BIL. BY 2017," <https://www.flowcontrolnetwork.com/global-flowmeter-market-to-reach-5-1-bil-by-2017/> [4] Frost & Sullivan, "The flowmeter market still offers growth opportunities, according to Frost & Sullivan," <https://search.proquest.com/docview/226848989?pq-origsite=sunman> [5] "Flow Meters Market to Grow at 6.42% CAGR to 2022 led by Ultrasonic Segment," 2017. <https://www.prnewswire.com/news-releases/flow-meters-market-to-grow-at-6-42-cagr-to-2022-led-by-ultrasonic-segment--reports-reports-656624123.html> [6] "Next Gen. Flowmeters for Fluid Measurement and Control Solutions," Litre Meter Limited, 2011. <http://litremeter.info/faq/flowmeter-history/> [7] "Using Flowmeter Technologies to Reduce Energy Costs," <https://www.azom.com/article.aspx?ArticleId=12453> [8] Rosemount 9800 Series Vortex Flow Meters, <http://www.emerson.com/en-us/catalog/rosemount-9800-vortex> [9] M G Hvasta, D Dudt, A E Fisher, and E Kolemen, Calibrationless rotating Lorentz-force flowmeters for low flow rate applications, 2018, Measurement Science and Technology, 29 075303 <http://iopscience.iop.org/article/10.1088/1361-6501/aac3b5/meta>