UMI SCANS OF PIPES WITH ELBOWS

NATIONAL SHIPBUILDING RESEARCH PROGRAM (NSRP) FY26 PANEL PROJECT (PP26-??)

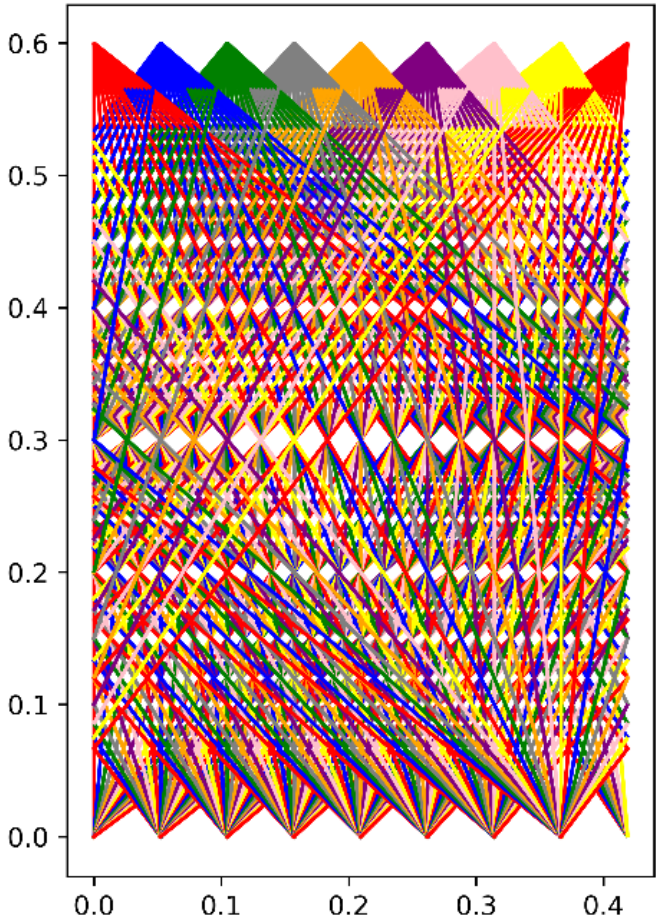
17 June 2026

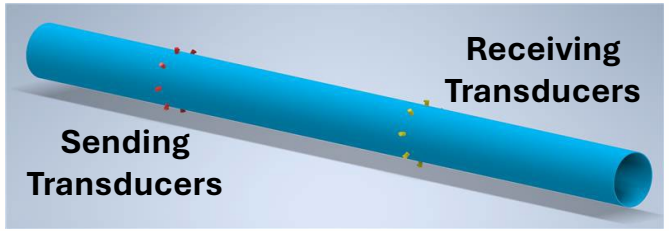
Antech Team

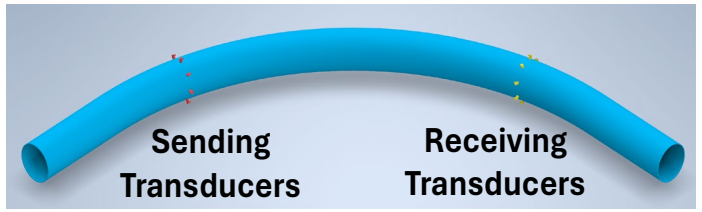
AGENDA

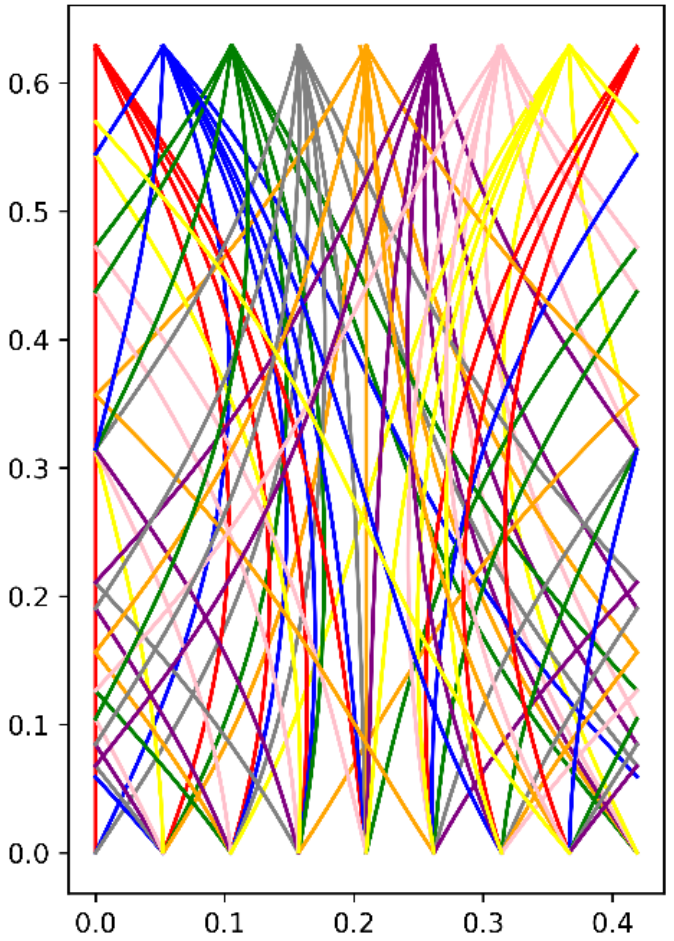
- Why bends and elbows are hard
- Solving the tomography
- Initial testing

ELBOW PATHS VS STRAIGHT PIPES







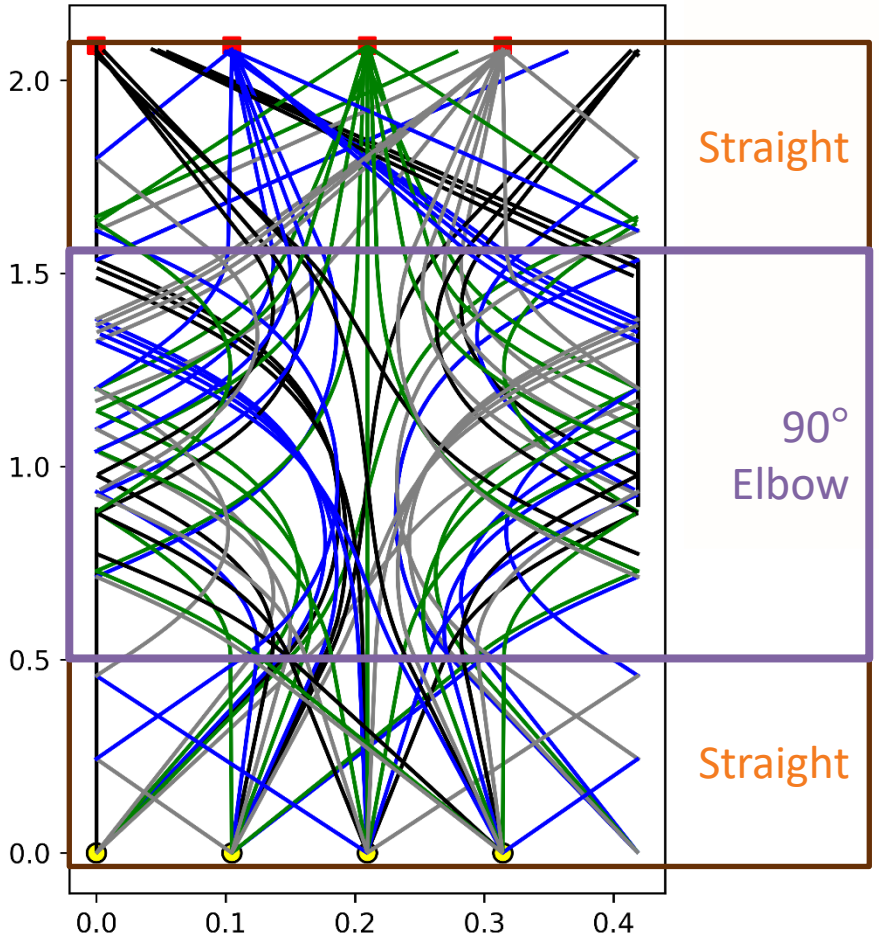


NON-ANALYTICALLY SOLVABLE SYSTEM OF PARTIAL DIFFERENTIAL EQUATIONS

$$
\begin{aligned}
\dot{\varphi}_1 &= \varphi_2 \\
\dot{\varphi}_2 &= -\frac{1}{r}\sin(\varphi_1)(R + r\cos(\varphi_1))\varphi_4^2 \\
\dot{\varphi}_3 &= \varphi_4 \\
\dot{\varphi}_4 &= \frac{2r\sin(\varphi_1)}{R + r\cos(\varphi_1)}\varphi_2\varphi_4,
\end{aligned}
$$

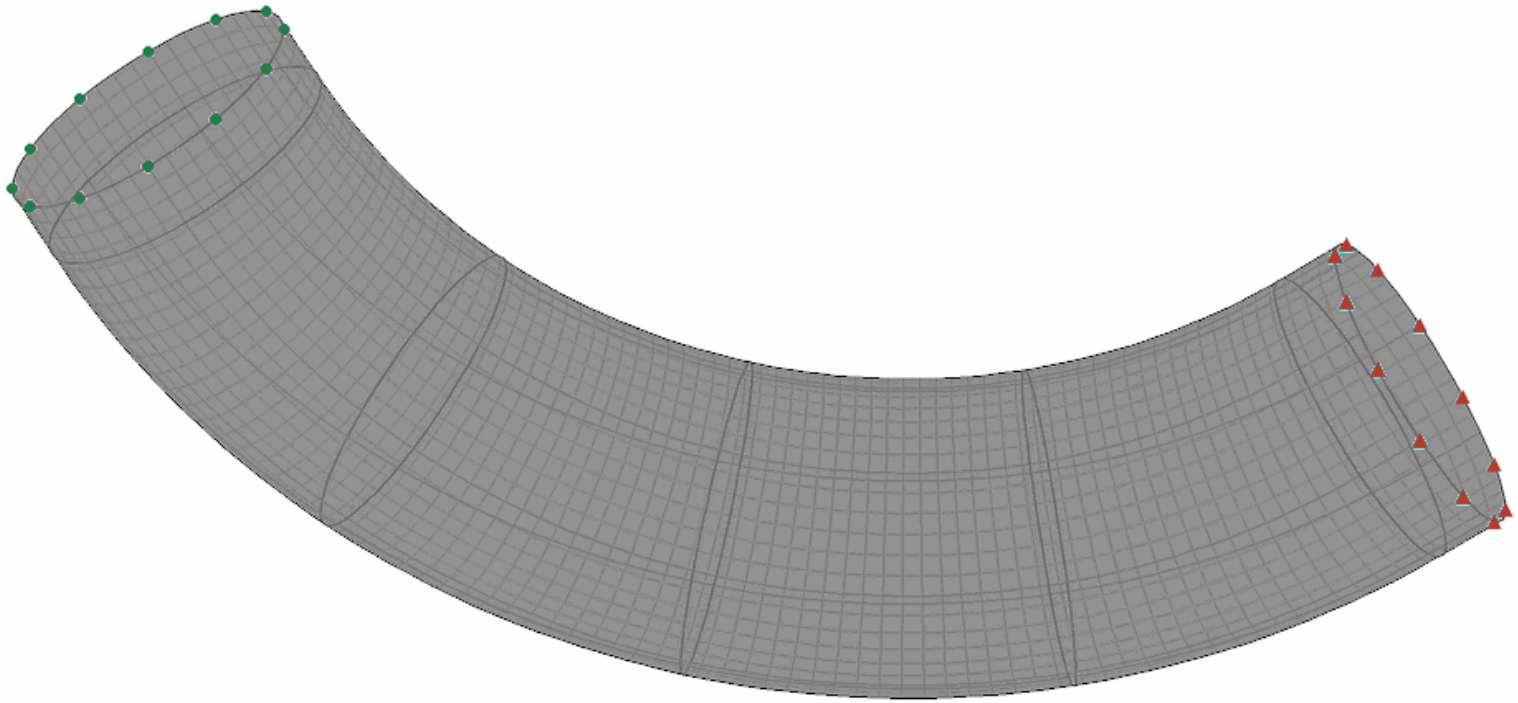
with $\varphi_1 = u$, $\varphi_2 = \dot{u}$, $\varphi_3 = v$, $\varphi_4 = \dot{v}$.

STANDARD CONFIGURATION OF STRAIGHT AND ELBOW PIPES



FIRST ARRIVAL SIMULATION IN SMALL PIPE BEND

Pipe radius = 2.265 in | Bend radius = 12.000 in



FLATTENED SIMULATION

- All are traveling at same speed
- Difference in time is from different distance of travel

LAB TEST SETUP

FIELD TEST AT ABOVE GROUND STORAGE TANK FACILITY

THANK YOU, QUESTIONS?