

Goals and Methods

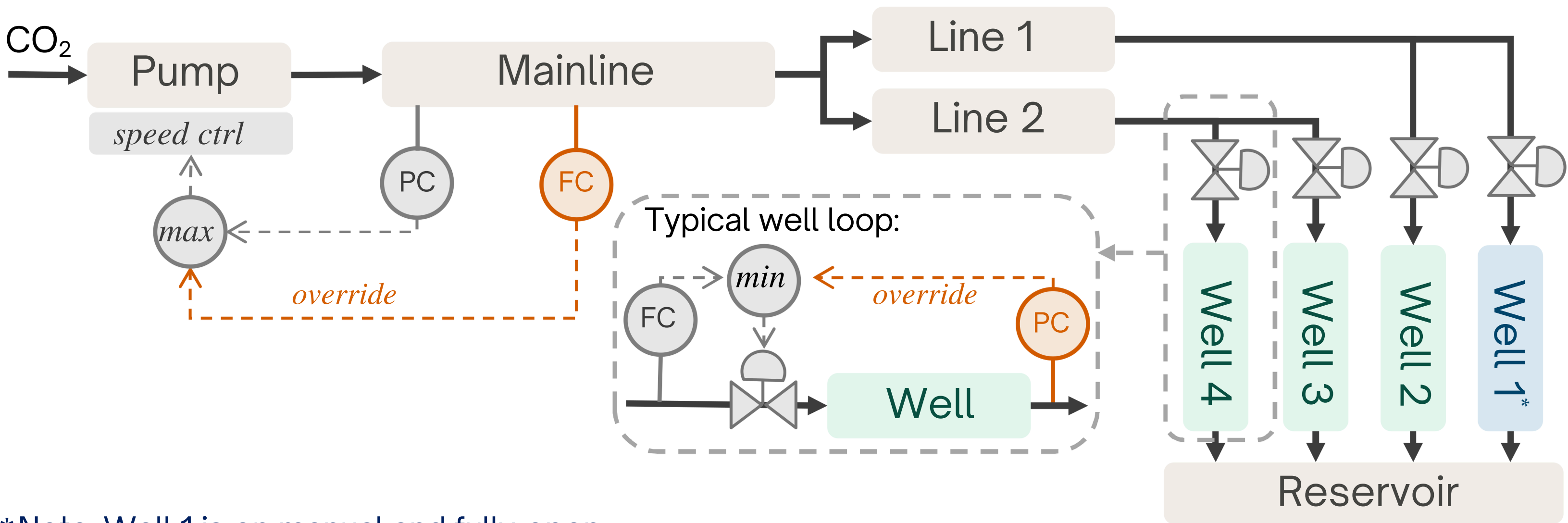
- Goals:**
 - Develop an effective foundational control structure for an **interacting** CO₂ pipeline-injection network
 - Reliable **throughput management** and constraint control

Process simulation: LedaFlow multiphase dynamic flow simulator

PID controller tuning: Model Identification - **First Order Plus Dead Time (FOPDT)**, Tuning - **SIMC Rules**

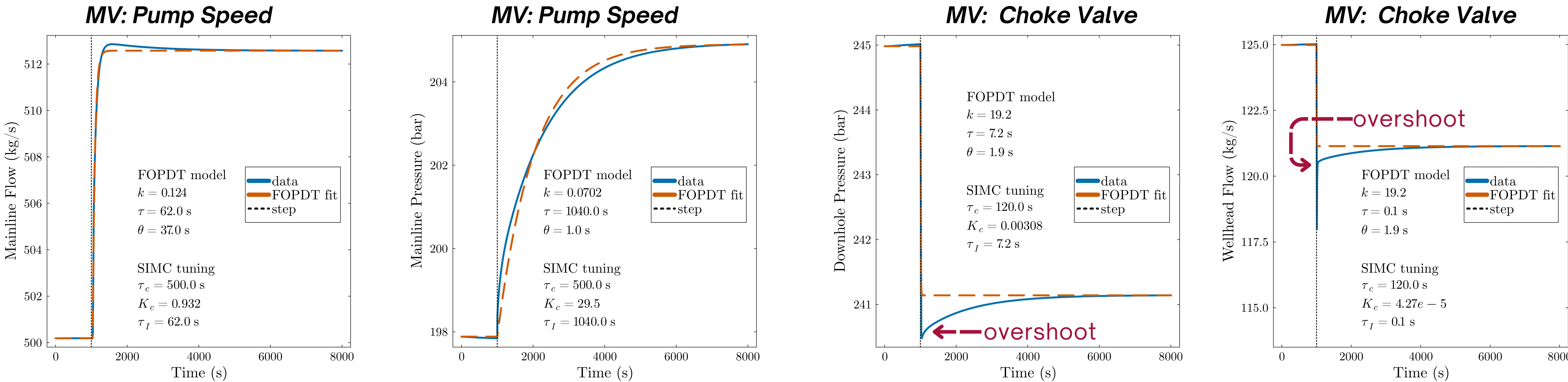
PID controller set-up: Velocity form, 30s control interval

Control Structure

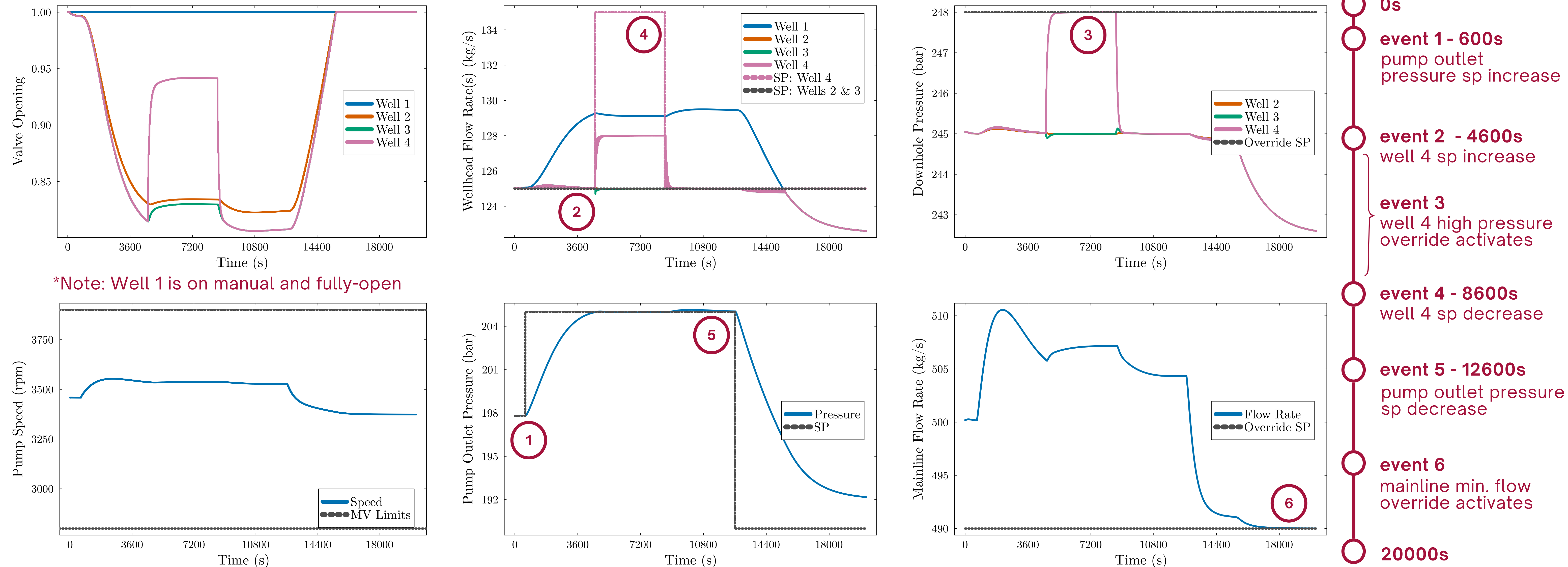


*Note: Well 1 is on manual and fully-open

FOPDT Model Identification
$$g(s) = \frac{k e^{-\theta s}}{\tau s + 1}$$



LedaFlow Closed-loop Dynamic Simulation



Timeline

- 0s

event 1 - 600s

event 2 - 4600s

event 3

event 4 - 8600s

event 5 - 12600s

event 6

20000s

Conclusions

Key Results

- Mainline throughput tracked during setpoint increase (event 1)
 - Flow and pressure constraints respected (events 2 - 6)
 - FOPDT tuning is sufficient at the tested operating point

Limitations

- Loop interaction limits aggressive tuning
 - Well 1 acts as an uncontrolled disturbance
 - Wellhead flow and downhole pressure respond on two time scales: (a) fast initial peak, (b) slow decay

Future Work

- Feedforward (upstream measurements) to counteract disturbances
 - Different closed-loop time constant per well to decouple interacting loops

References

[1] Ruud, T. (2024). MPC for transportation and injection of CO₂ [Master]. NTNU.

[2] Skogestad, S. (2003). Simple analytic rules for model reduction and PID controller tuning. Journal of Process Control, 13(4), 291–309. [https://doi.org/10.1016/S0959-1524\(02\)00062-8](https://doi.org/10.1016/S0959-1524(02)00062-8)

[3] Sunde, M. (2026). Coupling LedaFlow Simulations with Non- linear Model Predictive Control for CO₂ Pipeline Transport and Injection Systems [Master]. Norwegian University of Science and Technology.

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