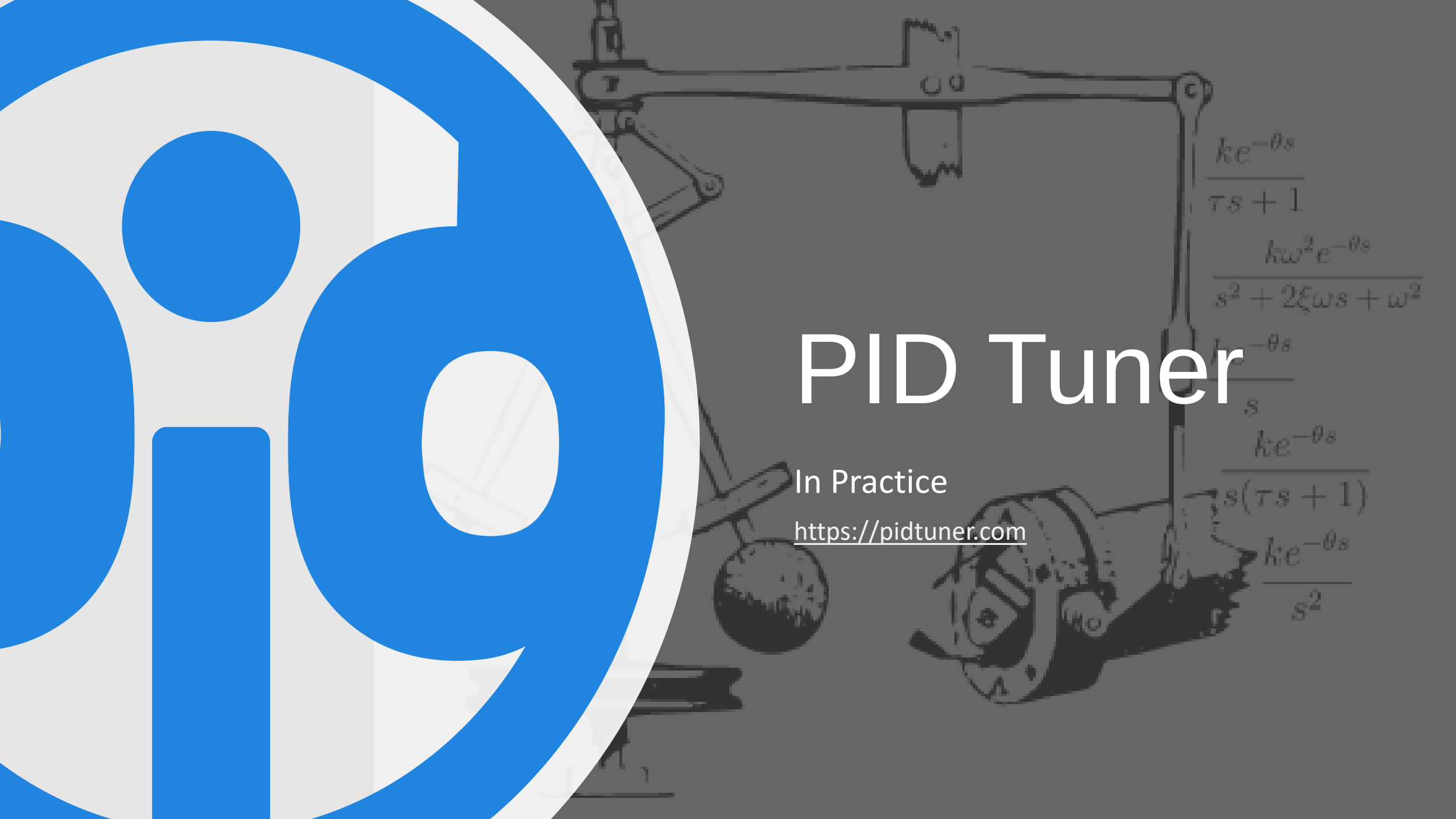


PID Tuner

In Practice

https://pidtuner.com

FAQ

https://forum.pidtuner.com

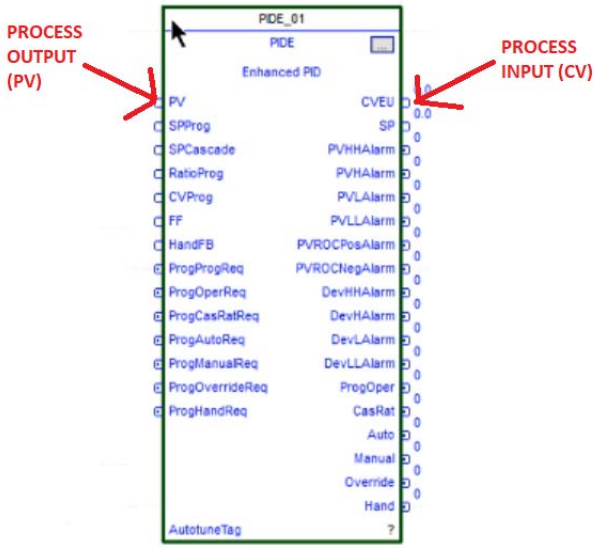
- What data do I need to import?
- How do I make a step test?
- What are the models used for?
- How to set the performance slider?

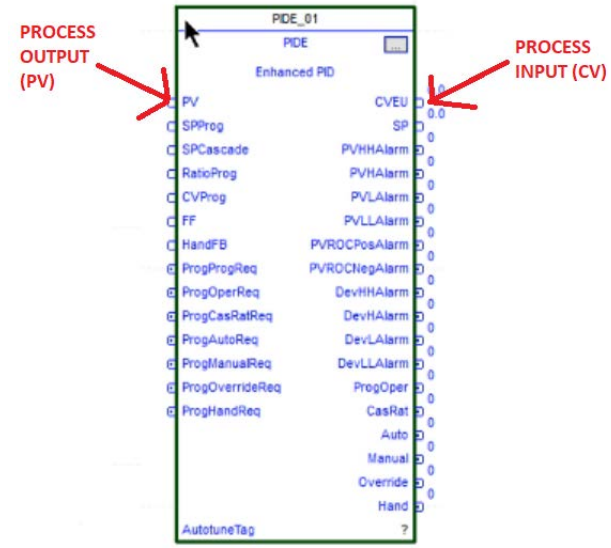
What data do I need to import?

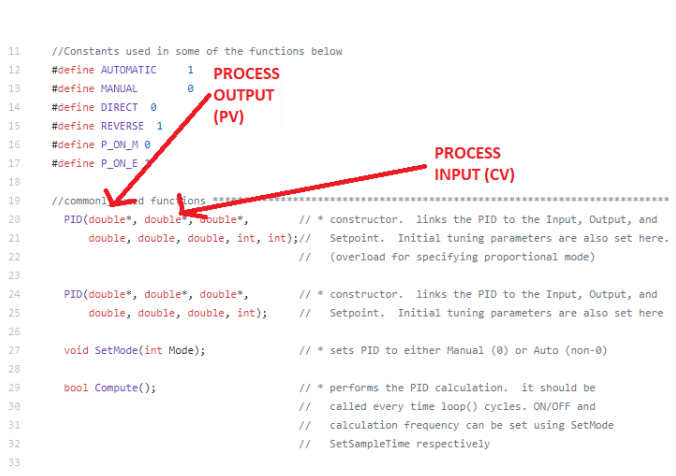
- Time, Input and Output?
  Of the Process!

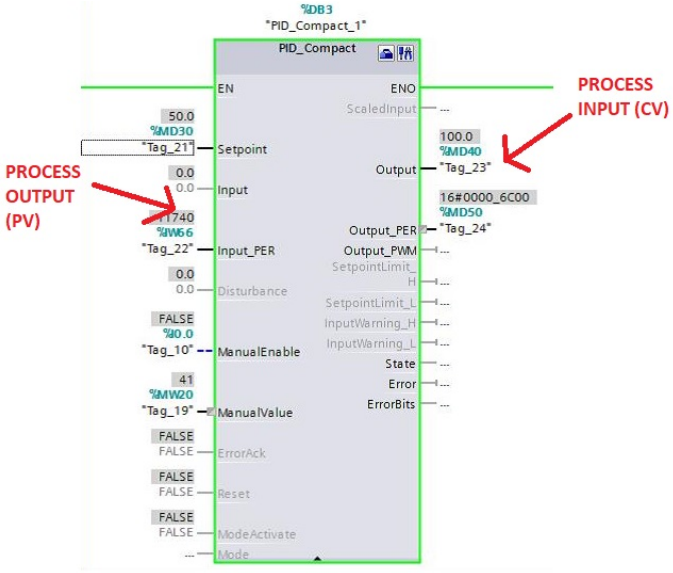
- But what is “the Process”?
  Everything that **is not** the PID.

- Where is the PID?
  A block of code that has **PV** (Process Variable) and **SP** (Setpoint) as inputs, and the **CV** (Control Variable) as output.



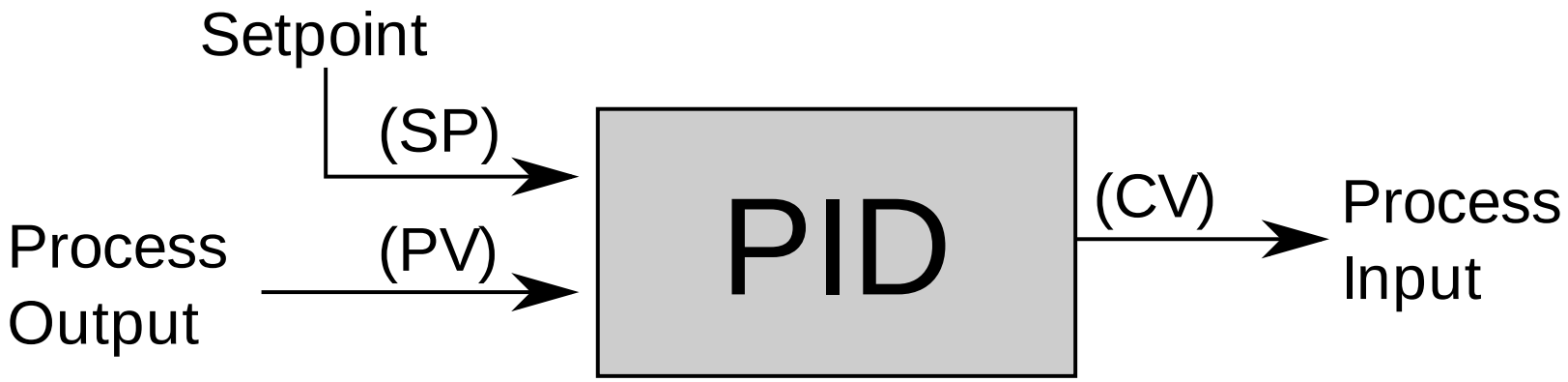






Time, Input and Output

- If the process is everything that is not the PID then:
- The **CV** is the Process **Input** and,
- The **PV** is the Process **Output**
- **Time** must always be in <u>seconds</u>.

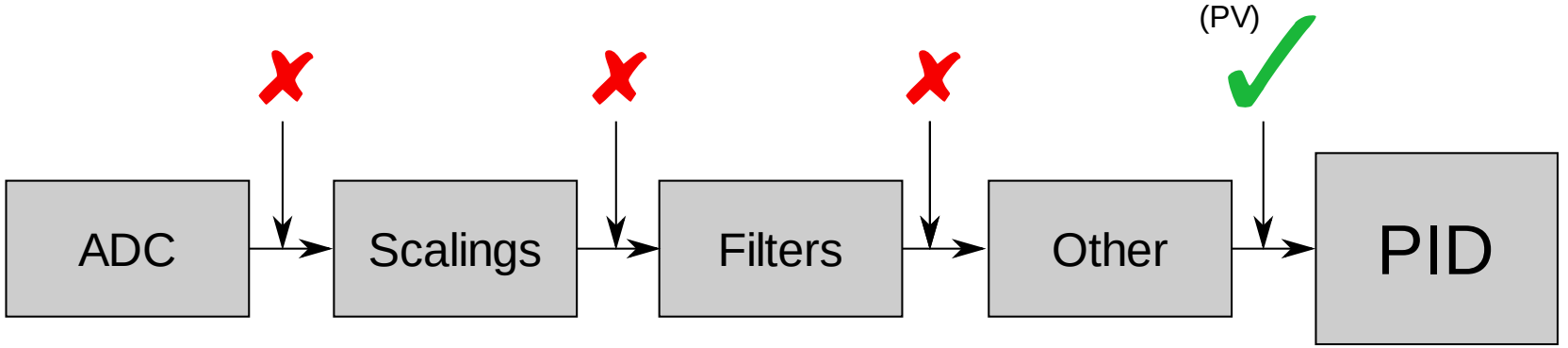


PV= Process Variable = Process Output

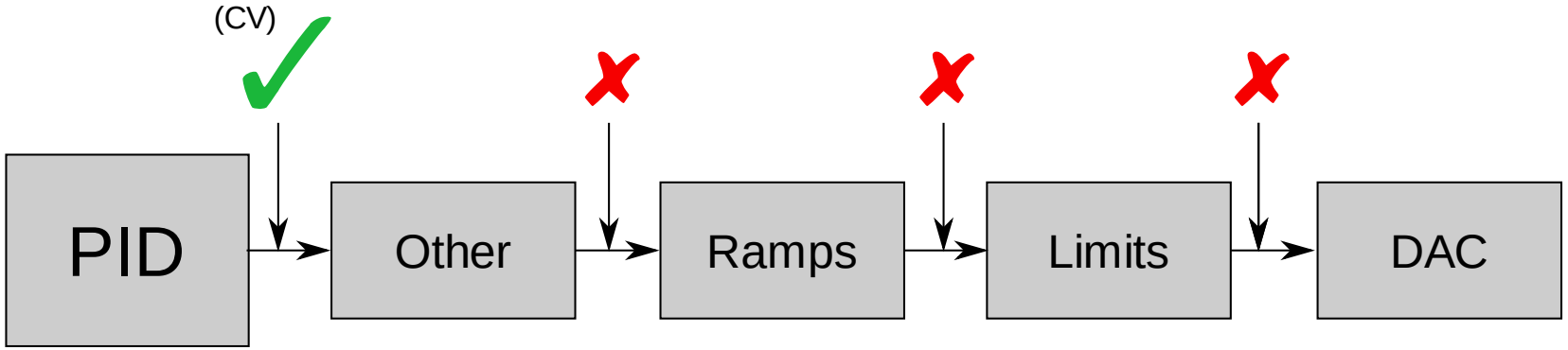
CV= Control Variable = Process Input

Common Mistakes on Data

- Considering **filters**, ramps, scalings and other transformations.
- Need as **Output** exactly what comes **into** the PID (as PV).



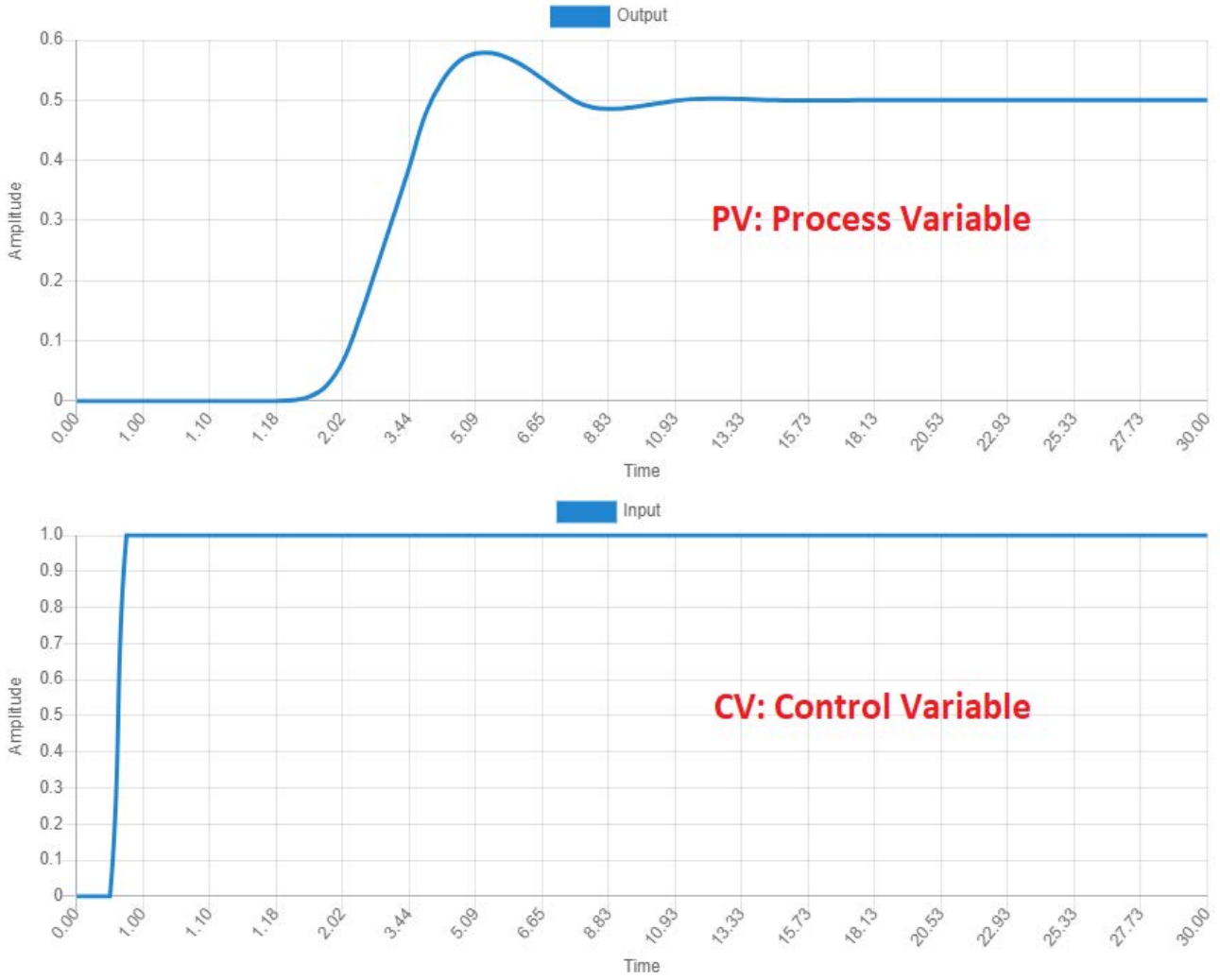
- Need as **Input** exactly what comes **out** of the PID (as CV).



What is a step test?

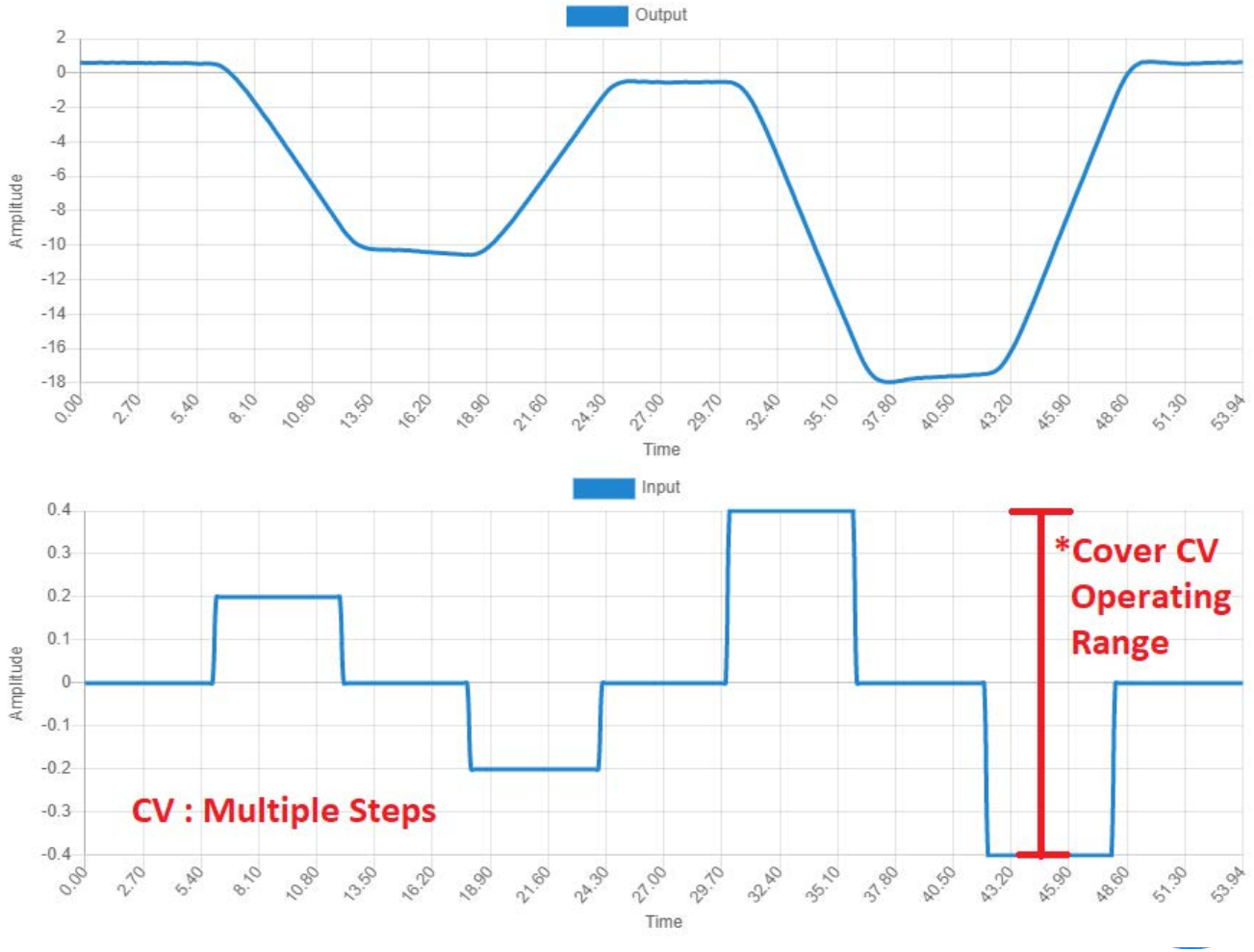
- Consists in making a manual step change in the **CV** (Process Input), to observe how it affects the **PV** (Process Output).

- A common mistake is to make the step change in the **SP** (Setpoint), when it must be done in the CV.



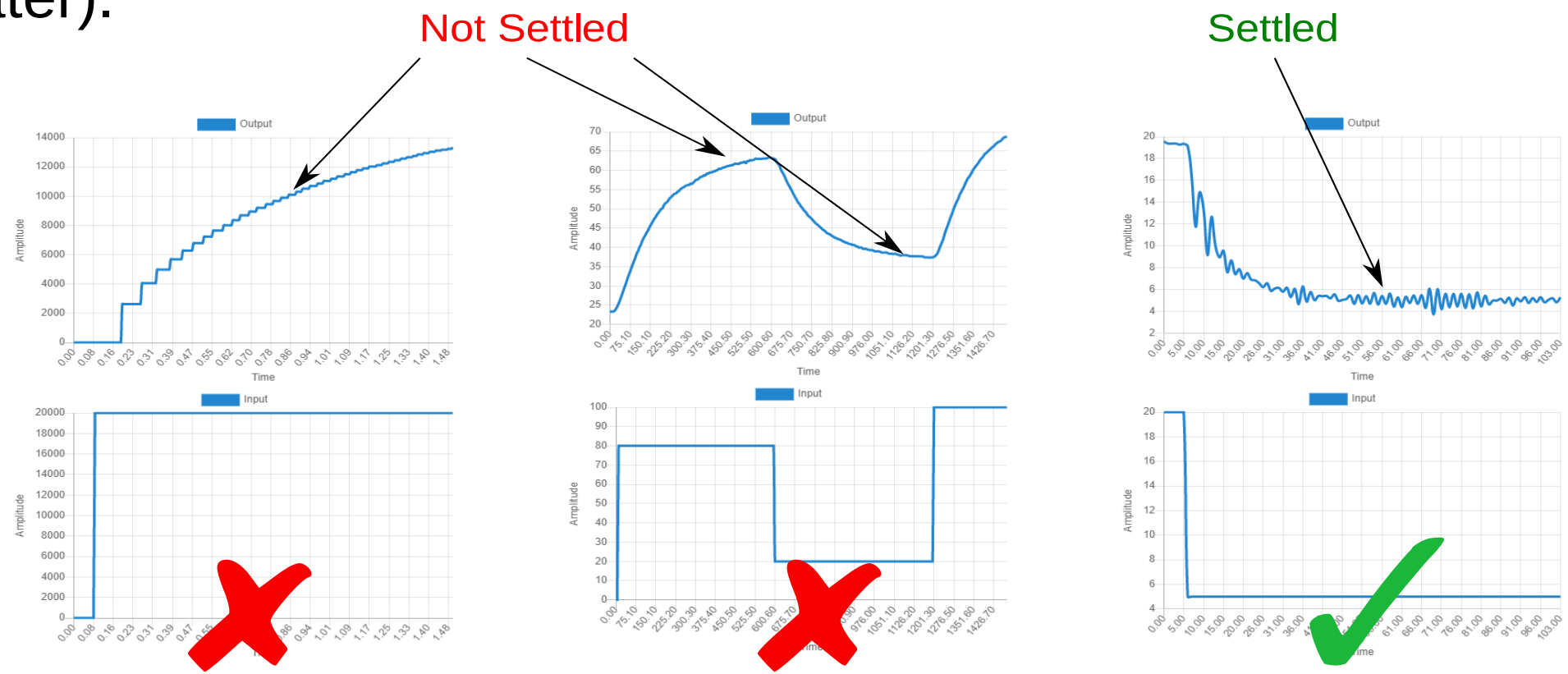
How do I make a step test?

- Step must be done with loop in “**manual**” (PID turned off).
- Avoid violating process limits.
- Record one or **more** steps.
- Cover the CV **operating range**.



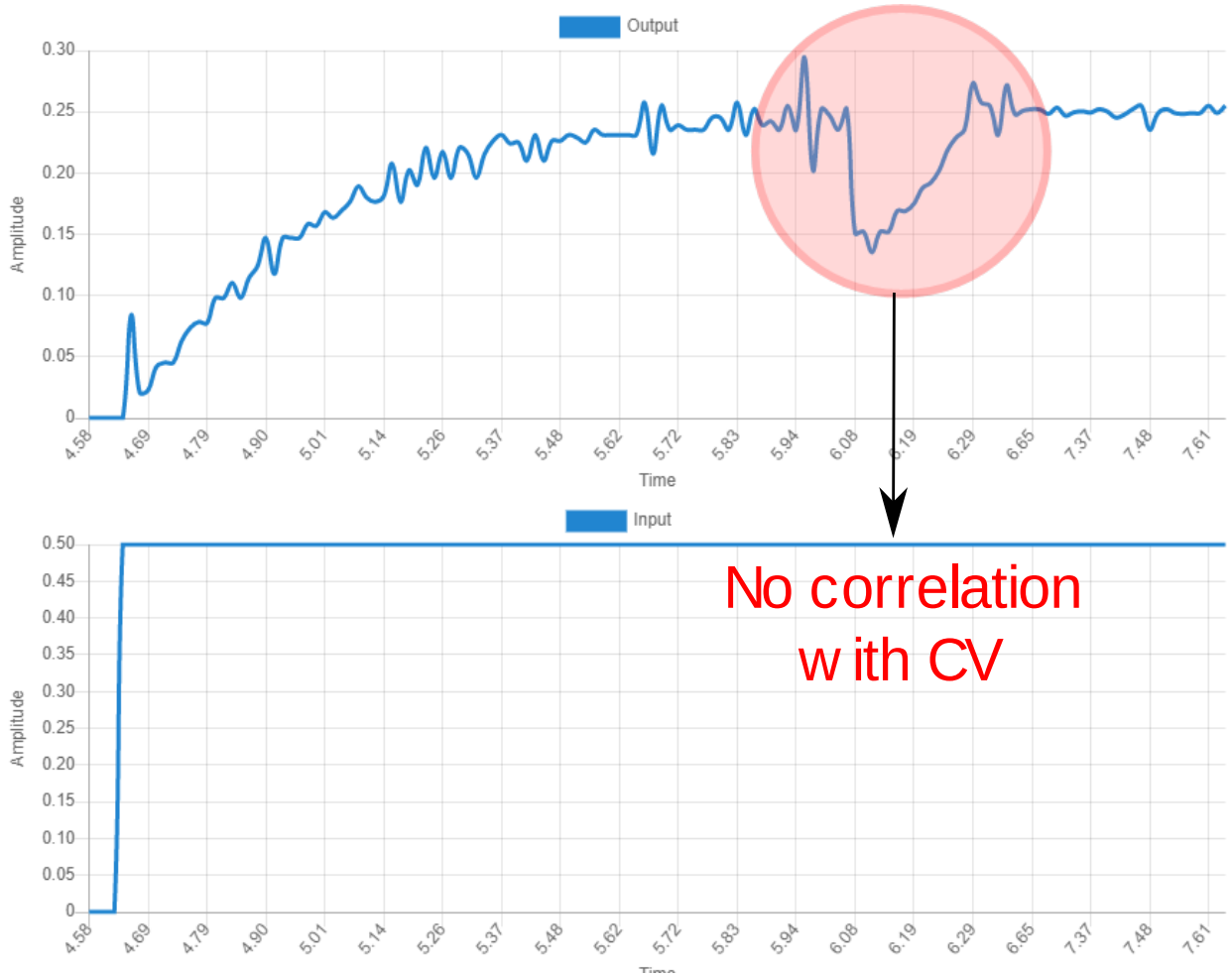
How long should I record?

- The step test must contain the full PV transition from one operating point to another, **until settled**.
- Some processes do not settle after a CV change (more on this later).



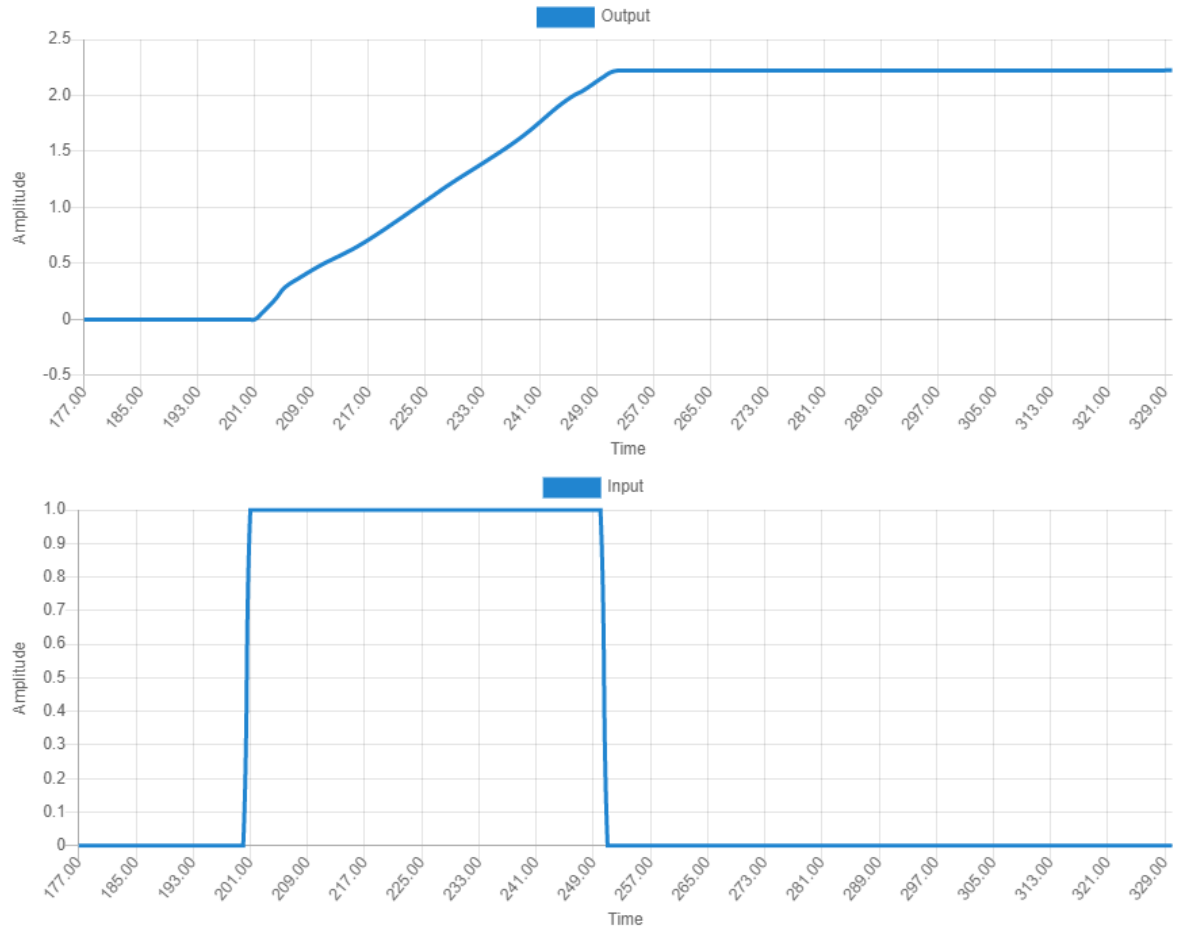
Common Mistakes on Step Test

- We are trying to train a **model** to learn **only** the effect that the CV has over the PV.
- **Other loops or variables** that affect the PV must be disabled, or fixed to a typical operating value.



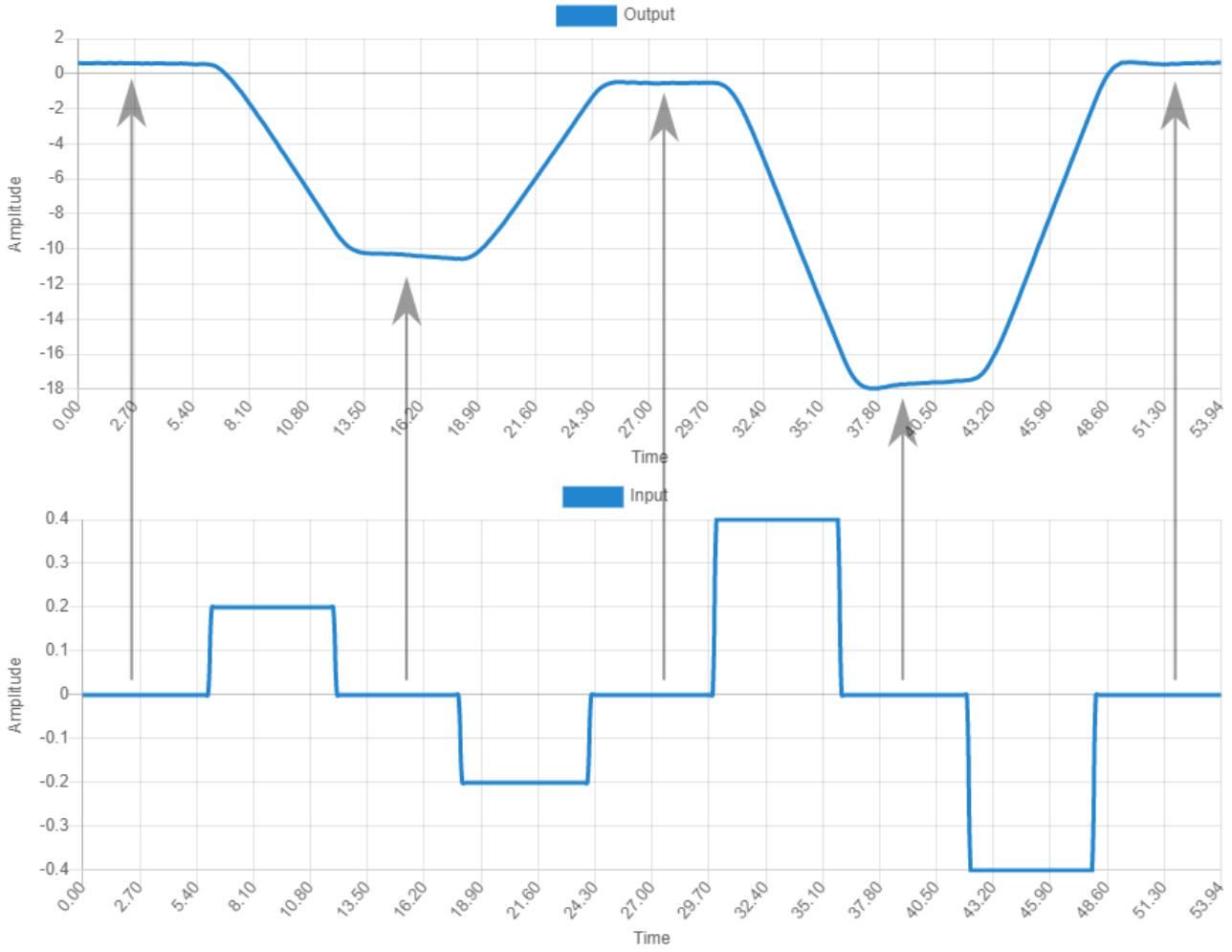
Integrating Process

- What PV does not settle, but <u>keeps increasing or decreasing</u> (when **CV not 0)**?
- This is an “**integrating**” process.
  Only settles when CV = 0.
- Ex: a tank level (PV) keeps increasing when the intake valve (CV) is open (CV not 0), only settles when valve is closed (CV = 0).



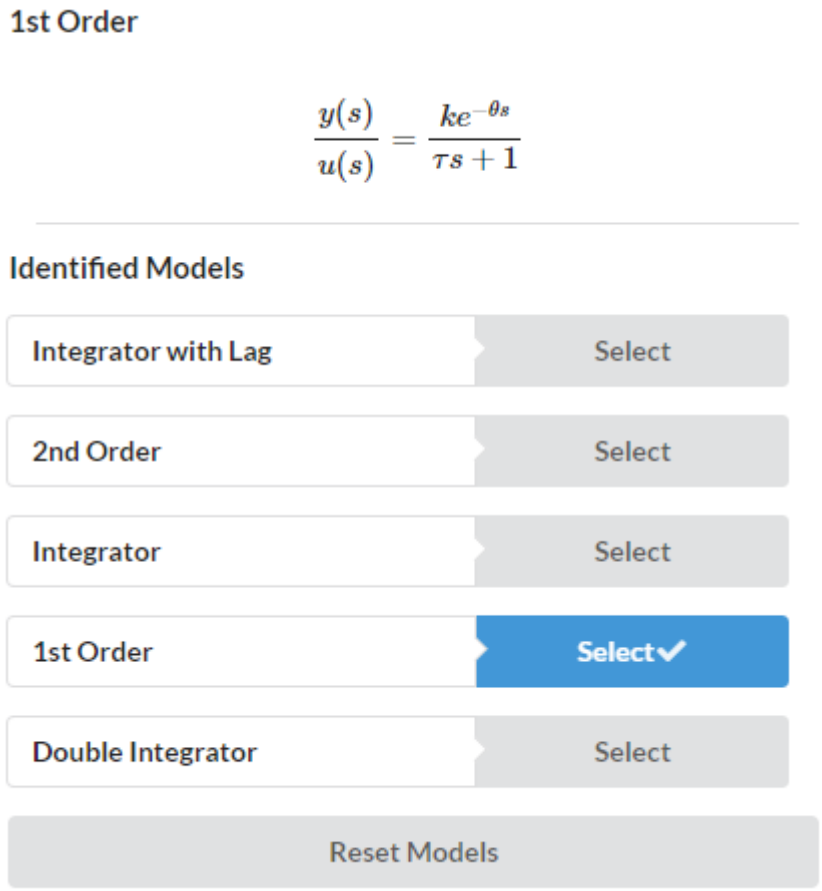
Step Test for an Integrating Process

- A step test can be designed with a **series** of **step up** and **step down.**
- Take care of staying inside safe operating conditions.



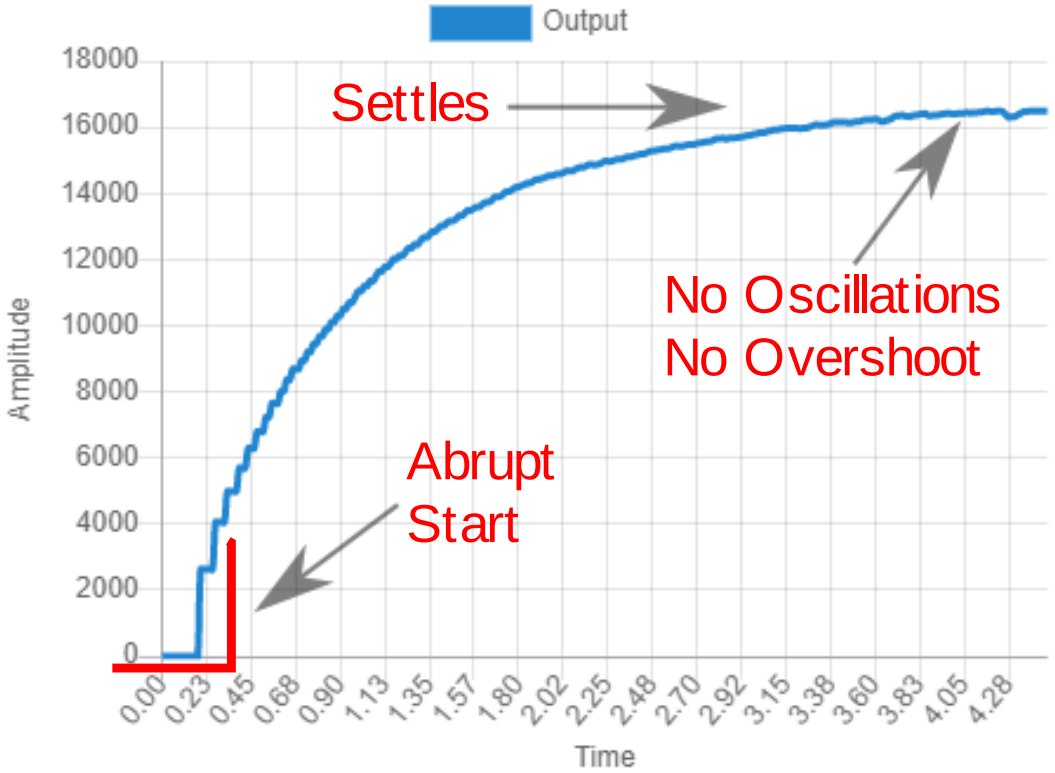
What are process models?

- Processes can be categorized according to the PV response to a CV change.
- A **model** is a (very useful) simplification of that response.



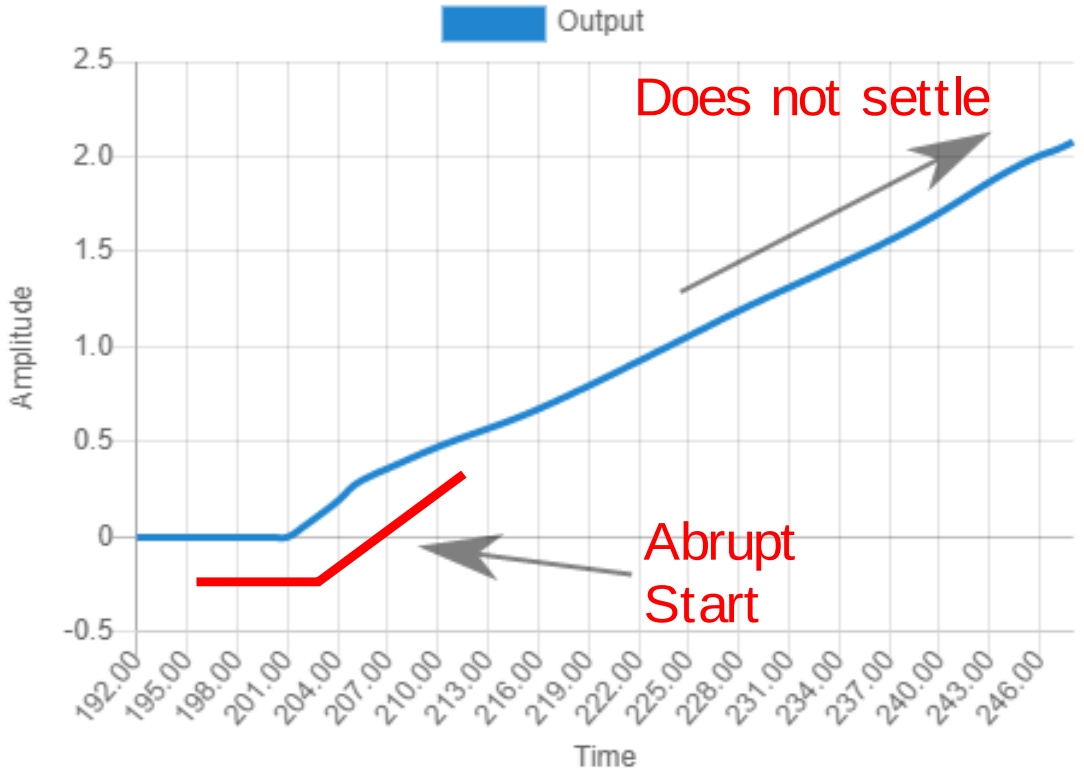
Models

First Order: PV *abruptly* transitions with exponential growth, but settles eventually.



First Order

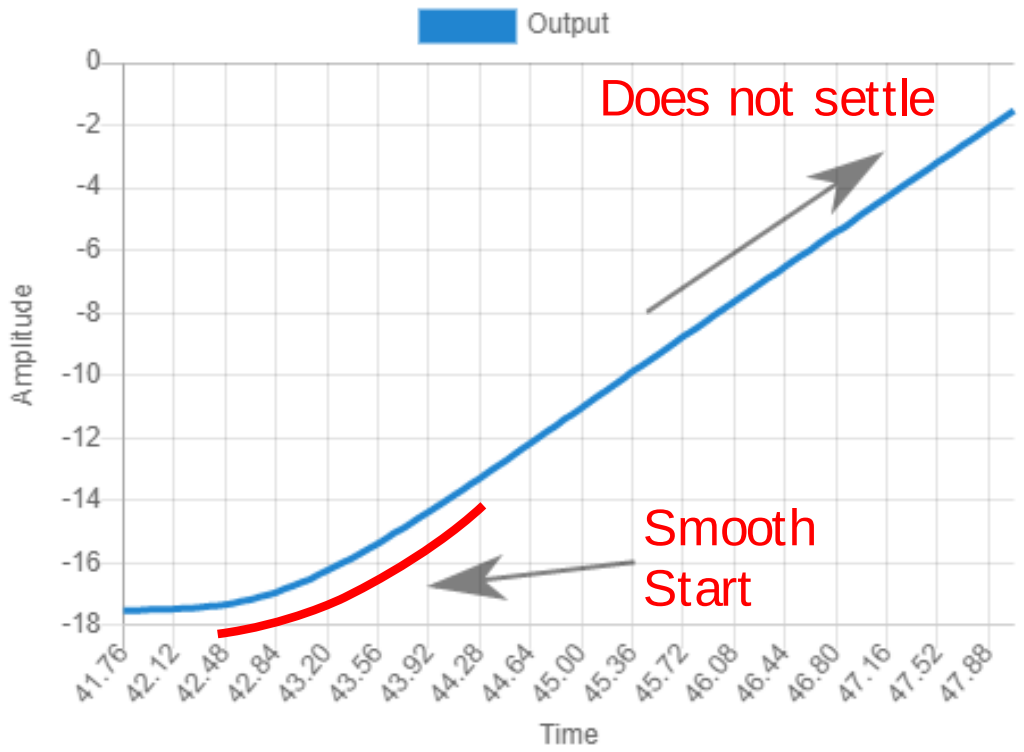
Integrator: PV *abruptly* starts increasing (or decreasing) with a constant rate as long as CV is not 0, and does not settle.



Integrator

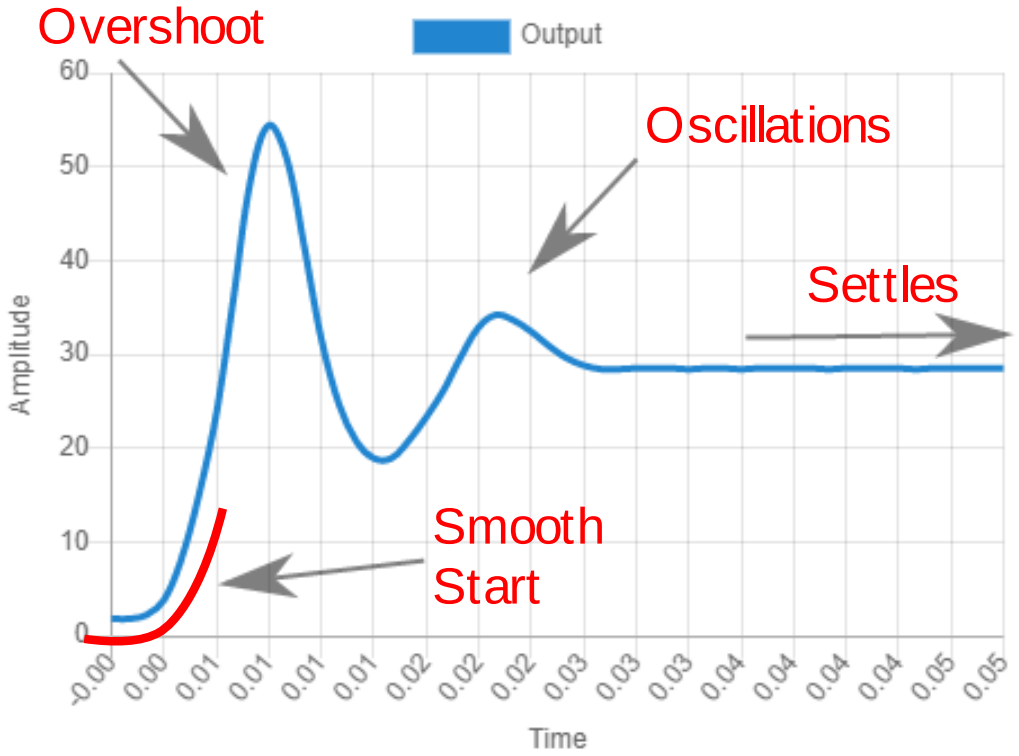
Models

Integrator with Lag: PV *smoothly* starts increasing (or decreasing) until reaching a constant rate (similar to an Integrator).



Integrator with Lag

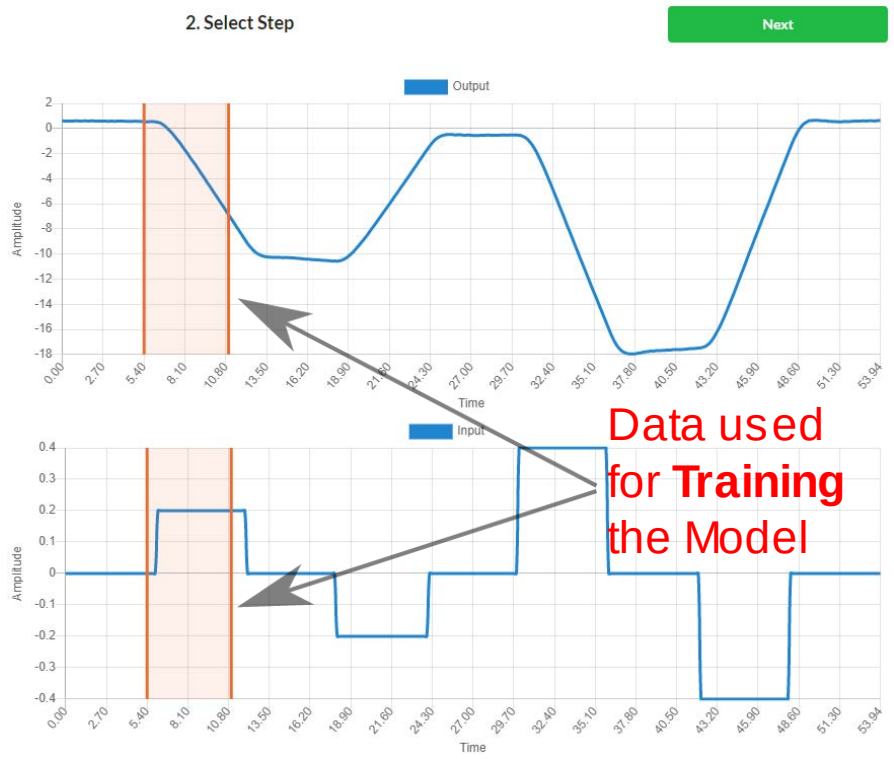
Second Order: PV *smoothly* transitions with exponential growth, and might <u>overshoot</u> or show <u>oscillations</u>, then <u>settles</u> eventually.

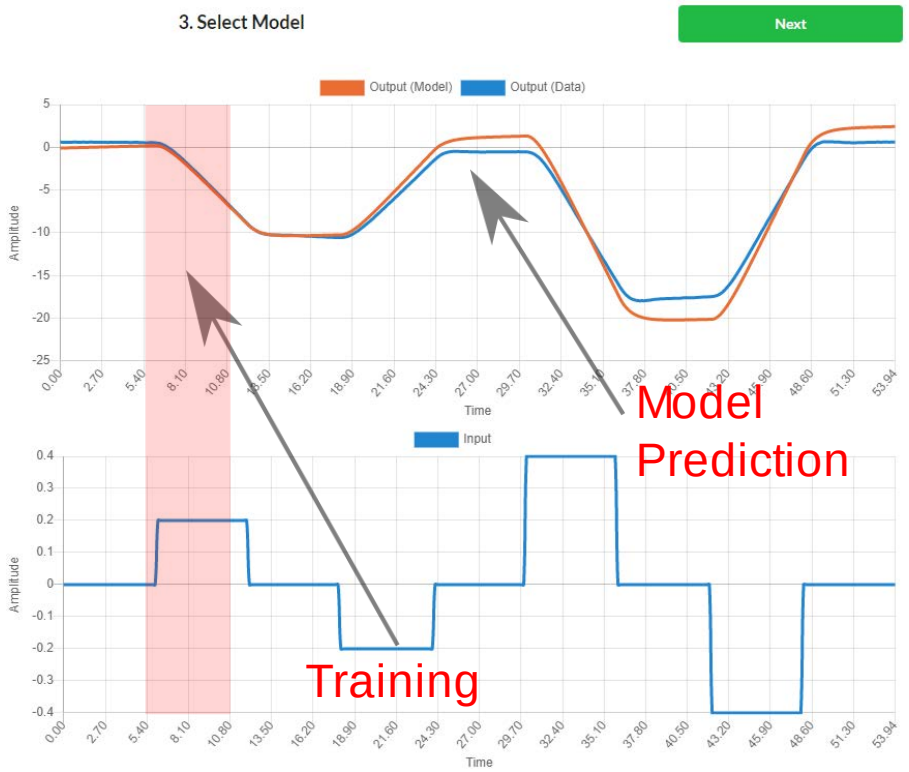


Second Order

What are the models used for?

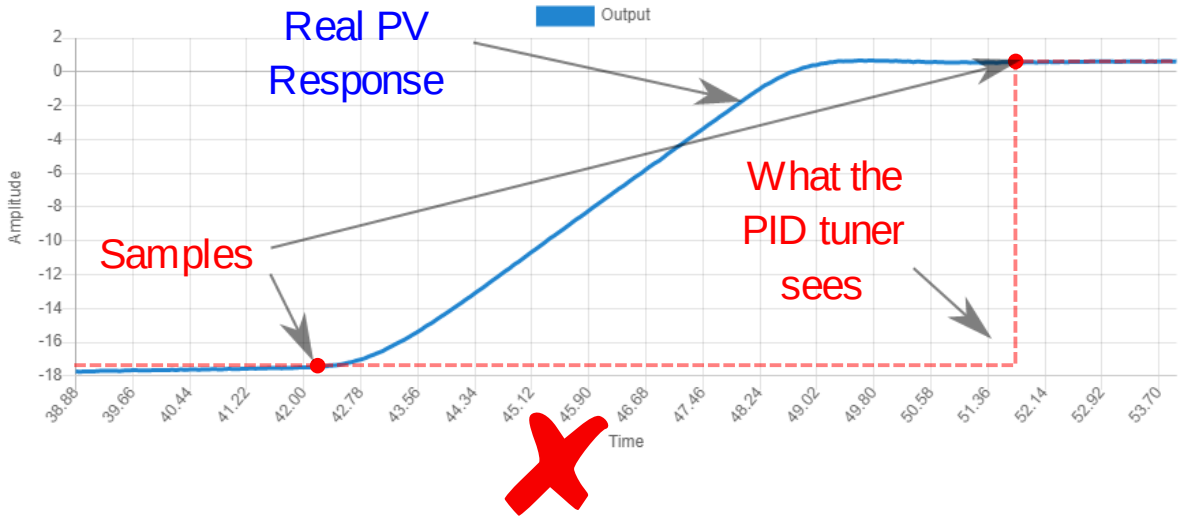
- Capture the main dynamics of the process with a **simplified** model.
- The model is used to adjust PID gains and make simulations.
- Always choose the model that gives the best **predictions**.

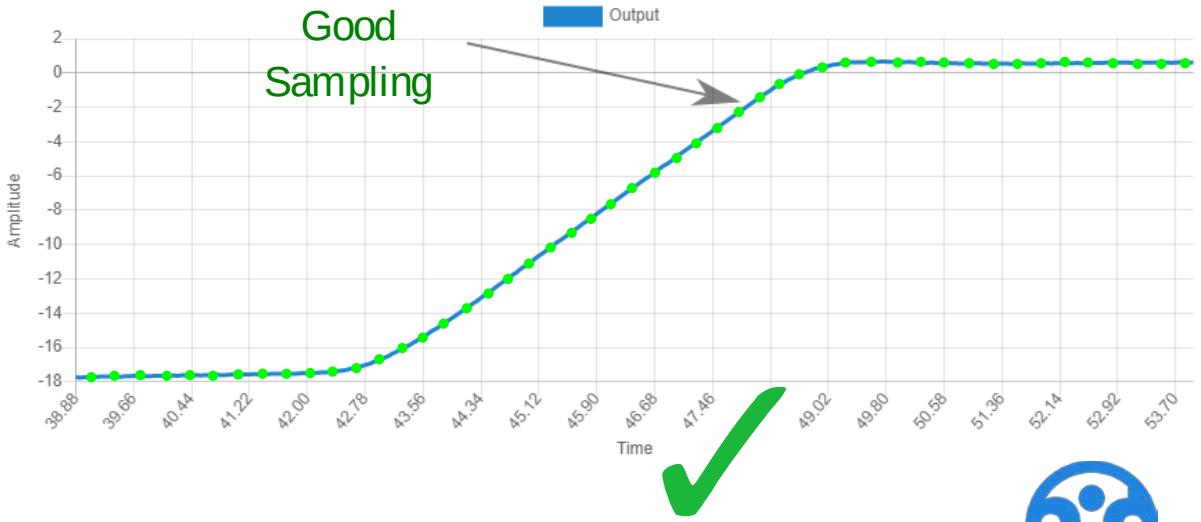




Data Sampling

- The PID Tuner needs to see the full transition of the PV from one operating point to another.
- If the data is **under-sampled**, the PID Tuner will not be able to see (therefore to learn) the process main dynamics.
- Tip: at least **80 points** for the transition.



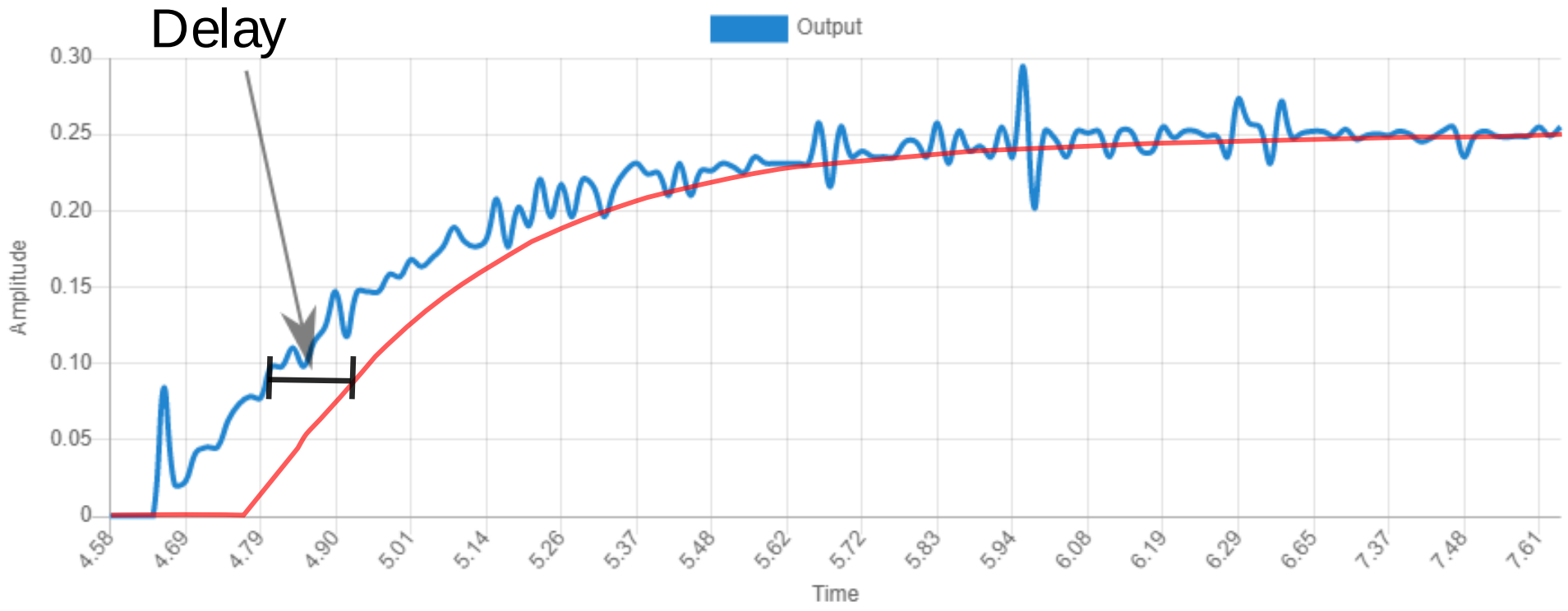


How to set the performance slider?

- Models are not perfect by definition (they are a simplification).
- The tuning slider reflects the **confidence** we have on the model.
- Slider to the left means less confidence (less aggressive PID).
- Slider to the right means more confidence (more aggressive PID).

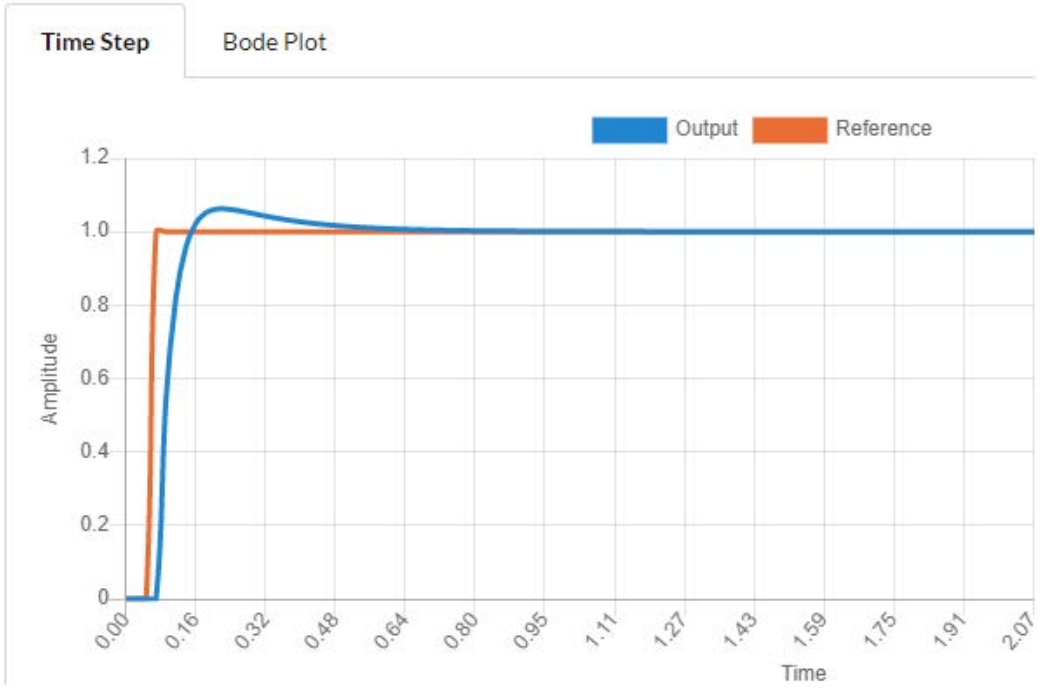
Note on Filters

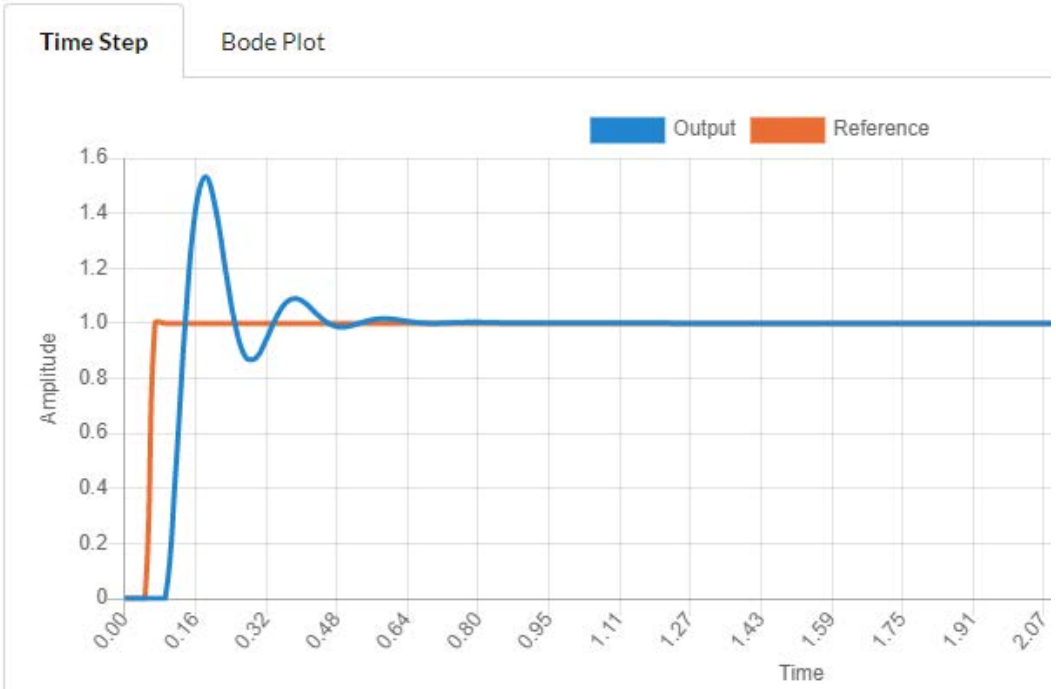
- Filters only **hide** the underlying problem; **noise**!
- Filters introduce delay, delay degrades **performance**.



Note on Delay

- Delay **limits** how far to the right we can set the PID Tuner performance slider (limits how aggressive we can control).
- If we filter heavily, we have to accept slow control.

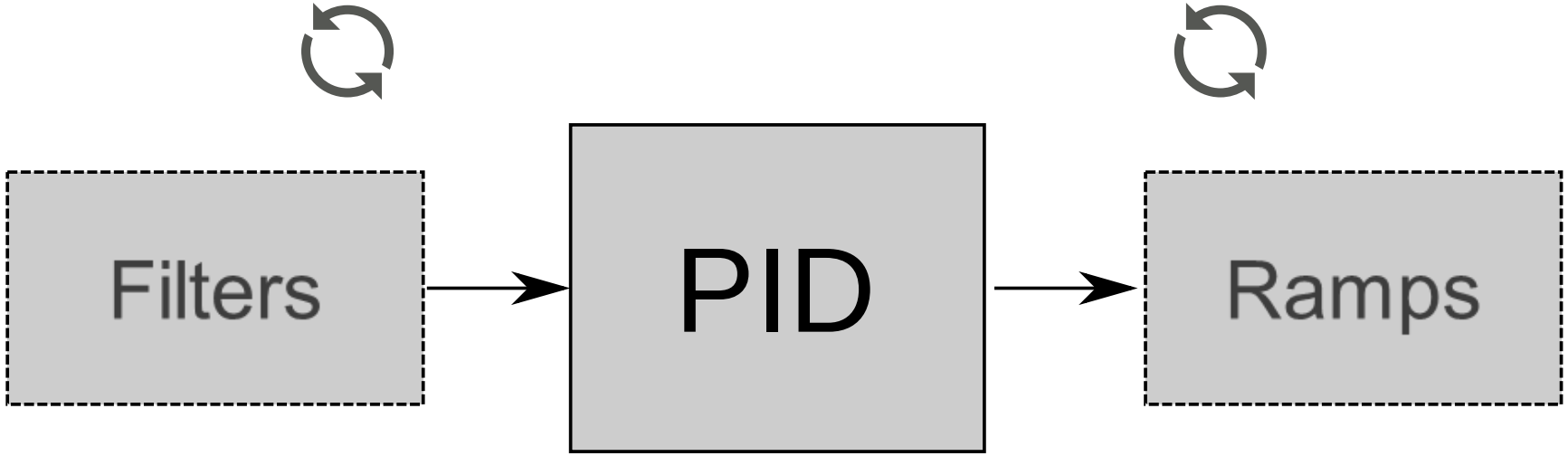




*Example: same process, same PID gains, just 0.02s delay difference

Filters and Step Test

- If filters (ramps, scalings or other transformations) are **changed**, we need to repeat the step test.
- Changes in filters, **change** what the PID “sees”, since the process changes in the eyes of the PID (remember process is everything that **is not** the PID).

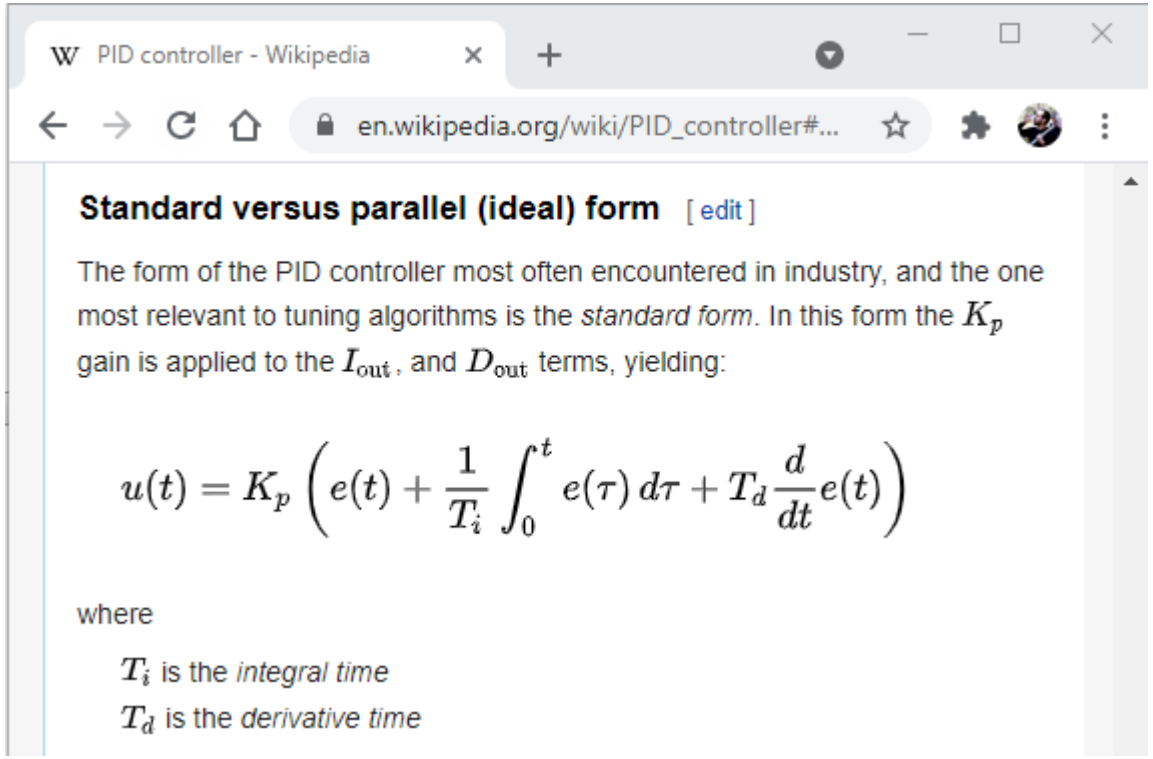


How Acceptable is Noise?

- Noisy PV measurements produce noisy PID signal (CV).
- Noisy PV can be a big problem, specially when **D gain** is needed.
- In some processes, feeding noise to the **actuator** can be dangerous.
- Ex. Feeding a noisy signal to the motors of a quadcopter drone produces so much heat, it can burn the electronics.

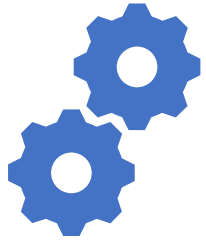
Non-standard PIDs

- The PID Tuner assumes the **standard** or **ideal** form of the PID.
- Some PID implementations use non-standard PID gains.
- Might need to convert the PID Tuner gains to non-standard.
- Read your vendor's PID block documentation.



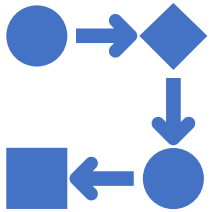
https://en.wikipedia.org/wiki/PID_controller

Summary : Key Points



Step test must be from CV (process Input) to PV (process Output), with PID disabled (in manual).

Transition of PV must be sampled fast enough (at least 80 points for one transition). Time always in seconds.



Plan the step test safely, reducing external factors that affect the PV, make as many steps necessary to cover the operating range.

Summary : Key Points

If possible, fix noise at source. Set the PV filters before making the step test. Accept more filtering will limit performance.

Repeat step test if anything outside the PID changes (filters, ramps, etc). These changes require PID re-tuning.

Read your PID documentation. Convert gains as required.