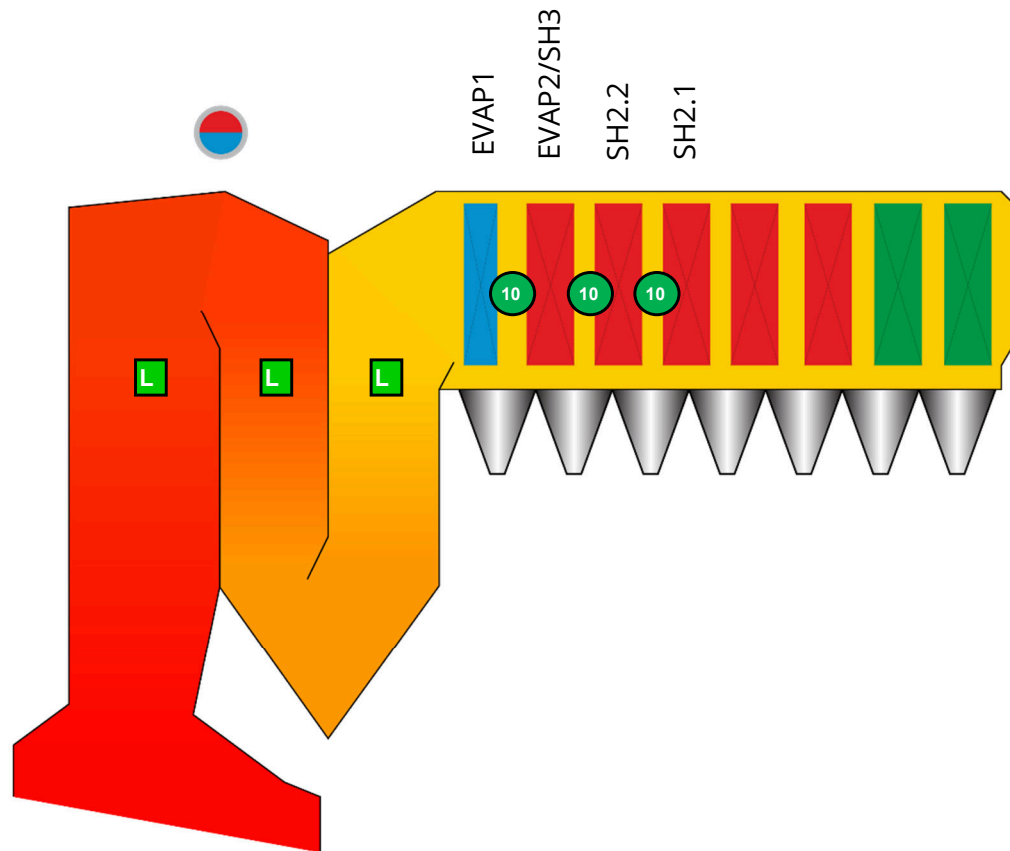



Reference Plant

WtE boiler Luzern (Perlen) / CH

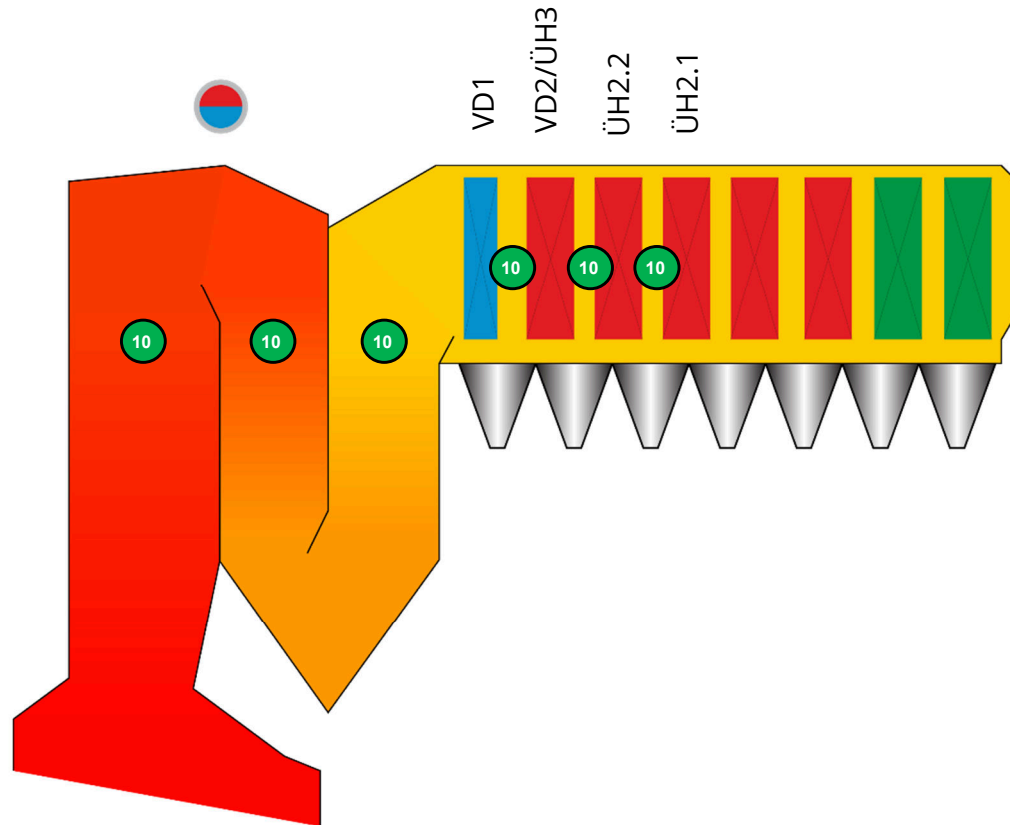


 Shock Pulse Generator EG10L at side wall

 Shock Pulse Generator SPGr10 at side wall

- 2 boilers with 58 t/h steam throughput per unit, since 2015.
- Capacity increase to 70 t/h in 2020 (120% of the original design)
- Boiler width 5.5 m
- 6x Shock Pulse Generator EG10L, since 01/2015 (3 per boiler), enable to maintain a constant FG temperature at the inlet to the horizontal pass, even at 70 t/h steam capacity. From July 2022 3x SPGr10 in operation at Boiler 1.
- 6x Shock Pulse Generator SPGr10, since 08/2021 (3 per boiler), enable to prevent strong increase of pressure drop in the horizontal pass and to achieve long travel time. Common operation with the existing rapping system.
- Plant supplier: Hitachi Zosen Inova
- Plant operator: Renergia

Boiler 1: Operation of 6x SPGr10 from July 2022



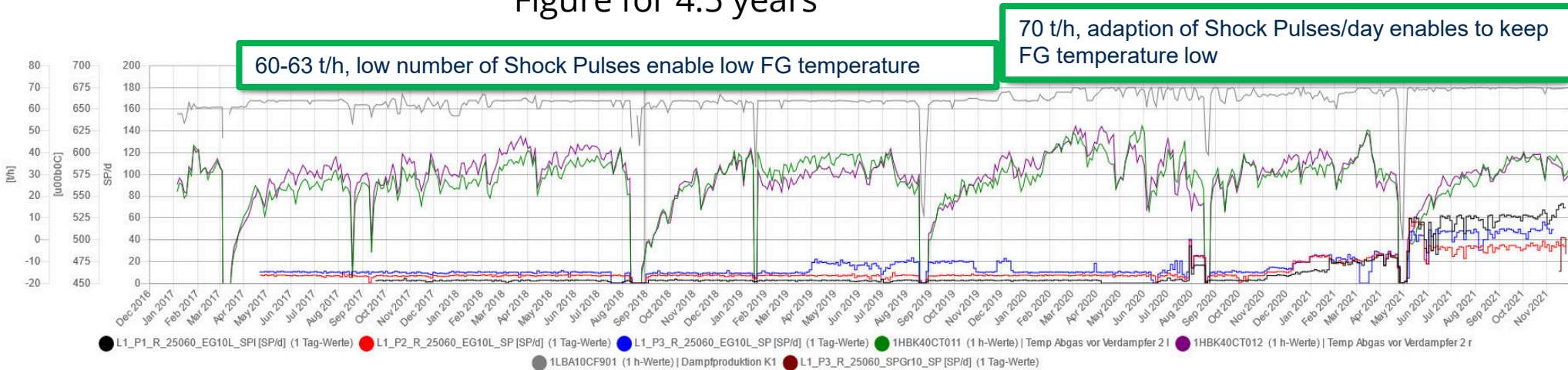
10 Shock Pulse Generator SPGr10 at side wall

- At boiler 1, the three EG10L will be replaced by three SPGr10 in June 2022
- Afterwards operation of six SPGr10
- Further optimization of cleaning effect by adaption of Mixed Mode, based on weekly analysis of boiler operation data
- Reduction of operation and maintenance cost
- System unification with respect to handling and control from DCS
- Same adaption is planned for boiler 2 in year 2023
- The combustion air for twelve SPGr10 is provided by one Air Compressor Unit ACU260-80-2

3x EG10L enable low inlet temperature into horizontal pass, even after capacity increase



Figure for 4.5 years



Black: Shock pulses/day of EG10L in 1st pass; Red: Shock pulses/day of EG10L in 2nd pass, Blue: Shock pulses/day of EG10L in the 3rd pass;
Green: Flue gas temperature before EVAP2, left side; Purple: FGT before EVAP2, right side;
Gray: Life steam flow
Brown: Shock pulse/day of an SPGr10, testwise installation for comparison

Result:

The SPGs enable a low flue gas temperature at the inlet of the horizontal pass, even after the capacity increase of the boiler (measurement at inlet EVAP2-SH3, at outlet of small evaporator bundle EVAP1).

By adjusting the shock pulses/day, even lower FG temperatures could be achieved. Additional optimizations with mixed mode operation of the SPGs are currently carried out.

Significant reduction of flue gas pressure drop, applying three SPGr10 together with rapping

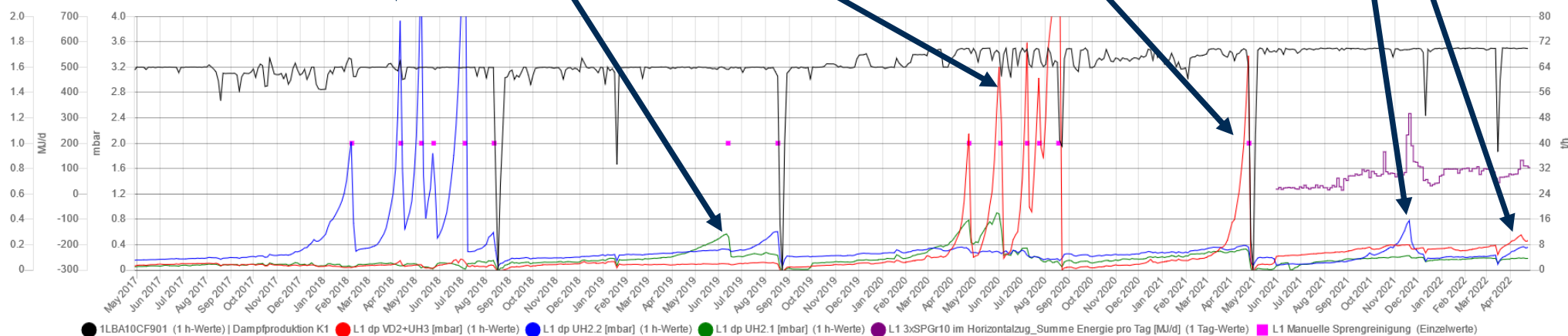


Trendcurve for Boiler 1 for 5 years

2018 till 2020: Rapping cannot prevent strong increases of flue gas pressure drop at SH2.2 or EVAP2-SH3 respectively. Manual explosive cleaning was necessary. The time between manual cleanings became shorter.

April 2021: One SPGr10 at the inlet of EVAP2-SH3 can slow down the increase of the flue gas pressure drop at EVAP2-SH3 and enables continuation of operation until planned shut down, without manual explosive cleaning.

November 2021 and April 2022: Three SPGr10 can reverse the increase of flue gas pressure drop at SH2.2. No necessity for manual explosive cleaning.



- Black: Steam flow
- Red: Flue gas pressure drop at EVAP2-SH3
- Blue: Flue gas pressure drop at SH2.2
- Green: Flue gas pressure drop at SH2.1
- Purple: Sum of Converted Energy/day of three SPGr10 in horizontal pass

3x SPGr10 & rapping can reverse the increase of flue gas pressure drop in critical SH bundle



November 2021:

Operation of three SPGr10 at horizontal pass.

By increase of number of Shock Pulses/day the increase at the flue gas pressure drop in SH2.2 can be reversed for the first time, together with the rapping system.

There was no manual explosive cleaning necessary.



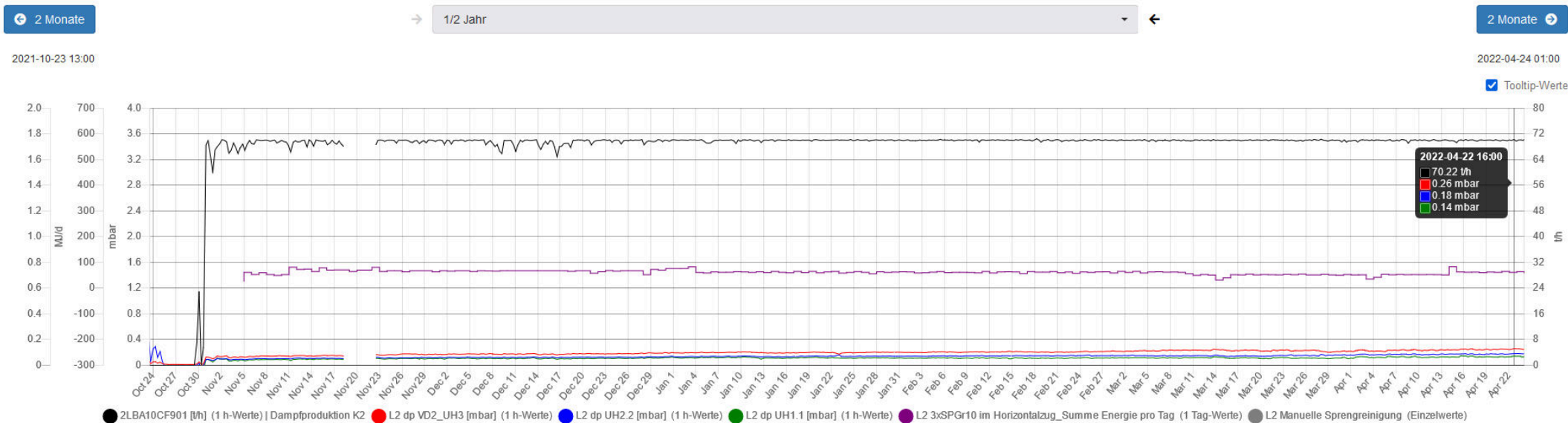
Detailed Diagram for Line 1 for six months (zoom from previous page)

- Black: Steam flow
- Red: Flue gas pressure drop at EVAP2-SH3
- Blue: Flue gas pressure drop at SH2.2
- Green: Flue gas pressure drop at SH2.1
- Purple: Sum of Converted Energy/day of three SPGr10 in horizontal pass

3x SPGr10 & rapping can keep flue gas pressure drop continuously low at line 2



Trend curve for boiler 2 for six months operation after boiler maintenance



- Black: Steam flow
- Red: Flue gas pressure drop at EVAP2-SH3
- Blue: Flue gas pressure drop at SH2.2
- Green: Flue gas pressure drop at SH2.1
- Purple: Sum of Converted Energy/day of three SPGr10 in horizontal pass

Reference plant WtE boiler Lucerne (Perlen) / CH 3x EG10L for empty passes 1-3, per boiler



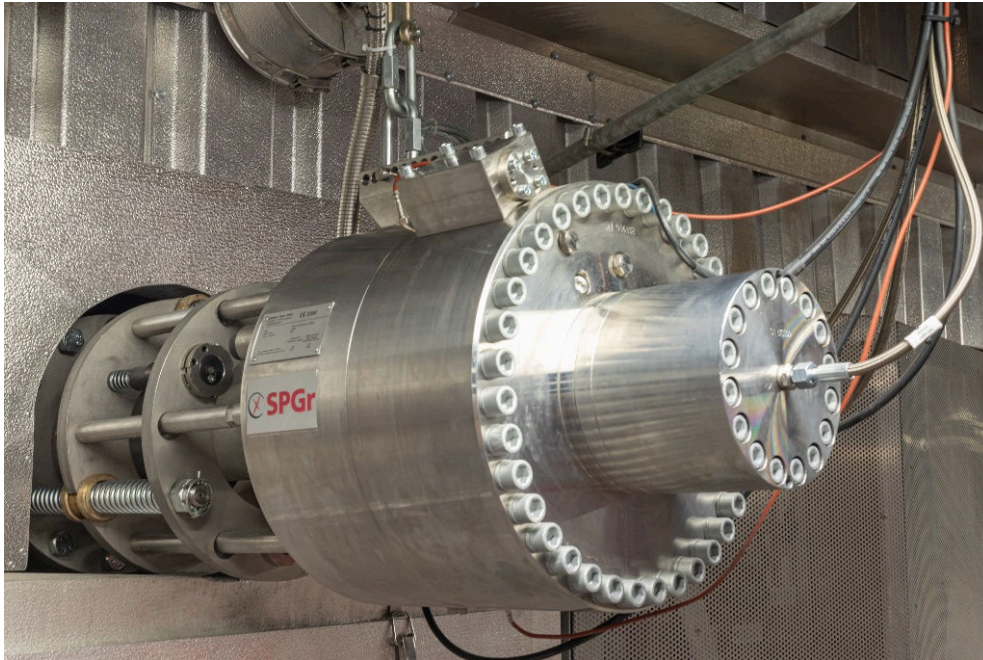
Reference plant WtE boiler Lucerne (Perlen) / CH: Gas supply for EG10L



Reference plant WtE boiler Lucerne (Perlen) / CH 3x SPGr10 in horizontal pass, per boiler



Reference plant WtE boiler Lucerne (Perlen) / CH SPGr10 and ACU



Detailed view of SPGr10 installed at horizontal pass.

Air Compressor Unit ACU260-80-2,
supplying combustion air to all SPGr10

