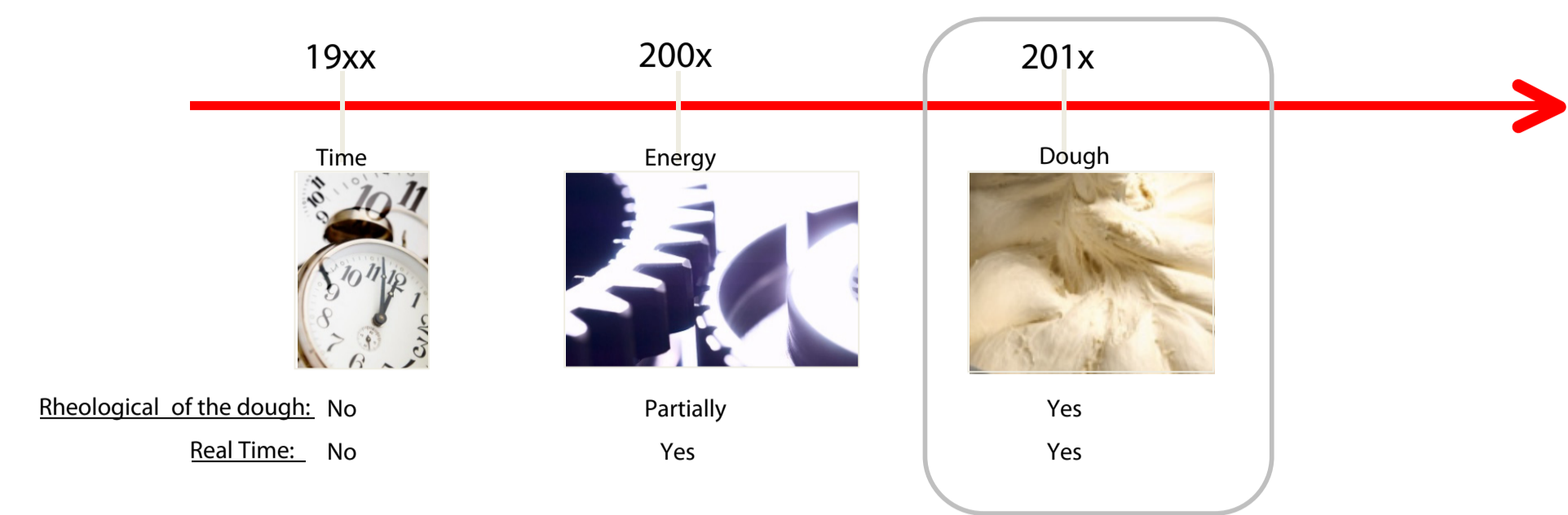


Advanced Technology , characterizing the dough in real time during kneading

To start with

- For years, bakers have only had variable Time to operate
→ **Measure completely decoupled from the rheological of the dough**
- Several manufacturers of mixers, including VMI, have made it possible in recent years to measure the Energy consumed by a mixer
→ **Measure partially and non directly related to the state of dough mixing.**

- Today, VMI offers a measuring method that allows us to account for the condition of the dough , in real time during the dough mixing process , without being disturbed by mechanical phenomena (friction) or electrical issues (system stability) related to the designing of the mixer itself or to the environment not directly related to the dough
→ **The measure only takes into account the condition of the mixing dough.**



Methodology

Research and related development tasks have consisted mainly of:

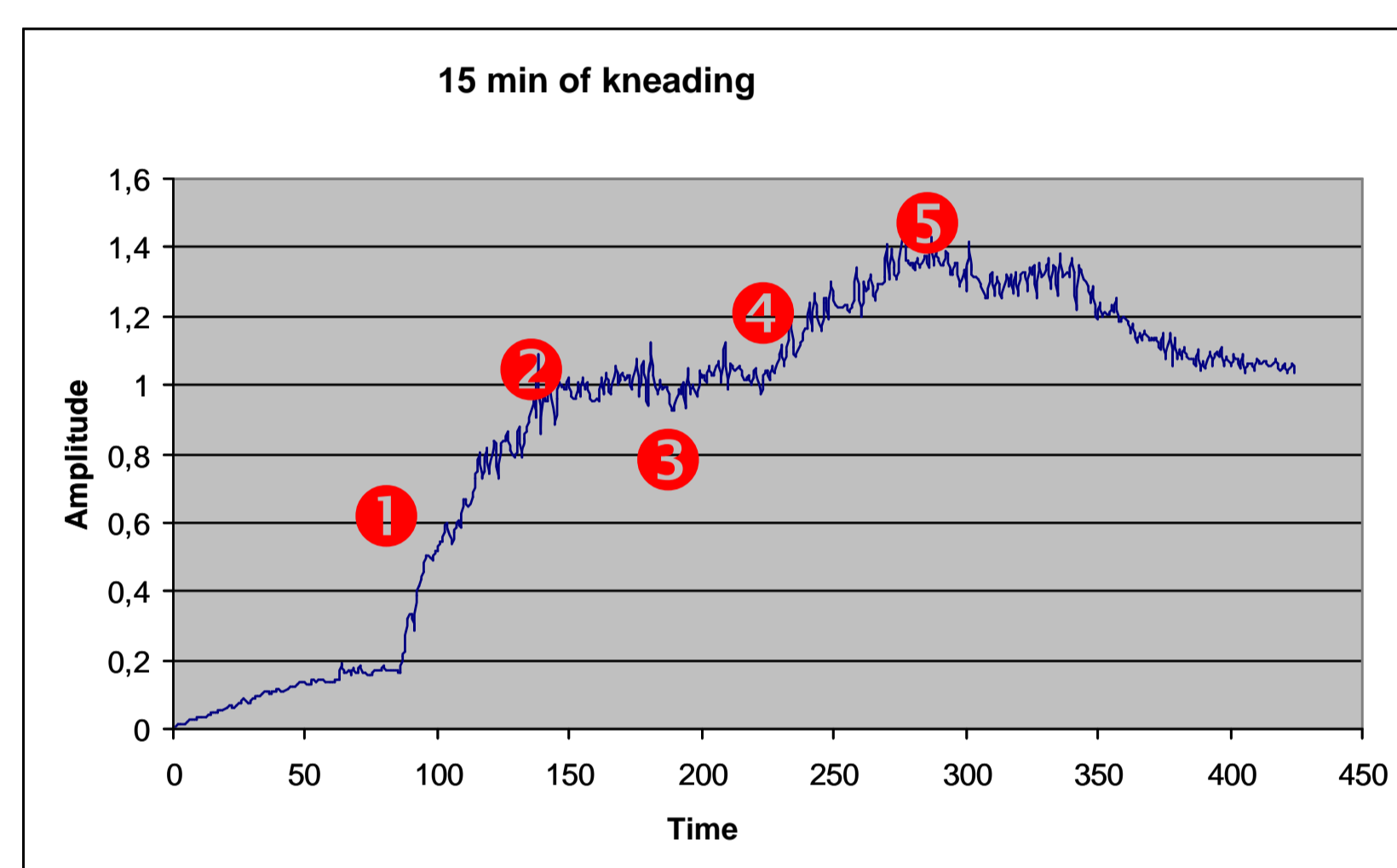
1. Selecting the most appropriate technology for real time characterization of strongly absorbing and viscoelastic media.
2. Validate stability and reproducibility of measurements
 - Reliability, terms of use (measure robustness)
 - Sensitivity of measurements by type of ingredient
 - Sensitivity of measurements by charge and size of machines
 - Industrialization

For each try, the dough is prepared as per the following instructions using a laboratory spiral mixer (SPI10):

- 2000g of baking flour consisting of a temperature lower than 20C
- 1200g of water consisting of a temperature of 15C
- 40g of pure salt added 3 minutes before the end of the 9 minute cycle of which the first three minutes are processed at a low speed

Results

The setting, inside the mixer bowl, of sensors measuring consistency of the dough every 2 seconds, allows recording of a signal that we represent here within as a typical evolution:



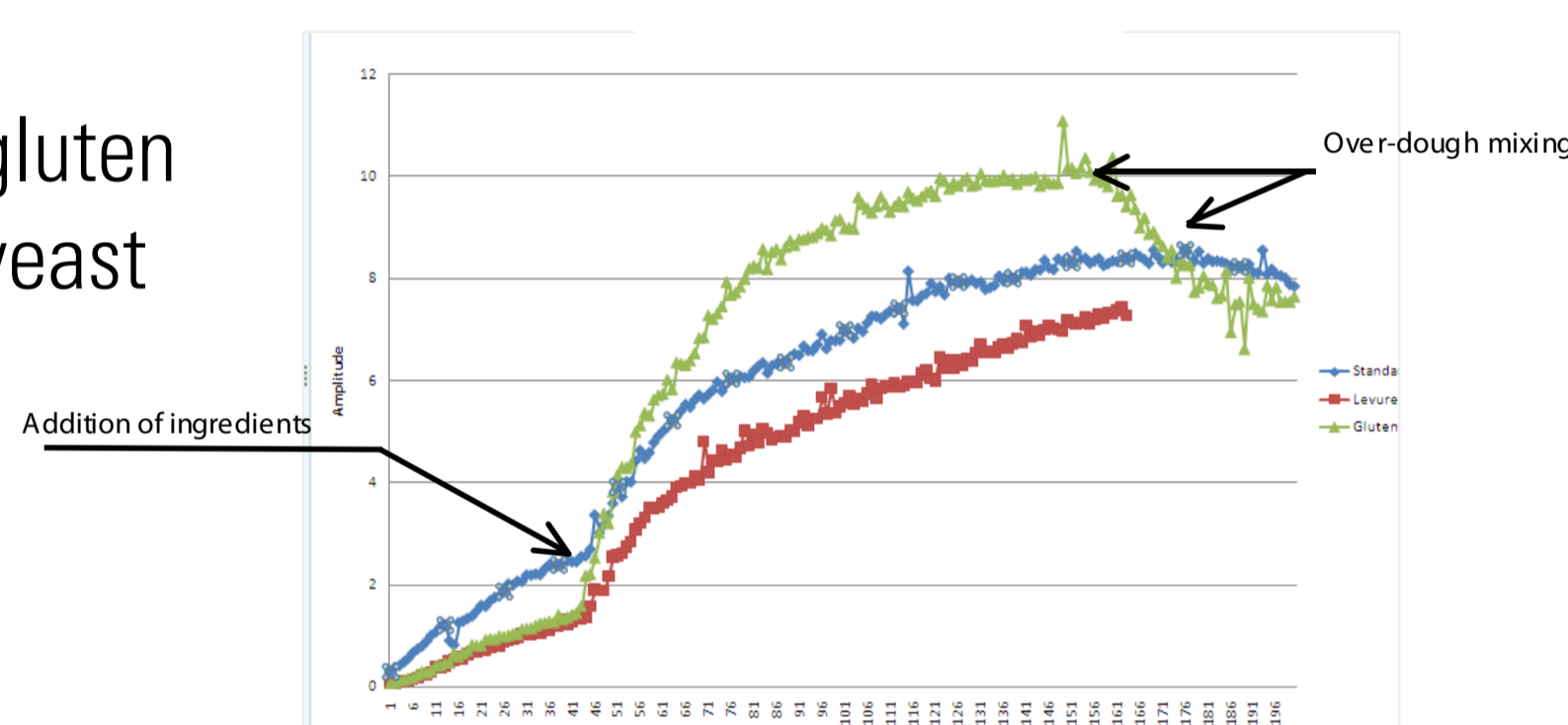
Recordings obtained reflect the baker's empirical knowledge, also well characterized by other research based on energy measurements –or rheological:

- ① - Gaining "force" (elasticity)
- ② - Stop before adding salt
- ③ - Decrease of elasticity after addition of salt
- ④ - New slope due to the gain in force after addition of salt
- ⑤ - Peak-over-dough mixing

Influence of ingredients

In order to validate our method of real time characterization, we made several measurements on dough varying in consistency.

- With added gluten
- With added yeast
- No addition



The results obtained exemplify the phenomena observed and expected for a long time and demonstrate the relevance of our measurement technology:

- the addition of gluten led to a faster and more intense gain of speed, and a higher level of protein
- pitching yeast lessens the gain of force , because of a higher level of moistness

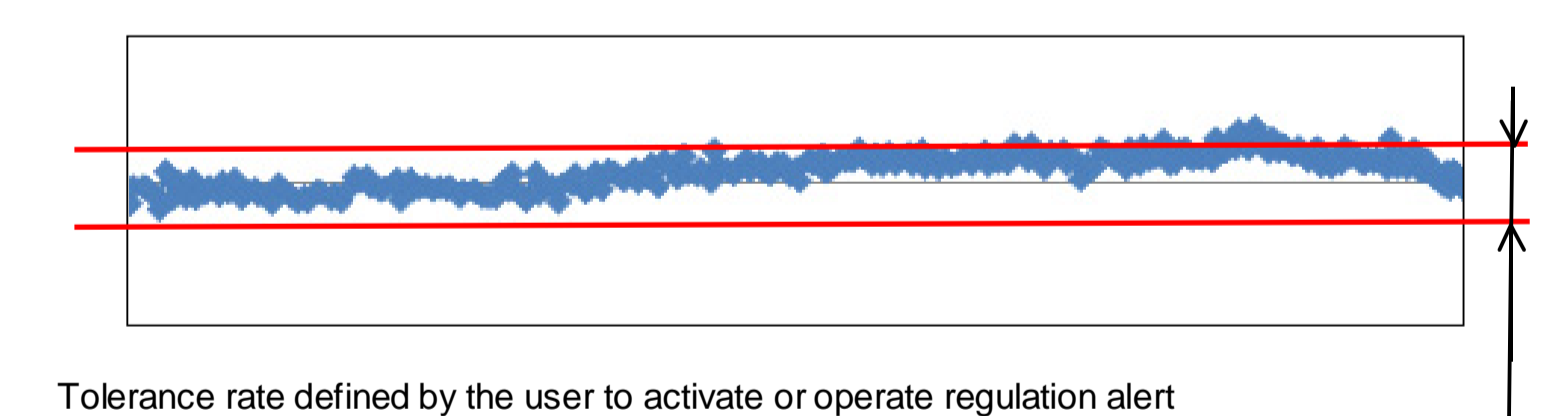
The control of dough mixing

This technology of characterization in real time gives the user several possibilities

Continuous dough mixing (steady state characterized of established dough output from the mixer)

2 levels of control are possible:

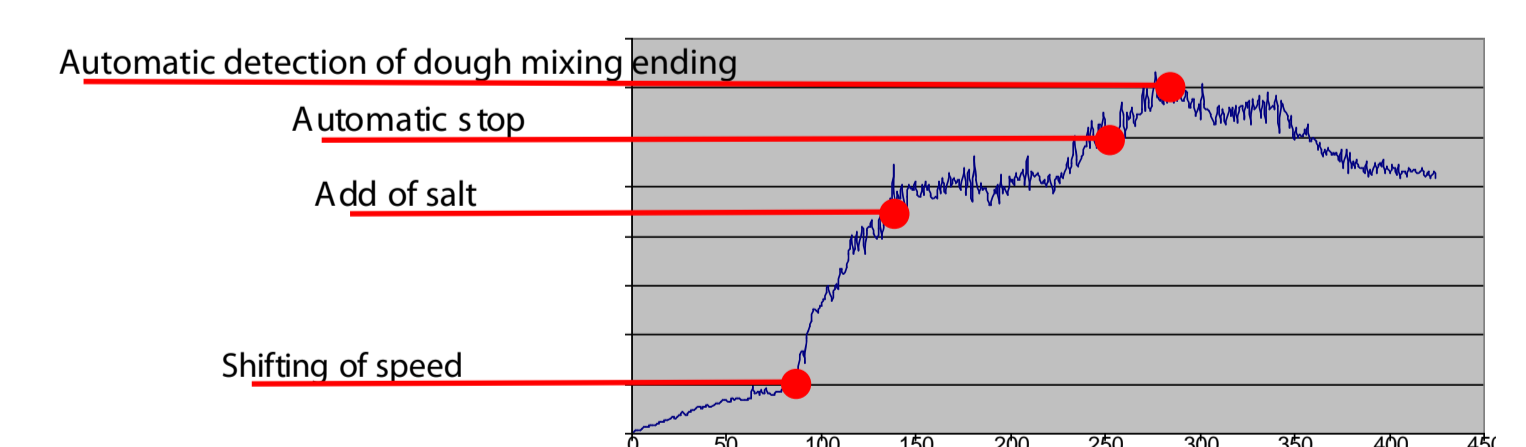
1. **Alert** of production tracking for manual adjustments of mixer settings
2. **Regulation** to ensure consistent quality by automatically adjusting the dough mixing settings



Dough mixing in batches (dough in a characterized phase in the tank)

3 levels of control are possible:

1. **Control of reproducibility** of successive batches by superposition of curves
2. **Detection of notable points** to assess the impact of dough mixing parameters (speed, time, ingredients, quantities, ...)
3. **Regulation** to ensure consistent quality by automatically adjusting settings related to dough mixing in function of changes in characteristics of ingredients



Conclusion

1. The signal obtained by a sensor with appropriate characteristics and carefully integrated in the bowl of mixers, allows a reliable reading of changes in dough consistency during dough mixing

2. It's implementation thus provides a means of real-time measurement in the progress of mixing, free from various parameters not directly related to the state of the dough.

3. This temporal extent, relatively stable, and obtained almost instantly, allows digital processing permitting dough mixing operations:

1. Through alerts to the user
2. By comparing successive productions
3. By detection of thresholds that trigger adjustment of parameters.

More detailed information on www.vmi.fr

