

NIR spectroscopy for automated grain analyzers

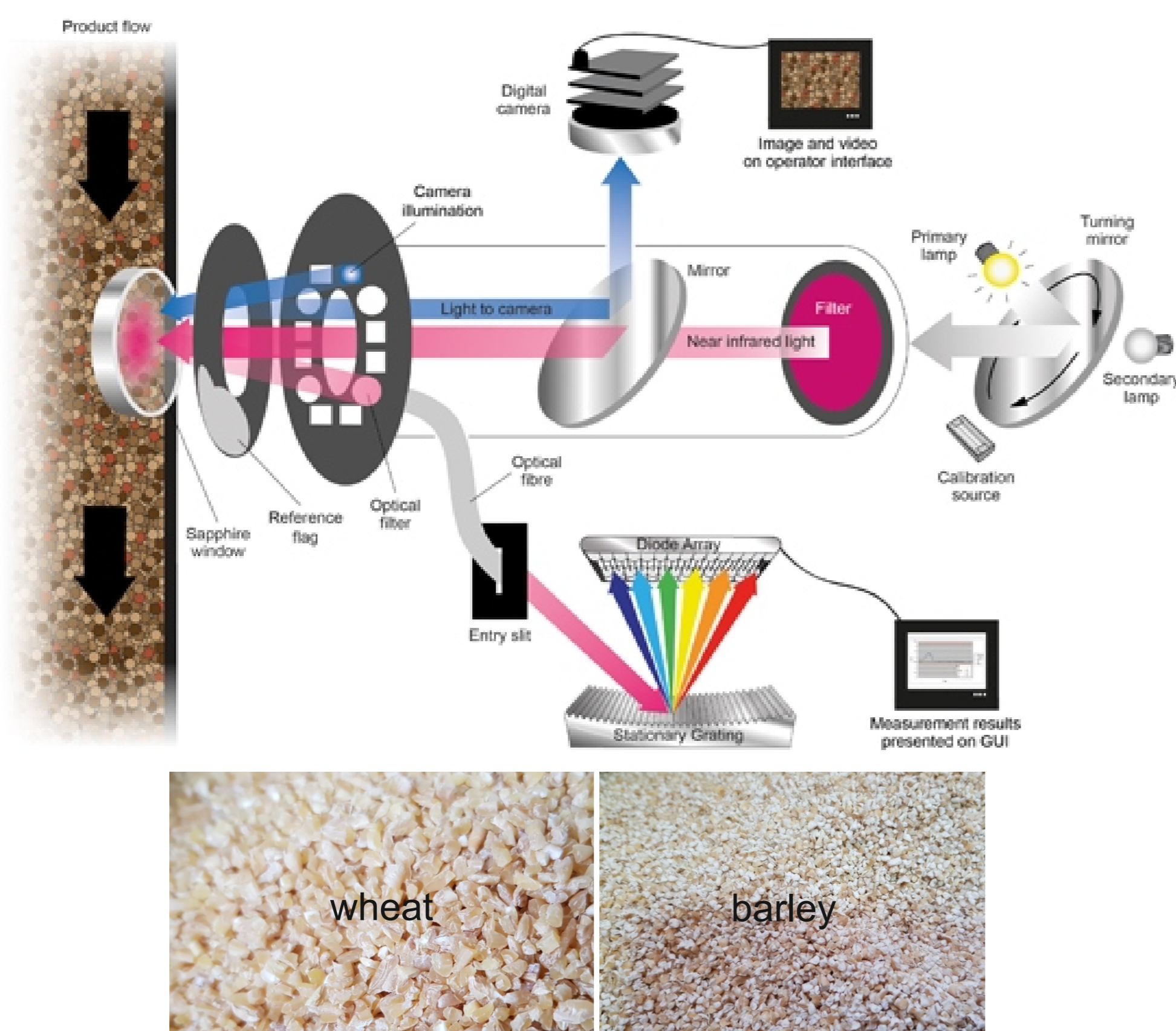
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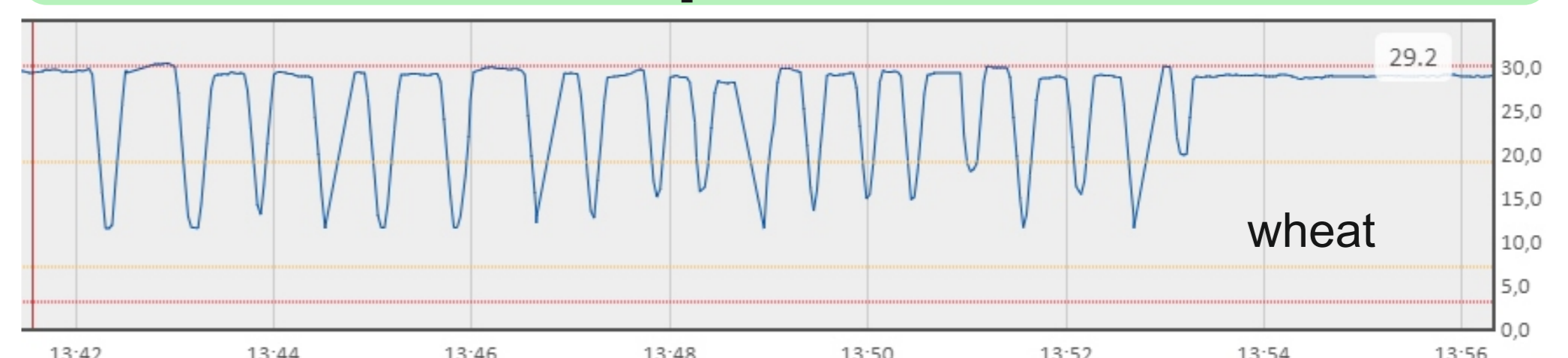
SUMMARY

Today, enterprises of the feed mill industry suffer enormous losses due to a significant shortage of enterprise management systems. As a result of this deficiency in aggregate, only Ukrainian enterprises annually lose an equivalent of \$40 million. The basis of the problem is that the automatic control systems operating at the enterprises of the feed mill industry, both in Ukraine and in the World, do not use the data of technical and chemical control. At the same time, almost at every enterprise there is a full-fledged laboratory with the most modern equipment, however, the data that laboratory employees receive are simply recorded later in the relevant journals. Sampling gets into the laboratories with too much time delay and the ultra-precise data obtained is simply not relevant. Each truck that enters the territory of the enterprise with raw materials is subject to inspection – mandatory sampling with special cranes in the amount of 3 to 4 kg. However, it should be borne in mind that all the data obtained as a result of such analyzes characterize the state of raw materials from different production sites with a period of limitation of 2 hours and in no way take part in the correction of algorithms of automatic control systems. Among other things, such an approach to the organization of techno-chemical control assumes the presence of full-fledged multispectral analyzers in the laboratories of each enterprise. If this is not about a single plant, but about a whole holding that unites a multitude of enterprises, then this requires very large investments, and an investment to obtain data that is then not used in any way in the automatic control systems of the enterprise. Even with the organization of the use of these data – the time of their relevance, as mentioned earlier, is up to 120 minutes. It should be noted that the nominal capacity of large feed mills today is on average up to 30 tons per hour per line, and on average each such enterprise has about three lines in one location. A simple line of just 60 minutes as a result of an emergency stop costs business owners \$6 thousand. Existing stream analyzers use the same technology as stationary modern multispectral analyzers and, accordingly, are very expensive (about 80 thousand dollars). Investments of this kind are simply impossible and therefore often set at best one or two such stream analyzers, which of course cannot provide a relevant understanding of the processes occurring at the enterprise and reflects information about the processes running only at its key sites. However, portable spectral analyzers are now appearing that perform analyzes directly from the device using artificial intelligence, but are not connected with any communication channels to professional stationary analyzers.

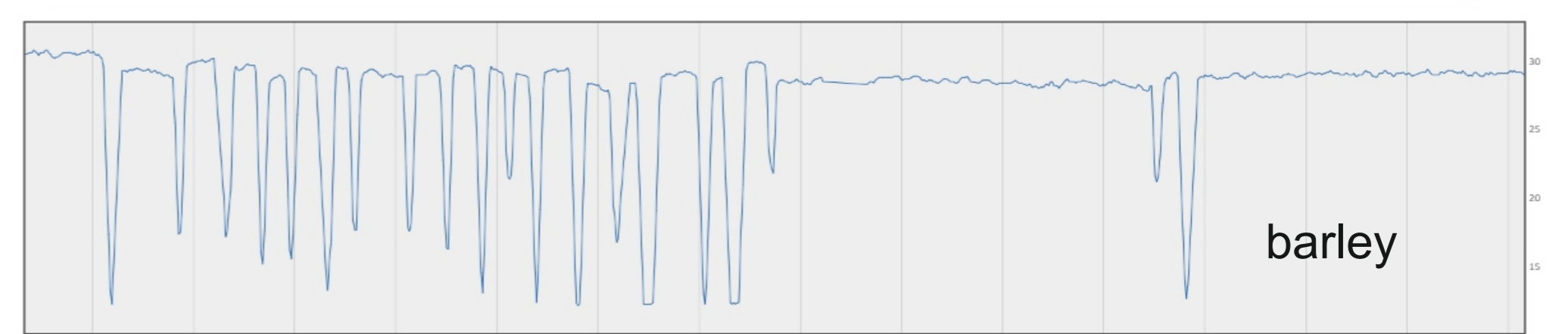
Lab setup and grain samples



Measurement process and results



Parameter	Average	SD	Min	Max	Range
Protein Asls	-25,05	13,02	-34,5	12,4	46,9
Gluten Asls	-103,96	46,38	-137,3	28	165,3
Moisture	26,28	5,23	11,4	30	18,6



Parameter	Average	SD	Min	Max	Range
Protein Asls	-32,23	0,41	-33,2	-31,5	1,7
Gluten Asls	-125,24	2,54	-129,6	-119,9	9,7
Moisture	29,14	0,23	28,6	29,9	1,2

CONCLUSIONS

The above solution is a reflection of simultaneously two technologies of the industry 4.0, namely Internet of Things (IoT – each individual sampler is connected to the Internet and merges with it the necessary information) and Big Data, as the result of the computing cloud is the image of many data that in turn needs to be analyzed. As we know, the modern Big Data solution consists of several blocks that require the joint work of teams with different competencies and the integration of the set of Open – and software components:

1. A technical solution for collecting, storing and processing

large volumes of data marked on the schematic as Big Data Tools. This solution is usually based on the Hadoop stack, because it represents a good balance between cost, reliability and functionality.

2. Advanced analysis of data using data science (Data Science) and algorithms of machine learning.

3. Visualization of large data, as well as creation of interactive reports for management of the company, employees and clients (Business Intelligence). The analytical platform used must be compatible with the Hadoop stack.