Since ancient times, people have had to store information in order to pass the acquired knowledge on to future generations. The methodology for storing information has developed significantly over the centuries. However, although the existing technological solutions for data storage are very advanced, they cannot keep up with the increasing number of bits. Currently, the amount of data generated is almost twice as large as the capacity of conventional media such as hard drives or flash memory devices, and the trend is growing rapidly. The disadvantage of commonly used hard drives is their limited stability. Every 10 years or so, data has to be copied onto a new medium. In addition, projections show that in 20 years, the annual demand for digital data storage will exceed the supply of silicon, assuming that all data will be stored in hard drive memory. Moreover, data center maintenance requires enormous amounts of energy. In short, we will soon have a serious data storage problem.

How to save all world data in one kilogram of material? A material that does not require energy to store data and the readout speed of information comparable to that of hard drives. POLYDIGIT offers an interesting solution (Fig. 1)

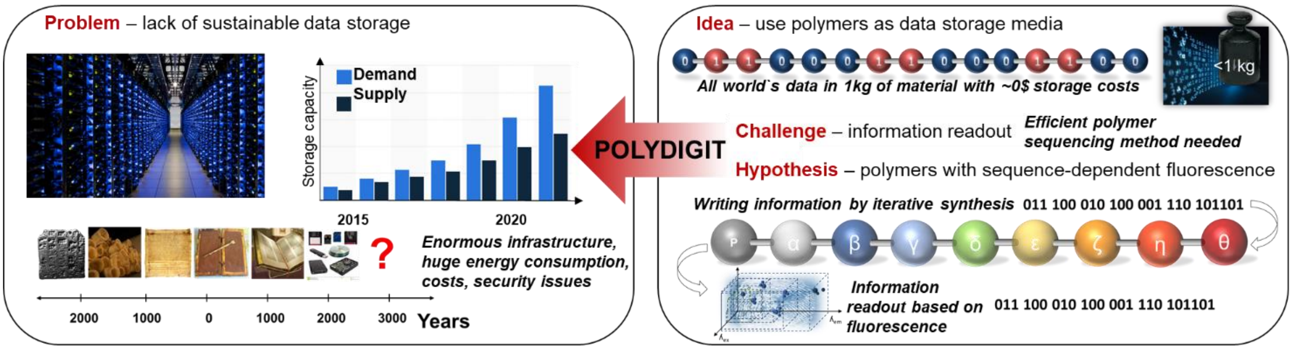

Fig. 1. The project aims to develop a new class of fluorescent polymers as a new generation of data carriers.

The nature uses DNA for data storage - natural polymers made of nucleotides that contain all the information necessary for the proliferation of living organisms. Defined Sequence Polymers (SDPs) offer a stable, resource-efficient, energy-efficient, and sustainable data storage solution. The properties of synthetic polymers can be precisely modulated and adapted to the requirements. The characteristics of the polymer can be fine-tuned by selecting appropriate building blocks from a wide library of synthetic monomers. Modern, advanced nanosynthesis methods allow materials to be easily produced with the precision of monolayers. Macromolecules can be sequentially arranged in a small volume and used as high-capacity data storage materials. Currently, the challenge is to read the information stored in digital polymers easily and quickly. The lack of convenient methods for reading information using non-destructive techniques prevents the development of new data storage materials based on synthetic polymers.

The project aims to study fluorescent polymer materials for their usefulness for storing data and reading information encoded in the monomer sequence based on the fluorescence pattern. In the project, monomers containing fluorescent dyes will be programmed and used to record digital information in macromolecular chains using automated iterative synthesis. The information will be encoded in the fluorescent properties of the polymer, which are sequence-dependent. Various fluorescence effects such as energy transfer, emission quenching, emission shift, emission enhancement, and excimer formation will be applied to ensure sequence dependency of properties. The obtained data will be used to create artificial intelligence. The evaluation of fluorescence as a method of reading information encoded in macromolecules will be performed using artificial intelligence tools.

The project will fill a gap in fundamental knowledge about sequence-dependent properties of fluorescent polymers. Currently, no data are available on the behavior and properties of multi-fluorophore-containing fluorescent macromolecules, at least eight different, for which a huge network of interactions is possible and predicted, e.g. multi-stage energy transfers. The project will provide data on possible communication between monomers and investigate how they affect fluorescence properties, including sequence-property relationships. POLYDIGIT is the first step to prove the concept of a new data storage technology based on reading information encoded in fluorescent polymers, which can be further developed and commercialized.