The Centre of Plant Structural and Functional Genomics

We study nuclear genomes to support crop breeding

Who we are

The Institute of Experimental Botany
of the Academy of Sciences of the Czech Republic

- Established in 1962
- Headquarters in Prague
- Director: Dr. Martin Vágner
- Staff: ~200 (FTE)
- Fundamental research in plant genetics, physiology and biotechnology
- 14 research laboratories and centers (some located outside Prague)

Our research centre

Centre of Plant Structural and Functional Genomics
Institute of Experimental Botany AS CR

C. R. HANÁ

Centre of the Region Haná for Biotechnological and Agricultural Research (EU-funded project)

Four main research directions

One main goal: to understand the structure, evolution and function of plant genomes

Delivering a knowledge and molecular resources to facilitate breeding improved crops

Important crops and models:

- Triticeae cereals (wheat, barley, rye, their hybrids and wild relatives)
- Forage and amenity grasses (fescue, ryegrass and their hybrids)
- Bananas (polyploid and hybrid clones)
- Arabidopsis (chromatin structure and DNA repair)

Eight research groups

- **Jan Bartoš**
  - The evolution and biology of supernumerary B chromosomes
- **Petr Cápal**
  - Novel approaches to facilitate the analysis of complex genomes
- **Eva Hřibová**
  - Genome organization
- **David Kopecký**
  - Genome composition
- **Aleš Pečinka**
  - Chromatin in develop
- **Jan Šafář**
  - Flowering time in wh
- **Hana Šimková**
  - Three-dimensional organization of the cereal genomes
- **Miroslav Valárik**
  - Powdery mildew resistance genes incl. host pathogen interactions

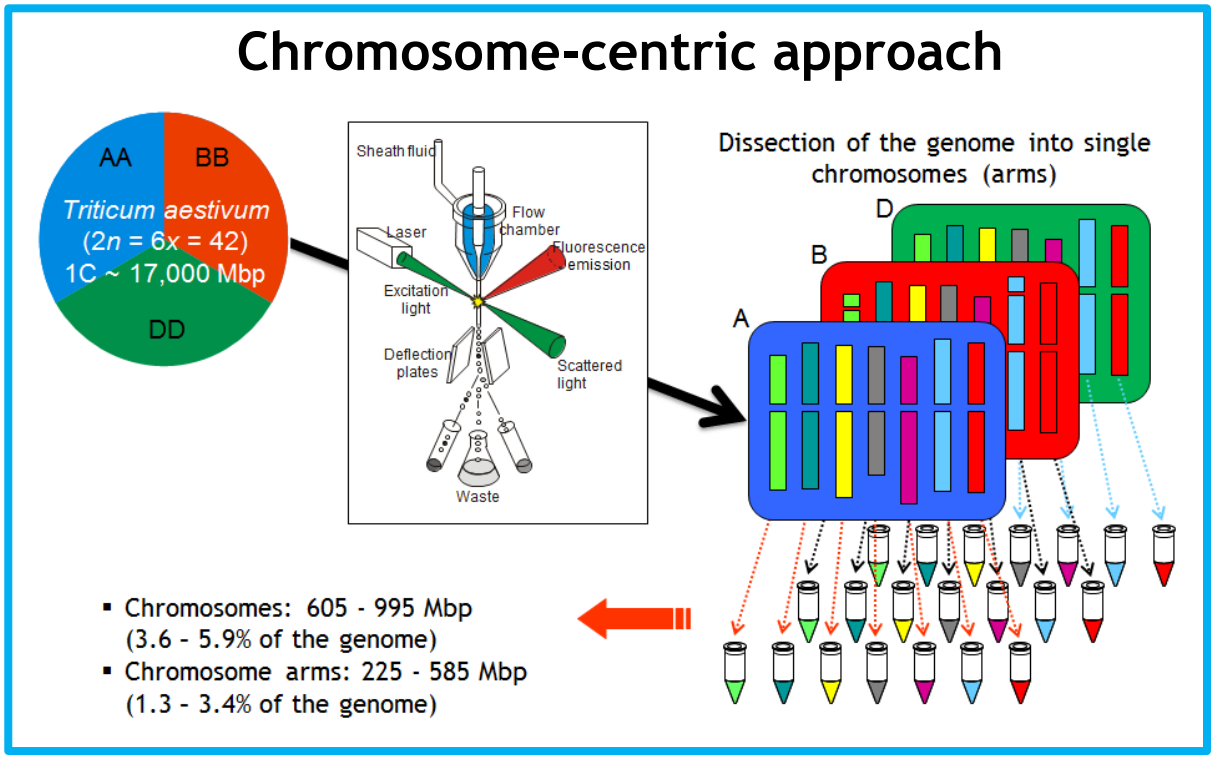
Staff overview

- Researchers and postdocs: 30
- Research assistants: 3
- PhD students: 15
- Laboratory technical staff: 7
- Technical support staff: 14
- BSc. students: 6
- MSc. students: 14

Multidisciplinary experimental approaches

Nuclear genome is not made from a single DNA molecule and is divided into separate chromosomes

- Flow cytometric analysis and sorting
- Molecular cytogenetics and 3D microscopy
- Genetics
- Genomics
- Cell biology
- Proteomics



Sequencing facility

Technologies available:

- Sanger (ABI 96 capillary system)
- Illumina
- OxfordNanopore

Illumina platforms

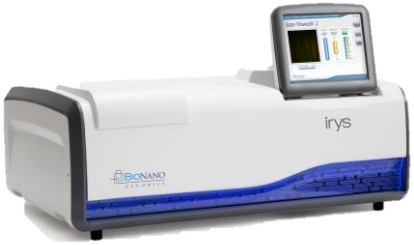
Platform	Max. no. of reads	Max. read length	Max. capacity
iSeq	$4x10^6$	2x150 bp	1.2 Gb
MiSeq	$25x10^6$	2x300 bp	15 Gb
NovaSeq6000	$10x10^9$	2x150 bp	3 000 Gb*

*Corresponds to ≈200x genome of bread wheat

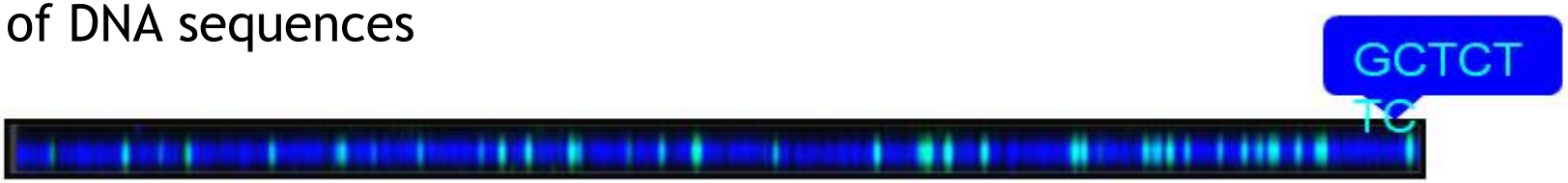
Optical mapping

Platforms available:

- Bionano Genomics IRYS: 100Gb
- Bionano Genomics SAPHYR: 3900Gb



- Mapping short sequence reads on long DNA molecules
- Optical maps show real order of DNA sequences



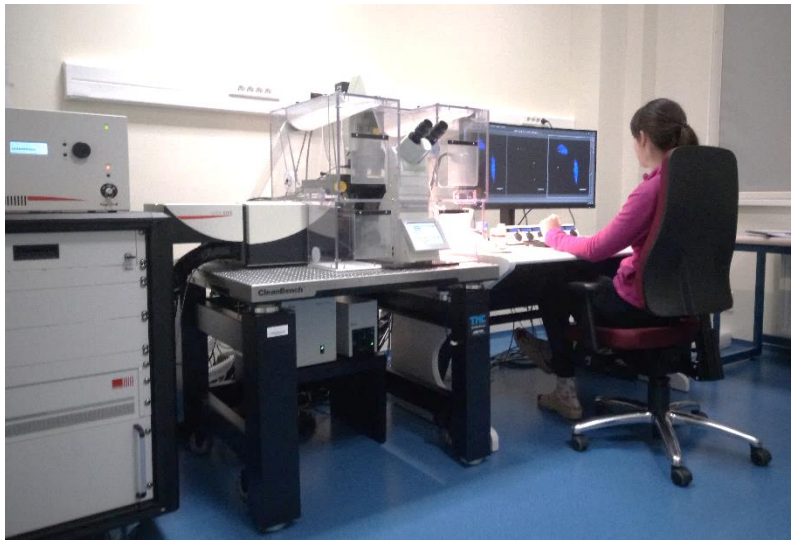
Applications:

- Supporting the assembly of genome sequences
- Characterization of structural variability after comparing two or more genomes

Super-resolution and 3D microscopy

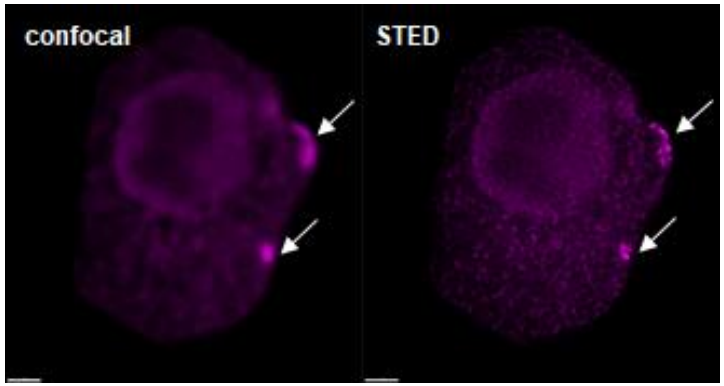
The instrument:

- Nanoscope Leica TCS SP8 STED (Stimulated emission depletion)
- Resolution: x,y: 60nm; z: 120nm



Applications:

- Analysis of chromatin structure and genome organization in 3D nuclear space

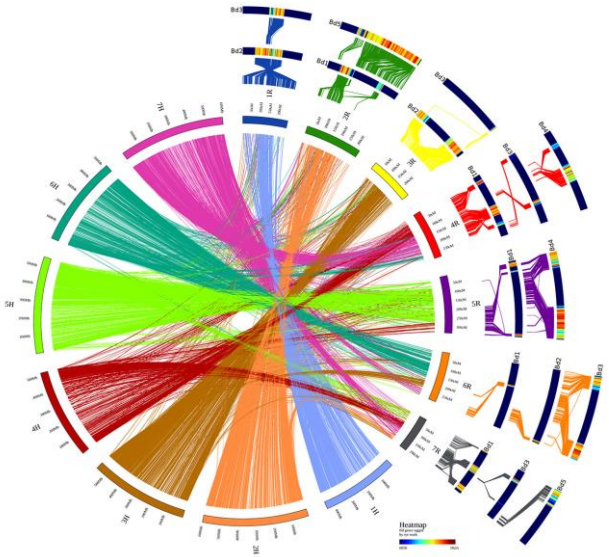


- Flow-sorted nuclei of barley
- FISH with centromeric DNA sequence (arrows)
- Centromeric DNA labeled by Aberrior STAR 635P
- Resolution x,y: 80 nm

Genomics of Triticeae

Research focus on:

- Genome sequences of cereals with large and complex genomes and their wild relatives
- Comparative genome analysis at chromosome level
- Targeted marker development and gene cloning



International partnerships:

- International Wheat Genome Sequencing Consortium (IWGSC)
- Barley Genome Sequencing Consortium
- Rye Genome Sequencing Consortium

Triticeae gene mapping and cloning

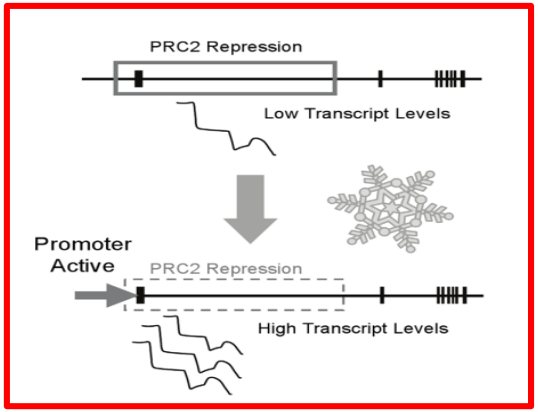
Flowering time in wheat

Photoperiod pathway

- Ppd-B1 copy number variation

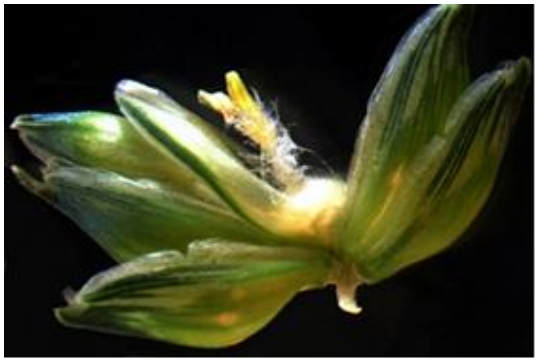
Vernalization pathway

- Characterization *Vrn-A1* alleles
- Molecular mechanisms of vernalization



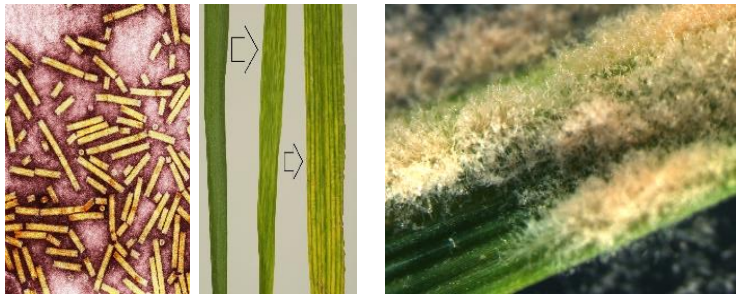
Mapping of agronomic traits

- Resistance (powdery mildew)
- Yield (seed size and shape)
- Quality (gluten / celiac disease)



Gene cloning

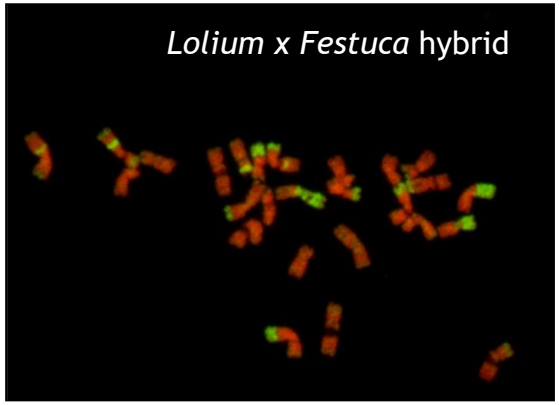
- Resistance genes, AVR genes
- Gene editing (CRISPR-Cas9)

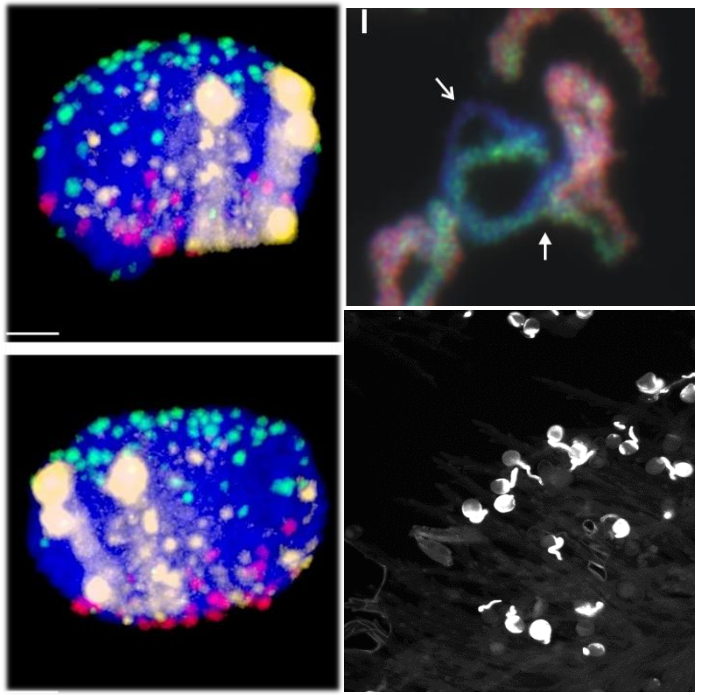


Genome structure and evolution in hybrids

Research focus on:

- Changes accompanying hybridization and polyploidization
- Stability of hybrid genomes
- Interactions of parental genomes in hybrids
- 3D architecture of hybrid nuclei





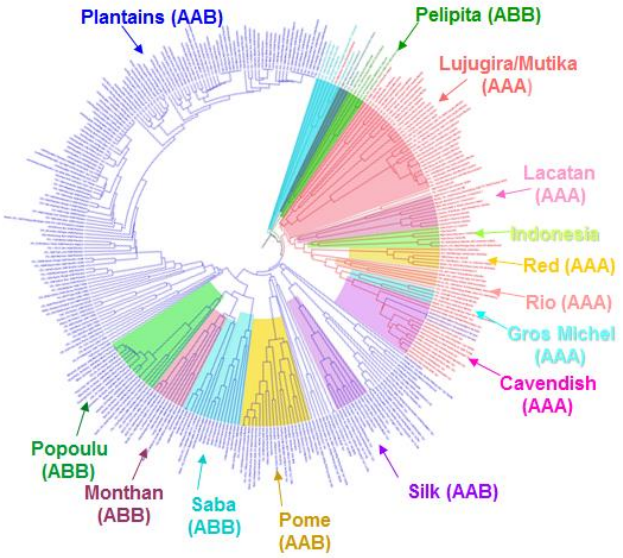
International partnerships:

- Collaboration with several breeding programs
- EUCARPIA
- Festulolium Working Group

Musa genome structure and evolution

Research focus on:

- Characterization of Musa genetic diversity (ploidy, genome size, SSRs)
- Molecular organization of chromosomes and karyotype evolution
- Genome sequencing
- Genomic prediction for breeding



International partnerships:

- Global Musa Genome Resource Center
- Global Musa Genotyping Center
- IITA project: Breeding Better Bananas

Triangle Mission

Bioversity International

musa genomics

PROMUSA

IITA Research to Nourish Africa

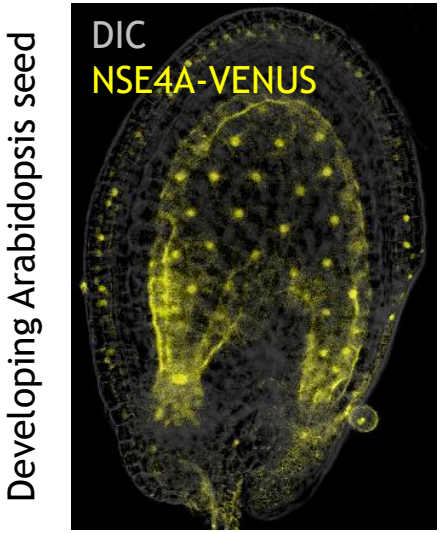
Role of chromatin in seed development

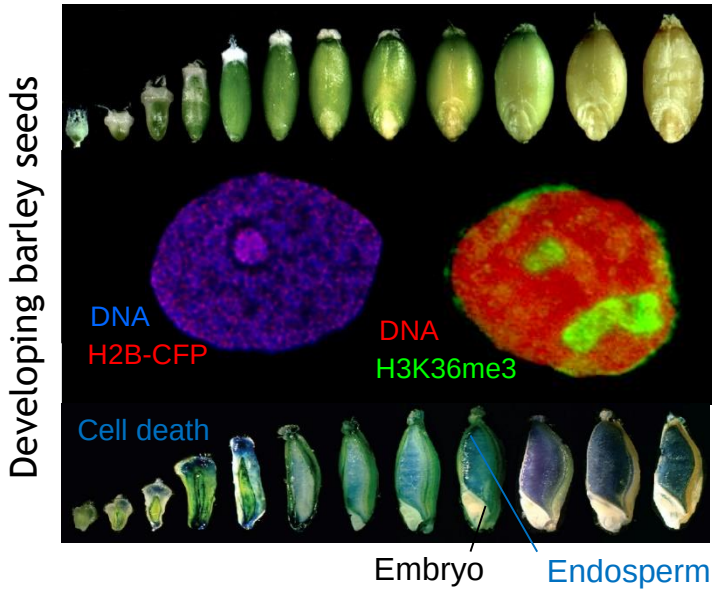
Research focus on:

- Chromatin changes during seed development in Arabidopsis and cereals
- Tissue specific gene expression
- Programmed cell death in endosperm development

International partnerships:

- IPK Gatersleben
- COST Action: Impact of Nuclear Domains on Gene Expression and Plant Traits





Aplied Laboratory for Agricultural Research

Web: aplab.olomouc.ueb.cas.cz
E-mail: aplab.olomouc@ueb.cas.cz

APLIKAČNÍ LABORATOŘ
pro zemědělský výzkum
Ústavu experimentální botaniky AV ČR, v. v. i. v Olomouci

Akademie věd České republiky
Strategie AV21
Špičkový výzkum ve veřejném zájmu

Děkuji vám za pozornost!