NGS Based Applications – Future of Genomics

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NGS Applications – Basic Science

- Ancient DNA
- DNA mixtures from diverse ecosystems, metagenomics
- Resequencing previously published reference strains
- Identification of all mutations in an organism
- Errors in published literature
- Expand the number of available genomes
- Comparative studies

NGS Applications – Basic Science

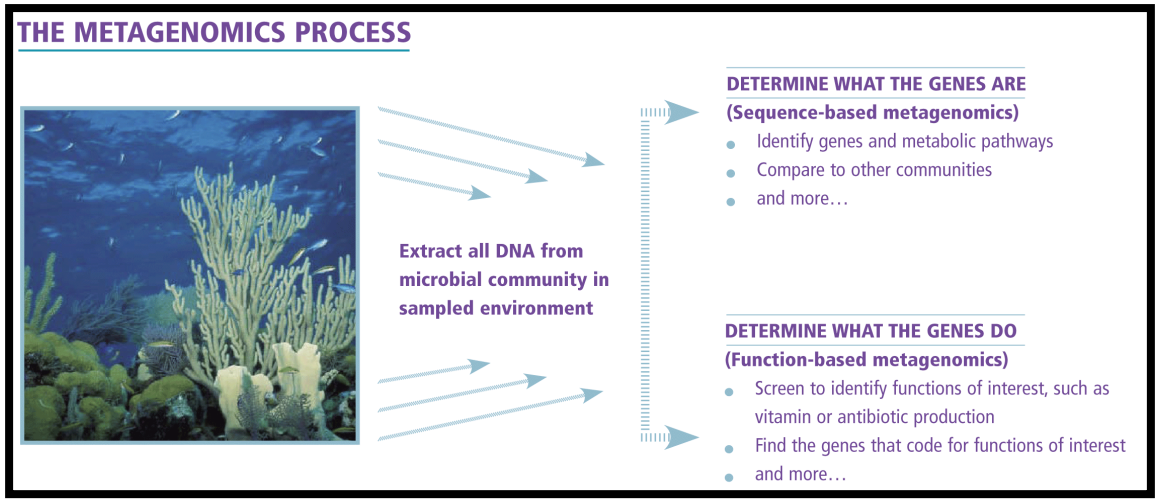
- Deciphering cell's transcripts at sequence level without knowledge of the genome sequence
- Sequencing extremely large genomes, crop plants
- Detection of cancer specific alleles avoiding traditional cloning
- Chip-seq: interactions protein-DNA
- Epigenomics
- Detecting ncRNA
- Genetic human variation : SNP, CNV (deseases)

NGS applications – Microbial Genomics

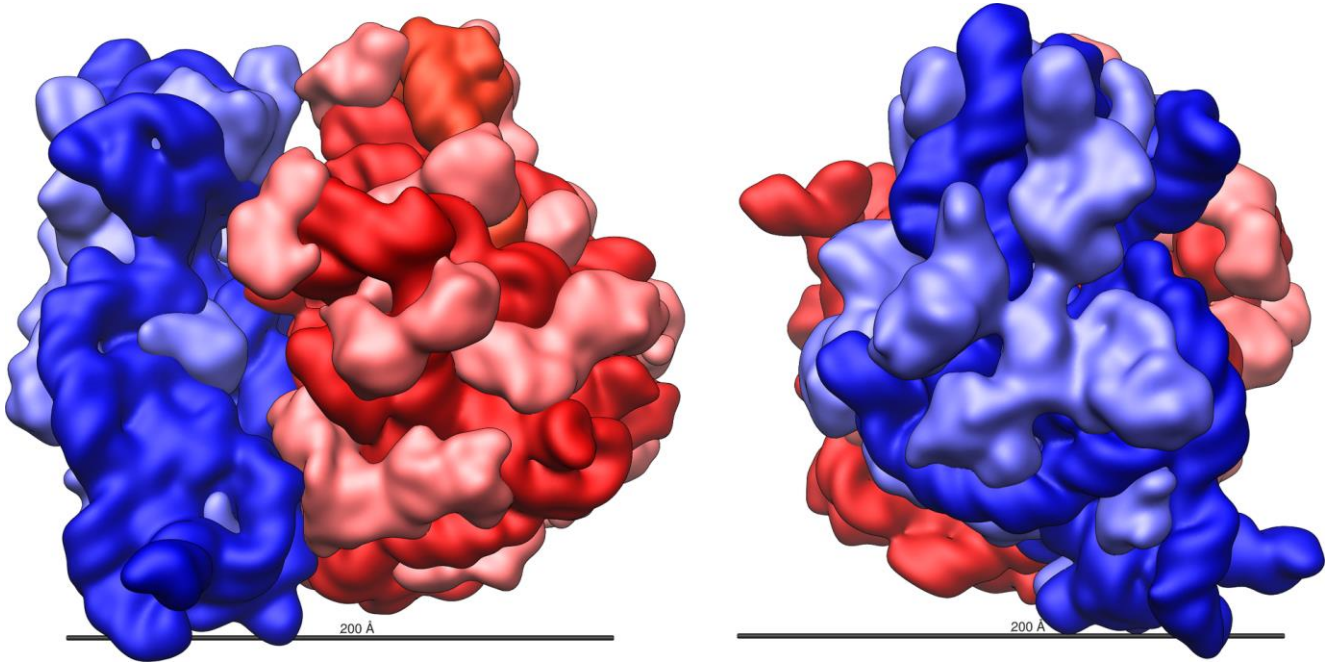
- rapidly detect and treat pathogens (disease-causing microbes) in clinical practice
- develop new energy sources (bio fuels)
- monitor environments to detect pollutants
- protect citizenry from biological and chemical warfare
- clean up toxic waste safely and efficiently

NGS applications – Metagenomics

- Characterizing the biodiversity found on Earth
- The growing number of sequenced genomes enables us to interpret partial sequences obtained by direct sampling of specif environmental niches
- Examples: ocean, acid mine site, soil, coral reefs, human microbiome which may vary according to the health status of the individual



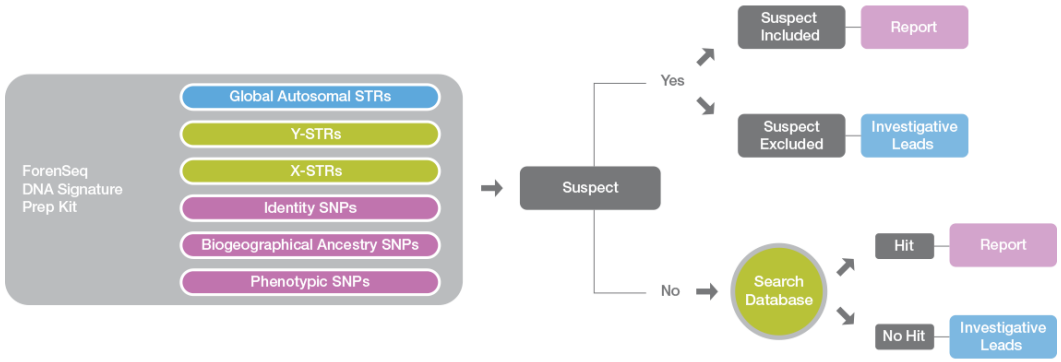
NGS applications – 16S RNA Metagenomics



ribosomal ribonucleic acid (rRNA) is the RNA component of the ribosome, and is essential for protein synthesis in all living organisms

Three-dimensional views of the ribosome, showing rRNA in dark blue (small subunit) and dark red (large subunit). Lighter colors represent ribosomal proteins.

NGS applications – Forensics - MiSeq FGx

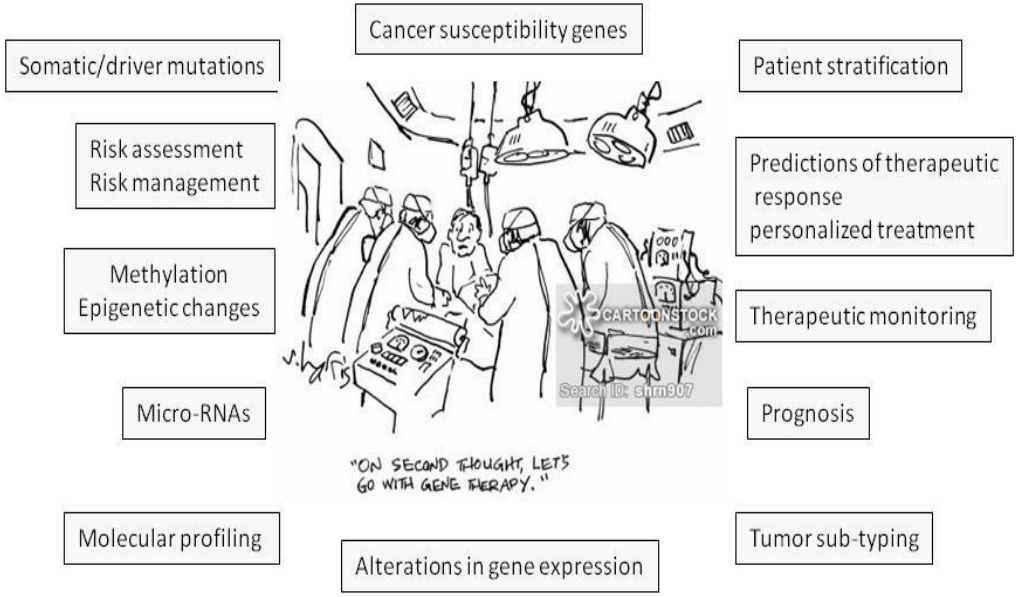


NGS can provide more information than traditional methods. Using the MiSeq FGx System DNA database laboratories can:
Simultaneously analyze every locus now in use by crime laboratories around the world
Future-proof local, national, and international databases
Easily expand sequencing runs to include more markers
Benefit from minimal sample preparation time

NGS applications – Molecular Medicine

- improve diagnosis of disease
- detect genetic predispositions to disease
- create drugs based on molecular information
- use gene therapy and control systems as drugs
- design “custom drugs” (pharmacogenomics) based on individual genetic profiles

NGS applications – Clinical – MiSeq Dx



The MiSeqDx System, designed specifically for clinical laboratories, delivers a broad range of sequencing applications right at your fingertips. The flexible, scalable system offers tunable read lengths and output options to support diagnostics and research needs.

Groups of Genome - wide NGS Tests

1) Diagnostic tests: defining the cause of a rare disease or for identifying high-risk susceptibility for a specific disease

2) Tests for Mechanisms of diseases: e.g. examination of the genetic changes in a malignant tumor, Hematological Disorders, Neurology and Psychiatry, Vision and hearing, Cardiology as well as many undiagnosed Disease.

3) Pharmacogenomics: refers to the relation between the human genetic profile and individual differences in clinical drug response. The aim of pharmacogenomics is to optimize treatment outcome and individualize therapy.

4) Predicting susceptibility: genetic risk profiling for common diseases

Groups of Genome - wide NGS Tests

- **Analysis of Structural chromosomal variants using NGS**
  - structural variants in the Human Genomes
  - structural variants and Human Diseases
- **NGS in Oncology**
  - Familial Genetic Testing
  - Molecular calcifications of Diseases
  - Circulating cell free tumor DNA and circulating tumor cells
  - Treatment in last resort patients
  - Treatment monitoring
  - Biomarkers in Clinical decision-making
- **Next Generation Sequencing in hematological Disorders**
  - Acute Myeloid Leukemia
  - CSF3R mutation in chronic Neutrophilic Leukemia
  - Non-Hodgkin Lymphomas
  - Thrombocytopenia Absent Radius Syndrome

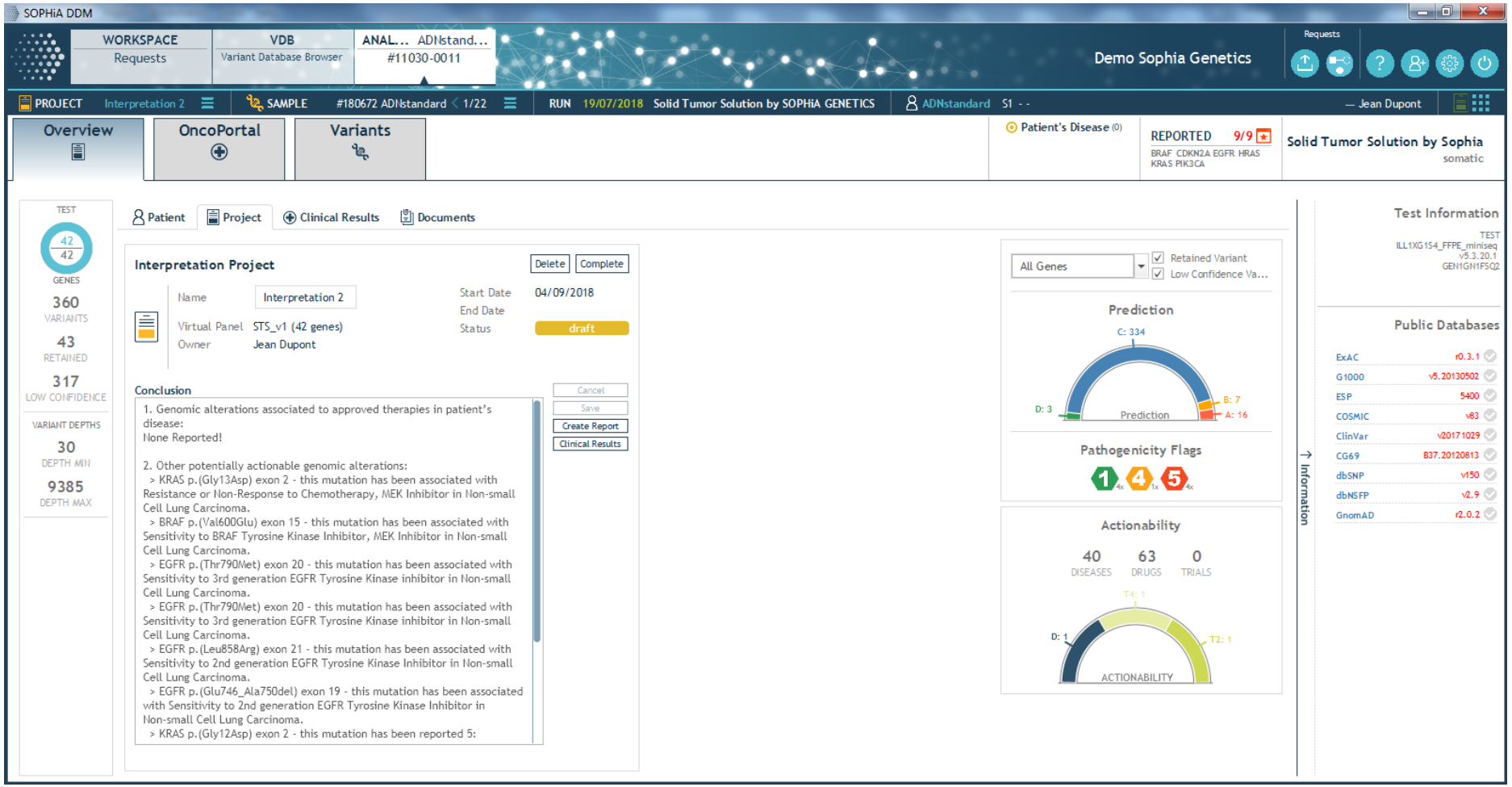
Groups of Genome - wide NGS Tests

- **Next Generation Sequencing in Neurology and Psychiatry**
  - Epilepsy
  - Ataxia
  - Autism
  - Neuromuscular Disorders
  - Movement Disorders
  - Neurodegenerative Disorders with Dementia
- **Next Generation Sequencing in Dysmorphology**
  - Congenital defects syndromes
  - Genetic testing in Dismorphology
  - Screening of Rare Disorders in Newborn
- **Next Generation Sequencing in Vision and Hearing Impariment**
  - Vision and hearing Disorders
  - Digenic and Oligogenic Inheritance

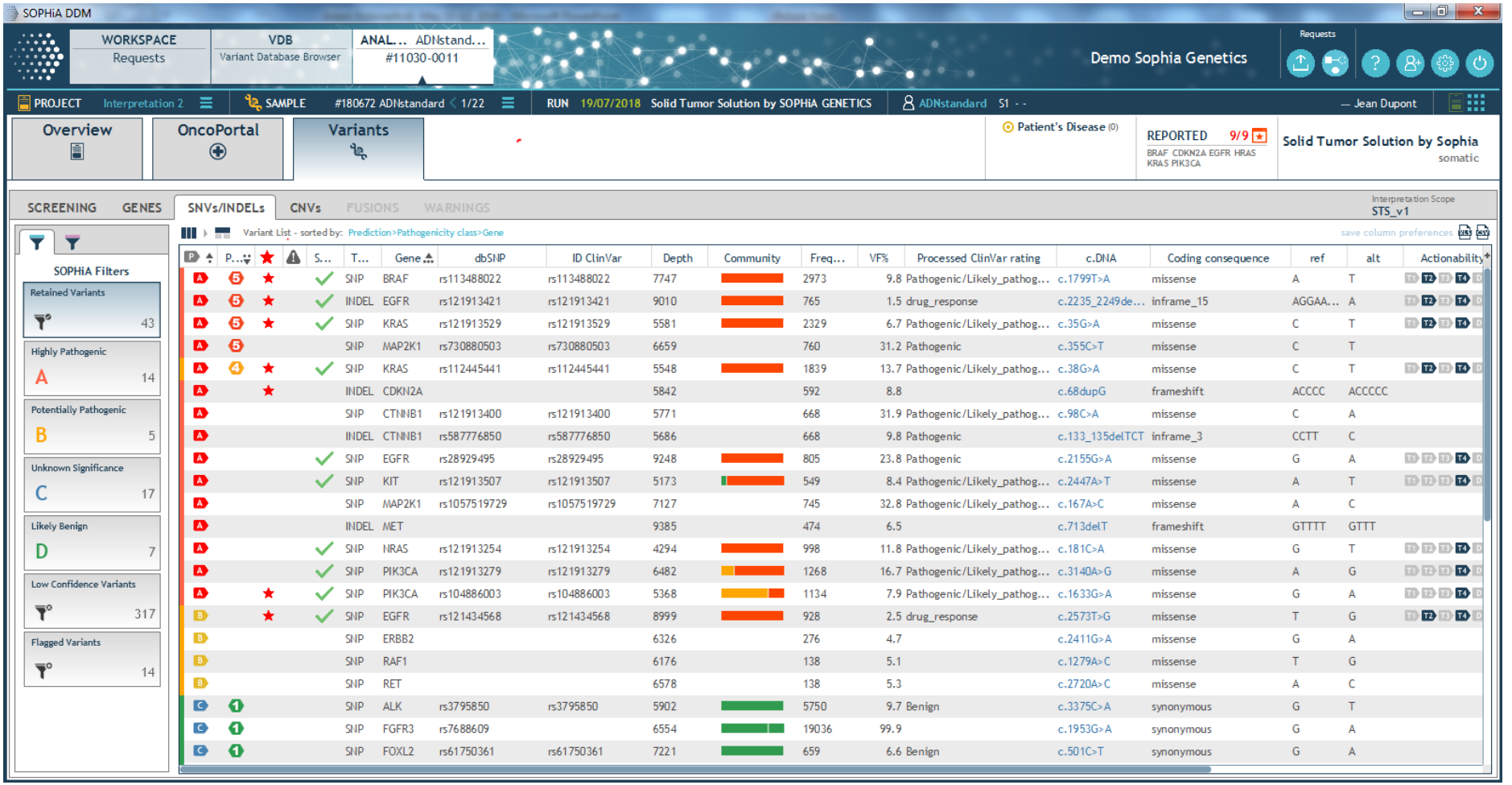
Groups of Genome - wide NGS Tests

- **Next Generation Sequencing as a tool for Noninvasive prenatal tests**
  - NGS of Fetal DNA
  - properties of cell free fetal DNA
  - Maternal – Fetal DNA comparative analysis
- **Next Generation Sequencing in Cardiology**
  - Cardiomyopathies
  - Hypertrophic Cardiomyopathies
  - Arrhythmias
  - Brugada Syndrome
  - Atrial Fibrillation
- **Next Generation Sequencing in Pharmacogenomics**
  - NGS in noncancerous pharmacokinetics
  - NGS in Transplantology
  - Multigene Pharmacogenetics
- **Next Generation Sequencing in Undiagnosed Diseases**
  - NGS testing for Rare Disease
  - pathogenetics

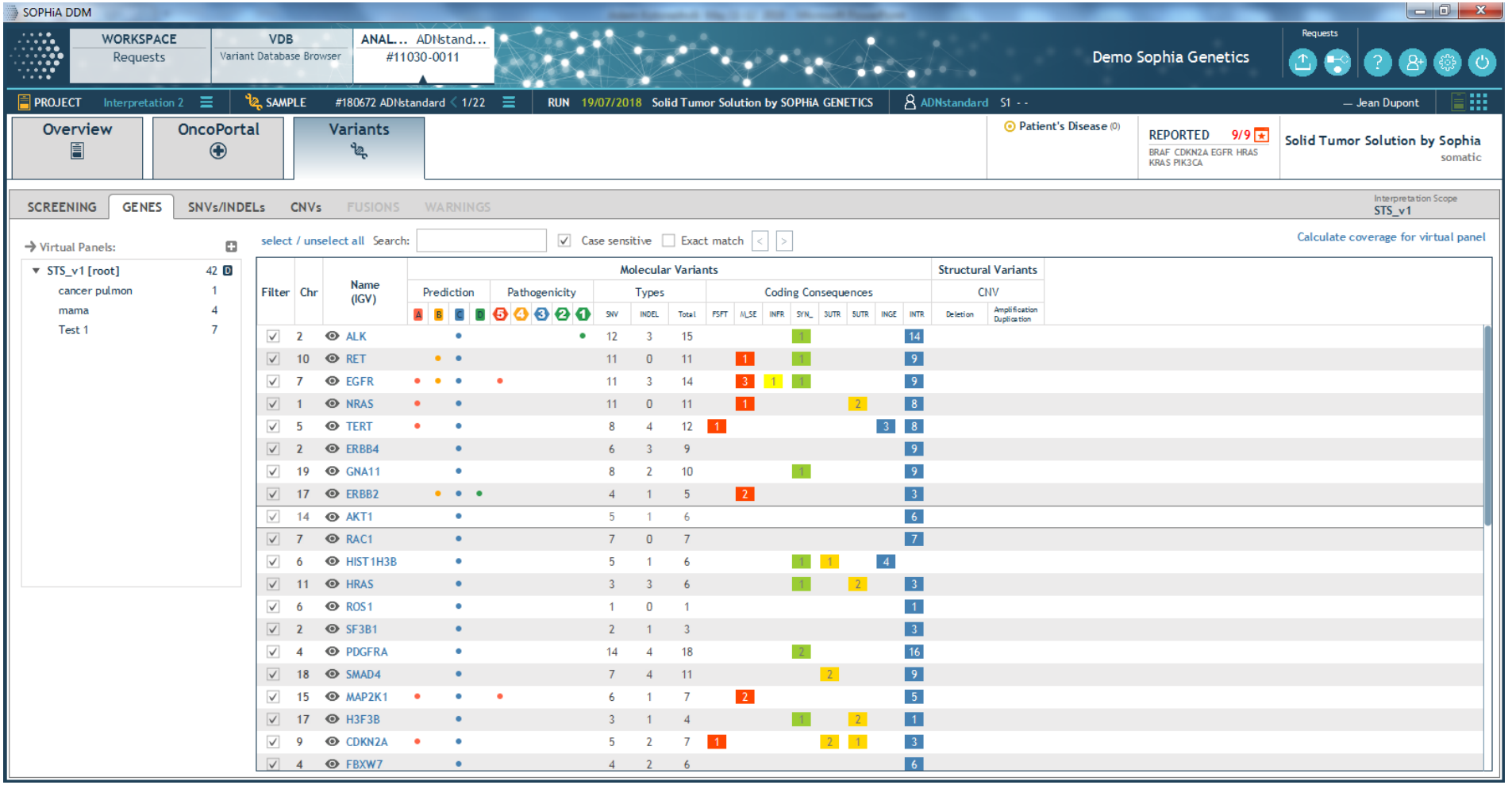
SOPHiA Genetics – Overview



SOPHiA Genetics – Overview



SOPHiA Genetics – Overview



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☑	10	RET	11	0	11		1		1				9
☑	7	EGFR	11	3	14		3	1	1				9
☑	1	NRAS	11	0	11		1				2		8
☑	5	TERT	8	4	12	1						3	8
☑	2	ERBB4	6	3	9								9
☑	19	GNA11	8	2	10				1				9
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☑	14	AKT1	5	1	6								6
☑	7	RAC1	7	0	7								7
☑	6	HIST1H3B	5	1	6				1	1		4	
☑	11	HRAS	3	3	6				1		2		3
☑	6	ROS1	1	0	1								1
☑	2	SF3B1	2	1	3								3
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☑	15	MAP2K1	6	1	7		2						5
☑	17	H3F3B	3	1	4				1		2		1
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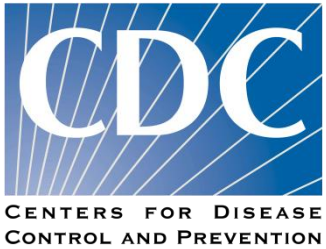
☑	4	FBXW7	4	2	6								6

Our Collaborators

(Incomplete list)



Genome Center at National Center for Disease Control and Public Health

Projects at Genome Center

1. Completed project with G. Eliava Phage Institute : "Comparative Whole Genome Sequencing of Diagnostic *Brucella* Phages" Project was funded by DTRA, Manuscript is published
2. Completed project with Tbilisi Agrarian University : "Genetic characterization of mitochondrial DNA of Georgian wheat's varieties" funded by AgrUni internal grant foundation, manuscript published
3. Completed project with Biotechnology Institute of National Academy of Sciences of the Kyrgyz Republic: "Microbiological Monitoring of Uranium-Contaminated Environments" funded by ISTC
4. Completed project with G. Eliava Phage Institute: "Characterization of mechanisms of adaptive phage-host co-evolution using next generation sequencing and phenotypic profiling " funded by GRDF
5. Ongoing project with AIDS center "Genetic characteristic of hepatitis C virus in Georgia: implications for hepatitis C elimination program" Funded by CDC
6. Ongoing project G. Eliava Phage Institute: "Phage mediated antibiotic resistance gene transfer in marine, freshwater and extreme environments" funded by GRDF
7. Ongoing project with Batumi State University, Institute of Phytopathology "Whole Genome Sequencing of quarantine plant bacterial pathogen *Ralstonia Solanacearum* Isolated in Republic of Georgia" funded by GRDF and Rustaveli Foundation.

Thank you for your attention !