Hello everybody. My name is Irina Prosvirina and today I would like to talk about the synergetic air-breathing rocket engine – or shortly SABRE - which was worked out by a British company called “Reaction engines”. I’ve chosen this topic because some experts believe this engine to be the biggest breakthrough in propulsion since the Jet engine.

Well, to begin with, I would like to ask you: “What do you think is the most significant disadvantage of a launch vehicle?” … So the main disadvantage is that rockets are disposable. That’s the problem which could be solved be SABRE.

SABRE is essentially a rocket engine designed to power an aircraft directly into space, and in a different configuration to allow an aircraft to cruise at hypersonic speed within the atmosphere.

In the past, attempts to design single stage to orbit propulsion systems have been unsuccessful largely due to the weight of on-board oxidizer such as liquid oxygen, needed by conventional rocket engines. One possible solution is reducing the quantity of on-board oxidizer required by using oxygen already present in the atmosphere.

SABRE is the first engine to achieve this goal by operating in two rocket modes: initially in air-breathing mode and subsequently in conventional rocket mode.

I would like to play a video, so that you could understand the process clearly.

Here you can see the design of the engine itself. It’s extremely close to the conventional rocket engine except some differences which result from a synthesis of elements from rocket and gas turbine technology.

The main elements of SABRE are engine nozzles, injectors, compressors and pumps, compressor intake. These are typical parts of the traditional rocket engine. The difference is about the intake cone and precoolers which are considered the most complicated parts of the engine. I’ll speak about them in more detail a little bit later.

In the air-breathing mode the rocket engine sucks in atmospheric air as a source of oxygen to burn with its liquid hydrogen fuel in the rocket combustion chamber. And can you imagine that within this stage the air has to be cooled from over 1,000 °C to minus 150 °C in less than 1/100th of a second.

Then, when the atmospheric part of the trajectory is over, the intake cone closes and the engine switches over into the conventional rocket mode when both fuel and oxygen are consumed from the tanks on-board.

Now I would like to say a few words about the cooling system. The tremendous speed of cooling is reached by using a tiny helium-filled tube system.The impact that these miniaturized heat exchangers will have on aerospace propulsion systems is comparable to the impact of the silicon chip on computing: new products, new markets, new capabilities.

The video I would like to play shows in simplified form the complete SABRE cycle. Firstly, in the air-breathing mode, the air from the intake (blue) is shown going through the Pre-cooler and into the compressor. Then it divides into two flows: one goes into the pre-burner, another one – into the combustion chamber and nozzle itself. Another flow is liquid hydrogen from the on-board tank (red). It goes through the pump into the pre-burner. Then hot hydrogen with combustion products are injected into the nozzle.

The cooling is achieved with helium (green) that has been itself cooled by the liquid hydrogen fuel pump. Once it has left the Pre-cooler the helium is further heated in by the products of the Pre-burner to give it enough energy to drive the turbine and the liquid hydrogen pump.

In the rocket mode the hot hydrogen with combustion products provide all the energy needed to drive the liquid hydrogen and the liquid oxygen pump within the engine. Re-using heat in this way increases engine efficiency.

As the cycle video illustrates, the use of lightweight heat exchangers is the key technological innovation for SABRE engine development.

To sum up, I would like to repeat the core idea of SABRE. First of all, when SABRE is in the Earth's atmosphere the engine can use air to burn with hydrogen fuel, which gives an 8 fold improvement in fuel consumption and saves the aircraft from carrying over 250 tons of on-board oxidant. And this removes the necessity for massive throw-away first stages that are jettisoned discarded once the oxidant they contain has been used up, allowing the transition from single-use multi-stage launch vehicles to multi-use single stage launch vehicles such as SKYLON.