IVCHENKO-PROGRESS INNOVATIONS

FOR TURBOPROP ENGINES

Sergiy Dmytriyev
Department manager SE Ivchenko-Progress

5th Symposium on Collaboration in Aircraft Design

October 12th-14th, 2015, Naples

“SCIENTIFIC PRODUCTION ASSOCIATION “A. IVCHENKO” CORPORATION

corporation IVCHENKO®

YEAR OF CORPORATION ESTABLISHMENT - 2007

	1907 - Creation of Motor Sich JSC	1945 - Creation of Ivchenko-Progress SE
Sphere of activity	Development, production and overhaul of gas-turbine engines for civil and military aviation, industrial gas-turbine drives and power-generating plants, consumer goods.	
Structure	14 structural units located in different parts of Ukraine as well as in China, India, UAE, Algeria	one structural unit located in Zaporozhye
Number of employees	over 21 000	3 100

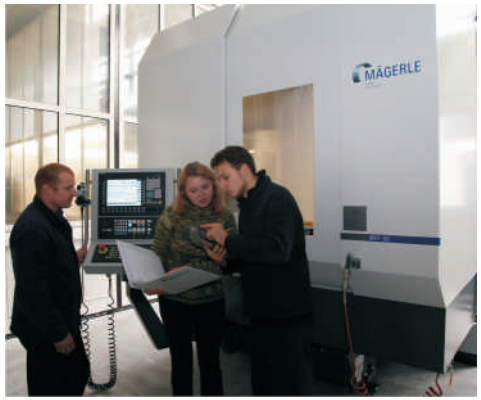
CORPORATION ‘SPA ‘A.IVCHENKO’ ON THE MAP

THE BASIC SPHERES OF ACTIVITIES

IVCHENKO PROGRESS

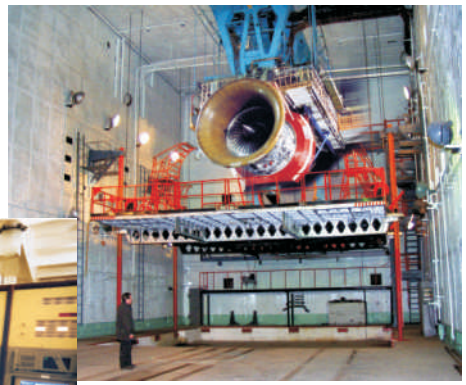
DESIGN

MANUFACTURE



OVERHAUL

TEST, DEVELOPMENT AND CERTIFICATION



PUTTING IN SERIES PRODUCTION AND IMPROVEMENT OF CONSUMER'S CHARACTERISTICS

DIRECTIONS OF ACTIVITY

IVCHENKO PROGRESS

CIVIL AVIATION: commercial helicopters and aircraft


MSB-2, Mi-2M

DA50-JP7


An-148/158


An-225

STATE AVIATION: trainers and combat trainers, multipurpose aircraft, military transport aircraft and helicopters


Yak-52-450


Mi-8MT/-17


Mi-24/-35


Mi-26/26T


L-15 LIFT


Be-200


An-70


An-124

RECOGNITION OF CERTIFICATION AUTHORITIES

IVCHENKO PROGRESS

Totally 75 certificates of various types

GOSAVIASLUZHBA

State Department of Aviation Transport of Ukraine
Certificates No. SP 004, No. UA.145.0073, No. 0009 and others

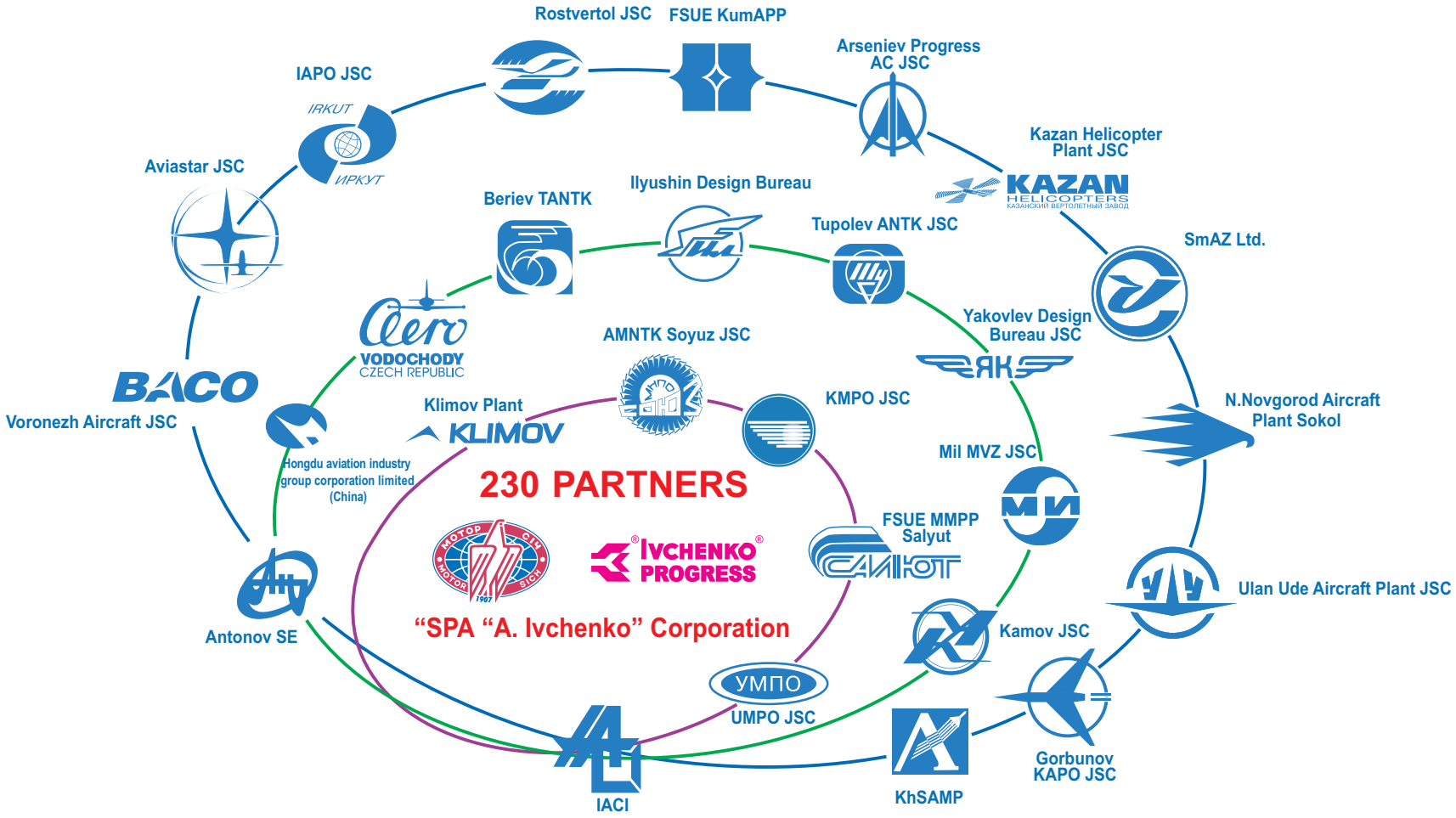
Bureau Veritas (France)
Certificate EN 9100:2009 No. FR015515-1, EN 9110:2009 No. FR015516-1, ISO 9001:2008 No. UA227484

European Aviation Safety Agency (Germany)
Certificate No. 216/2008, No. 1702/2003 Part 21A.23(b)2

Aviation Register of Interstate Aviation Committee (ARMAK)
Certificates No. SPR-11, No. SPR-15, No. R-56, No. R-69 and others

Federal Air Transport Agency (Russia)
Certificates No. 2021130360, No. VR 27.1.4223-2011

PARTNERS OF “SPA “A. IVCHENKO” CORPORATION DESIGNES AND MANUFACTURERS OF AERO-ENGINES AND AIRCRAFT



Among the partners of “SPA “A. Ivchenko” Corporation are more than 130 designers and suppliers of vendor items and more than 100 suppliers of materials and semi-finished products

COUNTRIES OPERATING AIRCRAFT POWERED BY IVCHENKO CORPORATION ENGINES

IN ALL: 104 COUNTRIES

AZERBAIJAN
ALGERIA
ANGOLA
ARGENTINA
ARMENIA
AFGHANISTAN
BANGLADESH
BELARUS
BULGARIA
BOLIVIA
BRAZIL
BURKINA FASO
BURUNDI
CANADA
CHINA
CHAD
COLUMBIA
CONGO
COTE D'IVOIR
CROATIA
CUBA
CZECH REPUBLIC
CYPRUS
DJIBOUTI
DR CONGO
ECUADOR
EGYPT
EQUATORIAL GUNEA
ERITREA
ESTONIA
ETHIOPIA
GAITI
GEORGIA
GERMANY
GHANA
GREECE
GUINEA-BISSAU
HUNGARY
INDIA
INDONESIA
IRAN
IRAQ
IRELAND
ISRAEL
JAPAN
KAMPUCHEA
KAZAKHSTAN
KENYA
KOREA PDR
KYRGYZSTAN
LAOS
LATVIA
LIBERIA
LIBYA
LITHUANIA
MACEDONIA
MADAGASCAR
MALAYSIA
MALI
MEXICO
MOLDOVA
MONGOLIA
MOZAMBIQUE
NEPAL
NEW ZEALAND
NICARAGUA
NIGER
NIGERIA
PAKISTAN
PALESTINE
PANAMA
PAPUA(NEW GUINEA)
PERU
POLAND
PORTUGAL
ROMANIA
REPUBLIC OF SOUTH AFRICA
RUSSIAN FEDERATION
RWANDA
SENEGAL
SIERRA LEONE
SLOVAKIA
SOMALI
SOUTH KOREA
SPAIN
SRI LANKA
SUDAN
SWITZERLAND
SYRIA
TADJIKISTAN
THAILAND
TURKMENISTAN
TURKEY
WESTERN SAHARA
UGANDA
UKRAINE
UNION OF MYANMAR
UNITED ARAB EMIRATES
USA
UZBEKISTAN
VENEZUELA
VIETNAM
YEMEN
ZIMBABWE

Etc.

Ivchenko-Progress SE
Designed Engines

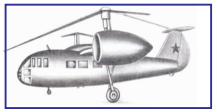
PISTON AND TURBOSHAFT ENGINES FOR LIGHT HELICOPTERS AND ULTRAHEAVY MILITARY TRANSPORT HELICOPTERS

IVCHENKO PROGRESS

Mi-1

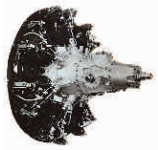
Yak-100

B-10,-11



B-5

G-4

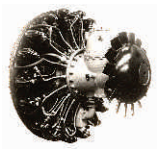


AI-26/GR/GRF
1945*

Ka-26

Ka-18

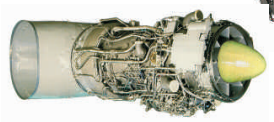
Ka-15



AI-14V
1951*

Mi-26T

Mi-26



D-136
1971*

Ka-226

Mi-2M

AI-450
1994*

MSB-2

Mi-2M/MSB-2

AI-450M,M1
2006*

Mi-26T2

D-136-2
2010*

RUMAS 245

AI-450M2
2013*

Helicopters of take off weight up to 15 t.

TV3-117VMA-SBM1V series 5,
TV3-117VMA-SBM2V
2013*

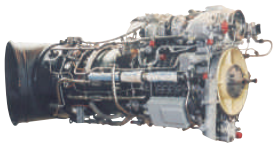
* - year of project launch

ENGINES FOR HELICOPTERS

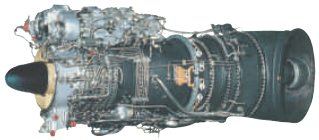
IVCHENKO PROGRESS

SERIES-PRODUCED AND OVERHAULED ENGINES

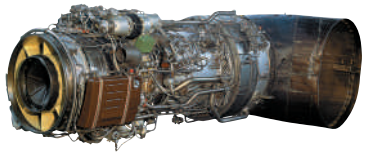
AI-450M modifications



TV3-117VMA-SBM1V Series 4/ 4E



TV3-117VMA-SBM1V Series 1, 2



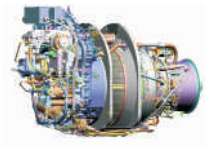
D-136

400 — 465 — 1 500 — 2 000 — 2 500 — 11 400

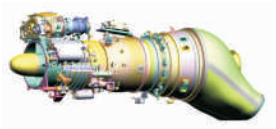
Take off power, hp

PROJECTS AND NEW ENGINES

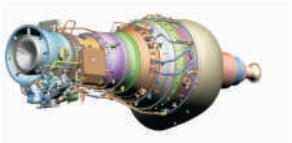
AI-450-2



NEW TURBOSHAFT

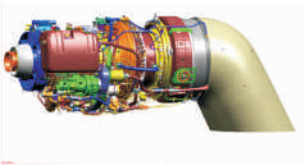


TV3-117VMA-SBM1V Series 5/-SBM2V



AI-8000V

D-136-2/AI-136T



AI-127

630 — 800 — 1 500 — 2 800 — 3650 — 7 600 — 8 300 — 11 400 — 12 200 — 14 500

Take off power, hp

TURBOJET BYPASS ENGINES FOR REGIONAL, MILITARY TRANSPORT AND MULTIPURPOSE AIRCRAFT

IVCHENKO PROGRESS

M-15

Yak-40

AI-25 Series 2, 2M
1962*

An-74TK-300

An-74

An-72

Yak-42

D-36 series 1, 1A, 2A, 3A, 4A
1967*

An-225

An-124

D-18T Series 1, 3
1972*

Be-200

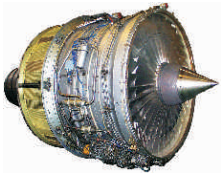
Tu-334

D-436T1,
D-436TP
1991*

An-148,-158

D-436-148
2002*

An-124-100M-150



D-18T
series 3M
2012*

An-178

D-436-148FM
2013*

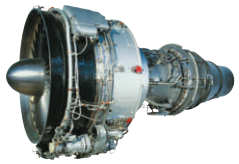
* - year of project launch

ENGINES FOR PASSENGER AND TRANSPORT AIRPLANES

IVCHENKO PROGRESS

TURBOFAN ENGINES






AI-450BP/BP-2		AI-25	D-36	D-436		AI-28		D-18T/AI-38	
4.0 (410)	5.5 (560)	14.7 (1 500)	63.8 (6 500)	62.8 (6 400)	84.4 (8 600)	73.6 (7 500)	98.1 (10 000)	229.9 (23 430)	313.9 (32 000)

Takeoff thrust, kN (kgf)

PISTON, BYPASS TURBOJET ENGINES, INCLUDING ENGINES WITH AFTERBURNER, FOR TRAINERS AND COMBAT TRAINERS

IVCHENKO PROGRESS

L-39M

Yak-130D

Yak-130

L-15

Yak-12

JL-8

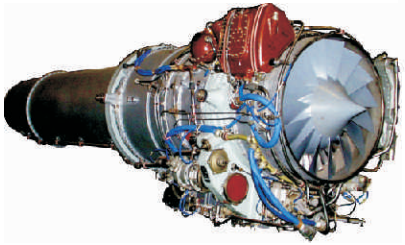
L-59(39MS)

AI-222-25F
2005*

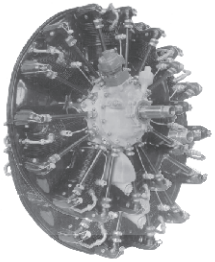
AI-222-25
1998*

Yak-18

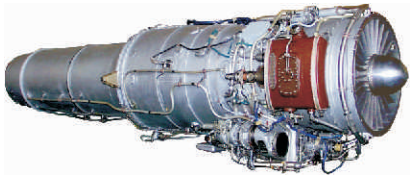
L-39



DV-2
1980*



AI-14
1948*



AI-25TL, AI-25TLK,
AI-25TLSh
1970*

* - year of project launch

ENGINES FOR TRAINERS, COMBAT TRAINERS AND LIGHT COMBAT PLANES

IVCHENKO PROGRESS

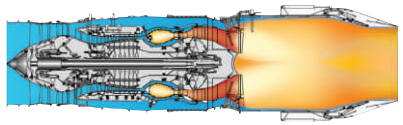
AI-25TL/TLK

AI-25TLSH

AI-222-25 modifications

AI-222-30 modifications

AI-222 versions with afterburner



AI-9500F engine with afterburner

16.9 (1 720)	18.2 (1 850)	24.5 (2 500)	29.4 (3 000)	39.2 (4 000)	49 (5 000)	88.3 (9 000)	98.1 (10 000)

Maximum thrust, kN (kgf)

ENGINES FOR UNMANNED AERIAL VEHICLES

IVCHENKO PROGRESS

TURBOPROP AND TURBOSHAFT ENGINES

AI-450
turboshaft and
turboprop engines

400 800

Takeof power, hp

TURBOFAN ENGINES

AI-450BP/BP-2

AI-25TL/TLSH

AI-222 modifications

410 560 1 500 1 850 2 500 4 900

Maximum thrust, kgf

TURBOPROP ENGINES FOR REGIONAL AND MILITARY TRANSPORT AIRCRAFT, SPECIAL PURPOSE AIRCRAFT AND GA

IVCHENKO PROGRESS

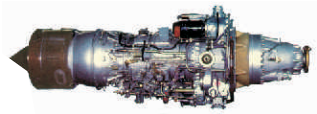
IL-38

IL-20, IL-22

IL-18

An-12

An-10

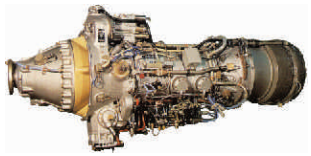


AI-20A Series 1, 2, 3, 4
AI-20M Series 6
1955*

An-30

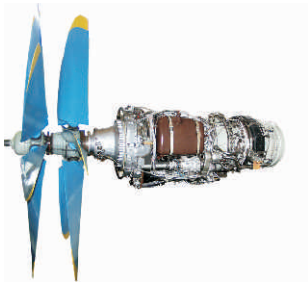
An-26

An-24



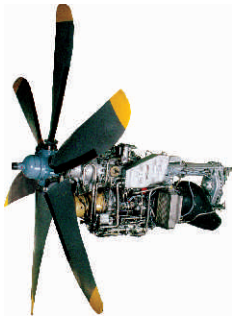
AI-24 Series 2,
AI-24T, AI-24VT
1957*

An-70



D-27
1985*

An-140



TV3-117VMA-SBM1
1996*

EV-55

AI-450S2
2011*

DA50-JP7

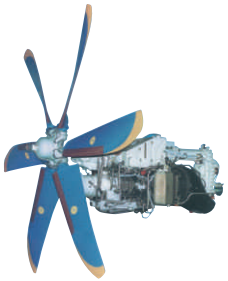
AI-450S
2012*

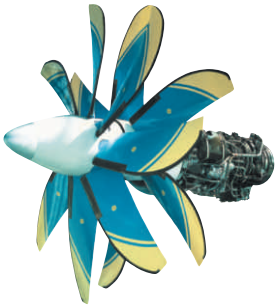
* - year of project launch

ENGINES FOR PASSENGER AND TRANSPORT AIRPLANES

IVCHENKO PROGRESS

TURBOPROP AND TURBOPROPFAN GAS-TURBINE ENGINES





AI-450S/S-2 **TV3-117VMA-SBM1/2** **AI-40** **AI-800** **D-27**

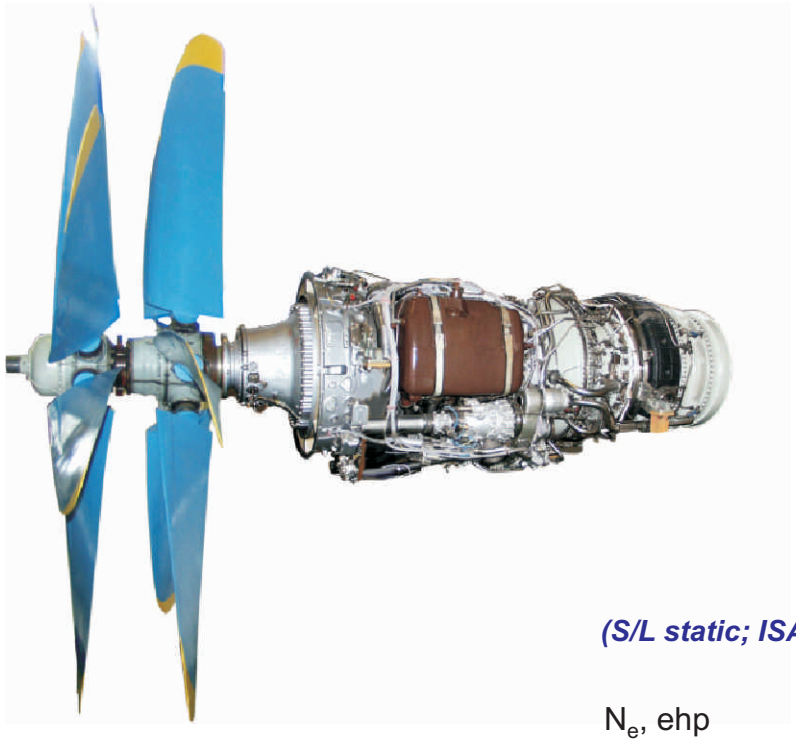
465 (340)	800 (590)	2 500 (1 840)	3 600 (2 650)	3 600 (2 650)	4 000 (2 940)	7 600 (5 588)	8 300 (6 102)	13 240 (9 735)

Takeoff power, hp (kW)

Innovations for Turboprop Engines

D-27 PROPFAN

Advanced contra-rotating (open rotor design) engine



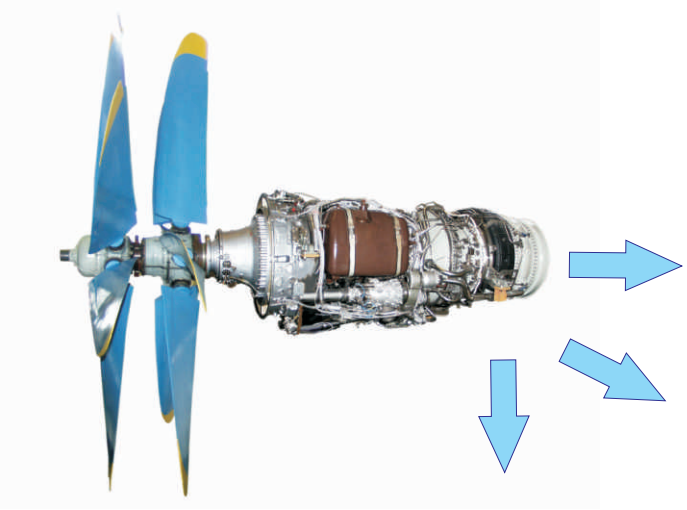
An-70

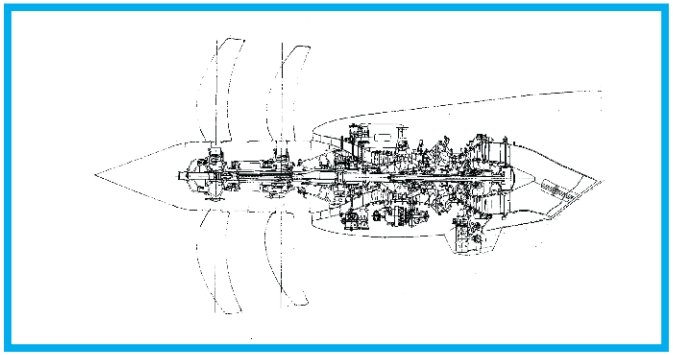
(S/L static; ISA)	D-27 *Takeoff*
N_e, ehp	13 240
C_N, kg/h/ehp	0.180

At present activities for mastering the D-27 propfan engine serial production are carried out

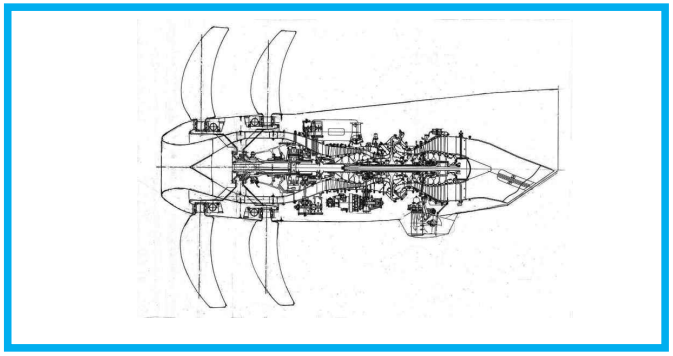
CREATION OF OPEN-ROTOR TYPE ENGINE DEMONSTRATOR

IVCHENKO PROGRESS

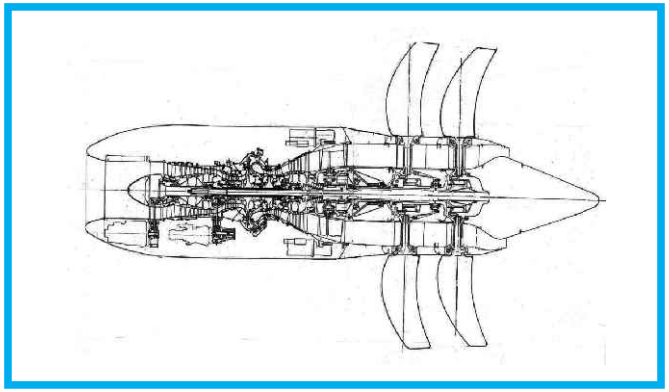




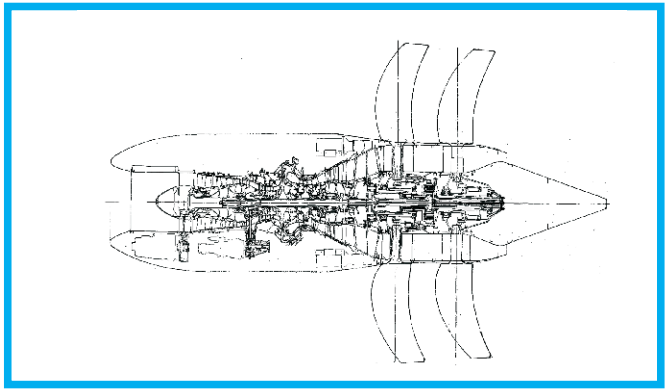
Tractor propfan of 3.5 m in diameter with retrofitted air intake



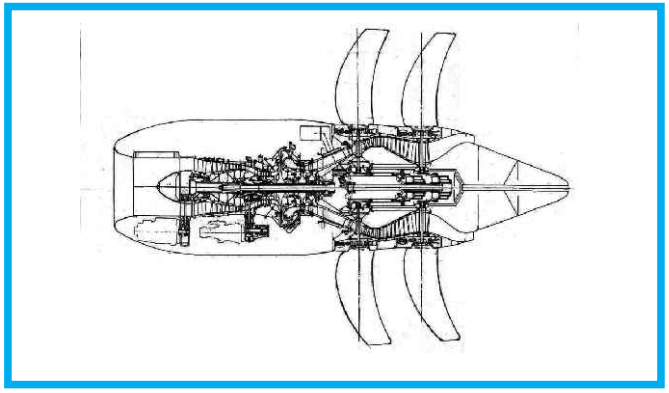
Tractor propfan with forward-type air intake



Pusher propfan with propfan-rotor front reduction gear



Pusher propfan with reduction gear between propfan rotors

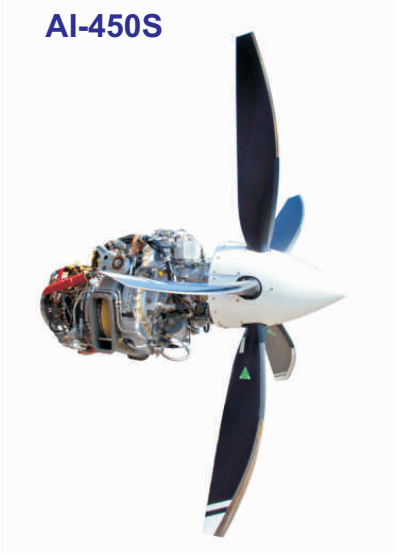


Pusher propfan with direct propfan drive

AI-450S, AI-450S-2

IVCHENKO PROGRESS

AI-450S



Engine can be used on similar aircraft

DA50-JP7 - 19/01/2015 Maiden flight

UAV

Light multi-purpose aircraft

Light trainers

(S/L static; ISA)	AI-450S	AI-450S-2
	Takeoff	
N_{prop}, hp	450...495	630...800
C_N, kg/h/hp	0.277	0.259

AI-450S-2

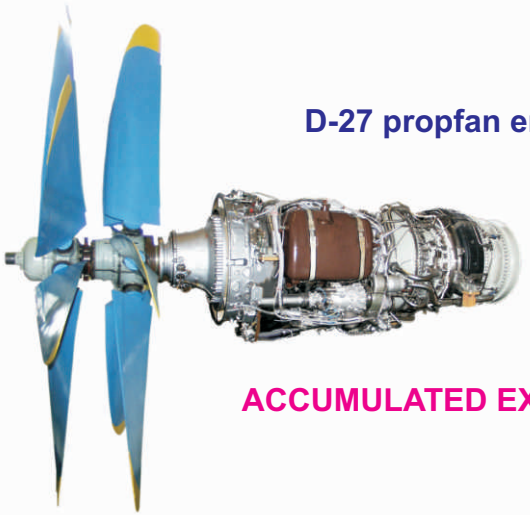
General-aviation light aircraft

Light multi-purpose aircraft

Developed under ESPOSA project of European 7th Framework Programme

DEVELOPMENT OF ADVANCED GTEs FAMILY CONCEPT (OPEN ROTOR) TO POWER LIGHT AIRPLANES

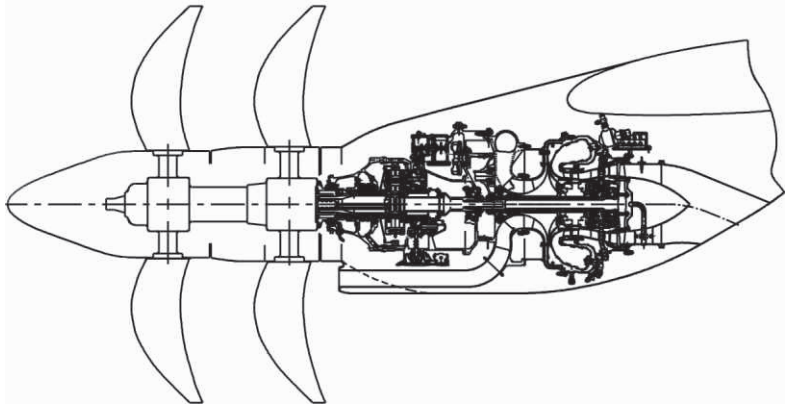
IVCHENKO PROGRESS



D-27 propfan engine

ACCUMULATED EXPERIENCE

450...750 hp

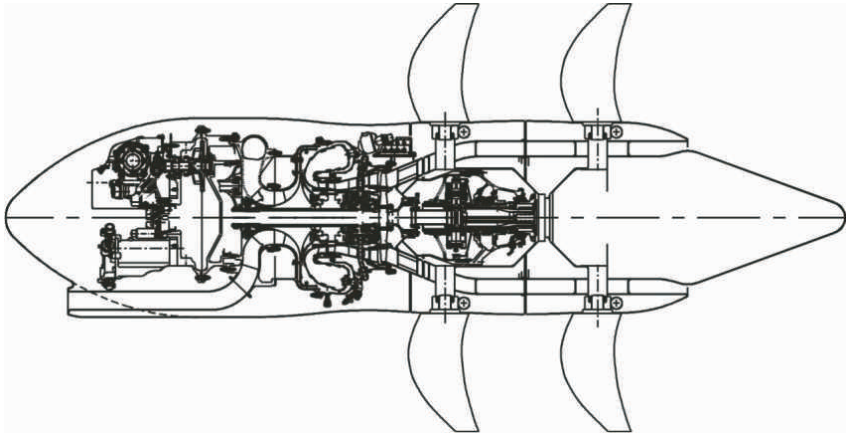


Tractor propeller

ADVANCED CORE

AI-450S/S-2 turboprop engine

Core developed under ESPOSA project
of European 7th Framework Programme



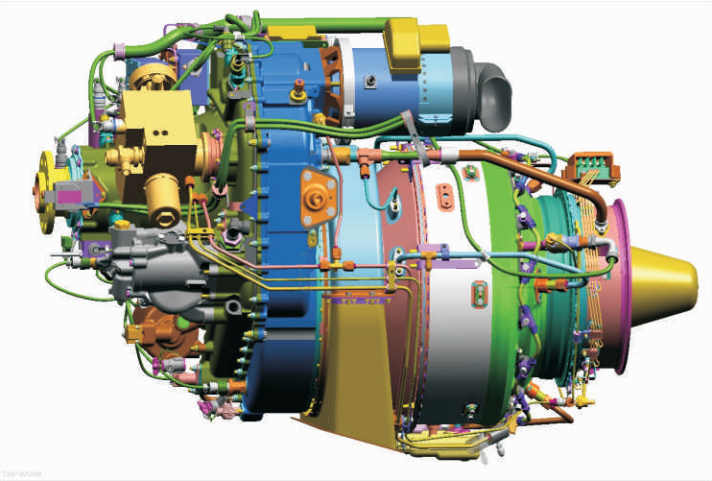
Pusher propeller

ESPOSA -
Efficient Systems and Propulsion for Small Aircraft

IVCHENKO PROGRESS

ESPOSA

Starting date - 01/10/2011. Duration in months - 57



Role in the project

SE Ivchenko-Progress will develop the mathematical model and perform trade-off studies for estimation of the performance data for the baseliner engine 2 (BE2) configuration, fulfil the specification and optimization of thermodynamic parameters of BE2 engine in the aircraft-enginepropeller system, develop a design of technical requirements for units and engine systems of BE2 and a design of laws of BE2 engine management, find an optimal design solution for high pressure compressor, realize the optimization, design and experimental investigations of high efficiency advanced small turbine, fulfil advanced dynamic modelling of high speed turbomachine, supply the specifications of the turbine components coating and carry out the demonstrator validation in terms of coating quality and performance under real service conditions, provider of complex tests and validation of BE2 in test rig, verify mathematical model of BE2 engine with results of tests, investigation of capacity development efficiency of GTE family designs for small aircraft on the basisof single advanced turbocompressor.

SE Ivchenko-Progress activities

ESPOSA

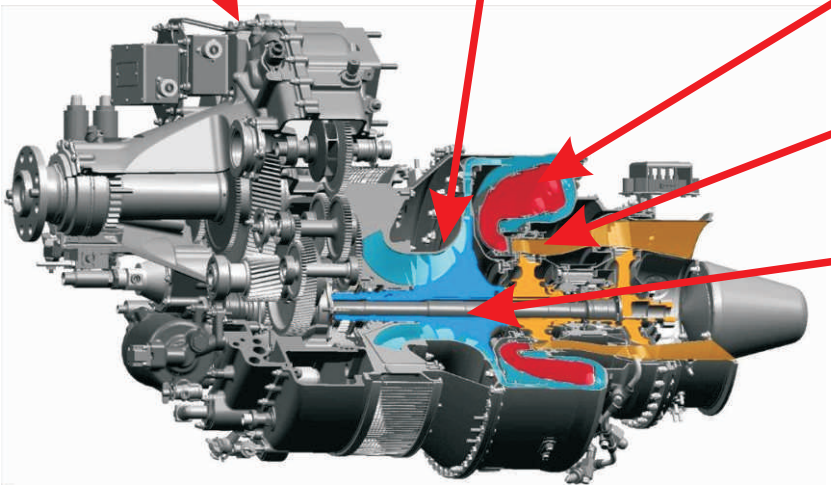
Advanced automatic control system for small engines

Optimal small compressor
(*Advanced centrifugal compressor impeller with a new blade geometry- 'winglet'*)

Efficient combustion concept
(*High efficiency, low emission combustor with new designed fuel injector with swirlers*)

Advanced Cooled Small Turbine
(*15 mm size of airfoil*)

Advanced dynamic modelling of high speed turbomachinery

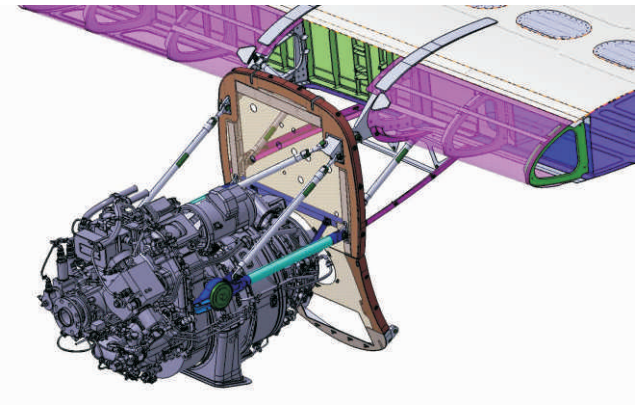


ADVANCED DESIGN METHODS FOR ENGINE INTEGRATION

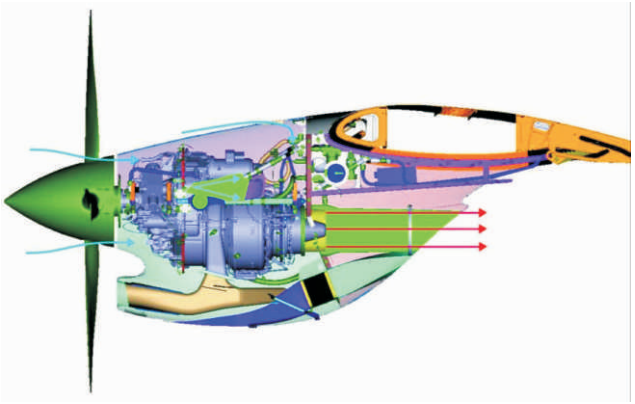
IVCHENKO PROGRESS

ESPOSA

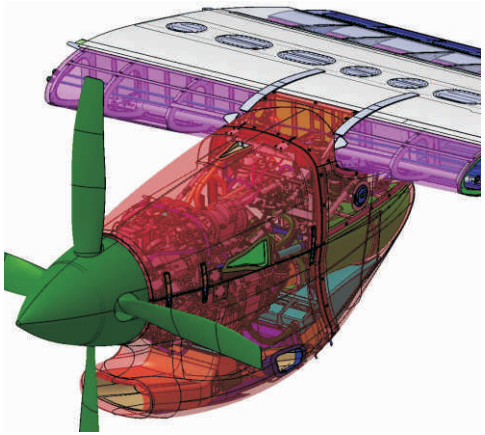
Complex design methodology for Engine Mechanical Integration



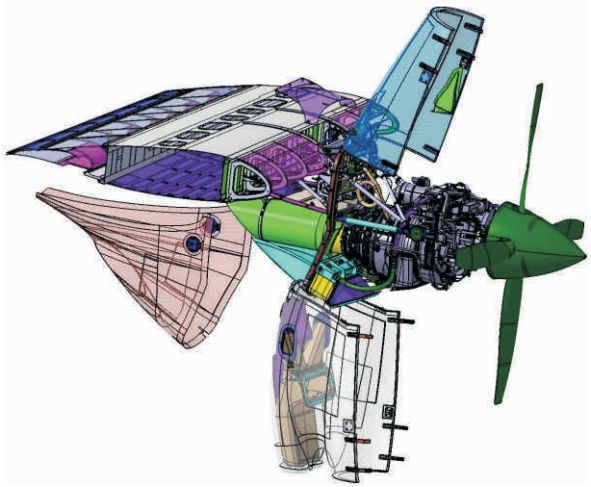
Engine Nacelle Ventilation. Reliable simulation tools for engine thermal integration



Reliable design methodology for aerodynamic and acoustic engine/airframe integration



NACELLE. Good accessibility and maintainability



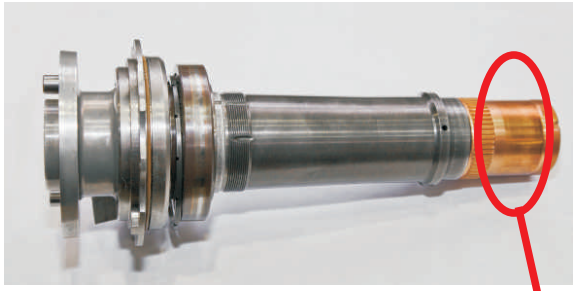
Technology Innovations for Turboprop Engines

DEVELOPMENT OF PROGRESSIVE COATING SOLUTIONS FOR ENGINE PARTS

IVCHENKO PROGRESS

ESPOSA

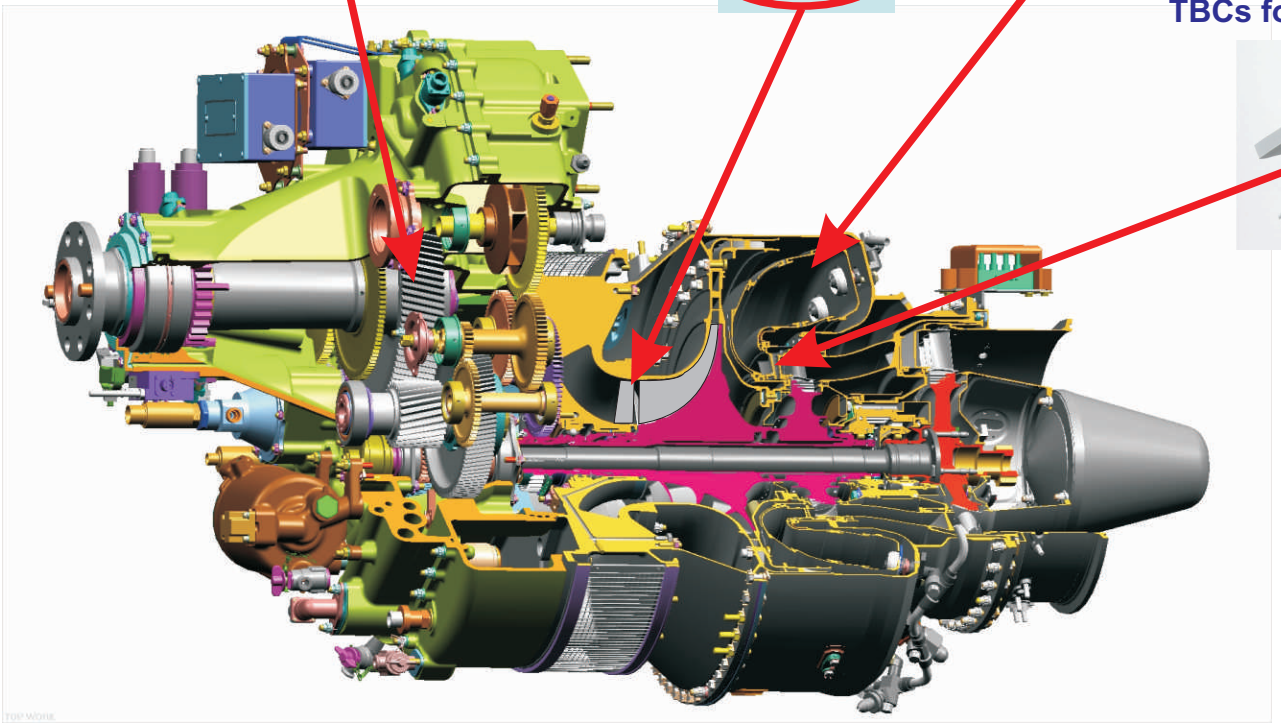
Wear resistant coatings for bearings mounting seats on engine shafts



Anti-fretting and anti-wear coatings for compressor rotor blade roots

Heat-protective coating for internal surface of small combustor

TBCs for turbine nozzle guide vanes



OXIGEN -
Oxide Dispersion Strengthened Materials for the Additive Manufacture of High Temperature Components in Power Generation

IVCHENKO PROGRESS

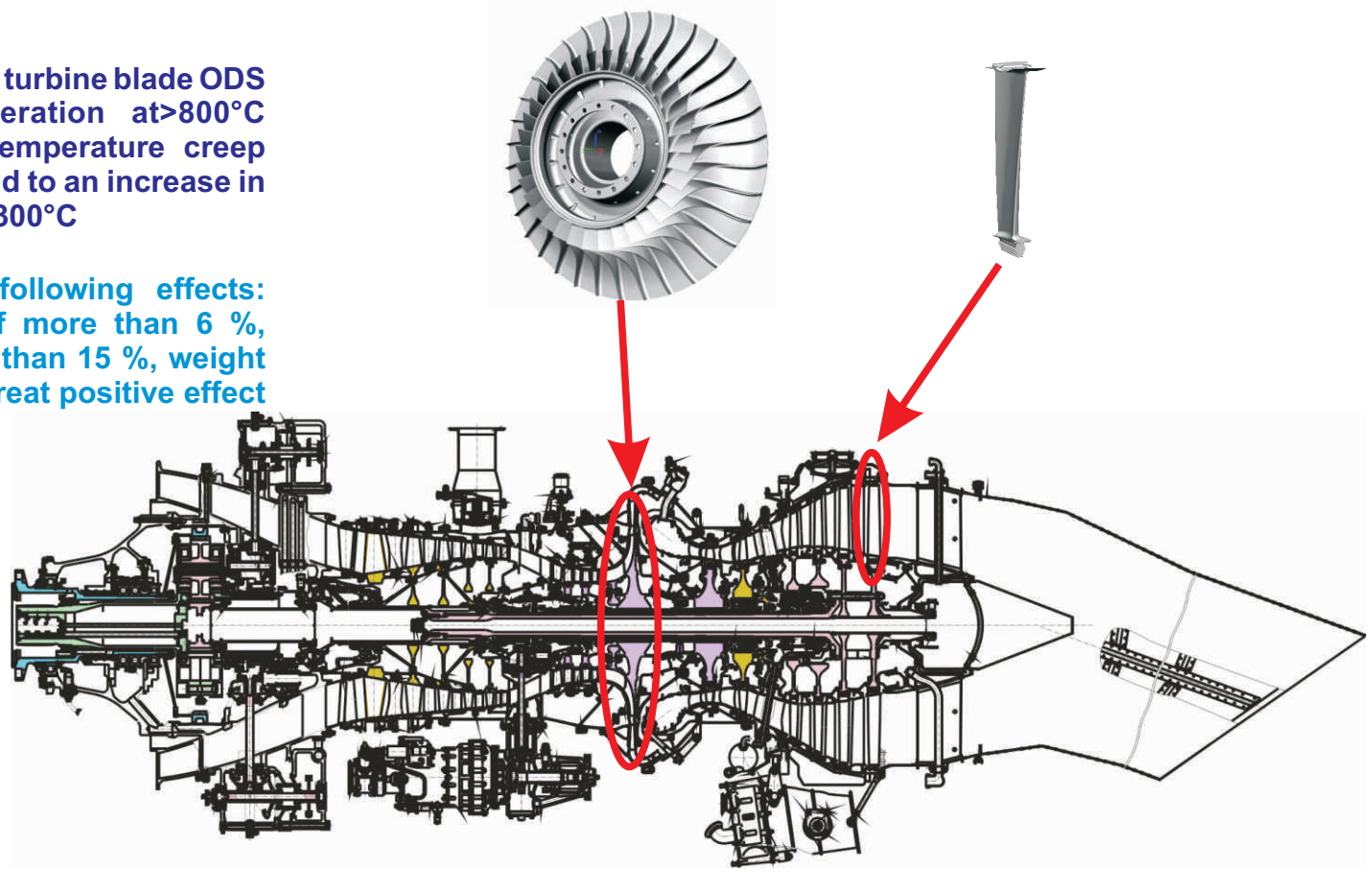
Starting date - 01/02/2013. Duration in months - 48

The manufacture of a compressor wheel and turbine blade ODS titanium-aluminium alloy will allow operation at>800°C (theoretically, based on increased high temperature creep strength properties) which would correspond to an increase in operating (inlet/outlet) temperatures by 200-300°C

Application of new materials will give following effects: reduction of specific fuel consumption of more than 6 %, increase of power can be reached of more than 15 %, weight reduction, engine life increasing, giving a great positive effect on the engine in whole

ODS TiAl alloy

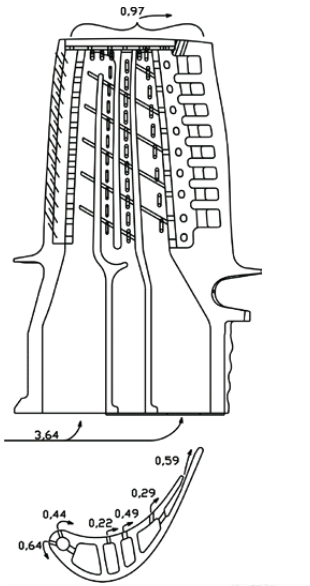
Centrifugal compressor wheel **Turbine blade**

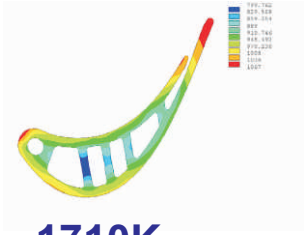


ADVANCED AERO-ENGINE HIGH PRESSURE TURBINE BLADE COOLING SYSTEM CONCEPT

IVCHENKO PROGRESS

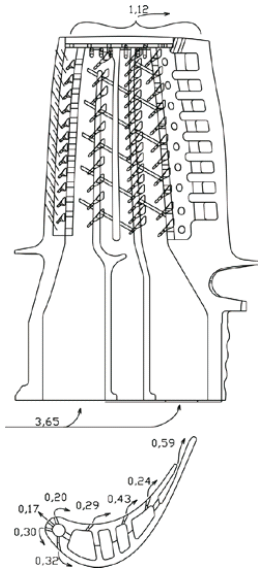
Base design

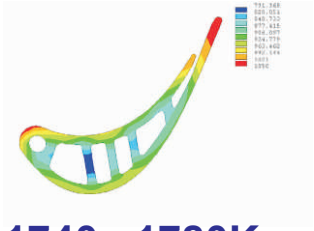




1710K

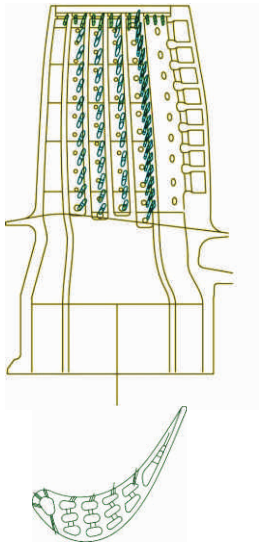
Modification 1, modified blade with shaped film cooling holes

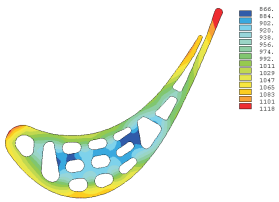




1740...1780K

Modification 2, wall-cooled system ("penetrating cooling")





1850...1900K

Blade Mean Section temperatures	Base	Modifi-cation 1	Modifi-cation 2
Leading Edge, °C	1067	1050	1031
Trailing Edge, °C	1063	1045	1015
Bulk Metal, °C	943	920	875

Modification 2, wall-cooled system blades has an average temperature of the middle section 68°C lower than the blade with base design.

Additionally, the use of TBC with 0.14 mm thickness and a thermal conductivity 2.8 W/(m•K) leads to the decrease in the average temperature of the blade cross section for 15 ... 20°C for all presented cooling blades.

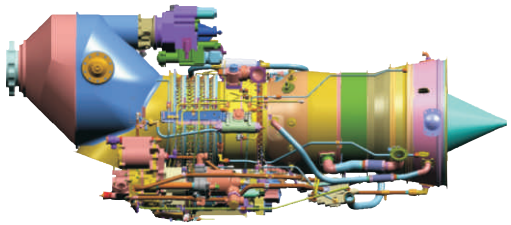
The results of presented investigation show, that one of the most challenging cooling systemfor the engines with gas temperature at HPT rotor blade inlet TET = 1800…1900 K is a wallcooled system ("penetrating cooling")

New
Designed Engines

TV3-117VMA-SBM2, AI-40, AI-8000

IVCHENKO PROGRESS

TV3-117VMA-SBM2



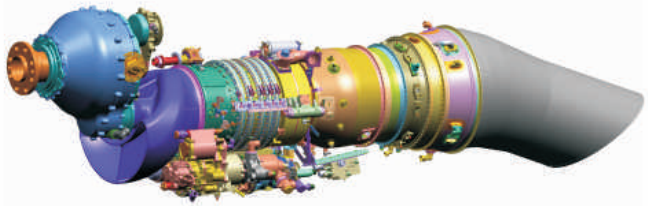
TV3-117VMA-SBM2

(S/L static; ISA)

	Takeoff	*Emergency*
N_e, hp	2 800	3 600
flat-rated to t°C	+35	+25
C_e, kg/h/ehp	0.210	

MA60/ MA700 type Regional airplanes

AI-40



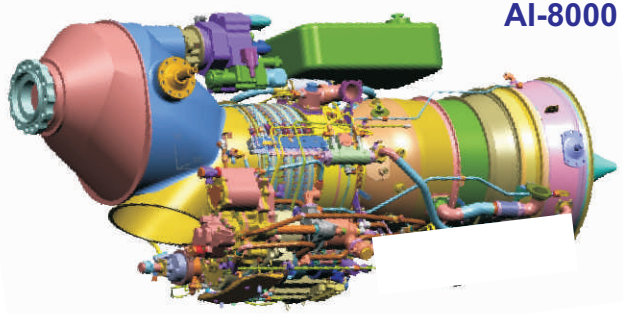
AI-40

(S/L static; ISA)

	Takeoff	*Emergency*
N_e, ehp	3 600	4 000
flat-rated to t°C	+40	+40
C_e, kg/h/ehp	0.196	

Regional passenger and light transport aircraft

AI-8000



AI-8000

(S/L static; ISA)

	Takeoff	*Emergency*
N_e, ehp	7 600	8 300
C_e, kg/h/ehp	0.175	

Transport and passenger aircraft

OUR MAIN GOALS FOR CUSTOMER SUCCESS

Safety

Reliability

Innovation

IVCHENKO PROGRESS

Economy

Efficiency

Modernization

We provide power to your fly

ENGINES DESIGNED BY IVCHENKO CORPORATION HAVE BEEN OPERATED IN MORE THAN 100 COUNTRIES OF THE WORLD

IVCHENKO PROGRESS

Zaporozhye Machine-Building Design Bureau Progress
State Enterprise named after Academician A.G. Ivchenko

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THANK YOU
FOR ATTENTION!