HYDROGEN ENERGY TECHNOLOGIES IN RUSSIA

Country update

IPHE Steering Committee meeting

Sao Paolo, 23-25 April, 2007

NATIONAL POLICY & PRIORITIES

- The priority directions of science and technologies to be developed in the Russian Federation
  - **Energy & Energy Saving**
- List of technologies that are of critical importance for the national economy
  - **Hydrogen technologies**

Russian President's Decree, May 2006

Hydrogen Related R&D Funding

■ **GOVERNMENT ALLOCATIONS:**	■ **INSTRUMENTS:**
■ Ministry of Education and Science, Federal Agency for Science and Innovations (FASI) ■ Russian Academy of Sciences ■ Russian Foundation for Fundamental Research ■Federal Agency of Industry ■ Federal Agency for Nuclear Energy ■ Federal Space Agency	■ Federal R&D Programs ■ Educational Programs ■ Basic Research Projects ■ Technology Oriented Projects ■ Demonstration Projects

Public private partnership

- ✓ **GASPROM – ROSATOM**
  - development and production of modular power units with 5KW SO and SPEC FC
- ✓ **Russian Academy of Sciences – "Norilsk Nickel" company**
  - R&D programme - $ 40 mln.
  - company "New energy projects"
  - company "New energy projects" + American company "Plug power"
- ✓ **AVTOVAZ – Technological Development Fund**
  - ANTEL – 1
  - ANTEL – 2
- ✓ **FASI – NAVE – PEI – Transportation company**
  - gasoline and hydrogen-powered autos

HYDROGEN RELATED R&D PROGRAMMES

- R&D in Priority Areas of Science and Technologies Development for 2002-2006
- R&D in Priority Areas of the Russian scientific and technological complex development for 2007-2012
- National technological basis for 2007-2011

The focus of hydrogen related R & D

- ✓ **Hydrogen production:**
- ✓new technologies and equipment for efficient hydrogen production (for stationary and portable systems)
- ✓ hydrogen production from renewable sources and nuclear reactors for energy accumulation and production
- ✓ new types of catalysts for hydrogen production technologies
- ✓ **Materials:**
- ✓ new materials for H2 production, storage & transportation
- ✓**Fuel Cells:**
- ✓ portable fuel cells and power systems based on solid oxide fuel cells
- ✓**Hydrogen/oxygen steam generators and high-temperature turbines**

tbc

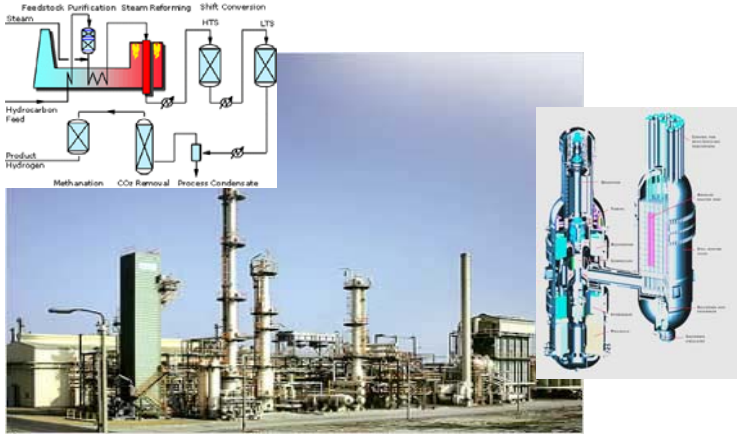
The focus of hydrogen related R & D

✓**Hydrogen storage:**
✓hydrogen storage in reversible solid systems (for stationary application)
✓hydrogen storage based on non-reversible systems for portable power generators and vehicles
✓ advanced systems for hydrogen liquification and liquid hydrogen storage
✓bulk underground hydrogen storage
✓**Hydrogen vehicles:**
✓hydrogen-powered vehicles with FCs
✓environmentally clean (low-emission) autos with internal combustion engines powered by gasoline with hydrogen admixtures
✓ **Hydrogen safety:**
✓development of safety devices and systems
✓development of national safety codes and standards and their harmonization with international regulations
✓**Education.**

INNOVATIVE HYDROGEN PRODUCTION TECHNOLOGIES

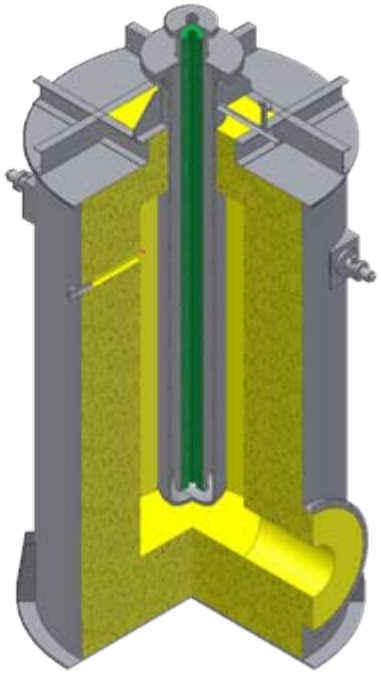
Steam conversion of methane in MGR-T

- $CH_4 + 2H_2O + +heat\ (>800\ ^0C) \Rightarrow CO_2 + 4\ H_2$

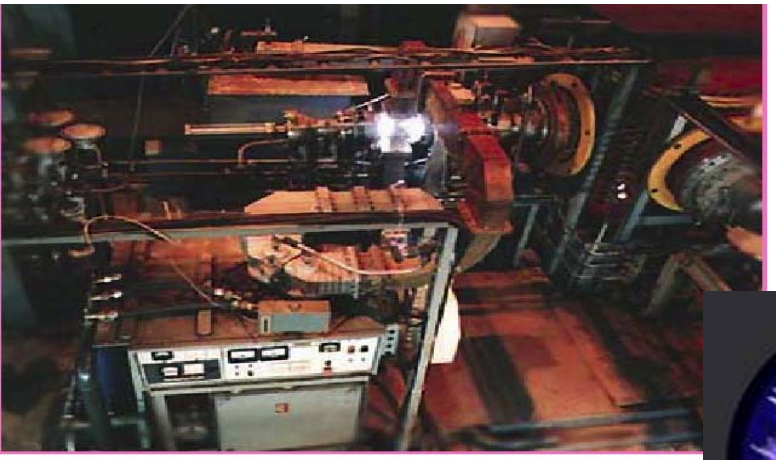


- H_2 yield two times higher than for pyrolysis of methane

H2 production by steam natural gas conversion



Innovative hydrogen production technologies:

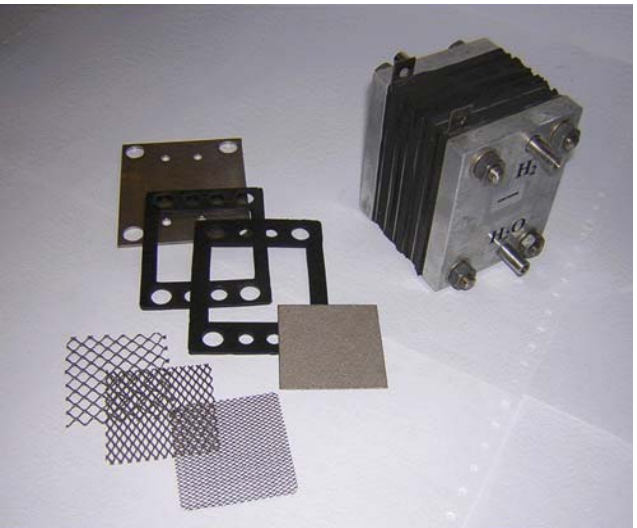


Microwave converters based on plasma chemical method

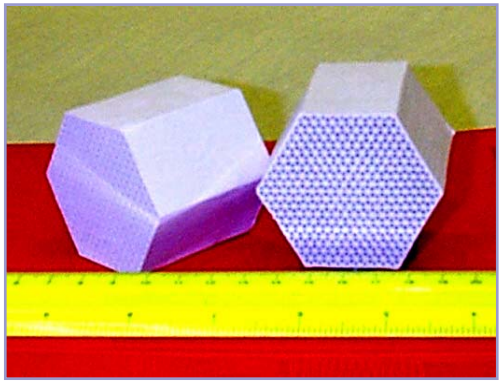
Two-stage pyrolysis of natural gas to produce hydrogen from natural gas and pure carbon materials

PEM Electrolyzers
for high purity hydrogen production

The fields of PEM-electrolyzer's application: fuel cells, gas chromatography, water-chemical regime correction systems of nuclear reactors, hydrogen welding, metallurgy, electronic industry, analytical chemistry, etc.
PEM-electrolyzer and plants on its base of different productivity (from several million to a dosen cubic meters per hour) and purposes have been developed
Hydrogen purity > 99.99%



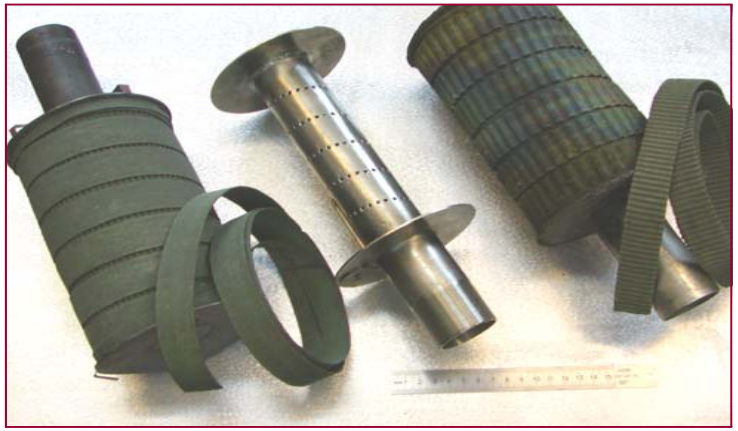
Catalysts & catalyst reactors for hydrogen production



Monolithic catalysts

Monolithic catalyst reactor

Tape catalyst

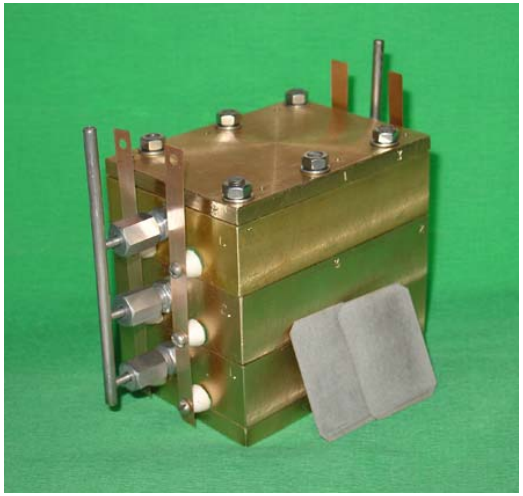


Tape catalyst reactor of the syngas capacity ca. 5 m^3/hour

Microcatalytic hydrogen production systems and a reactor for steam conversion of methanol

Microreactor with external heating

Microreactor with heat exchanger



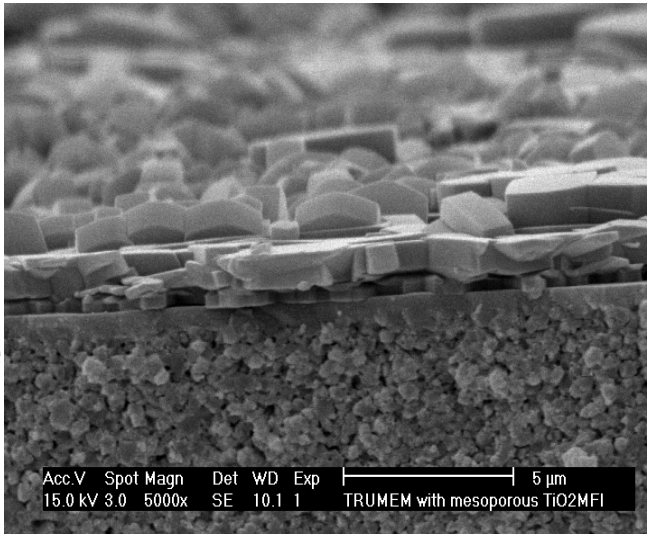
Sectioned high power reactor

Characteristics		
Dimensions		
∅30 h=60mm	**∅40 h=35 mm**	**65×90×85 mm**
Microchannel plate		
∅28 δ=0,3 mm	**∅35 δ=0,3 mm**	**30×40 mm**
Hydrogen output and heat power		
130 l/h; 300 W	**32 l/h; 73 W**	**320 l/h; 750 W**

International Project
on Fuel Cells Based on Nanoporous Structures

- Institute of Physical Chemistry and Electro-Chemistry after Frumkin (IPCEC)
- Institute for High Temperature (IHT)
- Institute of Petrol-Chemical Synthesis after Topchiev (IPCS)
- Institute of Chemical Physics Research (ICPR)
- Institute of Problems of Micro-electronics Technology and High Purity Materials (IPM)
- Moscow Power Engineering Institute (MEI)
- Academy for Fine Chemistry Technologies (MINCT)

- CMR Fuel Cells (UK)
- Lawrence Livermore National Laboratory (USA)
- National Physical Laboratory (UK)
- Fraunhofer Institute (Germany)
- Waterloo University (Canada)



Zeolit

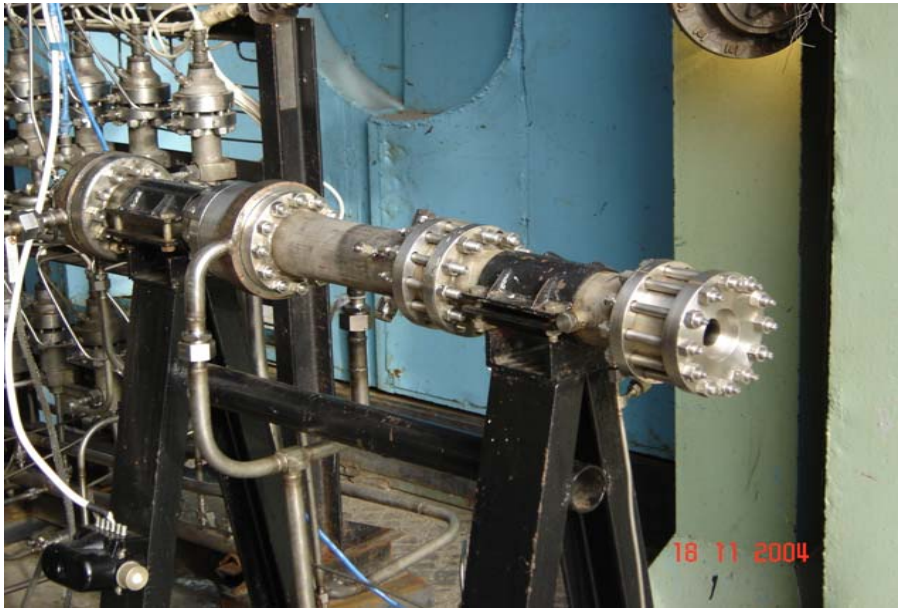
P_xTiO_{2-x}

$TiO_2 - ZrO_2$

Ni

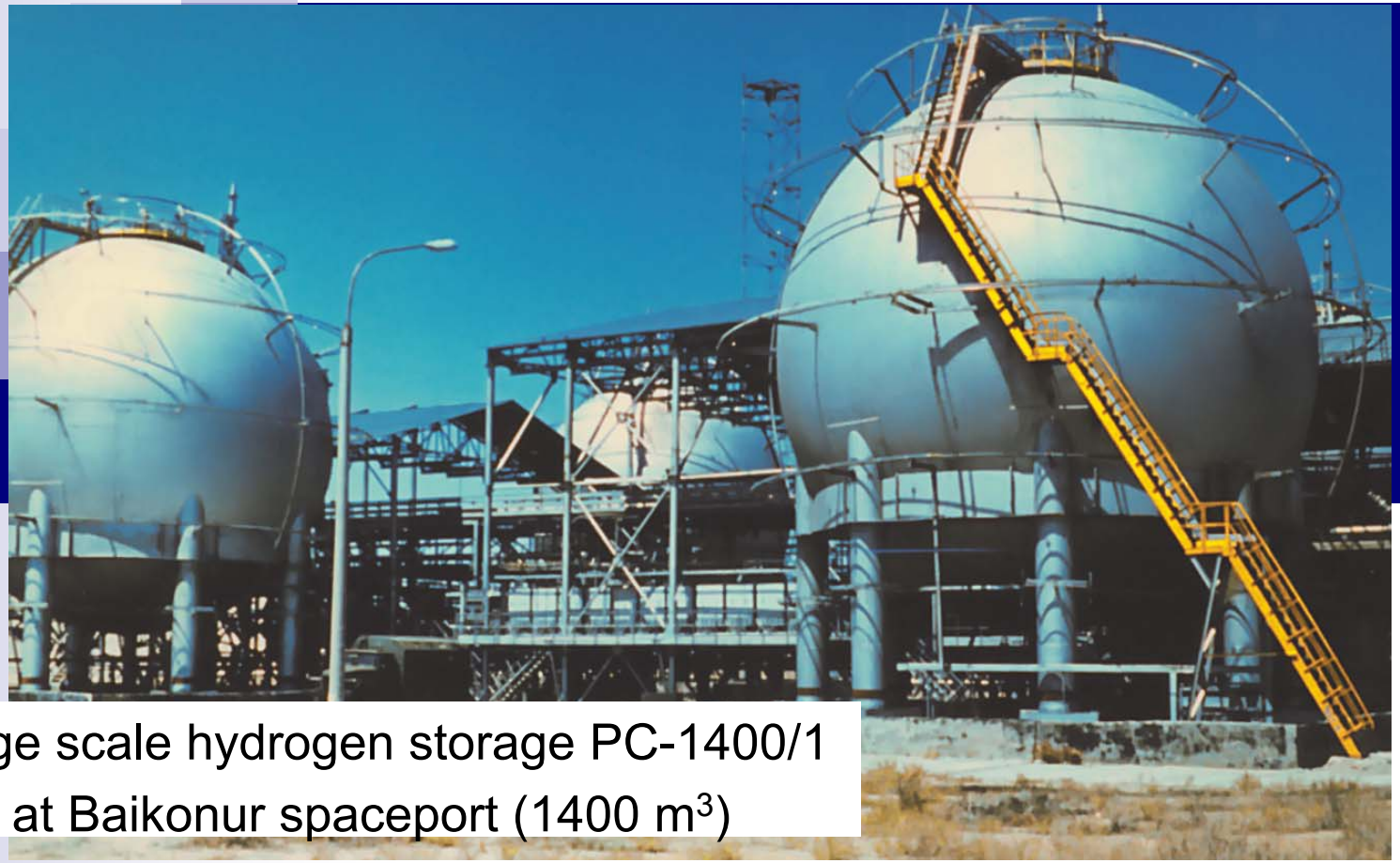
SOFC and PEM FC

Hydrogen combustion systems



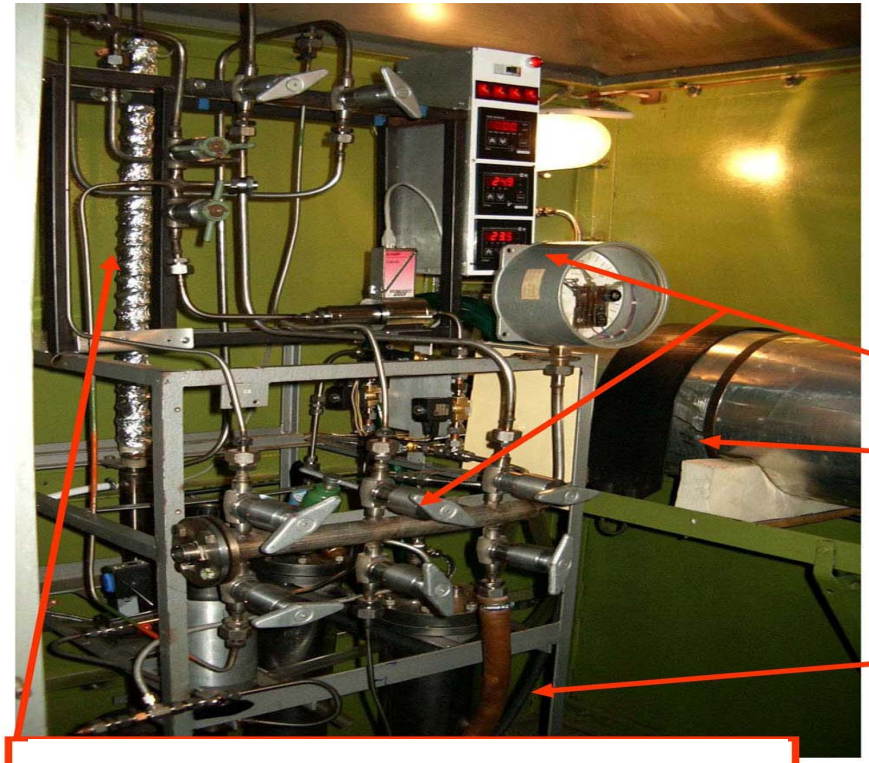
25 MW steam generator

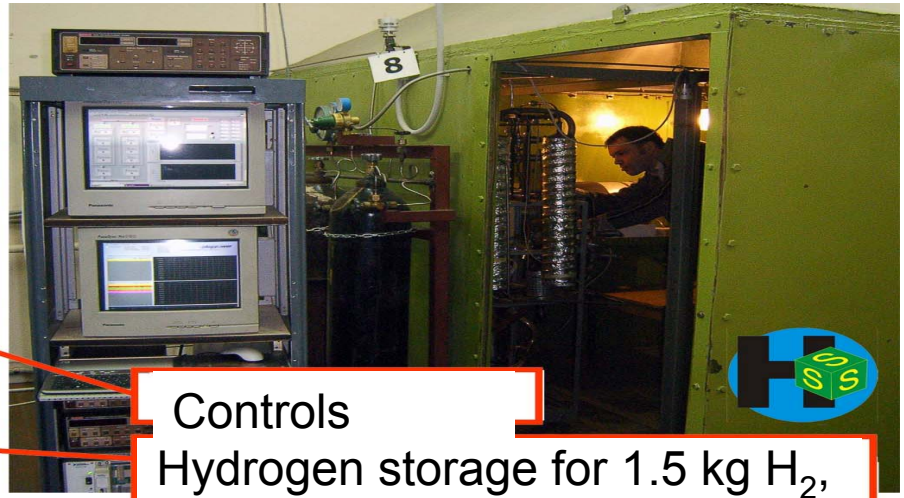
CRYOGENIC HYDROGEN STORAGE



Large scale hydrogen storage PC-1400/1 at Baikonur spaceport (1400 m^3)

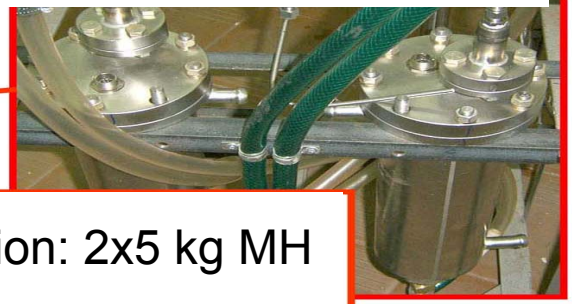
Lab experimental facility for complex investigations of solid-state reversible hydrogen storage and purification systems





Controls

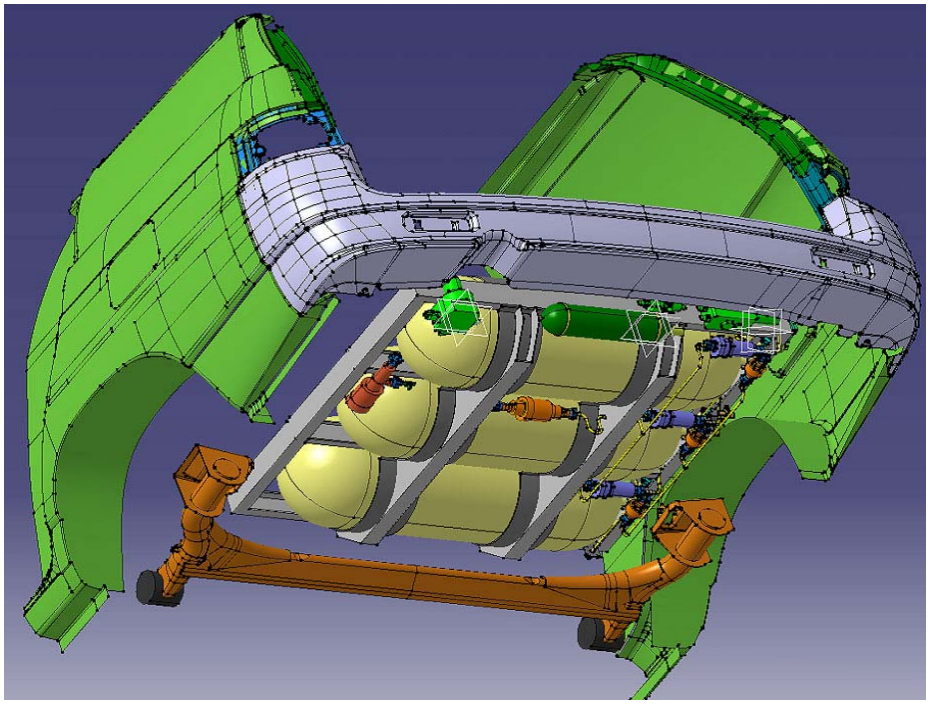
Hydrogen storage for 1.5 kg H_2, 159 kg MH



Preliminary purification: catalytic burner and dryers

Fine purification: 2x5 kg MH reactors

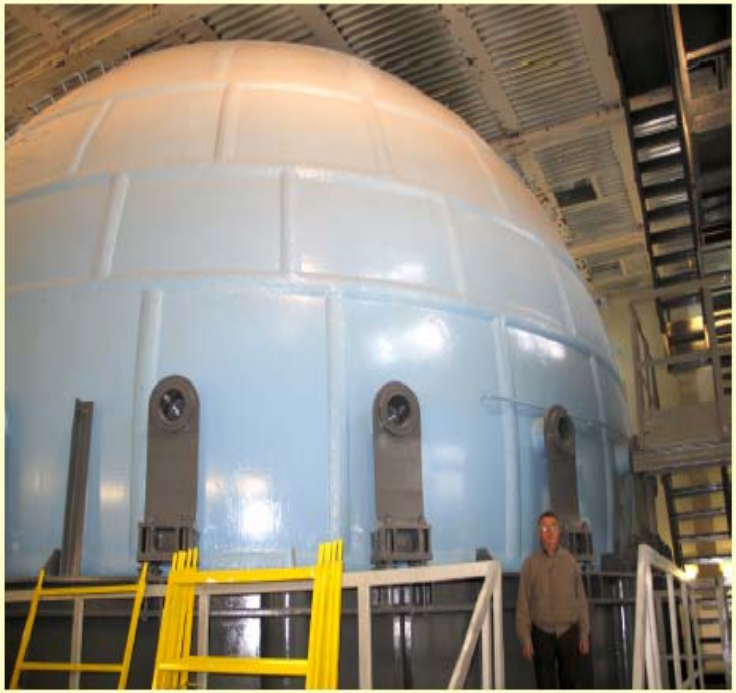
Hydrogen vehicles



Compressed Hydrogen

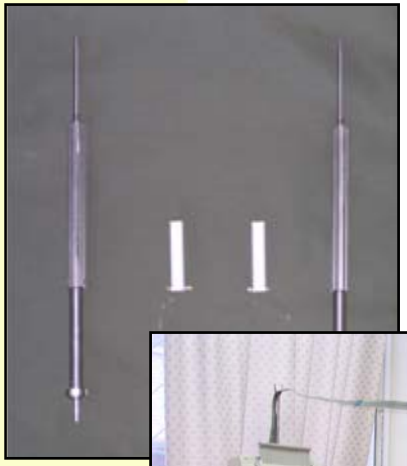
Hydrogen safety

Explosive chamber



Inside diameter – 12 m; Wall thickness – 100 mm; Weight – 470 t.
Chamber is designed for explosion up to 1000 kg TNT.

Hydrogen and Oxygen Gas Sensors



International Forum:

Hydrogen Technologies for Energy Production

February 6-10, 2006, Moscow

.

IPHE Collaborative Project Implementation Workshop

Education

Lectures
Hydrogen Labs
Young Scientists Conferences
Students Hydrogen Clubs

Moscow Power Engineering Institute
Moscow Institute of Physics and Technology
Moscow State University
Saint-Petersburg State University
Novosibirsk State University
Ural Technical University (Ekaterinburg)
Tomsk Technical University
Moscow State Technical University "MAMI"
Moscow Radiotechnics Electronics and Automatics Institute
and many others…

NEW DEVELOPMENTS:

November 2007 - International Conference on Hydrogen Energy Technologies

April 2008 – IPHE Steering Committee Meeting

WELCOME TO RUSSIA !

Contact:
Federal Agency of Science & Innovations
reutov@fasi.gov.ru partnership@fasi.gov.ru