Closed Fuel Cycle Strategies and National Programmes in Russia

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Unique Current Situation
International Aspect

Important political changes in the World during first half of this year

Global Restart of Nuclear Power

Conception of Federal Task Program "Development of atomic power complex of Russia on period of 2007 - 2010 and on prospect up to 2015"

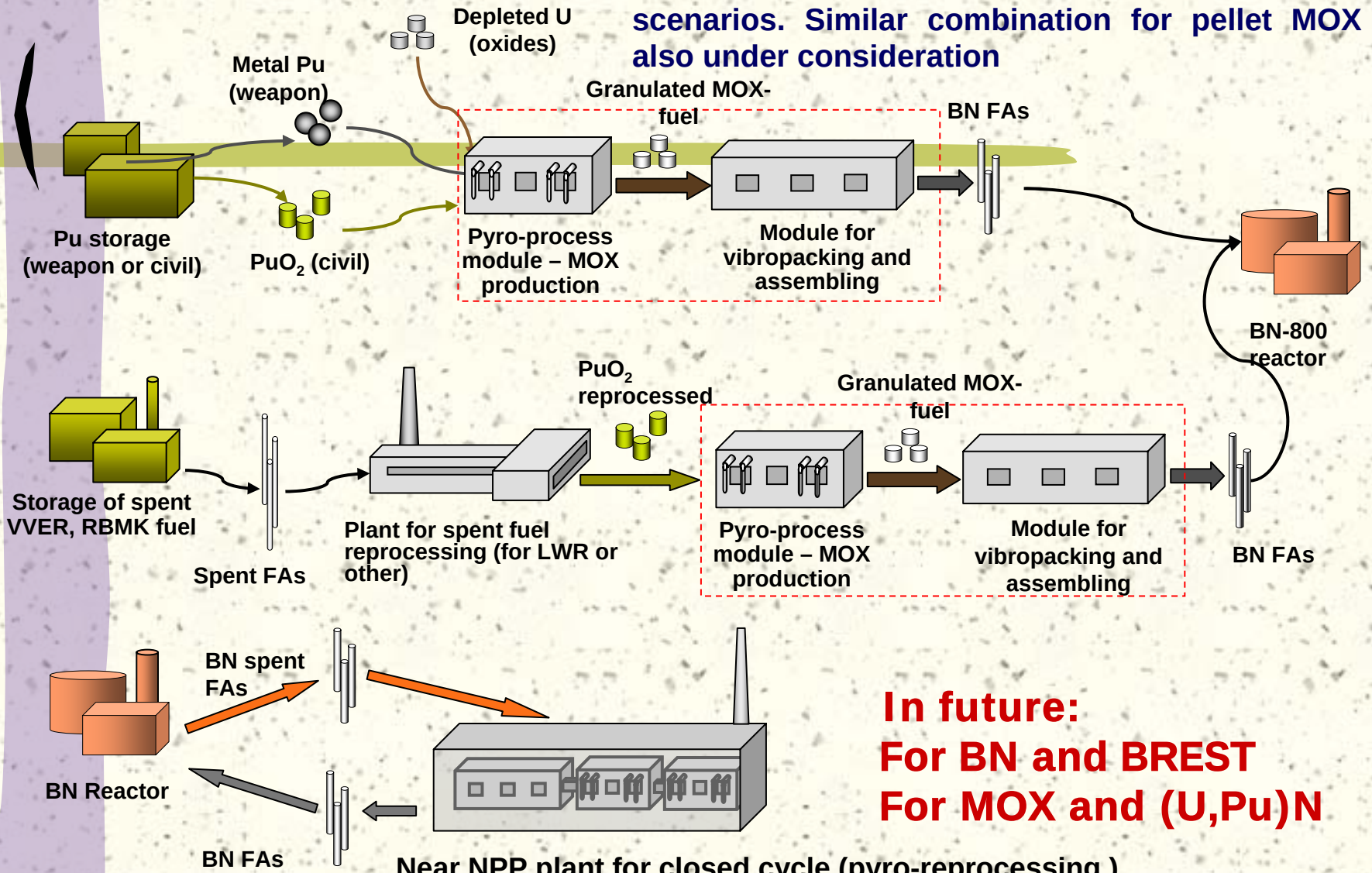
- Direction 1: Development of Nuclear Power Capacities
- Direction 2:Development and renovation of fuel cycle capacities
- Direction 3: "Development of capacities on managing with spent nuclear fuel and radioactive wastes of nuclear power plants and preparation of nuclear reactors for decommissioning"
- Direction 4: Transition to innovative nuclear tecnologies

Creation of New Technological Platform – way for simplification of the Nuclear and Radiation safety program

- Construction of BN-type fast reactors in Russia.
- Pilot facilities for Closing of Fuel Cycle up to 2030.
- NTP would increase Radiation and Nuclear Safety level (reduction of accumulation rate for SNF and RAW), but it would demand creation of new scientific and technological basis

Implementation prospects for BN-800 (BN-1600)

Combination of pyroprocess and vibropacking technology are proposed for creation of BN-type MOX fuel productions and recycling in different scenarios. Similar combination for pellet MOX is also under consideration



In future:
For BN and BREST
For MOX and (U,Pu)N

Near NPP plant for closed cycle (pyro-reprocessing)

Long-term tasks of NTP with BN

- Creation and construction of BN-type reactors with MOX-fuel
- Closed Fuel Cycle of the Fast reactors based on compact recycling methods for SNF and simplified technologies of fuel pins manufacture.
- Based principles of this Closed Fuel Cycle:
  - Minimization of expenses for Spent fuel recycling, fuel pins refabrication and waste treatment
  - Minimization of radioactive waste volume and complete recycle of minor-actinides for transmutation in the same system
  - Excluding of pure fissile materials (Pu) from recycling technologies and arrangement all procedures in remote systems.

Unique Current Situation
International Aspect

INPRO:

Consolidation of IAEA role as a world community forum on Nuclear energy development

Transition to Phase 2 (R&D international programs)

Russia

President Putin initiative on Global Infrastructure of Nuclear Fuel Cycles (GINFC):

- Develop International Nuclear Fuel Treatment Centers

Generation IV International Forum

US

President Busch initiative

- GNEP – Global Nuclear Energy partnership

Russia is invited both in GIF and also in GNEP

IAEA is International Forum on INS

G8 summit on energy security (July 2006)

Proposals to INPRO Phase II

Initial approaches

- INPRO is a acting mechanism of international R&D cooperation in the field of new generation Nuclear power
- Jointing idea for INPRO Phase II – international project of commercial fast reactor with safety CNFC (may be related to main approaches of GNEP)
- Key element – Pilot INFC on a base on one of Russian nuclear center including "demo" international SNF Storage and semi-industrial scale experimental Facility for testing and development of different type fuel cycle technologies of different type industrial reactors SNF reprocessing (recycling) and conditioning

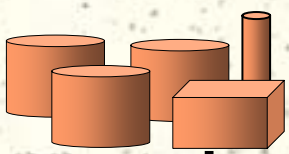
Proposals to INPRO Phase II

- International coordination of R&D in the field of national INS development, mutual comparison and international examination
- Possibility to elaborate and demonstrate of new INPRO roles:
  - "Umbrella" organization for new applied scientific projects
  - Regulation and organization of multilateral projects and studies
- Develop and support the links with other international and national Projects, Forums and Programs
  - GIF - GEN IV
  - GNEP
  - International Nuclear Fuel Treatment Centers Initiative
  - European FP6 (future FP7)
  - Russian NTP
  - Other Member States national programs
- Application for international R&D cooperation in frame of INPRO Phase II - Pilot complex of future Russian New Technological Platform (NTP) - BN-800 + RIAR + MAYAK reprocessing plant

CP Proposals to INPRO Phase II

G8 including RF

Gen IV / GNEP



International Commercial FR + CNFC

INPRO / IAEA

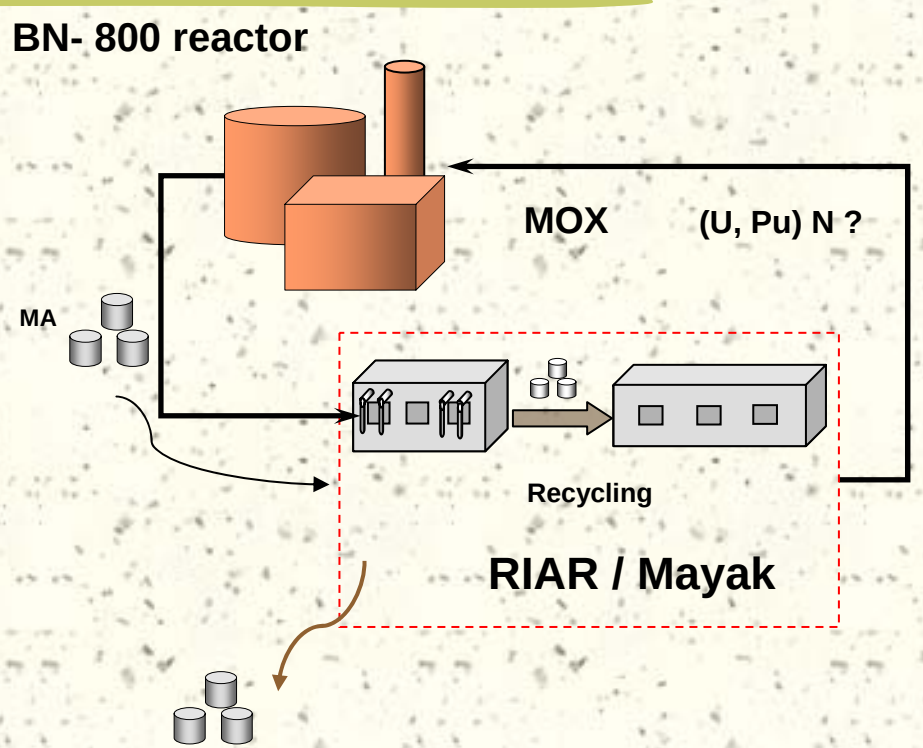
Joint initiatives on R&D in frame of INPRO Phase II

International Project of Commercial Fast Reactor

Pilot INFCC on a base on one of Russian nuclear center

Pilot complex of future Russian NTP - BN-800 + RIAR + MAYAK

Pilot complex of Russian NTP - BN-800 + RIAR + MAYAK



1. Irradiation in BOR-60, MIR, SM-3, BN-600/800 reactors:
   - Fuel, Fuel pins, FAs
   - Structural materials
   - In-pile devices
2. Fuel production, reprocessing, conditioning
3. PIE
4. RAW treatment

Possible flows of spent fuel

- VVER-440, VVER-1000 - U, Pu, MA
- RBMK - U, Pu, MA
- BN-600, BN-800 - U, Pu, MA
- Submarines, test reactors etc. - U, Pu, MA

In case of foreign spent fuel

- PWR, BWR - U, Pu, MA
- CANDU - U, Pu, MA

To store? To reprocess? To treat?

Basic approaches to SF reprocessing

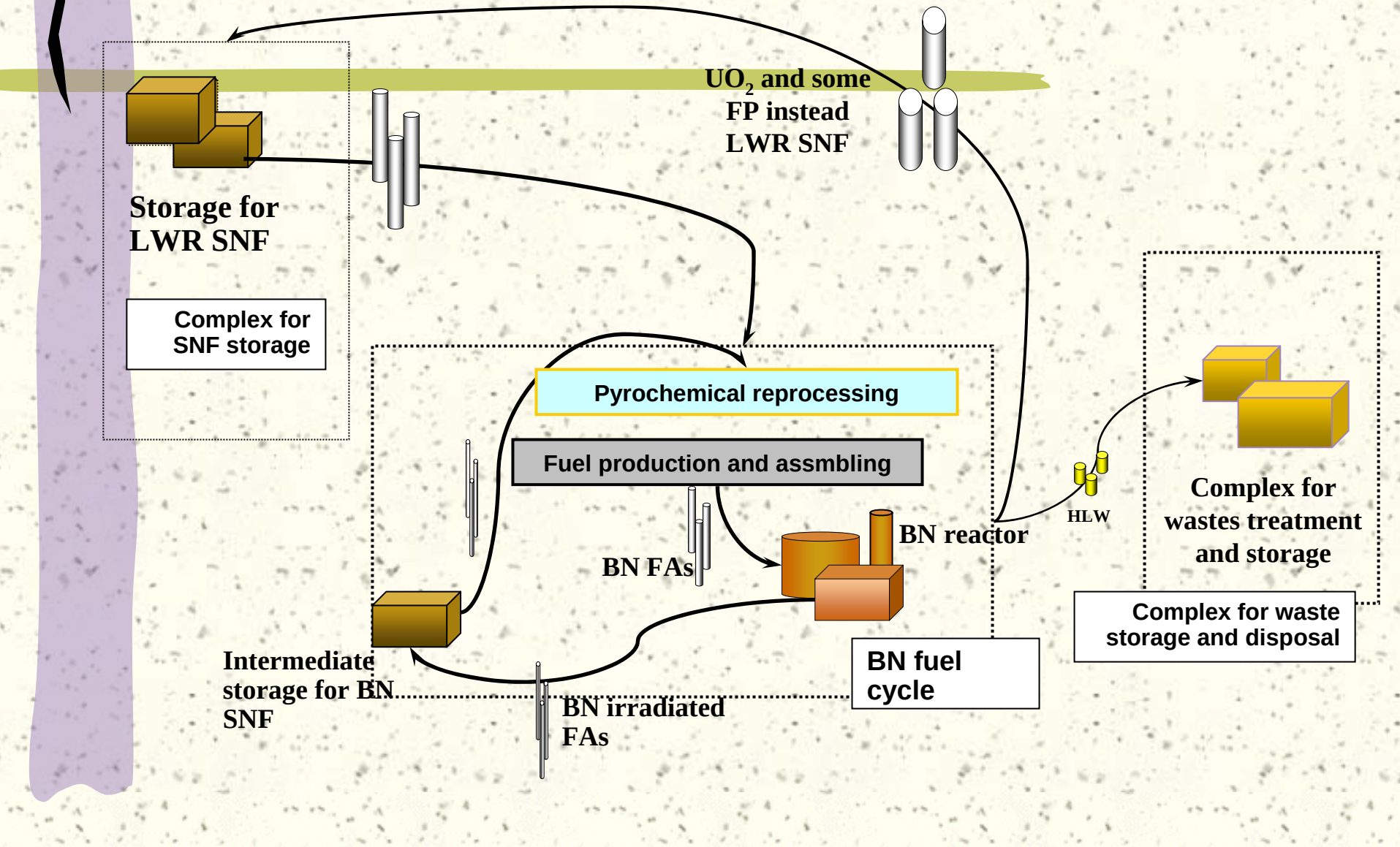
- Materials demanding for utilization
  - Reprocessing only in case of using of materials in fuel cycle
  - Excluding of recovery of basic components for stockpiles

Partitioning and recycling instead reprocessing

- All components must be introduced in closed fuel cycle
- Technologies flexibility and modules principle
- Criteria:
  - Minimization of wastes (and storage and disposal costs)
  - Non-proliferation (inherent barriers)

As an example

Combined fuel cycle of FBR with utilization of LWR SNF and replacement of LWR SNF by UO_2 after reprocessing

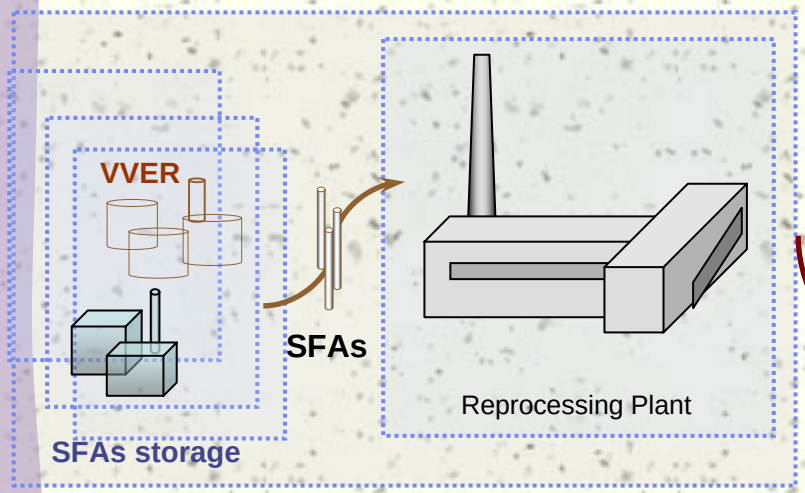


Possible flows for BN type reactors and LWR SNF

- Reprocessing of LWR SNF is possible for two tasks
  - recovery of slightly enriched uranium for re-enrichment (SNF with medium burn-up)
  - Recovery of Pu and MA for burning
- Program for BN type reactors introduction (BN-800,BN-1600,BREST) demands Pu (+ MA)
- One initial loading of BN-800 demands 160-220 tons of LWR SNF (+ annual additions)
- Uranium after recovery of Pu(+MA) could store instead LWR SNF with 5-10 times volume reduction

Triple-level structure of future Russian NFC

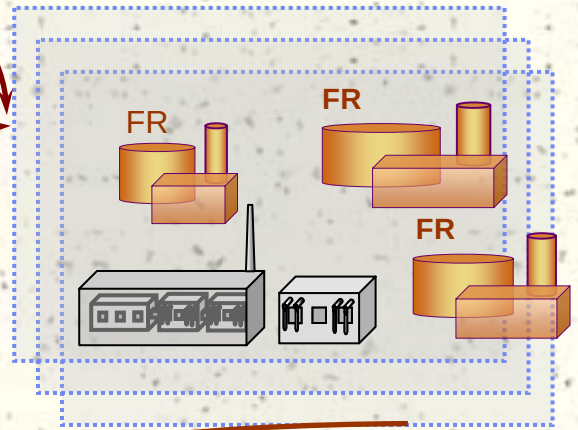
National Complex “VVER type reactors + large Reprocessing plant “



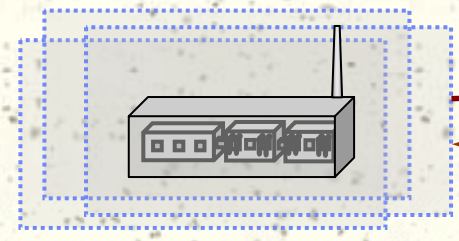
U for enrichment or disposal

Pu

Local Complexes “Fast reactor + on-site reprocessing”



Regional intermediate scale Reprocessing Plants

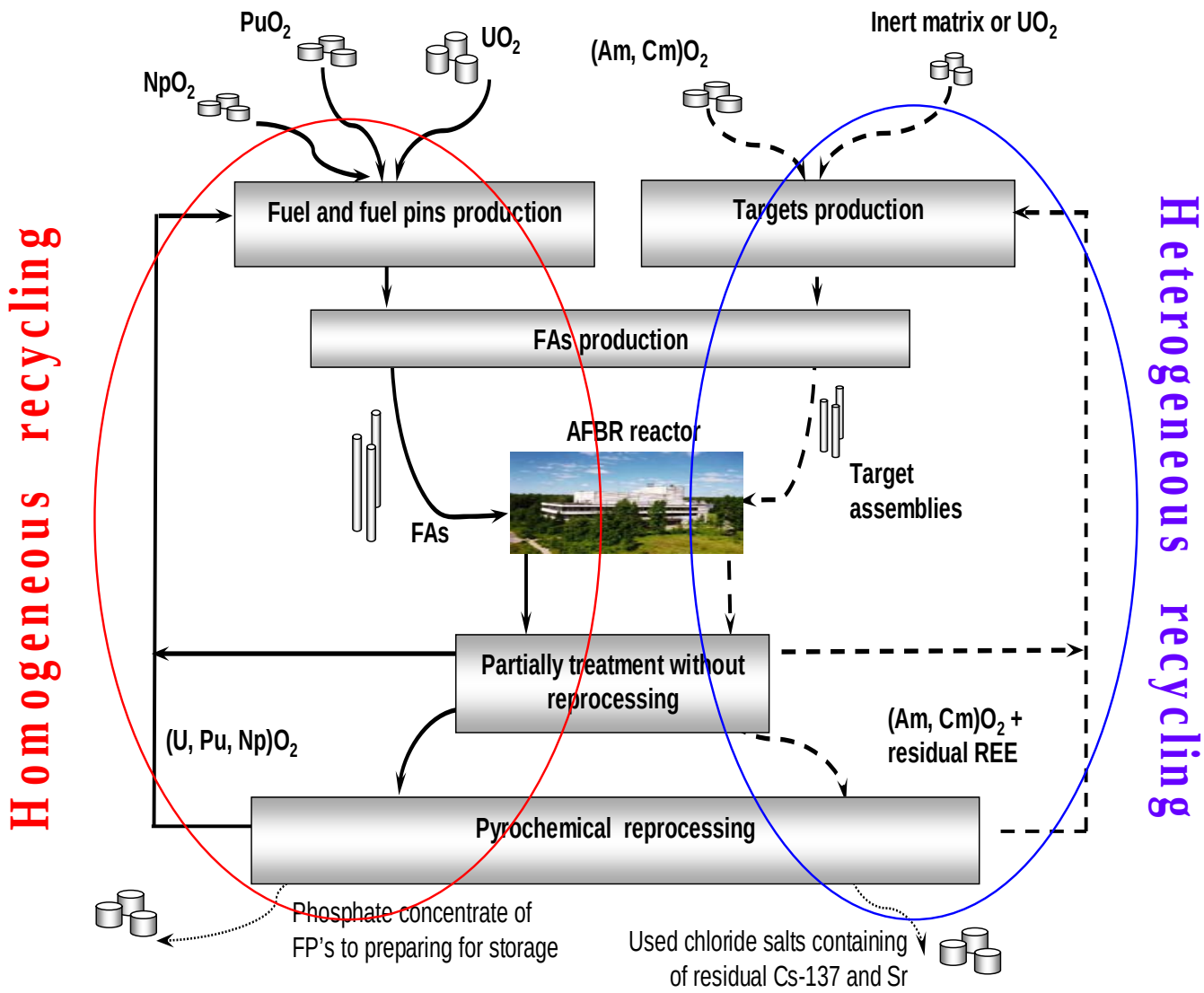


MOX

SFAs

As an example

DOVITA fuel cycle



Recent important projects in fast reactor cycle (RIAR)

- Modernization of semi-industrial facilities for MOX-fuel production
- Irradiation of 21 LTAs with vibro-MOX in the BN-600 reactor including PIE
- MOX fuel Production for so called Hybrid Core of BN-600 reactor
- Concept on MOX-fuel production for the BN-800 reactor (including recent facilities)
- Concept and experimental validation of closed fuel cycle for BN-800

Stages for Implementation of Closed fuel cycle with MOX fuel. RIAR view

Nearest possible stages for industrial implementation:

Stage 0:

Hybrid core of the BN-600 reactor (1500 kg of MOX fuel and 50 FAs annually), as pilot project for technology implementation and collection of industrial and irradiation statistics.

Stage 1:

Creation of MOX production lines for the BN-800 reactor with power grade Pu (up to 12 ton of MOX fuel and about 400 FAs annually) on the basis of MAYAK and RIAR cooperation with minimization of capital expenses

Stage 2:

Construction of the BN-800 closed fuel cycle (on MAYAK or near reactor) or for the next commercial BN reactor, as integrated plant with reactor, on the basis of developed technologies

Conclusions

- A number of technologies for recycling and treatment of Spent fuel are developed
- Production of recycling fuel after reprocessing could be organized in "non-proliferation" mode
- Flexible technological basis for International SNF Centers is developed
- Nearest and key candidate options is Fast reactor with closed fuel cycle as module for demonstration of technical aspects future International Centers for treatment of SNF