Report of the ANTT Subcommittee of NERAC

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Burton Richter, Chair
Victor Gilinsky
Darleane C. Hoffman
Susan E. Ion
Sekazi K. Mtingwa
Ronald P. Omberg
Joy L. Rempe

Highlights from the October 16-17 Subcommittee Meeting

- AAA program has been reorganized and is better focused.
- Some flesh has been put on the bones of our four goals:
  - Enhance long-term public safety.
  - Benefit the repository program.
  - Reduce proliferation risk.
  - Improve prospects for nuclear power.
- The analysis of the many approaches to transmutation is moving ahead.
- Facility needs for the next ten years have been looked at.
- The R&D program was reviewed.
- Roadmap II was discussed.

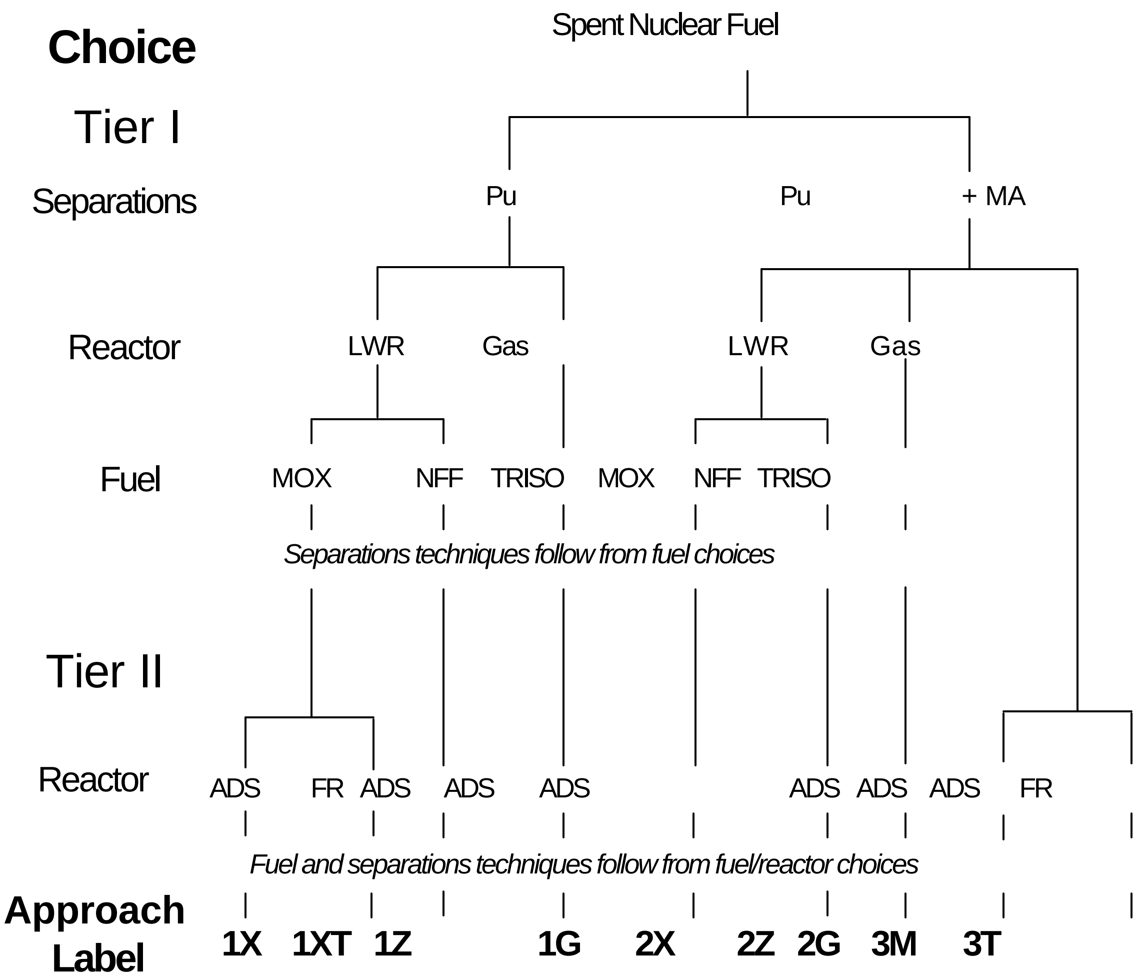
Preliminary Draft for Discussion

Top-Level Goals	Objectives	Quantitative Measures	Options for Meeting Objectives
Improve long term public safety	Radiotoxicity Objective: Reduce Radiotoxicity of Commercial Spent Fuel	Reduce Radiotoxicity of spent nuclear fuel below that of source uranium ore within 1, 000 years	Transmute about 99.5 % of the transuranics by minimzing separations and fuel fab lossess
	Dose Objective: Reduce Radiation Dose to Future Inhabitants of Repository Region	Reduce maximum predicted dose to future inhabitants by at least 99% compared to current predictions	Transmute most neptunium, some technetium, and perhaps iodine. Place remaining inventories in superior waste forms.
Provide benefits to the repository program	Heat Load Objective: Reduce Inventory of Materials that Create Long-term Heat Loads in Repositories	Reduce long-term heat load of spent nuclear fuel by at least 90% after 500 years	Transmute 99+ % of transuranics. Evaluate separation of cesium and strontium for special packaging and handling (short-term heat load)
	Criticality Objective: Effectively Preclude Future Criticalities	Maximize fissile material removal. Reduce inventory of plutonium in spent fuel by 99% & decrease fissile fraction in remaining plutonium and other fissile isotopes.	Reduce Fissile Material Fraction in waste repositories, especially by reducing & degrading plutonium content
	Mass Objective: Reduce Mass Requiring Disposal in Repository	Minimize Mass and volume to repository. Quantitative measure is the % reduction in mass and volume compared to once through spent fuel.	Separate & Divert Uranium Content. Pursue waste streams and waste forms that minimize mass or volume requiring deep geologic disposal.
Reduce the proliferation risk from plutonium in commercial reactor spent fuel	Plutonium Inventory Objective: Reduce Inventory of Plutonium within Fuel Cycle	Reduce or reverse the build-up of plutonium - Quantitative measure is the rate/time to achieve.	Transmutation system must be sufficient to overcome plutonium build-up from once through cycle.
	Plutonium Disposal Objective: Minimize Mass of Plutonium Transferred into Repository	Reduce inventory of plutonium in spent fuel by 99%.	Transmute high fraction of transuranics. The plutonium fissile fraction should deplete quickly.
	Plutonium Accessibility Objective: Minimize Potential for Diversion of Plutonium	Minimize transmutation facilities' footprint. Maximize radiation barriers with plutonium.	Keep radiation barrier isotopes with Pu that are difficult to separate. Minimize the infastructure and transportation.
Improve Prospects for Nuclear Power	Viability Objective: Provide viable and economically feasible waste management options for commercial spent fuel	Safely minimize transmuter support ratio, defined as the ratio fission rate (MWt) in transmuterss to fission rate in generators transmuters	Multi-Tier Systems with Tier-1 systems that fission larger fractions of transuranics should be more cost effective than those that pass most Pu to Tier-2
	Technical Risk Objective: Minimize technical risk to achieve solutions to nuclear waste challenges	Formally evaluate technical risk for all program and project aspects, including R&D. Minimize time and cost, and contingency required for implementation. Quantitative measure depends on methodology.	Use international collabor-ations to optimize fuels & separations developments. Use pilot projects based on sound R&D to eval production scale. Use known technologies

Observations on Goals

- Different long-term radiation measures are used by EPA (radiotoxicity) and NRC (dose).
- Effects of Fuel handling and separation have to be included in radiation estimates.
- Analysis needed on repository benefits in simplifying design and reducing number.
- Proliferation evaluation has to balance long-term versus short-term risks. Possible terrorist activities have to be looked at.
- Nuclear power prospects analysis has to include costs and externalities (Pu inventory reduction, radiation reduction, carbon-free power, etc.). Will eventually need policy guidance.

Choice Tree


Choice
Tier I
Separations
Reactor
Fuel
Tier II
Reactor
Approach Label
Spent Nuclear Fuel
Pu
Pu
+ MA
LWR
Gas
LWR
Gas
MOX
NFF
TRISO
MOX
NFF
TRISO
Separations techniques follow from fuel choices
ADS
FR
ADS
ADS
ADS
ADS
ADS
ADS
FR
Fuel and separations techniques follow from fuel/reactor choices
1X
1XT
1Z
1G
2X
2Z
2G
3M
3T

Observations on Approaches

- The commercial sector (Tier 0) can be used in some approaches for Tier 1 activities. This should not be ignored.
- A fast spectrum device is required in **all** approaches to complete the job.
- Non-fertile fuels significantly improve the effective transmutation rate. Partial core loads in Tier 0 reactors may be very useful.
- Separation efficiencies do not have to be as good as the 99.9% goal of the AAA program.
- Plutonium policy is important. Different answers if:
  - Pu is separated from minor actinides.
  - Pu stays with the minor actinides.
  - Partial separation (americium) is allowed.

  Keep options open and do not assume what will or will not be allowable.
- Options can be narrowed in six to twelve months.

Technology Readiness

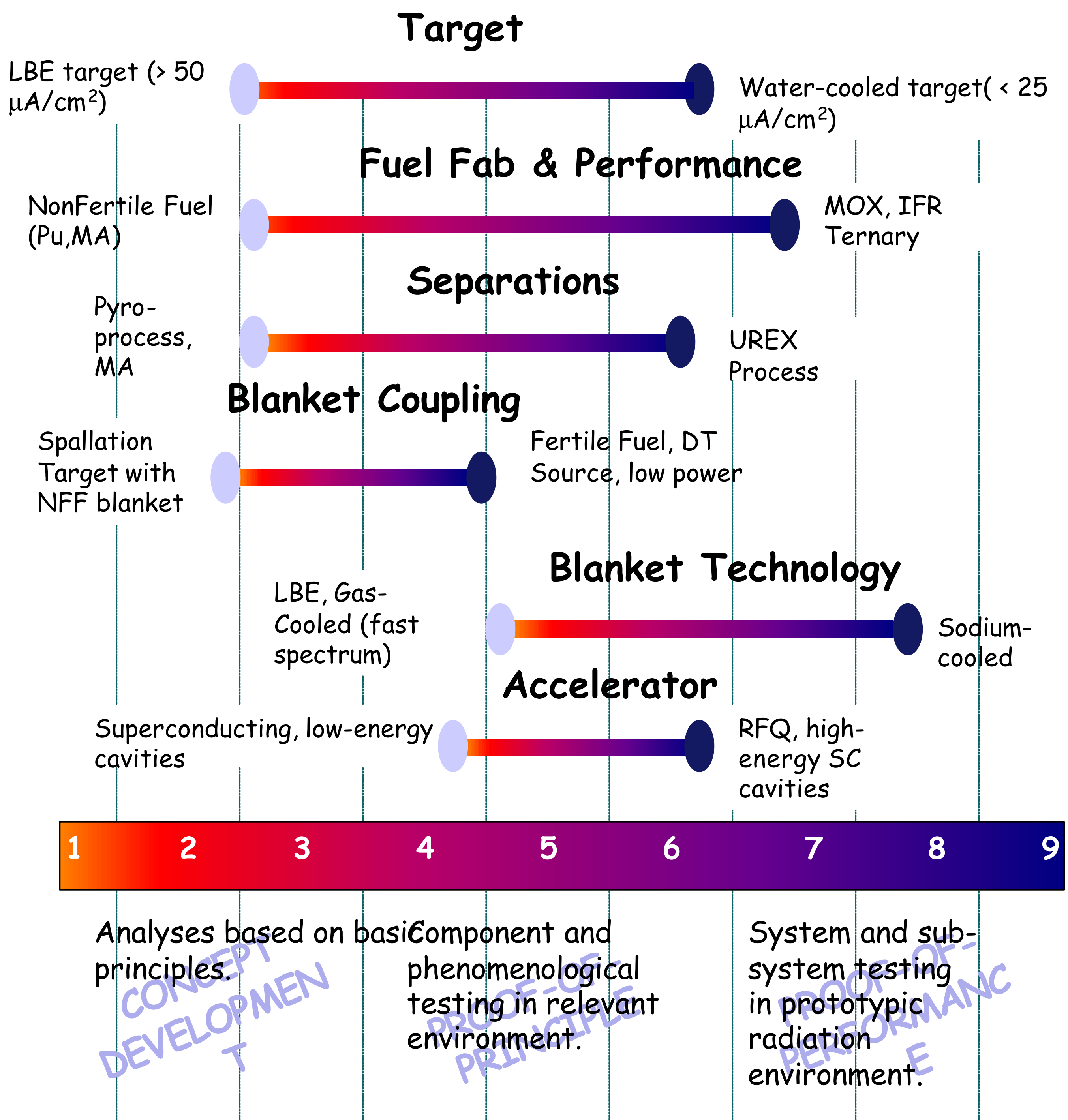
Assumptions:

- ADTF with 5-10MW linac and target and materials test (TMT) station ready to turn on in ten years.
- Subcritical multiplier (SCM) at 100MW maximum thermal power ready three years later.

Results of evaluation:

- Fuel and separation technologies have farthest to go.
- Accelerator is in the best shape.
- Test facilities required along the road pose a real problem

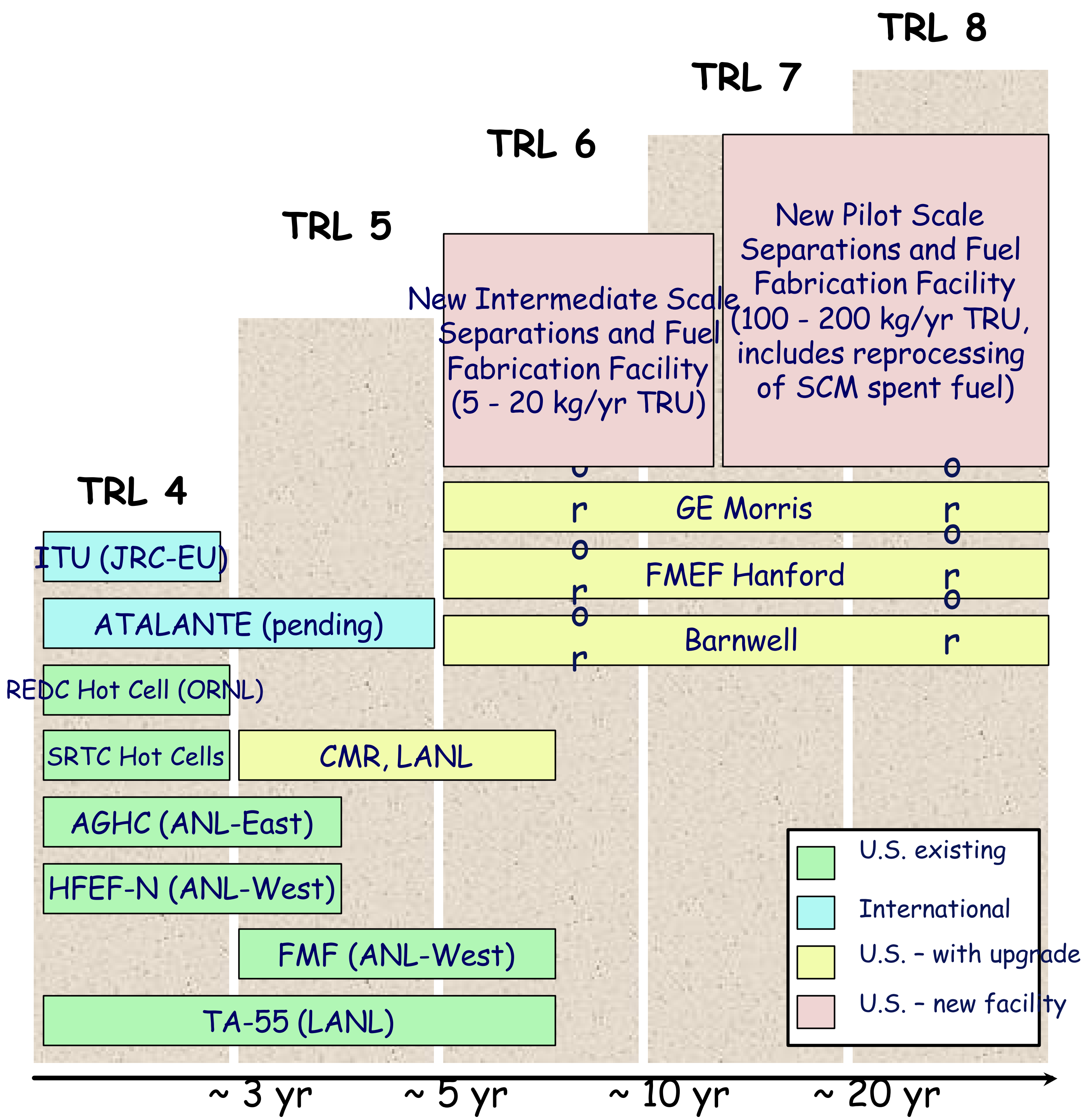
Area and Sub-System



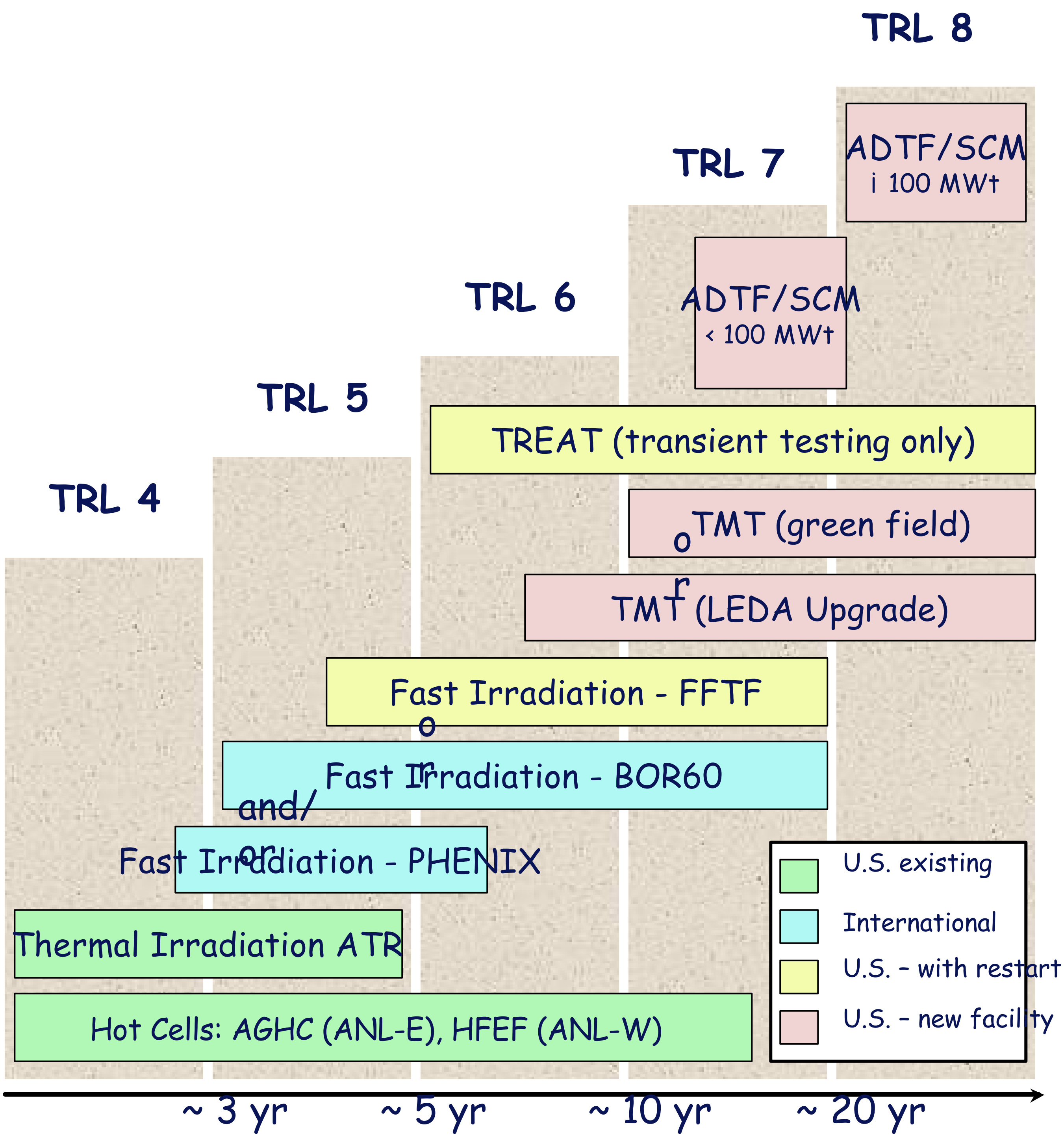
Test Facility Needs

- United States' nuclear R&D infrastructure is marginal at best.
- Many facilities have been mothballed and there has been little enthusiasm for restarting them.
- Even the earliest stages of technology development **require** the use of international facilities.
- The Subcommittee asked for a presentation on what would be needed for the next ten years to support the ADTF-TMT-SCM schedule.
- Much (most?) of what is needed is not presently available.

separations and fuel fabrication



For Tier-2 Fuel Development



Preliminary Analysis of Test Facility Needs

Target:

- 1MW beams available at PSI and LANCE.
- 2MW beam available in about four years (SNS).
- An upgrade of LANL's LEDA facility to 5-10MW may be needed.

Fuel:

- Thermal spectrum testing available at INEEL (ATR).
- Fast spectrum tests at PHENIX (France) until 2006 and possibly at BOR60 (Russia).
- FFTF restart (not likely) would be a big help.
- Transient testing needs a restart of the ANL-W TREAT facility or a new facility.

Separation:

- Small-scale facilities are available.
- A 5-20kg/yr facility is needed in about five years.
- A 100-200kg/yr facility is needed in about ten years.

Target-SCM Coupling:

- Foreign facilities can be used for the next three to five years.
- It is not clear what to do after that.

International Collaboration

- Europe and Japan (and others) are at least as interested in transmutation as we are.
- France has the best developed program.
- OECD’s NEA is about to issue a detailed analysis of the potential and the issues.
- Everyone faces the same need for facilities to carry out the R&D.
- It is to everyone’s financial benefit to share the load (win – win).
- DOE is working the problem, but for it to work we will have to invest in **some** of the facilities.

Road Map II

- Road Map I was detailed and described a system of large accelerators and SCM's connected to the power grid. The system took too long and cost too much.

- Road Map II is aimed at the multi-tier approach.

- It is too early for all the details of Road Map I. Road Map II should be a living document with realistic goals and milestones for the next five years and must necessarily be vague beyond that.

- It should be periodically updated.

- DOE has made a good start.

A Final Note

- The AAA group has done an excellent job in the last six months and the program is developing well.
- The AAA folks at the DOE and at the labs need to look ahead and give a realistic analysis of the potential of the program and the **cost** of moving it to the point of an operating SCM or other fast system.
- The look ahead should include the international dimension.
- It will probably take two years to get that far if there is sufficient support for the program until then.
- The FY2002 budget is $50 million, and Congress requires a report by May 1, 2002 that will have to be more on educated guess than a sturdy analysis.