

# *Path Ahead ....*

- ❑ ***Closed Fuel Cycle***  
*Minor Actinide Partitioning*  
*Recovery Of Fission Products*
- ❑ ***Thorium Fuel Cycle***

**P K WATTAL**  
BHABHA ATOMIC RESEARCH CENTRE  
INDIA



International Atomic Energy Agency Scientific Forum

**RADIOACTIVE WASTE:  
MEETING THE CHALLENGE**

Science and Technology for  
Safe and Sustainable Solutions

23–24 September 2014, Vienna, Austria

## ***Minor Actinide (MA) Partitioning***

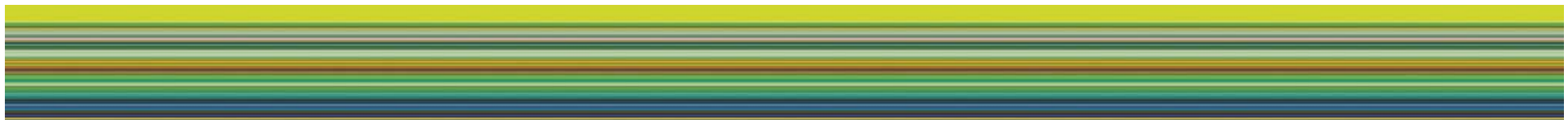
- ✓ Impact on reduction of radiotoxicity
- ✓ Substantial size reduction of Geological Repository
- ✓ MAs can be transmuted in Fast Reactors /Subcritical Reactors

## ***Recovery of Valuable Fission Products***

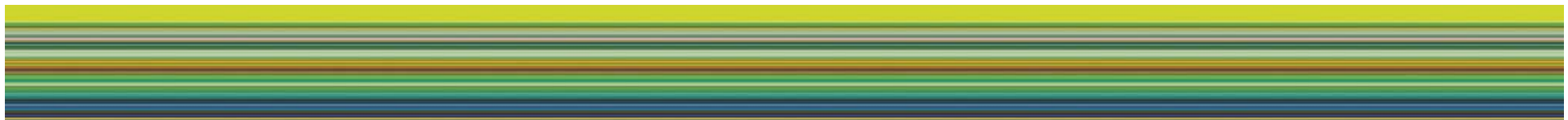
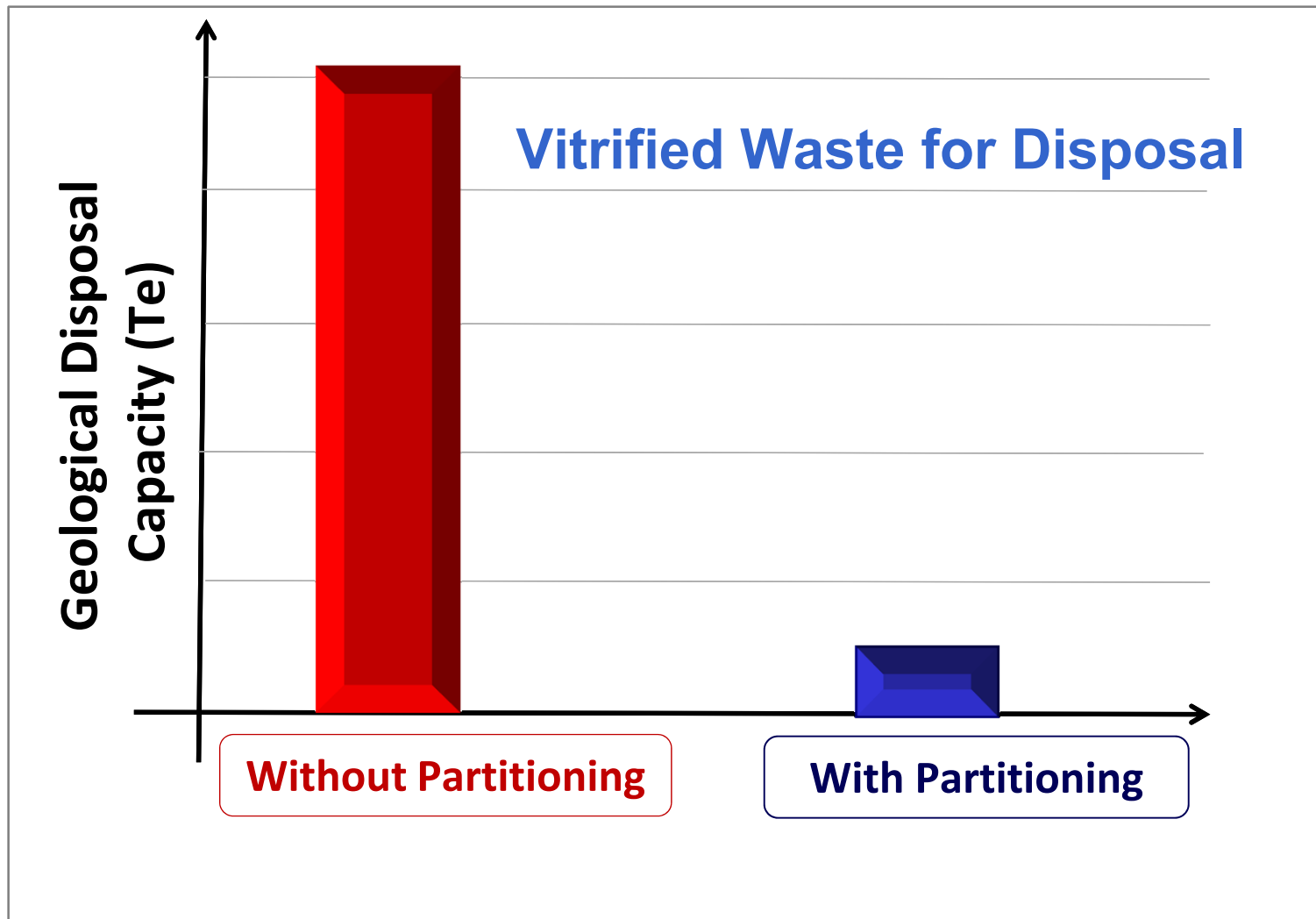
- ✓ Direct Societal Impact



***A promising approach for sustainable waste management***



# Impact On Geological Disposal Facility



# Vitrified Cesium for Irradiation

- *Brachy Therapy*
- *Blood Irradiation*
- *Food irradiation*
- *Hygenisation of sewage sludge*

## Cesium vs Cobalt

- ✓ *Less frequency of replacement*
- ✓ *Less shielding requirement*
- ✓ *Abundant availability in Radioactive Waste*

### Cobalt – 60

*Half – life : 5.37 Yrs*

*Energy : 1.17 MeV & 1.33 MeV*

*Sp Activity : 60 – 70 Ci/g*

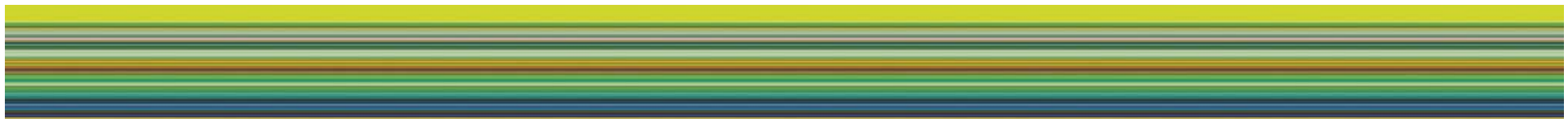
### Cesium -137

*Half – life : 30 Yrs*

*Energy : 0.66 MeV*

*Sp Activity : 10-18 Ci/g as CsCl*

*8-10 Ci/g as Cs in Glass*



# Attractive Features of Thorium Cycle

## Resource Availability

- ✓ Uniformly distributed in earth crust
- ✓ 3 to 4 times abundant than uranium

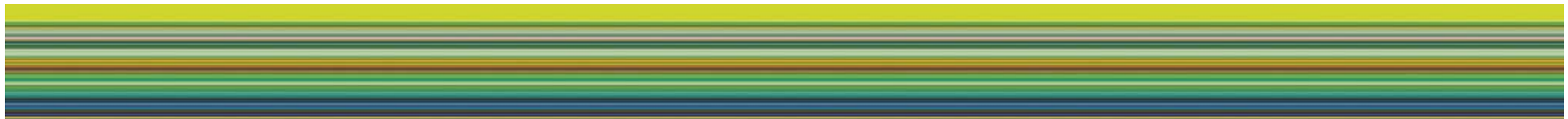
## Relative Ease in Waste Management

- ✓ Better Stability in *Geological Repository*, if directly disposed off.
- ✓ Reduced *radiotoxicity* due to trace quantities of Pu and MAs generated
- ✓  $U^{233}$  *proliferation resistant* in presence of high energy  $U^{232}$ .

MA (g/T) for U vs.Th fuel cycle ( 60 GWD/t)

MA	$U^{235} + U^{238}$	$U^{233} + Th^{232}$
Np	900	3
Am	470	0.002
Cm	220	0.0006

***MA production in U233-Th232 cycle is few orders lower***



*Thank you for your attention*



International Atomic Energy Agency Scientific Forum

**RADIOACTIVE WASTE:  
MEETING THE CHALLENGE**

Science and Technology for  
Safe and Sustainable Solutions

23–24 September 2014, Vienna, Austria