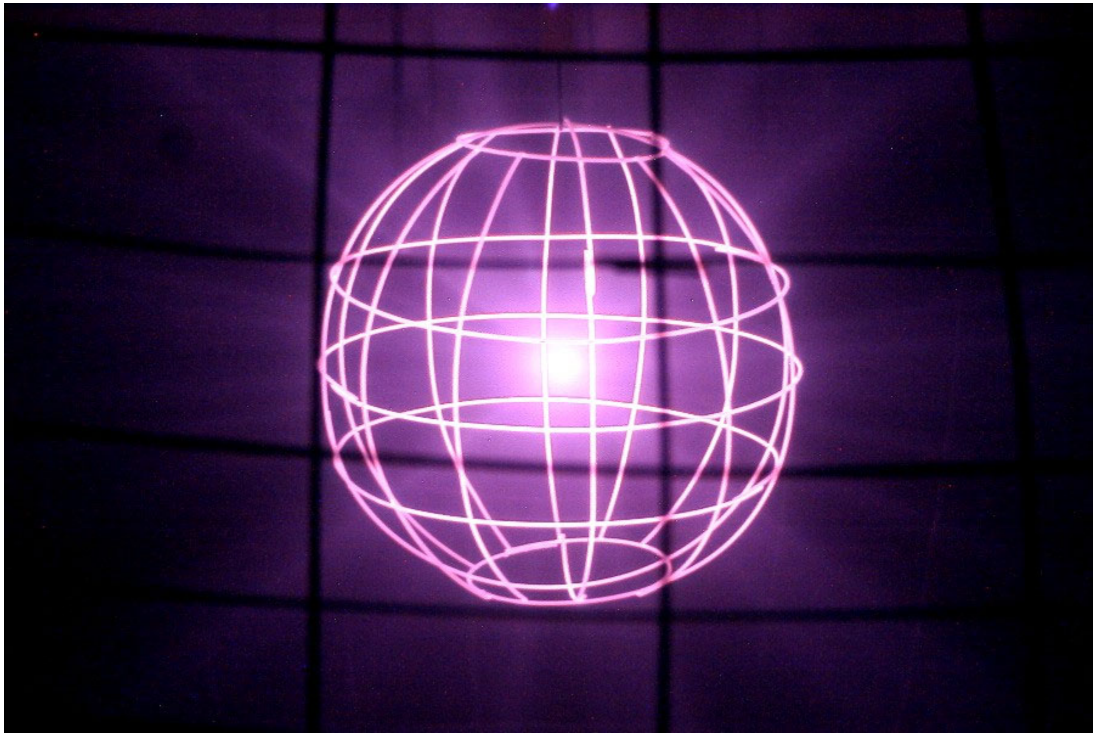
Using Lunar Helium-3 to Generate Nuclear Power Without the Production of Nuclear Waste



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The Public Developed a Resistance to Nuclear Power in the Late 20th Century

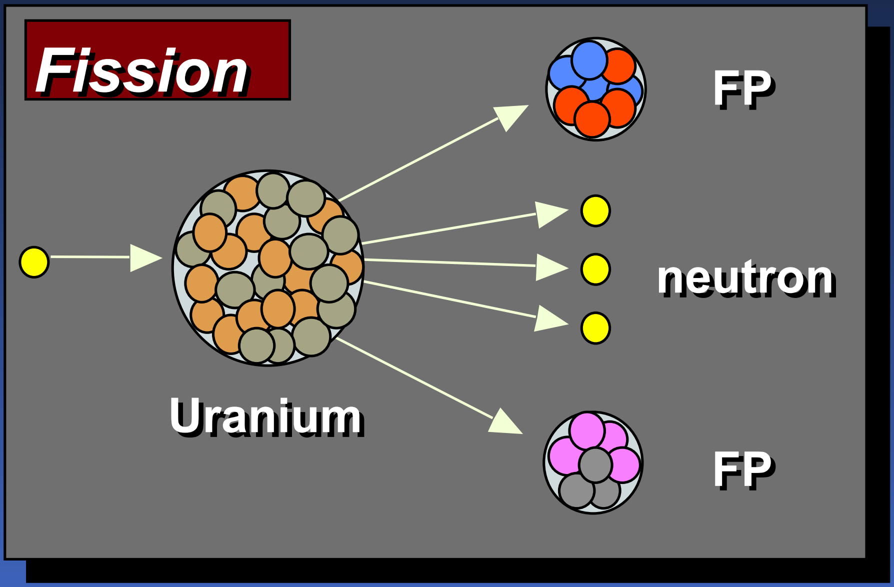
The resistance seems to be largely based on:

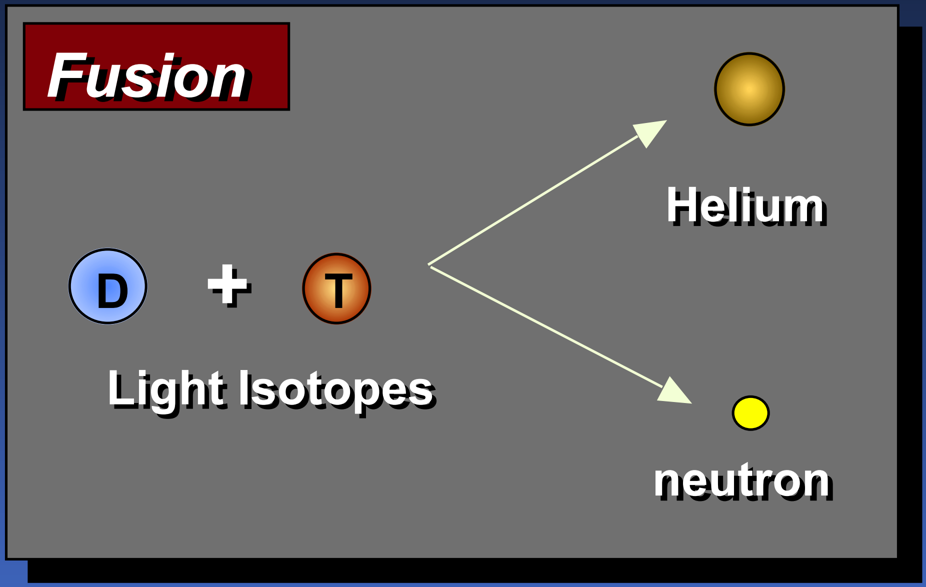
1) Fear of radioactivity releases
2) Uneasiness with long-term nuclear waste storage
3) Fear of proliferation of nuclear weapons grade material

All of the above problems stem from the nuclear reaction:

1) Radioactive fuel
2) Radioactive reaction products
3) Neutrons

There Are 2 Main Nuclear Reactions to Release Energy





The 20th Century Approach to Fusion Only Partly Alleviates Public Concerns About Nuclear Power

Public Concern	How DT Fusion Addresses Concern
Radioactive Releases	Avoid runaway reactions and "meltdown" scenarios However, still have gigacuries in reactor in the event of an accident
Long Term Radioactive Waste Storage	Choice of fuel and structural material can reduce effective half life to < 100's years However, radiation damage and replacement of components can produce large volumes of radioactive waste
Proliferation	Reactor does not require fissile or fertile material However, excess neutrons can be used to breed fissile fuel

Fusion Can be Conveniently Divided into Three Eras

1st Generation

$D + T \rightarrow n\ (14.07\ MeV) + {}^4He\ (3.52\ MeV)$

$D + D \rightarrow n\ (2.45\ MeV) + {}^3He\ (0.82\ MeV)$ {50%}

$\rightarrow p\ (3.02\ MeV) + T\ (1.01\ MeV)$ {50%}

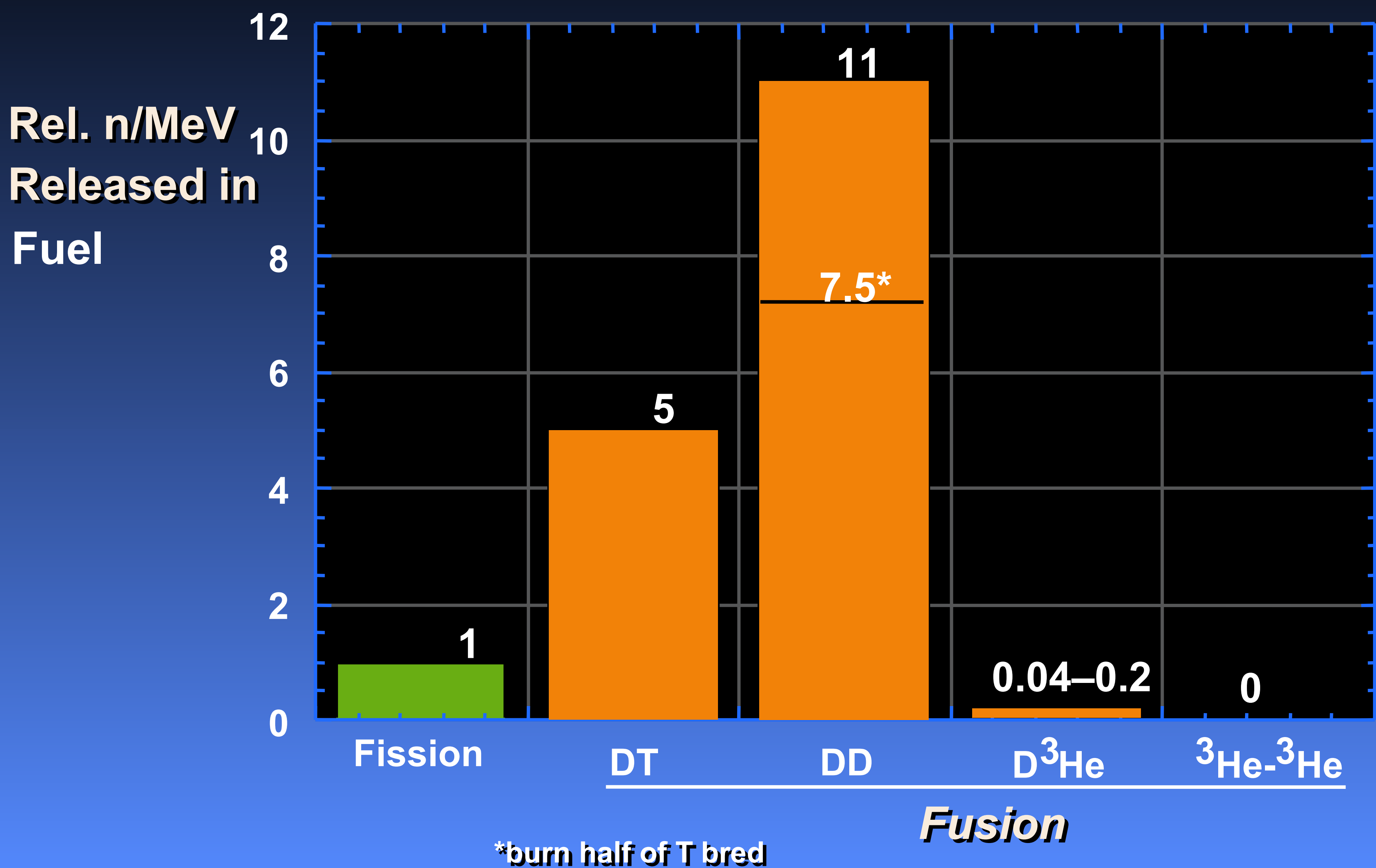
2nd Generation

$D + {}^3He \rightarrow p\ (14.68\ MeV) + {}^4He\ (3.67\ MeV)$

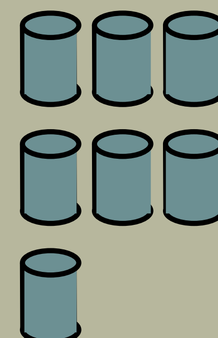
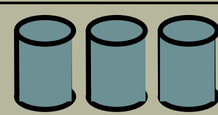
3rd Generation

${}^3He + {}^3He \rightarrow 2p + {}^4He$ (12.9 MeV)

The Number of Neutrons Generated by Helium-3 Fusion Fuels is Very Small



The Use of 2nd and 3rd Generation Fusion Fuels Can Greatly Reduce or Even Eliminate Radioactive Waste Storage Problems

Class of Waste	Relative Cost of Disposal	LWR Fission (Once Through)	DT (SiC)	D^3He (SiC)	$^3He^3He$ (any material)
		Relative Volume of Operation Waste/GWe-y			
Class A	1	several times Class C amount	several times Class C amount		
Class C	≈10				
Deep Geological (Yucca Mtn.)	≈1000				

Characteristics of D ^{3}He Fusion Power Plants

- No Greenhouse or Acid Gas Emissions During Operation
- Very High Efficiencies (>70%)
- Greatly Reduced Radiological Hazard Potential Compared to Fission Reactors (<1/10,000)
- Low Level Waste Disposal After 30 y
- No Possible Offsite Nuclear Fatalities in the Event of Worst Possible Accident

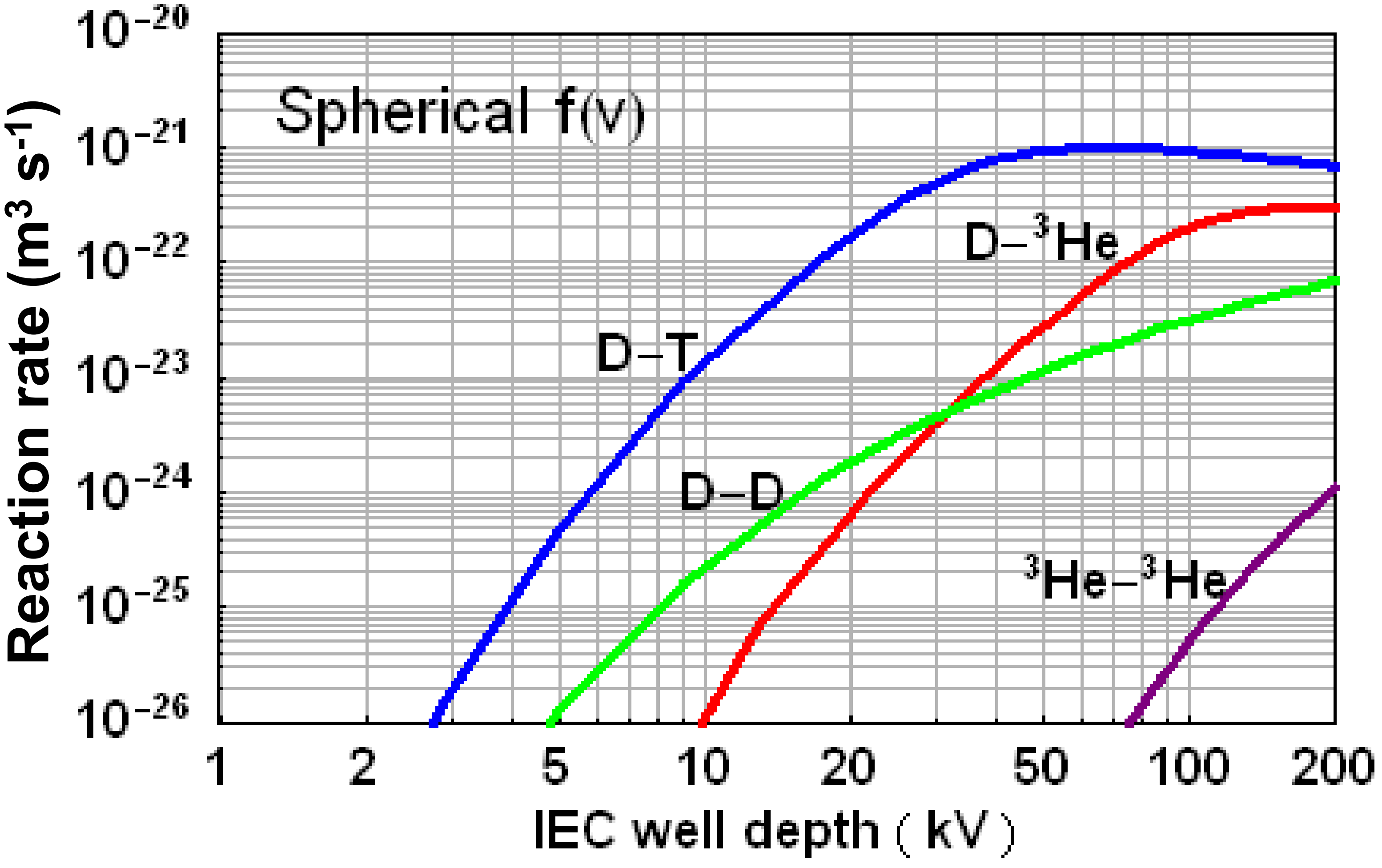
Characteristics of ^3He ^3He Fusion Power Plants

- No Greenhouse or Acid Gas Emissions During Operation

- Very High Efficiencies (>70%)

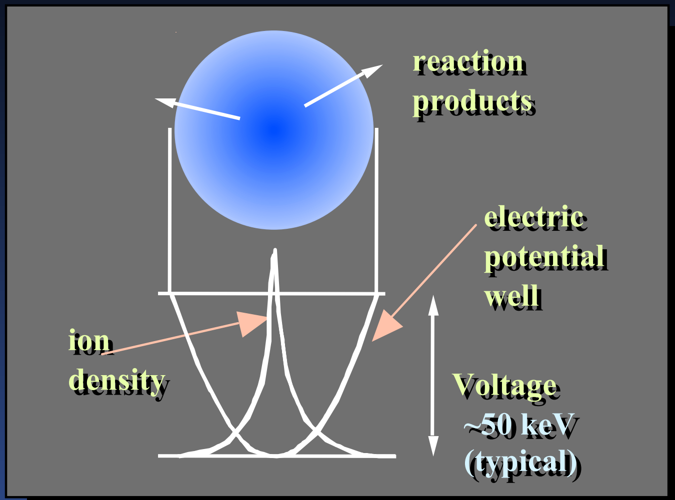
- No Residual Radioactivity After 30 Years of Operation (No Radioactive Waste, Radiation Damage, or Safety Hazard).

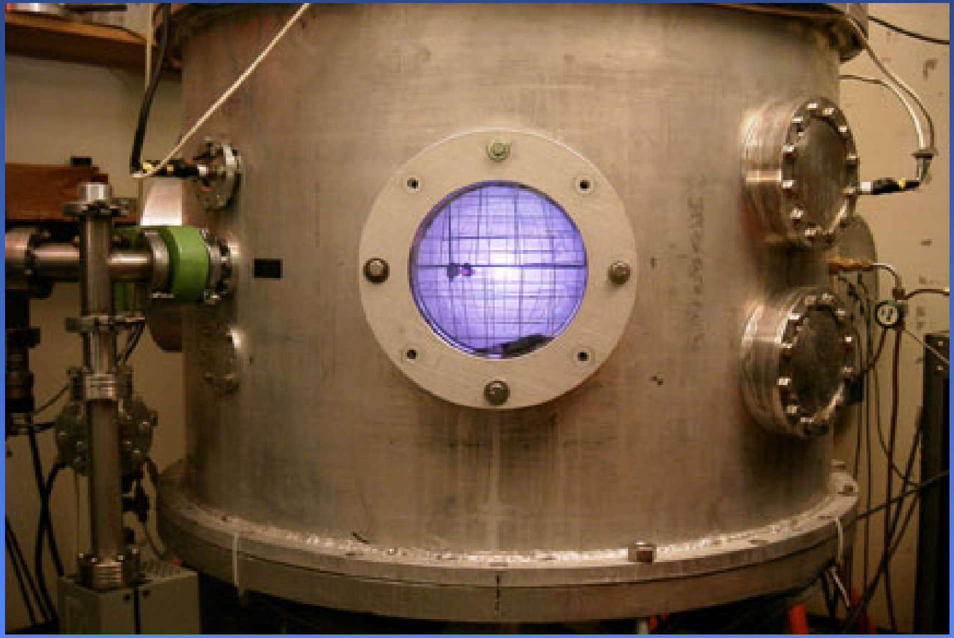
Fusion Reactivities for IEC Distributions



Steady State D ^{3}He Reaction Rate Achieved in Wisconsin IEC Device

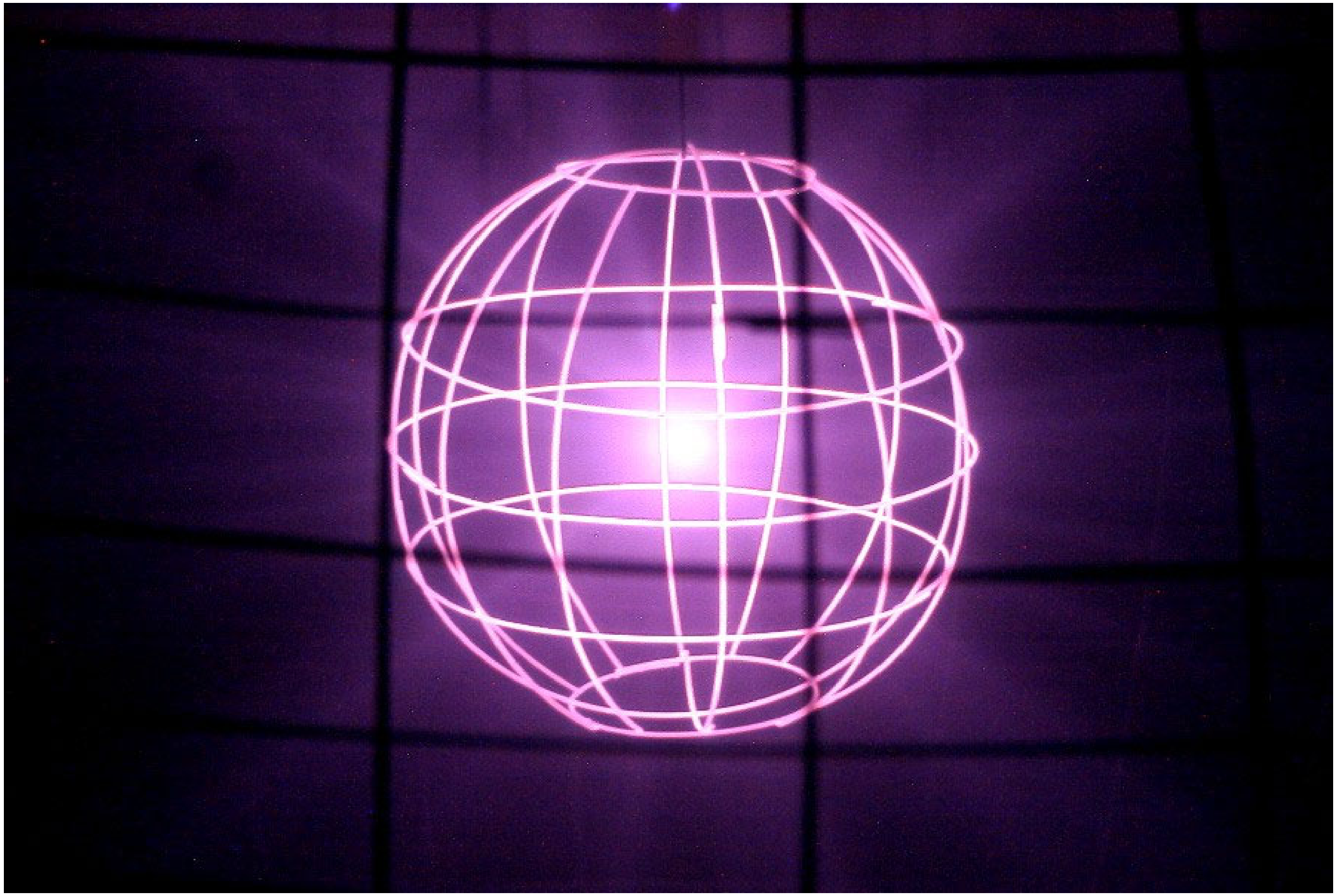
cathode voltage=55 kV
cathode current=60 mA pressure=1 mtorr



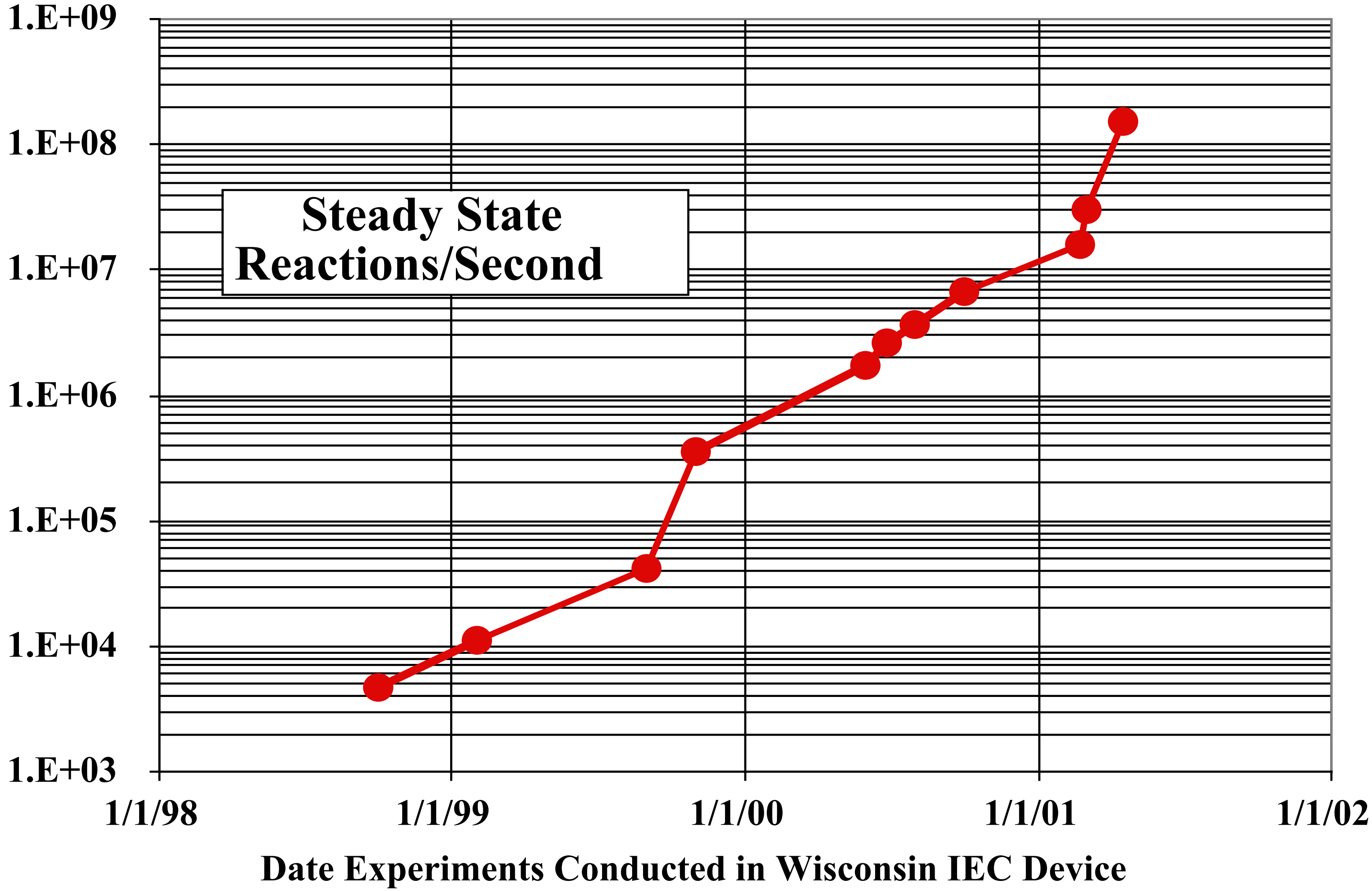


The Steady State D-^{3}He Fusion Rate in the UW IEC Device is Now 1.5 x 10^8 p/s

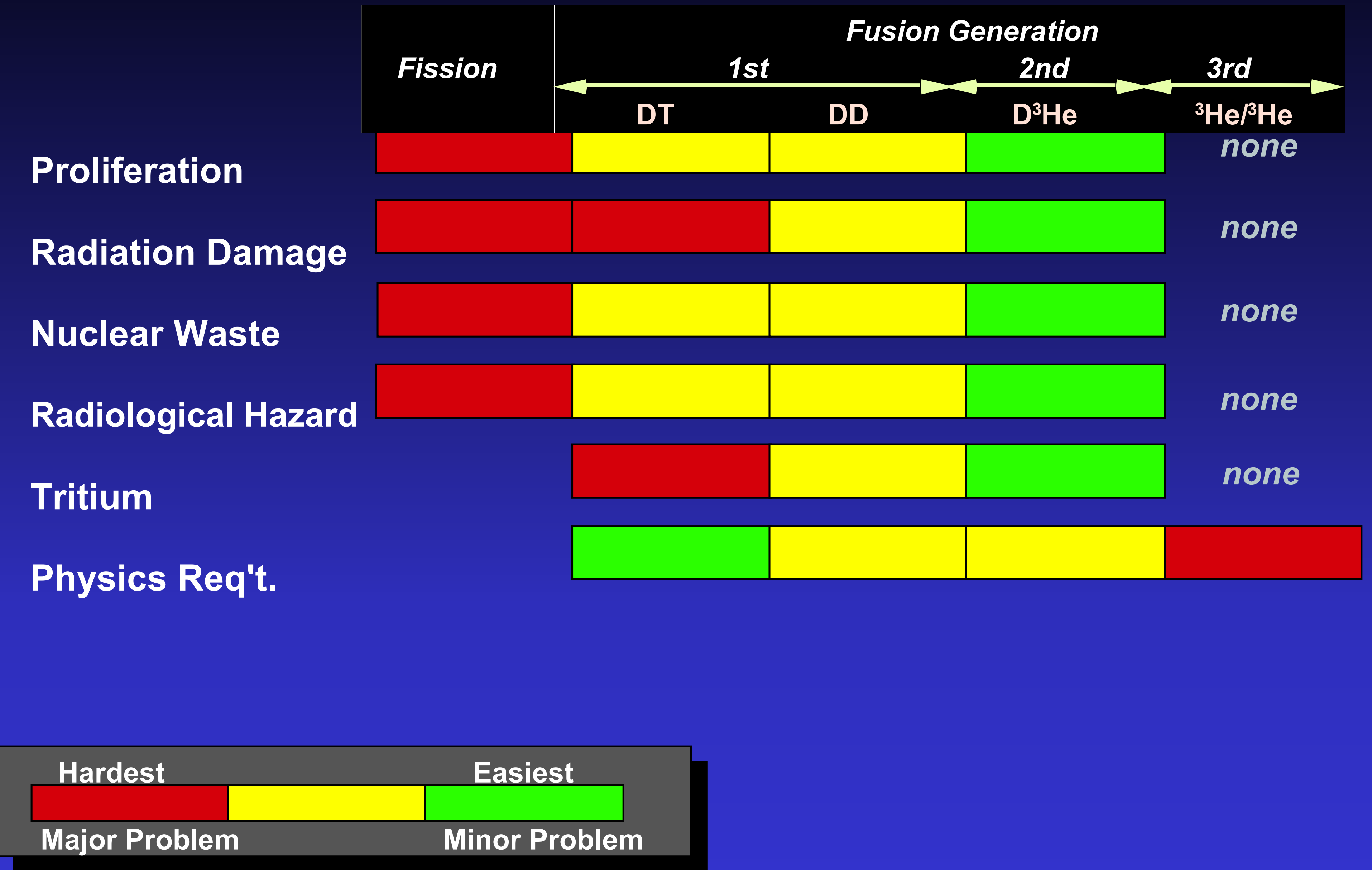
(115 kV, 60 mA)



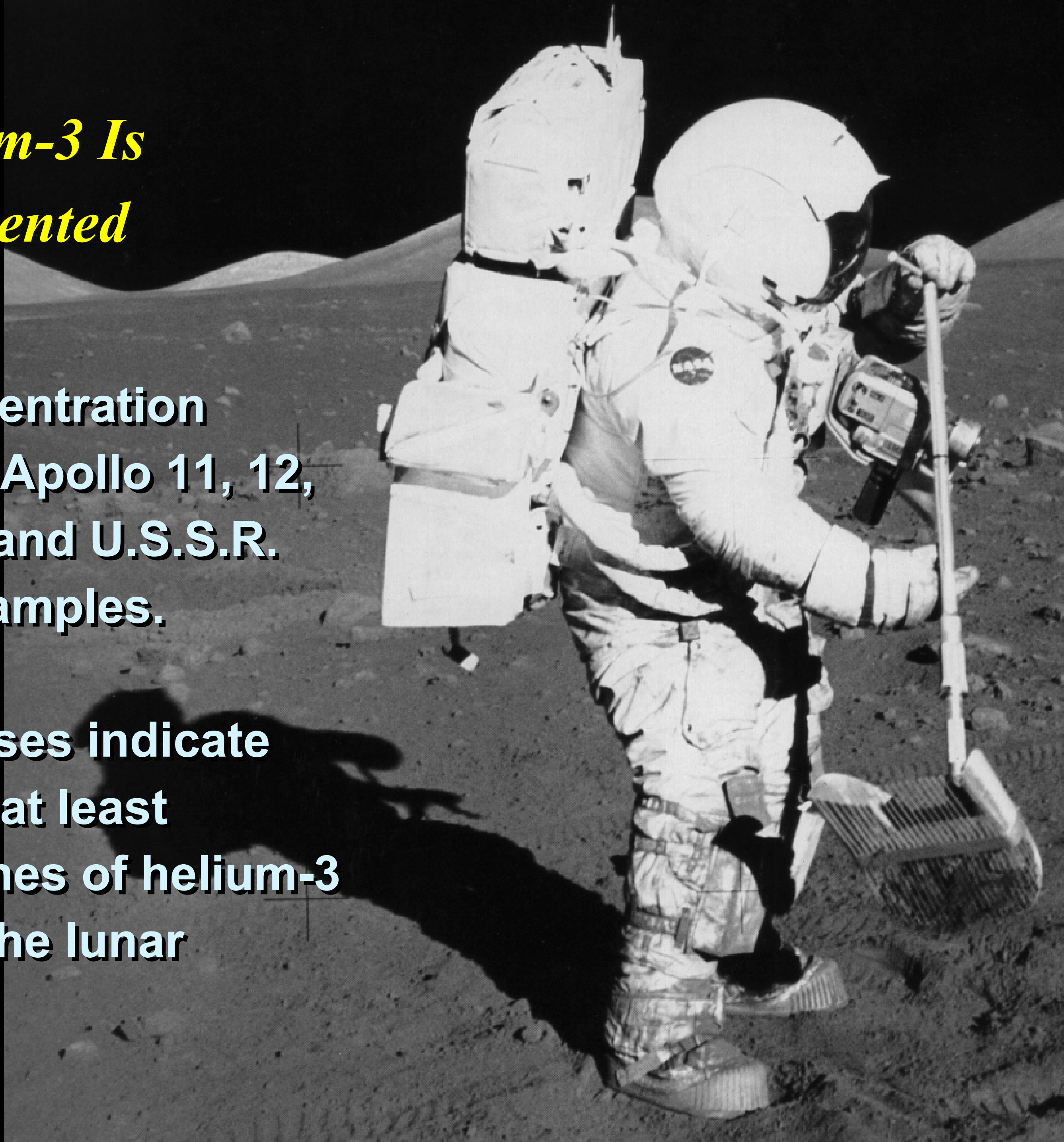
Significant Progress Has Been Made in Producing High Energy Protons from the D^3He Reaction



Major Societal and Technical Concerns of Nuclear Energy Options

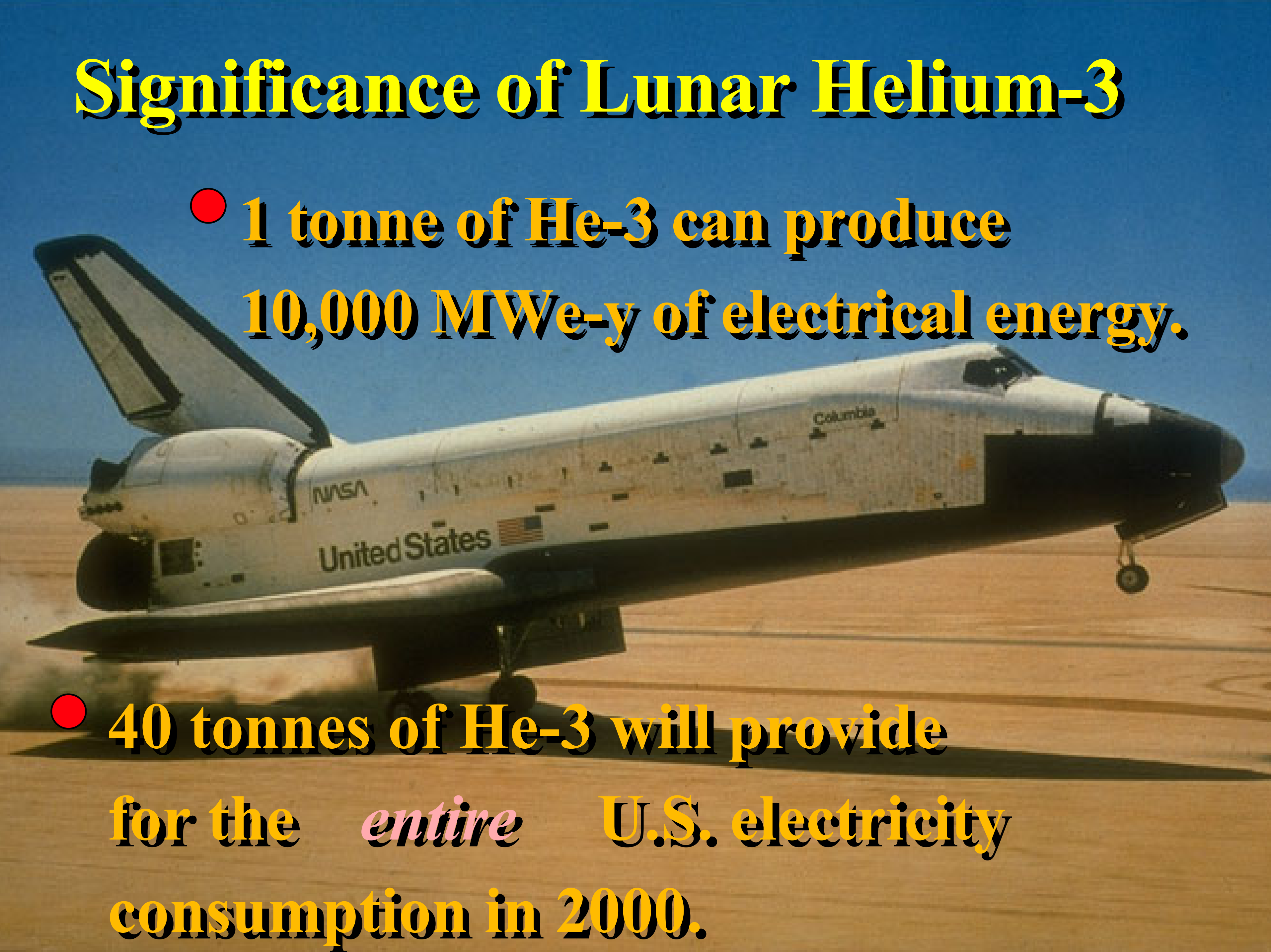


Lunar Helium-3 Is Well Documented



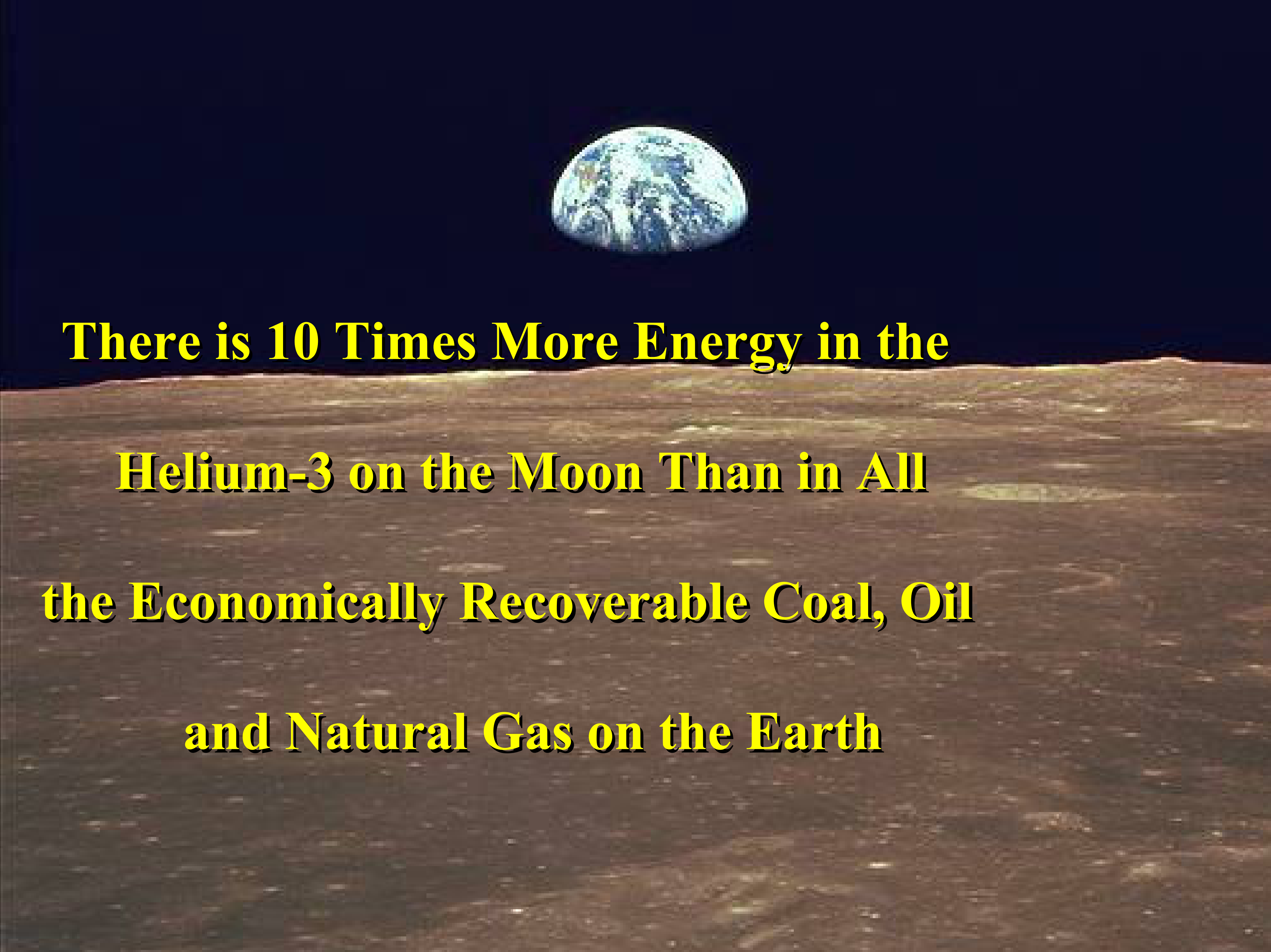
- **Helium-3 concentration verified from Apollo 11, 12, 14, 15, 16, 17 and U.S.S.R. Luna 16, 20 samples.**
- **Current analyses indicate that there are at least 1,000,000 tonnes of helium-3 imbedded in the lunar surface.**

Significance of Lunar Helium-3



- 1 tonne of He-3 can produce 10,000 MWe-y of electrical energy.
- 40 tonnes of He-3 will provide for the *entire* U.S. electricity consumption in 2000.


At 1 Billion Dollars a Tonne the Energy Cost of Helium-3 is Equivalent to Oil at $7 per Barrel
HEIDRUN


There is 10 Times More Energy in the
Helium-3 on the Moon Than in All
the Economically Recoverable Coal, Oil
and Natural Gas on the Earth

The Development of the 2nd and 3rd Generation Fusion Fuels in the 21st Century Could Lead to Near Term, as Well as Long-Term Benefits to Society

Phase 3

Long Range Benefits of a Q>10 IEC Device

- All of Phase 1
- All of Phase 2
- Small, Safe, Clean and Economical Electrical Power Plants

Phase 2

Intermediate Term Spinoff from a Q = 1–5 Device

- All of Phase 1
- Destruction of Toxic Materials
- Space Power
- Propulsion Technologies
- Remote Electricity Stations

Phase 1

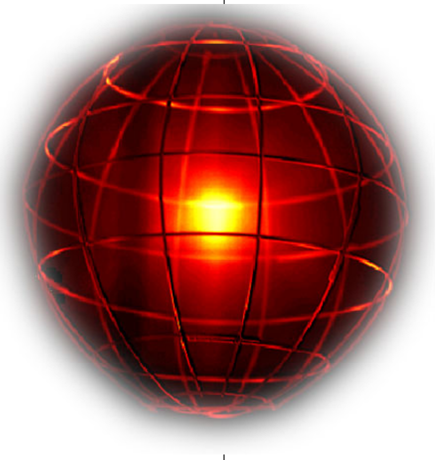
Near Term Spinoff from a Q < 1 Device

- Medical Treatment
- Civilian Commercial Markets
- Environmental Restoration
- Defense

Applications

Near Term

- Medical Isotope Production
- Cancer Therapy
- Detection of Explosives
- Detection of Chemical Wastes



Mid-Term

- Destruction of Fissile Material
- Destruction of Radioactive Wastes

Long Range

- Small (50-100 MWe) Electrical Power Plants
- Use of Advanced Fuels (Helium-3)
- Space Propulsion
- Base Load Electrical Power Plants
- Hydrogen Production
- Synthetic Fuel Production