The United States IEC Program

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History Timeline for U. S. IEC Research

- Salisbury Patent - Cylindrical IEC - 1949
- Elmore, Tuck, Watson - Spherical IEC Concept - 1959
- Farnsworth Patent - Spherical IEC - 1966
- Hirsch - 1st Gridded IEC DT Fusion - 1967
- Bussard - Patent Polywell™ - 1989
- ITT
- EMC²
- U of Wisconsin
- LANL
- MSFC
- INEEL
- DTI
- U of Illinois
- Greatbatch - 2000
R.L. Hirsch and G.A. Meeks: Mid-60’s Ion-Gun-Driven IEC Experiment

- Operated with D-T fuel
- Generated $\sim 10^{10}$ n/s
University of Illinois Facility
LANL Facility
MSFC Facility
UNIVERSITY OF WISCONSIN
Inertial Electrostatic Confinement Research Devices

60 cm
DTI Facility
Daimler-Benz Aerospace IEC Neutron Generator

Key Features

• $10^7$ neutrons/s (D-D pulse)
• Continuous output $5 \times 10^6$ n/s
• 10,000 hour operation lifetime between maintenance

IEC-PSI at $5 \times 10^6$ n/s (D-D)
Operating Regimes for Current U. S. Gridded IEC Devices

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Upper Voltage-kV</th>
<th>Typical Current Range-mA</th>
<th>Typical pressure-mTorr</th>
<th>Operating Devices (#)</th>
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</thead>
<tbody>
<tr>
<td>DD</td>
<td>80</td>
<td>10-100</td>
<td>1-10</td>
<td>Sph (3)</td>
</tr>
<tr>
<td>DD</td>
<td>75</td>
<td>50</td>
<td>≈10</td>
<td>Cyl(1)</td>
</tr>
<tr>
<td>DD</td>
<td>80</td>
<td>30-50</td>
<td>5-10</td>
<td>Sph(1)</td>
</tr>
<tr>
<td>DD</td>
<td>160</td>
<td>30-60</td>
<td>0.5-3</td>
<td>Sph(2)</td>
</tr>
<tr>
<td>D³He</td>
<td></td>
<td></td>
<td></td>
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## Current Directions

<table>
<thead>
<tr>
<th></th>
<th>Faculty/Scientists</th>
<th>Students</th>
<th>Main Thrust</th>
<th>Applications</th>
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<tbody>
<tr>
<td>U of Illinois</td>
<td>4</td>
<td>5</td>
<td>DD, Pulsed, Cylindrical</td>
<td>Detection, Propulsion, Electricity</td>
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<tr>
<td>LANL</td>
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<td>0</td>
<td>POPS</td>
<td>Detection, Electricity</td>
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<tr>
<td></td>
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<td>(2 summer)</td>
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<tr>
<td>MSFC</td>
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<td>Grid Design</td>
<td>NAA, Propulsion,</td>
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<td>U of Wisconsin</td>
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<td>6</td>
<td>Advanced Fuels</td>
<td>Isotopes, Detection, Electricity</td>
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</table>
Where is IEC Research Going in the United States?

- Near term applications
- Propulsion
- Electricity
- Hydrogen
- Waste transmutation.
The Steady State D-\(^3\)He Fusion Rate in the UW IEC Device is Now at the Level Where Isotope Production is Feasible

(140 kV, 48 mA)
What is the Future of IEC Support in the United States?

- Role of Industry?
- Role of Federal Government?
- Role of Utilities?
- Role of Universities?