Diversion signatures in a country scale scenario
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Goals & Objectives
- The Synthetic History workshop aimed to build a set of synthetic documentation produced by a National Weapons Program (based on Cyclus simulations), in order to better understand its role in:
  - nuclear disarmament plan verification
  - trust of completeness of weapon state declaration
- Using this fuel cycle baseline, this work aims to assess the impact of local diversion from a civilian fuel cycle to an undeclared military program using system-scale metrics:
  - SWU usage,
  - Uranium ore consumption,
  - Truck shipments,

Fuel Cycle
- **Civilian fuel cycle:**
  - Mine, Milling & conversion
  - Enrichment
  - Light Water Reactor
  - Spent fuel storage
- **LEU production (path A):**
  - A0: natural uranium diversion
  - A1: LEU diversion
  - A2: LEU diversion (military SWU reduced to match A0 HEU prod.)
- **Plutonium production (path B):**
  - B0: natural uranium diversion
  - B1: B0 + spent fuel reproc.
  - LEU+Pu:
    - A0+B0: natural uranium diversion

Fissile Material Production Rate

<table>
<thead>
<tr>
<th></th>
<th>Civ</th>
<th>LEU</th>
<th>Plutonium</th>
<th>LEU+Pu</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEU prod [S.Q./y]</td>
<td>N.A.</td>
<td>20</td>
<td>28</td>
<td>20</td>
</tr>
<tr>
<td>Pu prod. [S.Q./y]</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td>Civ SWU [SWU/y]</td>
<td>284</td>
<td>284</td>
<td>284</td>
<td>284</td>
</tr>
<tr>
<td>U ore Consumption [t/y]</td>
<td>449</td>
<td>564</td>
<td>593</td>
<td>561</td>
</tr>
<tr>
<td>LEU shipment [t/truck/y]</td>
<td>90</td>
<td>90</td>
<td>120</td>
<td>114</td>
</tr>
</tbody>
</table>

Technical Work and Results
- Almost all considered diversions have a specific signature with regards U-ore consumption, civilian SWU usage and LEU shipments.
- Might not be able to discriminate between HEU (A0) and Plutonium (B0) diversion base on those metrics.
- Possible to reduce the diverted quantities to limit the signatures:
  - For each HEU S.Q./y in case (A2):
    - 5.6t/y U-ore
    - 3.75k SWU/y (civilian)
    - 1.2 LEU truck/y
  - For each Plutonium S.Q./y in case (B0):
    - 4.3t/y U-ore

Conclusion & Future works
- Path to country scale diversion signature establishment
- Correlate the facilities operations knowledge and the detectors precision to diversion identifications threshold.
- Assess detectability of such diversion with regards to the uncertainty on the civilian facilities regular operations:
  - tails assays
  - fuel enrichment
  - power production
  - cooling time
- Extend this work to more complex fuel cycle