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How can this also be investigated using neutrons produced at the ESS?

Valentina Santoro

Lund University and ESS

- Associate Professor at Lund University
- **Senior Scientist** at ESS-European Spallation Source ERIC

Why does it matter exist?

- Associate Professor at Lund University
- **Senior Scientist** at ESS-European Spallation Source ERIC
- I am the Technical coordinator of the HIBEAM/NNBAR program that is looking for neutron to antineutron oscillations

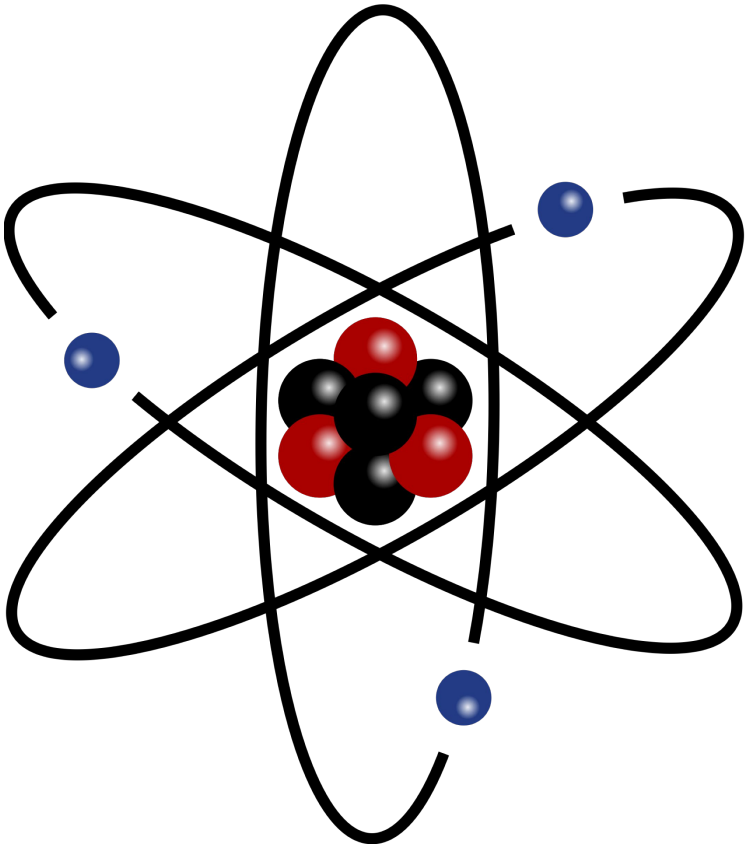
Why does it matter exist?

- Associate Professor at Lund University
- **Senior Scientist** at ESS-European Spallation Source ERIC
- I am the Technical coordinator of the HIBEAM/NNBAR program that is looking for neutron to antineutron oscillations
- Neutron oscillations are trying to answer to the same questions of the ESSnuSB program “*Why does it matter exist? “*

What is matter ?

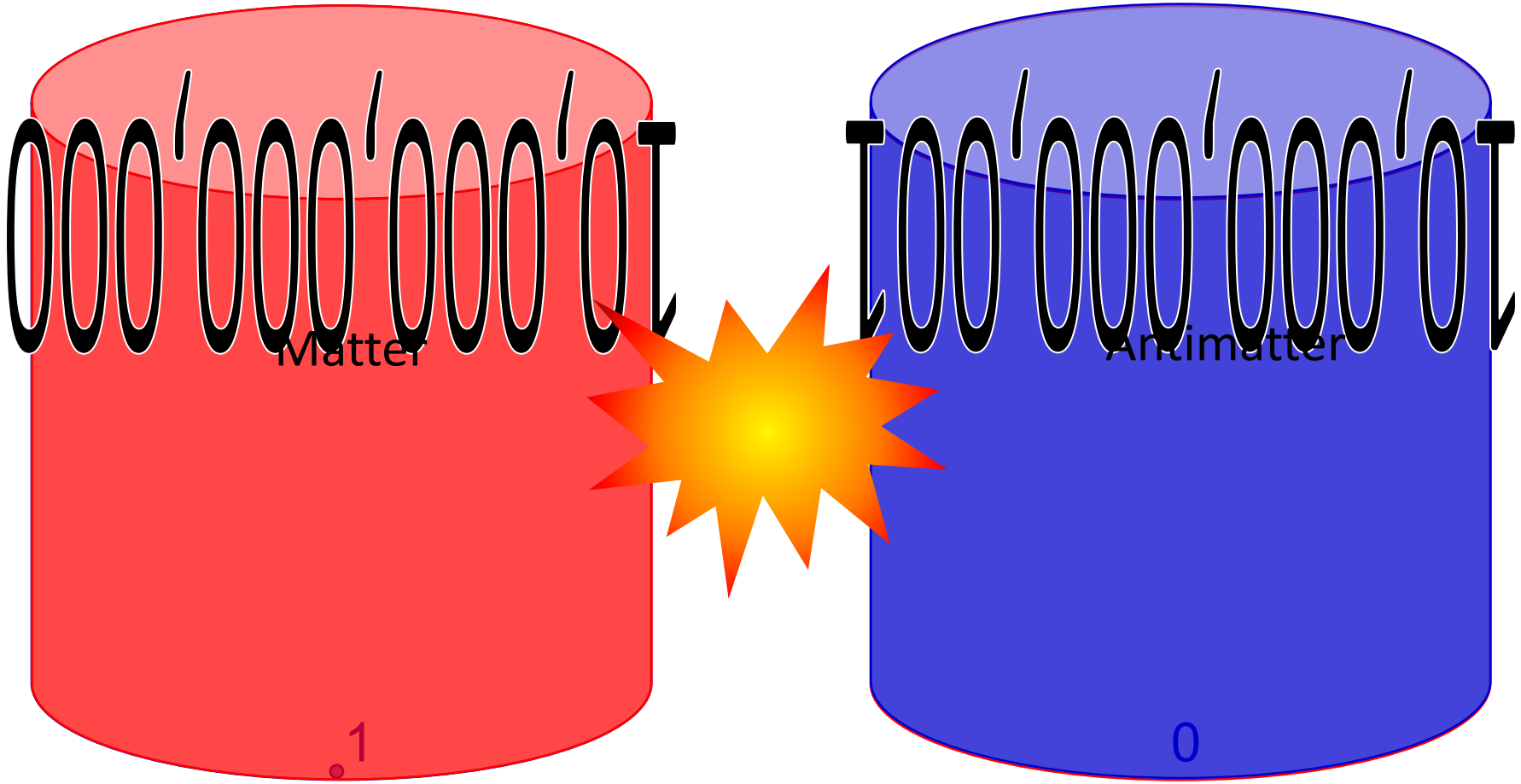
Why does it matter exist?

What is matter ?



Why does it matter exist?

Let’s take a time machine and roughly we go back 10^{-6} s after Big Bang



Current universe

Why does it matter exist?

Now what we do not know is why 10^{-6} seconds after the big bang there was 10.000.000.001 of matter and 10.000.000.000 of antimatter

Why does it matter exist?

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Why does it matter exist?

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The European Spallation Source

Why does it matter exist?

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What will the ESS do?

Why does it matter exist?

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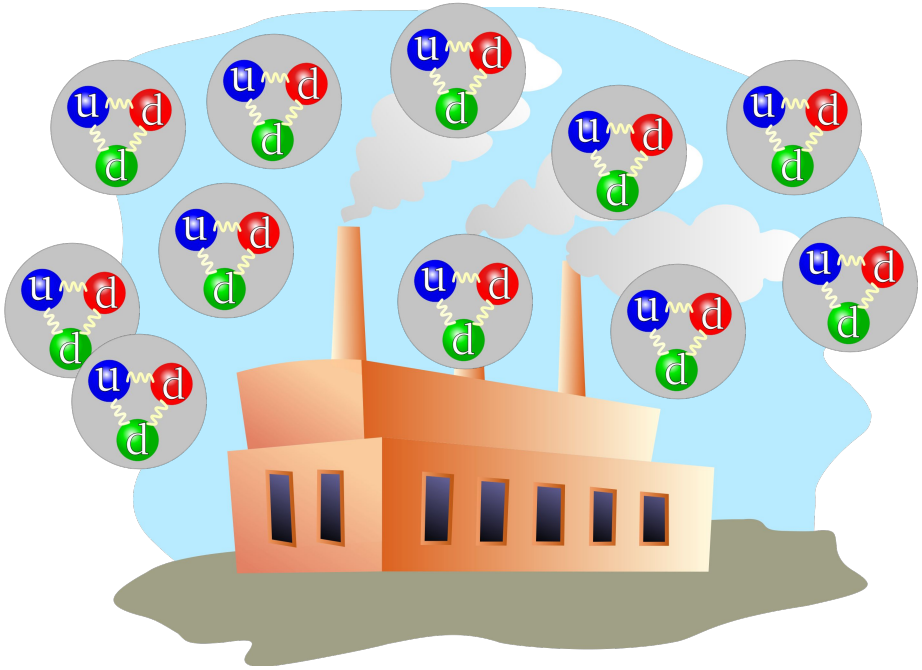
What will the ESS do?

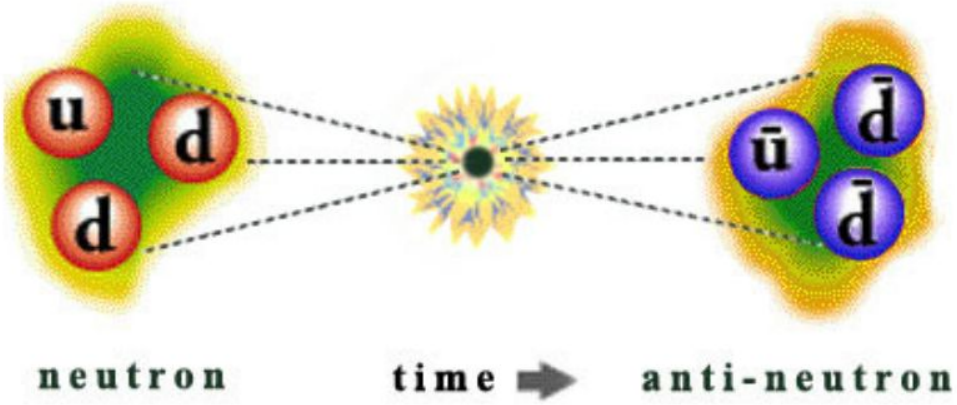


ESS is a neutron factory

Why does it matter exist?

- We want to search for

$n \rightarrow \bar{n}$ oscillations at ESS

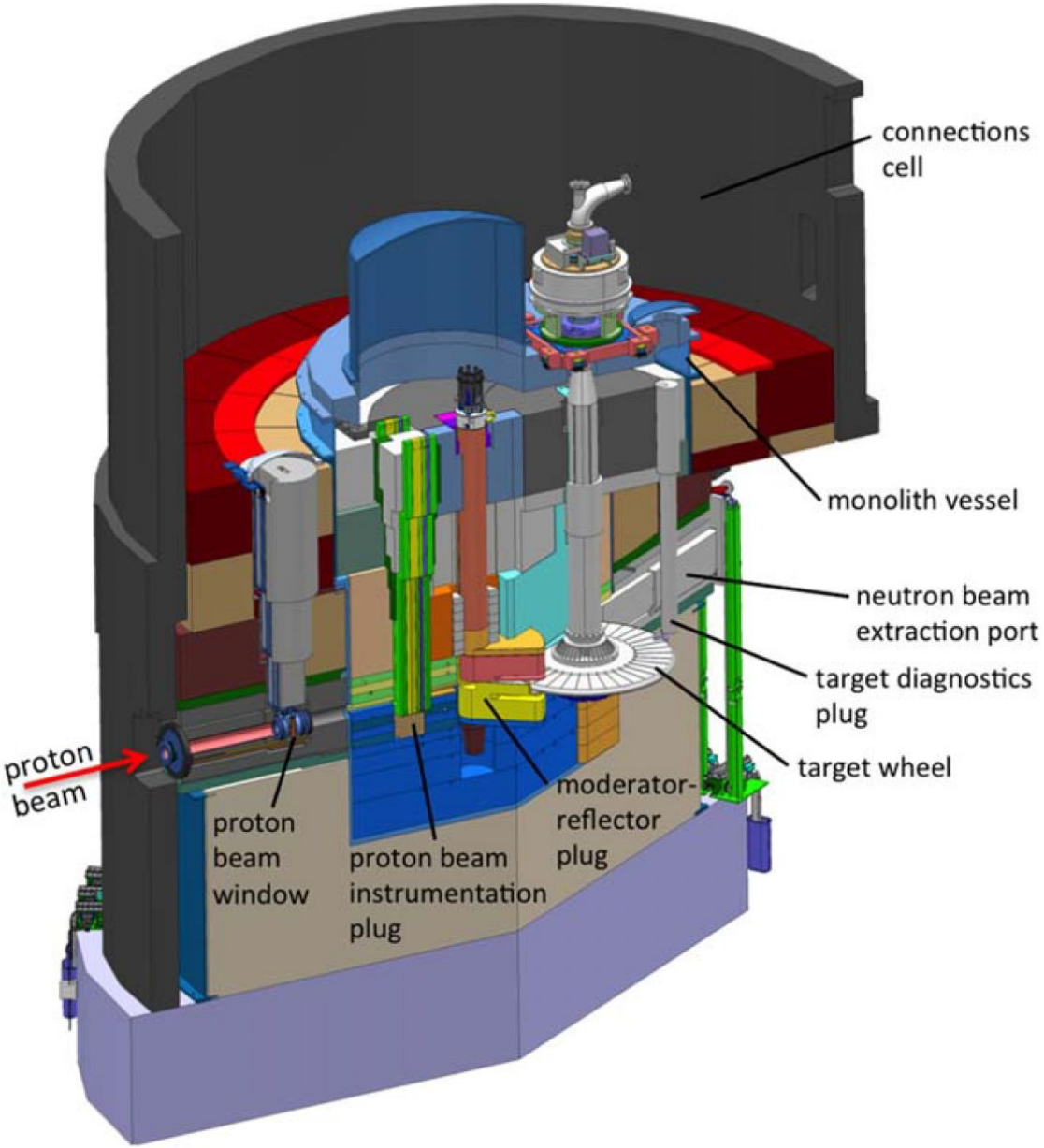


Why does it matter exist?

How do we do that?

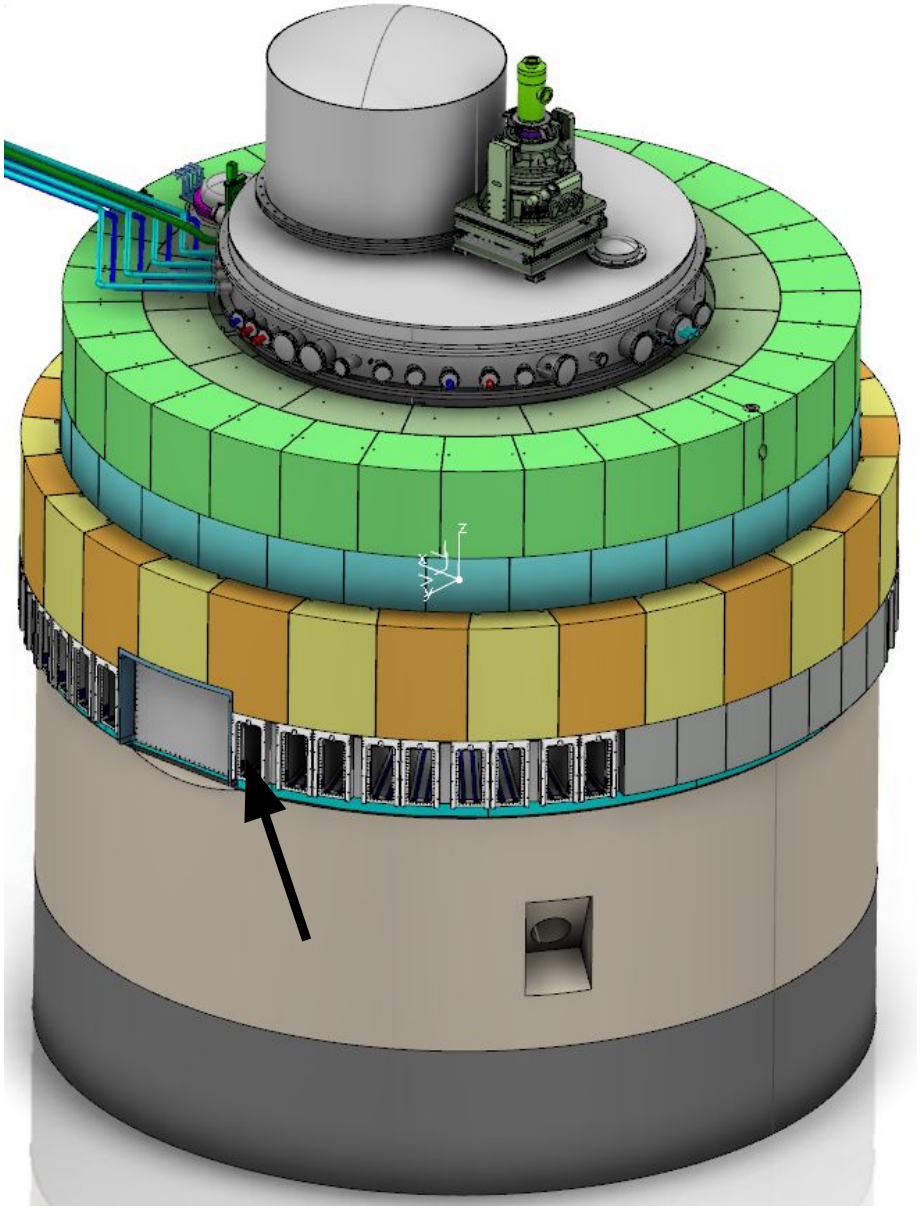
Why does it matter exist?

ESS Target Monolith



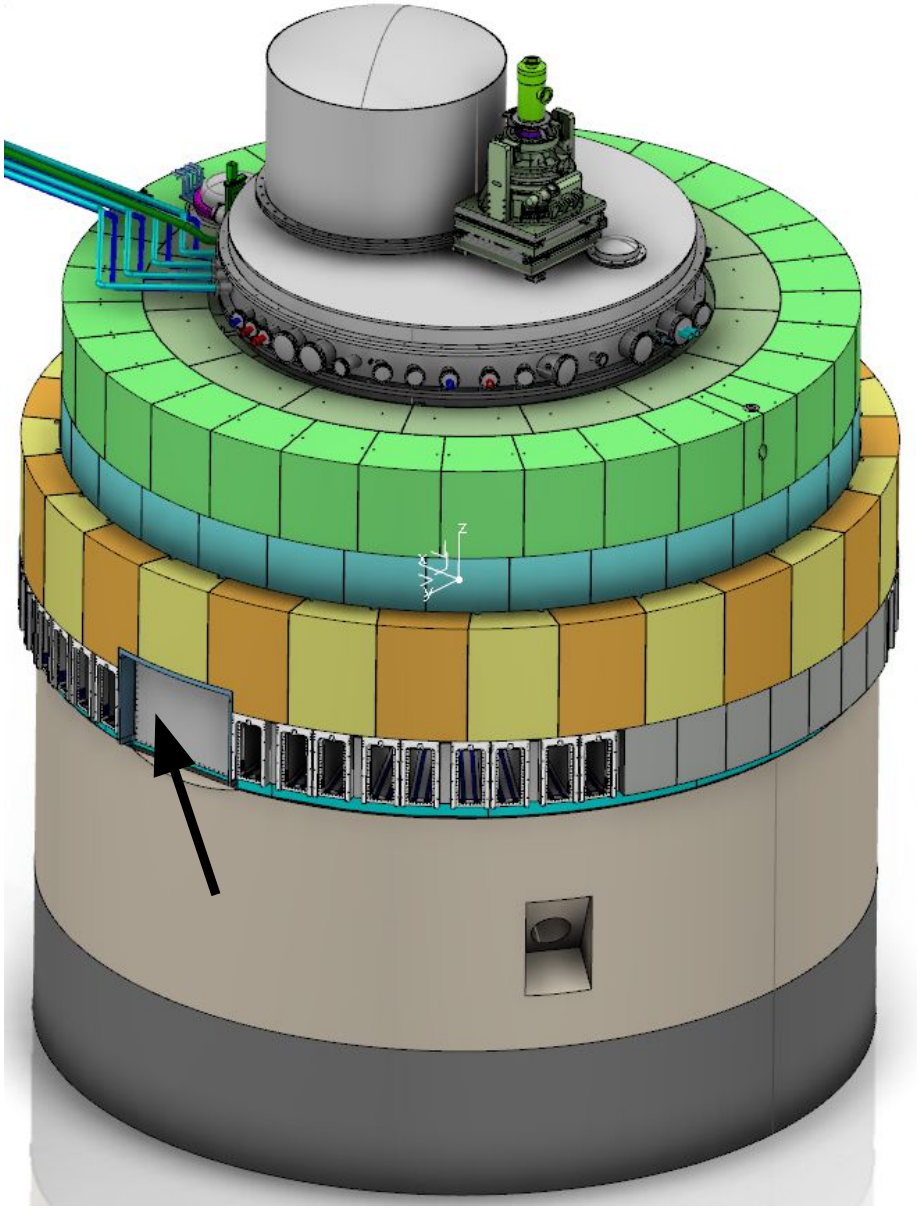
Why does it matter exist?

Neutrons are extracted from the ESS target from neutron beam port



Why does it matter exist?

ESS has a special beam port



Why does it matter exist?

ESS Superpower

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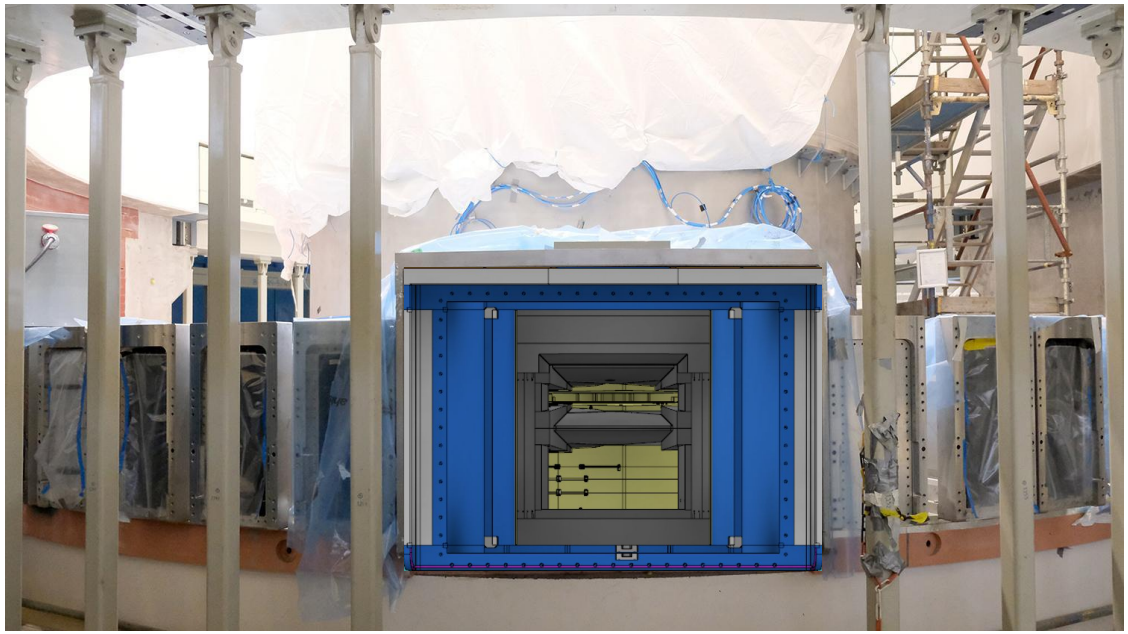

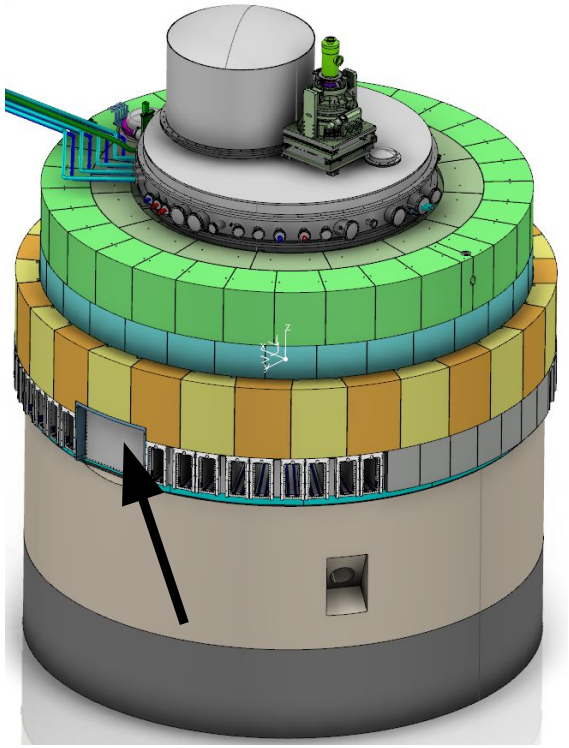

$4x10^{22}$ neutron per year

Why does it matter exist?

ESS Superpower

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4x10.000.000.000.000.000.000.000.
neutrons per years

Why does it matter exist?

ESS Superpower

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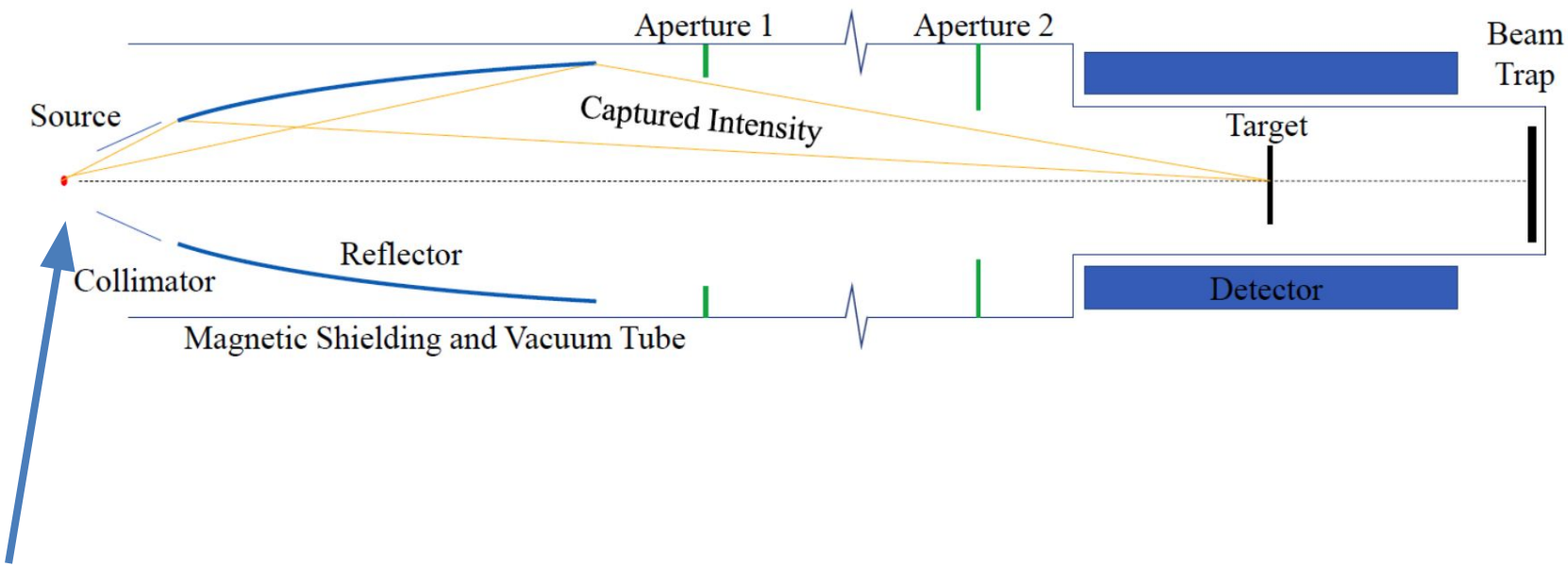
4x10.000.000.000.000.000.000.000.
neutrons per years

What do we do with that?

Why does it matter exist?

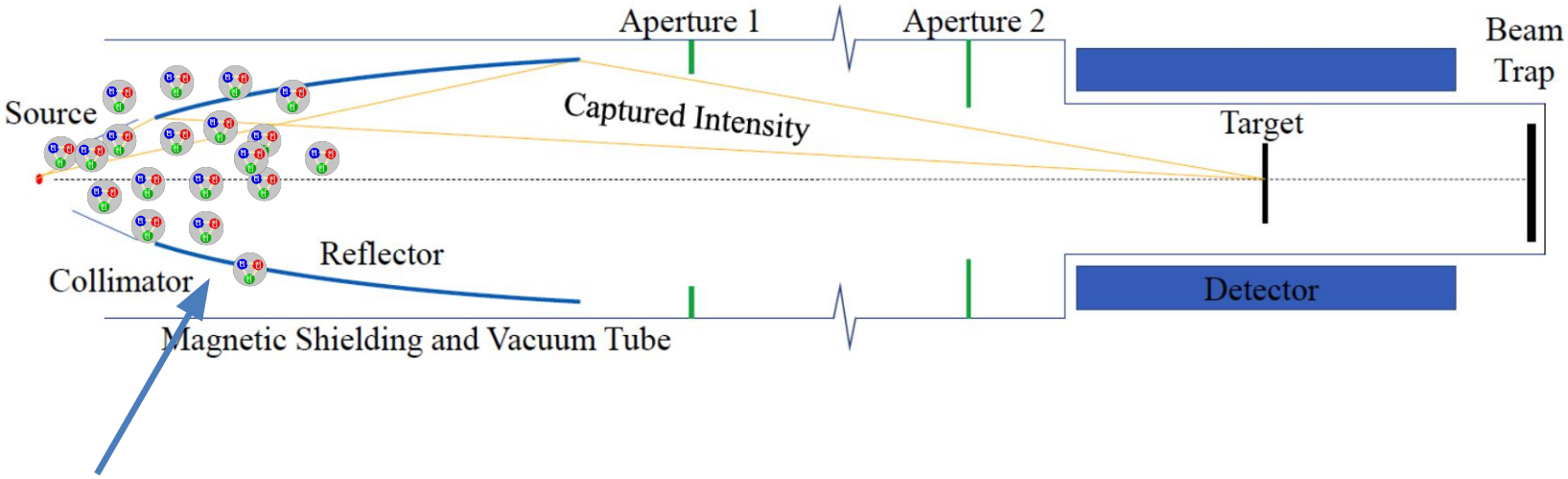
The Neutron-Antineutron Experiment



Neutrons are produced in the ESS target

Why does it matter exist?

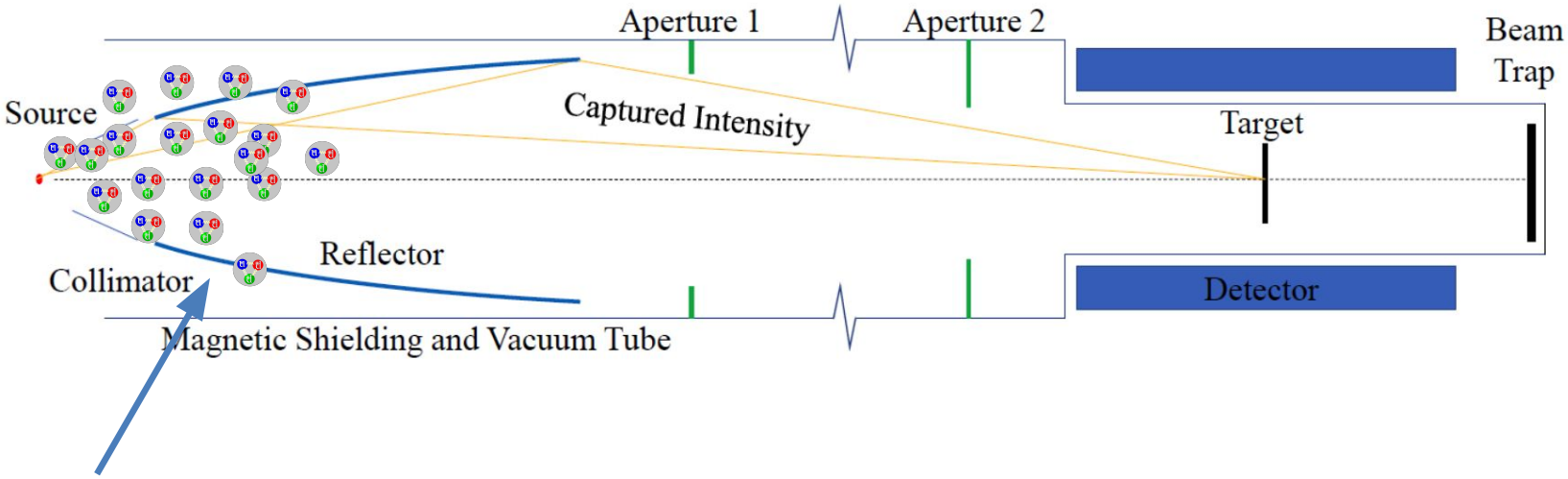
The Neutron-Antineutron Experiment



Neutrons start to fly from the target to the experimental area

Why does it matter exist?

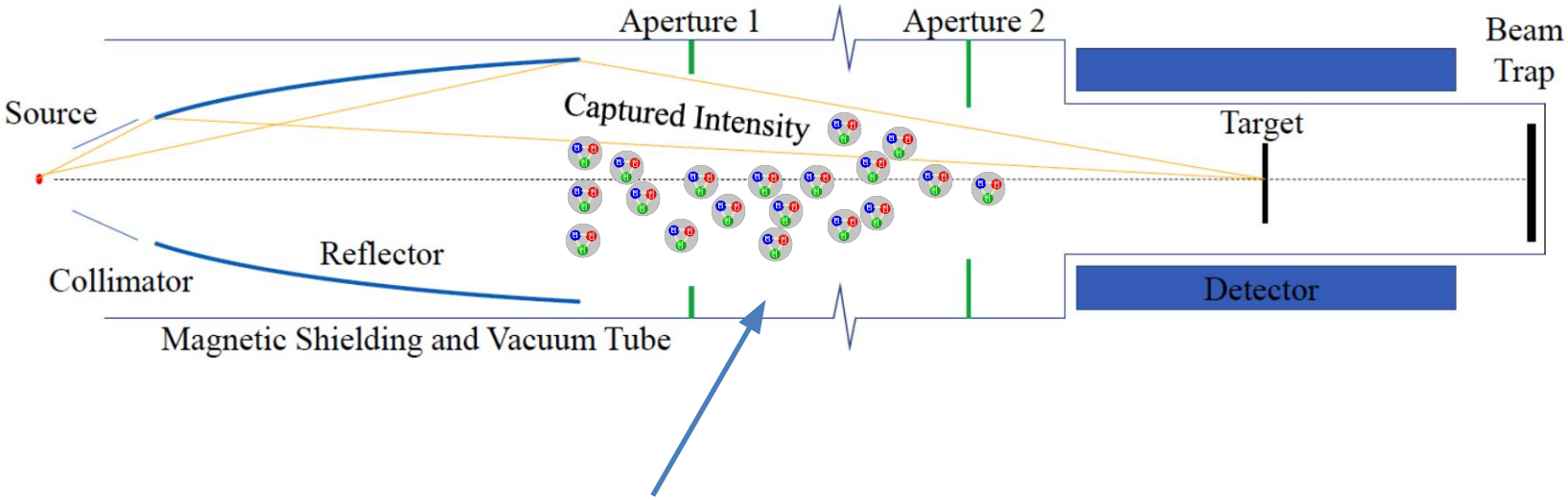
The Neutron-Antineutron Experiment



Neutrons must be collected to do that we use neutrons-mirror or neutrons guides

Why does it matter exist?

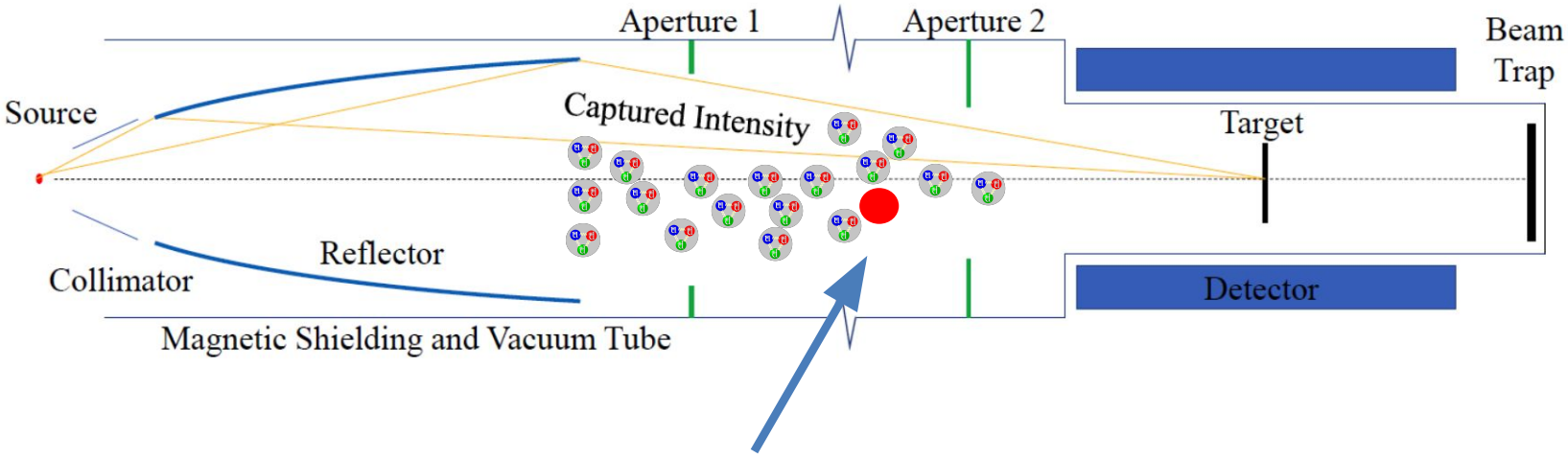
The Neutron-Antineutron Experiment



The beam is focused towards the experimental area

Why does it matter exist?

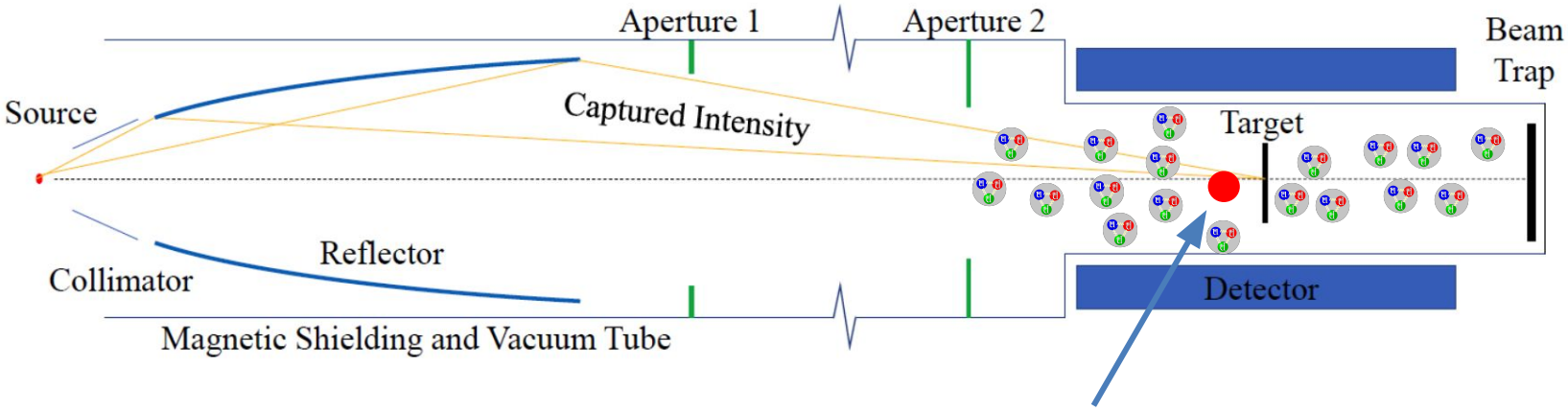
The Neutron-Antineutron Experiment



A neutrons has become an antineutron

Why does it matter exist?

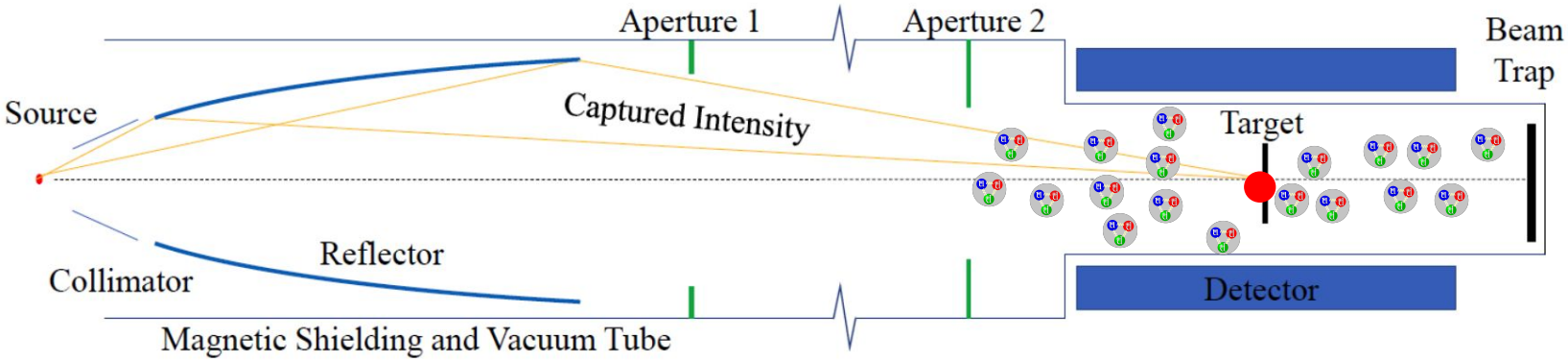
The Neutron-Antineutron Experiment



Antineutron is flying towards a target at the end of the beamline

Why does it matter exist?

The Neutron-Antineutron Experiment



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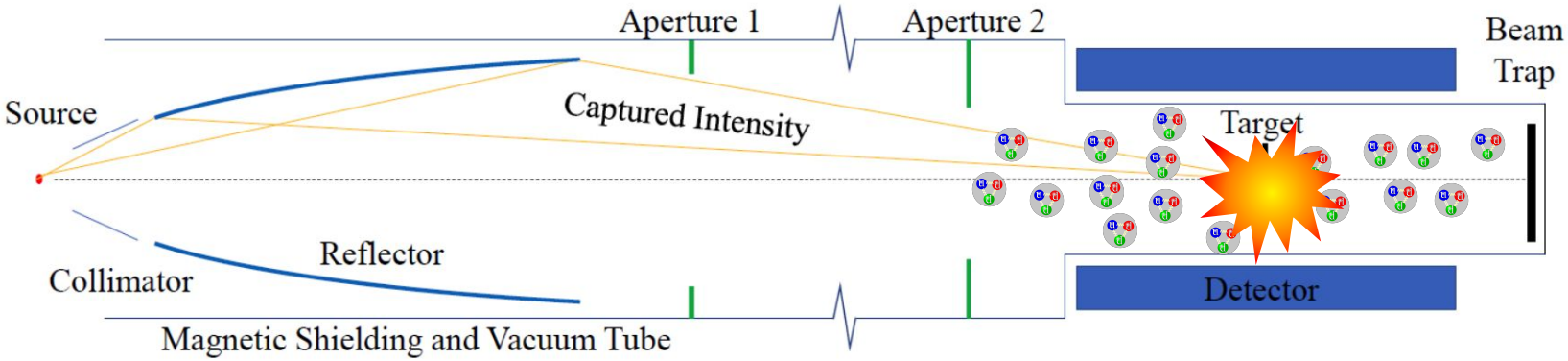
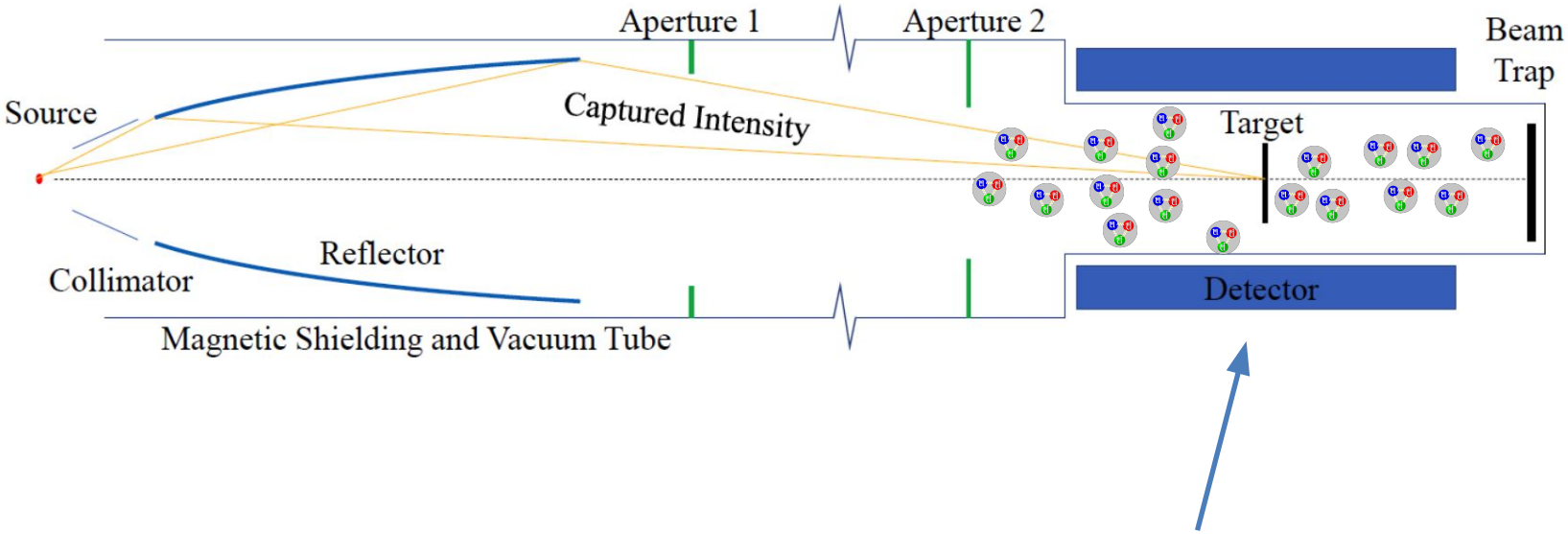


Why does it matter exist?

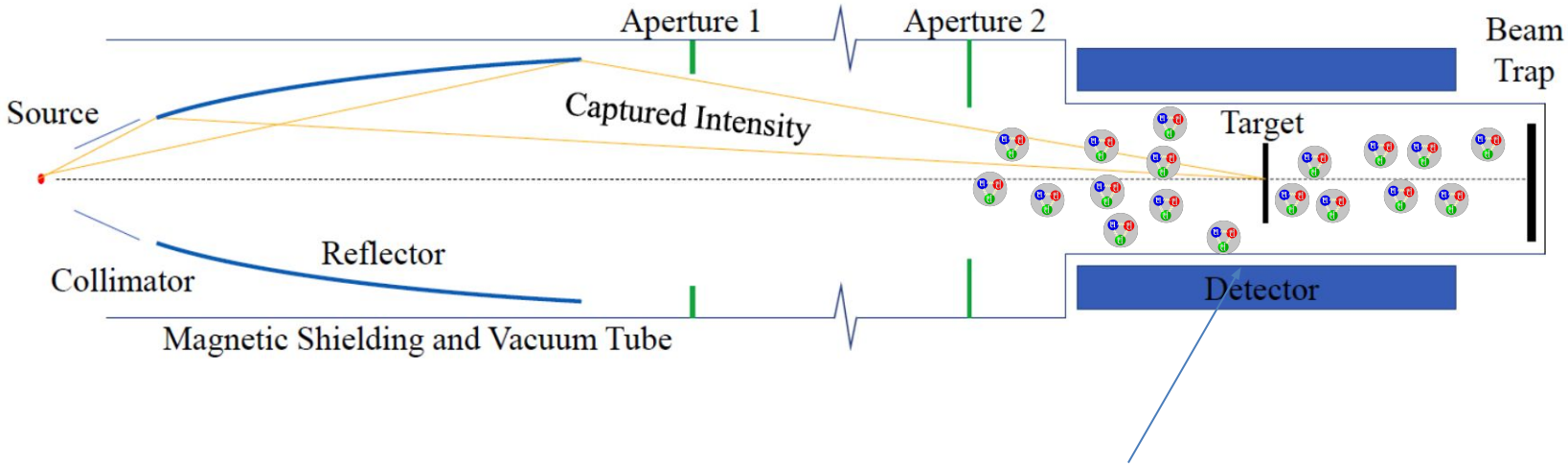
The Neutron-Antineutron Experiment



The detector will see this burst of energy

Why does it matter exist?

The Neutron-Antineutron Experiment



You have found for the first time a process that transform **matter to antimatter** and finally understand what have saved us 10^{-6} s after the big bang

Why does it matter exist?

Conclusions

- The neutron-antineutron experiment will look for neutron oscillations

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- We are complementary to the ESSnuSB project
- We are looking for the answer to the same questions: *Why does it matter exist?*

Conclusions

- The neutron antineutron experiment will look for neutron oscillations
- We are complementary to the ESSnuSB project
- We are looking for the answer to the same questions: *Why does it matter exist?*

- **We are developing a world leading particle physics program that will shape the future of science for 20 years**

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ESS partikelfysikprogram är en fantastisk möjlighet för svensk vetenskap som inte får missas!