Automation of the baking of the positron/positronium conversion target at AEḡIS

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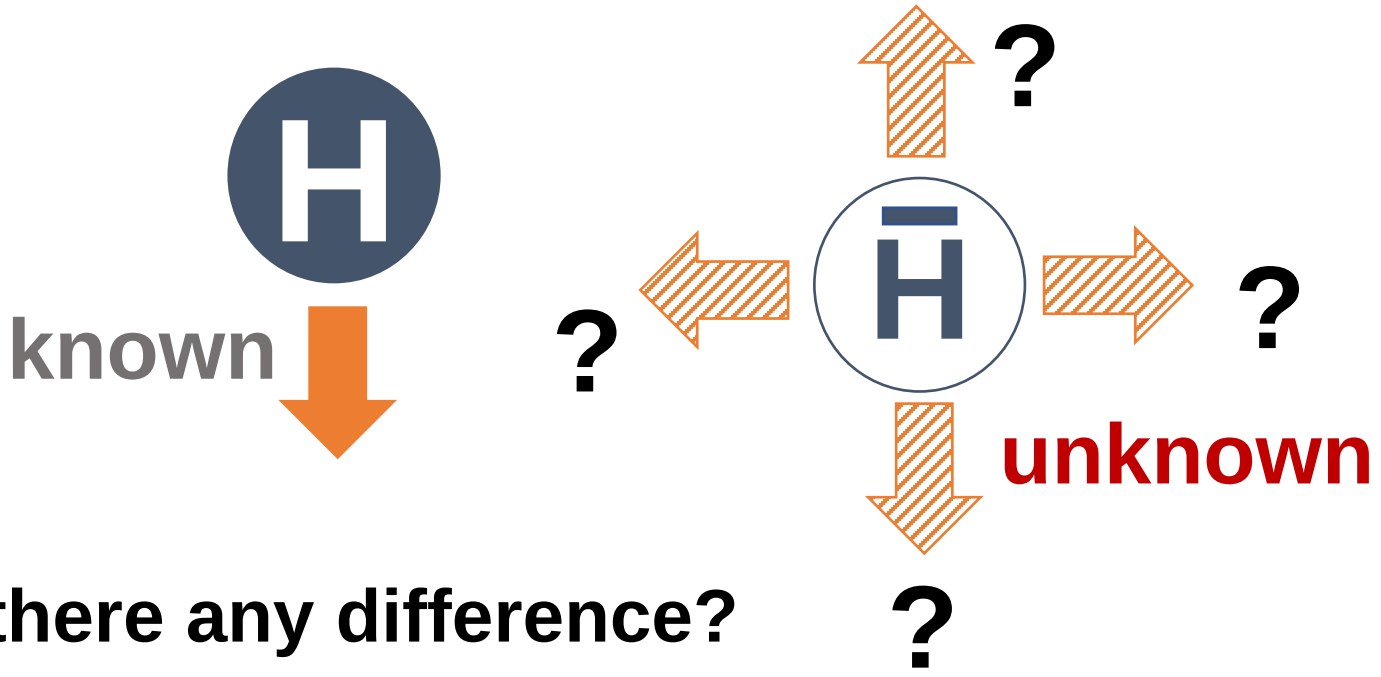
On behalf of the AEḡIS collaboration

AEgIS experiment

◆**What we want to know**

Gravitational acceleration of anti-matter



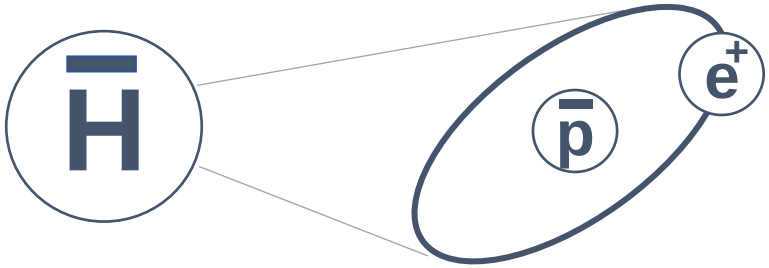
Is there any difference?

AEgIS experiment

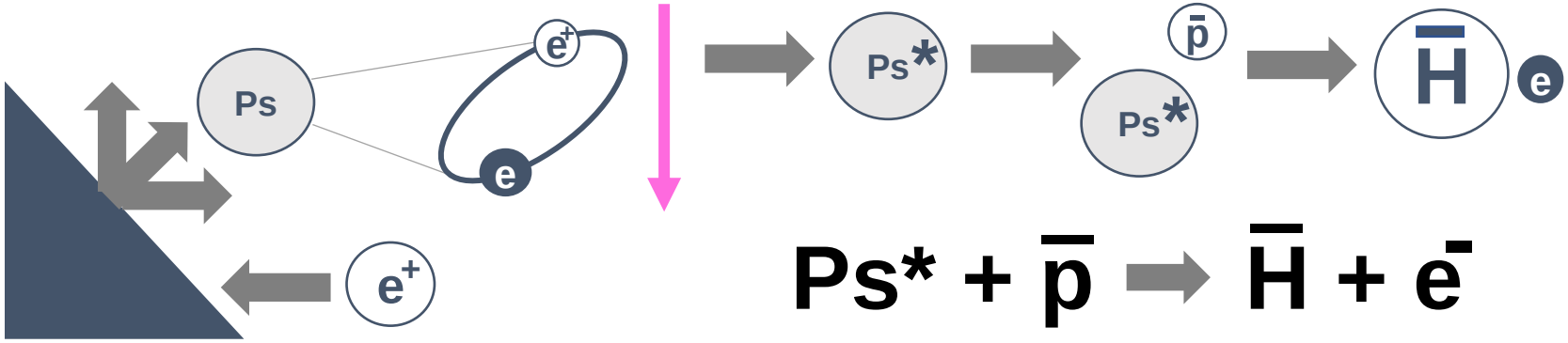
◆What we use

Anti-hydrogen atom

- **Pure antimatter**
- **Neutral charge**
- **Long life time**



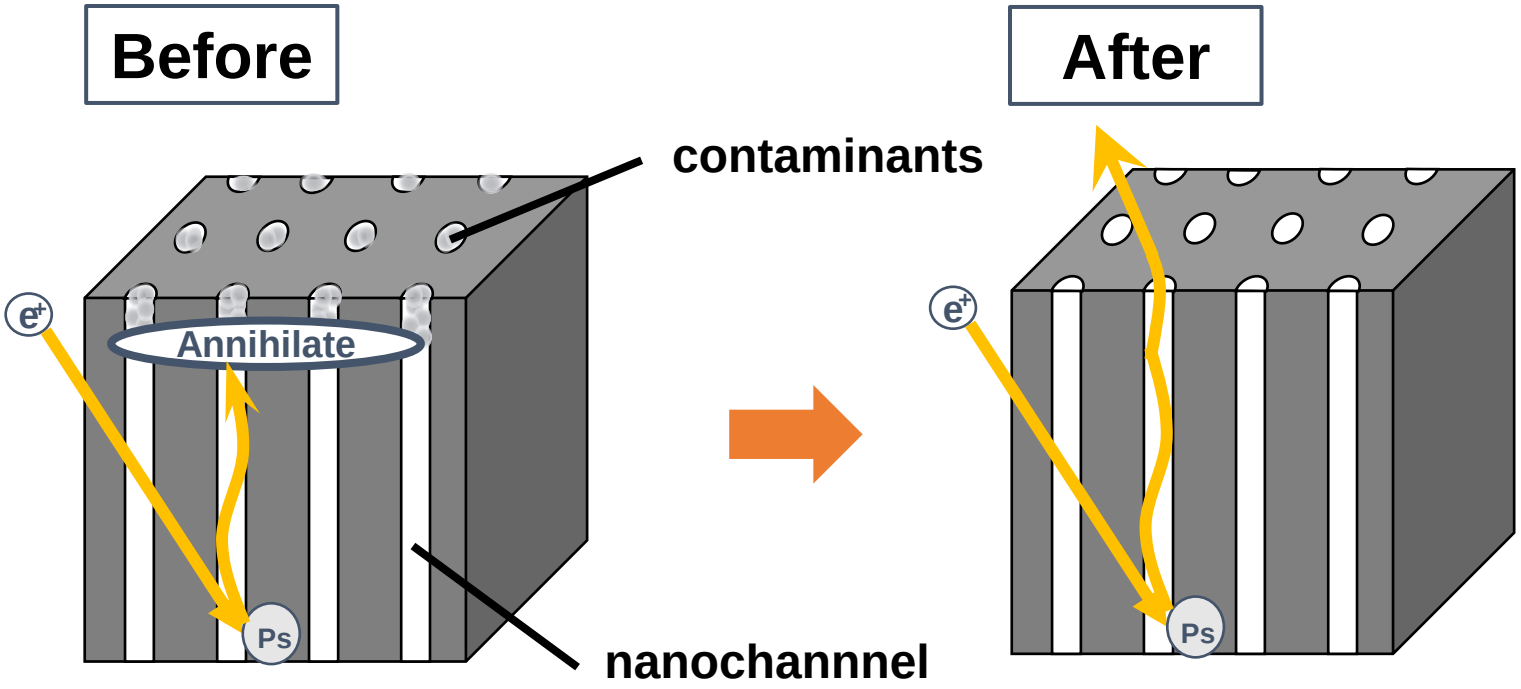
◆How to make



$$Ps^* + \bar{p} \rightarrow \bar{H} + e^-$$

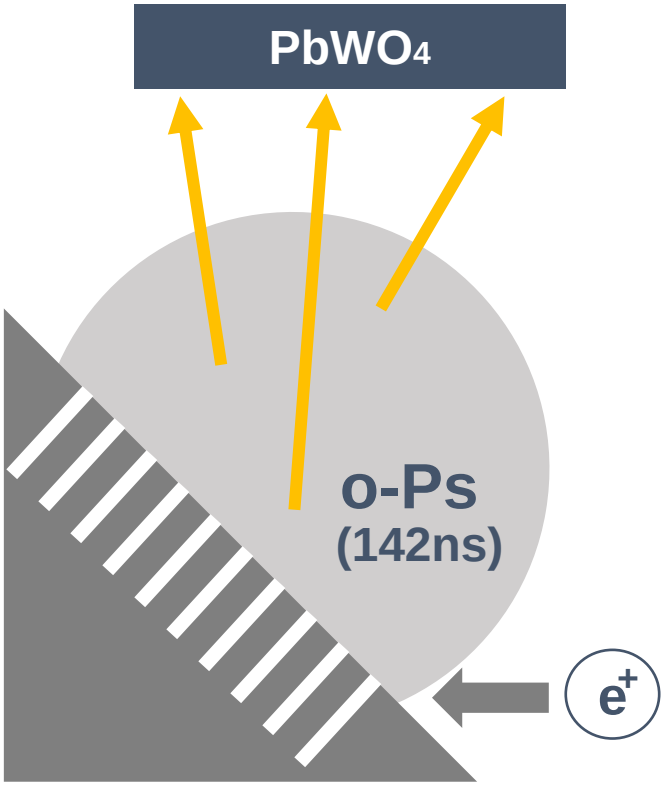
Target Baking

◆**Why do we have to bake**



Target baking

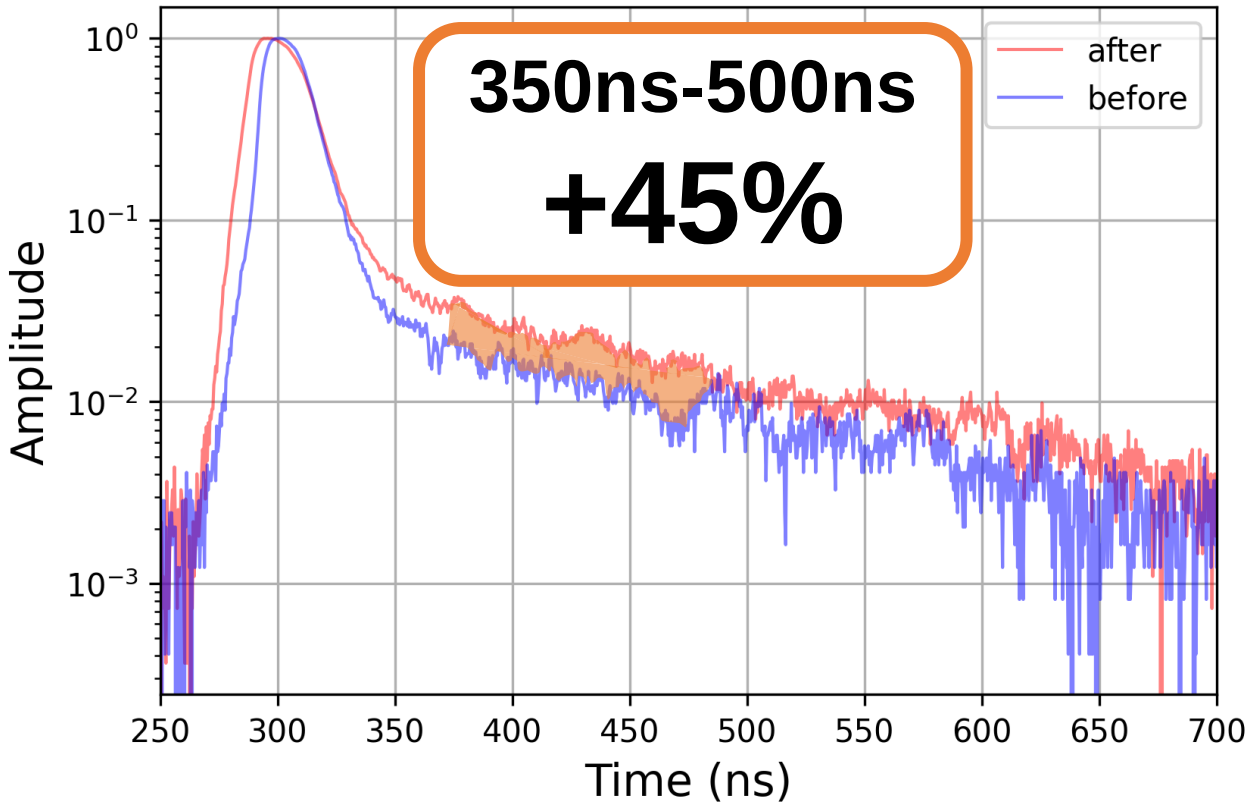
◆**Detect produced Positronium**



- **Detect γ-ray from annihilation**
- **Compare before/after baking**
- **Note: γ-ray emitted from ALL annihilation**

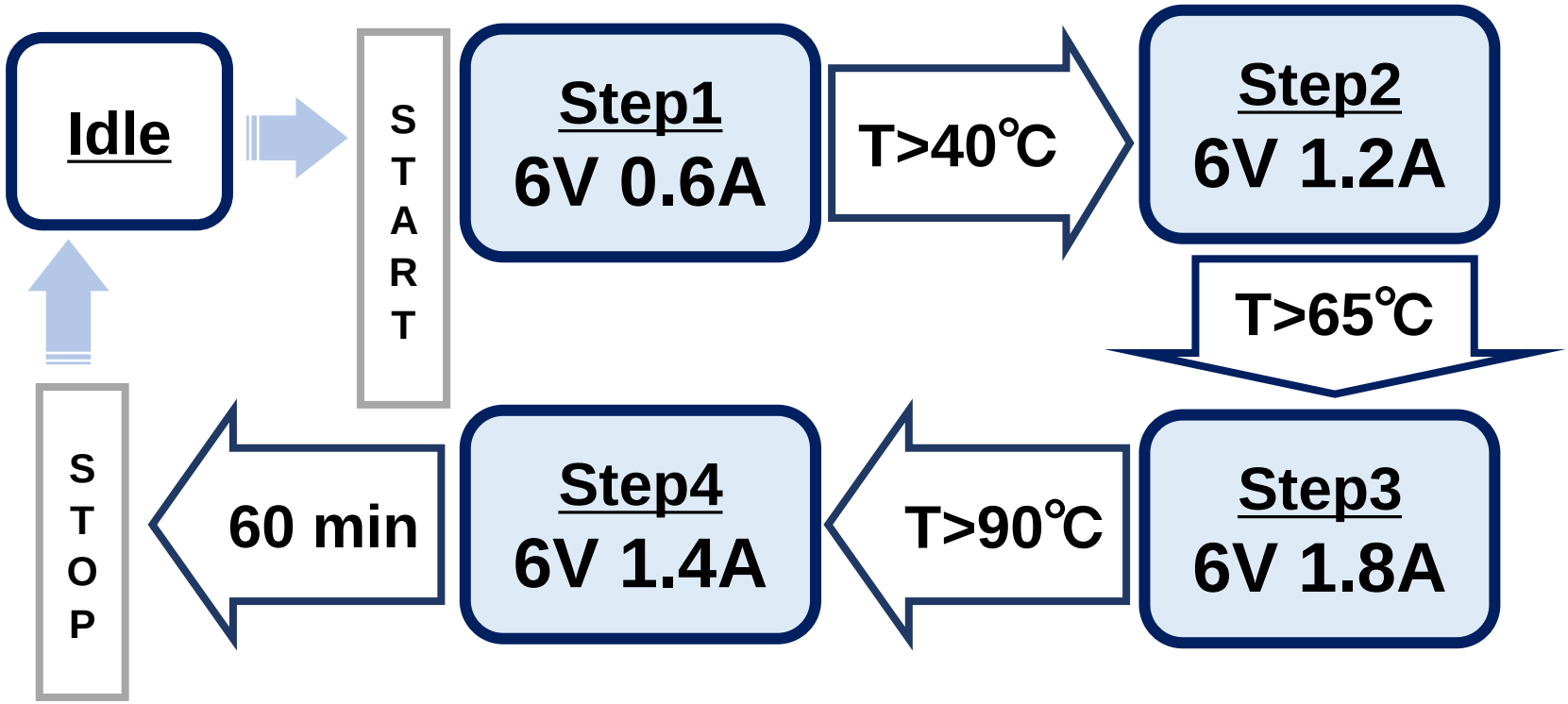
Target Baking

◆**comparison**



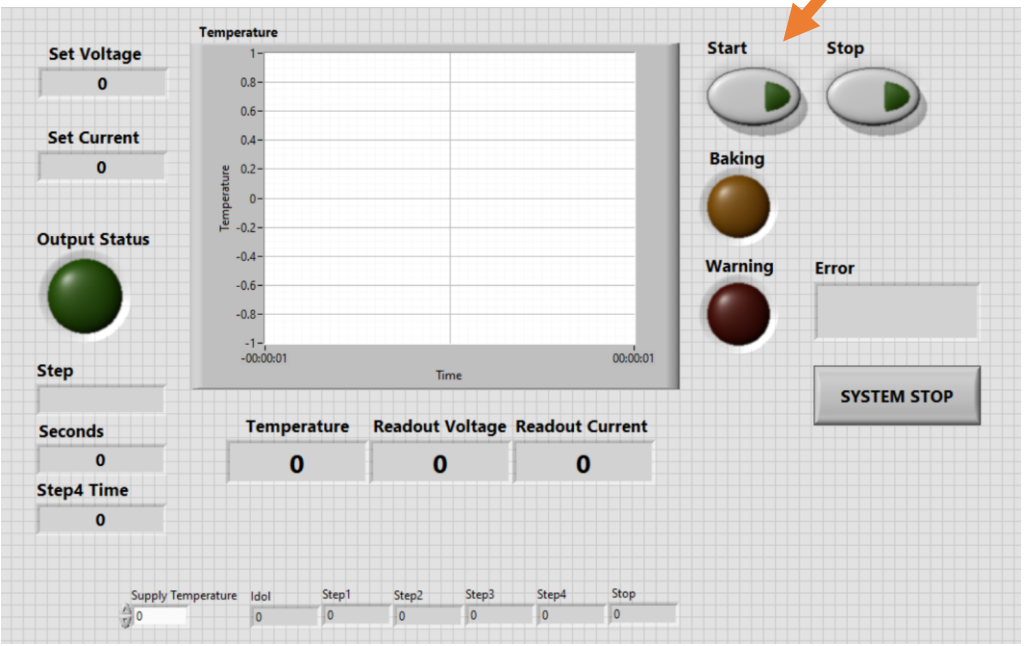
Baking system

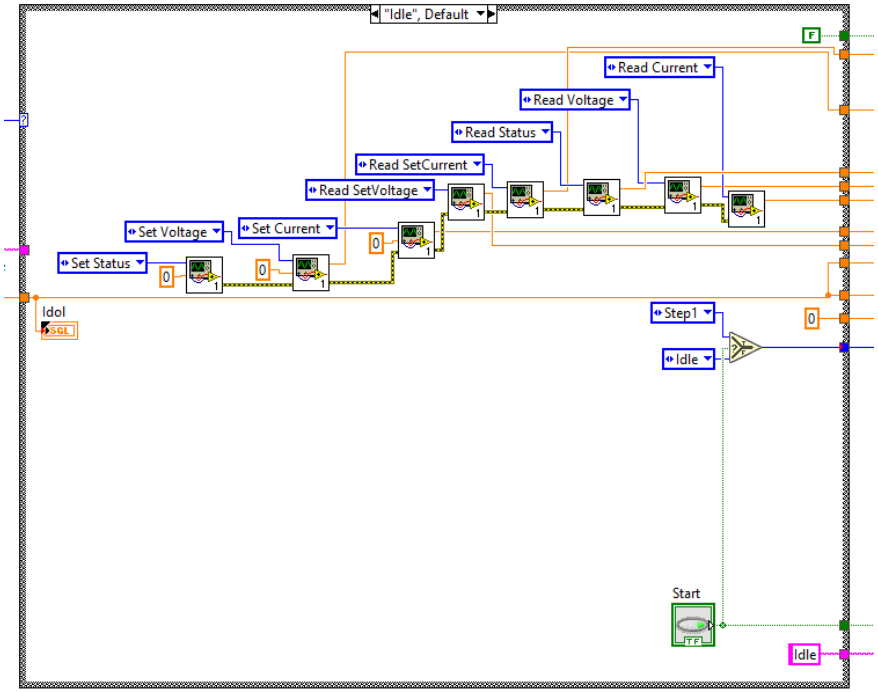
◆Recipe



Baking system

◆LabVIEW Program





Reference

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- Amsler, C., Antonello, M., Belov, A. et al., “Pulsed production of antihydrogen”, *Commun Phys,* **4**, 19 (2021)
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- Benjamin Rienäcker, “Creation and manipulation of positronium for ecient antihydrogen production at AEGIS”, Ph.D thesis (2021)

Acknowledgements

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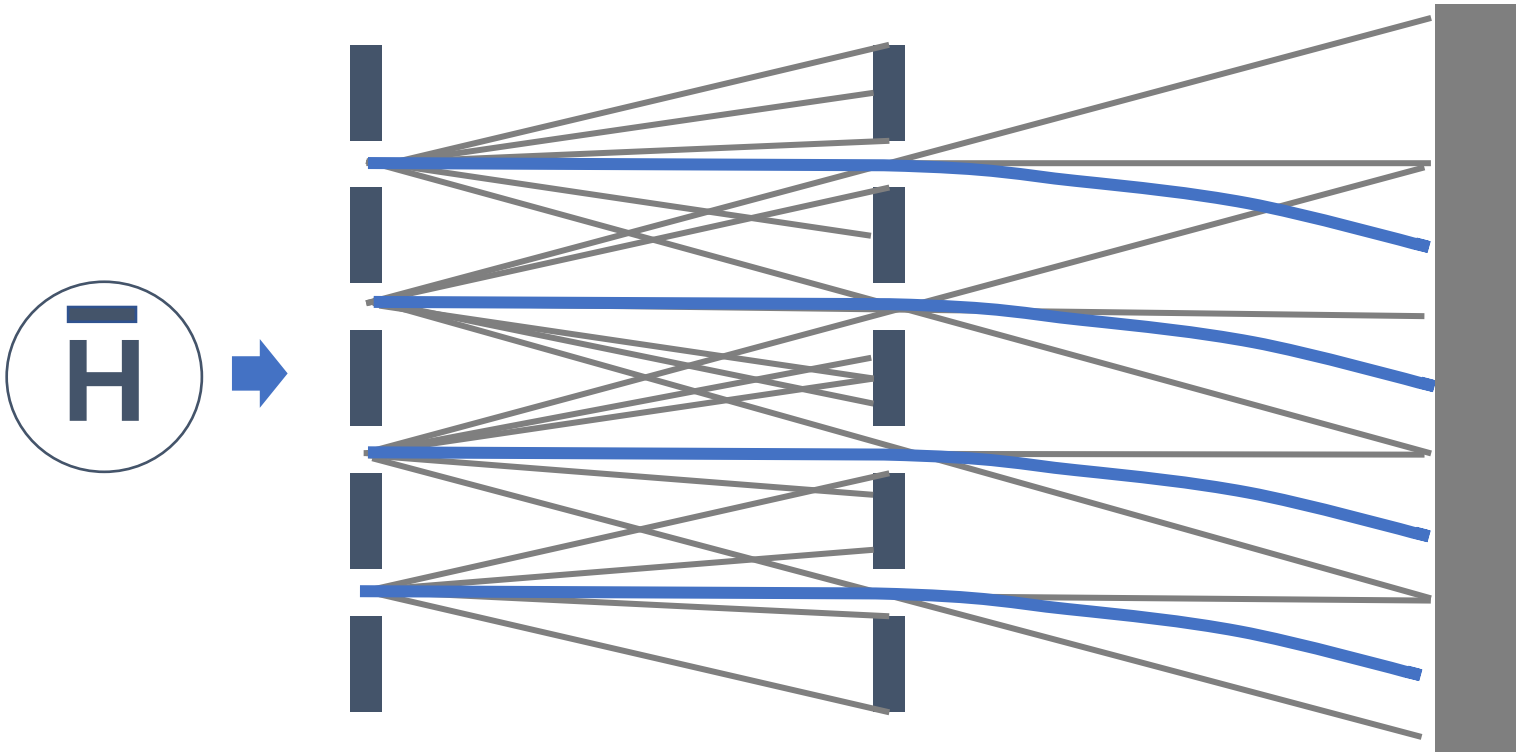
I would like to thank the members of AEgIS collaboration.

Thank you for listening

Back Up

Moire Spectrometer



Laser make lifetime longer

$$\frac{1}{\tau} = \frac{E_{Ps}}{\hbar} \cdot \frac{\alpha^3}{n^3} \cdot \left[1 - \frac{\alpha}{\pi}\left(5 - \frac{\pi^2}{4}\right) - 2\alpha^2 \ln\alpha + 5.1243\left(\frac{\alpha}{\pi}\right)^2 + \cdots\right]$$

Adding the laser

⬇

Ps excited

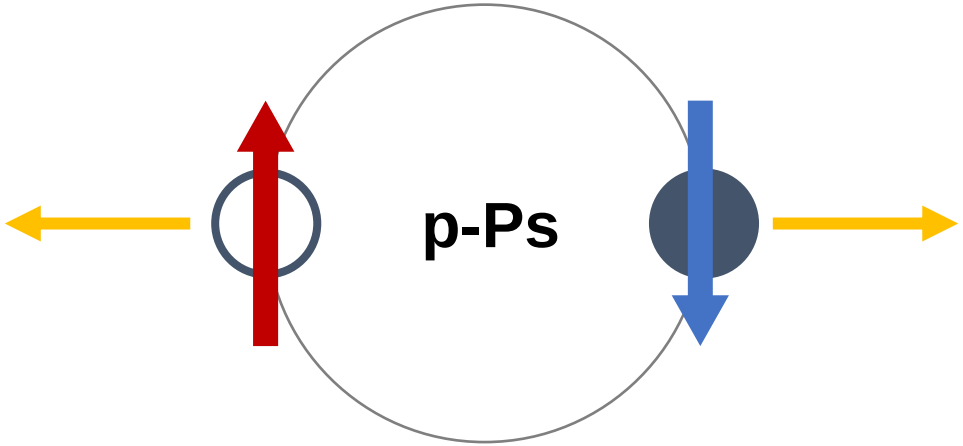
⬇

Diameter bigger

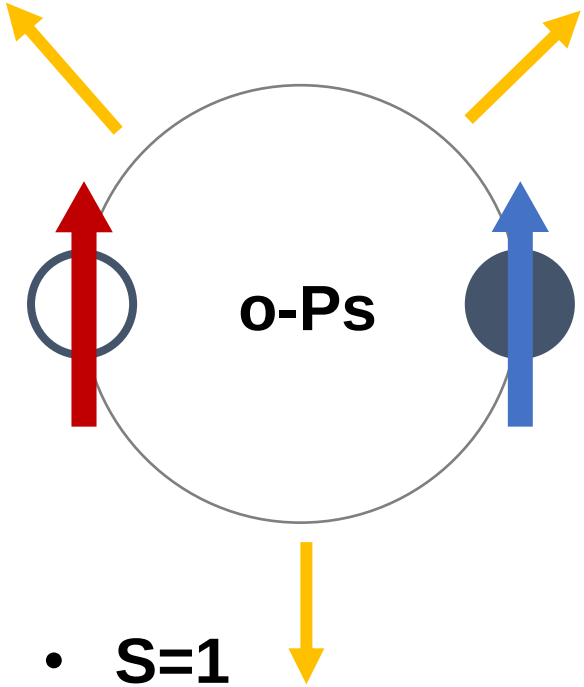
⬇

Probability of encounter decreased

Positronium



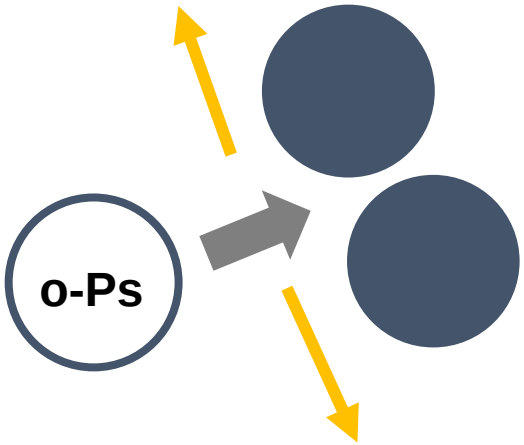
- S=0
- even γ
- 125 ps



- S=1
- odd γ
- 142 ns

Annihilation in material

- **Pick-off**



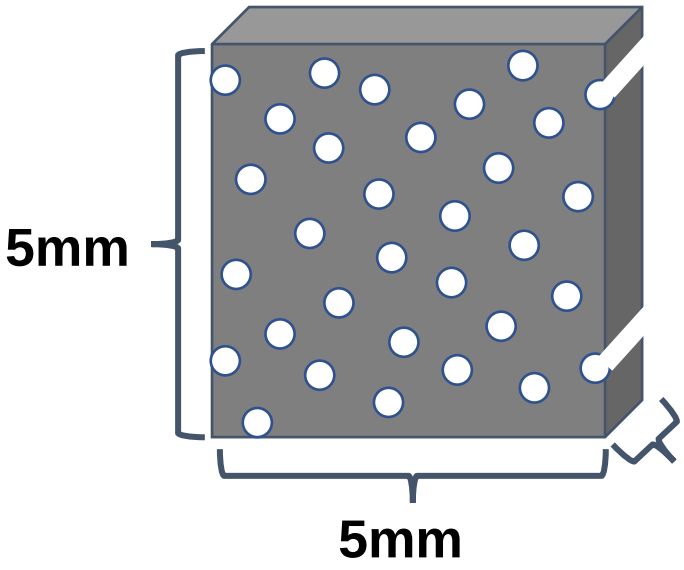
1. **o-Ps touches material surface**
2. **o-Ps collides with atoms**
3. **Annihilate**
4. **Emit 2γ (o-Ps finds opposite spin electron w/o binding)**

- **Spin flip**

1. **o-Ps changes into p-Ps (leptons remain bound)**
2. **Annihilate with p-Ps lifetime**

Target

- Silicon wafer – SiO_2 layer on channel surface



- Hole - nanochannel
  - r = 20nm
  - depth = 1μm