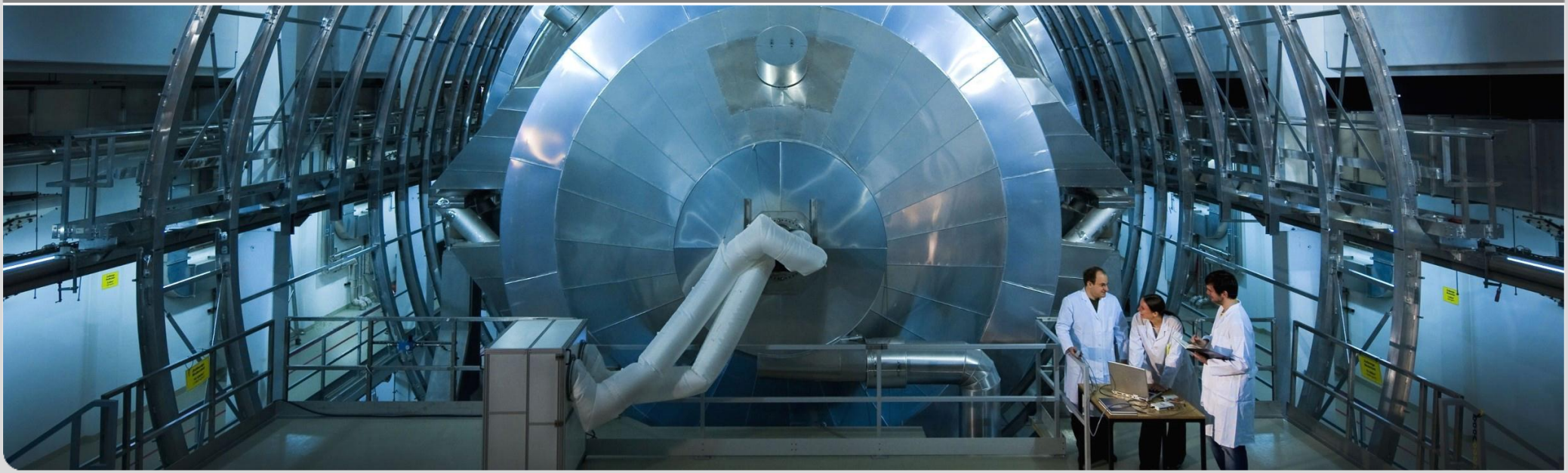
Karlsruhe Institute of Technology

# Status of the KATRIN experiment with special emphasis on source-related issues

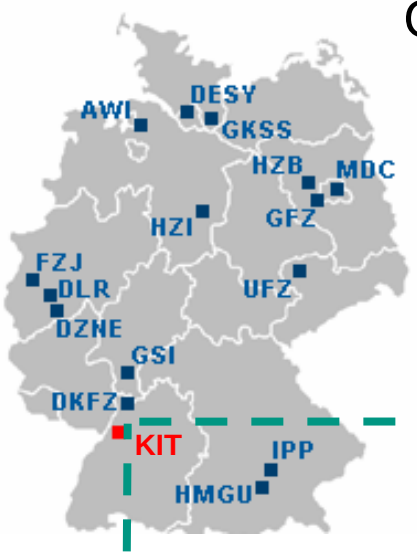
PIC 2011

**Michael Sturm for the KATRIN collaboration** **Karlsruhe Institute of Technology**

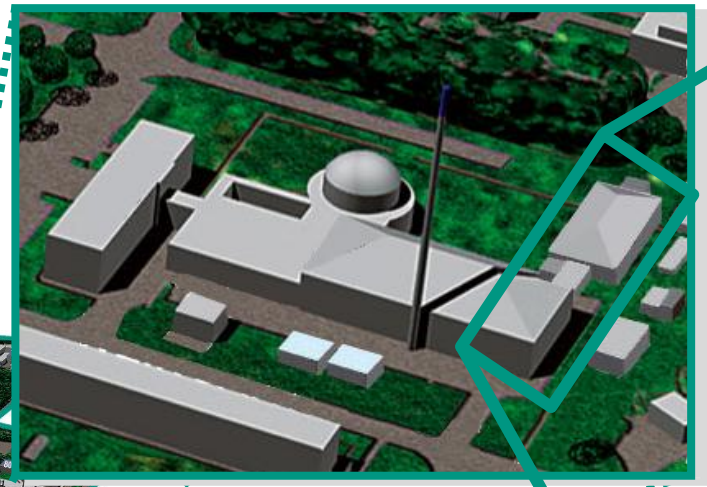


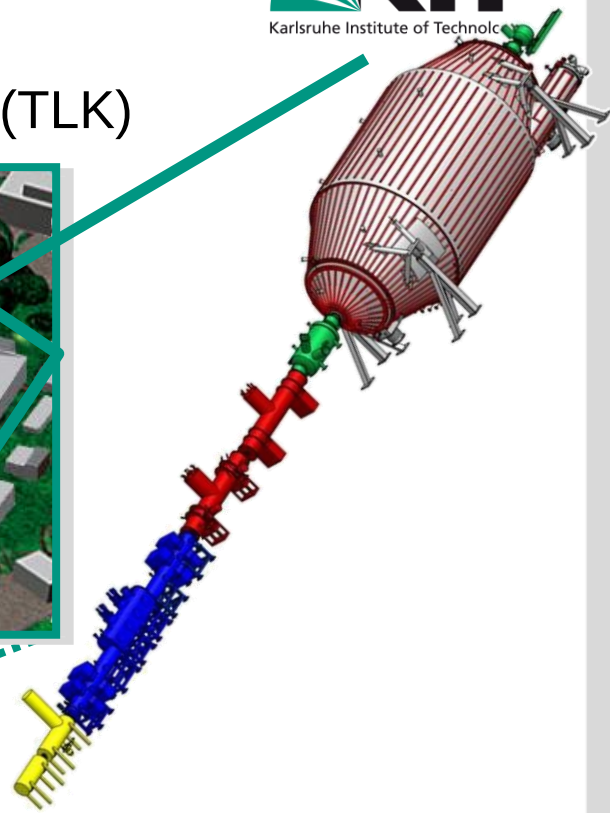
# KATRIN location

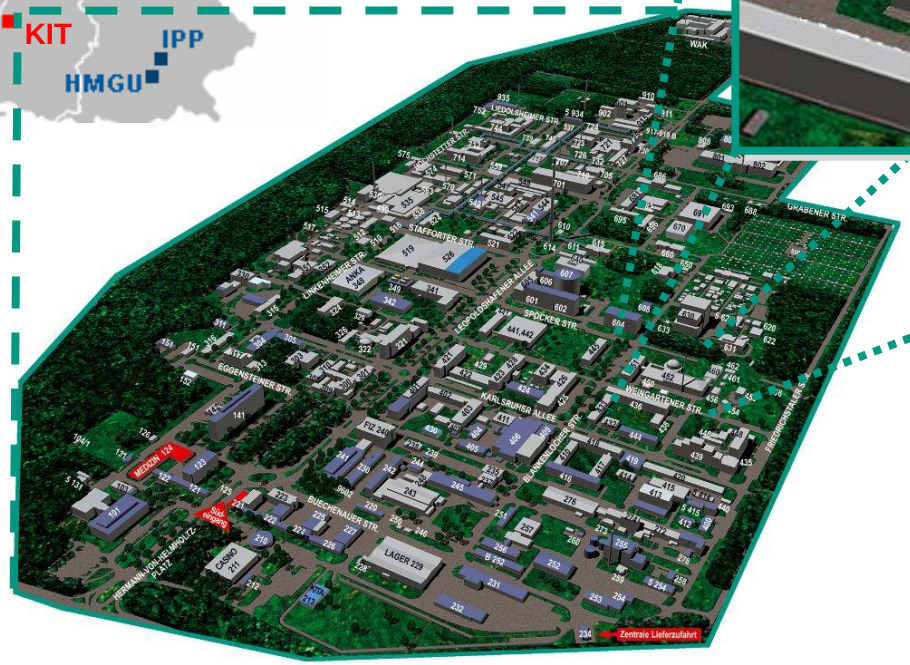
Germany




Tritium Laboratory Karlsruhe (TLK)



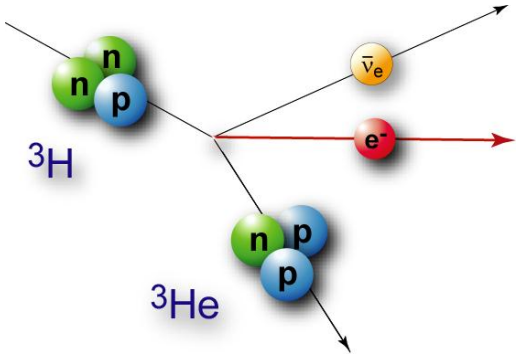




Karlsruhe Institute of Technology
Campus North (Research Center Karlsruhe)

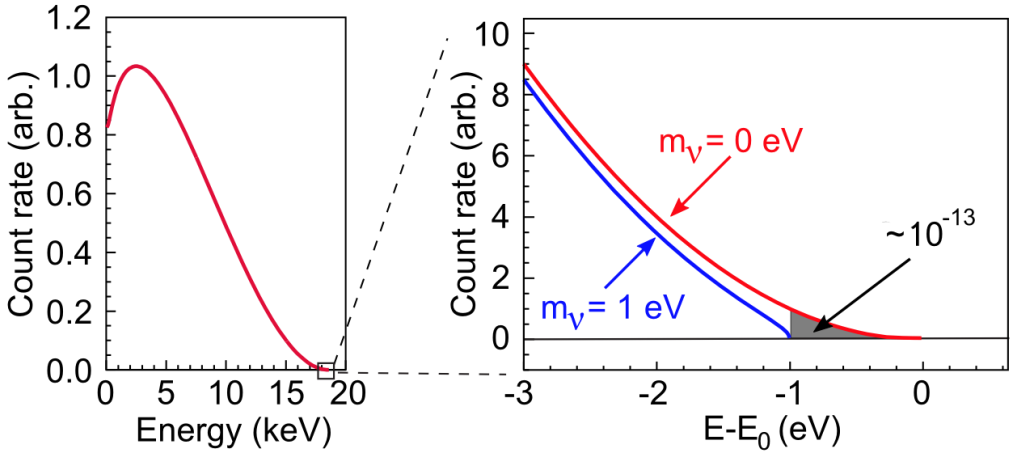
- Commissioned with tritium 1994
- License to handle 40 g tritium
- Science:
  - Tritium fuel cycle of fusion reactors
  - KATRIN experiment

# Tritium beta decay




$$^3H \rightarrow {}^3He + e^- + \bar{\nu}_e$$

**$E_0$ = 18.6 keV**
**$T_{1/2}$ = 12.3 y**




$$\frac{dN}{dE} = C \cdot F(E,Z) \cdot p(E + m_e) \cdot (E_0 - E) \cdot \sqrt{(E_0 - E)^2 - m_\nu^2}$$

observable:

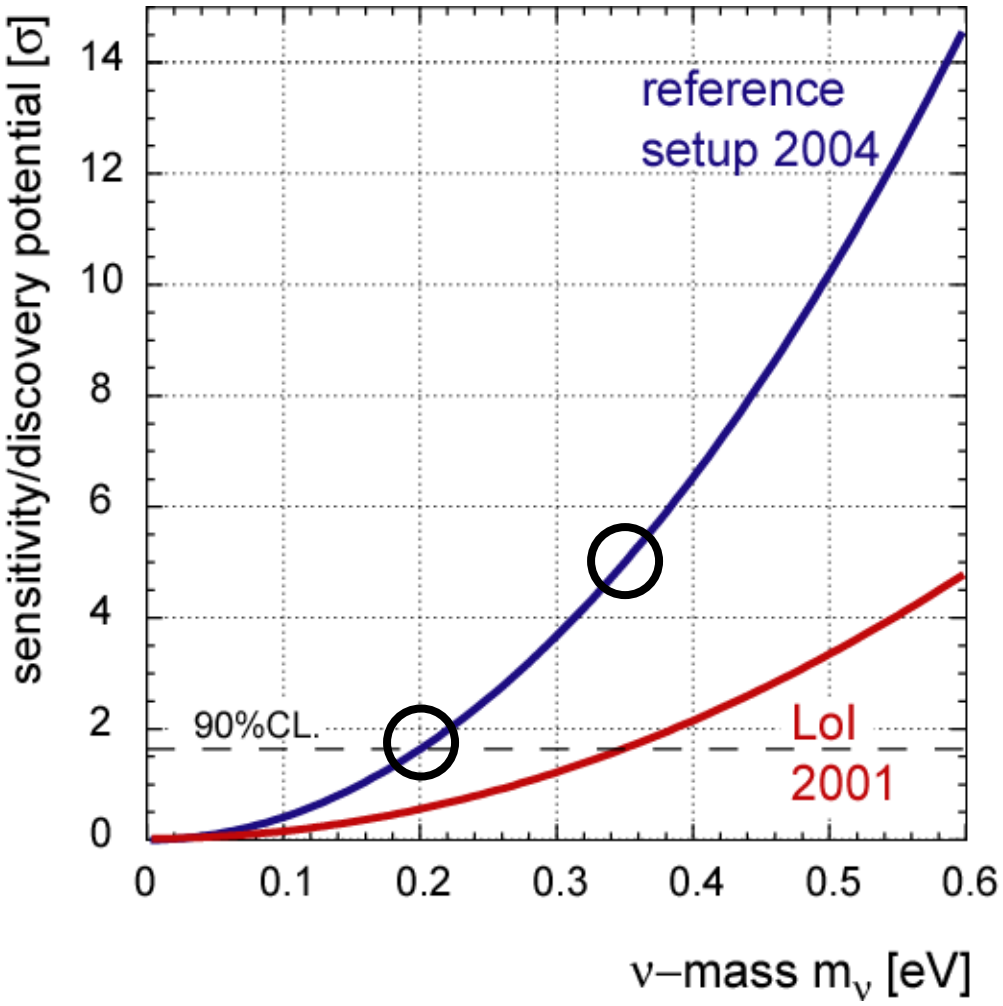
$$m_{\nu_e}^2 = \sum_{i=1}^{3} |U_{ei}|^2 m_i^2$$

- Requirements:
  - High tritium activity
    → Strong source (> 1 GBq)
  - High energy resolution (< 1 eV@18.6 keV)
  - Low background + small systematic uncertainties

KATRIN experiment:
200 meV sensitivity (90 % C.L)



# KATRIN sensitivity




**After 3 years data (5y real time):**

**discovery potential**
m(ν) = 0.35 eV (5σ)

**sensitivity (90% CL)**
m(ν) < 0.2 eV

$\Delta m_{tot}^2 = (\Delta m_{stat}^4 + \Delta m_{sys,tot}^4)^{½}$

$\Delta m_{tot}^2 \approx 0.025\ eV^2/c^4$

and

$\Delta m_{stat} = \Delta m_{sys,tot}$

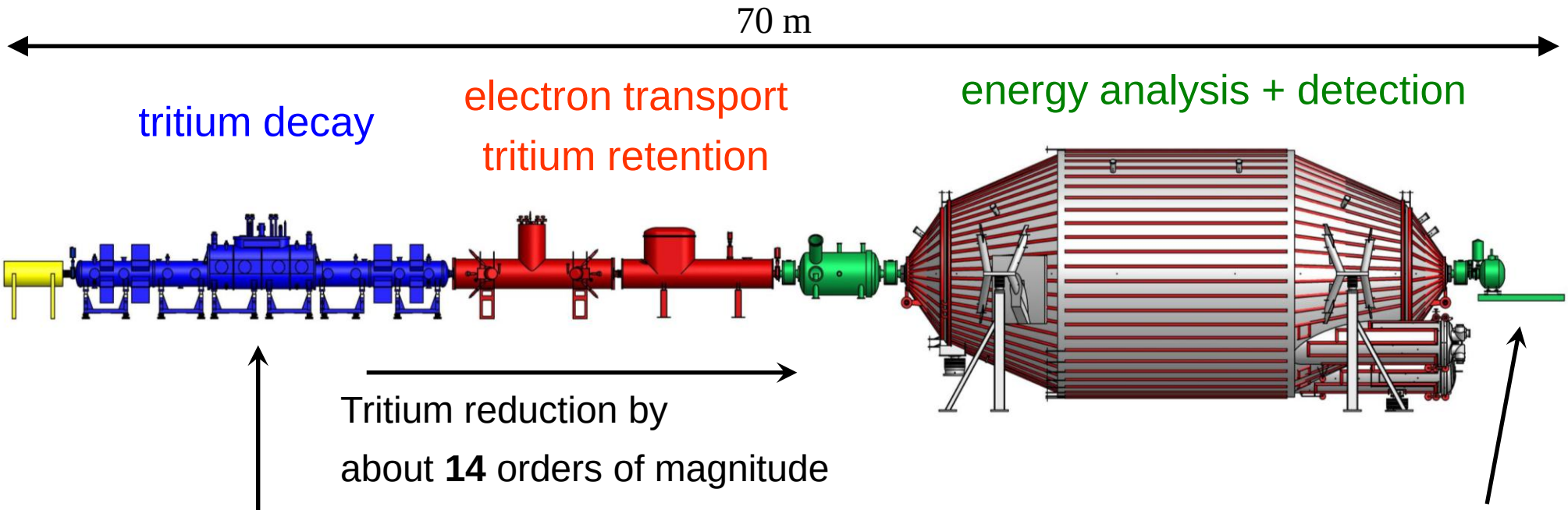
$\Delta m_{stat}^2 = 0.018\ eV^2/c^4$

$\Delta m_{sys,tot}^2 \leq 0.017\ eV^2/c^4$



# The KATRIN experiment

(**KA**rlsruhe **TRI**tium **N**eutrino experiment, location: Karlsruhe, Germany)




β-decay rate: **$10^{11}$** Hz

$T_2$ gas flow: 1.8 mbar l / s

background rate < **10** mHz

$T_2$ gas flow < **$10^{-14}$** mbar l /s

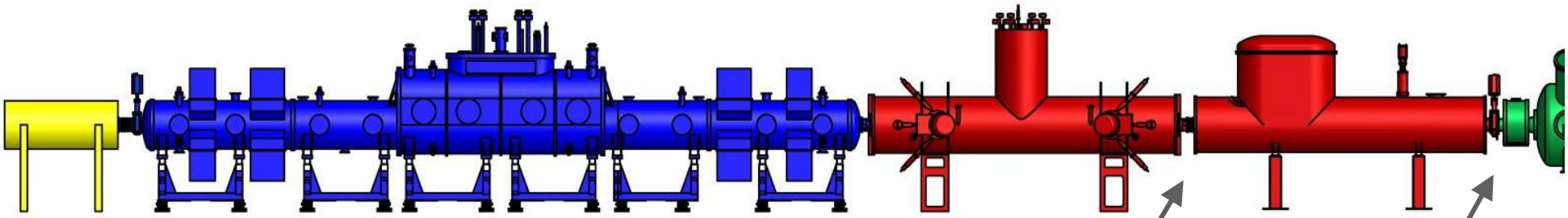
Partial pressure < **$10^{-20}$** mbar

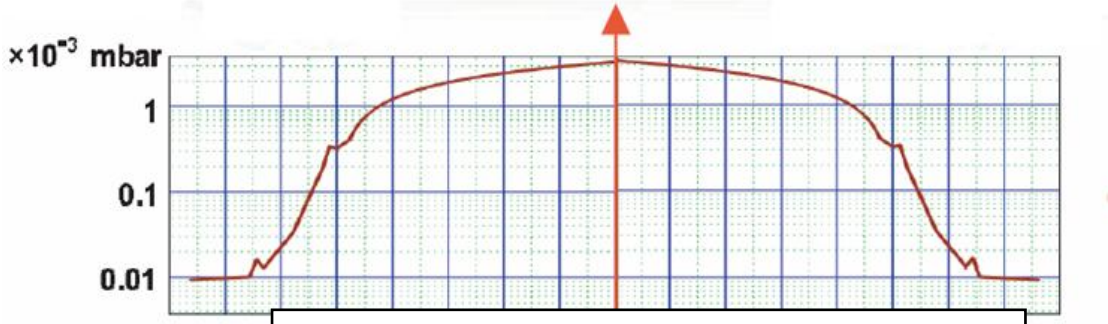
adiabatic guiding of electrons on meV level



# STS = Source & Transport System

CMS WGTS DPS2-F CPS






$T_2$-injection 1.8 mbar l/s (STP)
= $1.7 \cdot 10^{11}$ Bq/s = 40 g/d

≈ $10^{-7}$ mbar l/s

< $10^{-14}$ mbar l/s

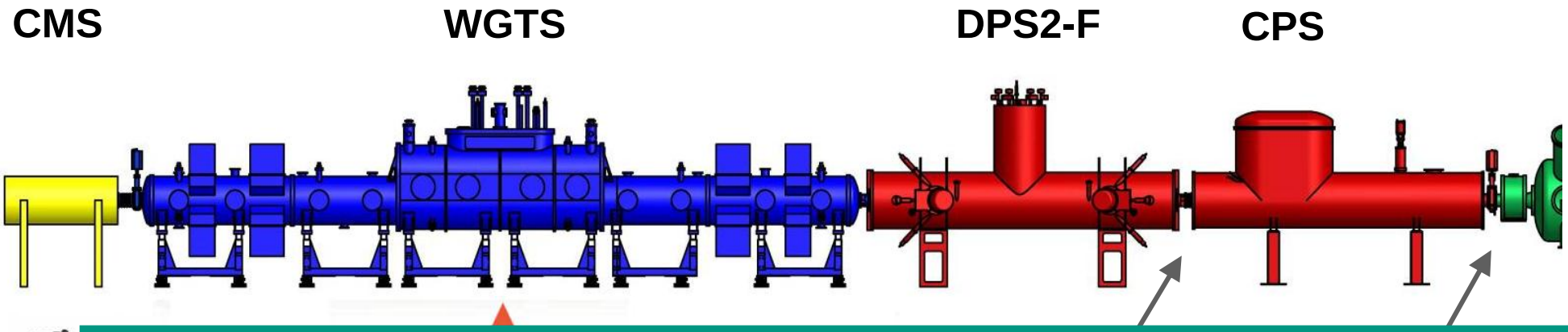
⇒ reduction > $10^{14}$

tasks for transport system
- electron transportation
- tritium retention

⇒ processing-system: “tritium loops”



# STS = Source & Transport System

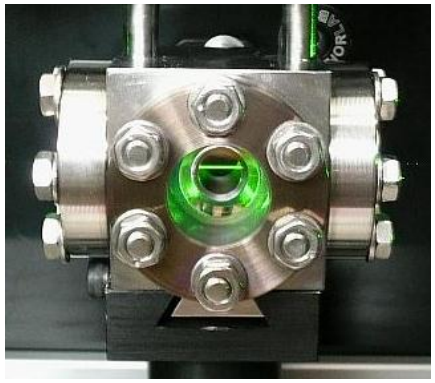


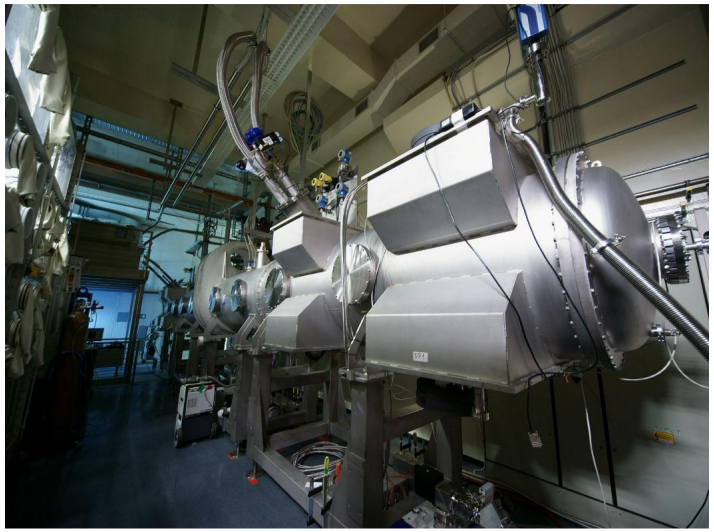

## Requirements to tritium source and loops

- column density: $5 \cdot 10^{17}$ molecules/cm²
- activity: $1.1 \cdot 10^{11}$ Bq
- injection: $5 \cdot 10^{19}$ molecules /s ≈ 40 g Tritium / day!
- content: ultrapure molecular tritium (> 95%)
- stability: 0.1% (injection, purity, temperature, $\Delta P_{in} / P_{in}$)

**= limit of what technically can be done!**



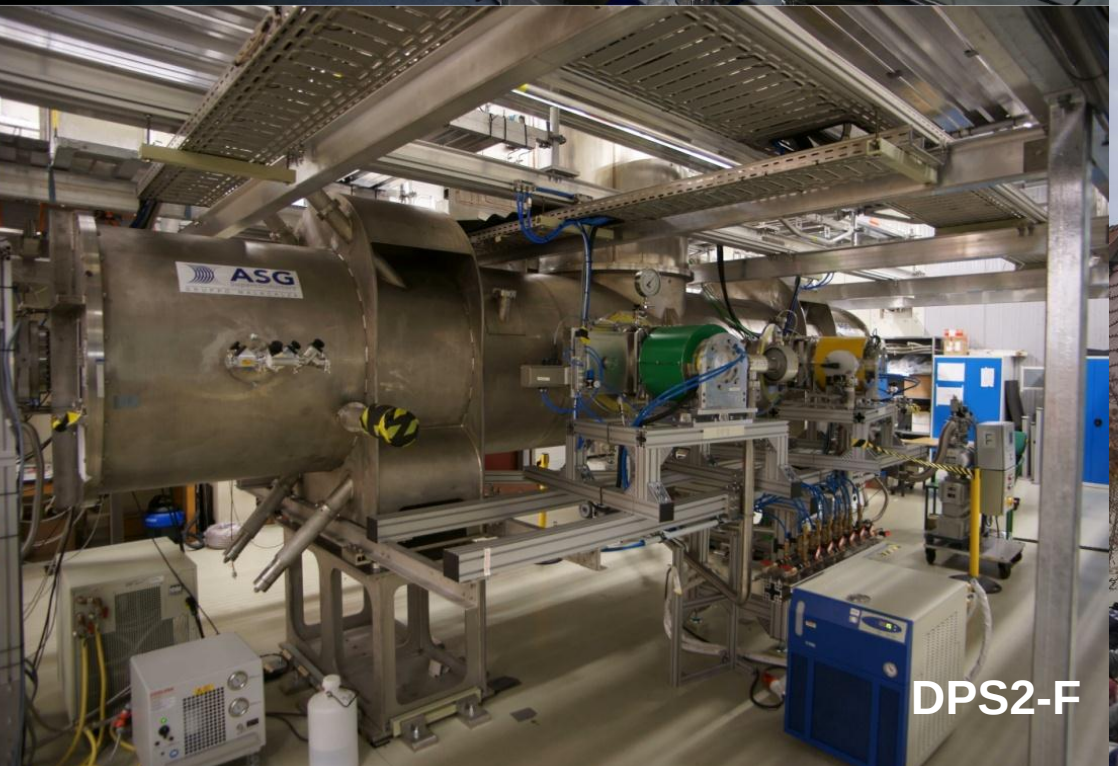




# Thank you for your attention


Demonstrator@TLK


Tritium Laboratory Karlsruhe



DPS2-F