The Windowless Gaseous Tritium Source (WGTS) for the KATRIN experiment

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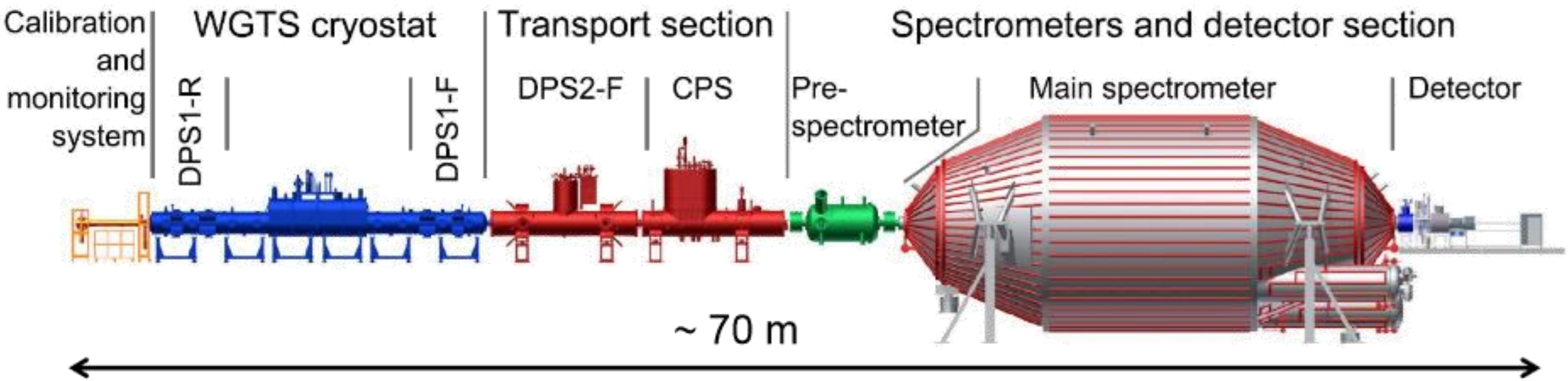
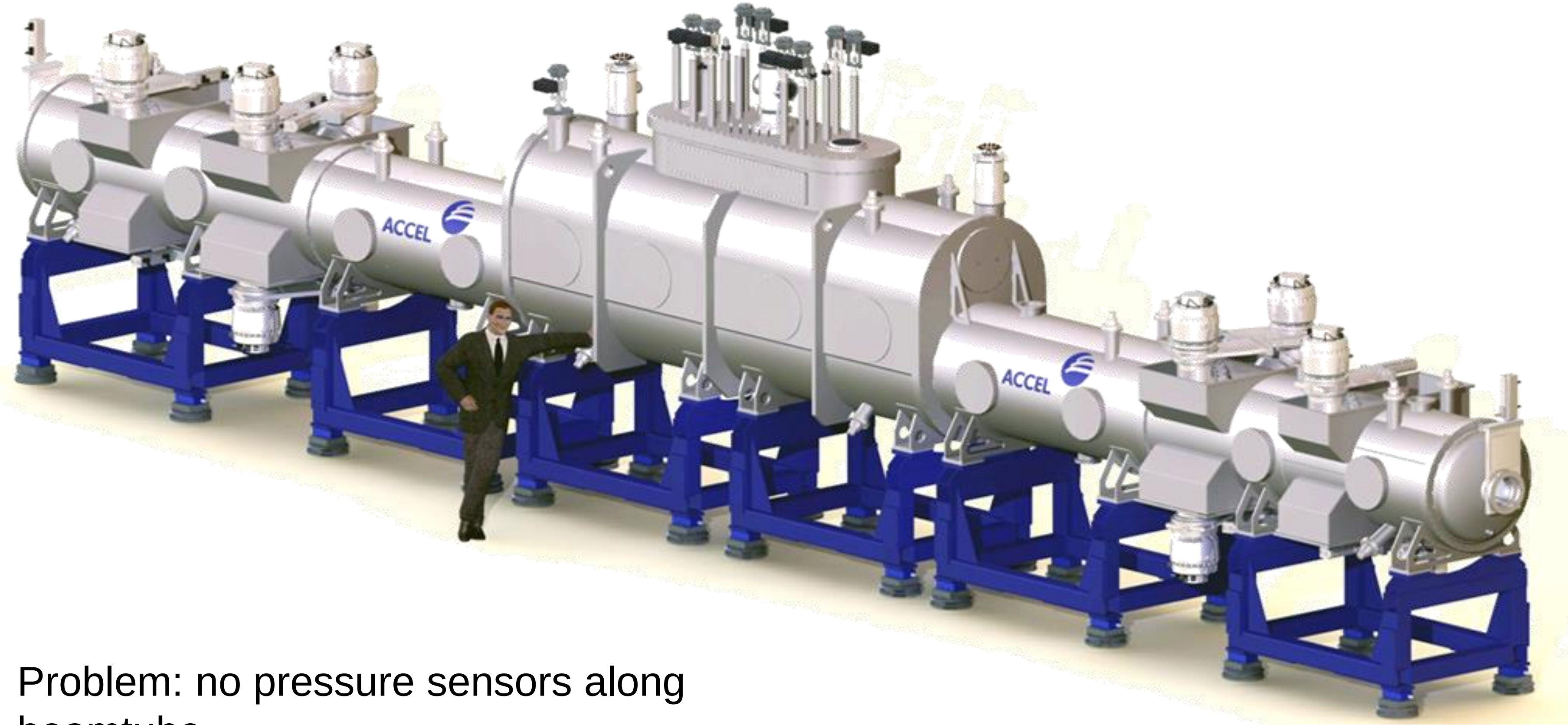
KATRIN



- Measurement of electron spectrum with MAC-E filter
- Improvement of neutrino mass sensitivity of a factor 10
  - → requires detailed understanding of systematics → see talk 6f by H. Seitz-Moskaliuk
- Tritium (column) density fluctuations to be known to the 0.2% level
  - → causes systematic uncertainty on neutrino mass

Tritium source - WGTS



Problem: no pressure sensors along beamtube

WGTS arrival

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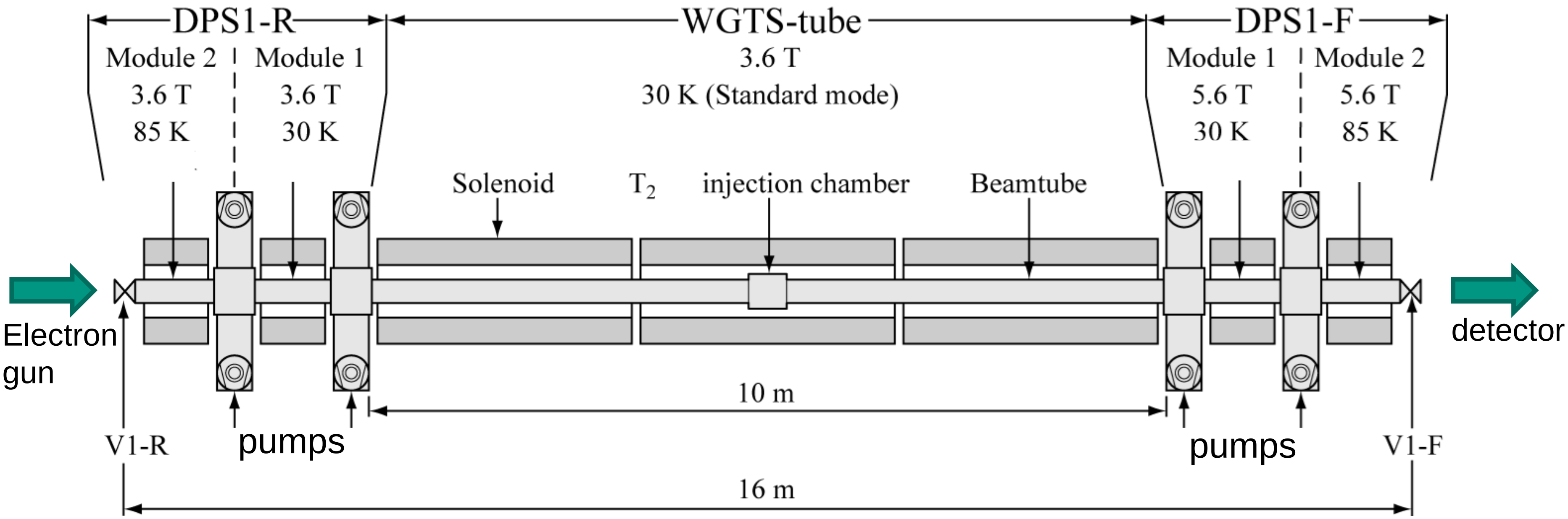
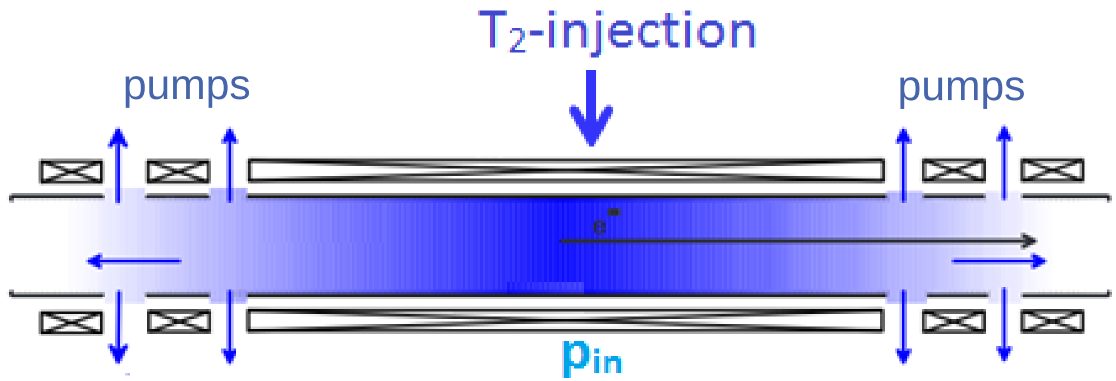
WGTS key parameters



- $L_{beamtube}$=10 m, Ø = 90mm, T = 30K (dT = 30mK)
- Adiabatic guiding of electrons through magnetic field lines (B=3.6…5.6T)
- T_2 injection with 3.37µbar (tritium column density ≈ $5 \cdot 10^{21}$ m^{-2}), $p_{ex,WGTS} \approx 10^{-2}\, p_{in}$

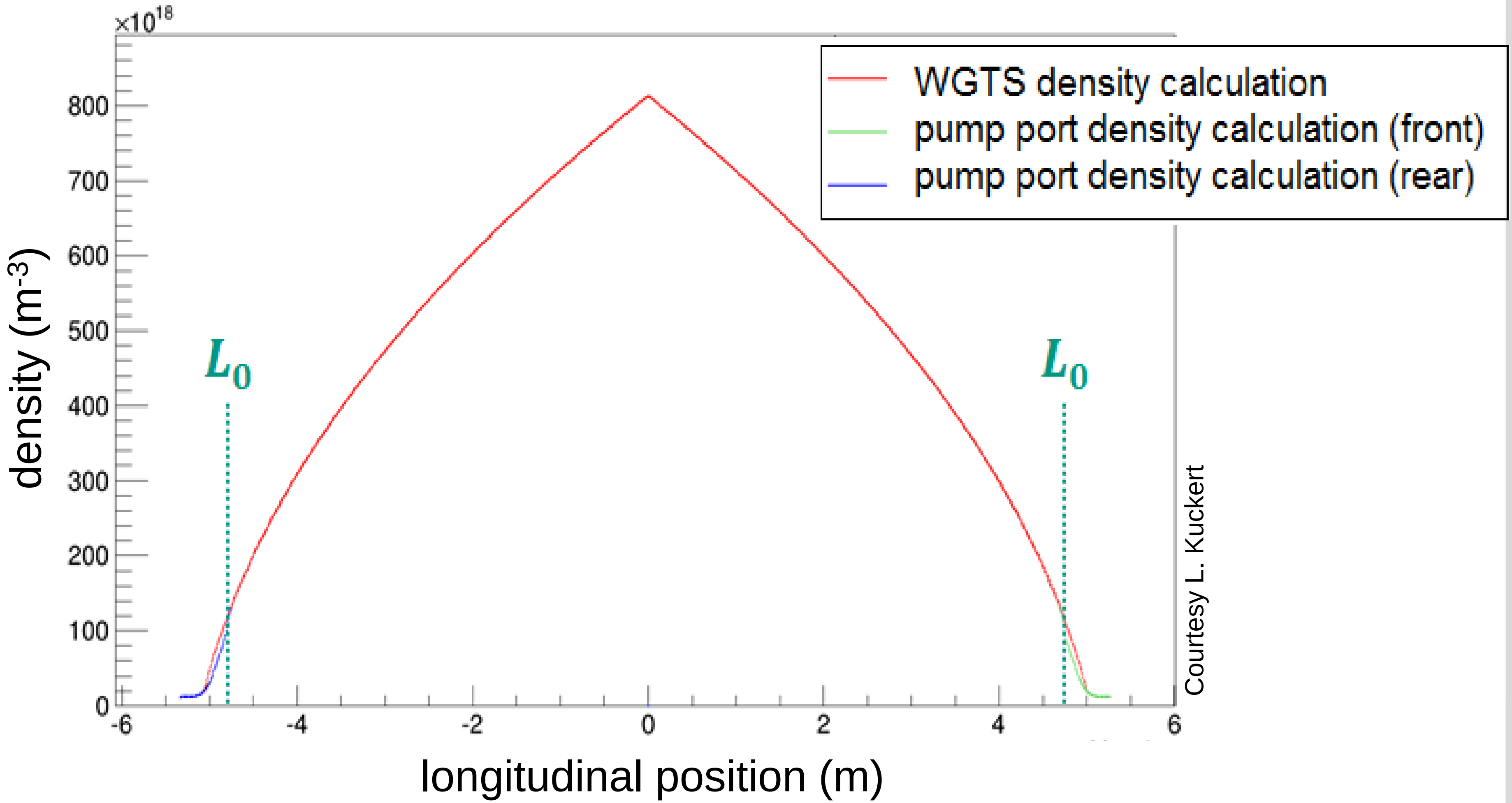
→ further pressure reduction in transport section (need **10^{14}** reduction of tritium flow)

WGTS gas flow regimes

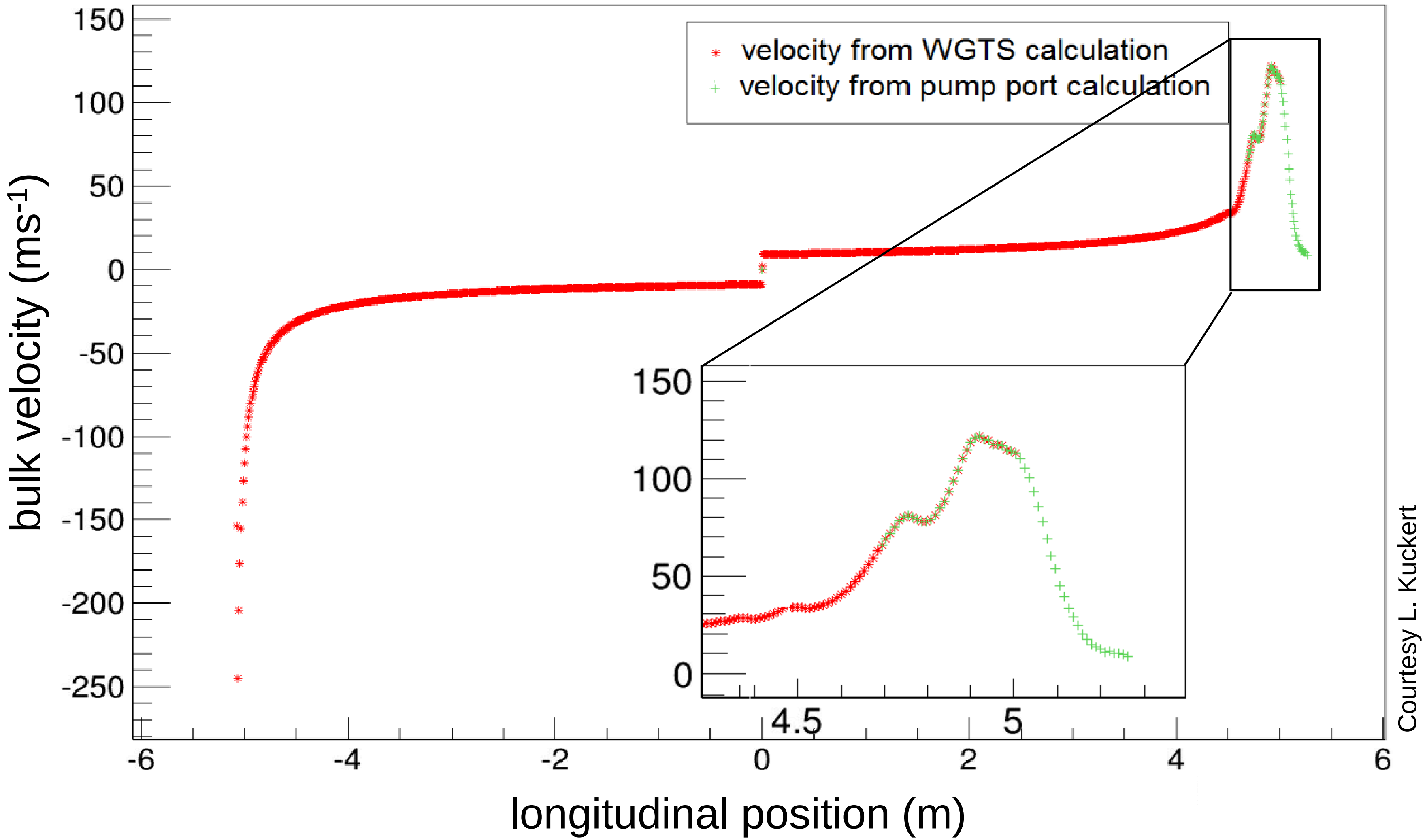


Pressure	$0.02 P_{in}$	0.34Pa	$0.02 P_{in}$	p
	0.46	23	0.46	δ
Flow Regime	**Transition flow**	**Continuum**	**Transition flow**	**Molecular flow**
Model equation		Navier Stokes equation	Boltzmann equation	Monte Carlo

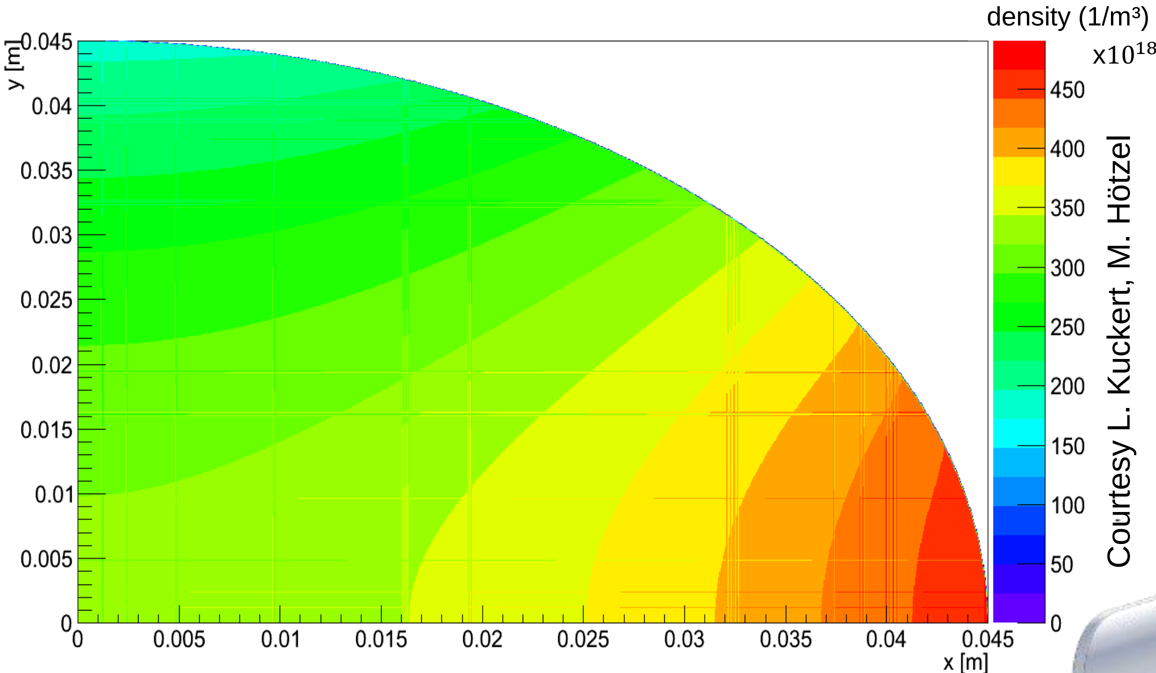
1D tritium density profile

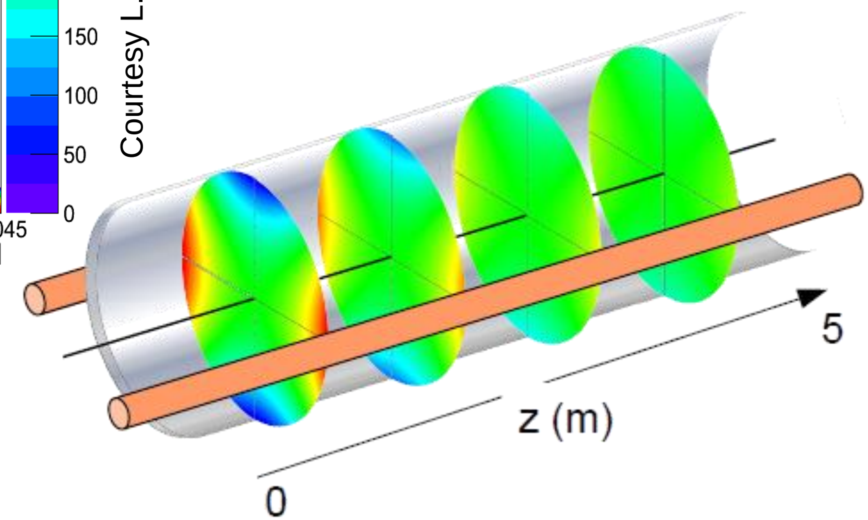


1D velocity profile



Pseudo 3D density profile





- Pseudo 3D density profile:

  Starting from 1D density distribution,

  applying 2D distributions for 25 precalculated δ values (from temperature variations) by interpolating according to $\delta(z)$ distribution

Uncertainties on tritium density calculations

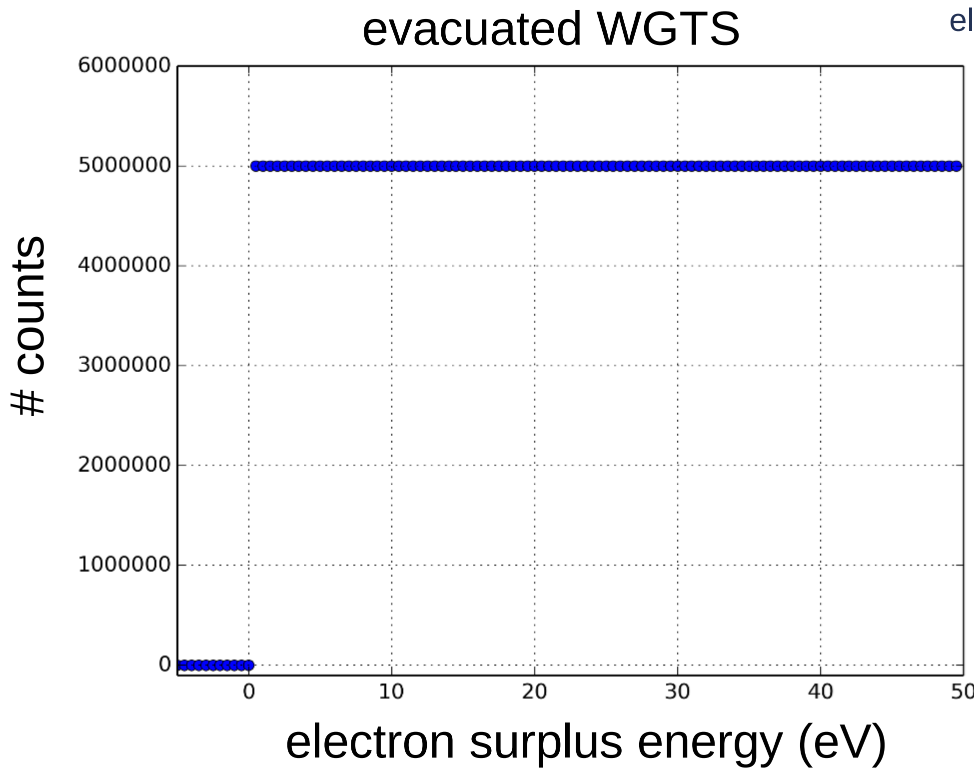
- Model equation
- Tritium viscosity interpolation
- Accomodation coefficient of tritium on steel

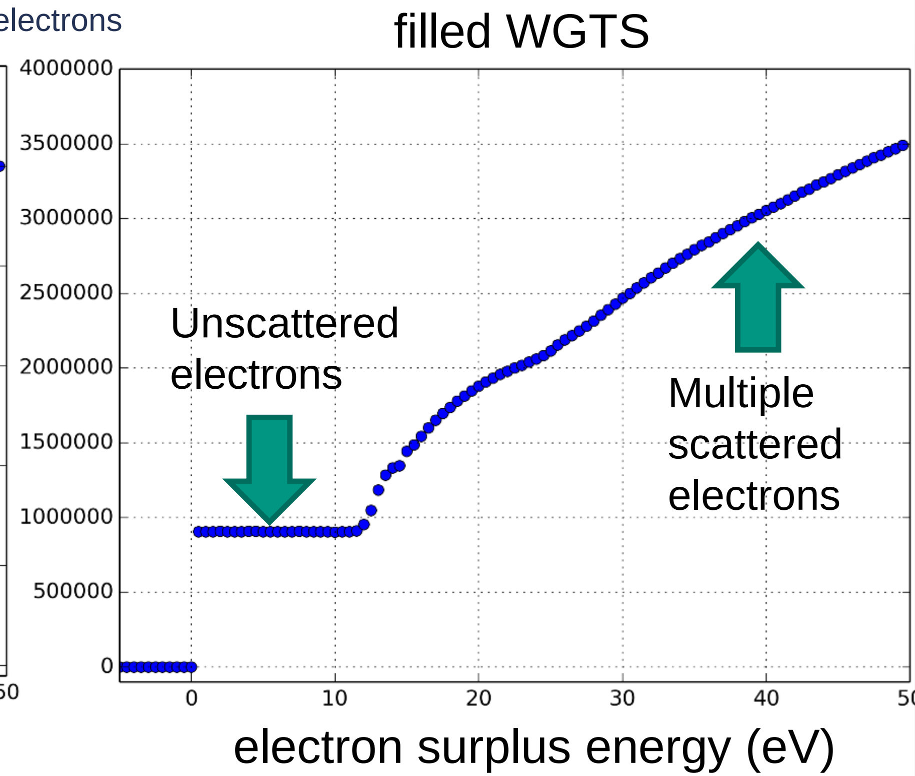
↳ Resulting uncertainty on simulated absolute tritium density 5%, required 0.2%

↳ Measurement with electron gun necessary

Emulation of tritium density measurement with the electron gun

5 million simulated electrons





Calculate via $P_0 = e^{-\frac{\rho d \sigma}{\cos(\Theta)}}$

- Use KATRIN main detector
- evacuating WGTS takes hours or even days
- measure at plateau around 5 V

Next steps

Software

- implement sensor data for usage in gasdynamics/spectrum calculation (temperature, magnetic field, inlet/outlet pressure)

Hardware

- Hardware: comissioning of source cryostat
- Training of column density measurement scheme with deuterium

Application of gasdynamics model with real-time sensor data

Summary and outlook

- Uncertainties on gasdynamics parameters require determination/monitoring of tritium column density
- Tool for tritium density monitoring: versatile electron gun

- 2016: Preparations for tritium commissioning
- First physics run with tritium targeted for end of 2016

Thank you

for your attention!

The Nobel Prize in Physics 2015
Takaaki Kajita, Arthur B. McDonald

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The Nobel Prize in Physics 2015

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Takaaki Kajita

Prize share: 1/2

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Arthur B. McDonald

Prize share: 1/2

The Nobel Prize in Physics 2015 was awarded jointly to Takaaki Kajita and Arthur B. McDonald *"for the discovery of neutrino oscillations, which shows that neutrinos have mass"*

"The Nobel Prize in Physics 2015". *Nobelprize.org.* Nobel Media AB 2014. Web. 10 Oct 2015. <http://www.nobelprize.org/nobel_prizes/physics/laureates/2015/>