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The Laser calibration system for the MicroBooNE detector

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Outline

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- The “laser”
- Principle of multiphoton ionization
- Results of laser measurements
- Feedthrough design
- Feedthrough test facility
- Beam line-up
- Power supply, racks, interlocks
- Next steps
- Conclusion

The "laser"

- Continuum Surlite I-10
- Nd:YAG laser with 1064 nm output
- Wavelength is reduced to 266 nm by two second-harmonics generators
- Laser properties:
  - Max pulse frequency 10Hz
  - Energy max. 60 mJ
  - Pulse width 4-6 ns
  - Divergence 0.5 mrad

One laser was ordered last week

Multiphoton ionization

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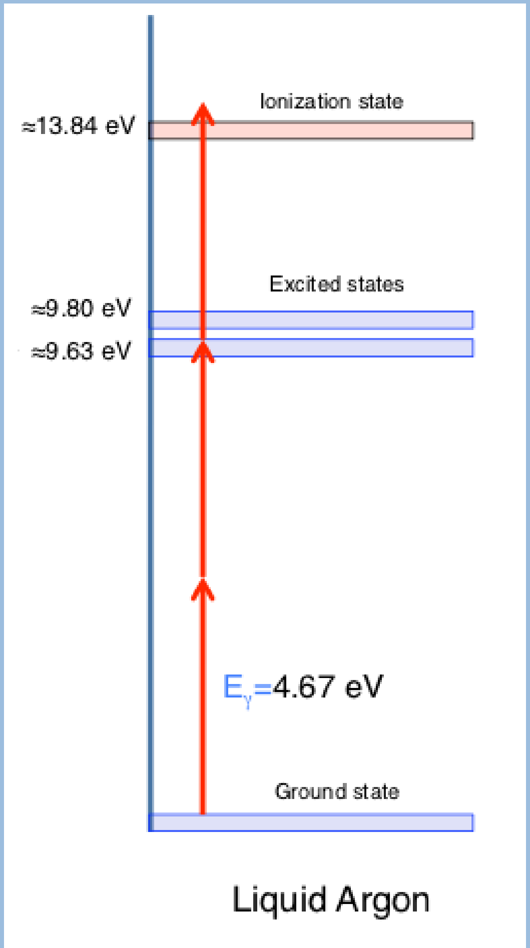
- λ = 266 nm correspond to E_γ = 4.67 eV
- For ionization ~14 eV are needed
- For non-resonant states the lifetime is given by

$$\tau_\gamma = \frac{\lambda}{2\pi c} = 1.4 \times 10^{-16} s$$

- For quasi-resonant states one has

$$\tau_\gamma \propto \frac{1}{\Delta E} = \frac{1}{(E_i - E_\gamma)}$$

- The laser has to have enough intensity to allow a three-photon ionization



See also: B. Rossi et al. 2009 JINST **4** P07011
I. Badhrees et al. 2010 New J. Phys. **12** 113024

Results of laser measurements

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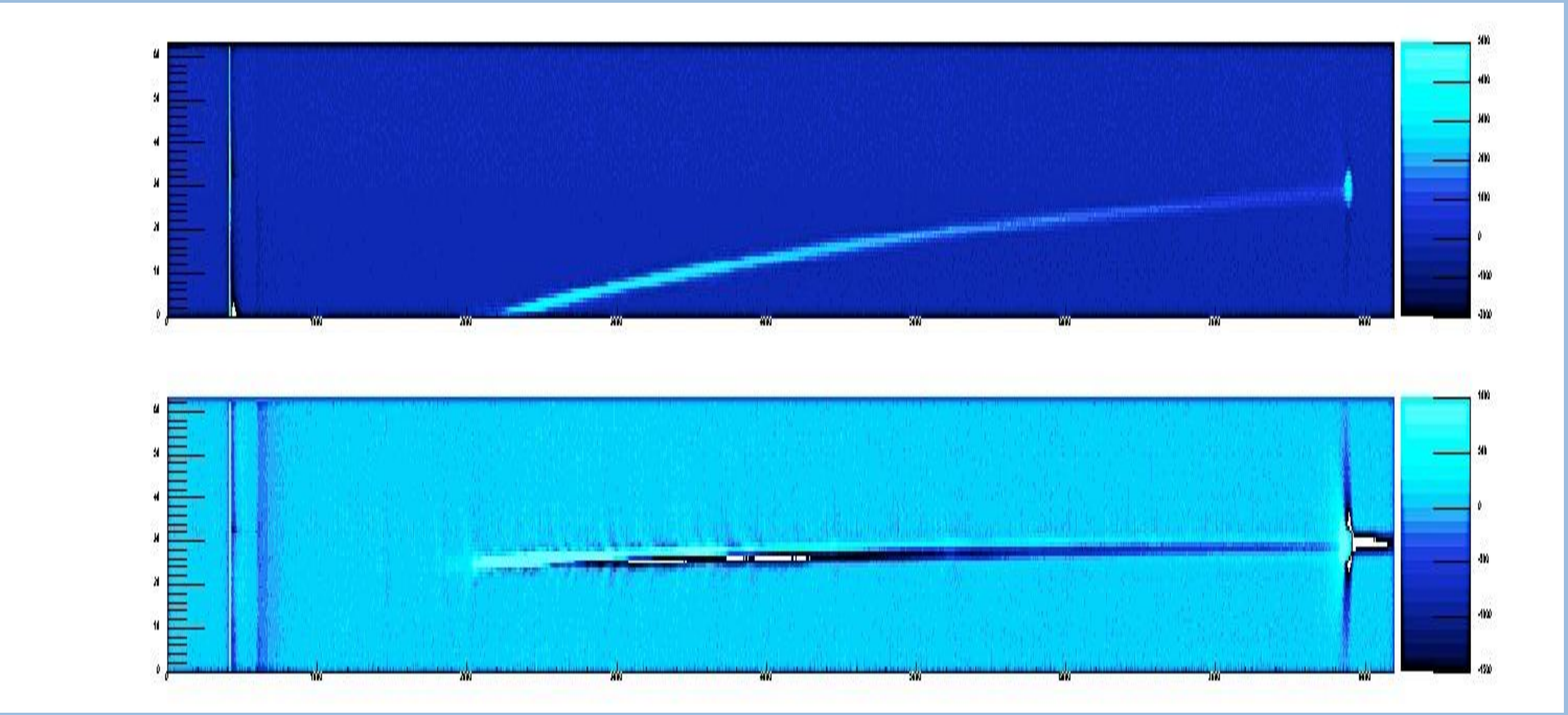

This picture shows a laser event in the Argontube detector. In the upper display the collection view and below the induction view are shown.

Results of laser measurements

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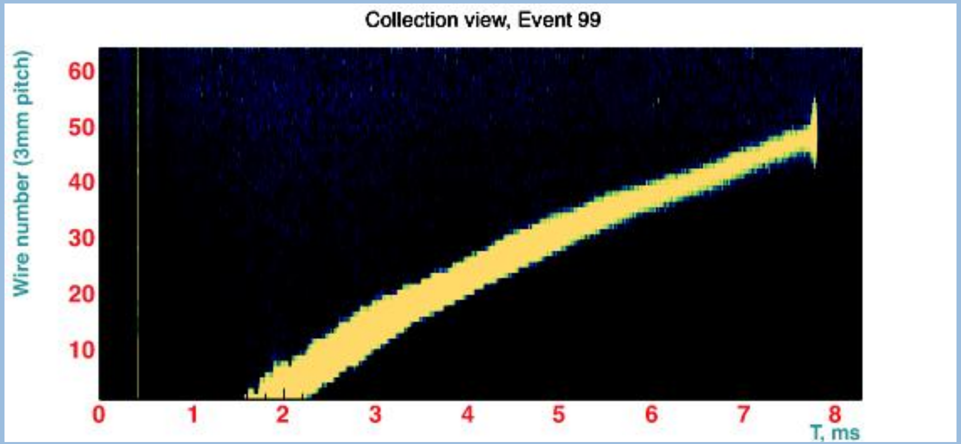
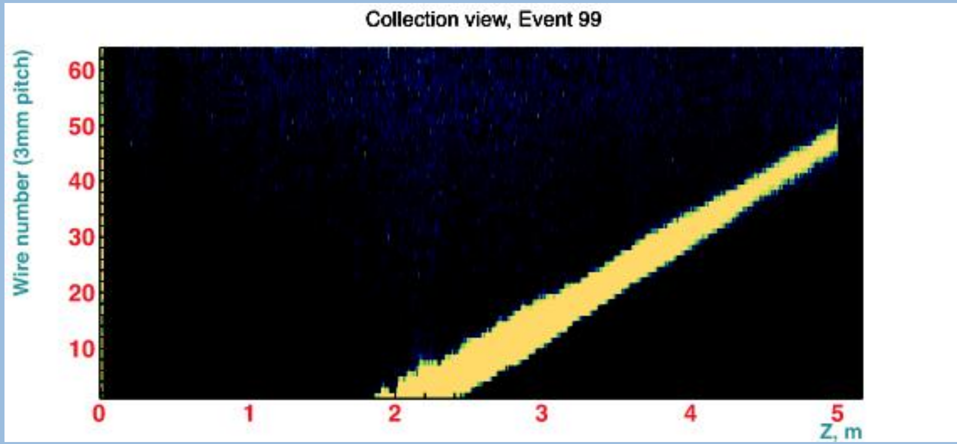
- Recent measurements with Argontube prove the feasibility of field corrections
- Above: collection view of a laser path in distorted field
- Below: same event after the electric field correction is applied





Results of laser measurements

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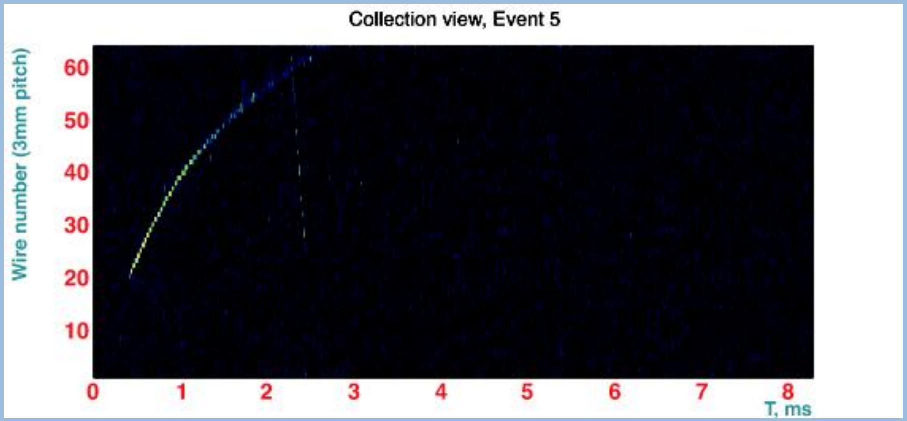
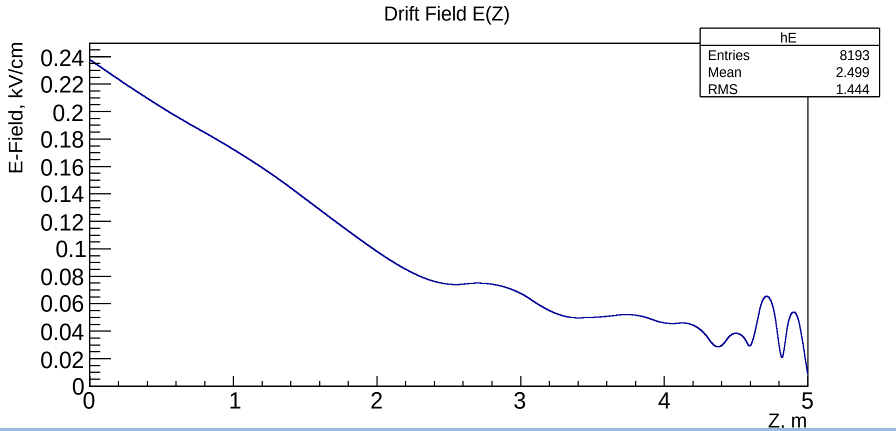
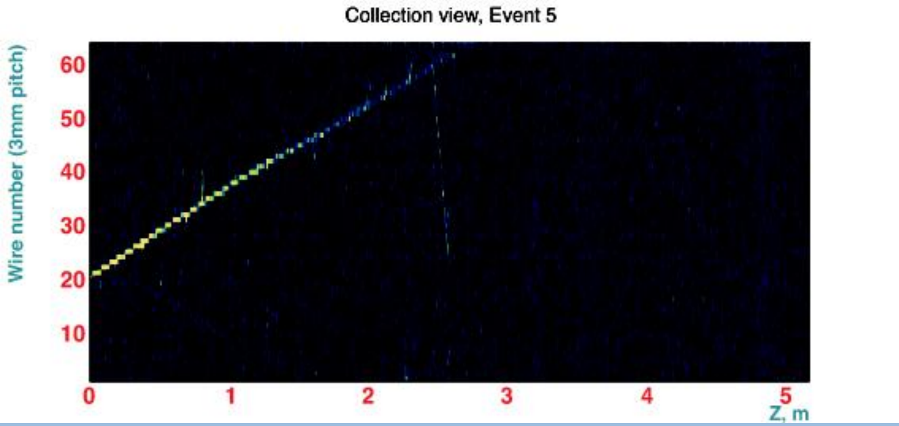
- Right side: correction applied to a cosmic muon event
- Bottom: Reconstruction of the Electric field in Argontube







Feedthrough design

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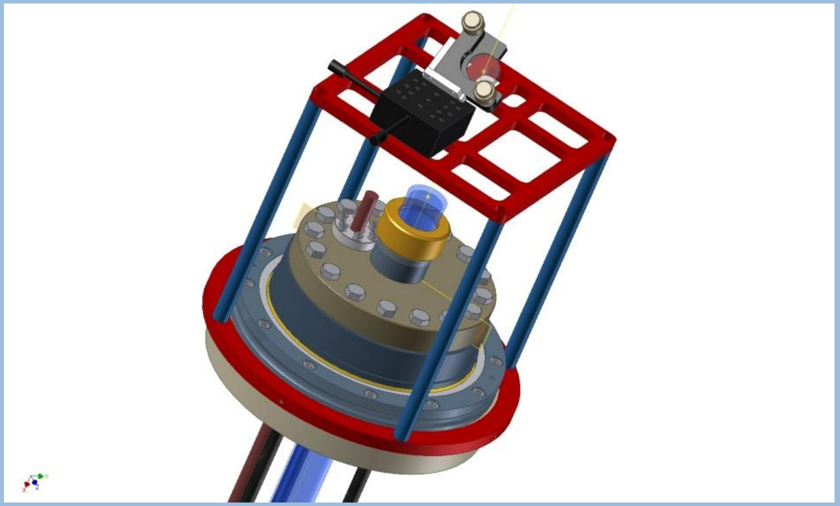
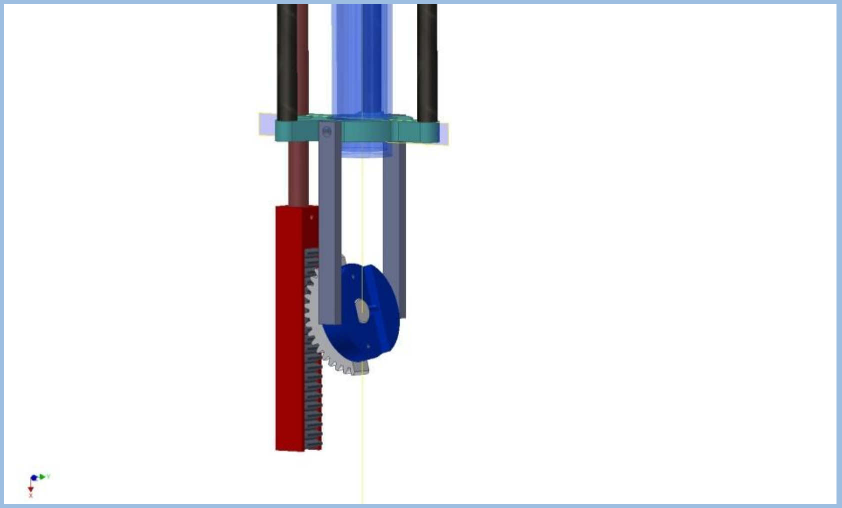
- Quartz glass tube immersed in liquid Argon, providing a flat surface for the laser
- CF-flange with a turnable head in order to swivel the mirror horizontally
- A linear feedthrough allows to tilt the mirror vertically
- The flange has to be vacuum tight





Feedthrough design

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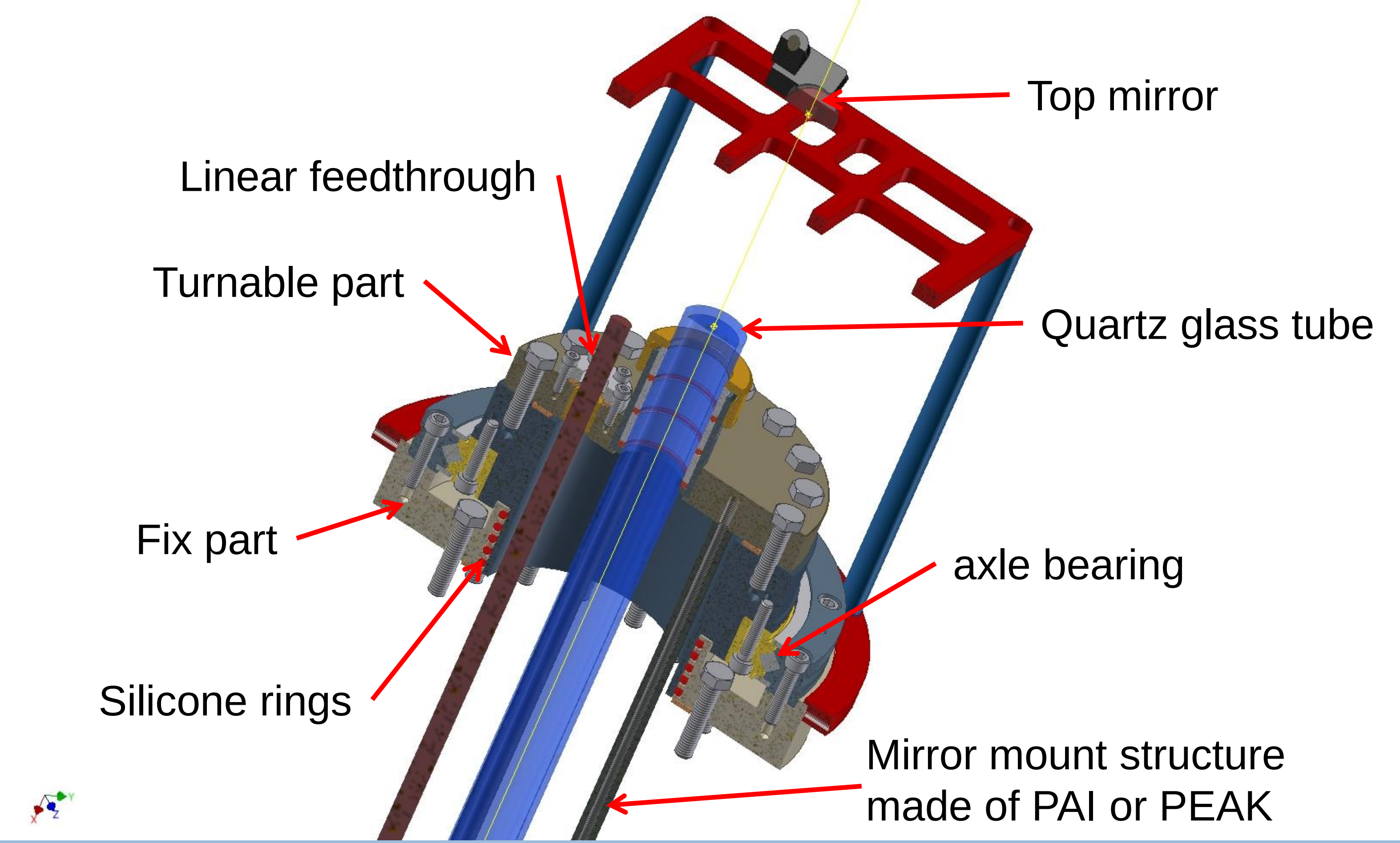


Feedthrough design

Top mirror holder

Turnable part

Fix part

Linear feedthrough bellow

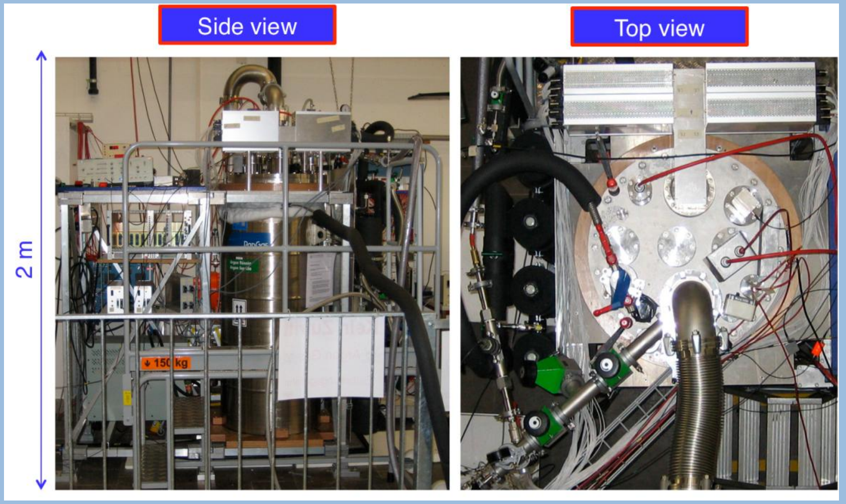
Glass tube holder

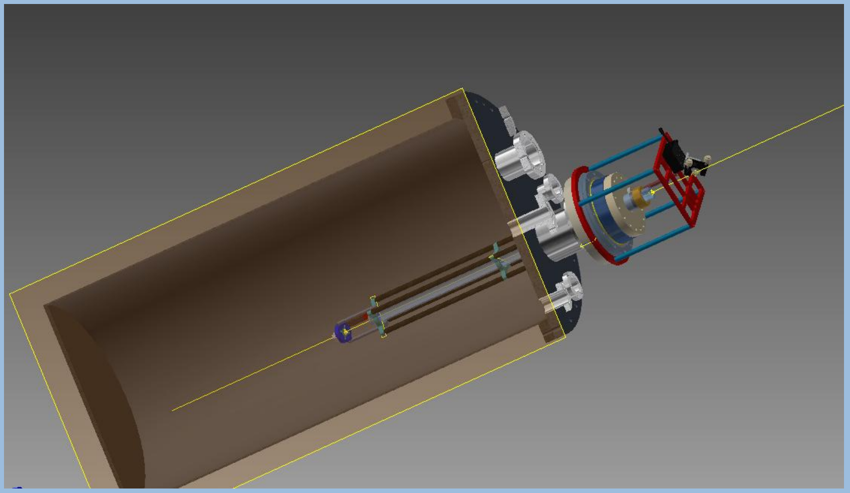
Bearing ring

Feedthrough test facility

- Test will be performed in medium-Argontube
- Cylindrical vessel
  - Height 1.1 m
  - Diameter 71.4 cm

- Vacuum test of the feed-through down to 10^{-5} mbar
- Torque and force measurements of the movable parts
- Cold test in liquid Argon





Beam line-up

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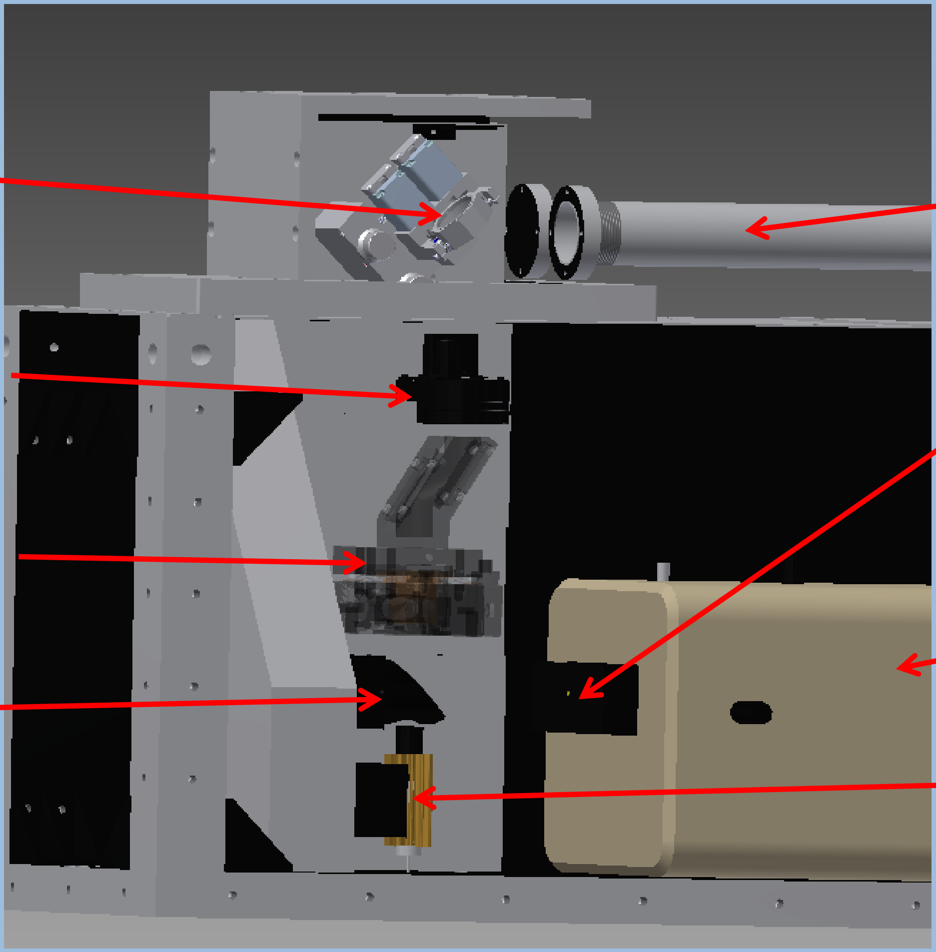

Beam line-up

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View from the point where the cold mirror will be placed

Power supply, Racks, Interlocks

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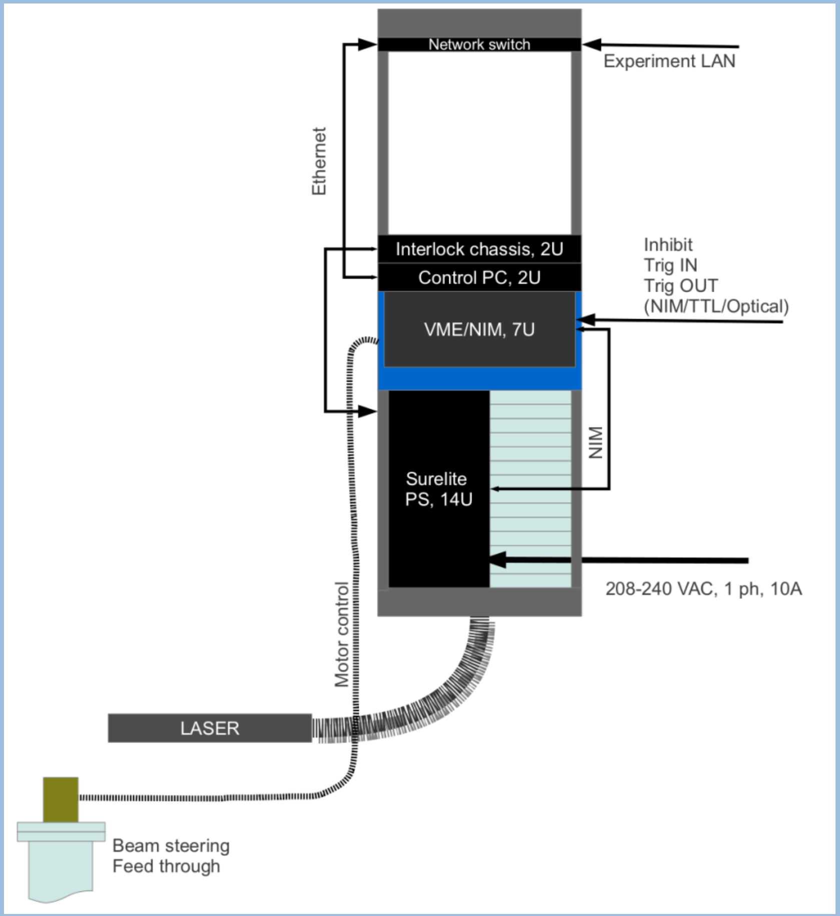
- Input 220 V single phase for the laser
- Interlock with PMT power supply (Laser off, if PMTs on)
- Interlock of the power supply if laser box is opened
- Panic button switches of laser if pushed
- System is designed with help of Linda, Bryce and Matt Quinn (LSO)



Next steps

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> Assembly of the feedthrough prototype (Nov 2012)
> Test of the feedthrough prototype (Nov 2012)
> Laser interlock system design (Nov 2012)
> Steering motor selection and order (Dec 2012)
> Arrival of the first laser in Bern (Dec 2012)
> Alignment test of the laser in Bern (Jan 2013)
> Alignment tests at Fermilab (Apr 2013)

Conclusion

- Argon can be ionized by an UV-laser
- The laser system is able to map the electric field
- Design phase of the feedthrough and the beam line-up is completed
- Feedthrough prototype parts are manufactured and ready for assembly
- Optical instruments are ordered
- First laser will arrive in Bern in about 7 weeks
- Preparations of feedthrough tests has started

Tank you!

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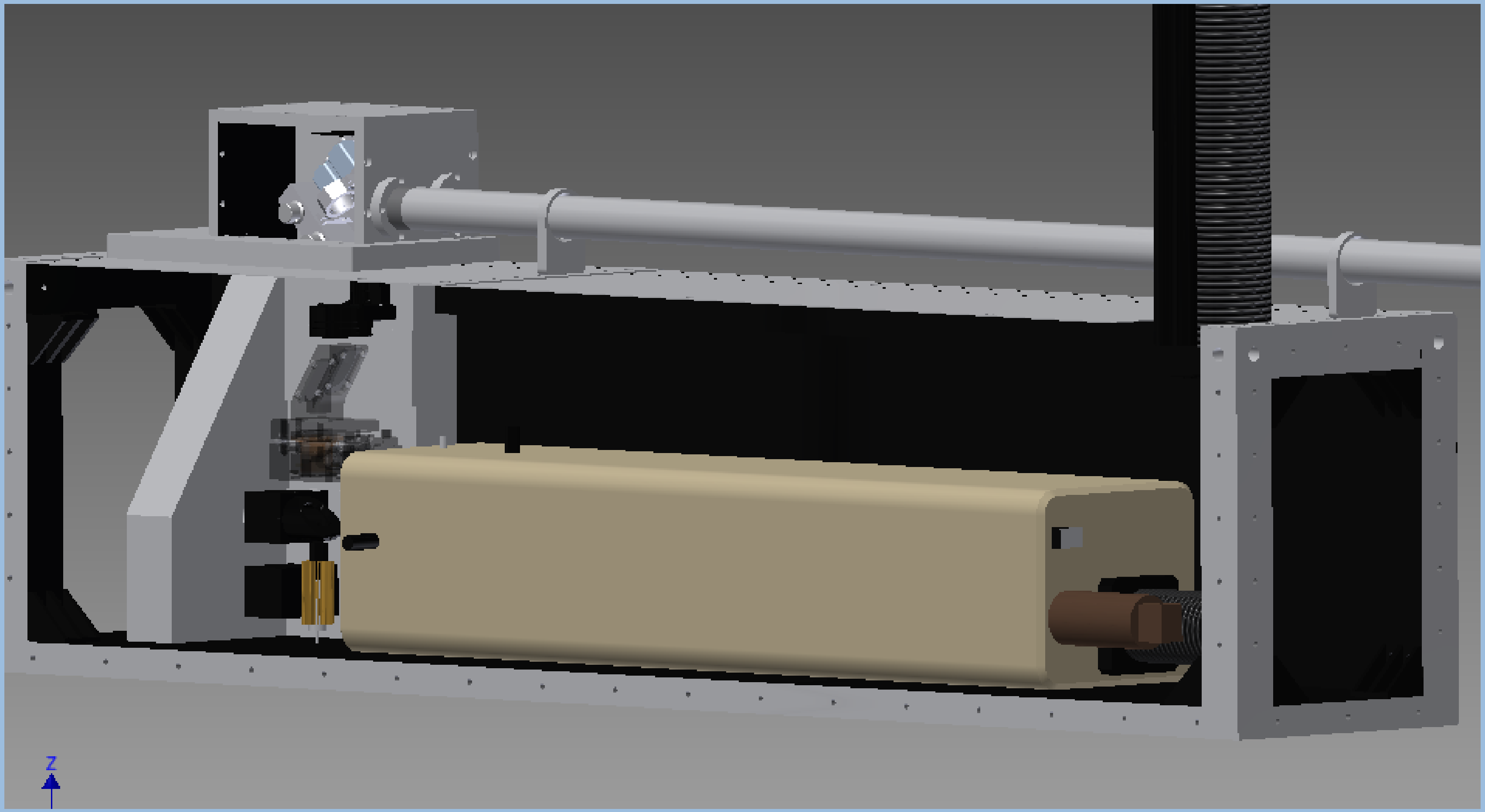

Backup

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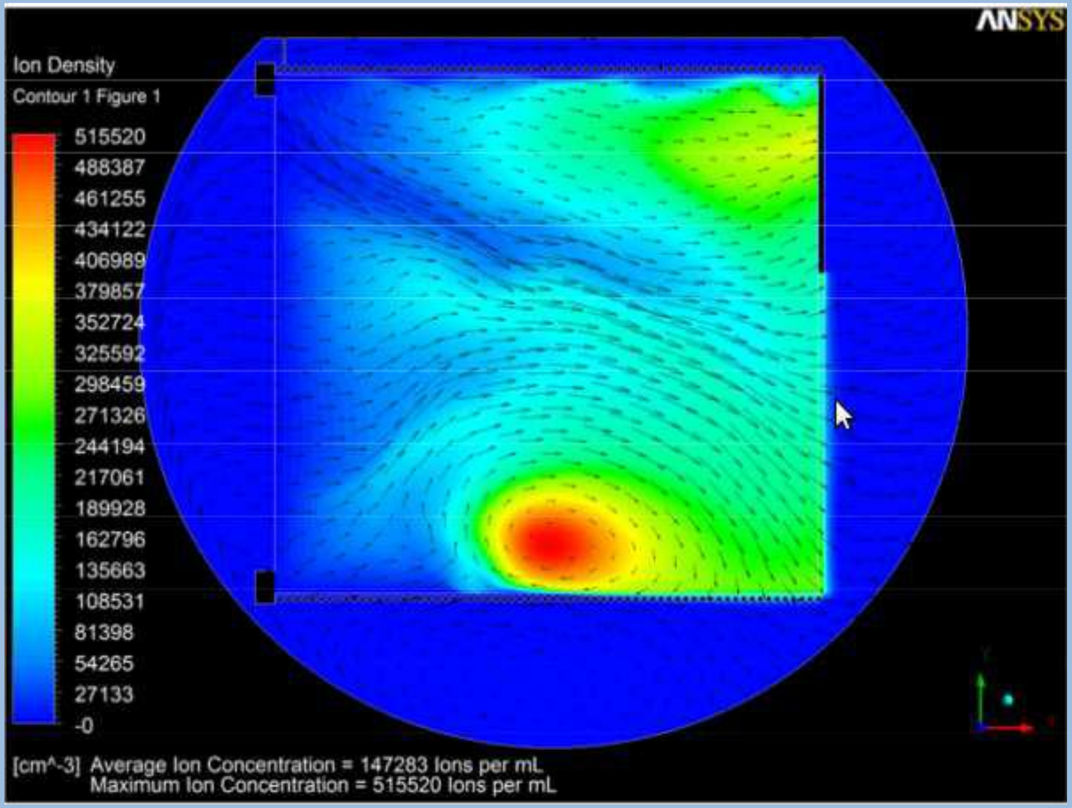
Why a laser?

- Cosmic rays produce Ar^+-ions
- Ion drift velocity is only of the order of cm/s
- Ar^+ accumulates
- Field distortions occur

- Laser delivers a straight path
- Field distortions can be corrected



Eric Voirin: MicroBooNE-doc-1895-v4

Laser position

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