Laserwire Emittance Scanner at CERN LINAC4

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Outlines

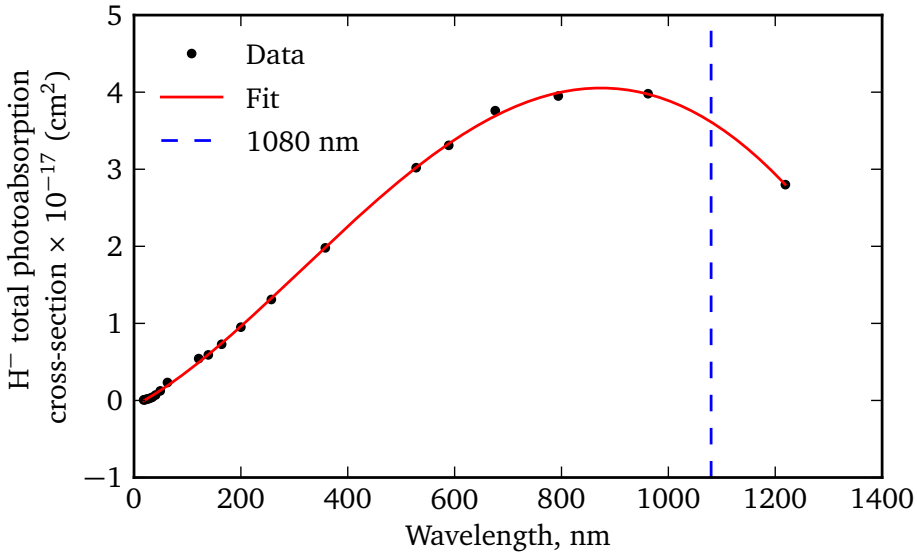
- Introduction
- Experimental setup
- Profile and emittance measurements
- Future improvements
- Summary

Introduction

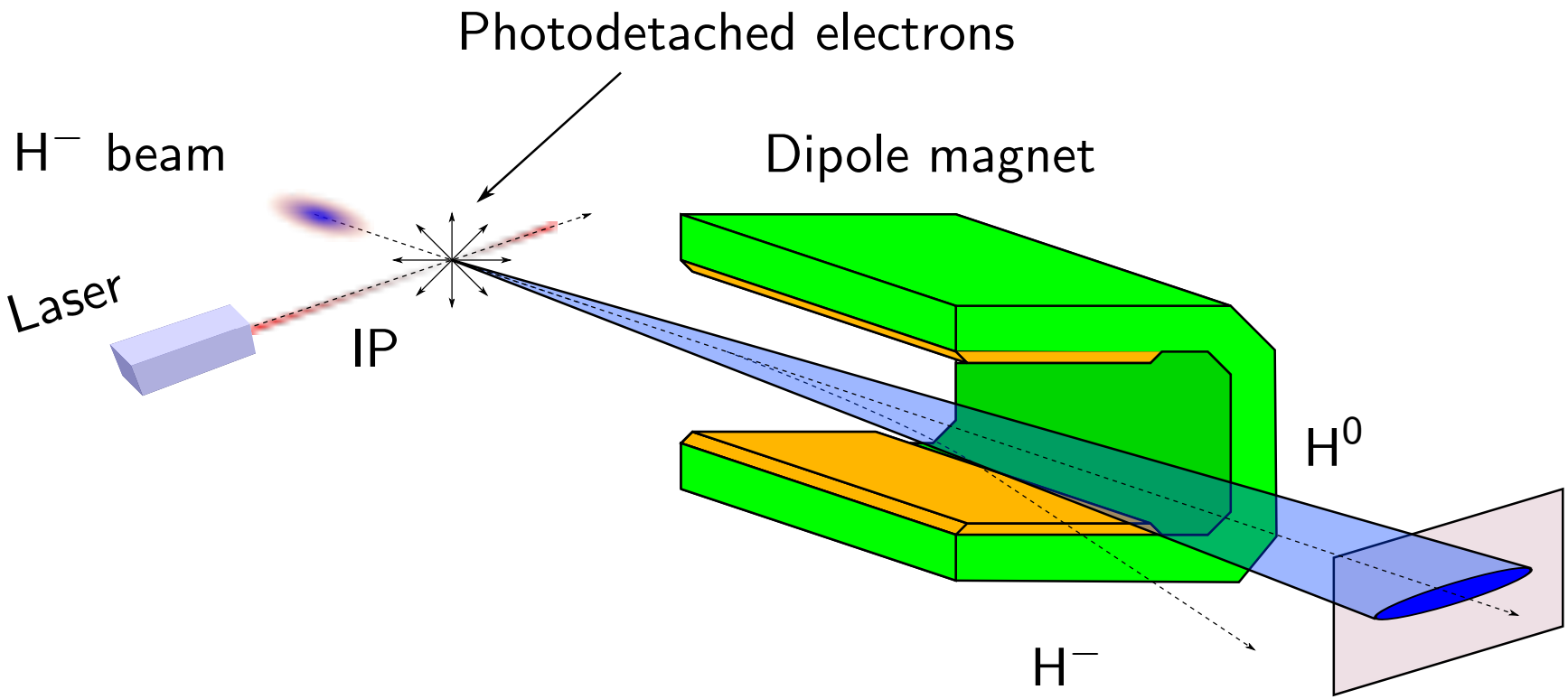
- The laserwire for H^- ions is based on photodetachment process

- Stripping probability:

$$p_{strip} = 1 - \exp\left(-\sigma(E_{ph})\, F_{ph}\, t\right)$$

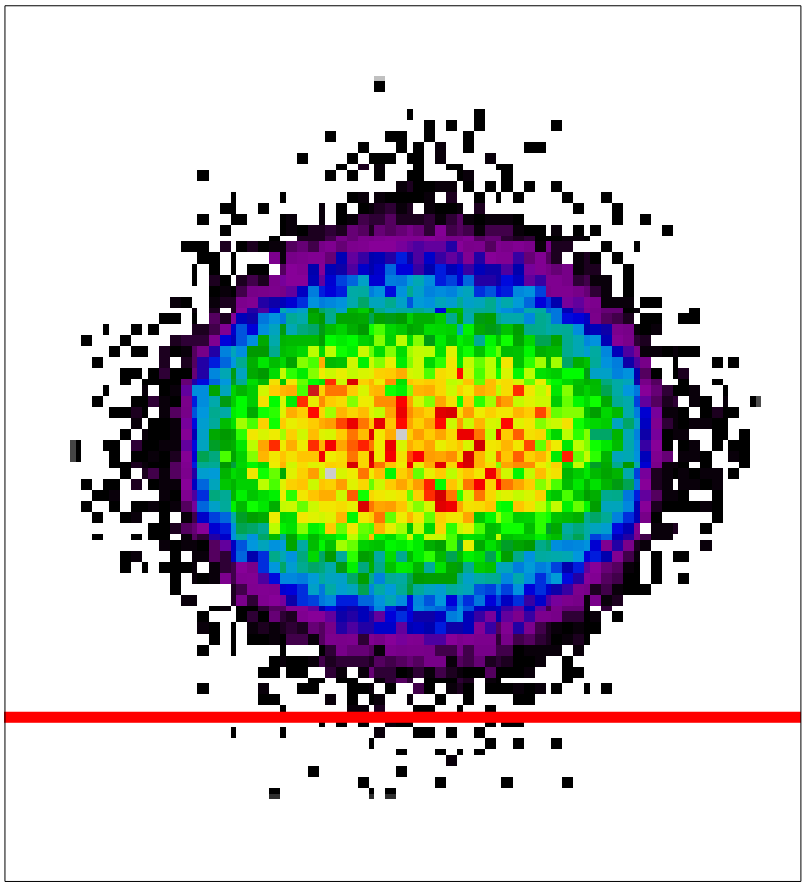


Basic principles

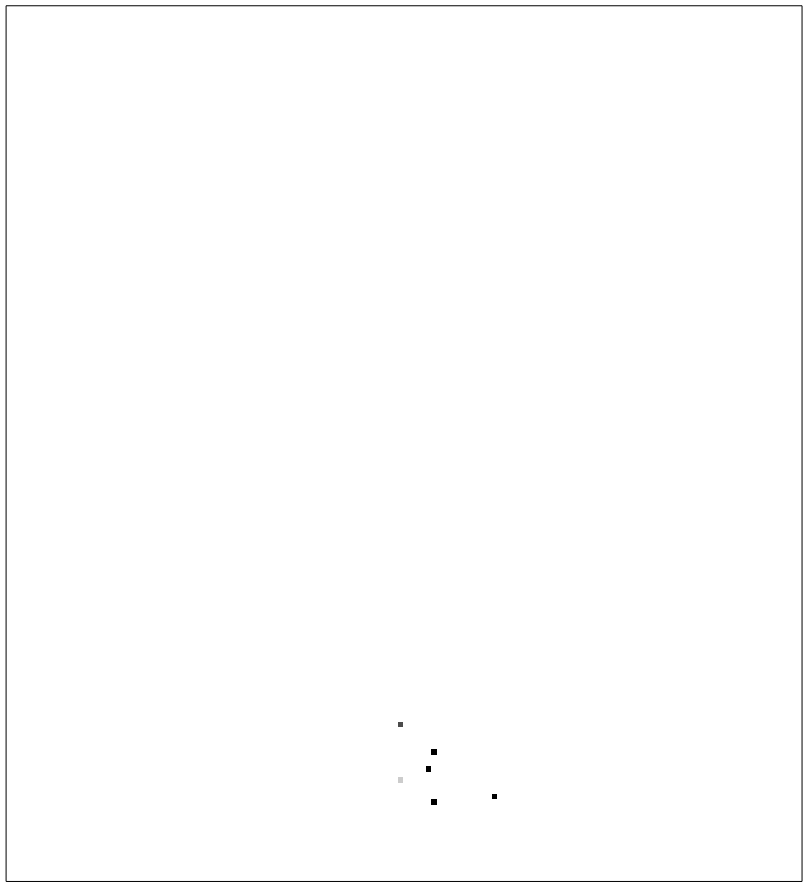


Basic principles

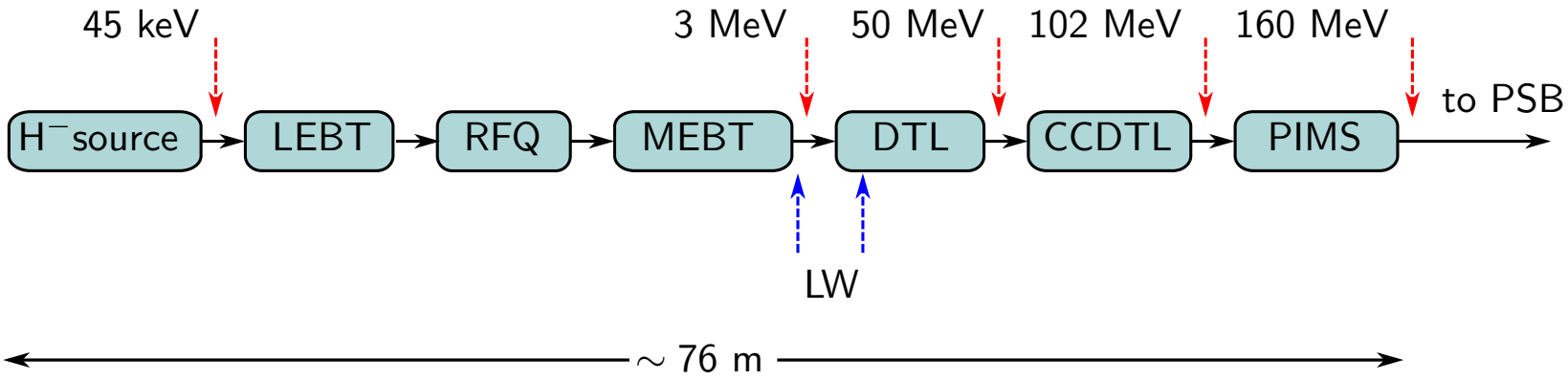
Distribution of H^- at the IP



Distribution of H^0 at the detector

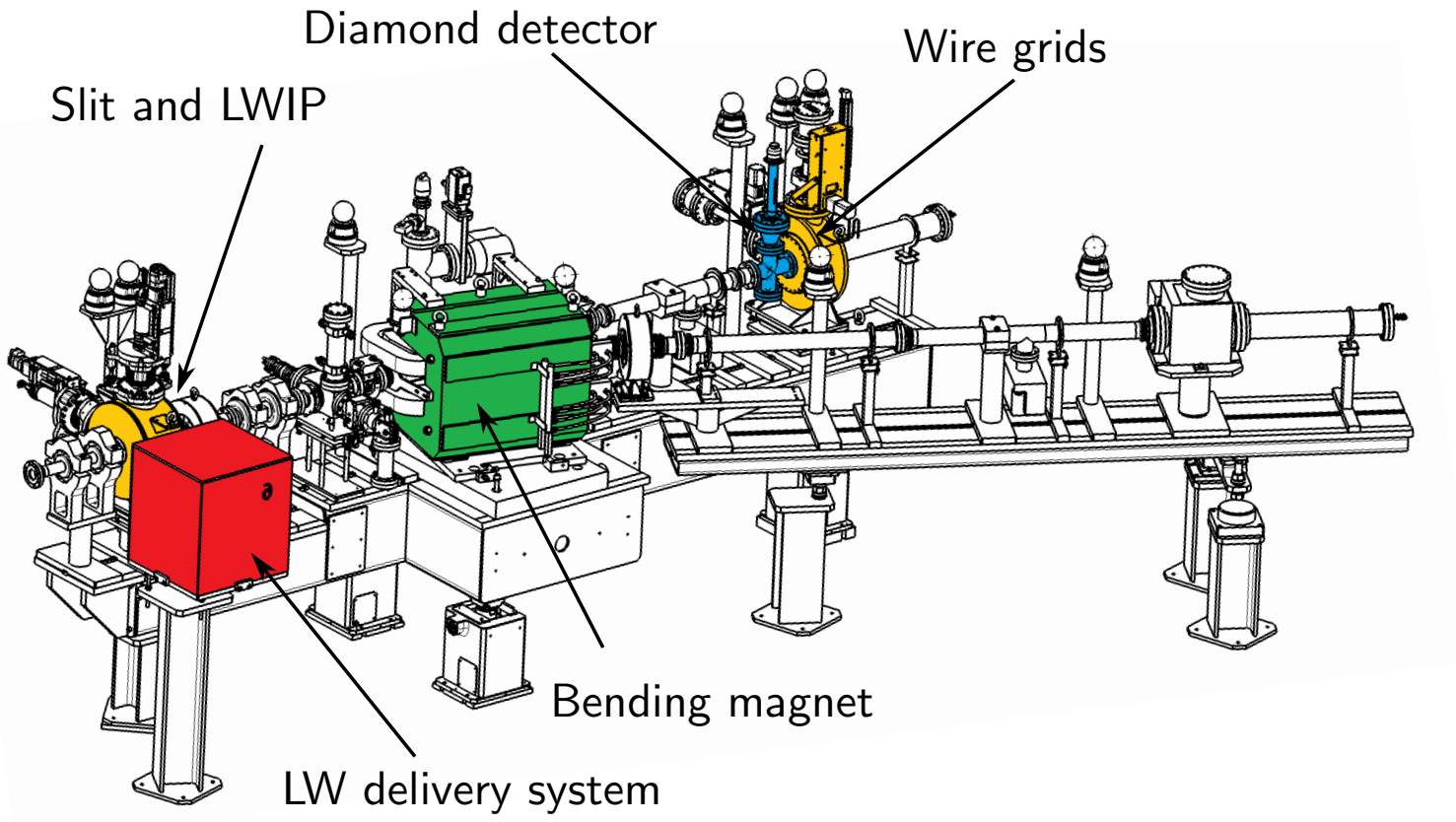


LINAC4

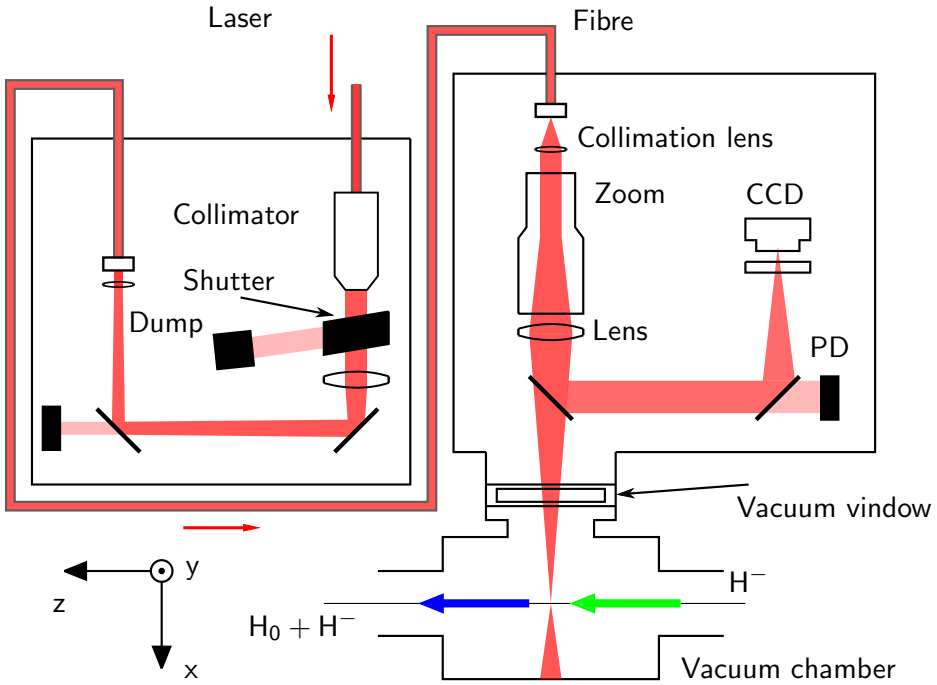


Parameter	Symbol	Value	Units
Overall linac length	L	76.33	m
Output energy	E	160	Mev
Bunch repetition rate	f_{bunch}	352.2	MHz
Beam pulse length	t_{pulse}	400	μs
Average pulse current	I_{pulse}	40	mA
Beam transverse emittance	ε	0.4	mm mrad

Experimental setup



Laser system

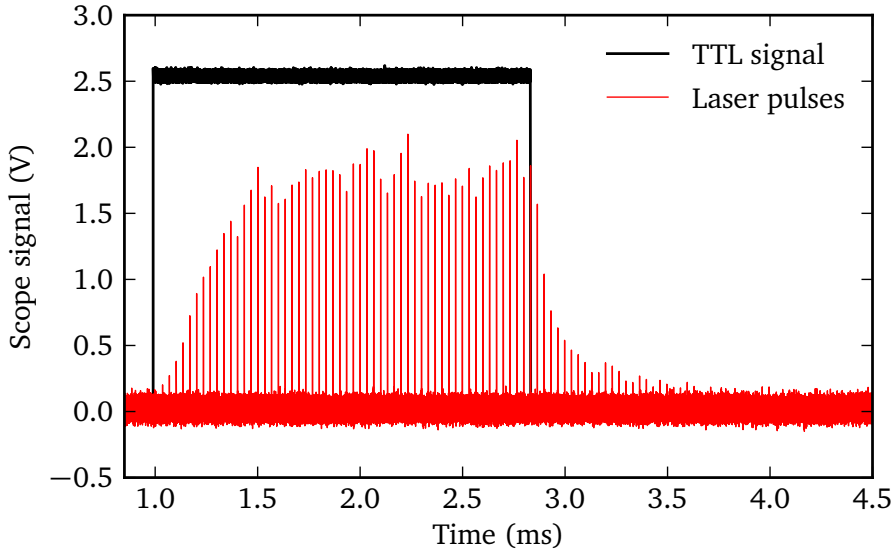


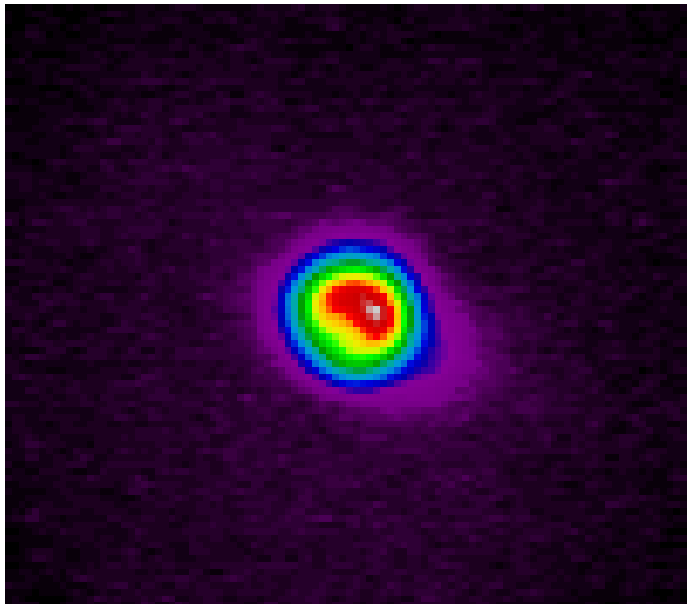
Laser: "Manlight"
model:MLXX-PL-R-TKS

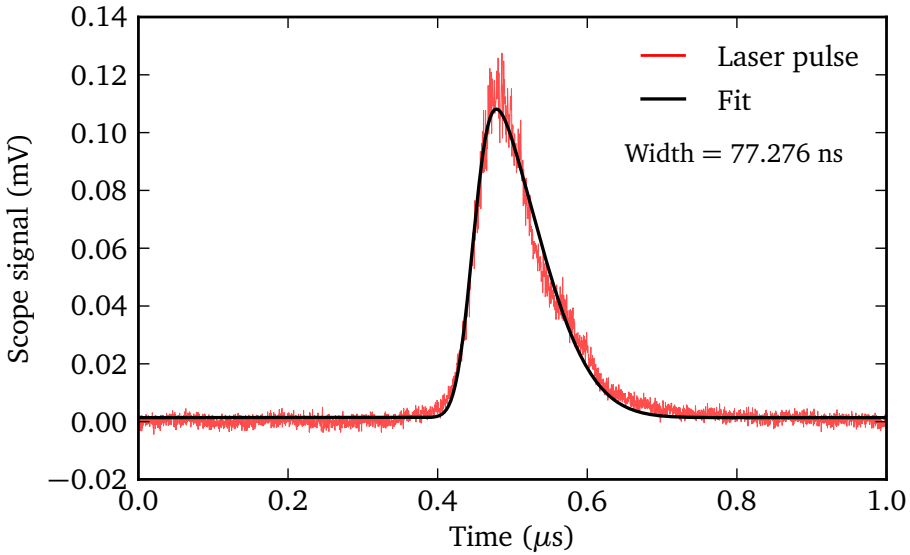
Main parameters of the laser system:

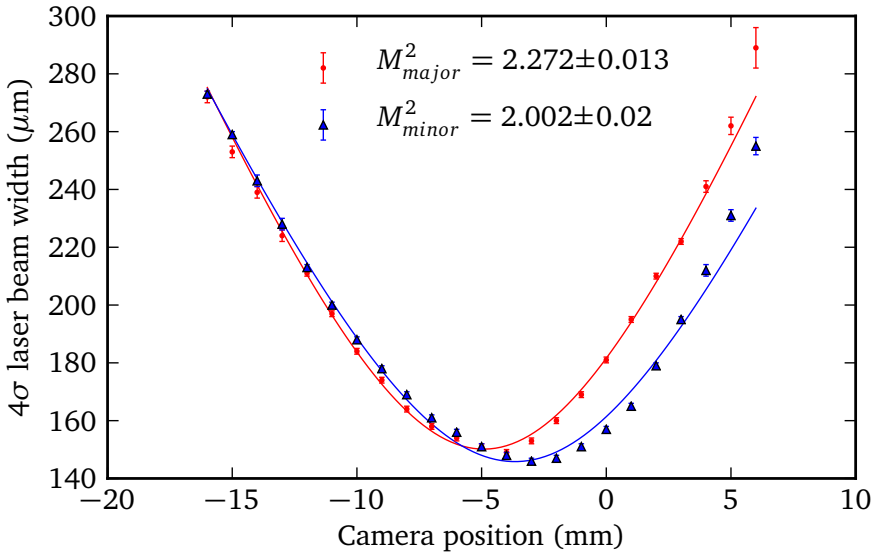
Parameter	**Value**
Wavelength	1080 nm
Pulse repetition rate (external trigger)	30 - 100 kHz
Average output power (CW pump)	30 W
Pulse duration	150 ns
Output power stability	< 2 %

Laser characterization



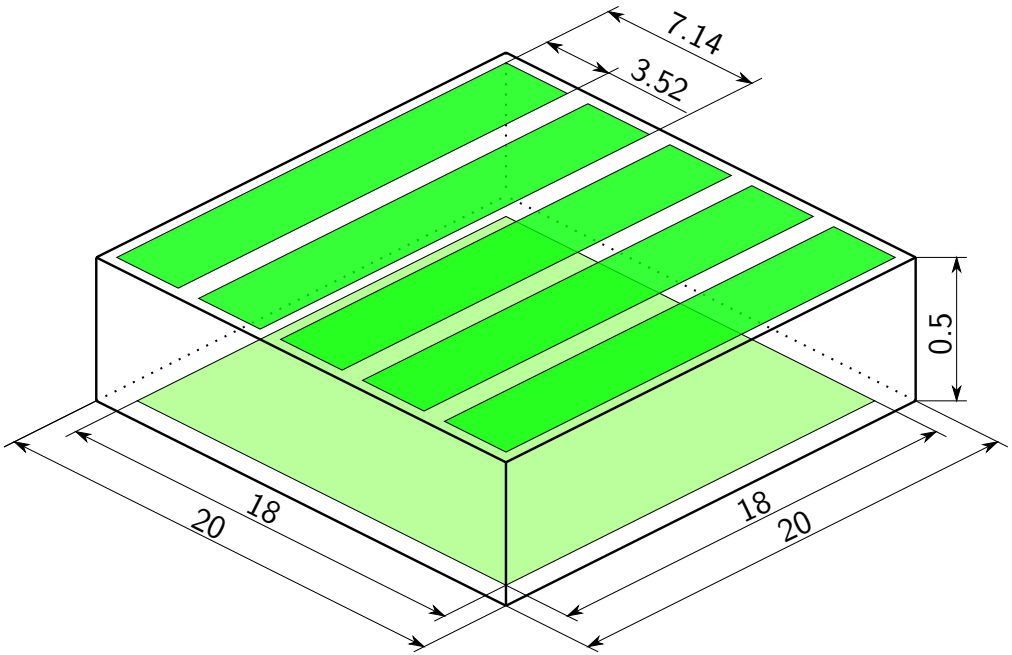


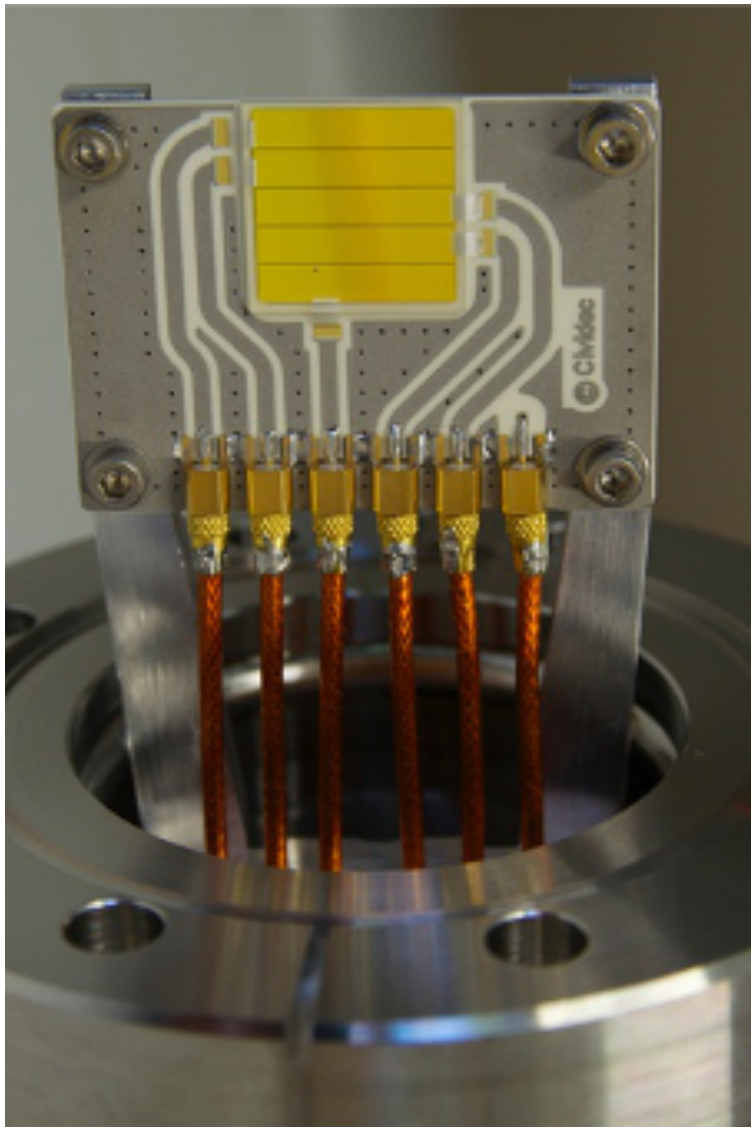




Diamond detector

"CIVIDEC" (http://www.cividec.at)

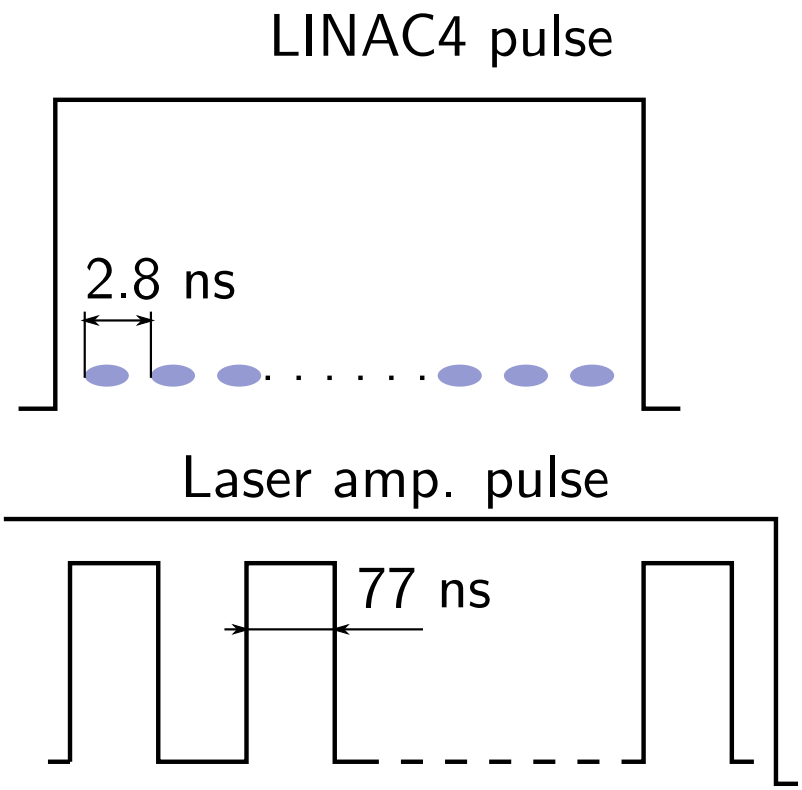




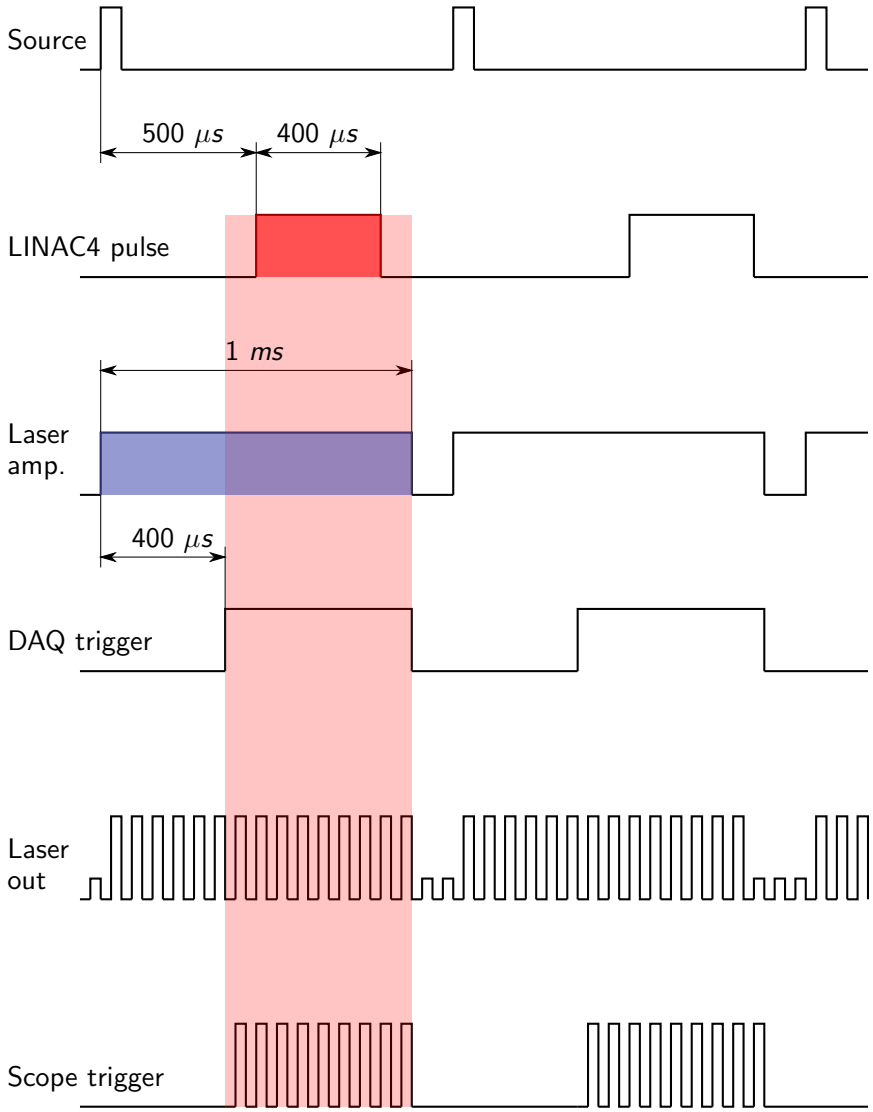
Advantages:

- Radiation hardness ($> 10^{15}$ MeV neq cm^{-2})
- Good sensitivity (10^4 electrons per H^0)
- Adequate bandwidth (10 ns response time)

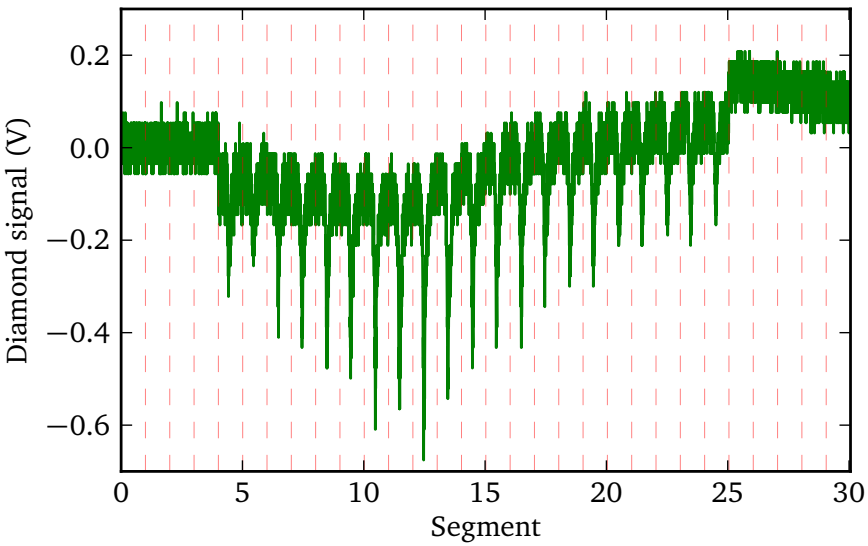
Temporal alignment

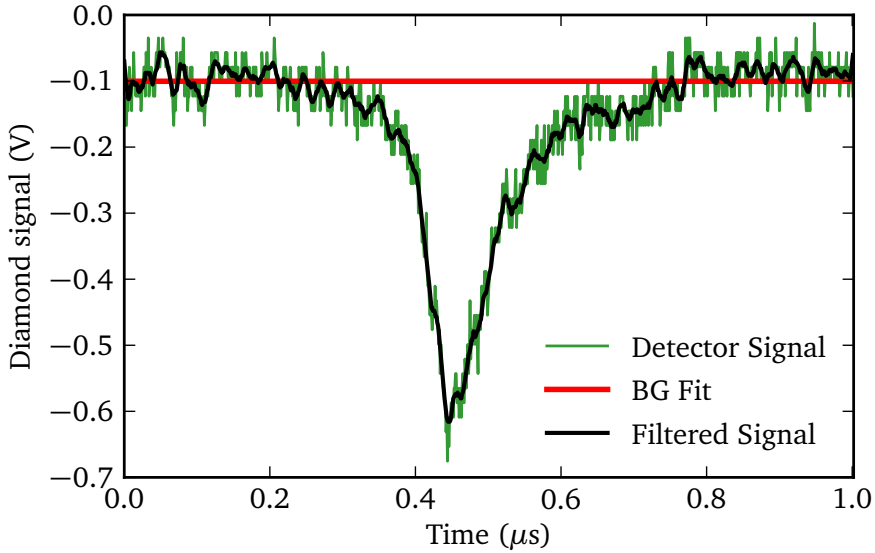


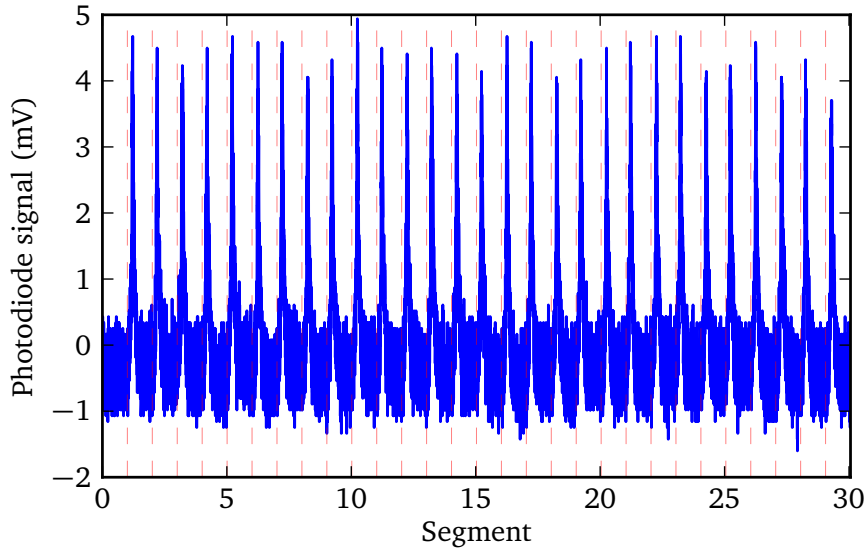
- $\sim$ 24 interactions per LINAC4 macro-pulse
- Each laser pulse interacts with $\sim$ 28 bunches

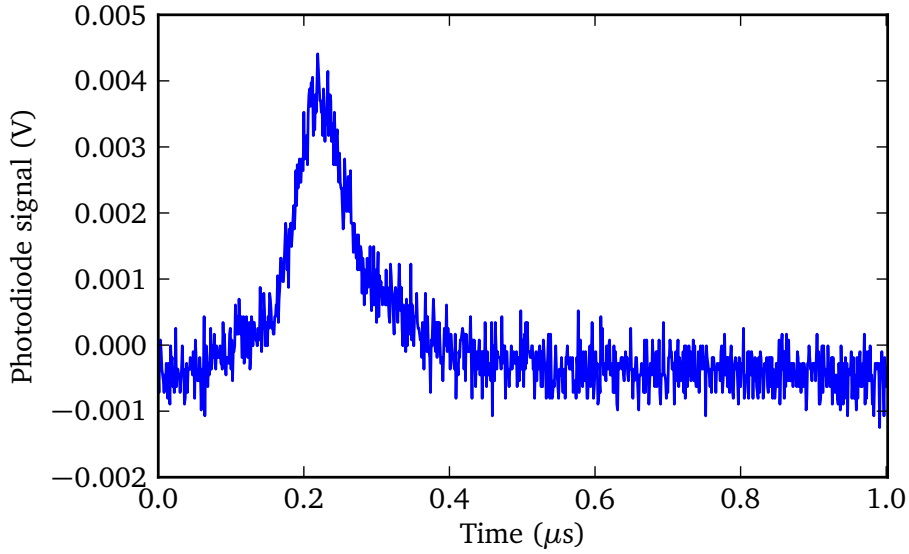


Detector signal

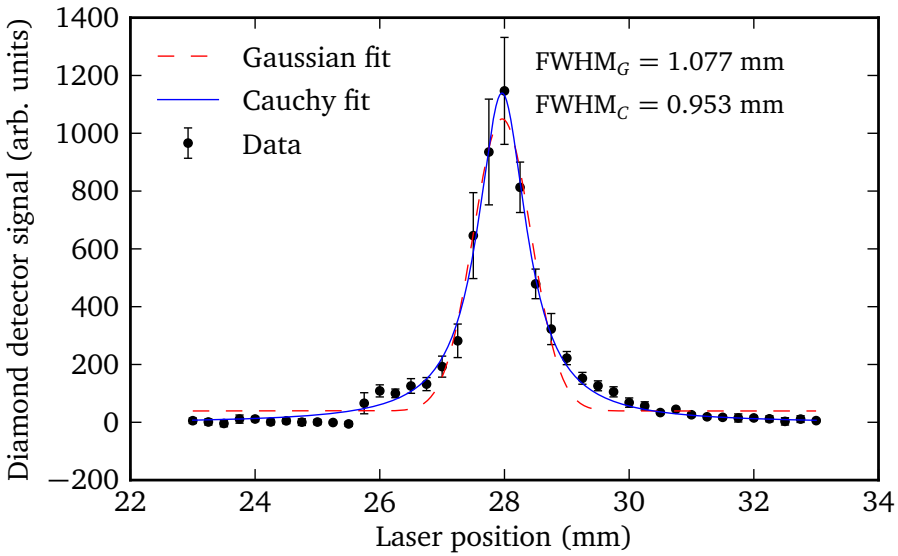




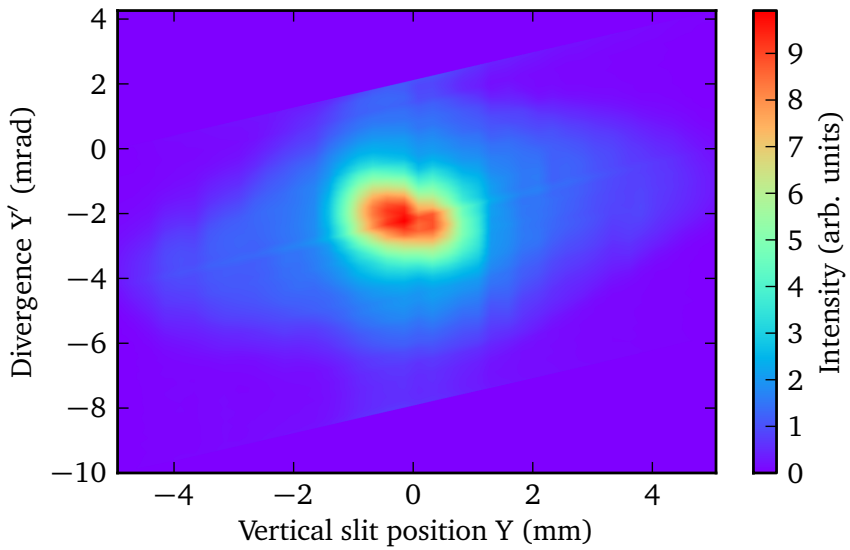


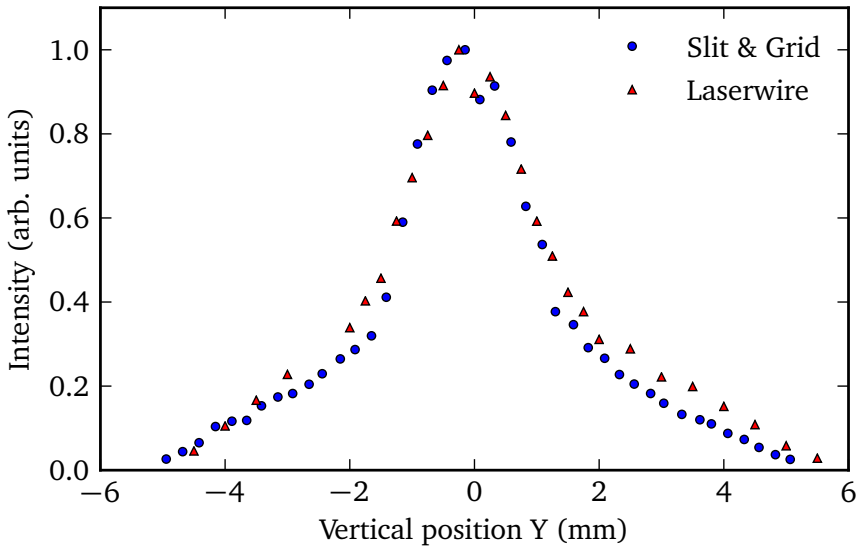


Profile and emittance measurements

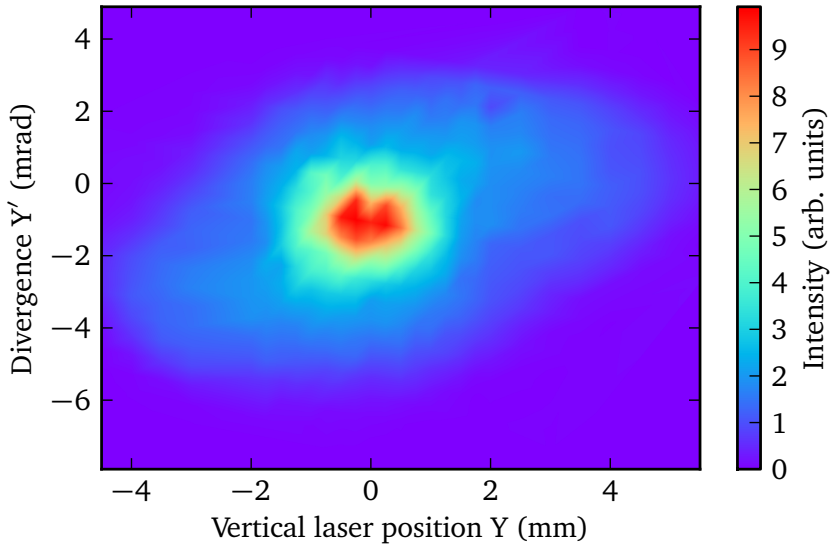


Slit & Grid:





Laserwire:



Summary

- A laserwire emittance scanner was successfully developed and tested at LINAC4 at 3 MeV.
- The measured signal and background levels compare very well with the expected ones from the simulations
- Beam profile and emittance measurement results from the laserwire scanner demonstrate very good agreement with conventional slit and grid diagnostics
- Further tests are planned for the 12 MeV beam. Obtained results already encourage prospects for a final laserwire station at 160 MeV