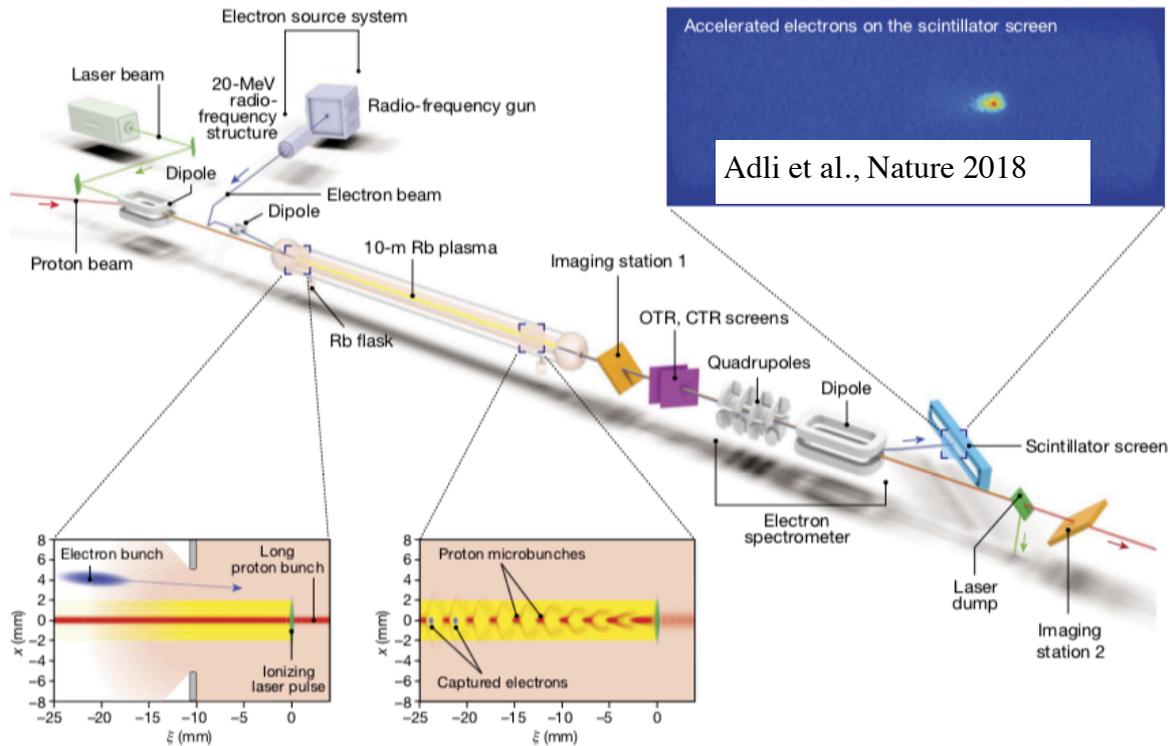


# Visualizing the plasma accelerator AWAKE at CERN using THz radiation sources



The Advanced Wakefield (AWAKE) experiment at CERN employs high-intensity proton bunches (400 GeV) to drive wake fields compared to intense laser fields (LWFA) to accelerate electrons to very high energies. Here long and thin proton bunches are used and they undergo a process called self-modulation (a particle-plasma interaction that splits the bunch longitudinally into a series of high-density micro-bunches), which then act resonantly to create large wake fields. Electron bunches are then injected into this wakefield which are then accelerated up to several GeV[1-3]. Optical probing technique using a secondary weaker short optical pulse is employed to visualize the plasma wakes [5]. In laser driven wakefields, the plasma density is high ( $10^{19}/\text{cm}^3$ ) enough to be probed with optical pulses. However, at AWAKE, the plasma density is several orders of magnitude lower ( $10^{14}$ - $10^{15}/\text{cm}^3$ ), hence the refractive index for optical light will be very small due to the lower plasma density resulting in lower sensitivity. Here the wavelength of the plasma wave is in the millimeter range ( $\sim 0.1$ -  $0.3$  THz) and hence longer wavelength probes are required. This requires shadowgraphic imaging in the THz spectral range.

At the Helmholtz Institute Jena, we have been developing state-of-the-art THz sources and diagnostic for a wide range of applications[5-7]. The goal of this project is to develop a THz based plasma imaging diagnostic module for the implementation at the AWAKE experiment at CERN. To be an active member of this project, we look for highly motivated students with good background in nonlinear optics, electromagnetism and basic scientific programming skills and enthusiasm to learn about advanced techniques in experimental physic.

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## Bachelor / Master / PhD Thesis

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