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- The Awake proton bunch and SMI
- OTR Diagnostic in AWAKE
- SPS proton testrun
- Conclusion

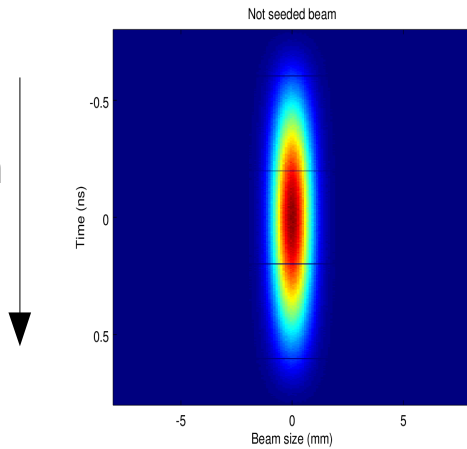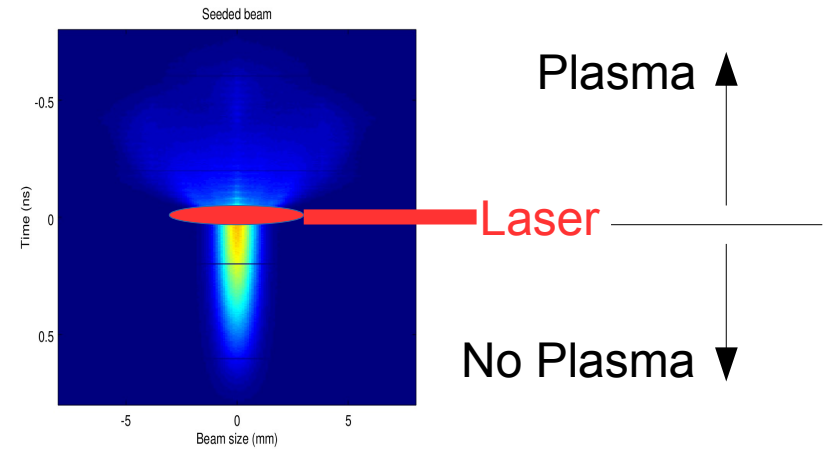The proton beam (how to solve ...)

Propagation direction of beam

Plasma OFF

Not seeded beam

Seeding of smi

Plasma ON

Seeded beam

Plasma

Laser

No Plasma

- Long SPS (~ns) driving bunch is no good driver for AWAKE plasma (n_pe ~10^14-10^15)
- Plasma – beam interaction modulates the bunch -> driving beamlets

- 3e11 protons per bunch
- σ1.4 ns (2 σ) long
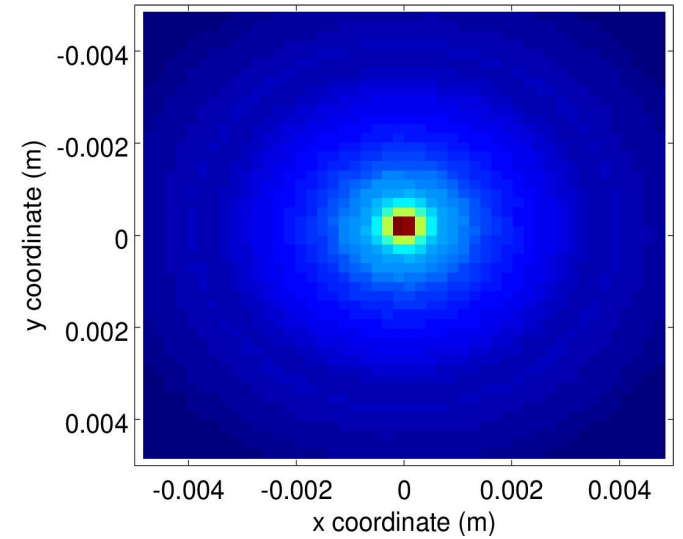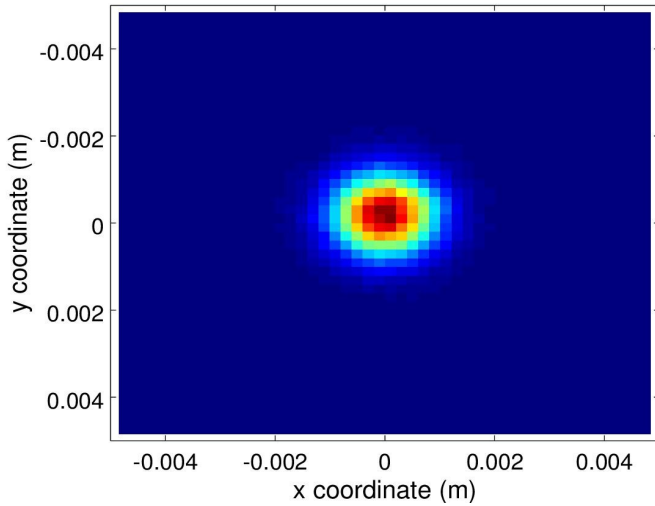
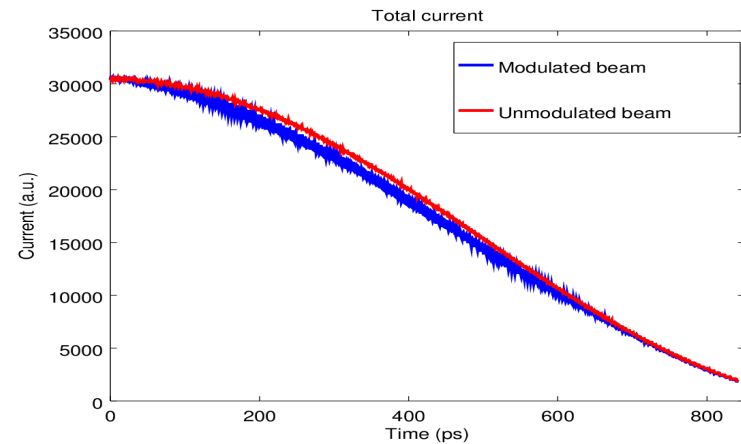Front view of beam: the modulated beam has a core and a halo
But the current is conserved

SMI Diangostics M. Turner

AWAKE SMI

Modulated beam density (a.u.)
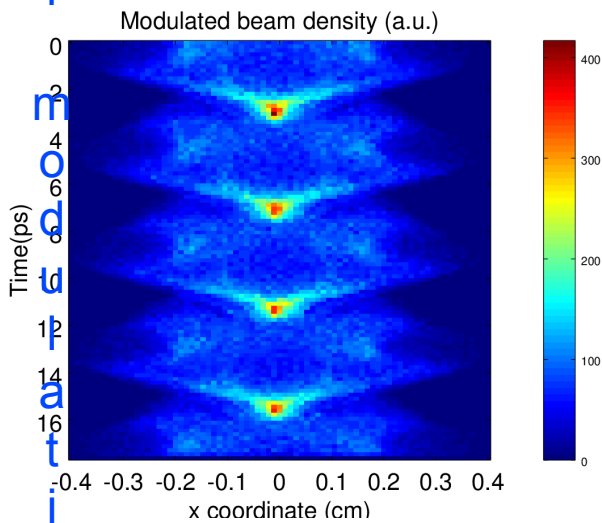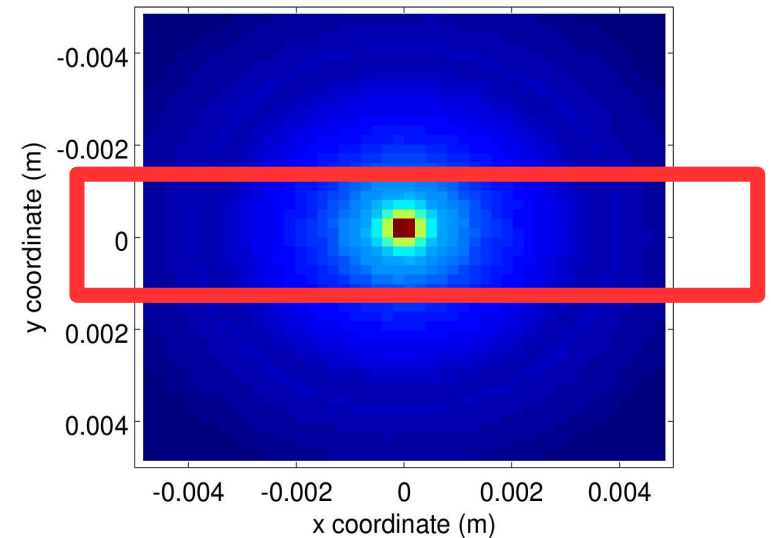
Lineout

Stretched in time

- Beam has a substructure on scale of plasma wavelength/frequency
  - efficiently drives wakefields
- AWAKE: Plasma frequency ~90-300GHz (<-> ~1-3mm wavelength)
- -> proton "bunchtrain" with ~ 2-5ps time difference between two bunches

Time resolved measurement

- Need timeresolved measurement of the beam
- Resolving beam spatially gives additional information

CTR:

- is prompt
- easy to operate
- good spatial resolution

Device:

- Streak camera
    - offers ~ps level time resolution
    - offers spatial resolution along one axis

AWAKE

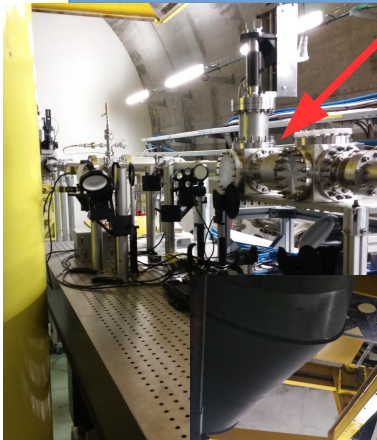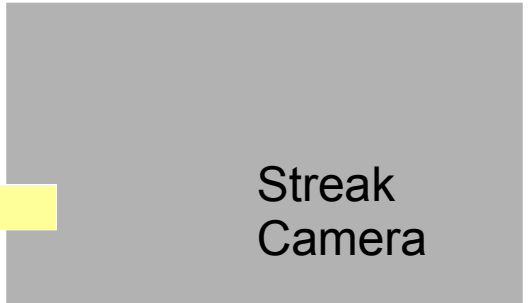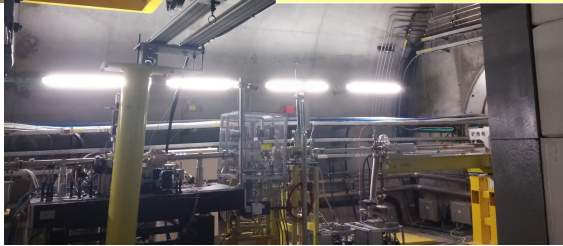Time and OTR setup

p+

OTR foil

Thick Wall

OTR Transport ~15m

Streak Camera

- Creation of OTR and collection
- Transportation of OTR
- Focussing to streak camera (imaging the foil)
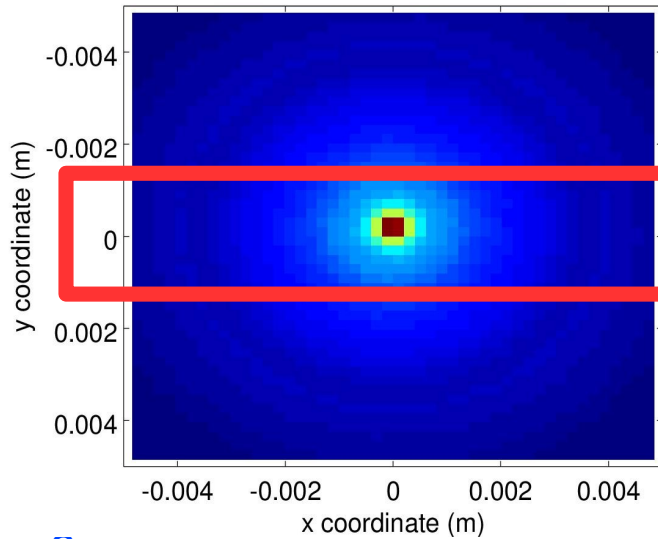- Additionally: 2 Photodiodes & 2 CCD's

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- OTR foil is imaged to streak slit
- Transport line cuts off OTR from particles that are off axis

Limited by streak slit & imaging demagnification

Imaging system: ~3:1 demagnifying system
Design wavelelength: 450nm,
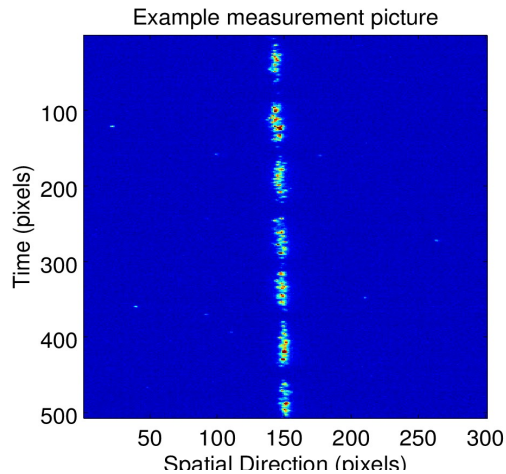
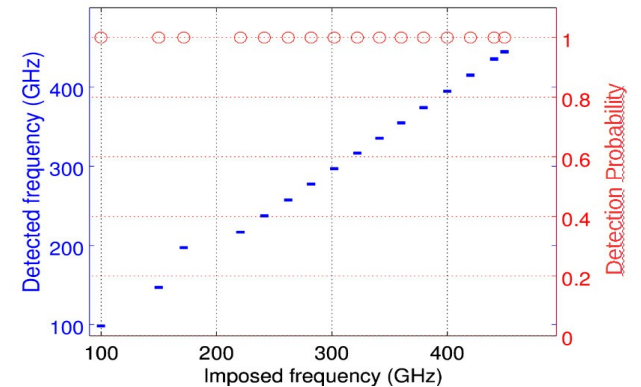f=500mm   f=2500mm   f=500mm   f=150mm   f=40mm

~15m
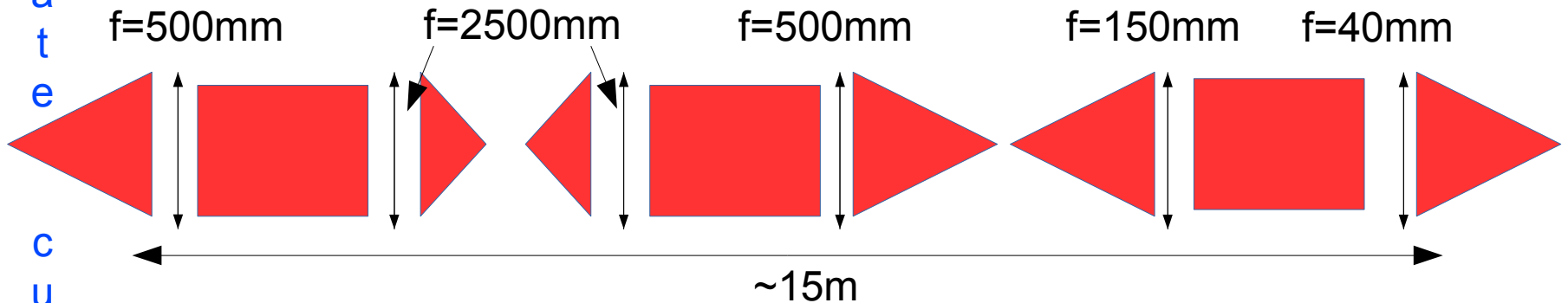
AWAKE

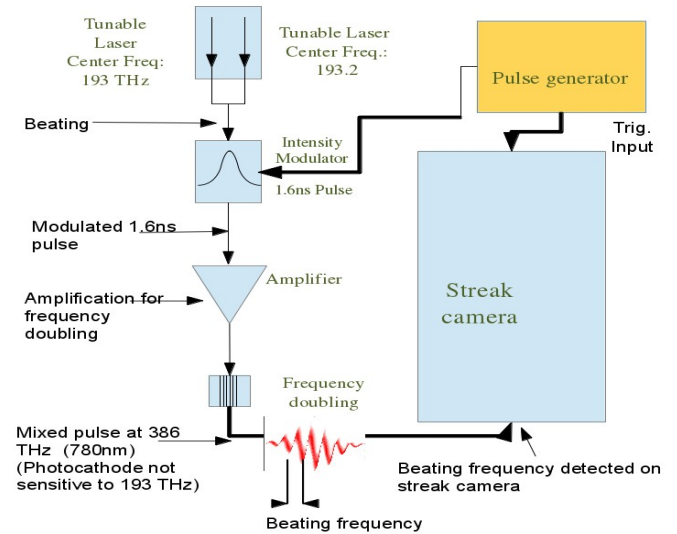## Streak camera

- We did tests by letting two laser beat at 50-450 Ghz (AWAKE 90-300GHz, design ~250GHz)
- Detect Modulation up to 450GHz
- Single event detection

150 Ghz example Image

100% detection up to 450GHz

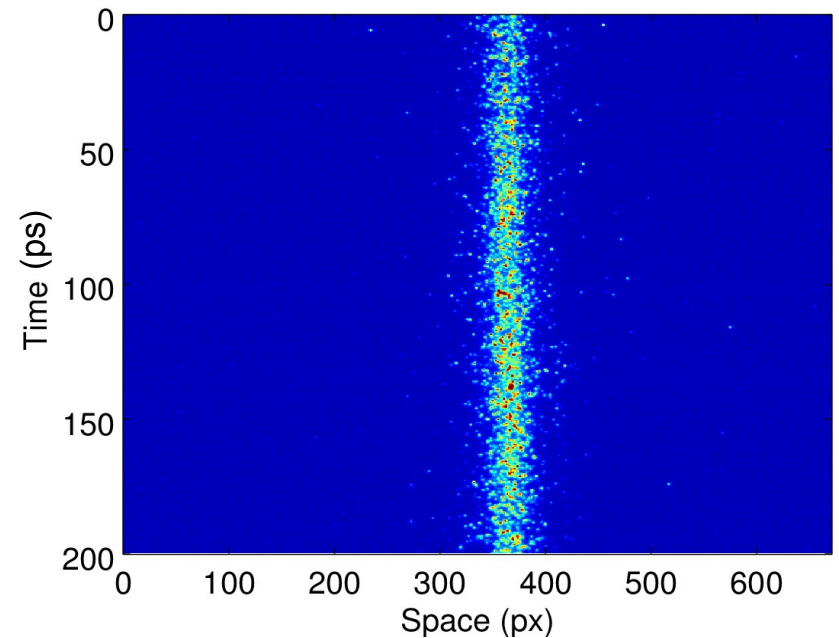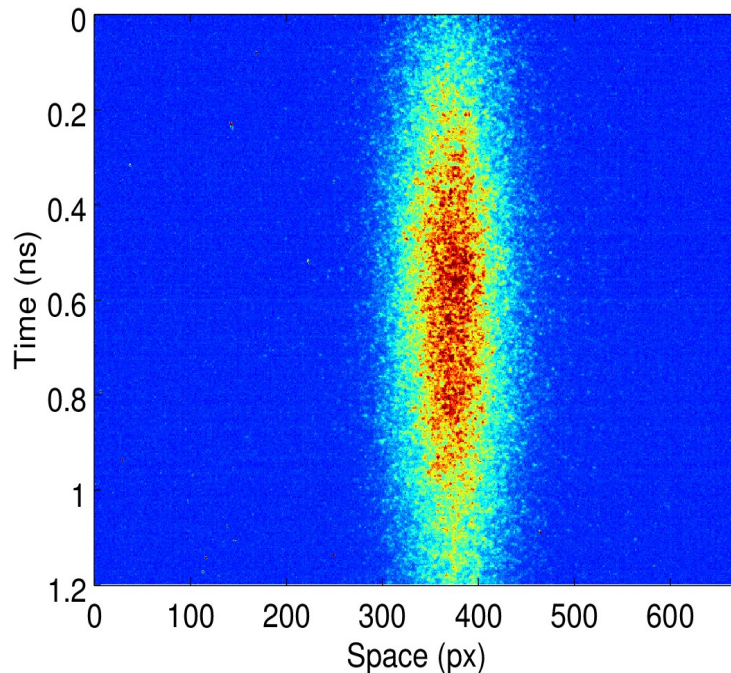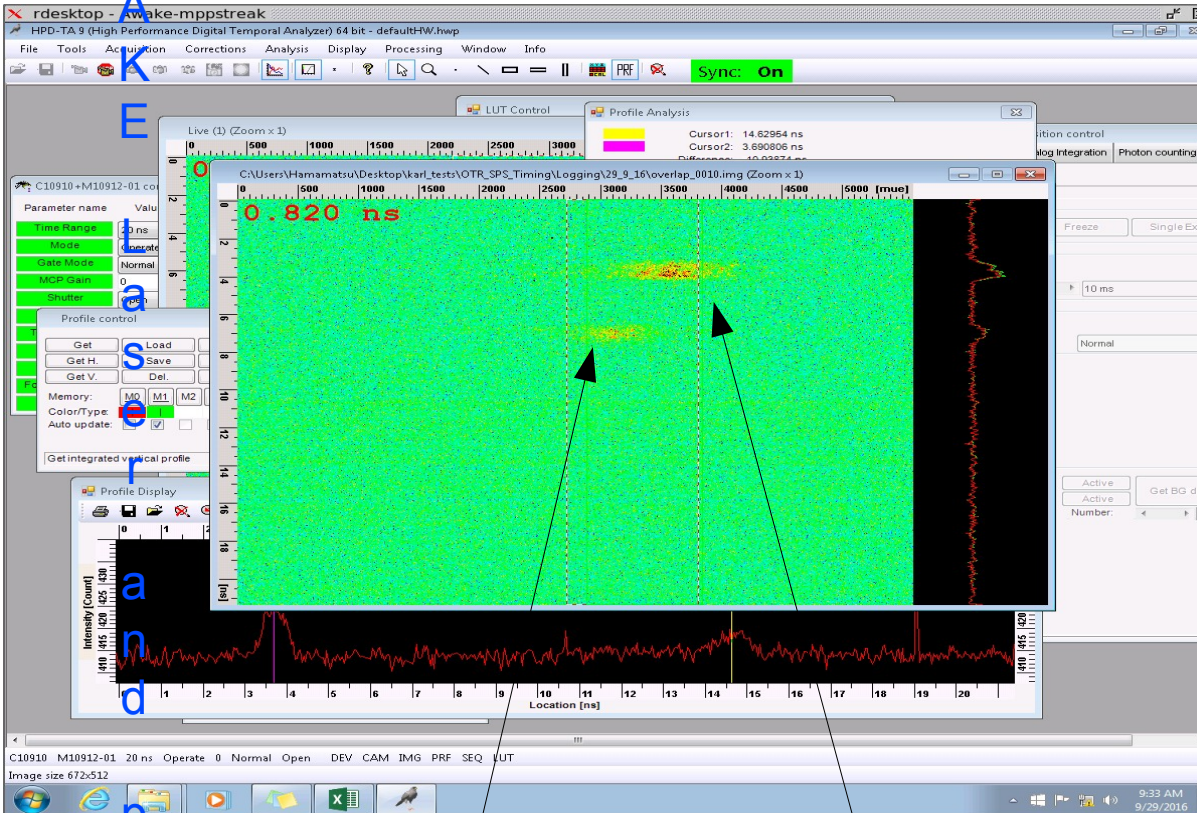# Demonstration

- We were able to image and streak proton bunch
- Enough OTR light is transmitted (even large enough signal on low timescales)
- AWAKE Goals achieved: Synchronization of SPS and AWAKE laser
- OTR Bandwith used: 400-500nm

OTR in AWAKE

- After commisioning OTR:

Time overlap between Laser and proton bunch

-> achieved and is now overlapping

High precision laser/proton/electron alignement: Steffano Mazzoni, Aurelie Goldblatt, Bartolomeij Biskup (all CERN)
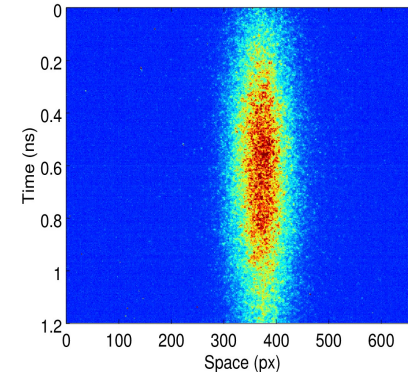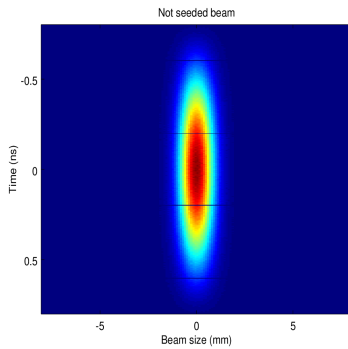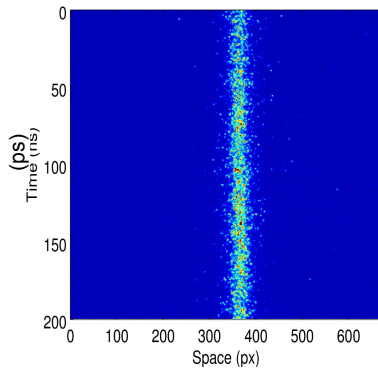
Protons   Laser

Conclusion

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- Experimental Diagnostics proven to work for low current
- Experimental Diagnostics fully installed and operational (commissioned)
  - SPS proton bunch synchronized with the AWAKE Laser
- Waiting for AWAKE experimental beam with plasma

Thanks for your attention!