
CERN

LHC fluorescence measurement

S. Mazzoni and the CERN BGC team,

BGC Collaboration Meeting at GSI, 19/3/2018

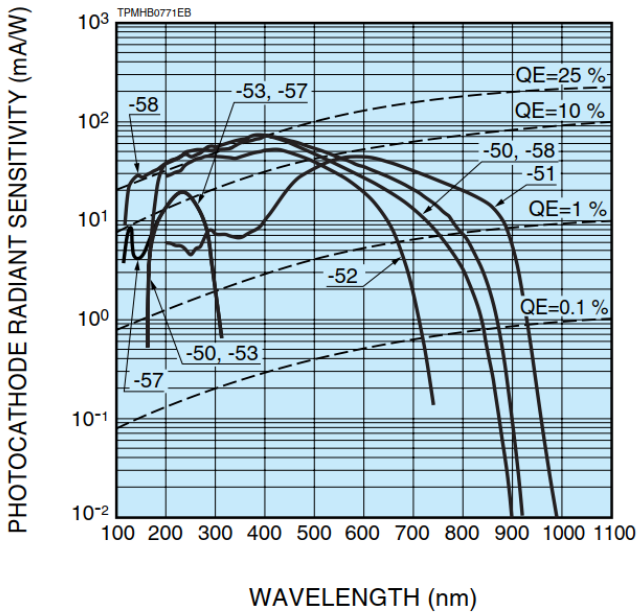
Introduction and outine

- Test of Beam Induced Fluorescence with LHC beam to:
  - Measure the fluorescence cross section for protons at LHC energies
  - Measure the LHC beam transverse profile
- Instrument for cross section measurement installed during 2017-18 YETS > status
- To be discussed:
  - Definition of experimental procedure
  - Installation of profile measurement setup

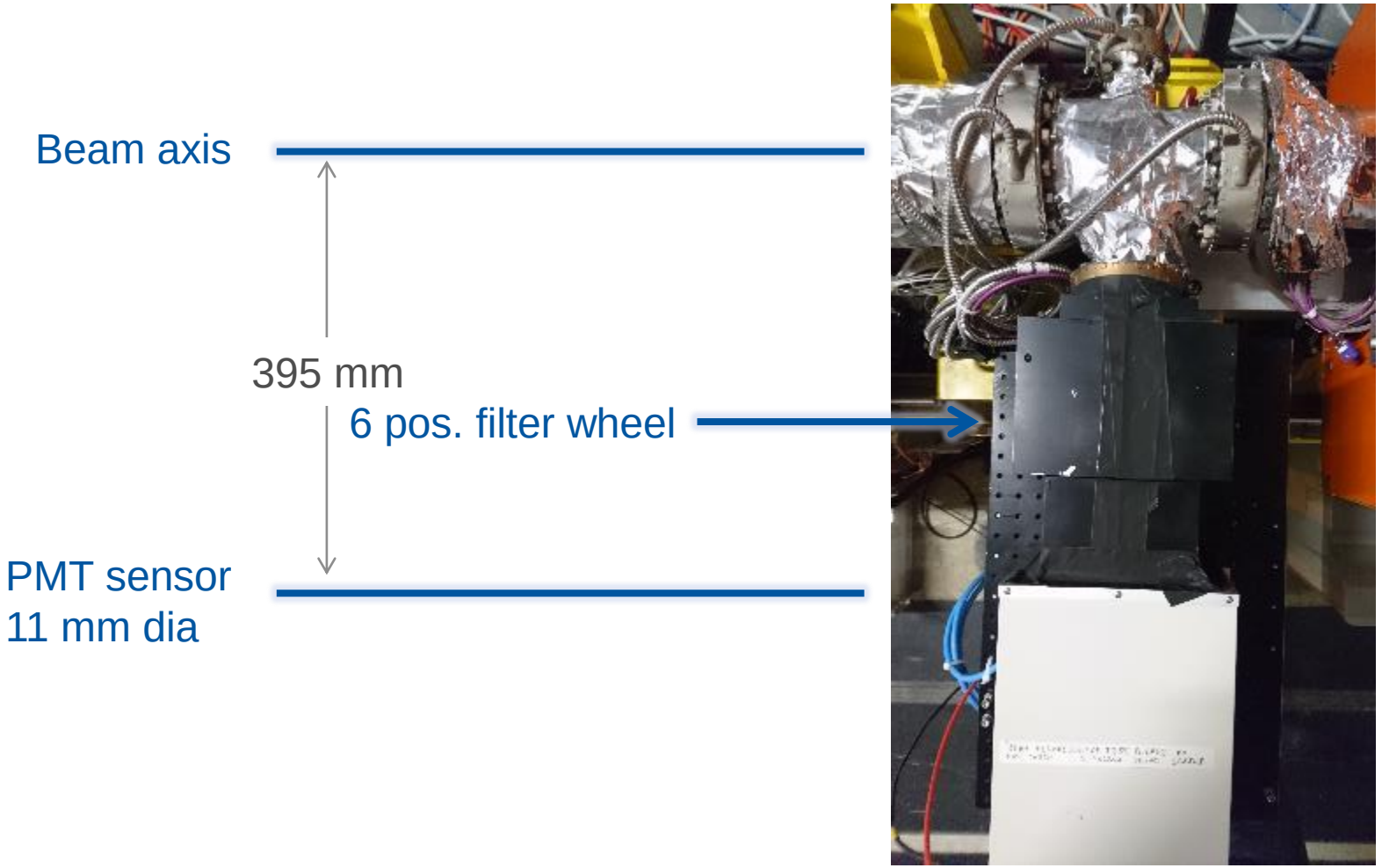
Installation during YETS

Installation during YETS

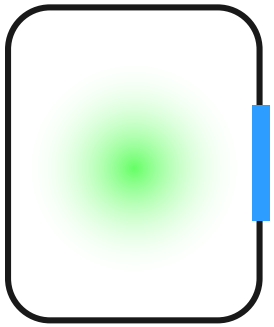
- Instrument installed during 2017-18 YETS
- MCP-PMT Hamamatsu R3809U-50 with “high” HV (3-3.2 kV) for single photon counting
- Multialkali, QE around 10% at 580 nm
- PMT cooled to -20 degC with TECs
- All basic functionalities (HV, cooling, motors, data acquisition) are OK



Installation during YETS



YETS installation



1

2

HV from US45, existing

Signal out

3

Discriminator

4

50 ohm coax

To UA43, VME counter

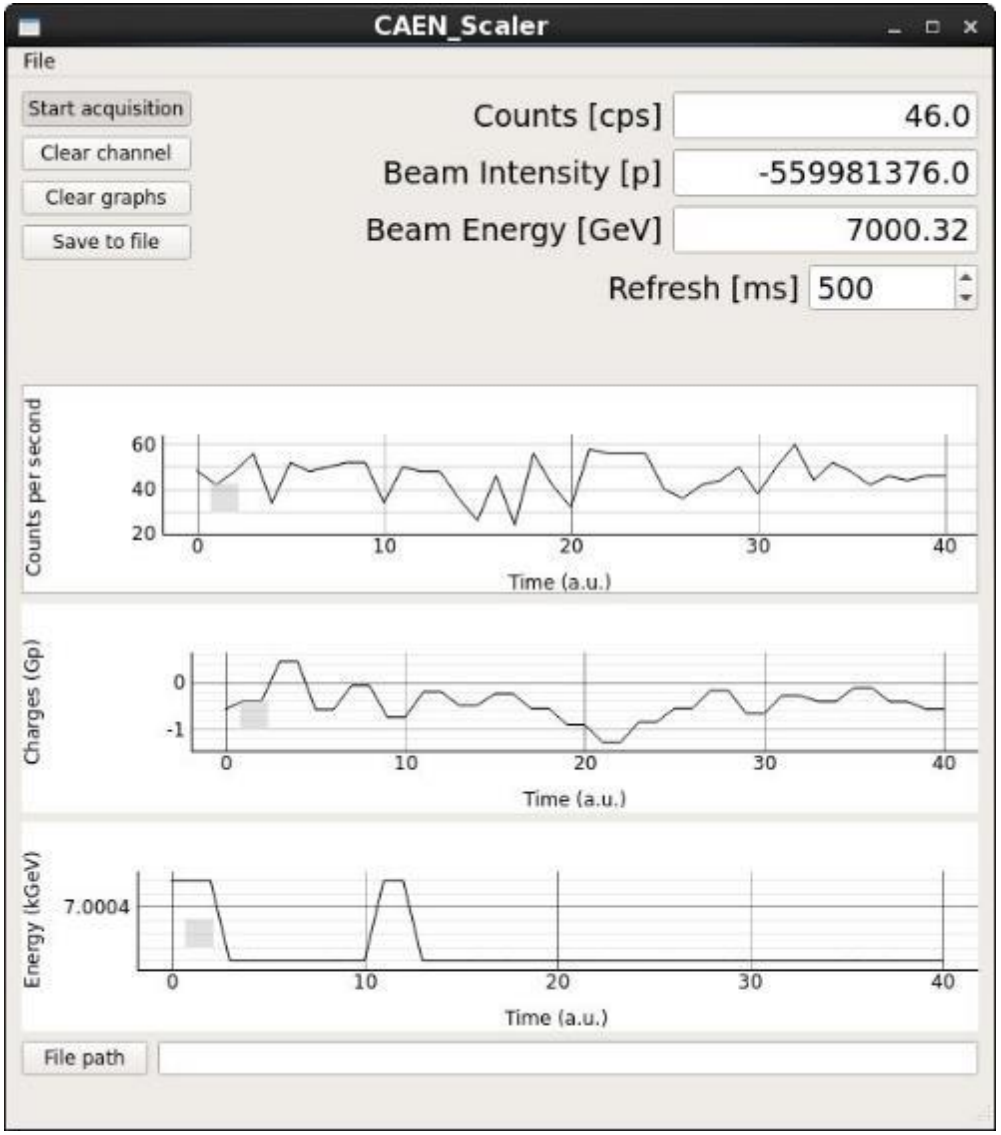
Use BSRT motor control

1. 6 pos Owis filter wheel
2. Hamamatsu MCP PMT R5916U
3. ORTEC 9327 1 GHz discriminator
4. CAEN V260N scaler (NIM)

1. Through / no filter
2. 585 +/- 20 nm
3. 340 +/- 13 nm
4. ND1
5. ND2
6. block

Software

- Counter software developed in Pyton / PyQT (with help of E. Bravin), almost done
- Control of HV, filter wheel through existing FESA classes
- Counts and beam intensity (from DCCT) are logged as a function of time.
- Ideally, gas pressure should be logged (is that a FESA device?)

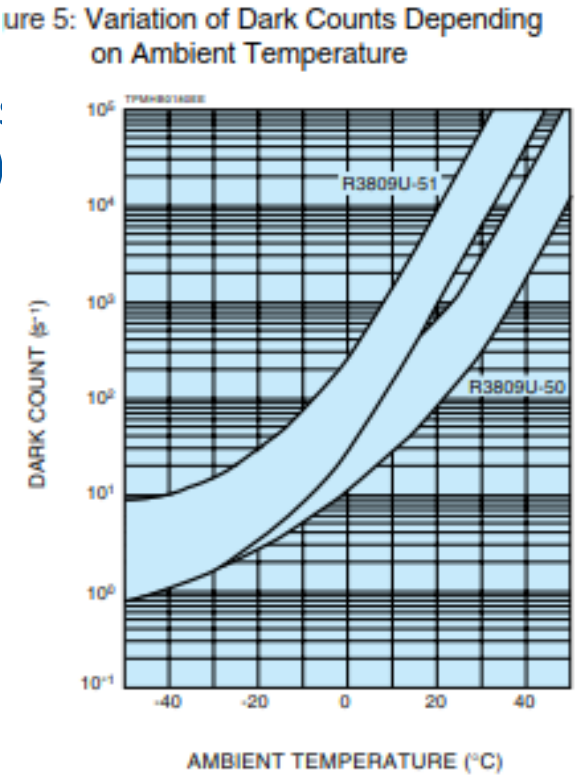


tentative for discussion!

Experiment procedure

- Absolute measurement: need to discriminate the real counts (order of **0.1 kHz**) from spurious (**? Hz**) and dark counts (**1-10 Hz without beam**)
- In principle:
  - with block filter and beam: **dark counts**
  - with 585 nm filter, beam, no gas: **spurious + dark counts**
  - with 585 filter, beam, gas injection: **real + spurious + dark counts**

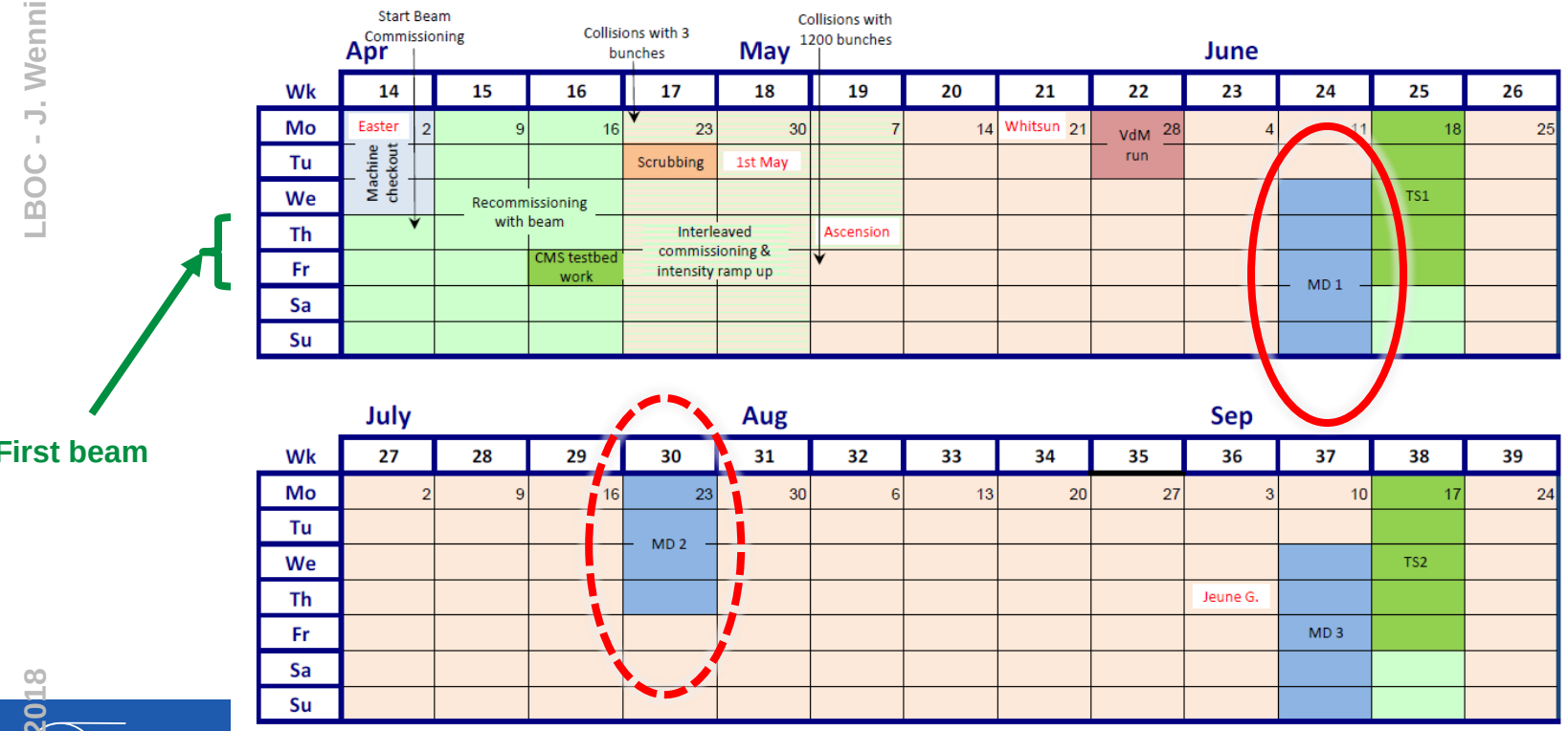
  fluorescence cross section could be measured from the above datasets
- Real and spurious counts are intensity dependent. Dark counts?
- How to operate the gas injection system?



Latest official 2018 start-up schedule

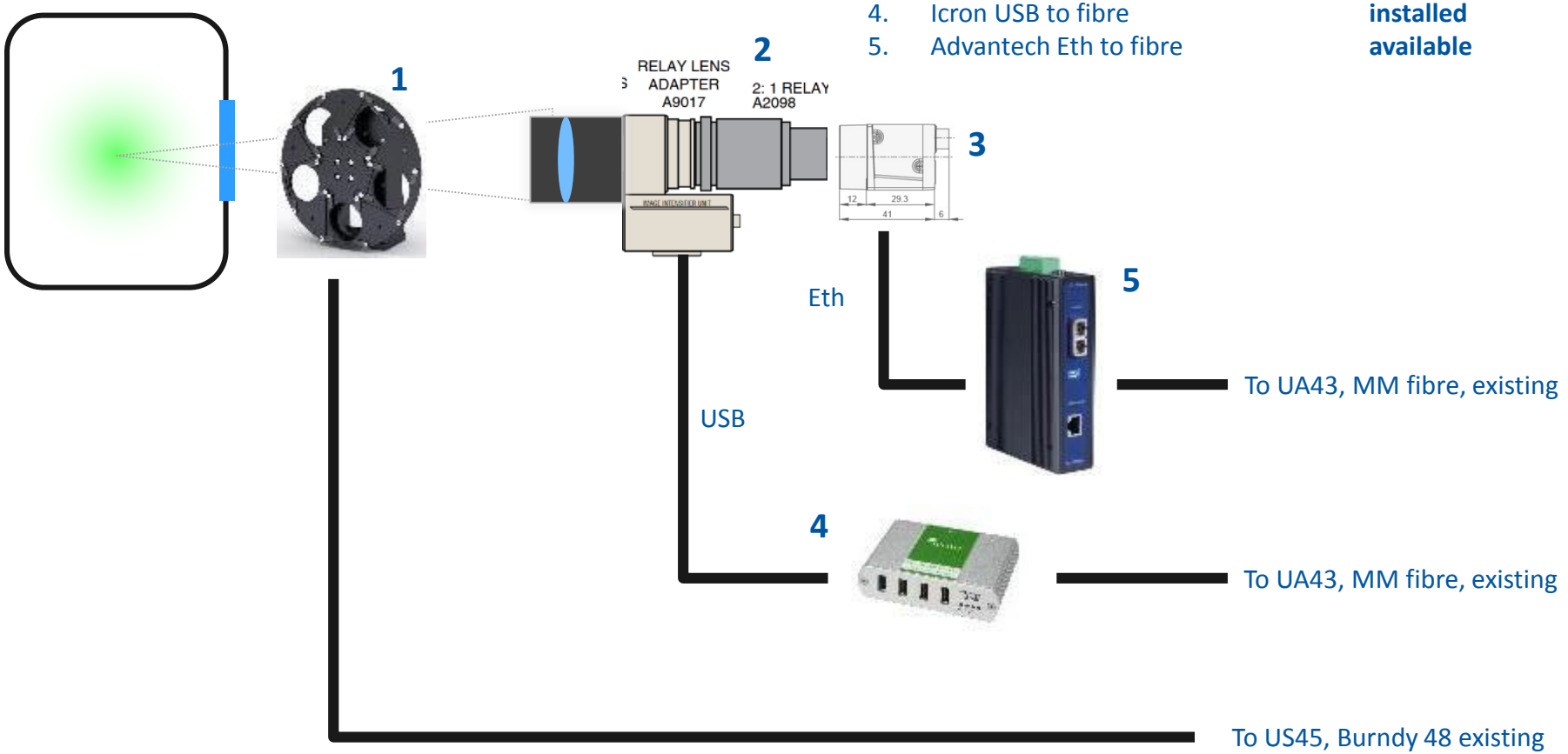
J. Wenninger, LBOC 13/3/2018

- **Powering tests** should be completed at the beginning of week 13.
- **Checkout** starts week 13, **opening of CMS vacuum valves is delayed** from Mo 26th March to Thu 29th March.
  - No BIS and full LBDS tests possible as long as CMS valves closed.
  - **TI2/8 test** middle of week 13.
- **First beam** postponed by 4 days to second half of week 14.

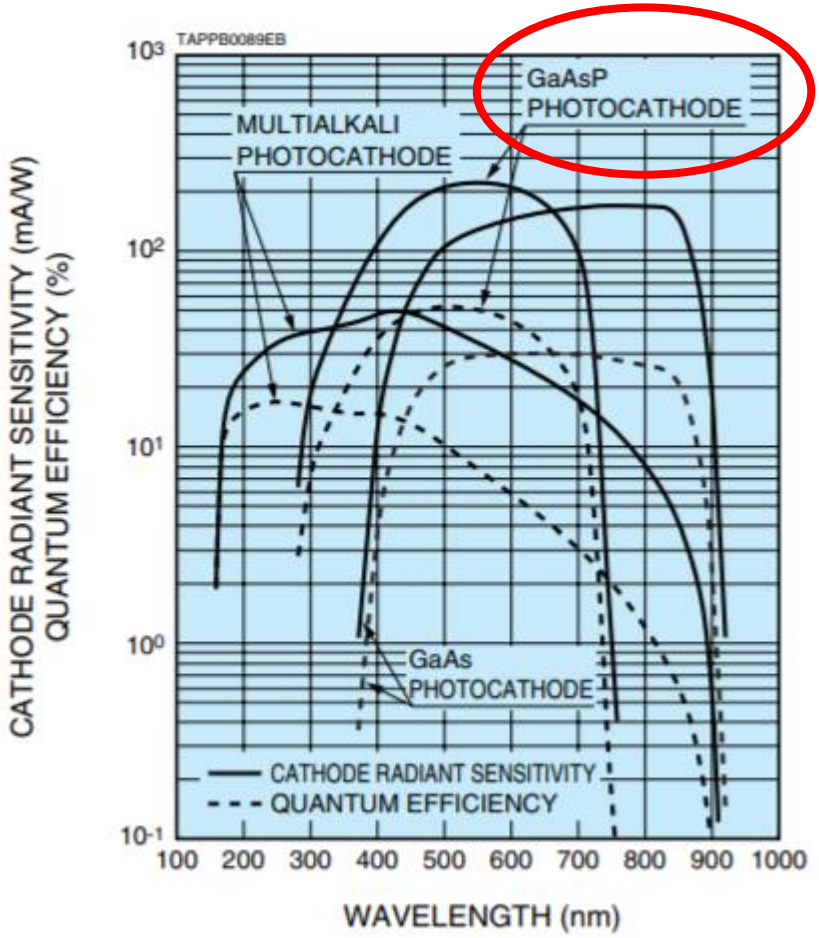


Profile measurement

1. Owis filter wheel **available**
2. Hamamatsu C9547-01 **ordered**
3. Basler CMOS, **available**
4. Icron USB to fibre **installed**
5. Advantech Eth to fibre **available**

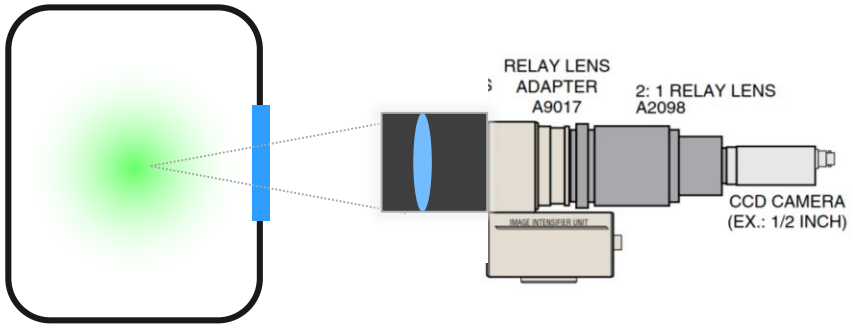


Profile measurement

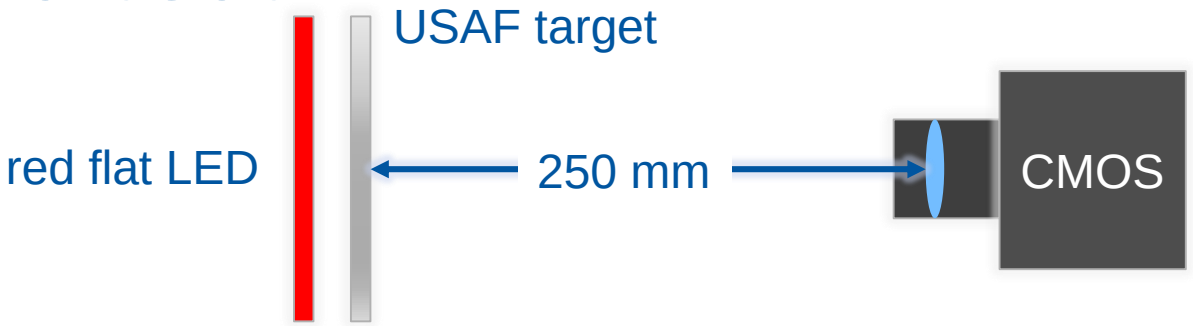


Profile measurement

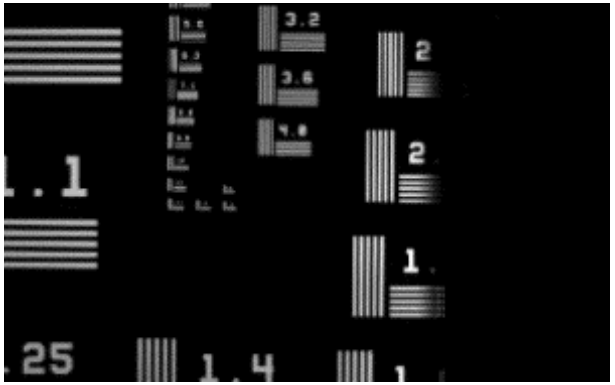
- Simple, single lens setup, no intermediate image. Camera lens mounted on the image intensifier.
- At present, distance beam axis – camera lens is at 250 mm.
- End magnification in the range 0.3 – 0.15
- Three lenses currently under test:
  - Thorlabs AC508–080-A cemented achromat 80 mm F1.5
  - Fujinon CF50B 50 mm F1.4
  - Zeiss macro milvus 50 mm F2.0



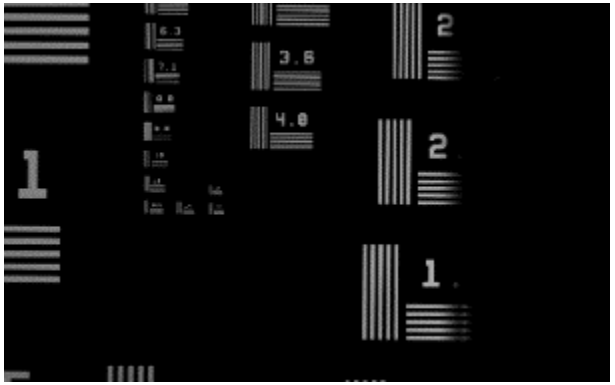
Lens test



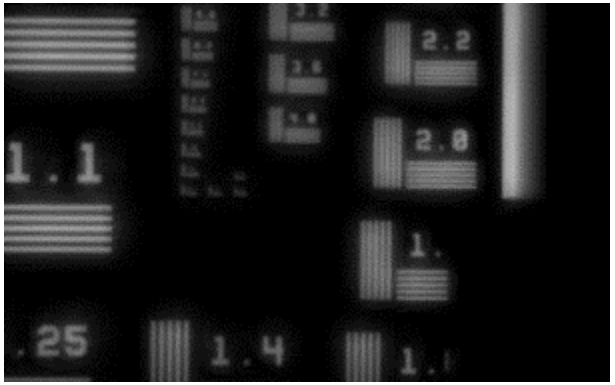
Fujinon 50 mm



Zeiss macro 50 mm



Achromat 80 mm (Thorlabs)



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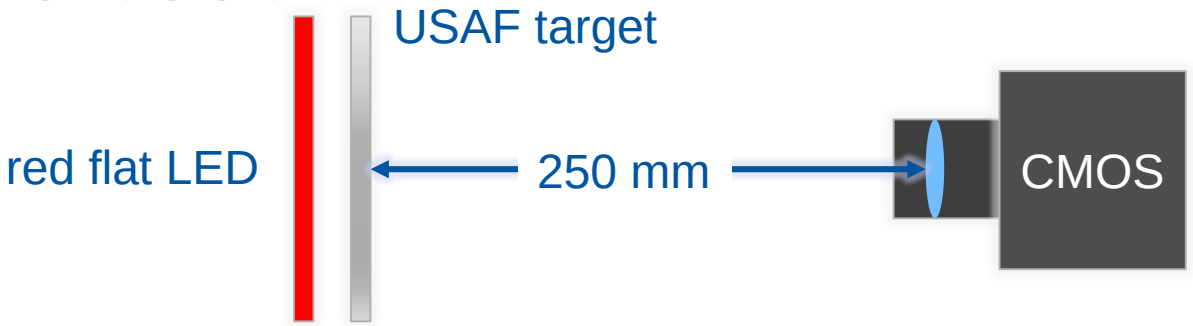

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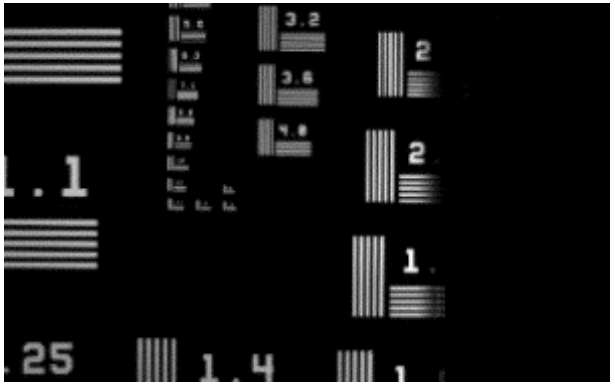

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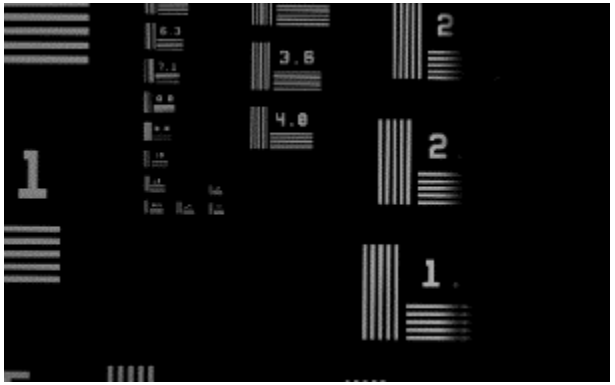

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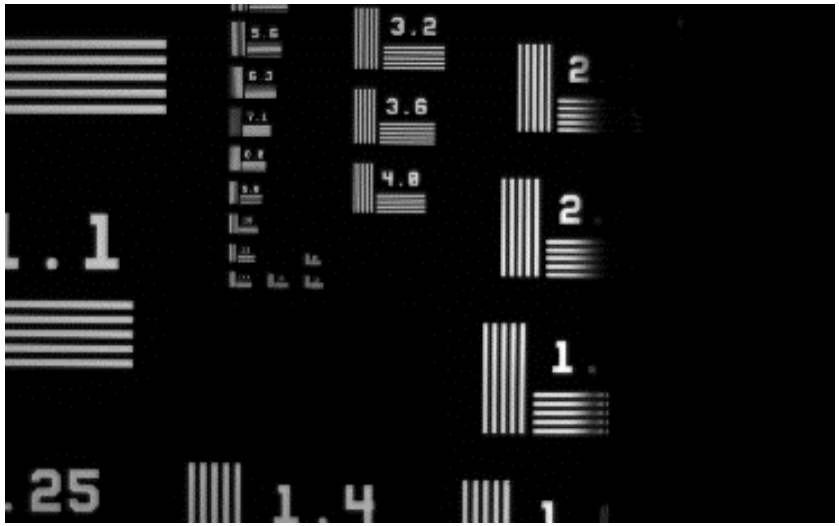

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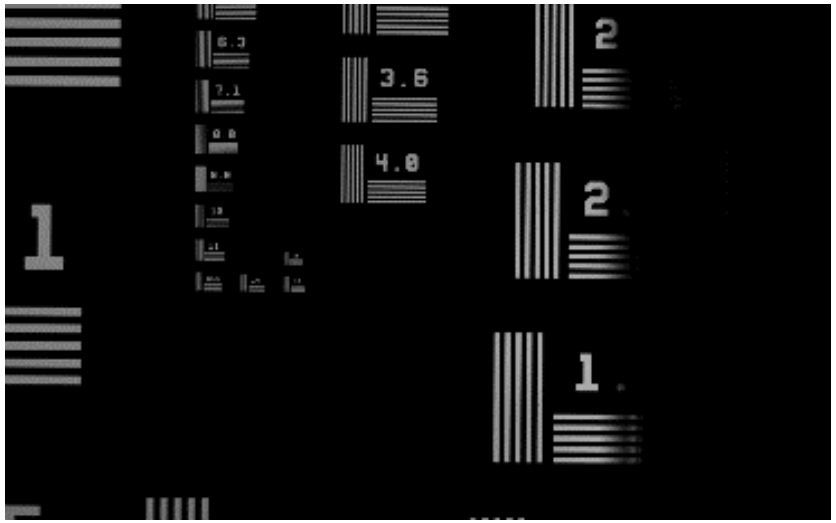

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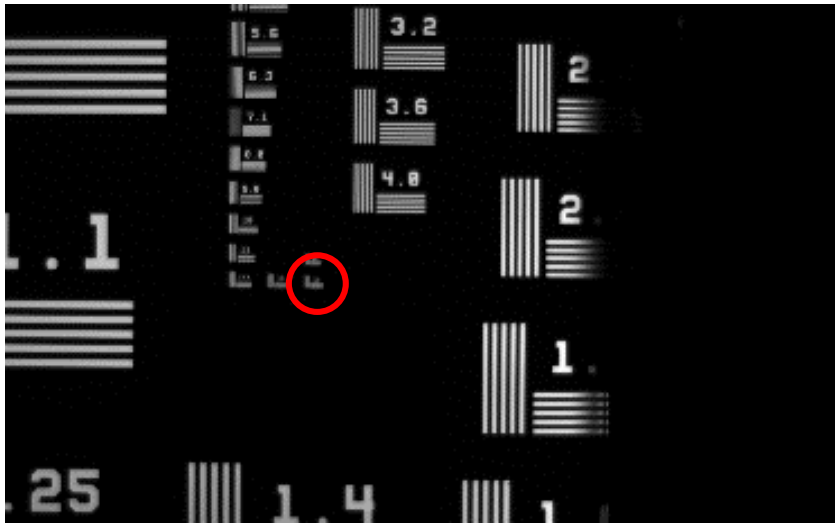

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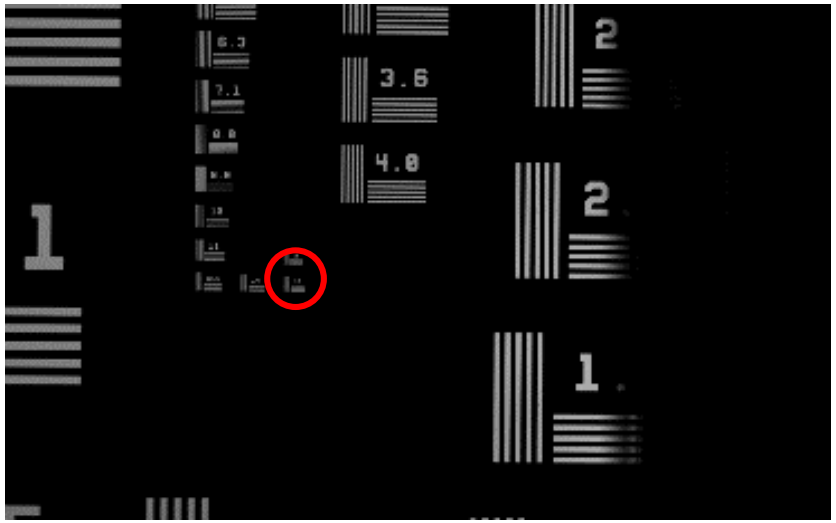
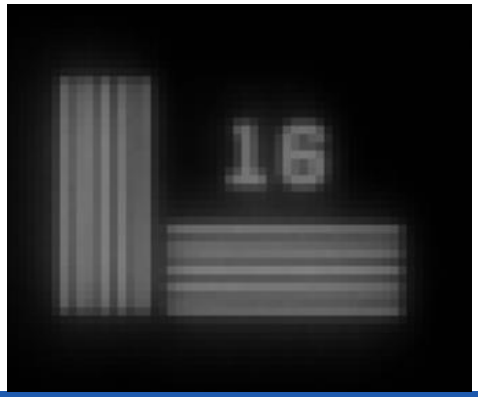
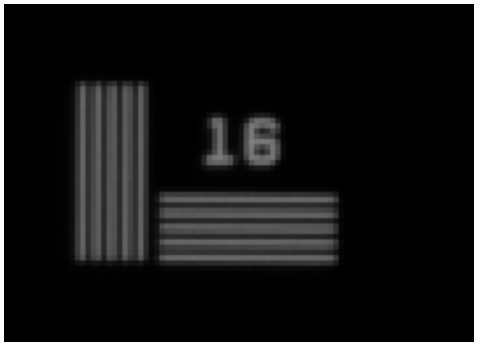
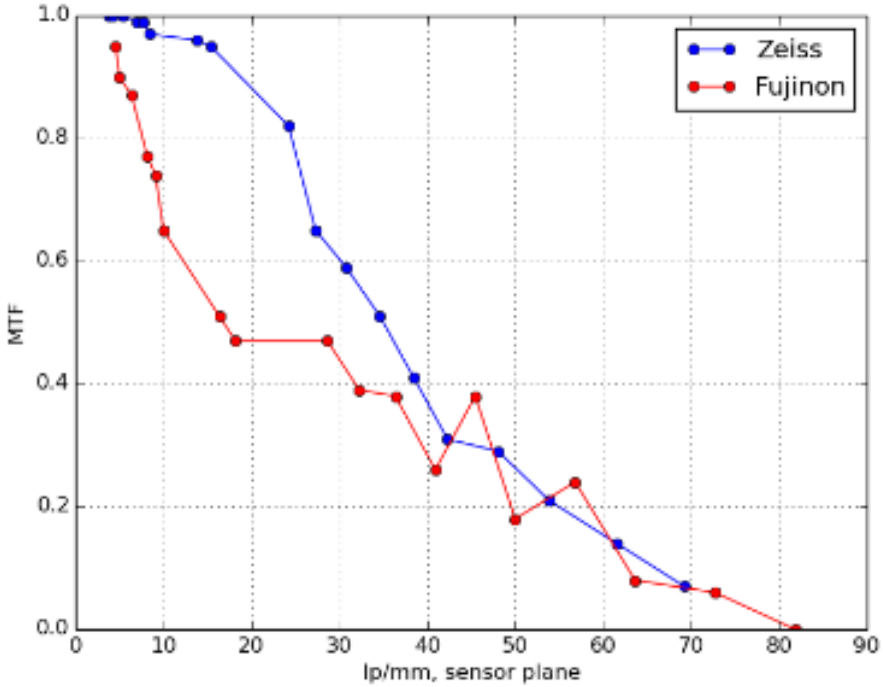






Modulation Transfer Function



- Beam (high energy) is a Gaussian with σ = 300 um => spatial frequencies around 4 lp/mm => 30 lp/mm at 0.13 magnification. Zeiss clearly better.
- BUT on paper Fujinon has 1.5 times more light acceptance than Zeiss.

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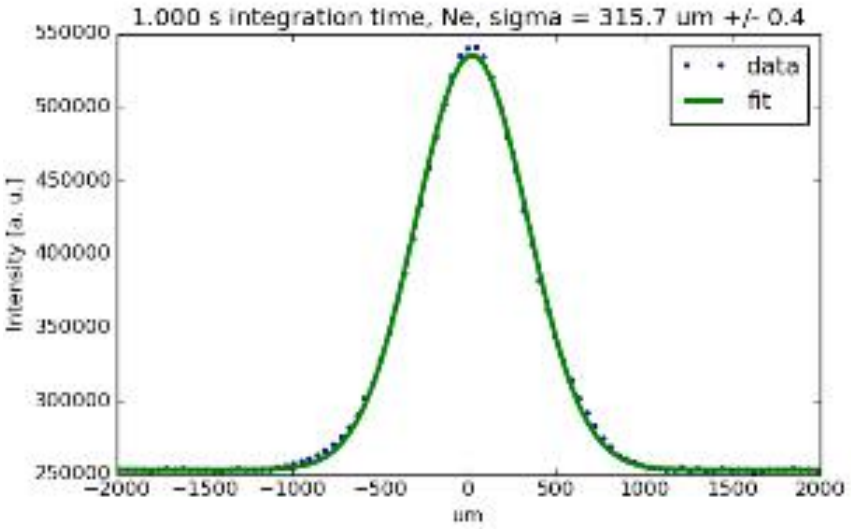
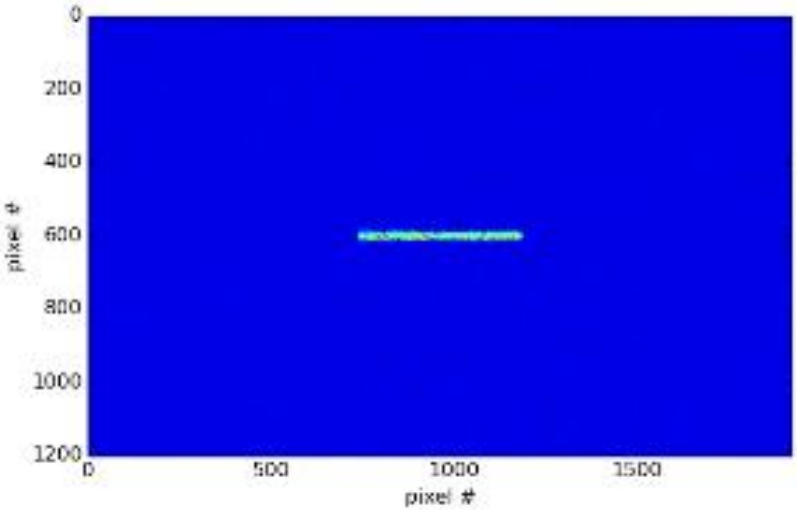
TRADE OFF ANALYSIS IN PROGRESS!

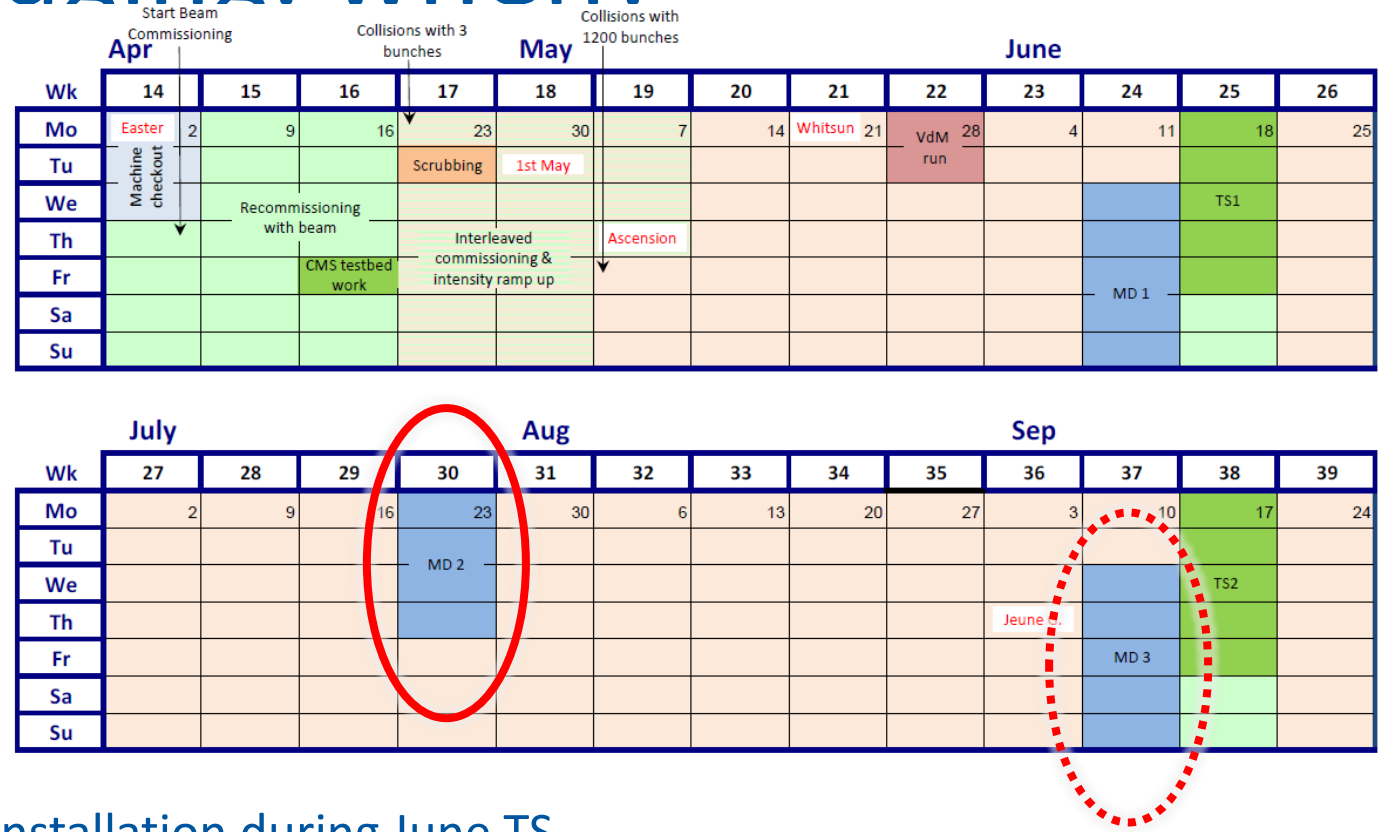
Simulations

- Simulations of optical performance with fixed optical resolution (Gaussian PSF with 20 um sigma)
- 1500 photons/sec with:
  - Zeiss Lens (25 mm dia)
  - 250 mm lens – beam dist.
  - $5x10^{8}$ mbar pressure
  - $2000x10^{11}$ protons
  - 1 second integration time
  - 0.13 final magnification
  - Cross section of $4.7x10^{-22}$ cm^{-2}
- More accurate results once resolution of intensified camera is measured





Imaging: when?



- Installation during June TS
- Test during MD2 (July) or MD3 (September)
- Need support of ML section for mechanical support of camera + Filter wheel

Summary

- Photon counting setup: installed and functional.
  Experimental procedure
  Possibly test during first MD
  } to be discussed

- Profile measurement setup: intensified camera should arrive end of March. Optical design almost finalized pending measurement of actual resolution of i. c. Installation during June TS, run during 2nd or 3rd MD to be discussed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