Westfälische Wilhelms-Universität Münster

hitrap EU RTD network

Detection systems for the $^{209}Bi^{80+}$ HFS experiment

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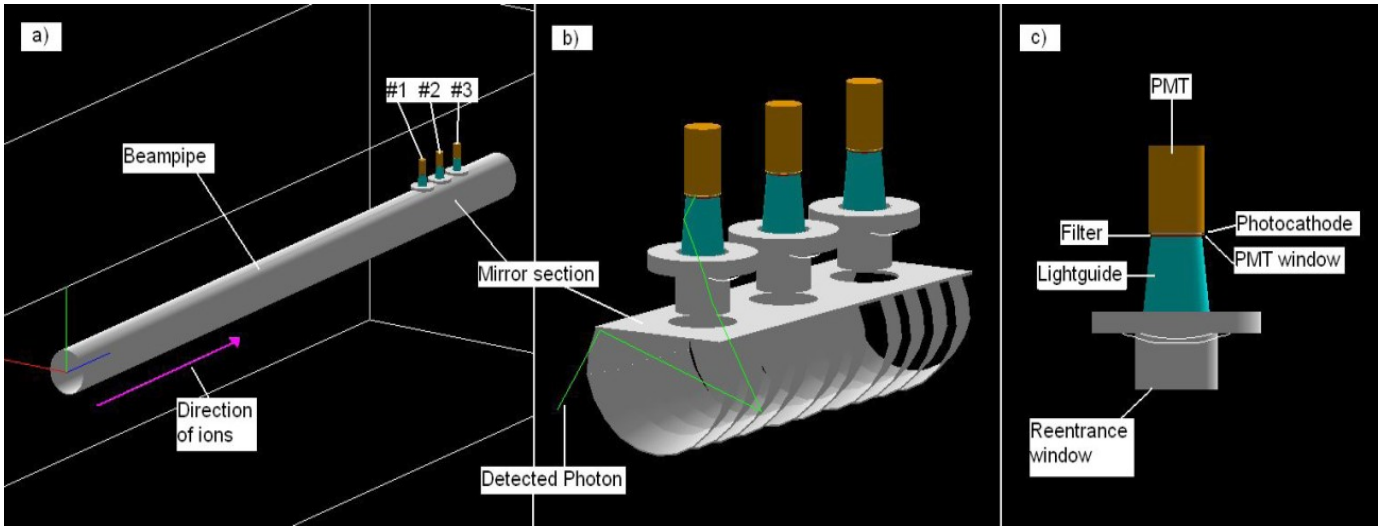
Mirror section

Used in the last experiment (2003)

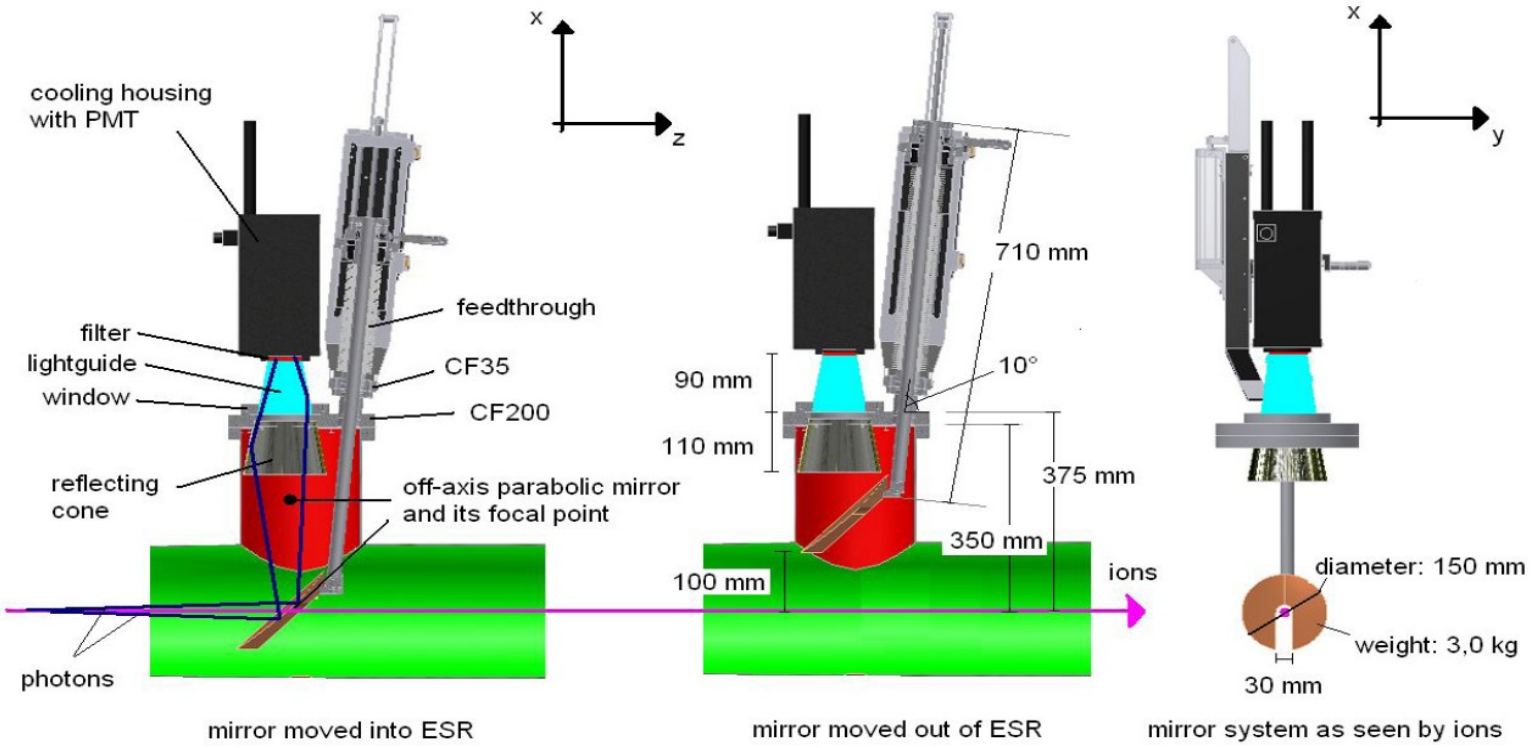


Problems because of very low overall signal rate of max. 15 Hz on a background > 600 Hz

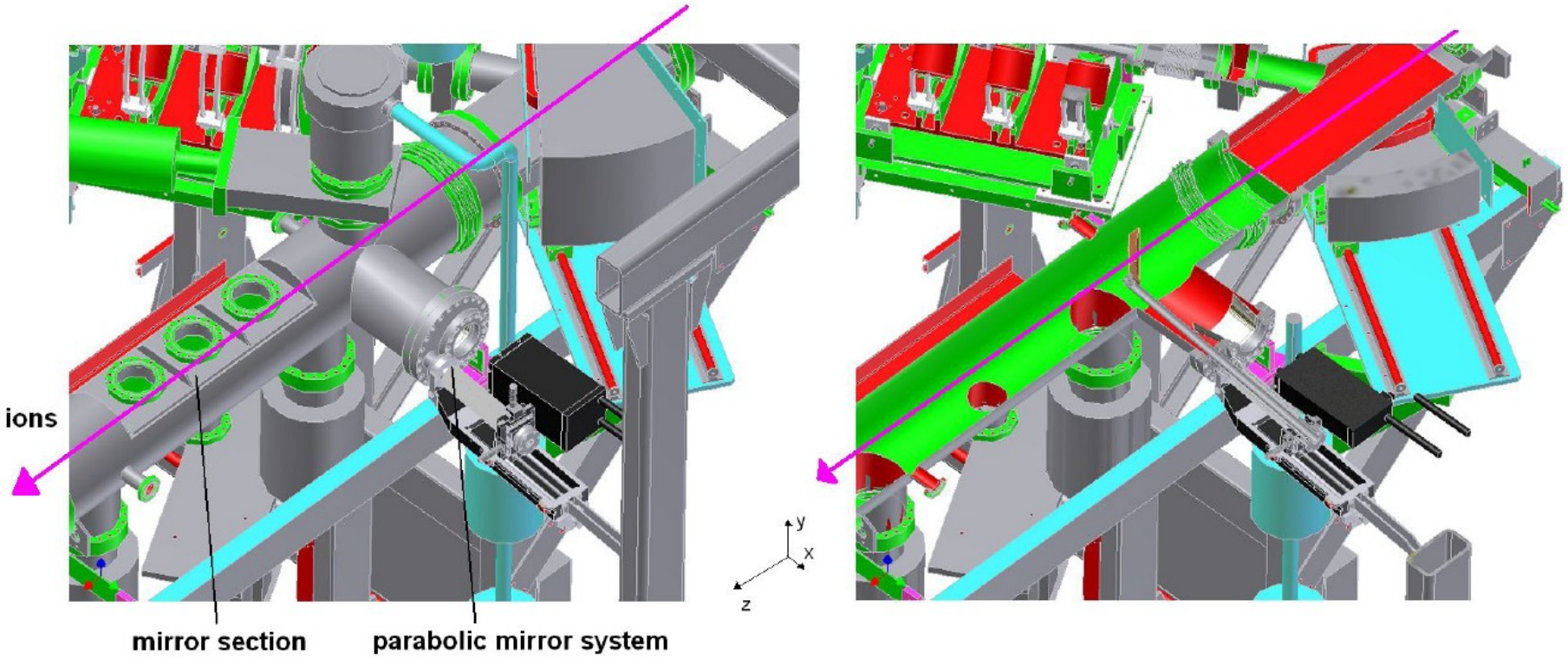
→ need for a dedicated detection setup, adapted to the characteristics of the experiment

Solution: Parabolic mirror system

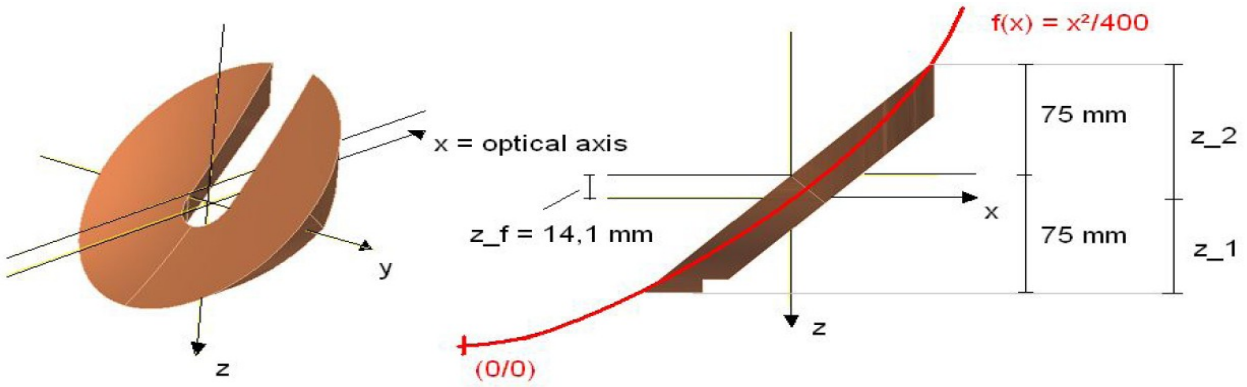
- Parabolic mirror with a central slit for ions, that can be moved into the beam to efficiently collect photons emitted under small angles (≈ small wavelength)



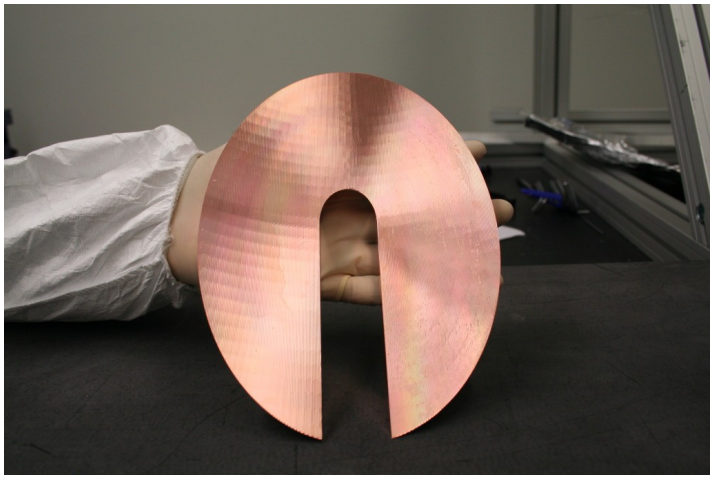
Setup at ESR



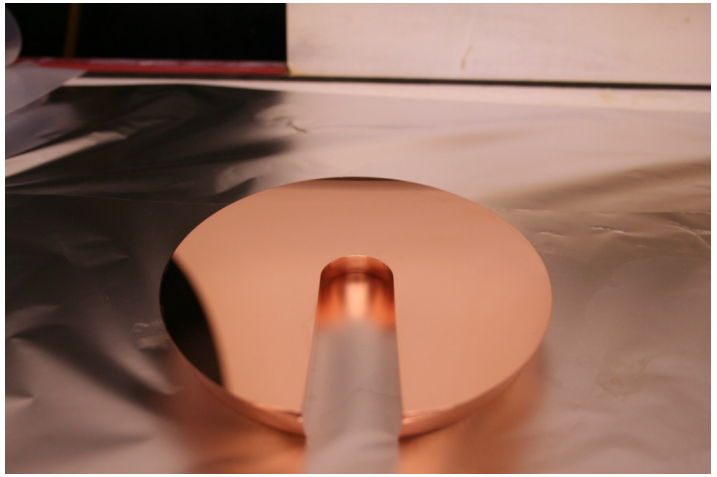
Parabolic mirror



mirror before



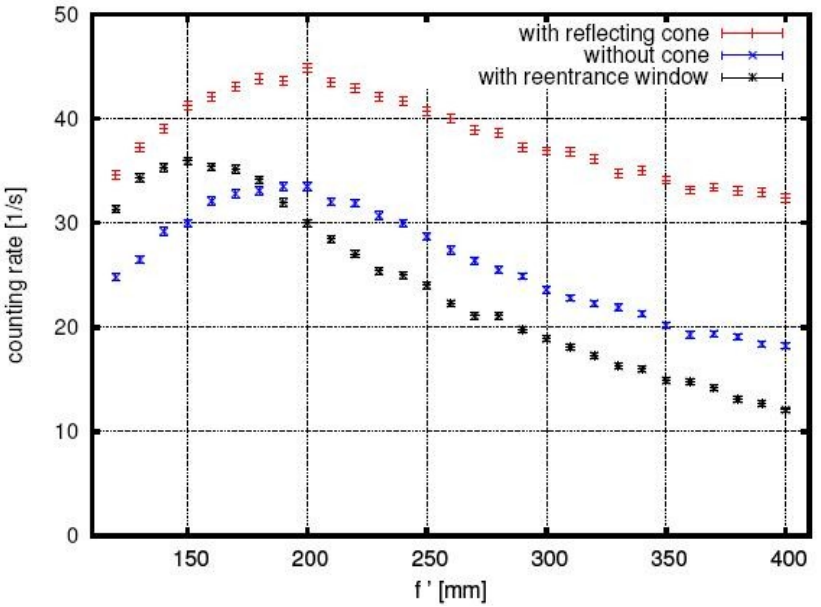
and after surface finish

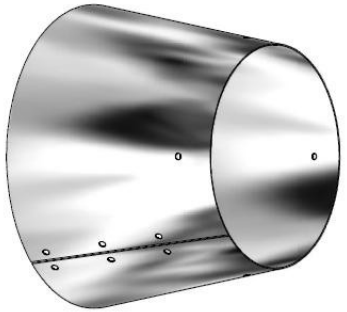


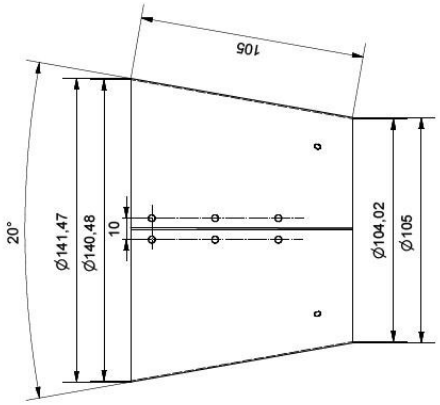
measured reflectivity for 635 nm laser light: (97.1±1.0) %

Mirror characteristics

- Highest count rate at focal length of f ’ = 200 mm using an additional aluminum (Miro 2) mirror cone on the vacuum side of the exit window with R = (89.4±0.9)%
- Simulated signal rates: 45 - 83 Hz, depending on exact QE of PMT and beam pipe reflectivity (background 375 - 600 Hz)

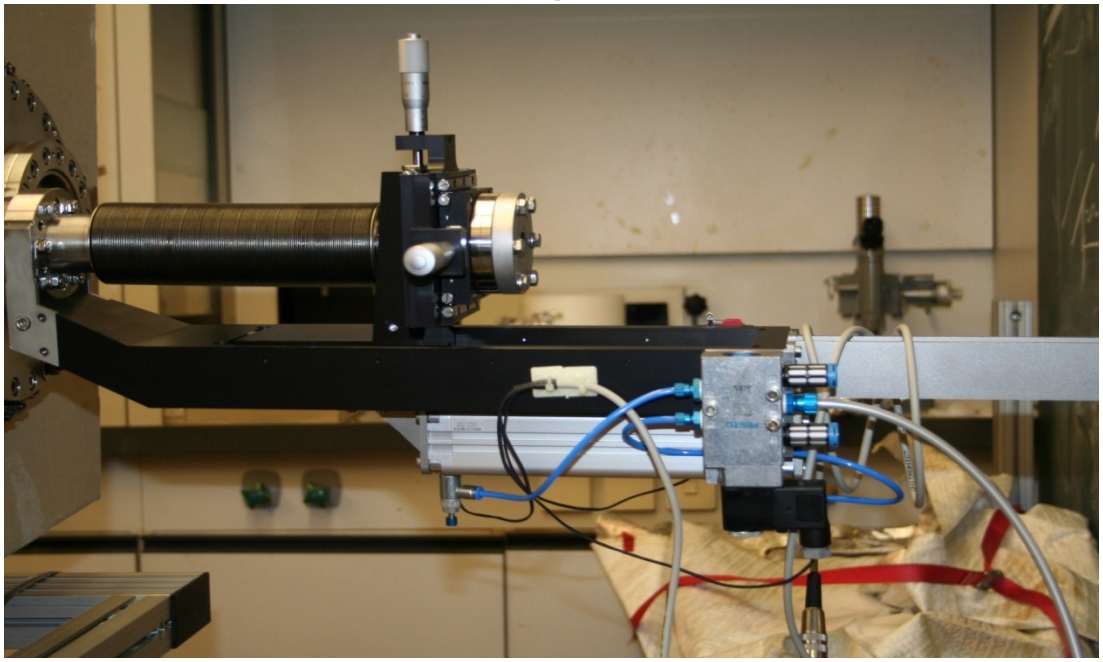






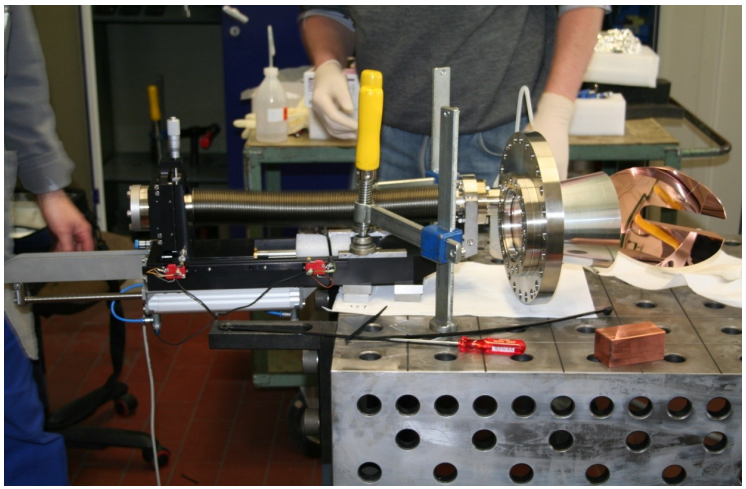
Linear feedthrough

- Pneumatic system with 180 mm range to move parabolic mirror in and out

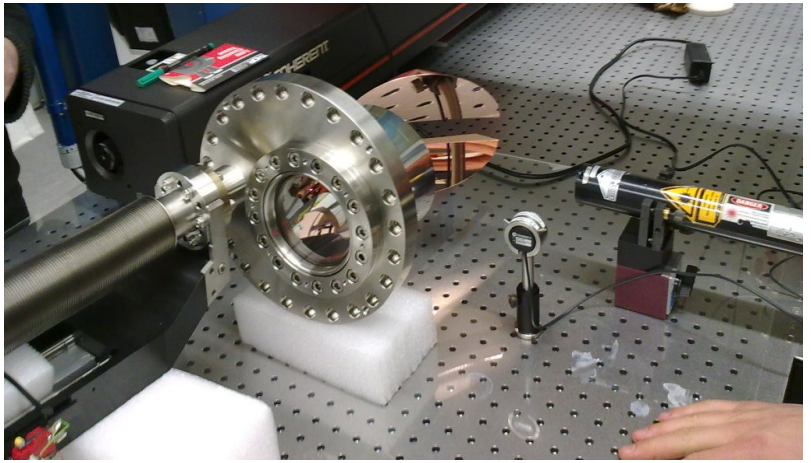


- Assembly and preliminary leak test performed in Münster

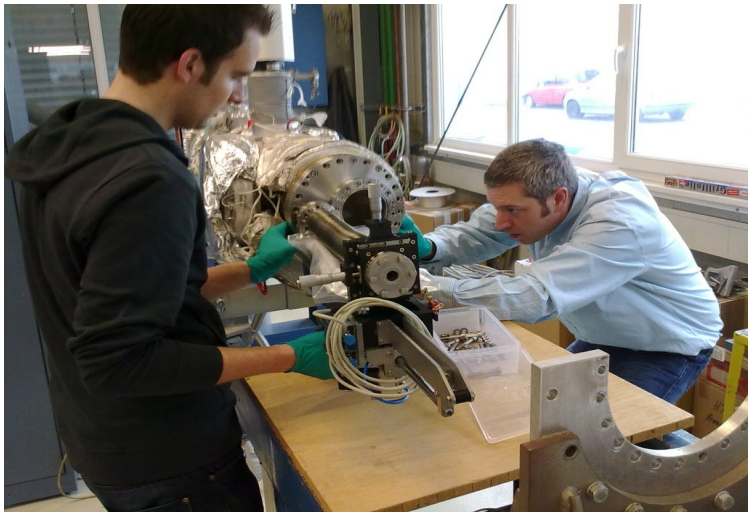
Mounting of parabolic mirror



Assembly and geometrical adjustments in Münster



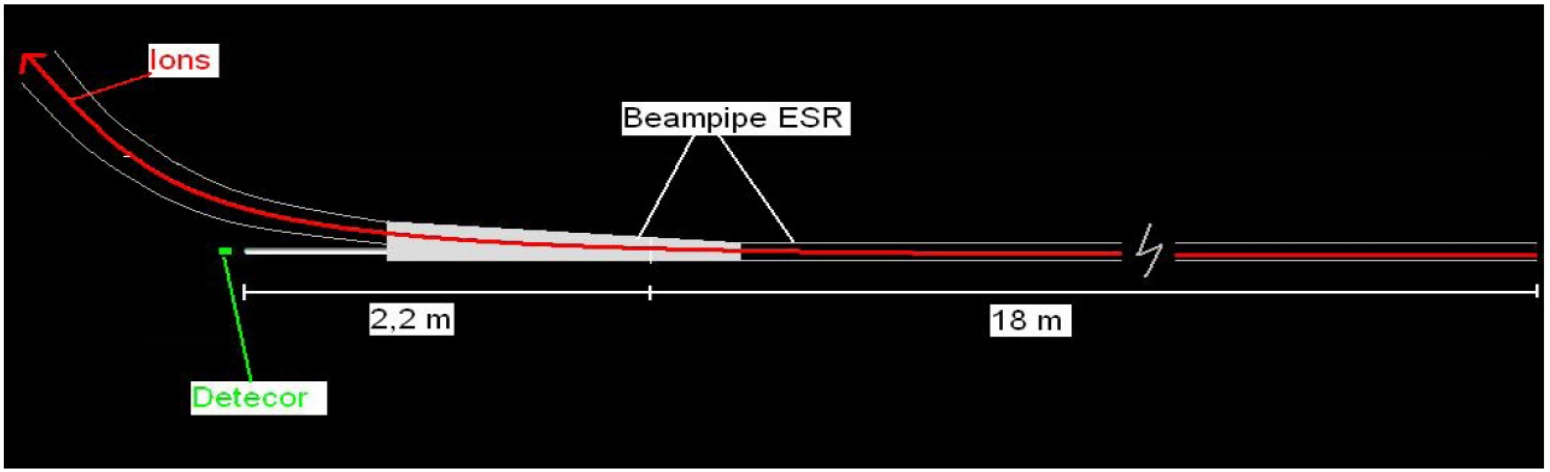
measurement of reflectivity at GSI



Preparation for UHV tests at GSI

… by now the mirror has already been mounted at the ESR

Detector in forward direction



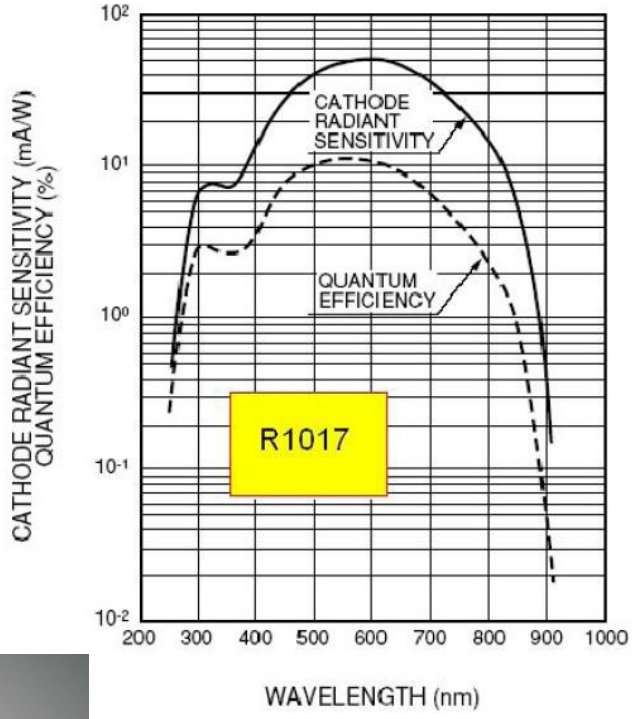
- An additional detector can be placed at the laser entrance window in forward direction
- However, due to the small solid angle a very low count rate is expected: S = (2.1±0.3)Hz on a ~30 Hz background
- A suitable PMT (low noise, high QE) at this position might still be a valuable addition for diagnosis purposes
- If the HFS signal is found, it can be confirmed by this detector in a ≈ 100 s measurement interval

PMT types

- Requirements forward direction:
  - High quantum efficiency to be able to detect very low photon rates
  - Very low dark count rate
- Requirement Parabolic mirror:
  - Large area to detect photons reflected by the mirror
  - and of course also a high QE
- Compare PMT measurements to CPM 1993, which has a QE of 4% at 635 nm, radius 7 mm, gain ~10^7 and a dark count rate < 10 Hz (at room temperature)

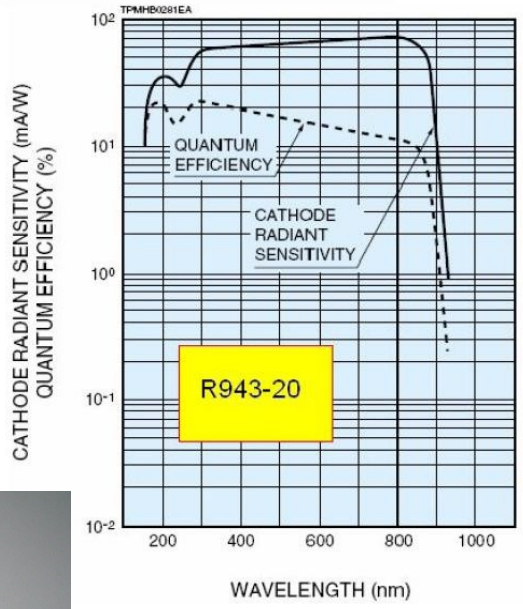
PMT-R1017

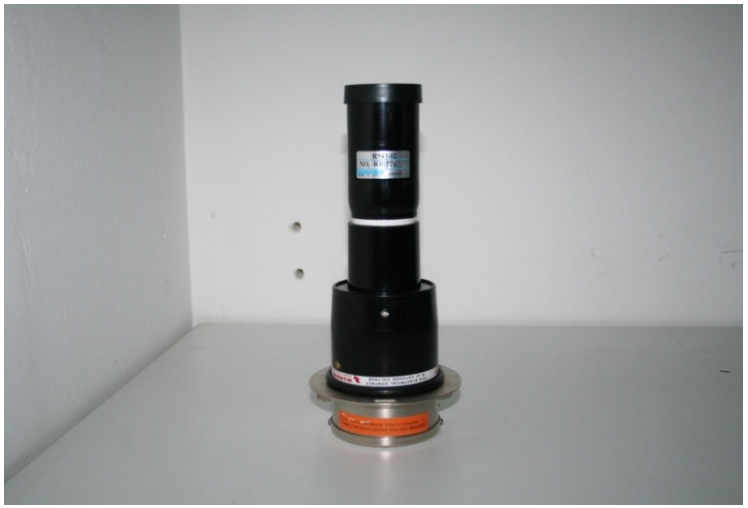
- Used with parabolic mirror
- Large area: Radius = 23 mm
- Dark counts @ -20ºC = 80 Hz-100 Hz
- Q.E.(theor.) @ 630nm > 10%
- Q.E.(meas.) = 2.1 × Q.E.(CPM)
- Need to set threshold very close to the noise level due to low gain



PMT R943-02

- Used in forward direction
- 10x10 mm^2 active area
- Dark counts @ -20ºC = 15 - 20 Hz
- Q.E.(theor.) @630 nm = 14%
- Q.E.(meas.) = 2.6 × Q.E.(CPM)



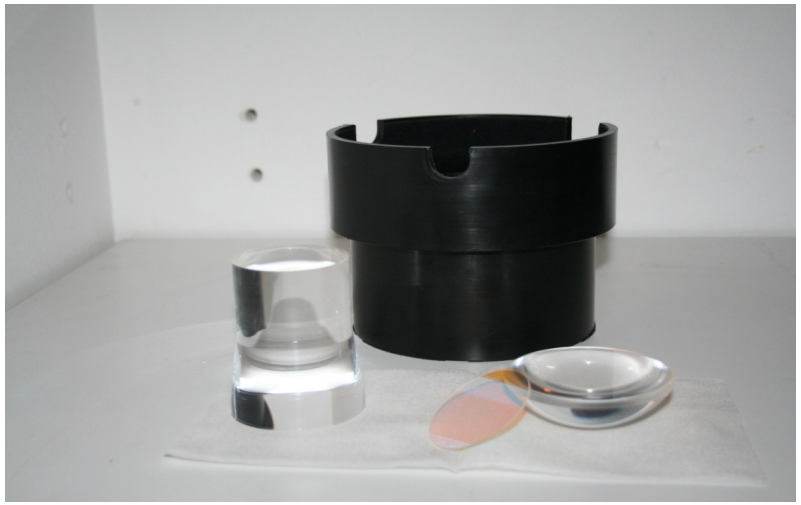


Conclusions

- Parabolic mirror setup with PMT R1017 should achieve signal rates between 45 - 83 Hz on 375 - 600 Hz background
- Forward detector acts as additional diagnosis tool
- To reach the desired sensitivity, the PMT needs to be operated very near the noise level
  → although it has a smaller area, the CPM 1972 type with QE = 8% @ 630 nm could still be an interesting candidate due to its high gain of 10^7

Outlook

- Parabolic mirror:
  Design of the PMT adaptor and the light guide has to be done
- Parasitic test measurements with the complete setup at GSI



- Forward direction:
  Optic system with lens, light guide, filter and adaptor has to be designed
- Check if CPM 1972 could be an alternative to the PMT R1017