



# ART-XC telescope update

**Mikhail Pavlinsky (IKI, Moscow)  
on behalf of the ART-XC / SRG team**

**eROSITA Consortium meeting, Garching 23 – 26/4, 2018**



## Last SRG news:

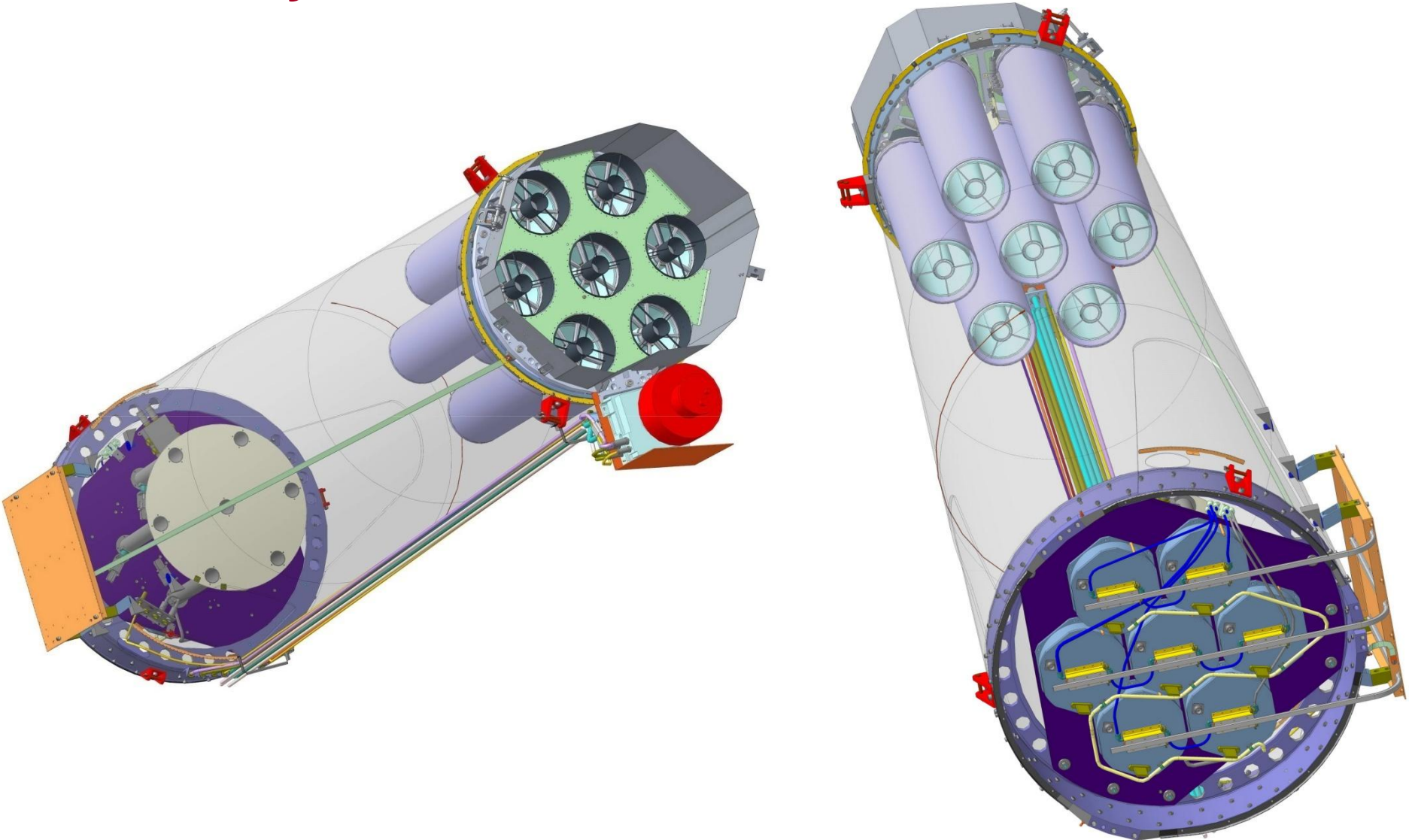
**April 3, 2018**

**FM radiocomplex was delivered to  
Lavochkin Association from RKS**

**April 19, 2018**

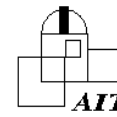
**radiocomplex successfully passed  
entrance control at LA**

# ART-XC layout





**SRG**



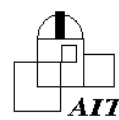
# ART-XC: X-ray mirror systems MSFC/NASA

- |   |                          |
|---|--------------------------|
| 1. Number of mirror systems                 | 7                        |
| 2. Number of nested mirror shells           | 28                       |
| 3. Form of shell                            | Wolter-I                 |
| 4. FOV with detector $\varnothing 28.56$ mm | $\sim 0.3 \text{ deg}^2$ |
| 5. On-axis angular resolution, HPD          | $\leq 35''$              |
| 6. Focal length                             | 2700 mm                  |
| 7. Length of shell                          | 580 mm                   |
| 8. Diameter of mirror shells                | 49 – 145 mm              |
| 9. Material of shells                       | Ni/Co                    |
| 10. Mirror coating materials                | Iridium                  |

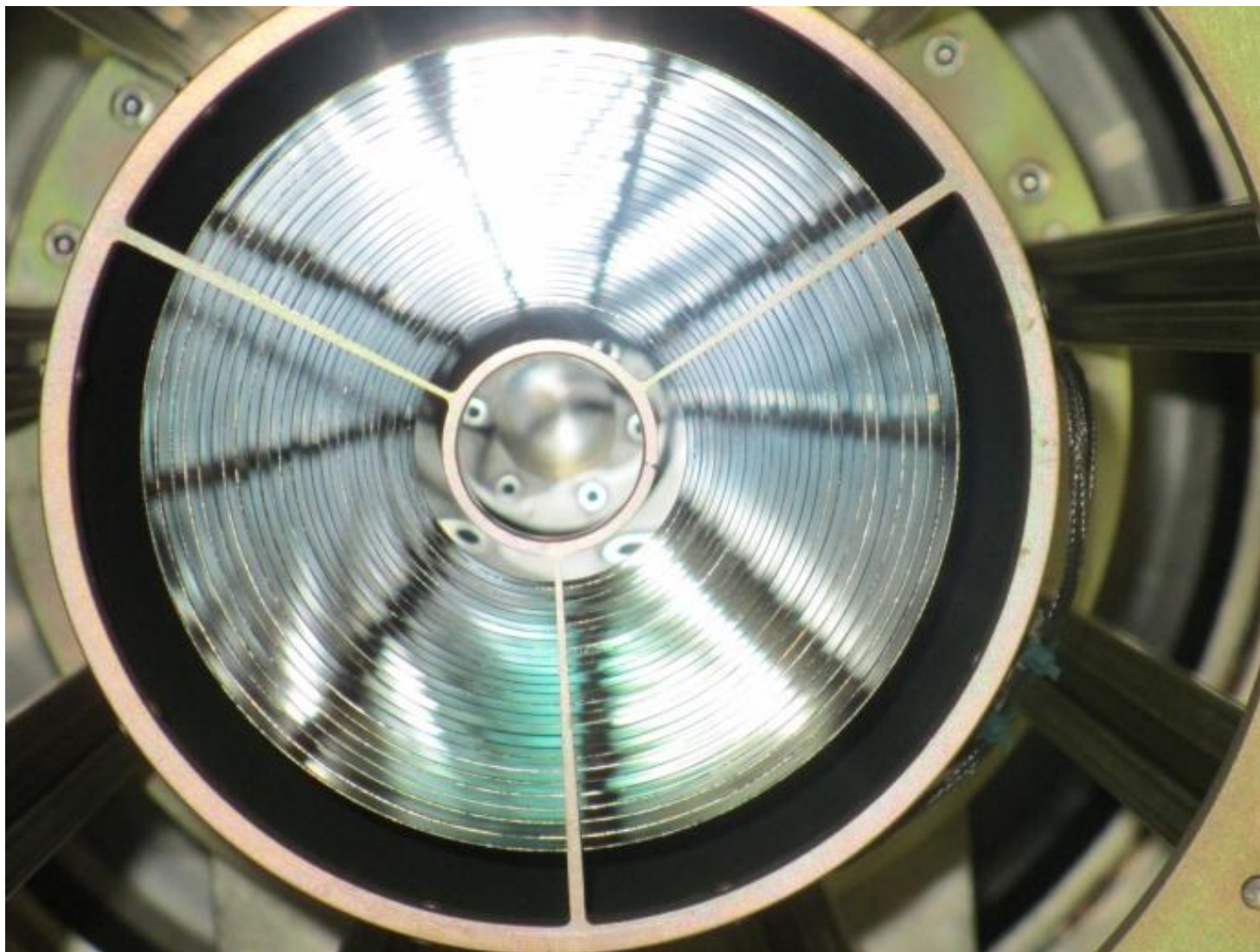




**SRG**

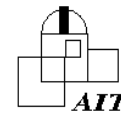
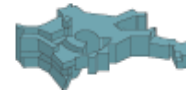


# ART-XC FM mirror system backside view





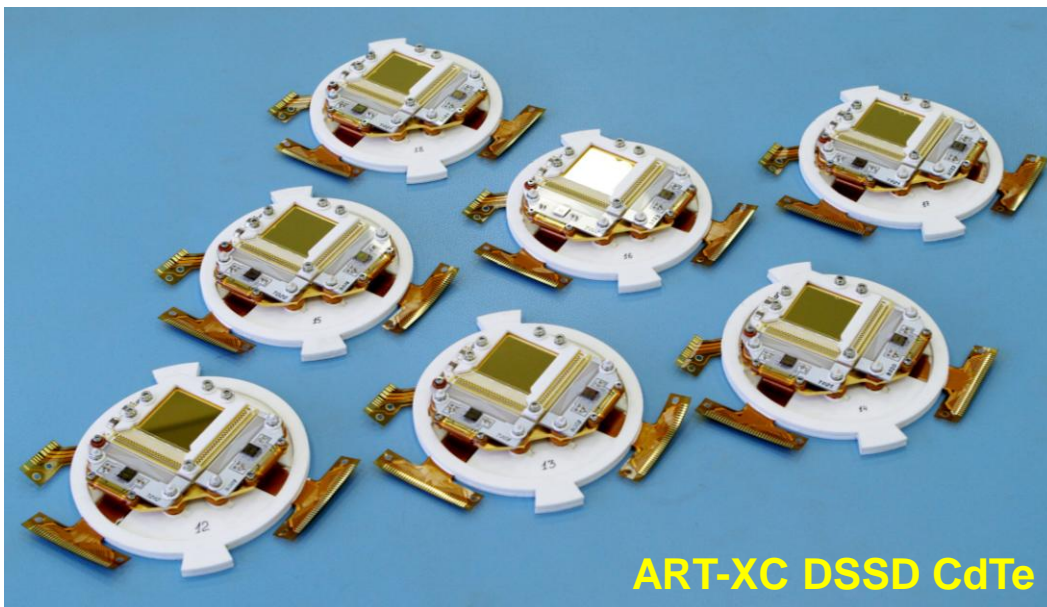
**SRG**



# ART-XC: DSSD CdTe detector IKI RAS

- |                         |  |
|-------------------------|--|
| 1. CdTe manufacturer    | ACRORAD  |
| 2. Dimensions           | $30 \times 30 \times 1 \text{ mm}^3$               |
| 3. Working area         | $28.56 \times 28.56 \text{ mm}^2$                  |
| 4. Energy range         | 4 – 160 keV  |
| 5. Number of strips     | 48 × 48  |
| 6. Strip pitch          | 0.595 mm (45")                                     |
| 7. Be entrance window   | $\varnothing 30 \text{ mm} \times 100 \mu\text{m}$ |
| 8. ASIC, 2 pcs.         | VA64TA1  |
| 9. Dead time            | 0.77 ms  |
| 10. Working temperature | – 21° C  |
| 11. Energy resolution   | $\leq 8.5\% @ 14 \text{ keV}$                      |

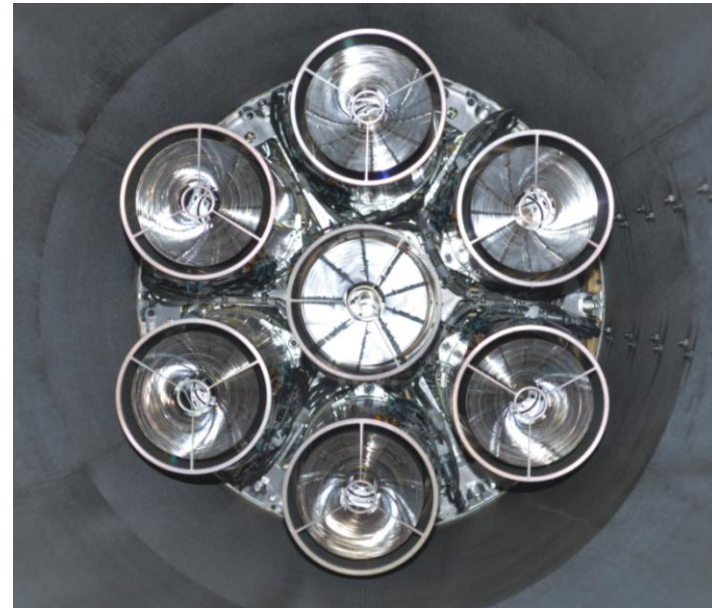
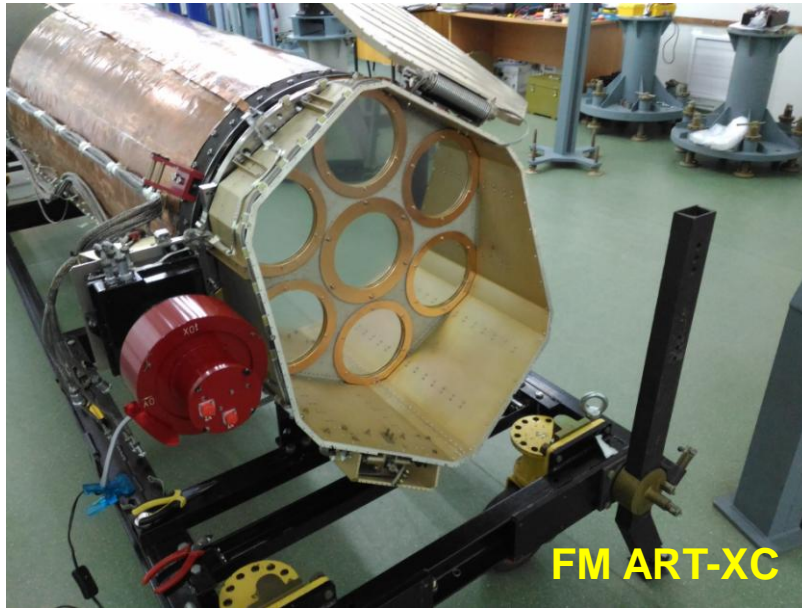




ART-XC DSSD CdTe



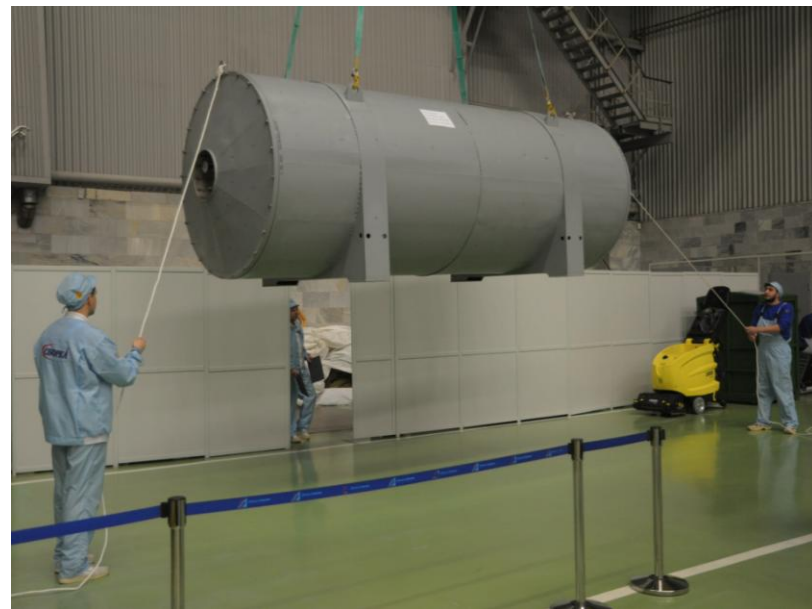








December 2016





July 2017





**September 2017 – April 2018**

**4 runs of ART-XC and S/C control system (BKU) software tests**

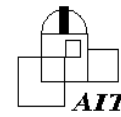
**January 29 – 30, 2018**

**test of compatibilities of FM ART-XC and S/C reaction wheels  $\Rightarrow$  upper limit is **1000** rotations per minute (strong requirement)**





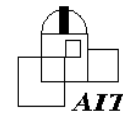
**SRG**



# Calibration at IKI test facility mirror system + DSSD CdTe telescope ART-XC / SRG



**SRG**

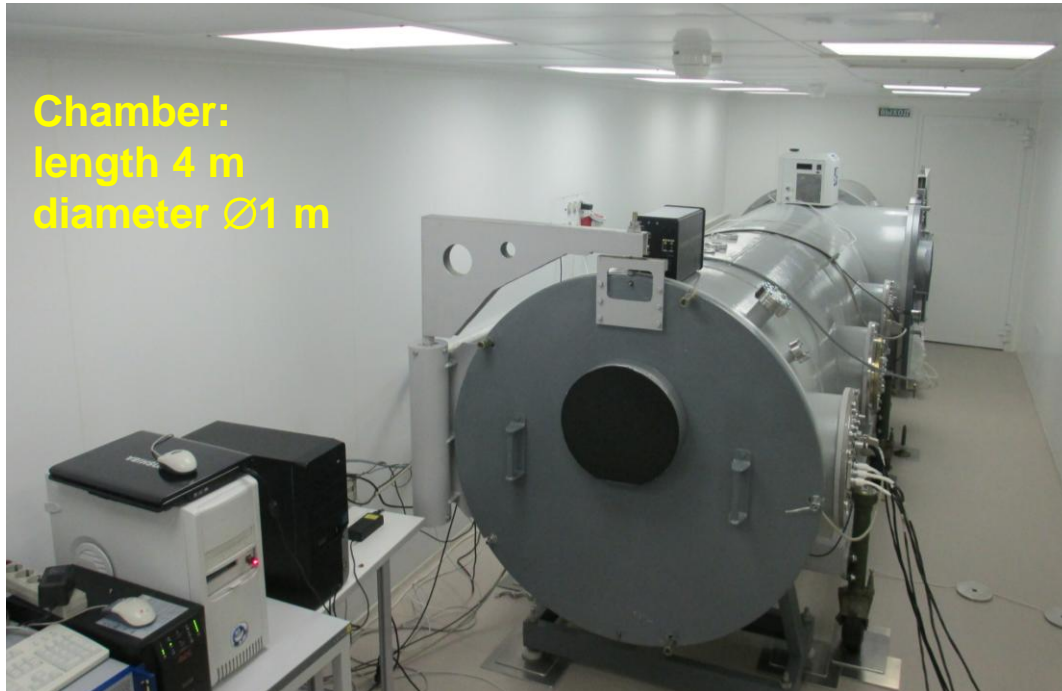


IKI test facility: pipe **60 m** + chamber **4 m**  
 X – ray source – mirror system distance: **61 m**  
 Residual pressure in pipe and chamber:  $\leq 4 \times 10^{-5}$  bar  
 X – ray tubes: Cr, Cu, Mo, Ag, 9 – 50 kV  
 Al filters, 28 – 448  $\mu\text{m}$   
 Two reference detectors – XR-100T-CdTe and XR-100SDD (Amptek)  
 Two hexapods

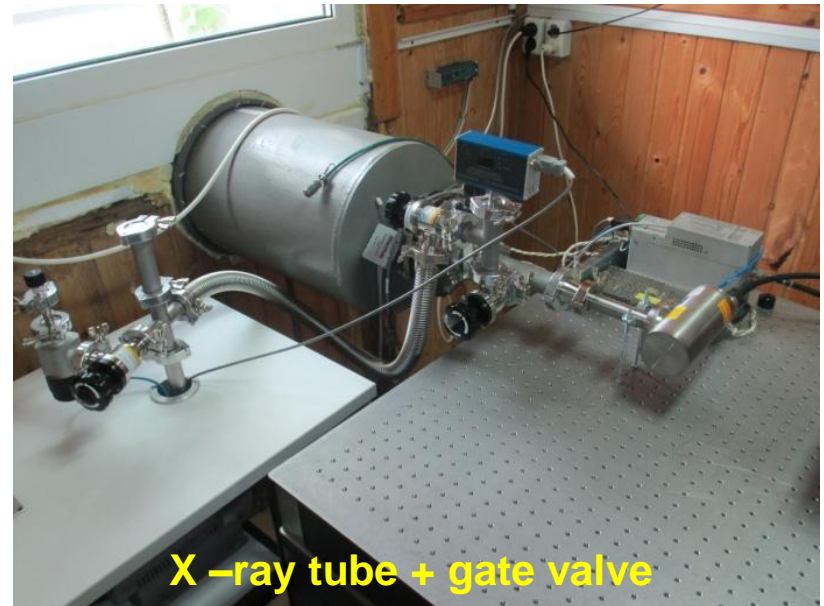


**Main gate valve**

07/09/2016 14:46

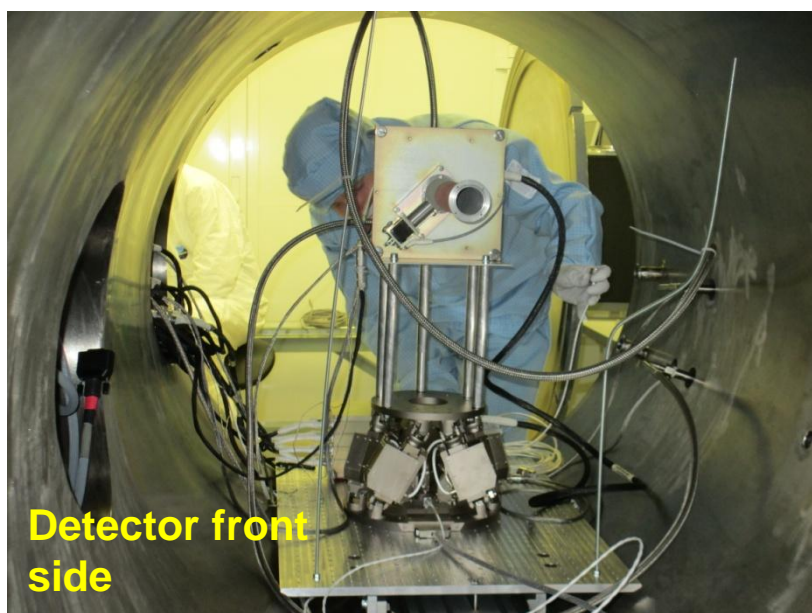
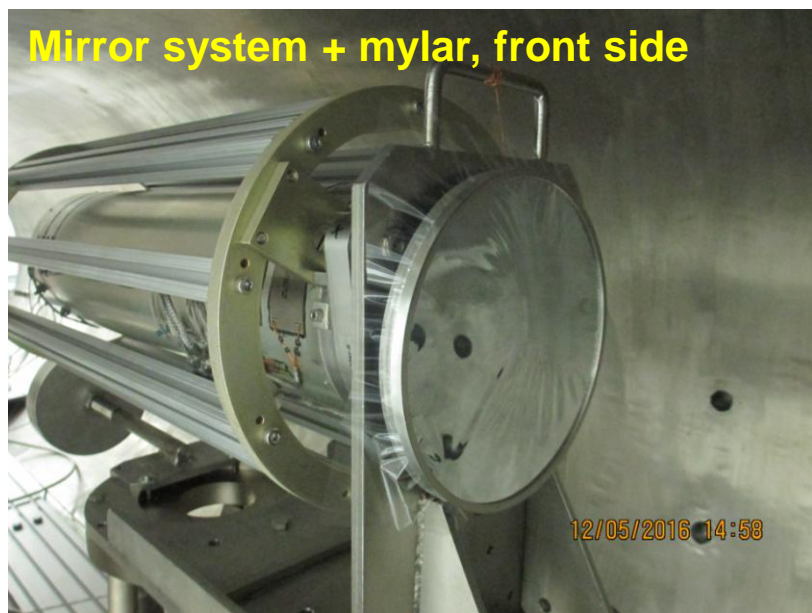


**Chamber:**  
length 4 m  
diameter  $\varnothing$ 1 m



**X – ray tube + gate valve**

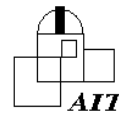




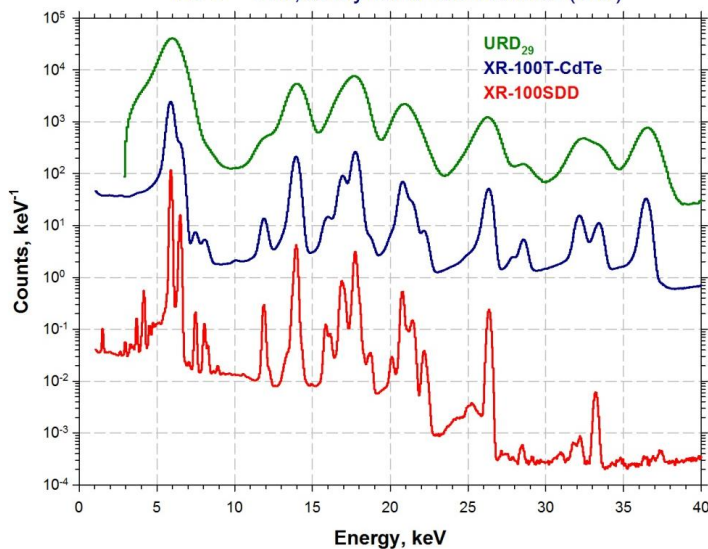




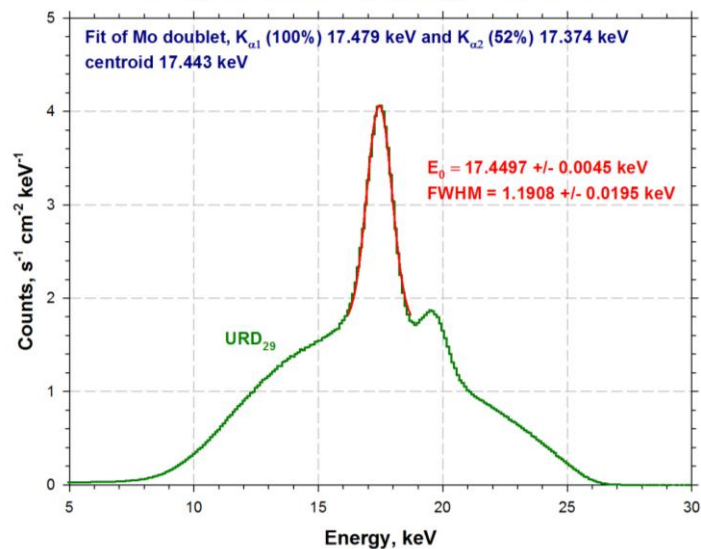
# SRG



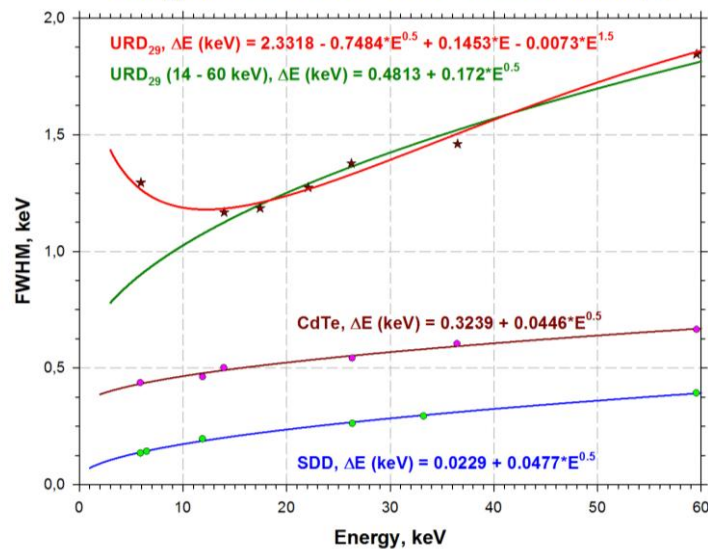
$^{55}\text{Fe} + ^{241}\text{Am}$ , X-ray calibration source (BKI)



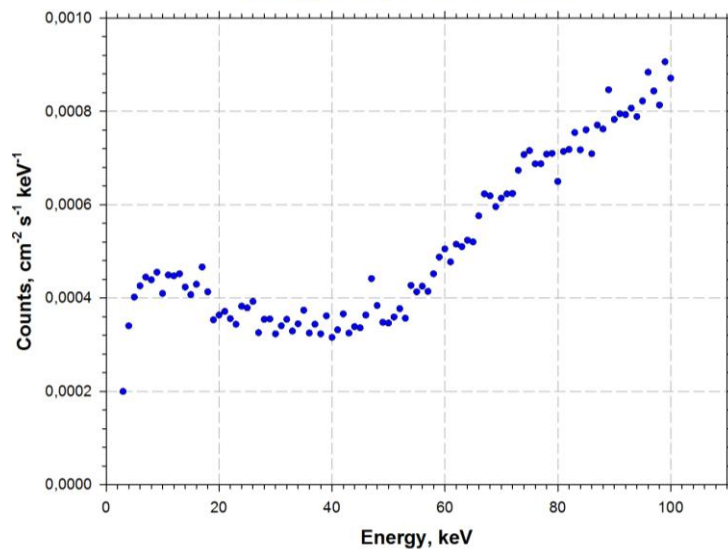
URD<sub>29</sub>, Mo (26 kV, 4 μA), Al<sub>filter</sub> 448 μm, 61 m



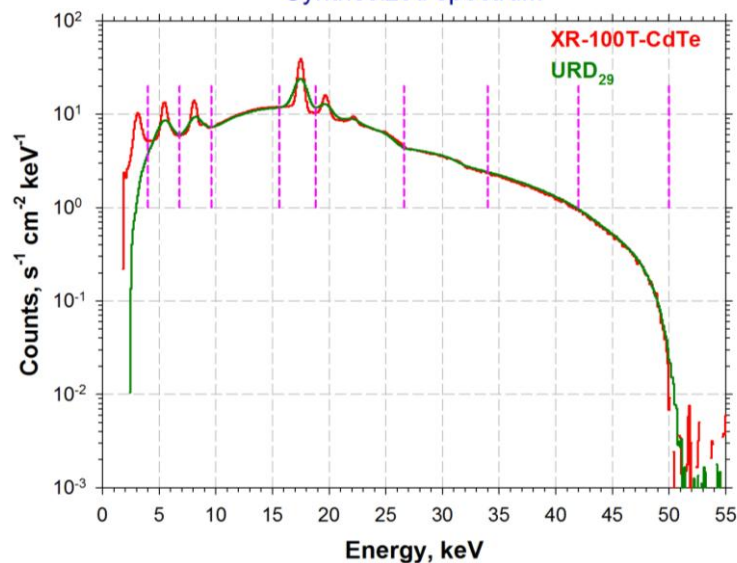
URD<sub>29</sub>, XR-100T-CdTe and XR-100SDD, FWHM(E)



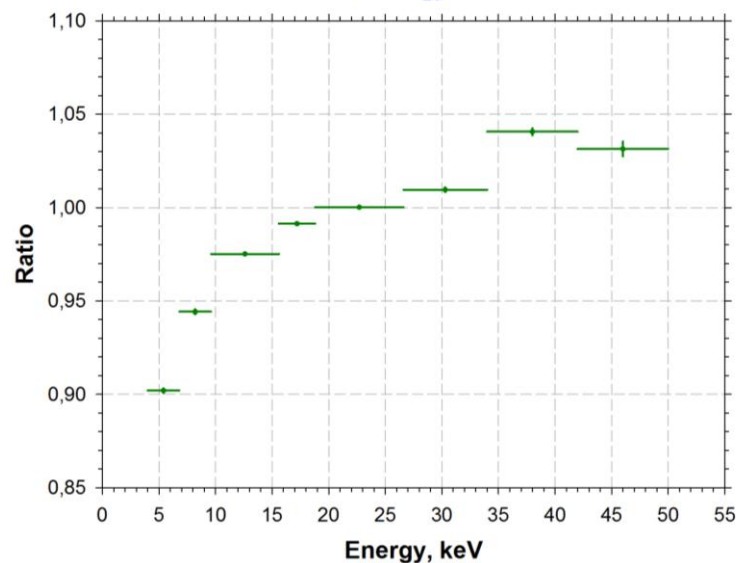
URD<sub>29</sub> background, 3 - 100 keV



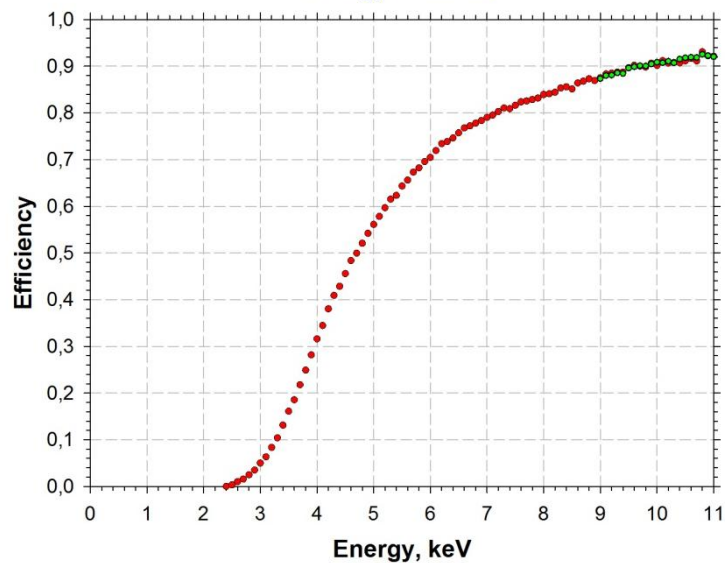
Synthesized spectrum



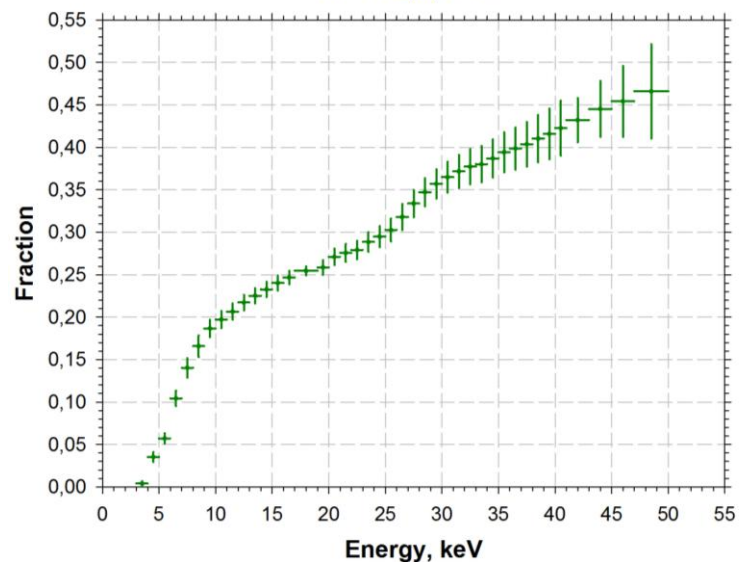
Ratio of fluxes, URD<sub>29</sub> / XR-100T-CdTe



URD<sub>29</sub> efficiency



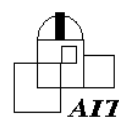
(All - B<sub>1</sub>T<sub>1</sub>) / All







SRG



34 – 50 keV

URD<sub>29</sub>, DSSD CdTe

strips: 48<sub>x</sub>, 48<sub>y</sub>

strips pitch: 0.595 mm

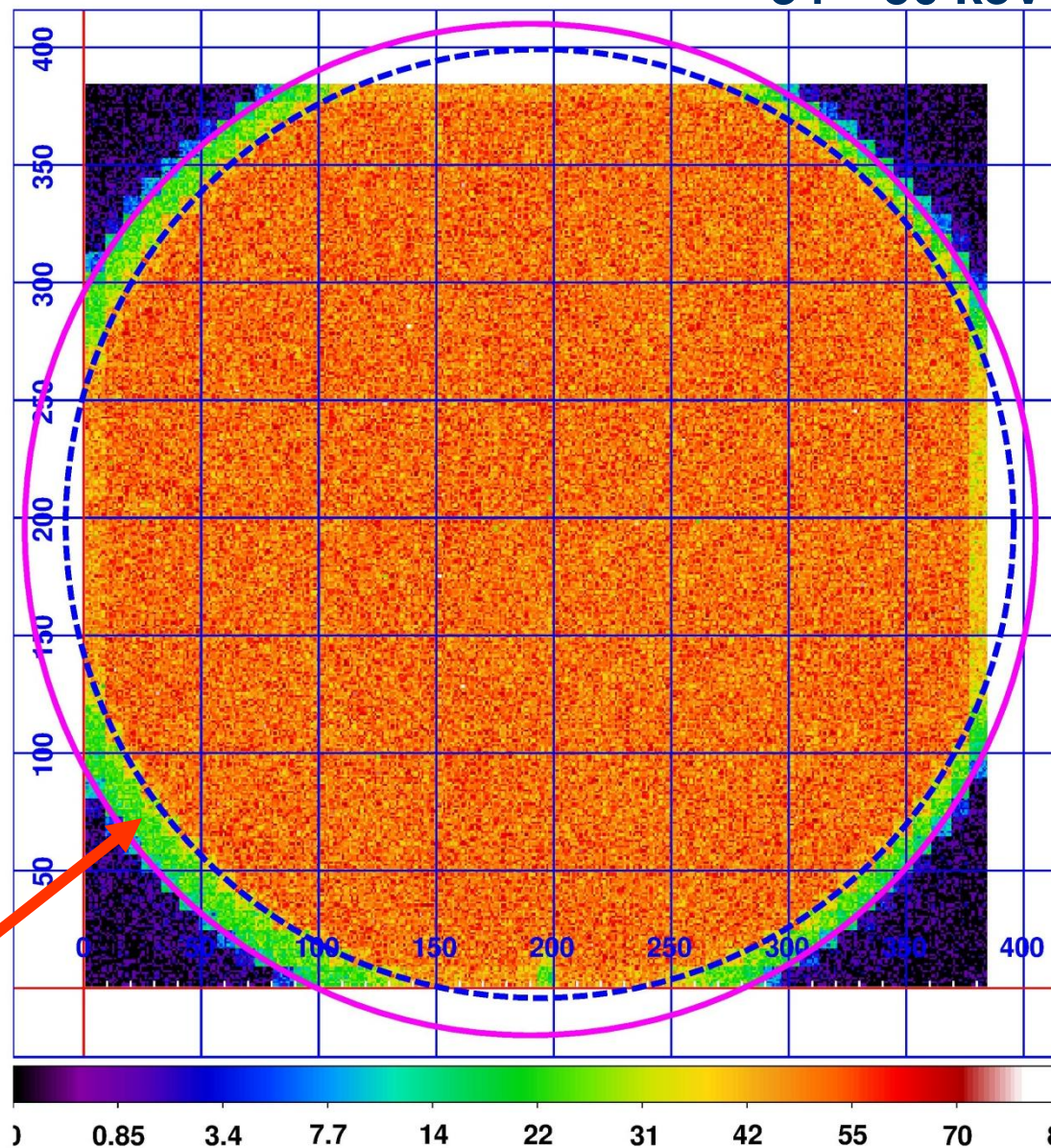
Be window: Ø30.0 mm

Working area under Be:

S = 6.896 cm<sup>2</sup>

D<sub>int</sub> of multilayer

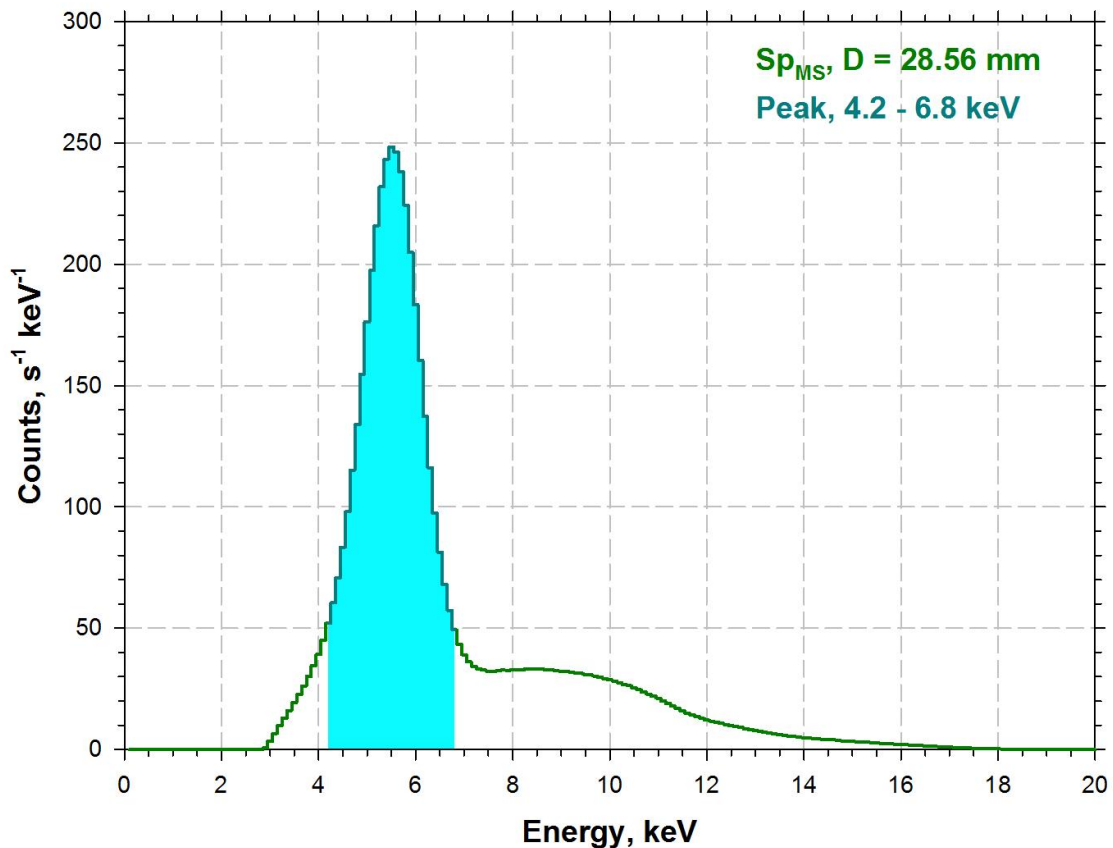
collimator : Ø32 mm



4 mm Al

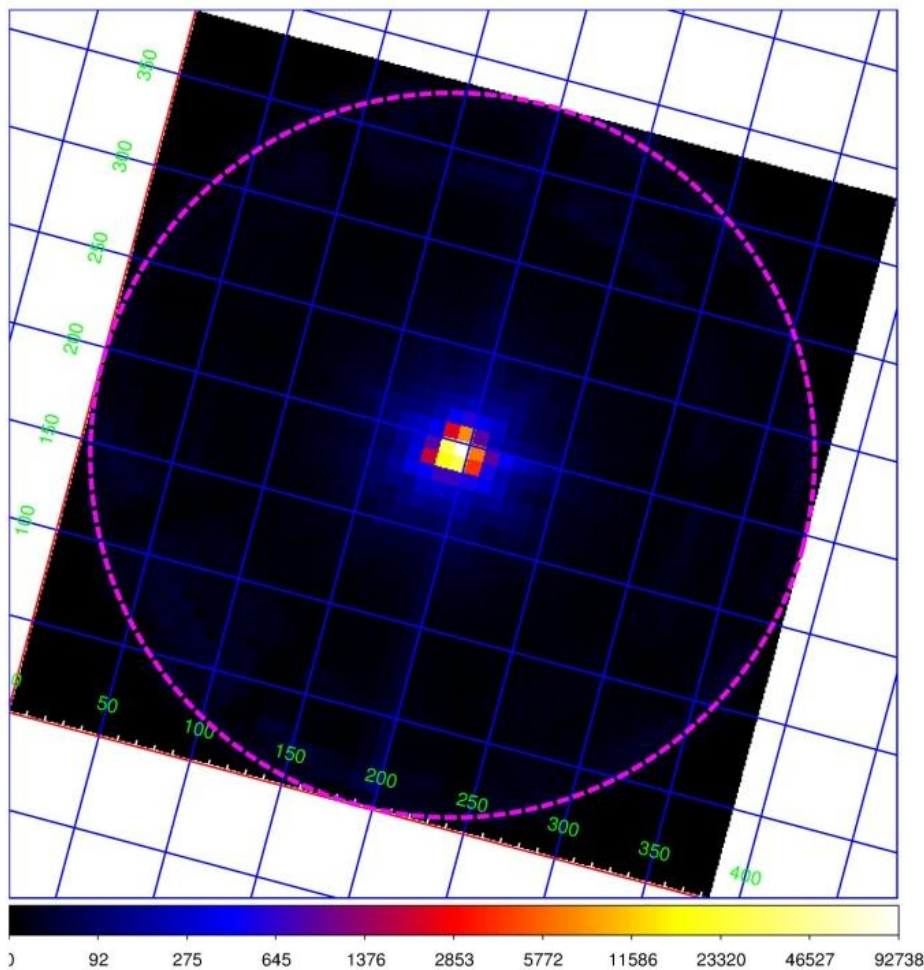


MS<sub>6</sub> + URD<sub>29</sub>, Tube Cr (18 kV, 0.5  $\mu$ A), Al filter 28  $\mu$ m

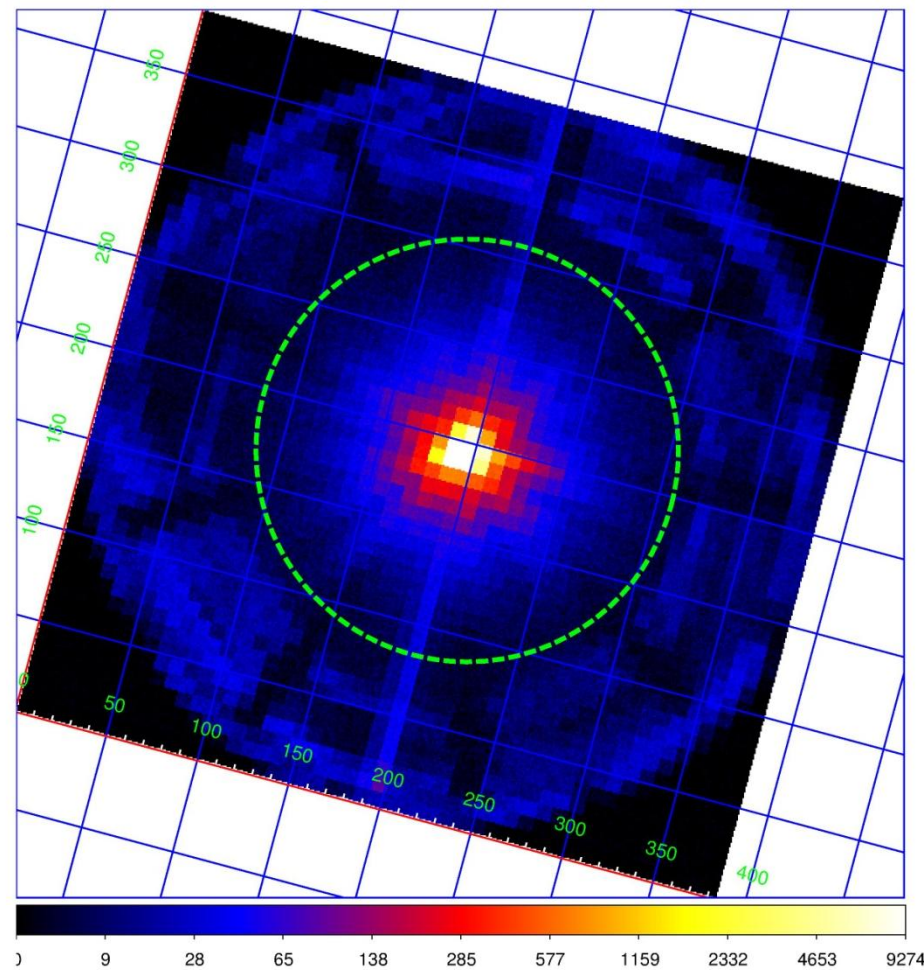


The integrated spectrum over an aperture  $\varnothing 28.56$  mm, when the detector URD<sub>29</sub> is illuminated through the MS by an X-ray tube with a Cr anode (18 kV, 0.5  $\mu$ A, Al filter 28  $\mu$ m). The solid area shows the peak of the Cr lines in the range 4.2-6.8 keV.

**MS<sub>6</sub> + URD<sub>29</sub>, Cr (18 kV, 0.5 μA), Al 28 μm, 4.2 – 6.8 keV, 61 m**



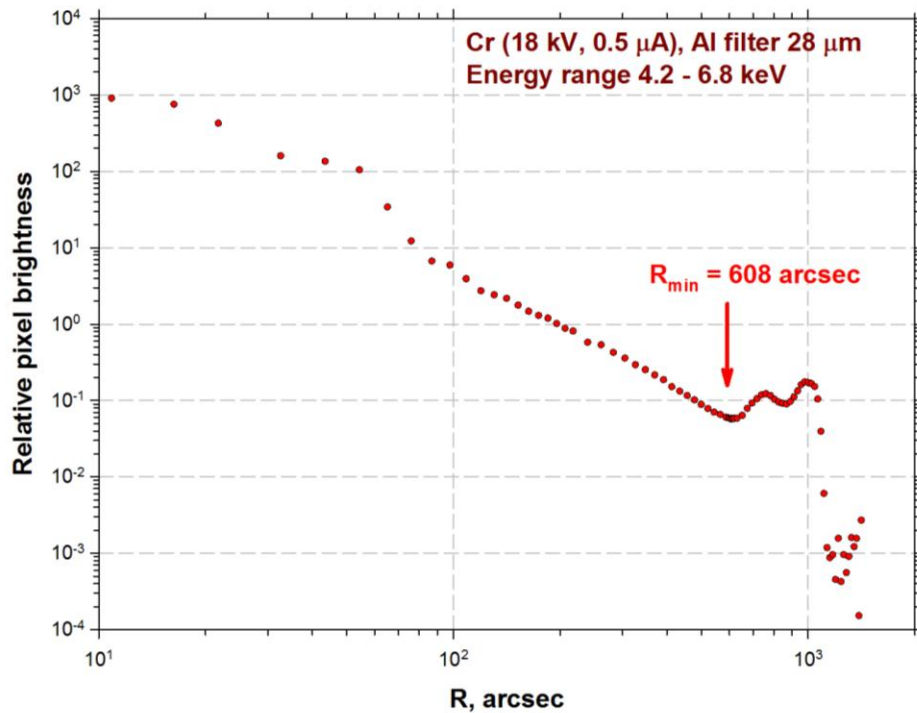
**Logarithmic scale**



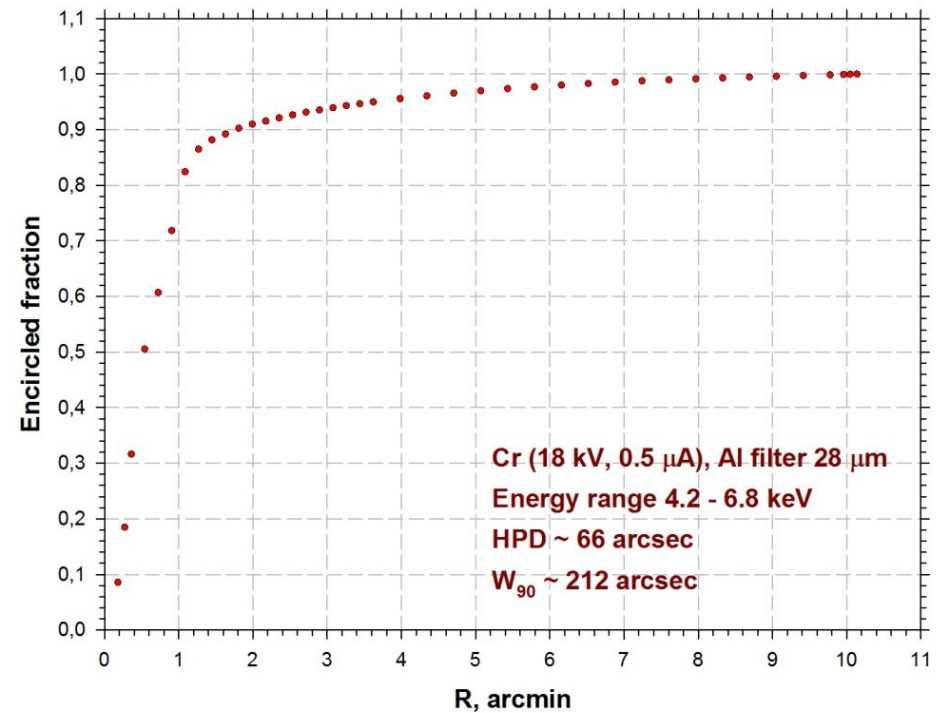
**10% of the maximum**

# MS<sub>6</sub> + URD<sub>29</sub>, Cr (18 kV, 0.5 μA), Al 28 μm, 4.2 – 6.8 keV, 61 m

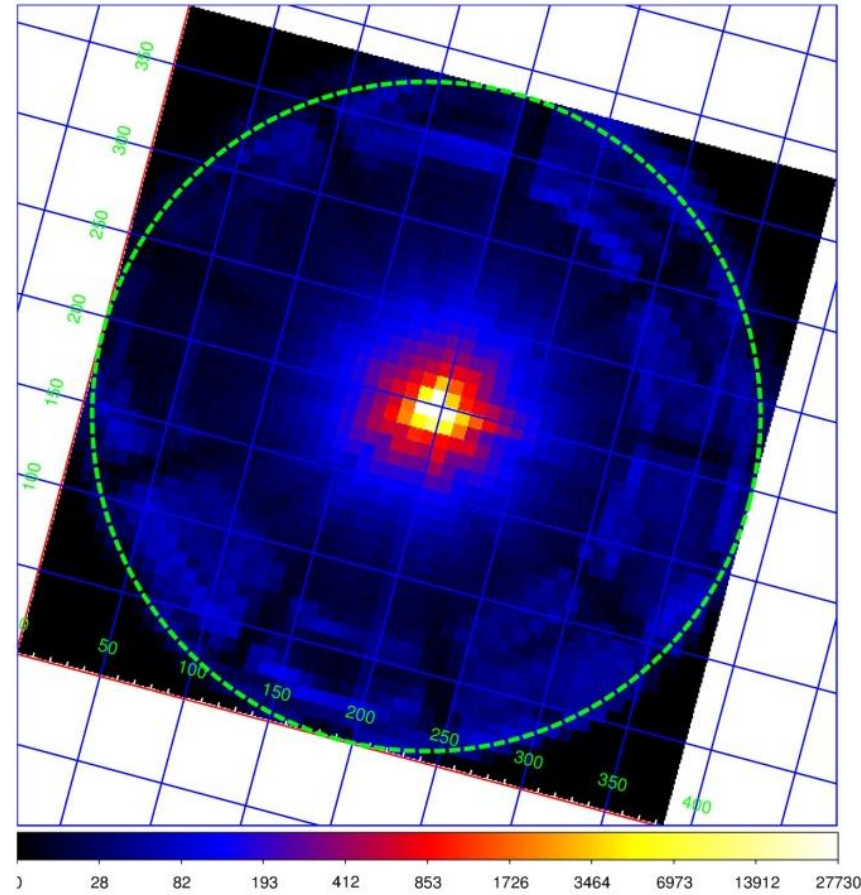
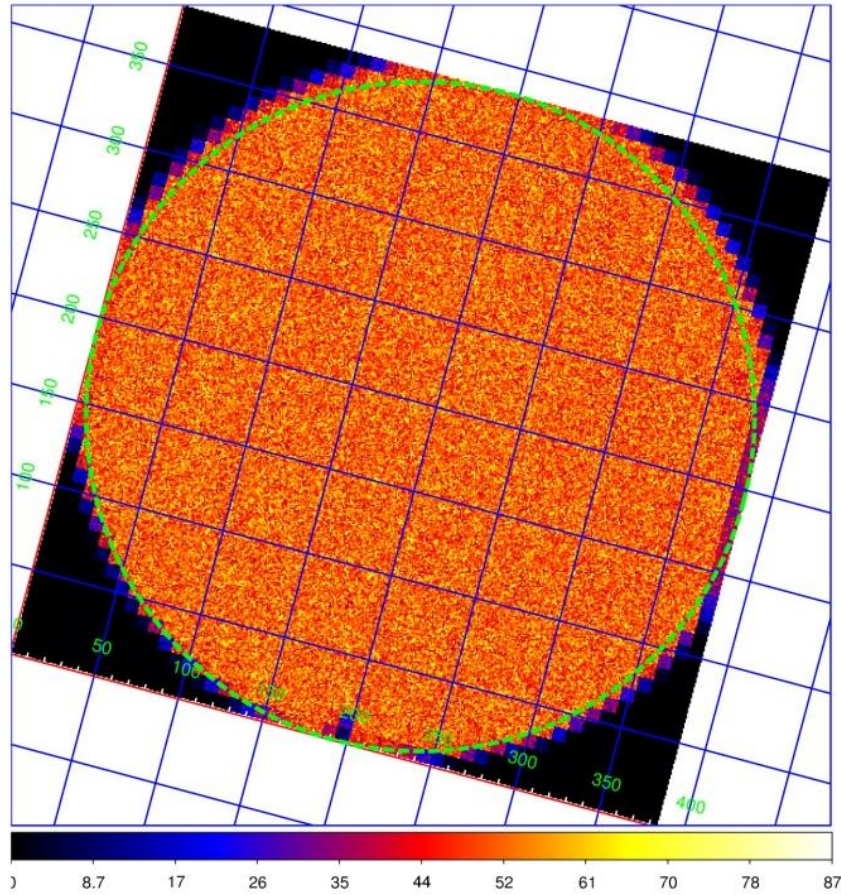
MS<sub>6</sub> + URD<sub>29</sub>, radial profile of the on-axis PSF, distance 61 m



MS<sub>6</sub> + URD<sub>29</sub>, D<sub>2</sub> encircled fraction, R = 10.139 arcmin, 61 m

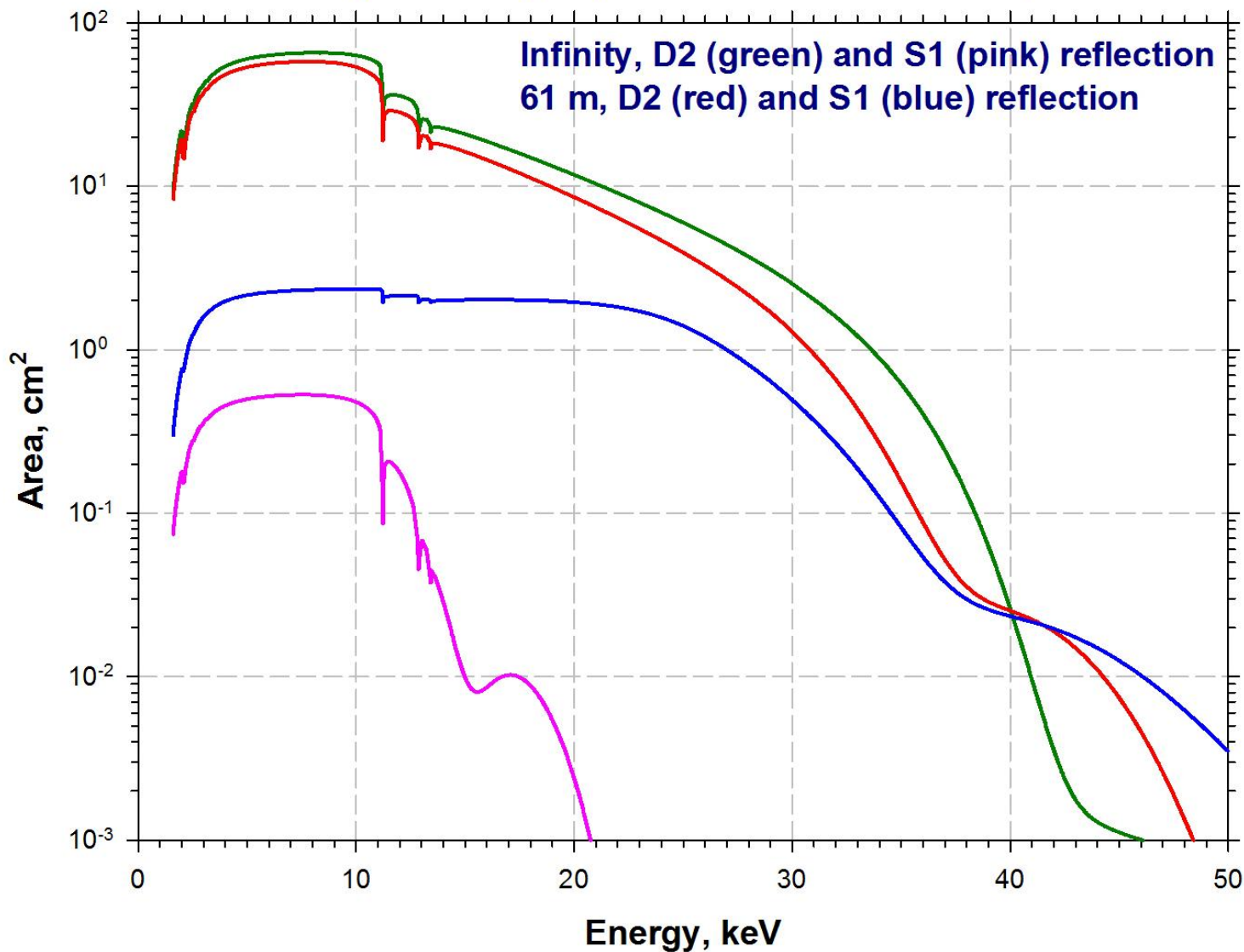




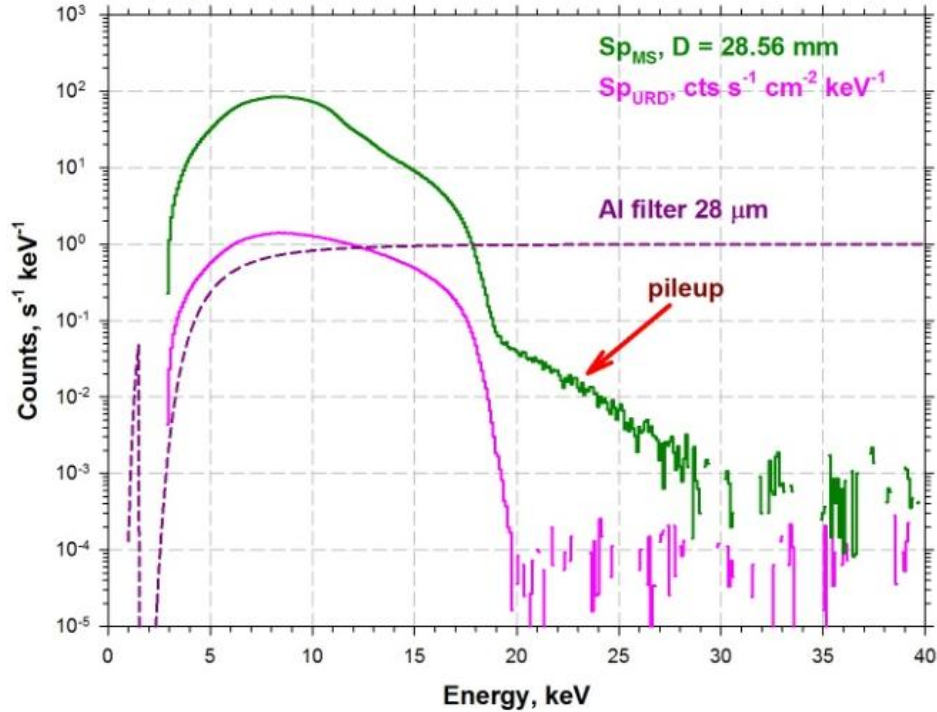


Left – detector image in the 4–18 keV band at direct illumination of URD<sub>29</sub> (linear color scale); Right – image of URD<sub>29</sub> illuminated through MS<sub>6</sub> (logarithmic color scale, cutoff at 10% of maximum value). The green dashed circle marks 28.56 mm diameter equal to  $\sim 34.76'$  for the 61 meter distance to the source.

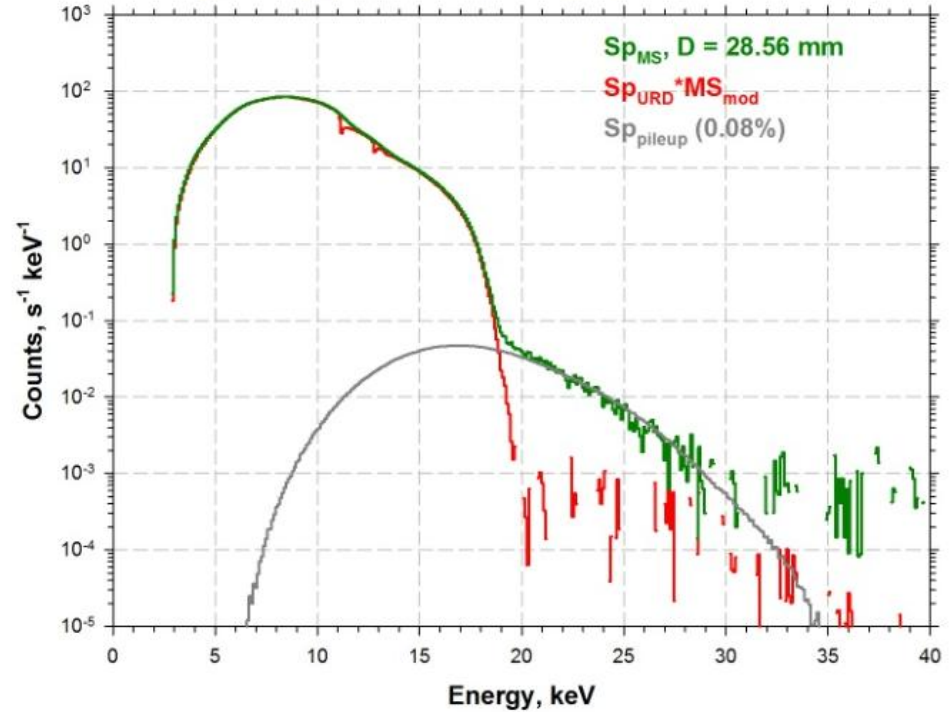
Model mirror system+mylar, effective area on-axis, D=28.56 mm



MS<sub>6</sub>+URD<sub>29</sub>, Tube Mo (18 kV, 1 μA), Al filter 28 μm



MS<sub>6</sub>+URD<sub>29</sub>, Tube Mo (18 kV, 1 μA), Al filter 28 μm



Left:  $\text{Sp}_{\text{URD}}$  – integrated spectrum of events for direct (without MS) illumination of URD<sub>29</sub> in units of  $\text{cts s}^{-1} \text{cm}^{-2} \text{keV}^{-1}$  (pink);  $\text{Sp}_{\text{MS}}$  – integrated spectrum of URD<sub>29</sub> illuminated through MS<sub>6</sub> within diameter of 28.56 mm (green); also shown here the photoabsorption transparency of the 28 μm thick Al filter (crimson). At energies above 19 keV in  $\text{Sp}_{\text{MS}}$  spectrum there is the pileup effect observed.

Right:  $\text{Sp}_{\text{MS}}$  (green),  $\text{Sp}_{\text{URD}} \times \text{MS}_{\text{mod}}$  – direct illumination spectrum multiplied by the mathematical model of the MS effective area  $\text{MS}_{\text{mod}}$  (red) and  $\text{Sp}_{\text{pileup}}$  – mathematical model spectrum describing the pileup effect, which relates to a small fraction  $\sim 0.08\%$  of the total number of events (grey).





**Thank you**