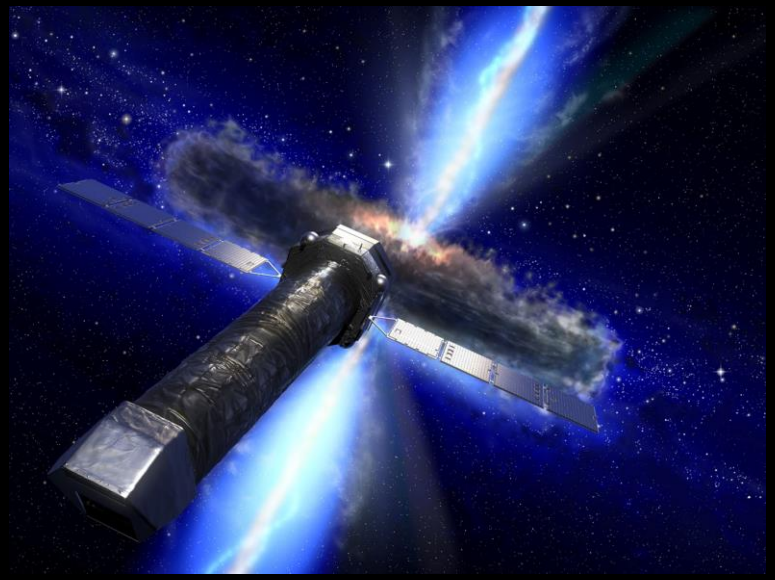
Röntgen in de ruimte en een bron op aarde







Willem-Jan Vreeling

SRON

Netherlands Institute for Space Research

Netherlands Organisation for Scientific Research (NWO)

Inhoud

- SRON
- Atmosfeer
- Röntgen in de ruimte
- Athena
- X-IFU
- Bron op aarde

SRON

- SRON, Netherlands Institute for Space Research
- Instituut van NWO-I
- 2 locaties: Utrecht (Leiden) en Groningen
- ~250 personen



DIFFERNIOZ
NWO-I, Institutes
NSCRARCNLCWI
organisation of NWO
AMOLFSRON
www.nwo-i.nl/merger
ASTRONNIKHEF

SRON

- Groningen: Landleven 12
- Gebouw van de RuG
- ARBO → SBE - Complex Vergunning



SRON

Astrofysica

The hot evolving Universe: eigenschappen en ontwikkeling van o.a. zwarte gaten en neutronensterren. (hoge energie astronofysica).

-> Röntgenstraling – Athena/X-IFU



The cool and obscured Universe, geboorte van sterren en planeten, evolutie van sterren en sterrenstelsels.(lage-energie astrofysica).

-> Ver-Infrarood straling – SPICA/Safari



Aardgericht onderzoek

Samenstelling en chemie van de atmosfeer (ozon, methaan, CO_2, aerosolen).

-> Zichtbaar, Nabij-Infrarood en UV – Sentinel 5 (Tropomi)

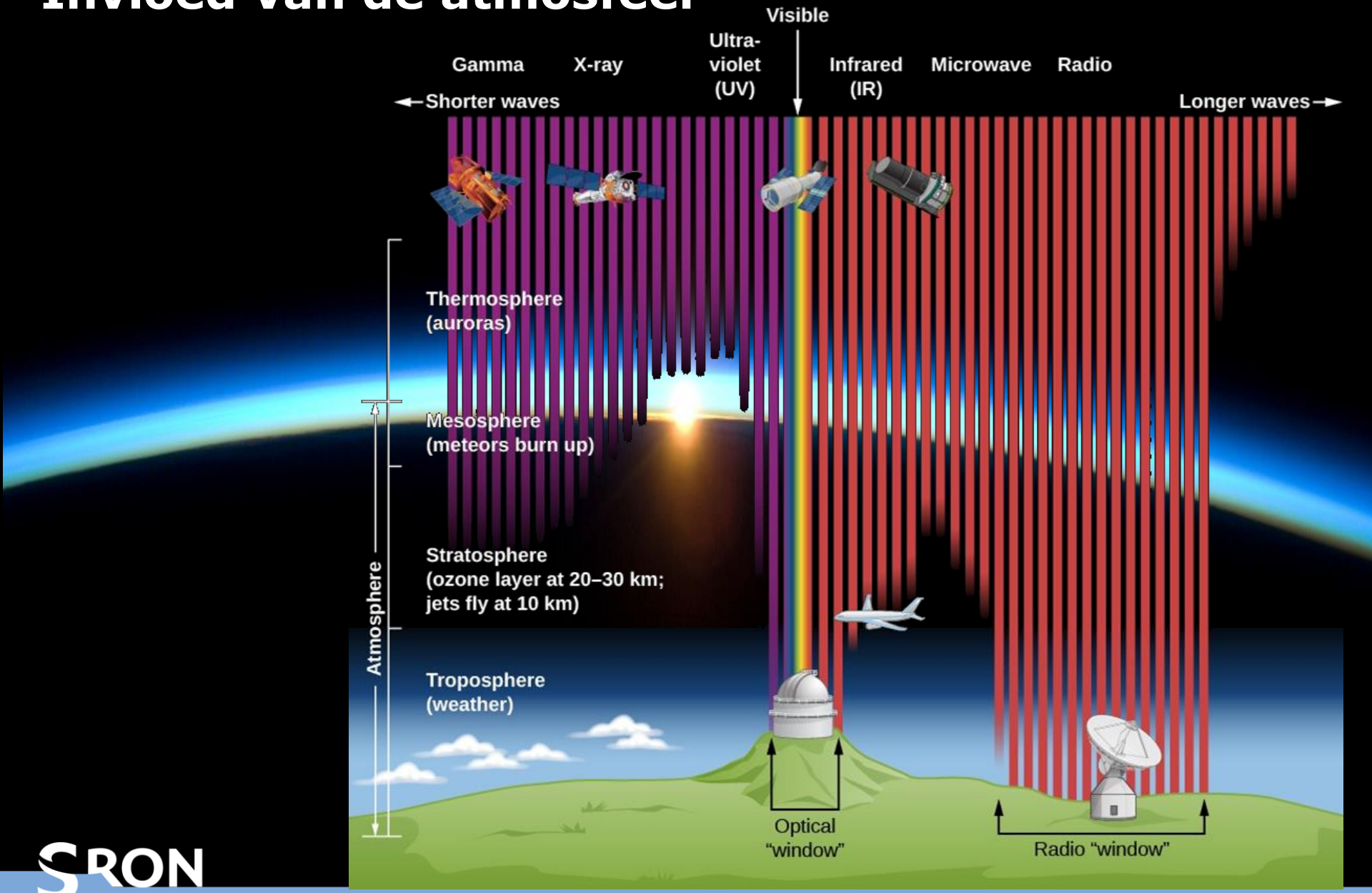


Exo-planeten

Characterisatie van exo-planeten.

-> Zichtbaar, Nabij-Infrarood - PLATO

Invloed van de atmosfeer



Invloed van de atmosfeer



Medium	Druk/dichtheid	Dikte
Atmosfeer, NL	980 g/cm2	~100 km
Lood	11,3 g/cm3	0,88 m
Aluminium	2,7 g/cm3	3,7 m
Beton	2,4 g/cm3	4,2 m

SRON

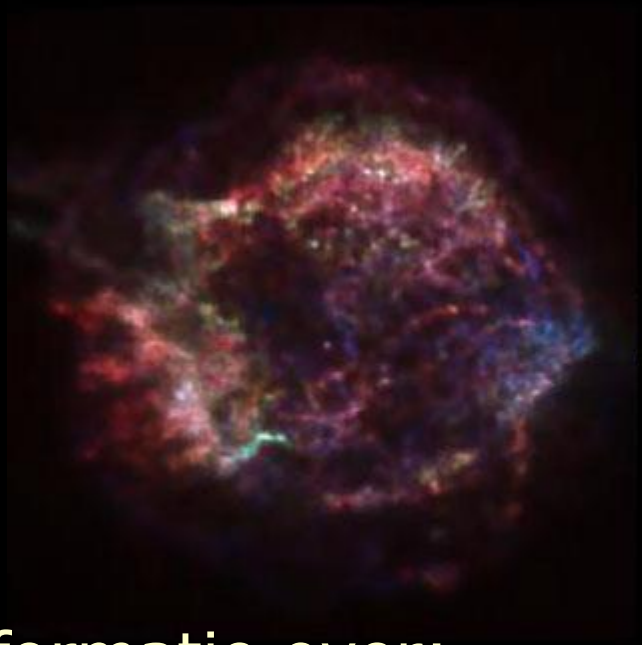
Invloed van de atmosfeer

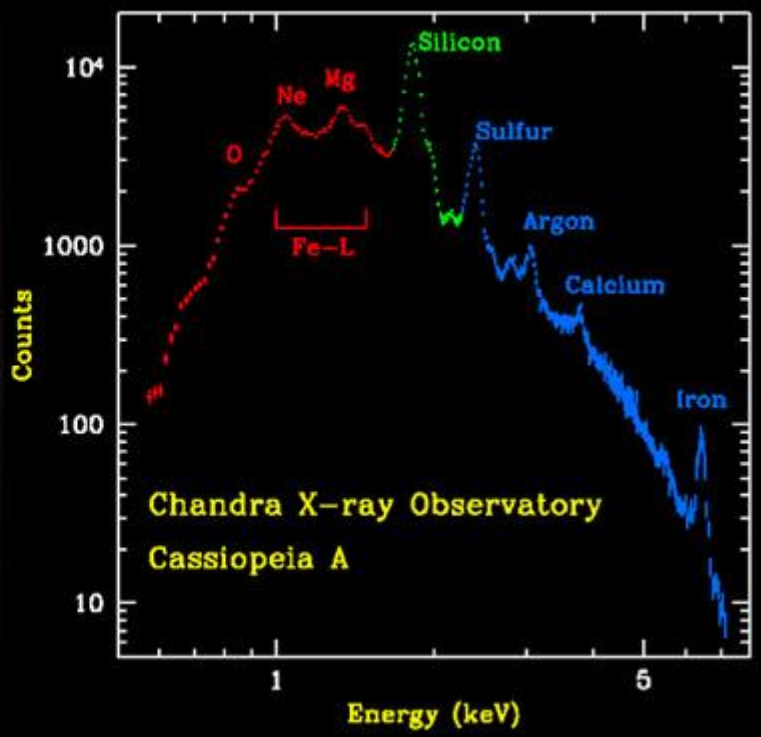


Invloed van de atmosfeer



Röntgen in de ruimte - Spectrum



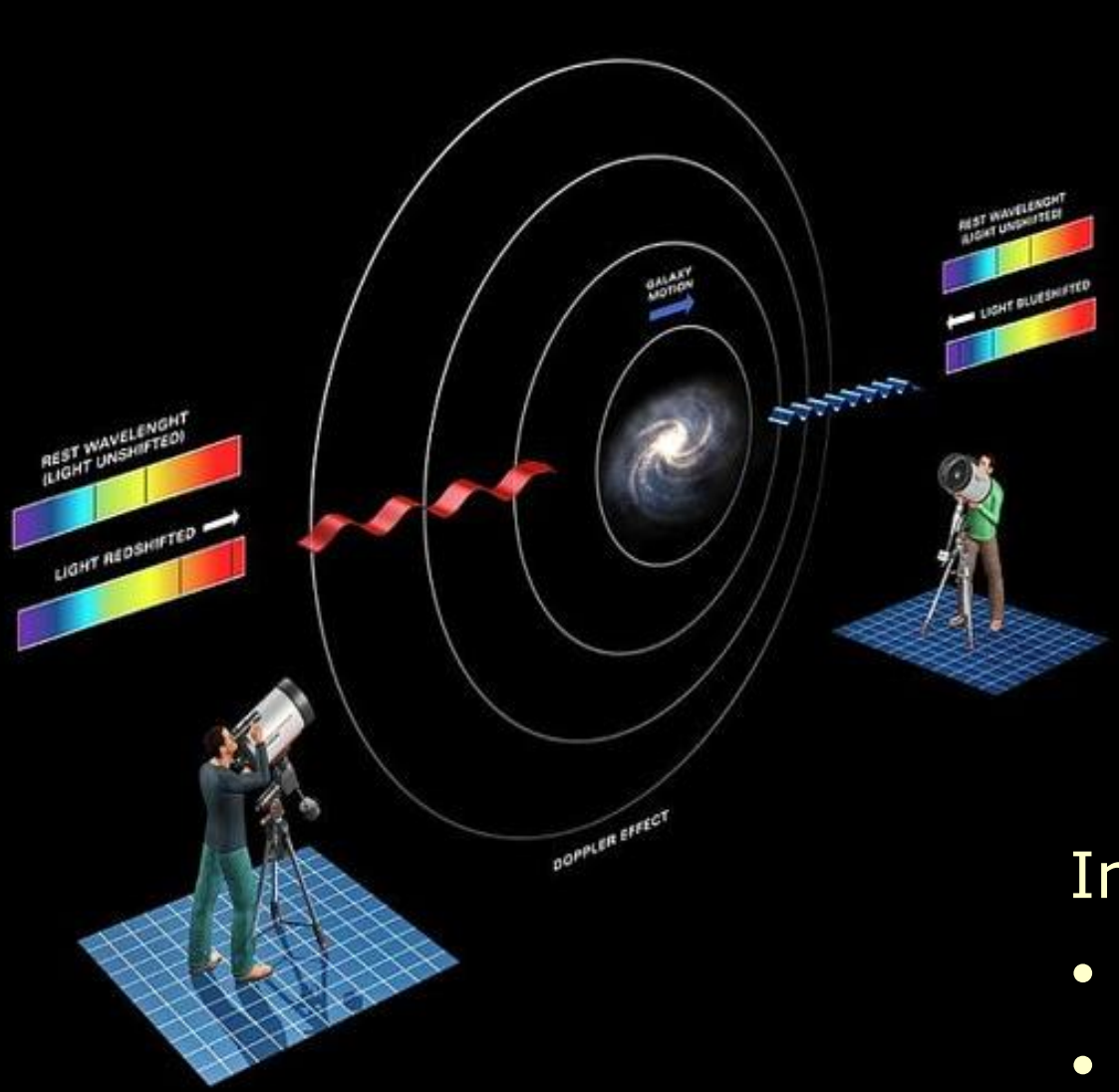


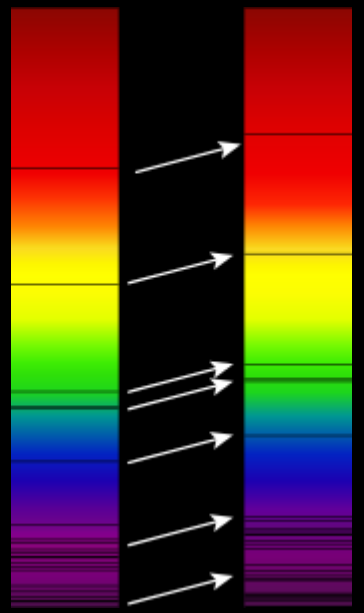
Informatie over:

- Samenstelling
- Temperatuur
- Druk
- Snelheid

SRON

Röntgen in de ruimte - Doppler





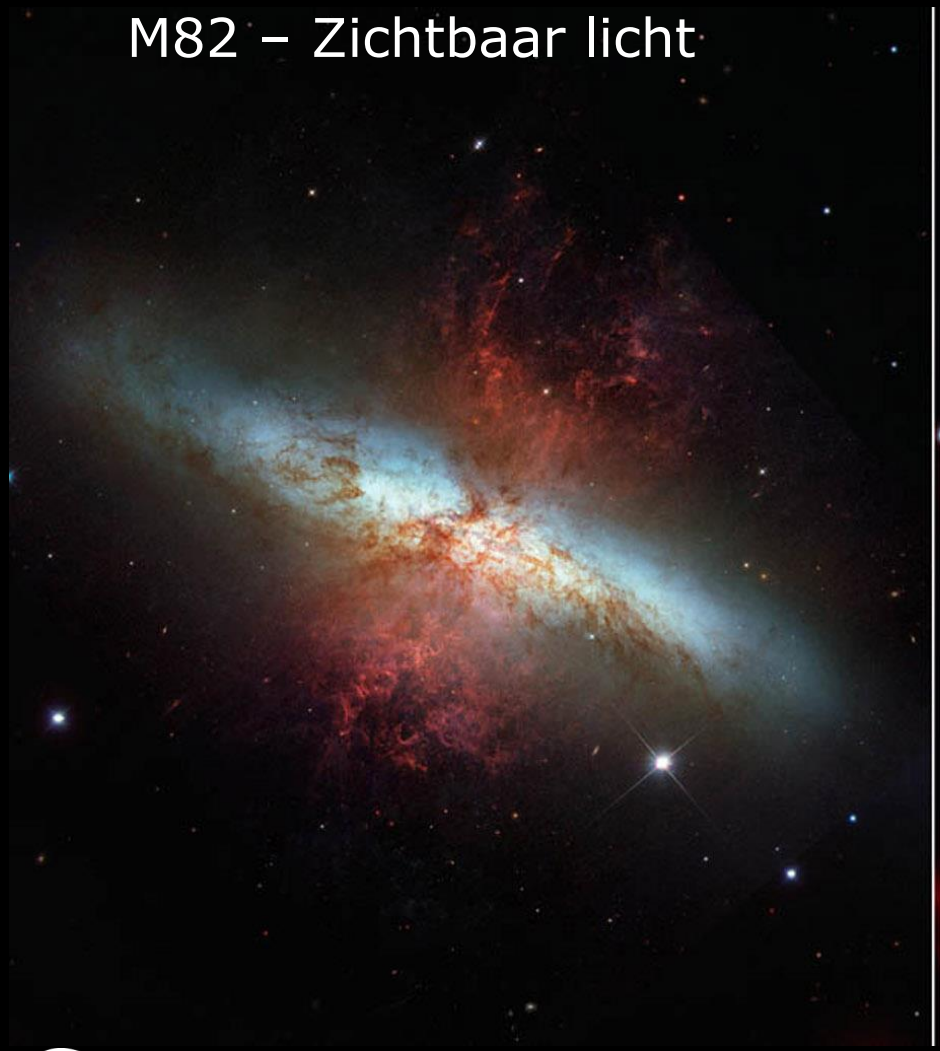
Informatie over:

- Snelheid
- Afstand

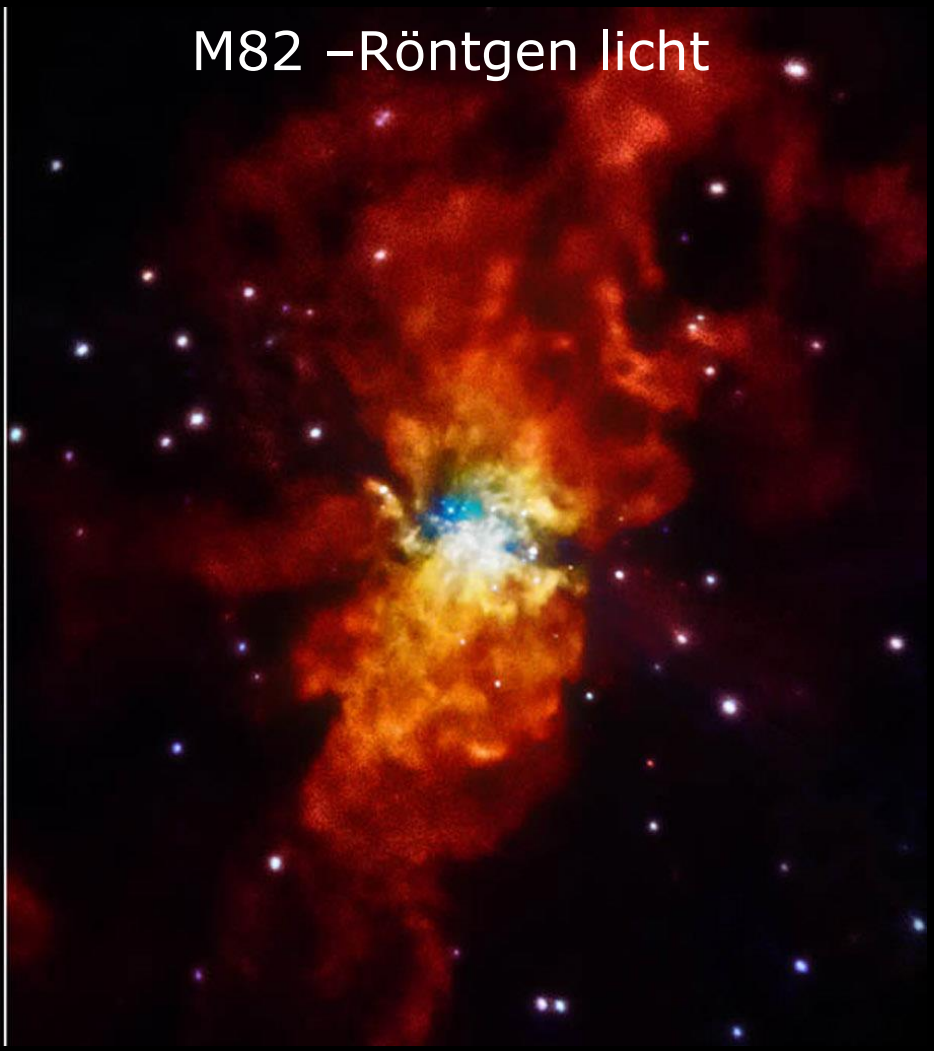
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Röntgen in de ruimte – VIS vs. Röntgen

M82 – Zichtbaar licht

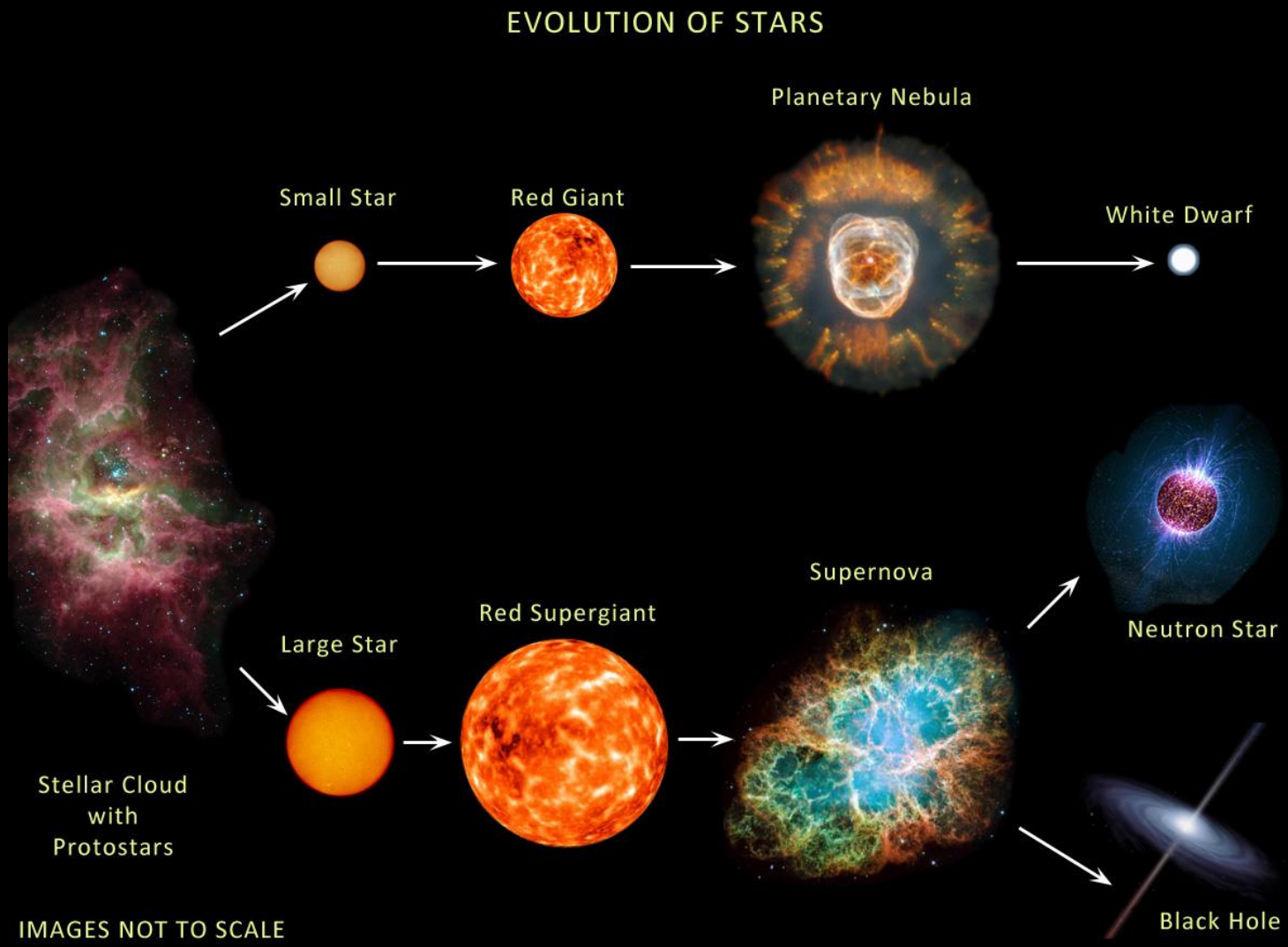


M82 –Röntgen licht



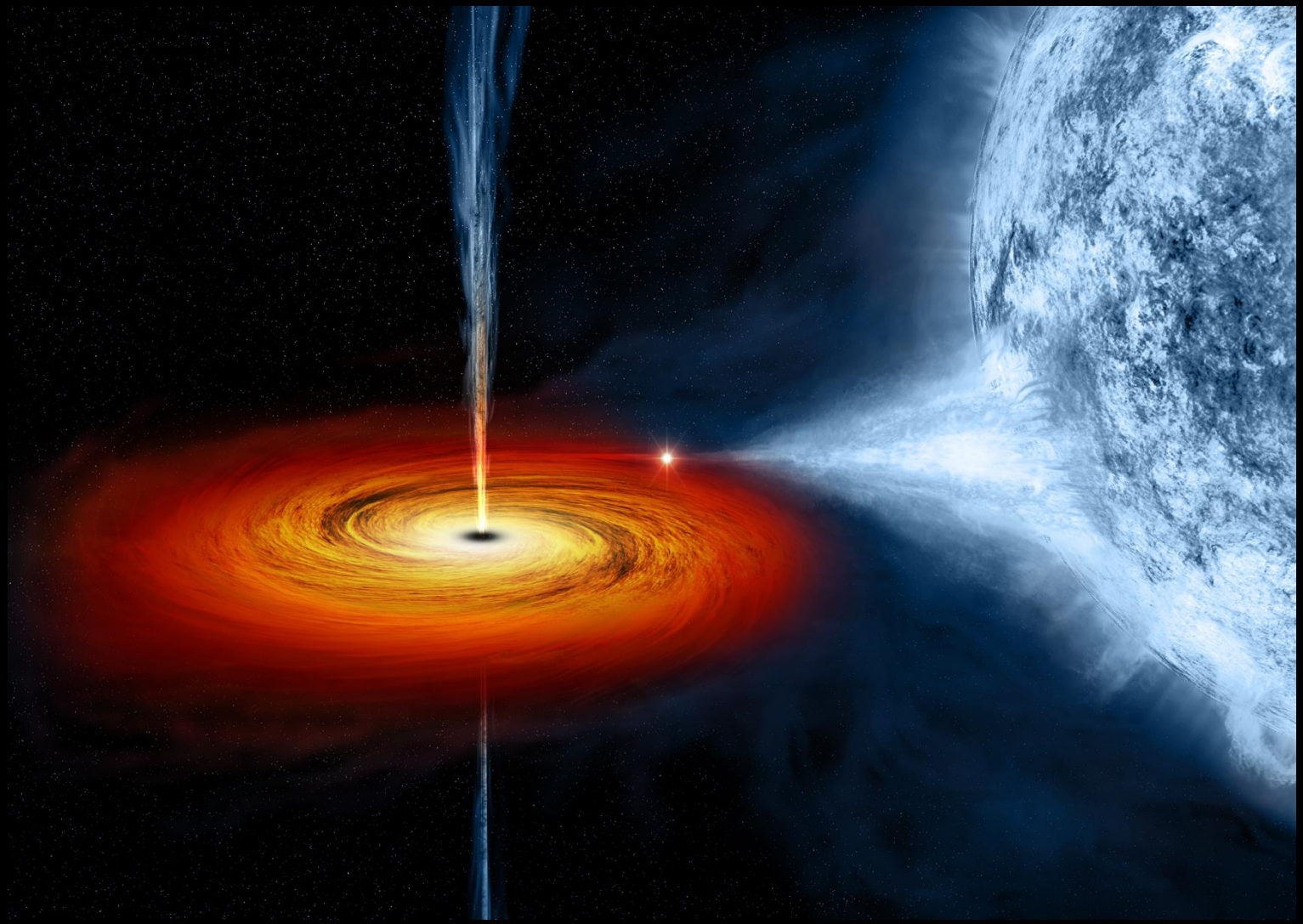
SRON

Röntgen in de ruimte – zwarte gaten



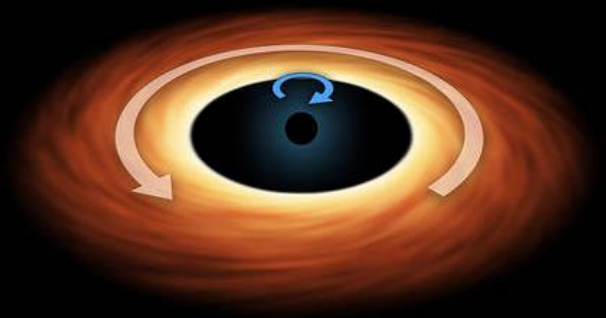
SRON

Röntgen in de ruimte – Binary ster

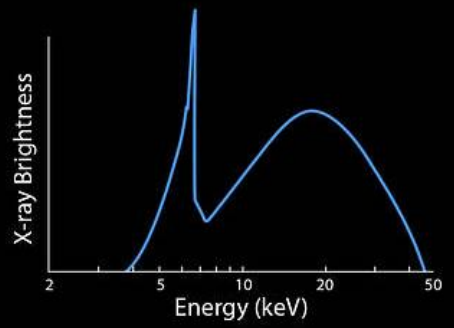


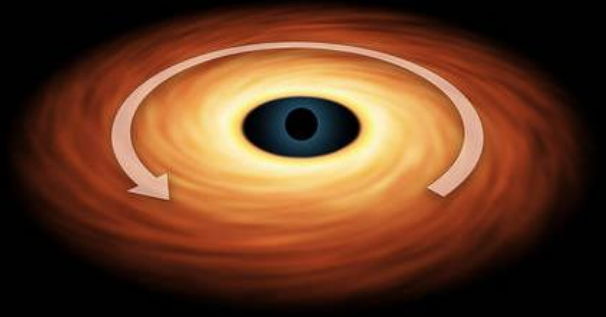
SRON

Röntgen in de ruimte - accretieschijf

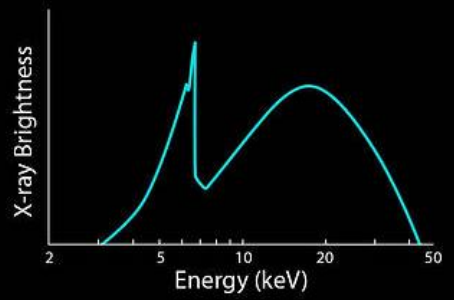


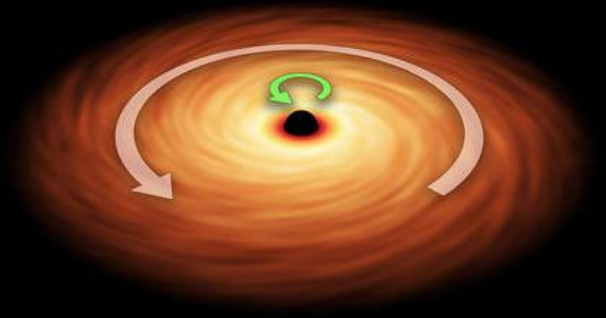
Retrograde Rotation



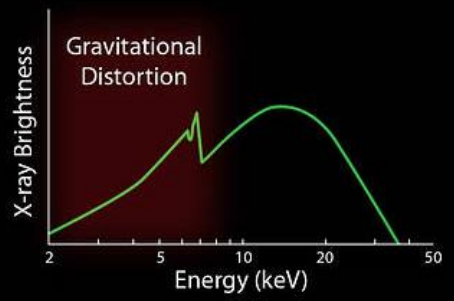


No Black Hole Rotation



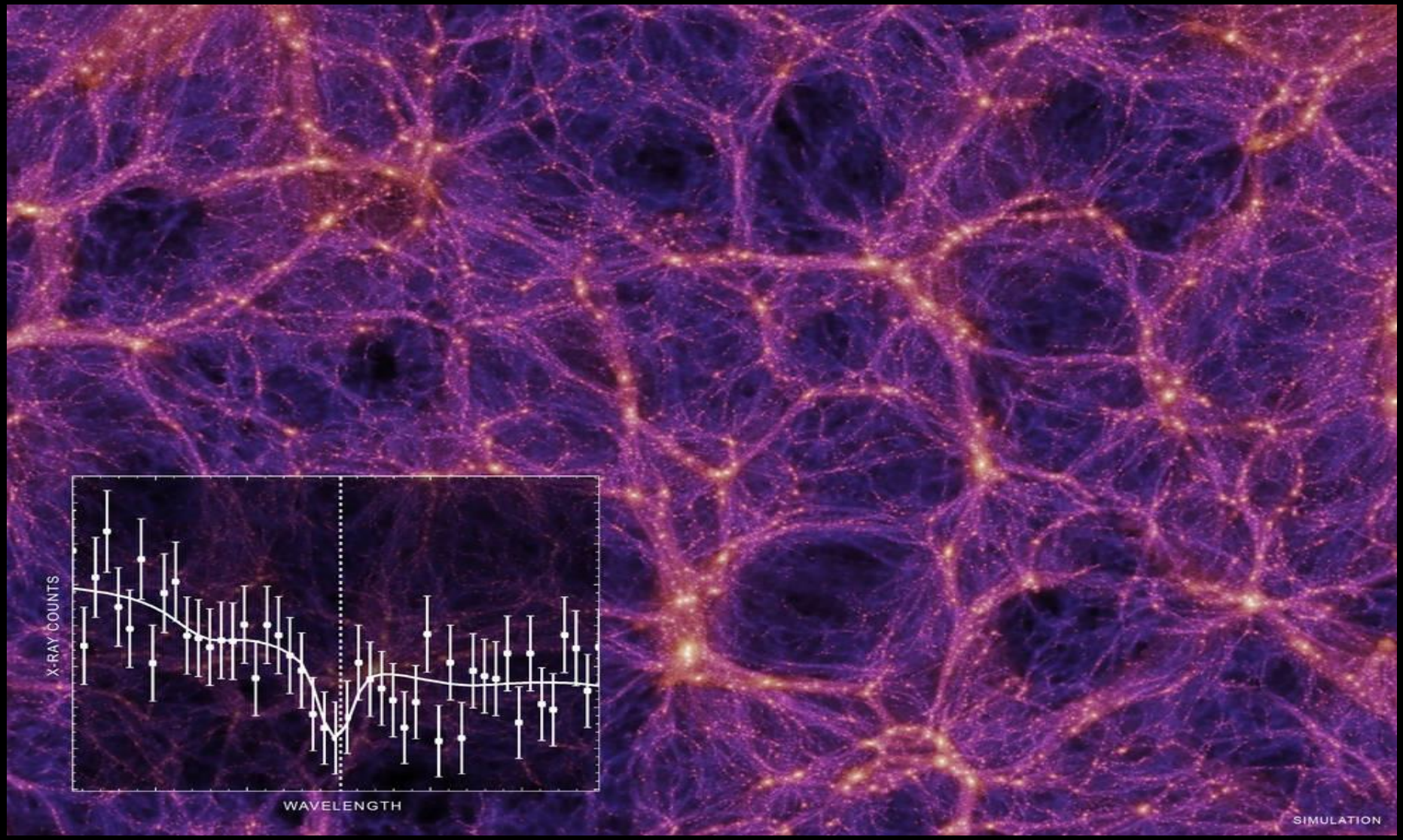


Prograde Rotation



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Röntgen in de ruimte – missende baryonen



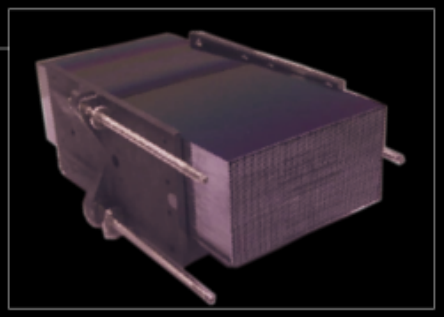
SRON

Athena

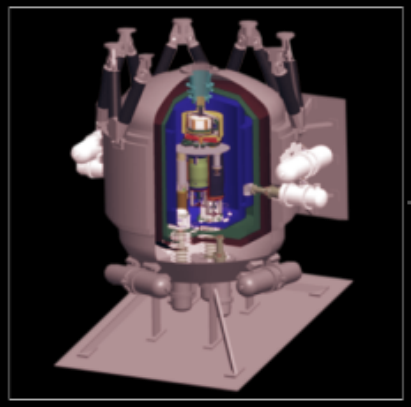
Advanced Telescope for High ENergy Astrophysics

Ariane VI class launcher
Satellite mass ~ 5500 kg
Power ~5600 W
Focal length: 12 m
Lifetime: 5 years (10 years)

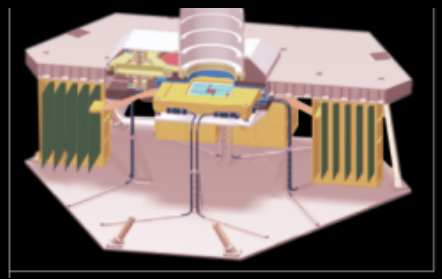




Silicon Pore Optics



X-ray Integral Field Unit

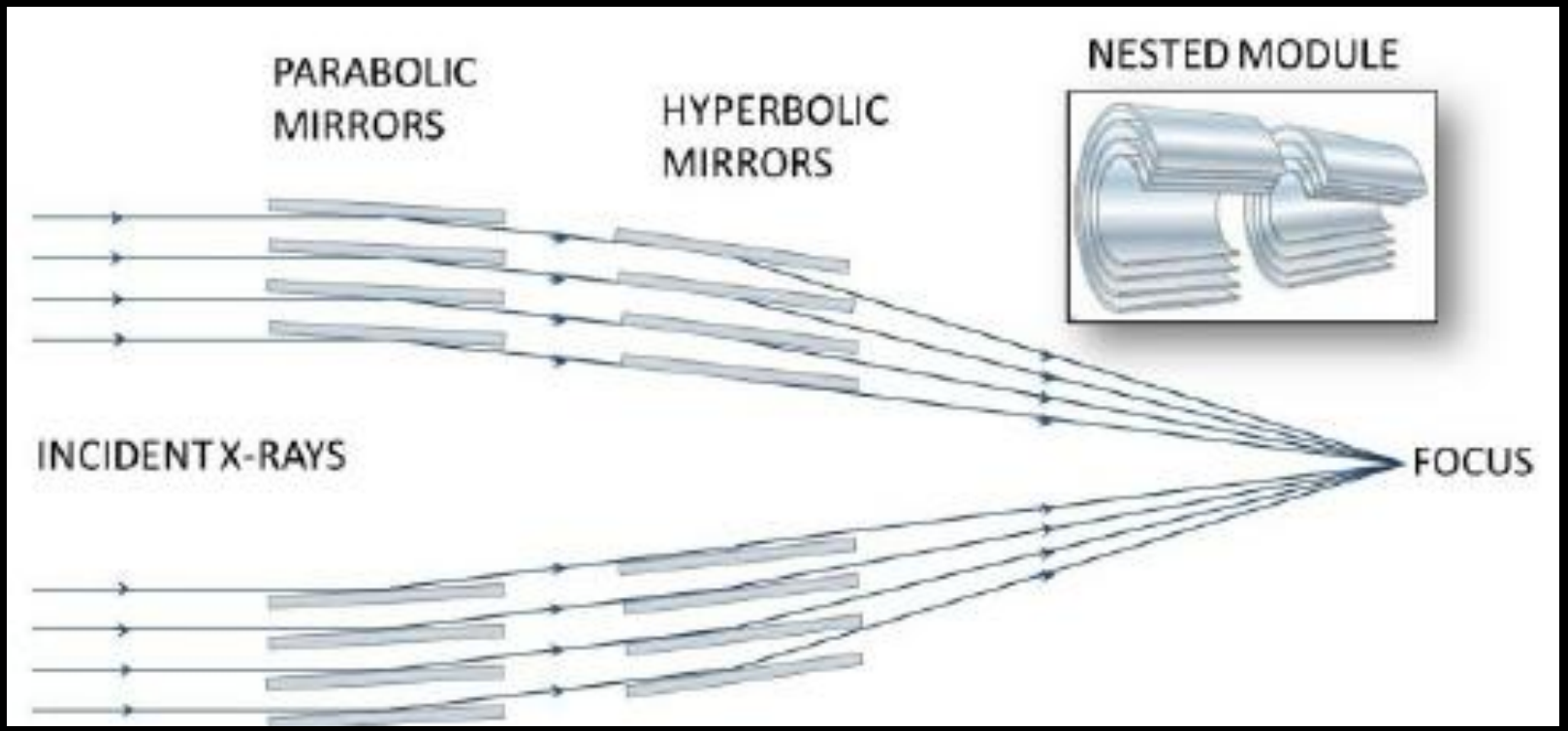


Wide Field Imager

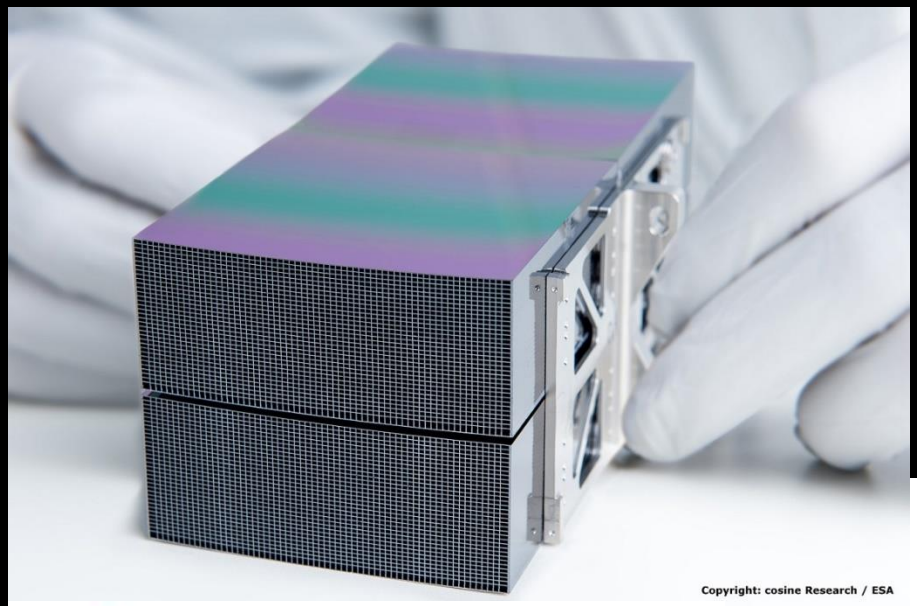
SRON

Athena - Telescoop

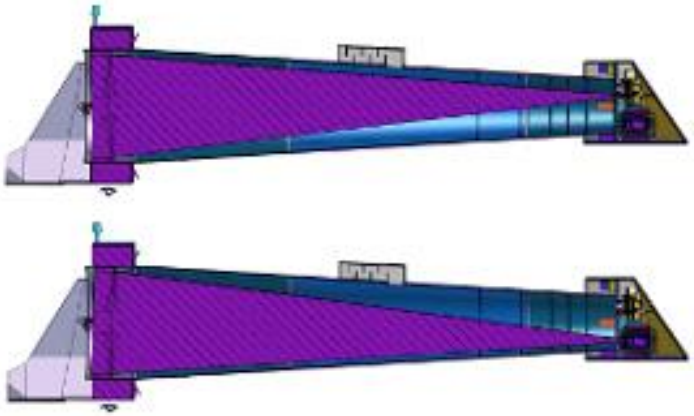
- Focus afstand 12 meter
- Kleinste details: 5 boogseconden
  5 boogseconden: euro munt op 950 m. afstand (KVI-SRON)



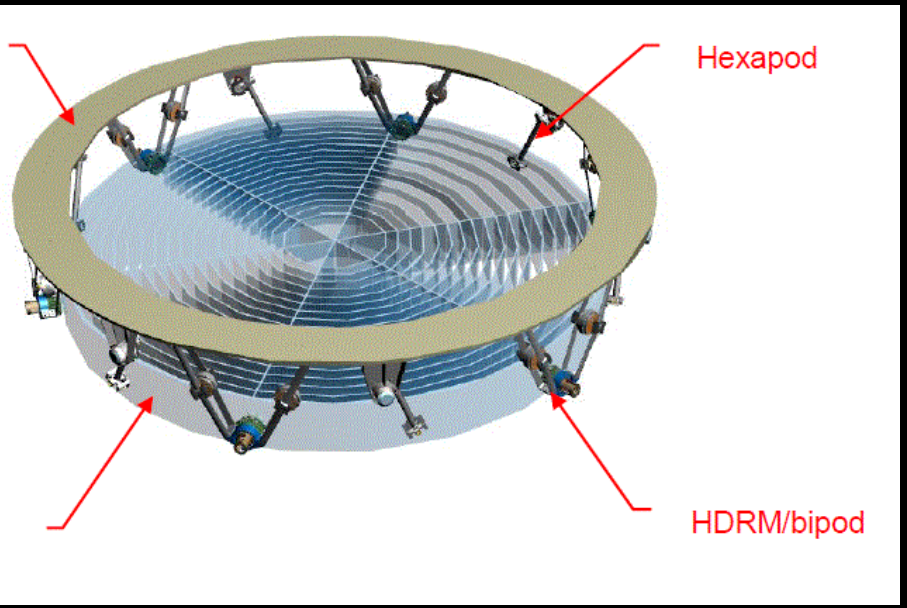
Athena - Telescoop



- Silicon Pore Optics (Cosine/Esa)
- ~800 modules
- 3 meter diameter
- Hexapod ophanging

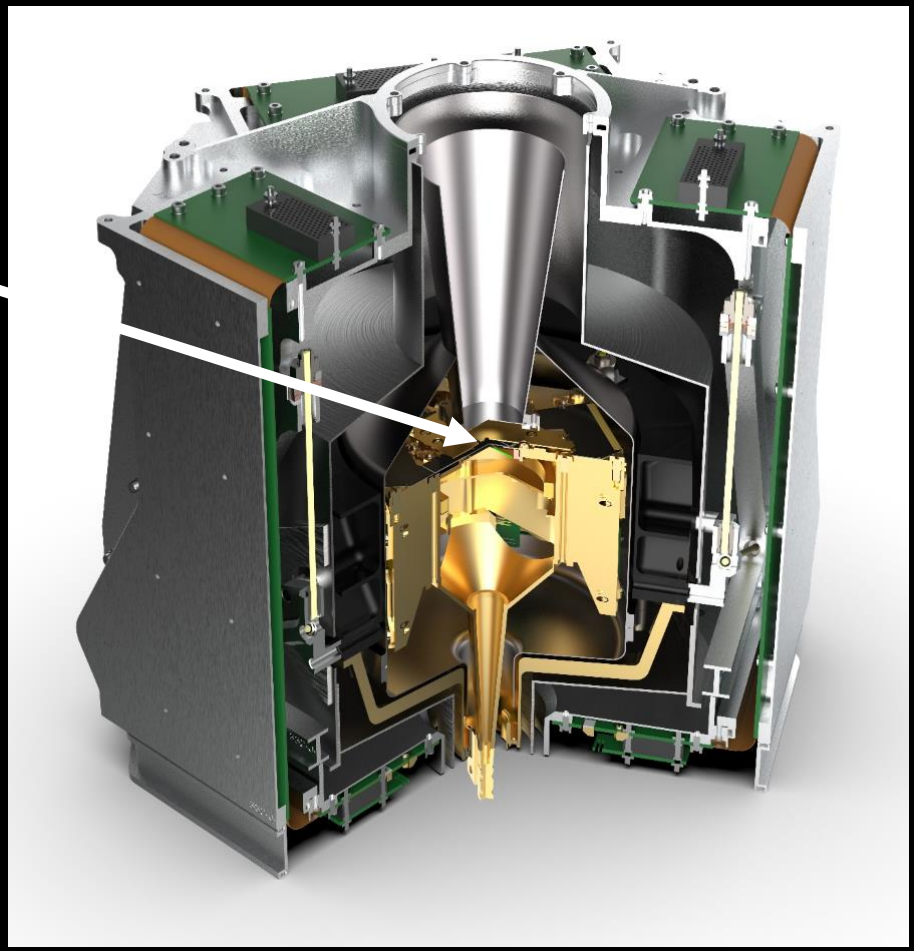


Mirror structure



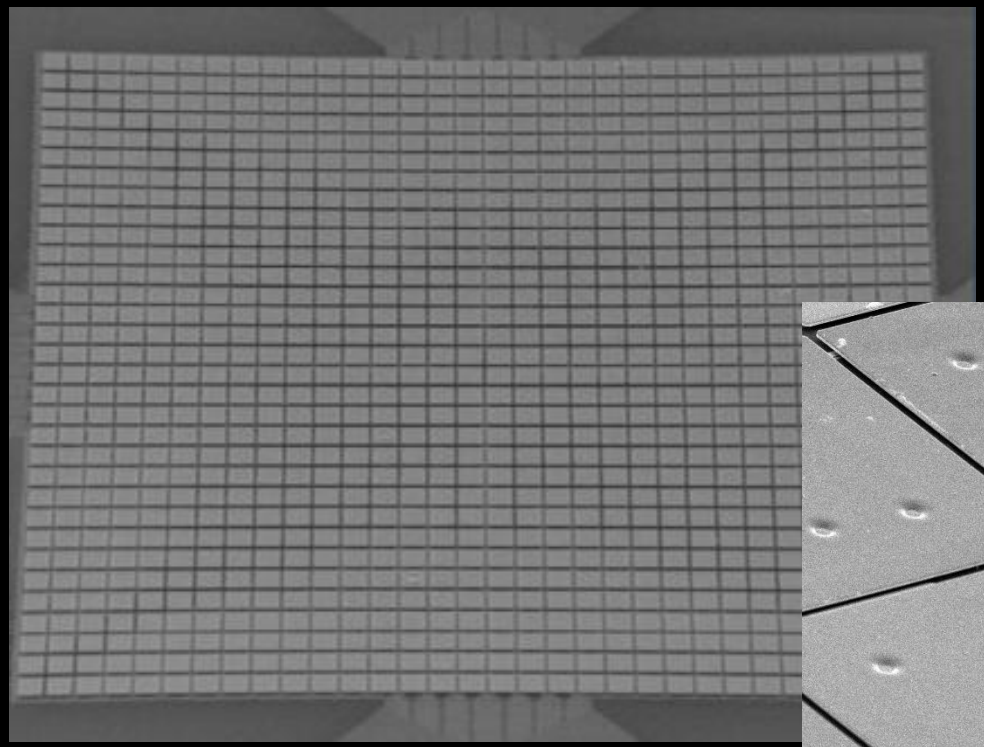
X-IFU – X-ray Integral Field Unit

- Kevlar ophanging
- Anti-magnetisch scherm
- ~50 mK binnenin
- Röntgen detector

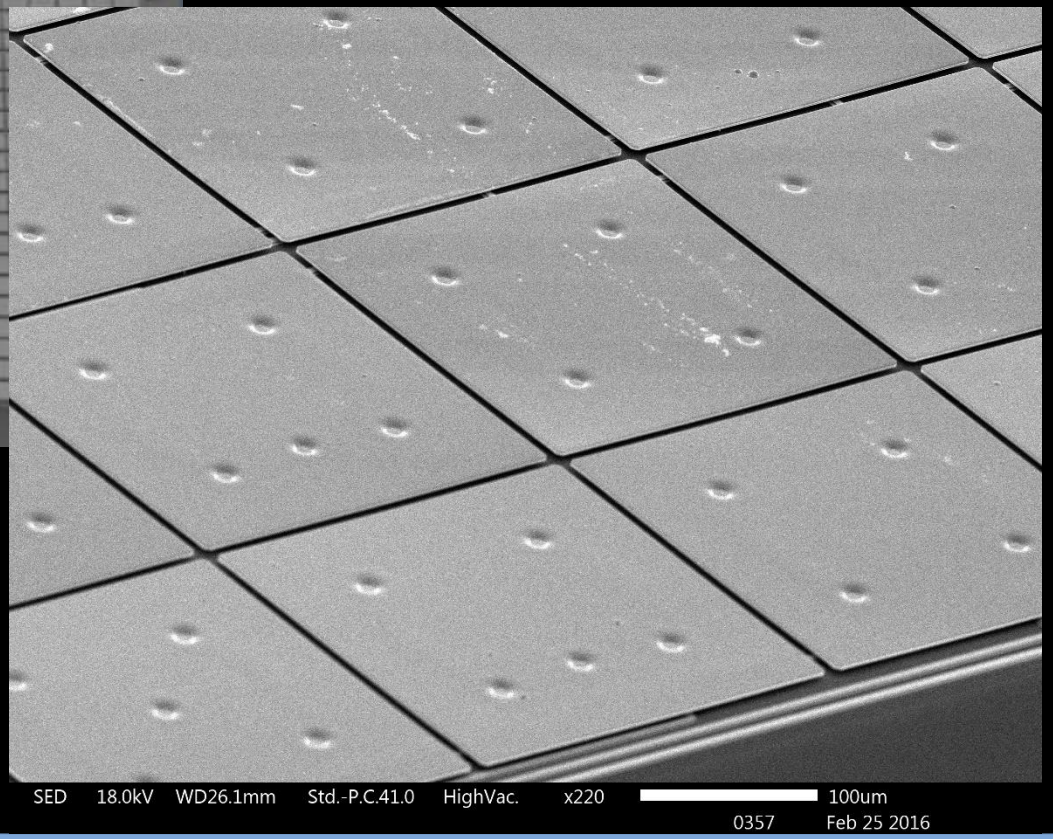


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X-IFU - Transistion Edge Sensor

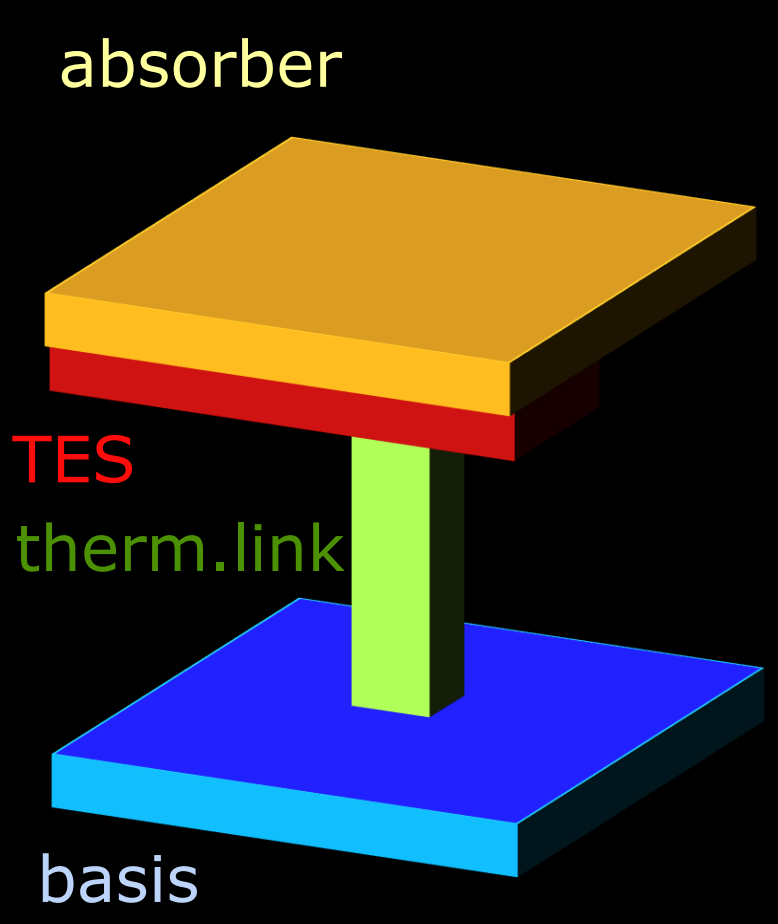


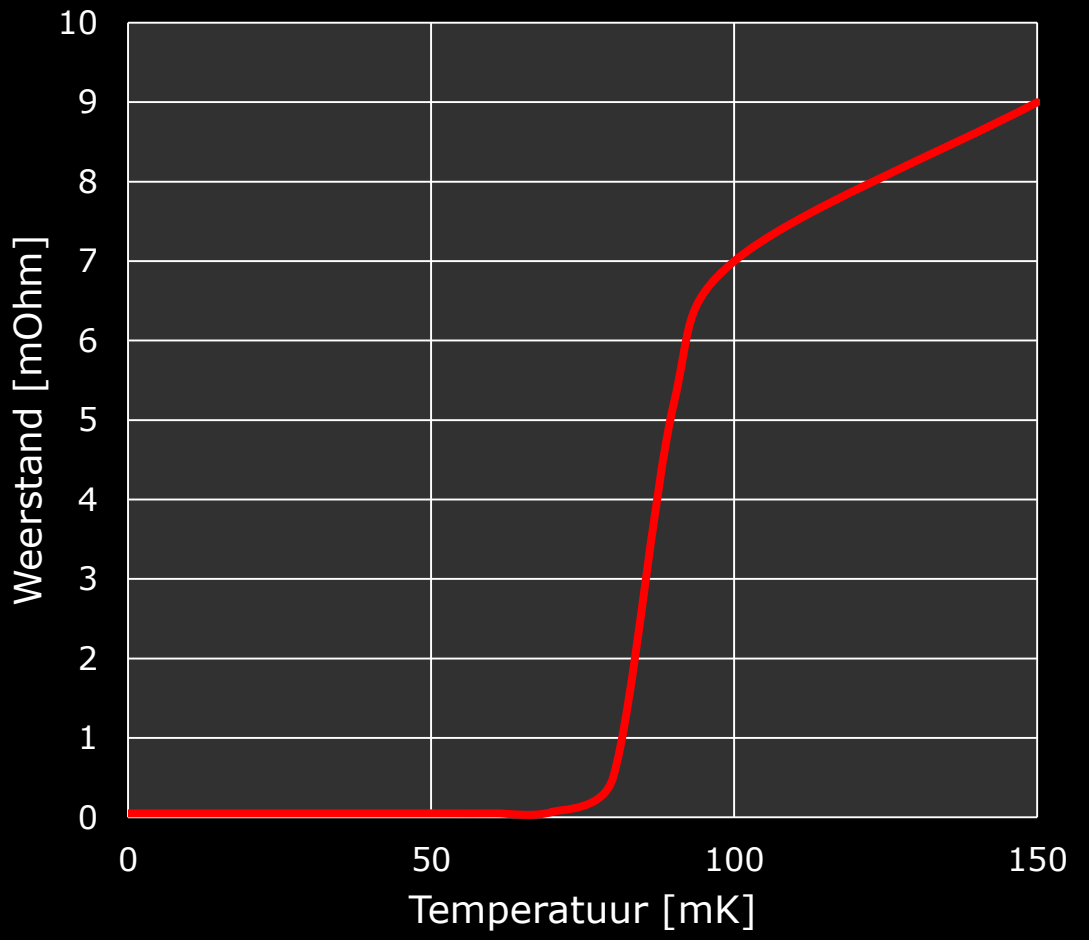
- 62 x 62 pixels
- 250 µm x 250 µm
- 0,2 keV – 12 keV
- 2,5 eV resolutie



SRON

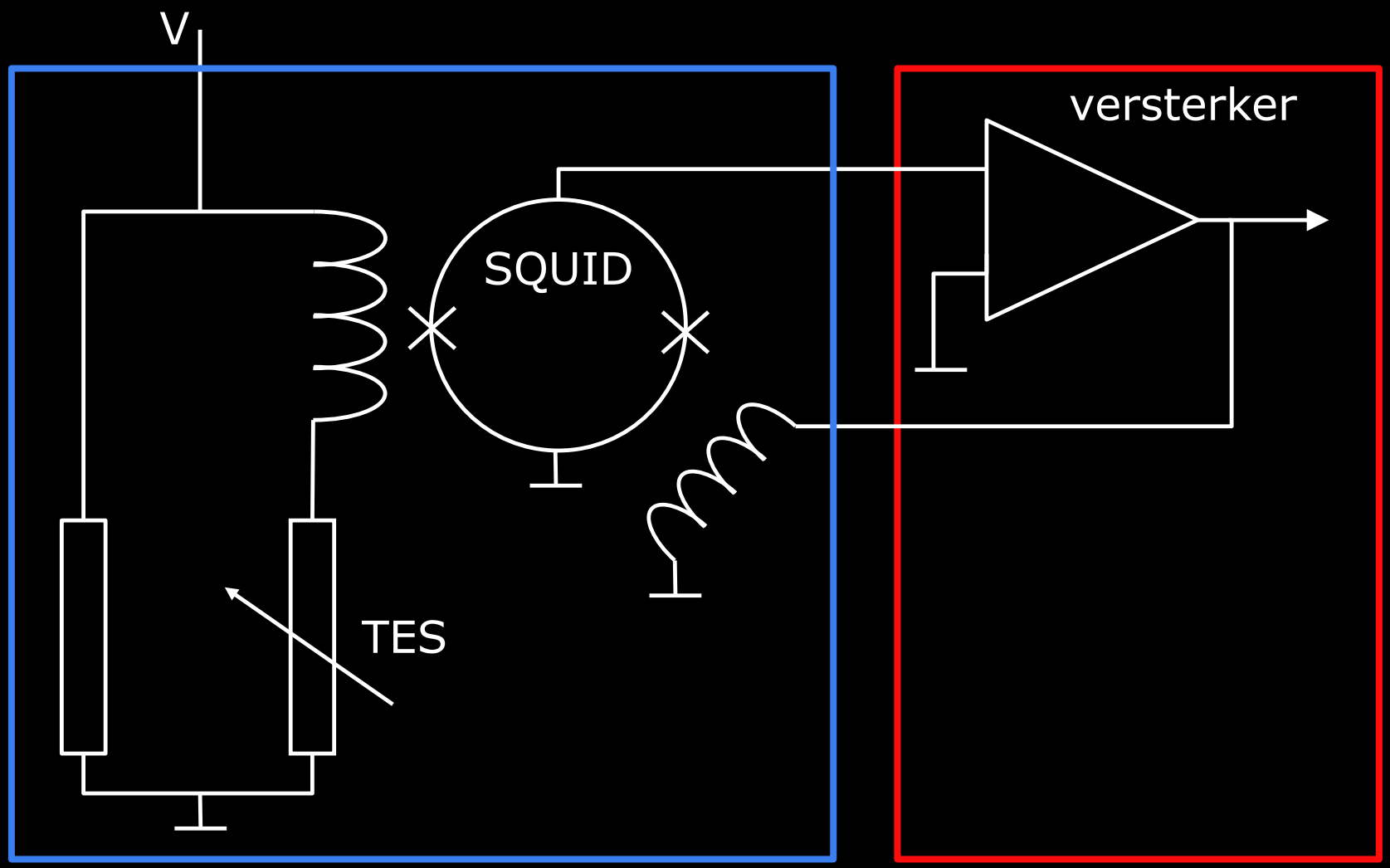
X-IF - Transistion Edge Sensor





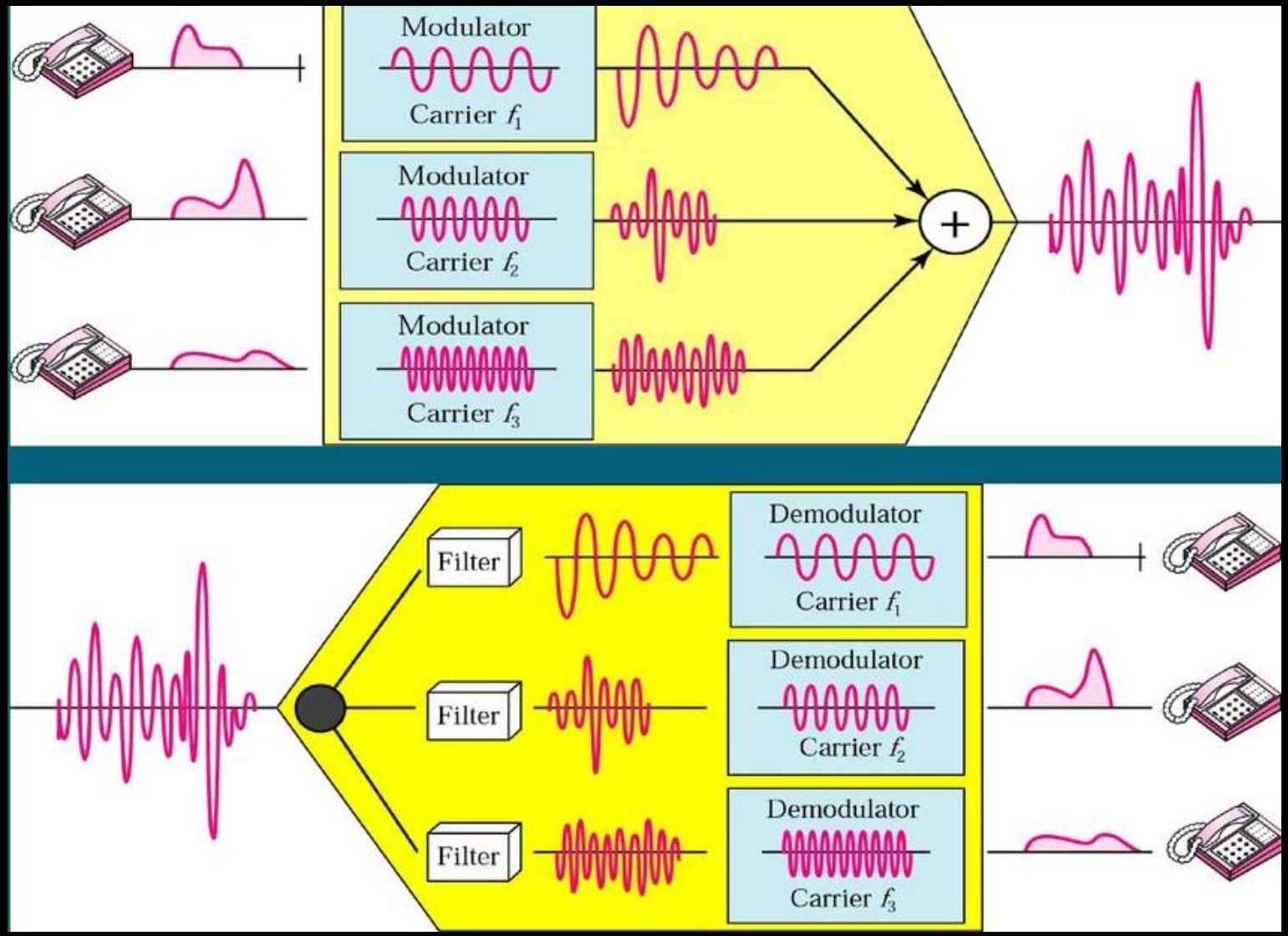
SRON

X-IFU - Transistion Edge Sensor + Squid



SRON

X-IFU - FDM


Modulator
Carrier f_1
Modulator
Carrier f_2
Modulator
Carrier f_3
+
Filter
Filter
Filter
Demodulator
Carrier f_1
Demodulator
Carrier f_2
Demodulator
Carrier f_3

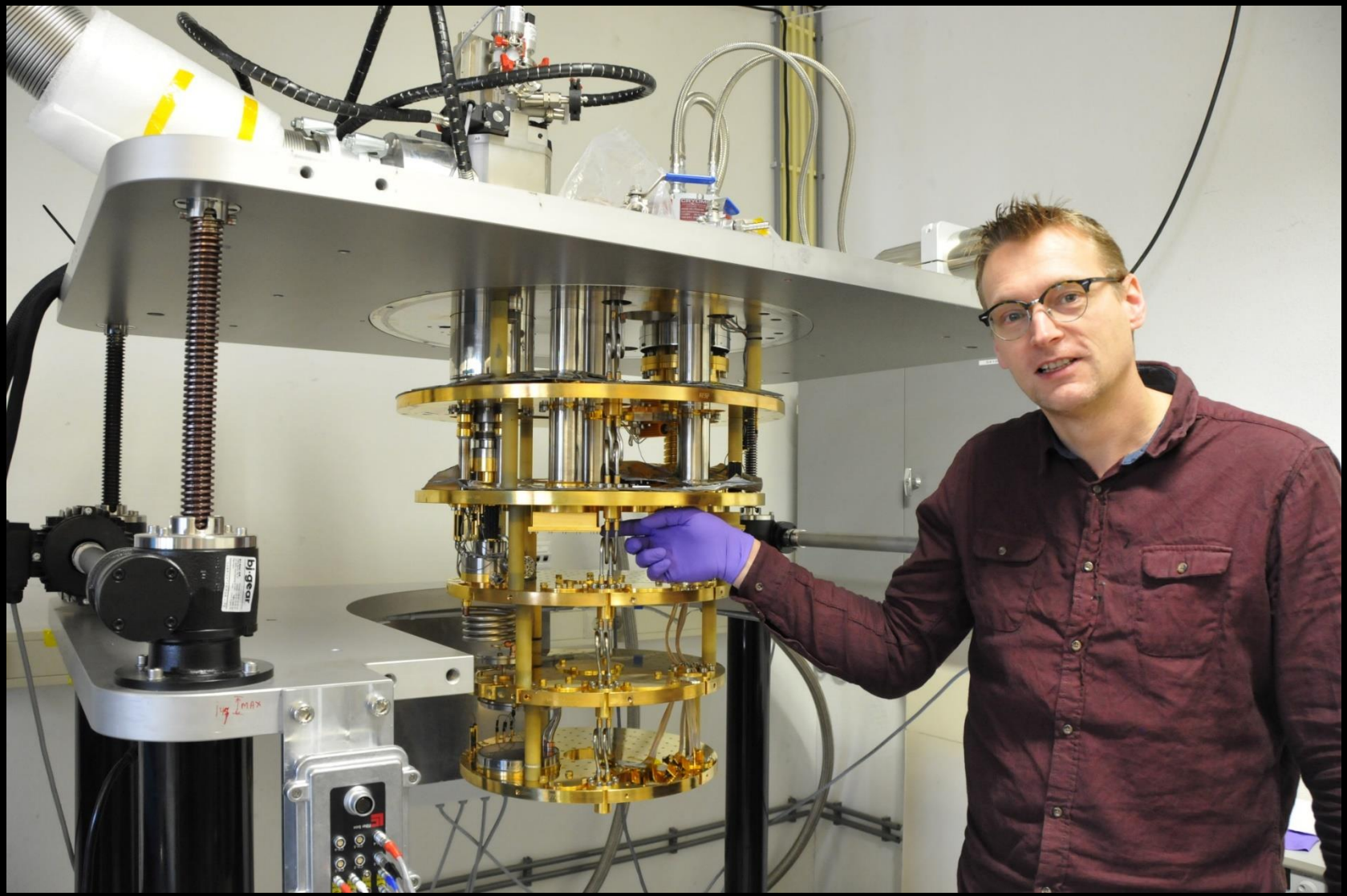
Calibratiebron - Fe-55





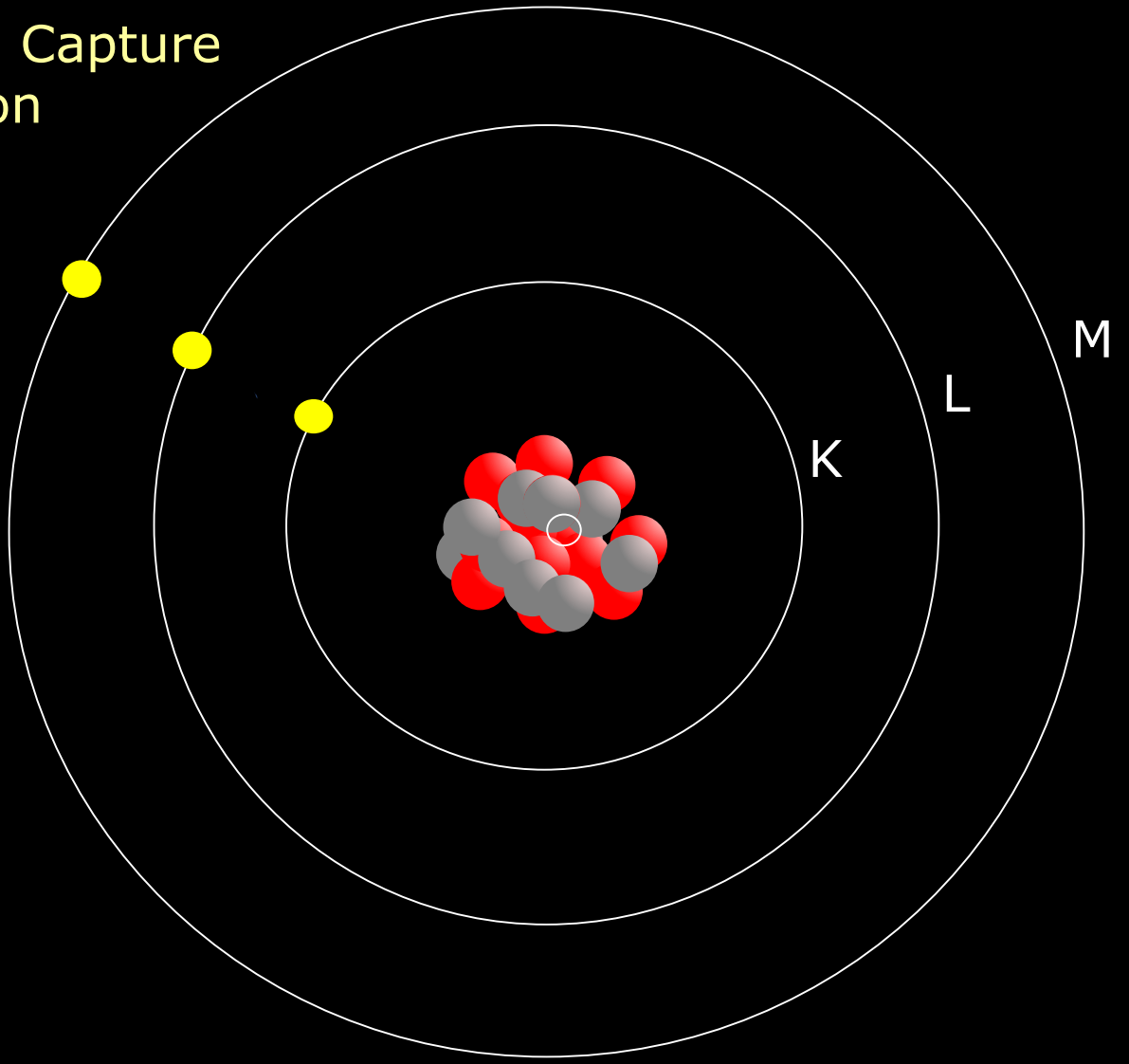


Calibratiebron Fe-55



Calibratiebron – Fe55

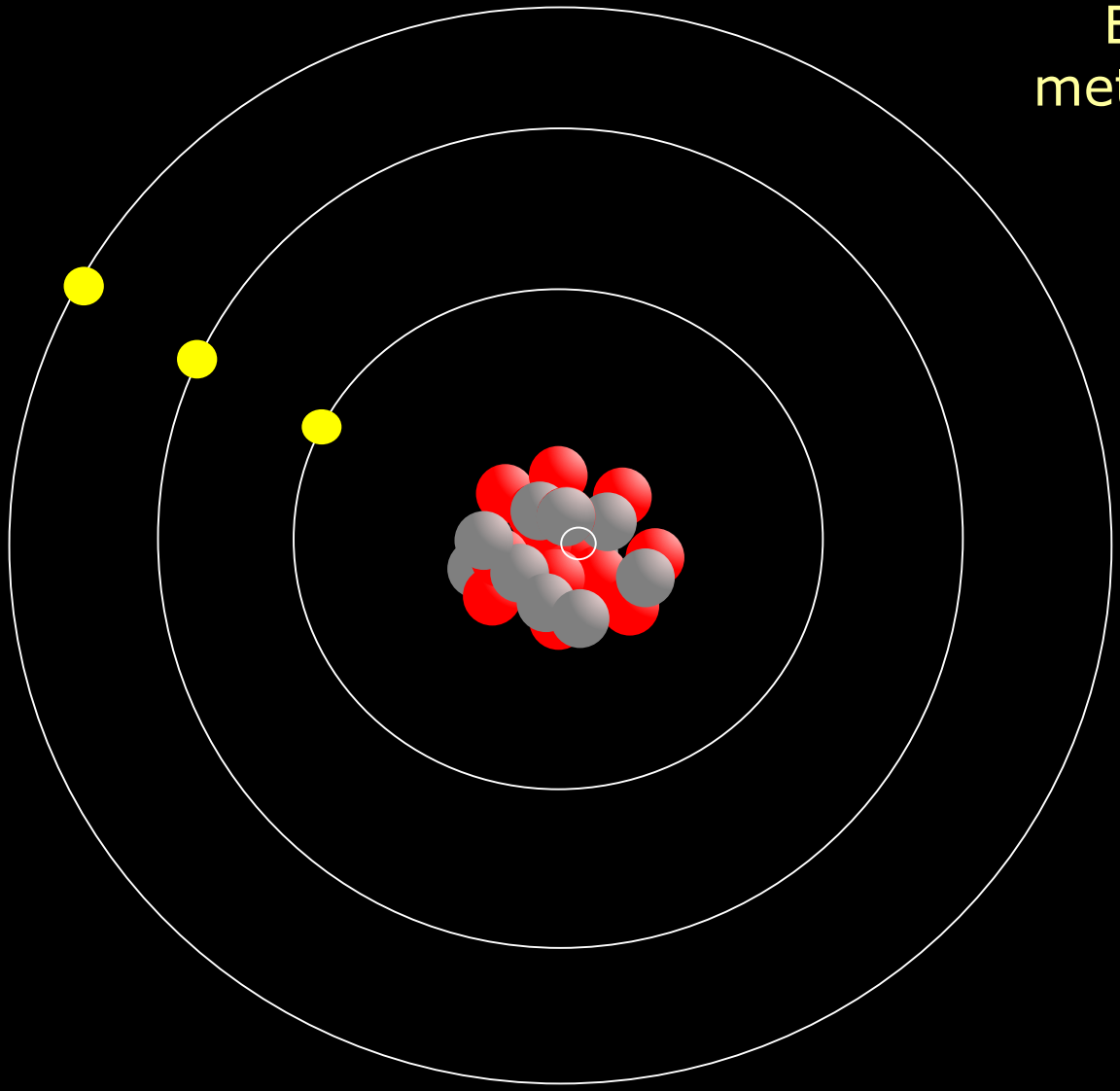
Electron Capture
met foton



en neutrino

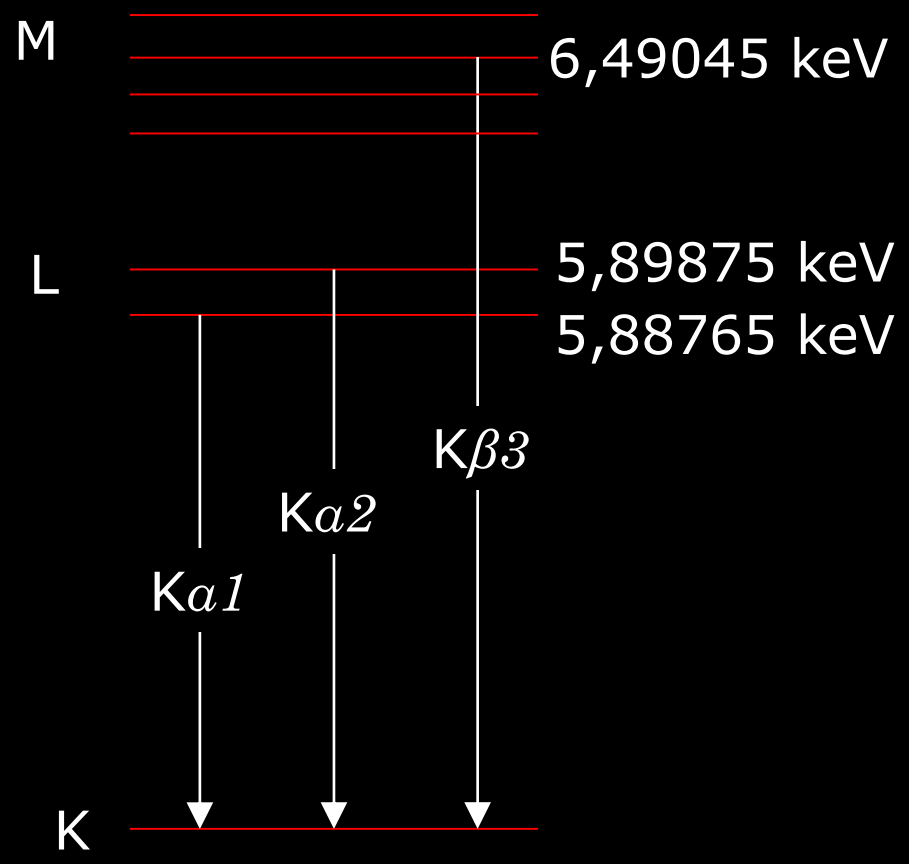
Calibratiebron – Fe55

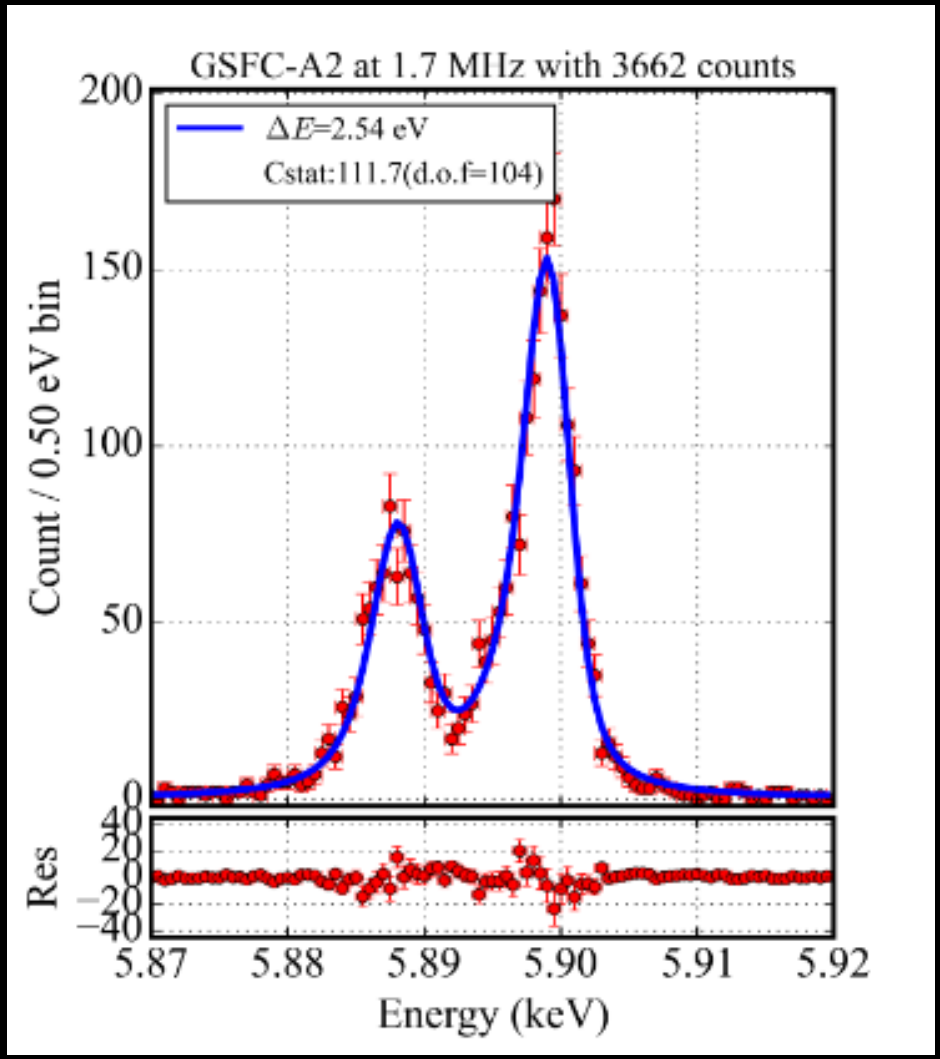
Electron Capture
met Auger-electron



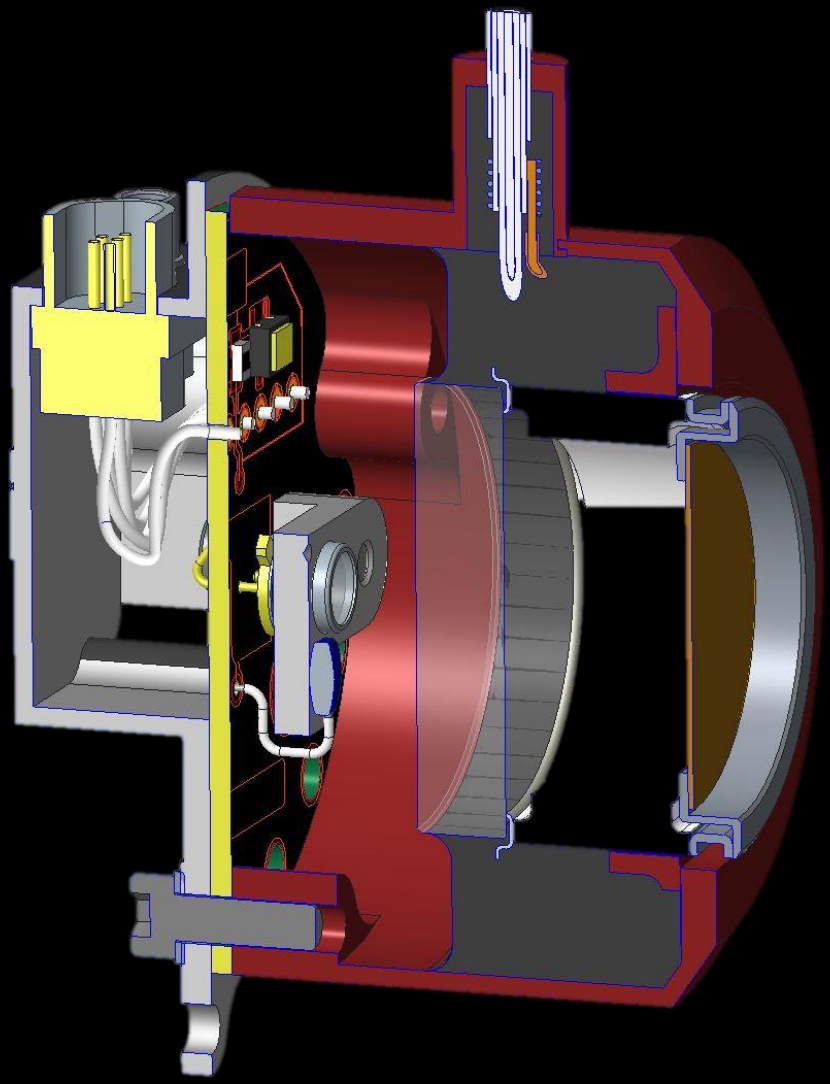
en neutrino

Calibratiebron – Fe55





Calibratiebron - MXS

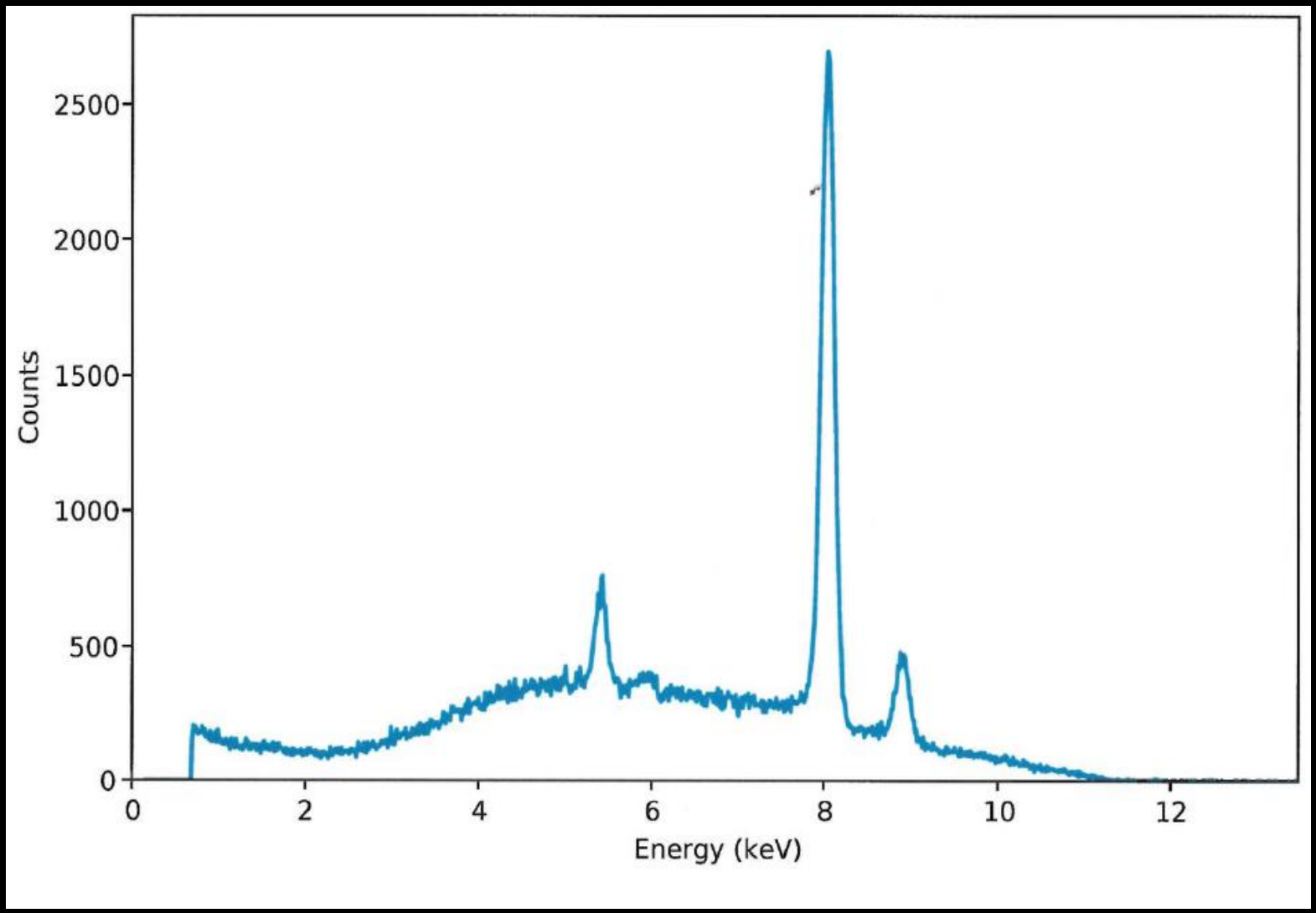


- Modulated X-ray Source
- LED blauw licht/UV
- Kathodede: vrije elektronen
- 15 kV versnelspanning
- Targets: bv. Cu, Cr
- Beryllium vacuum window/anode
- I_{max} = 50μA



- Diameter window

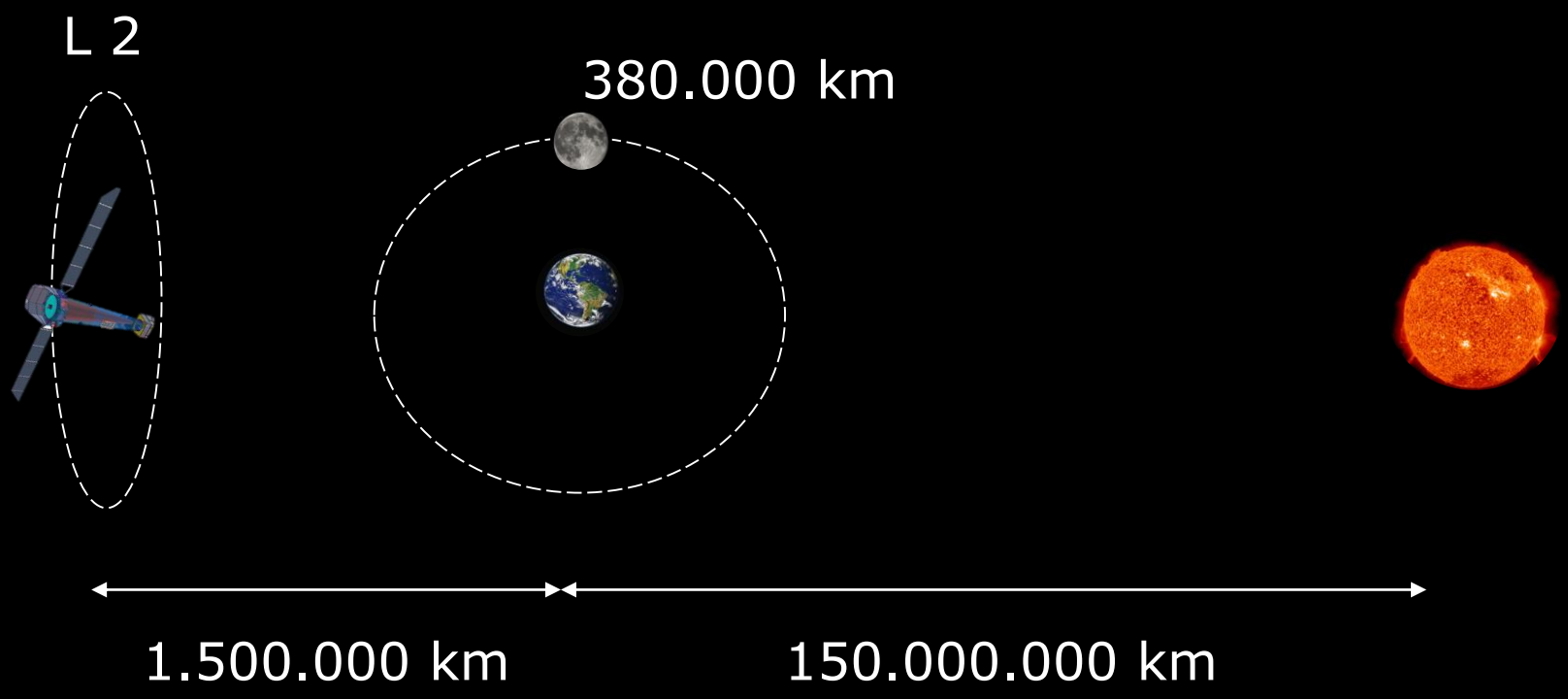
Calibratie bron - MXS



SRON

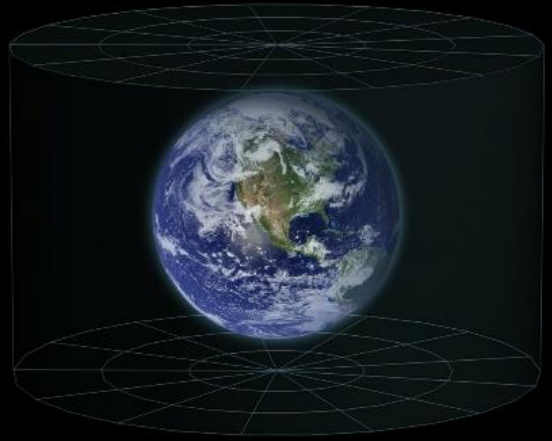
Vragen

Bonus

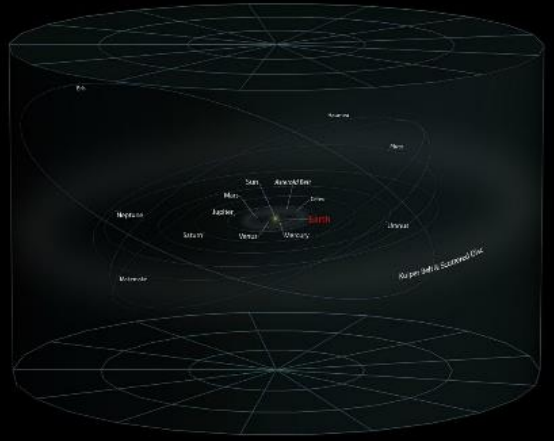


Bonus

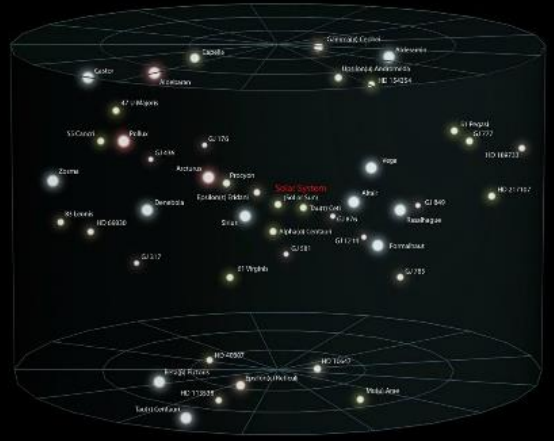
Earth



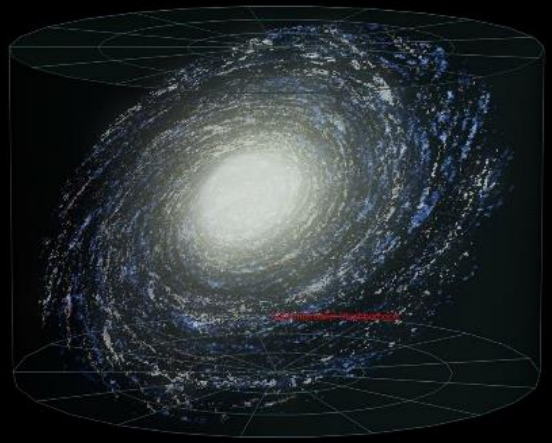
Solar System



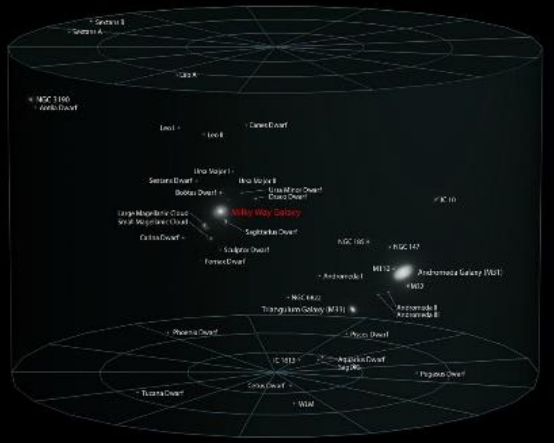
Solar Interstellar Neighborhood



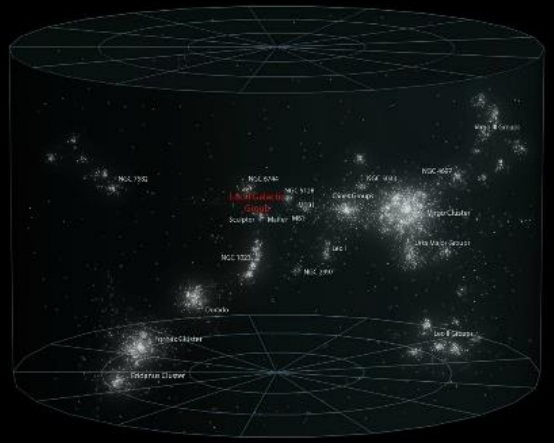
Milky Way Galaxy



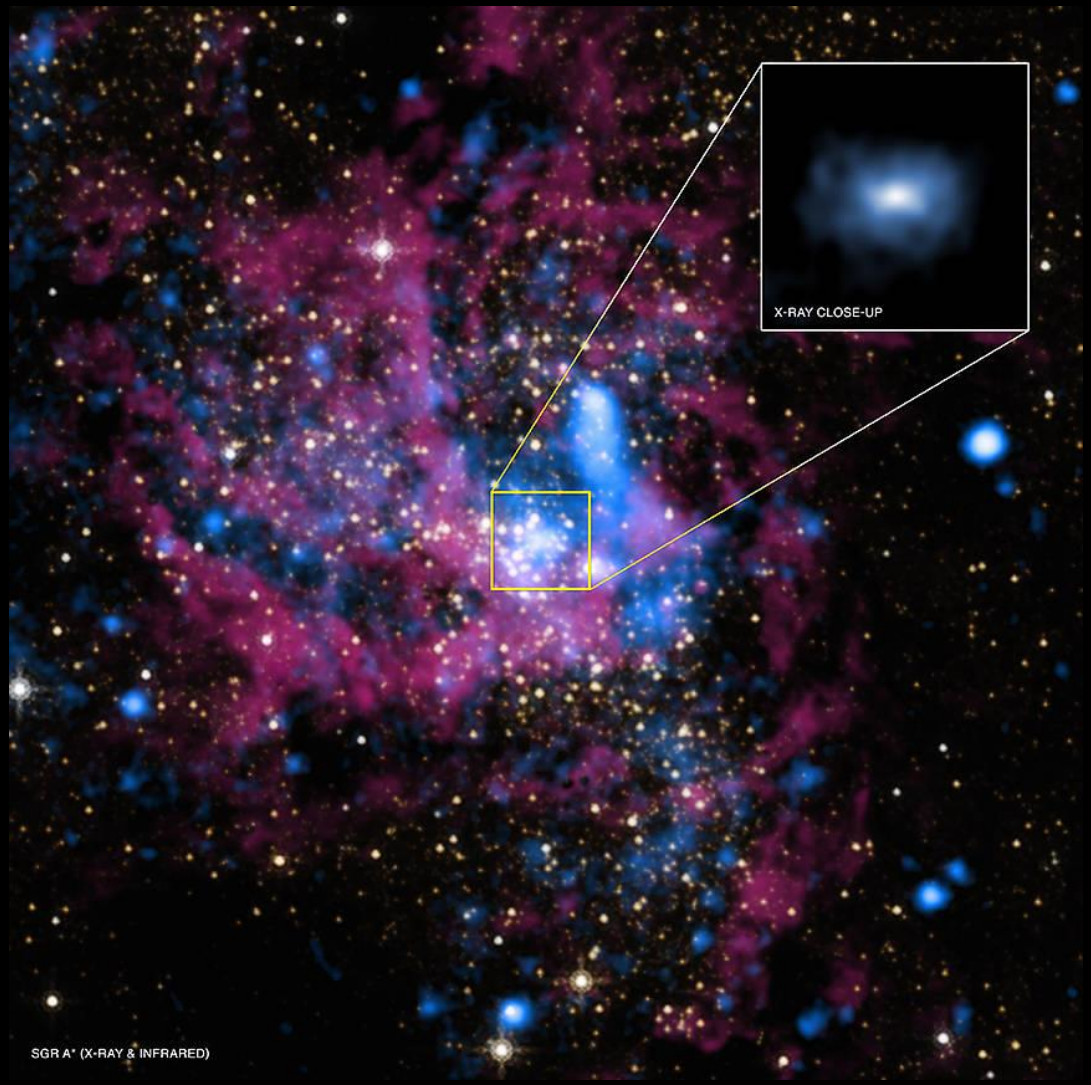
Local Galactic Group



Virgo Supercluster

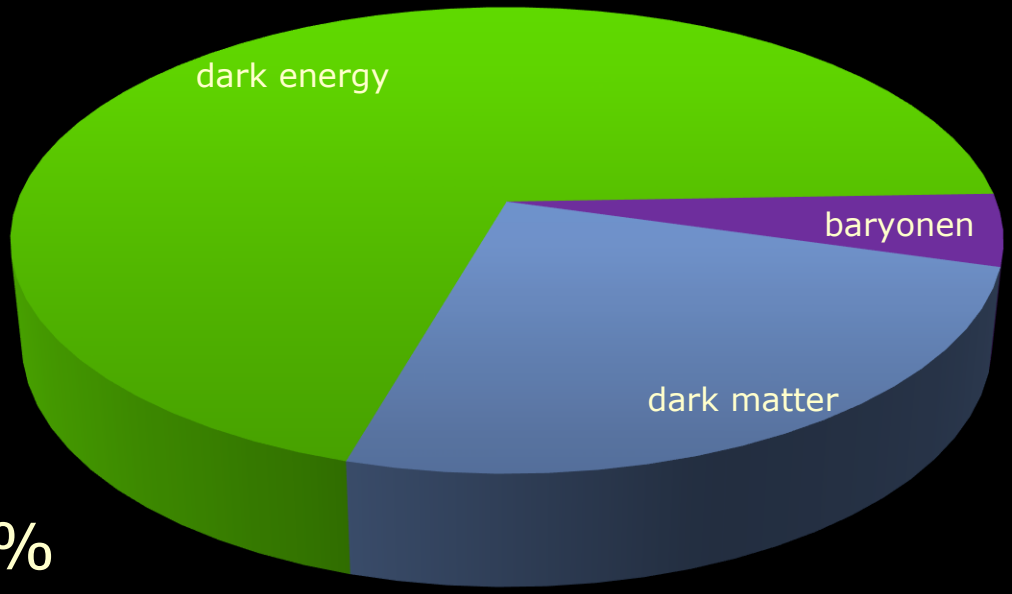


Röntgen in de ruimte - Saggitarius A*



SRON

Röntgen in de ruimte – missende baryonen



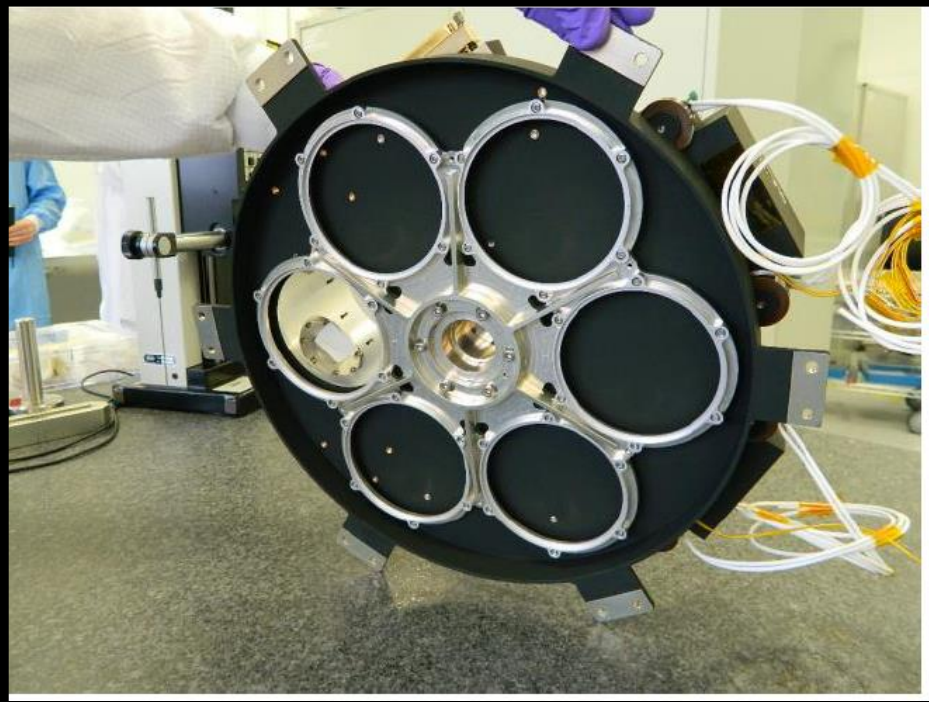
Missende materie

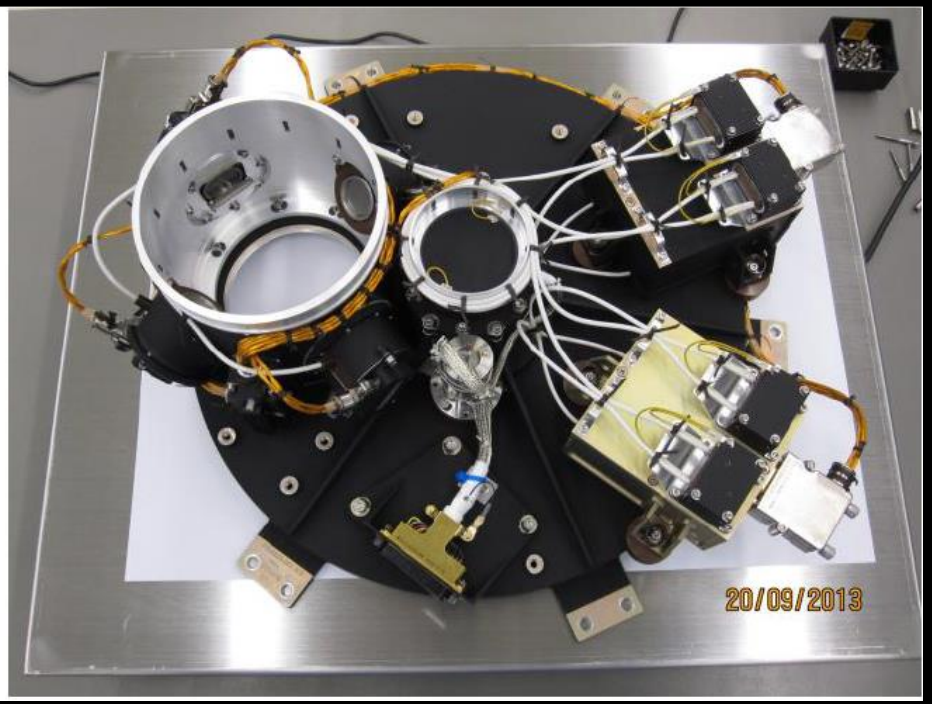
- Donkere energie – 69%
- Donkere materie – 26%
- Baryonen (gewone materie) – 5%
  - waarvan <10% in sterren en planeten
  - >90% was lang niet te vinden

SRON

Bonus

- Anti-coïncidence detector
- Filterwiel: Fe-55, MXS, ND-filter
- Koelers: Pulse tube, Joule-Tompson, ADR, 3-He sorb pomp

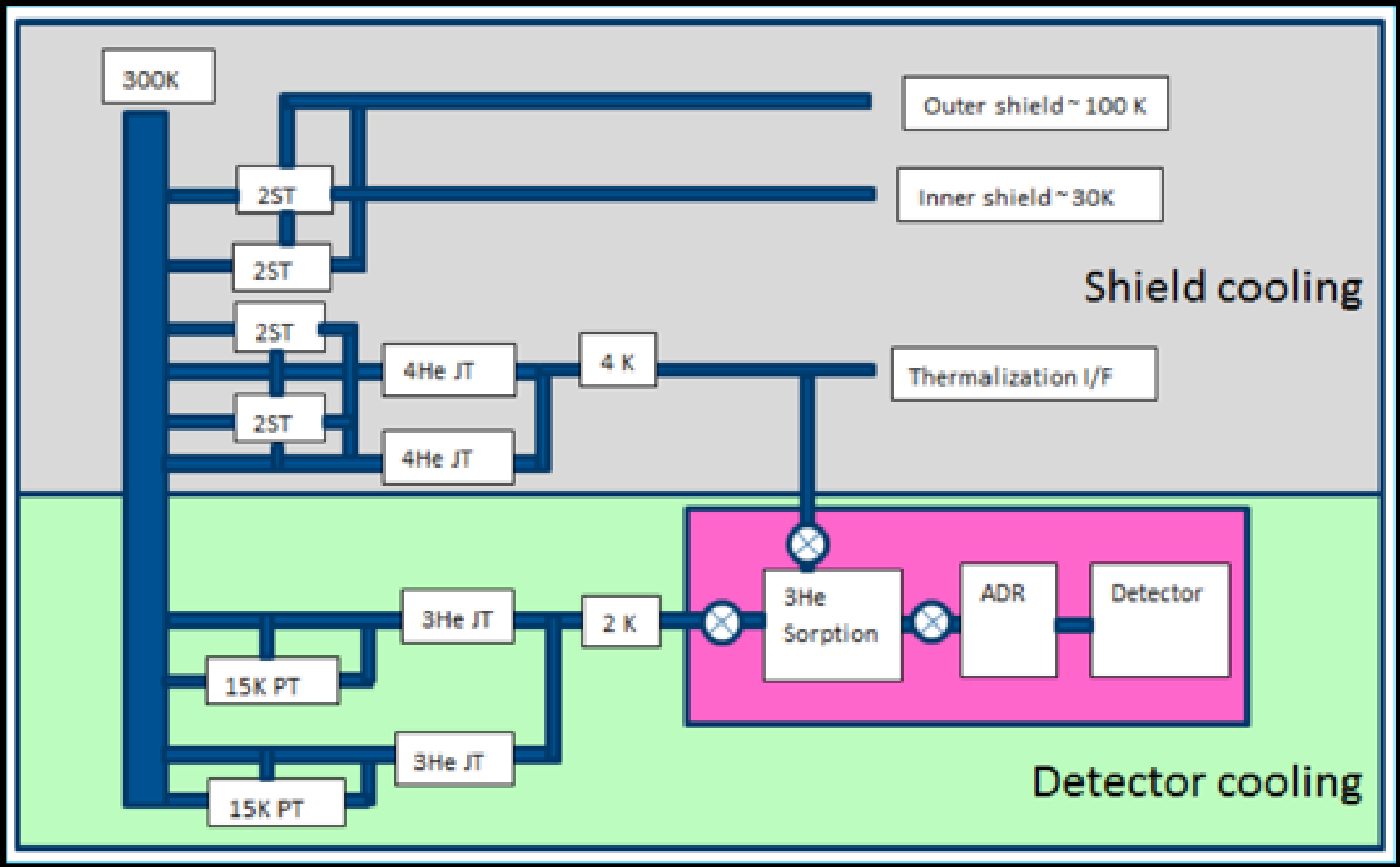




Bonus

- Anti-coïncidence detector
- Filterwiel: Fe-55, MXS, ND-filter
- Koelers: Pulse tube, Joule-Tompson, ADR, 3-He sorb pomp

Bonus informatie



Bonus informatie

