APQ JENA

Fluorite Polychromats

Concept

The focus of our development and manufacturing program is on completely new Universal Fluorite Polychromats and Wide Field Fluorite Polychromats, which are significantly superior to conventional apochromats

The production takes place in Jena Made in Germany. The small series character also allows for individual and special production as well as the consideration of individual customer wishes.

Innovation

The main feature of both optical designs is the polychromatic correction with a diffraction-limited imaging quality over a spectral range from 365nm (UV) to 1014nm (IR), which will benefit both visual observers and especially astrophotographers.

In the peripheral regions of the visual spectrum there is no decrease of the Strehl ratio near or below the diffraction limit as is the case with most apochromats.

Universal Fluorite Polychromats

A Fluorite Quadruplet Polychromat from APQ JENA is the first astronomical objective to be able to use the full UBVRI spectral range (365nm – 1014nm) of modern electronic sensors (CCD, CMOS).

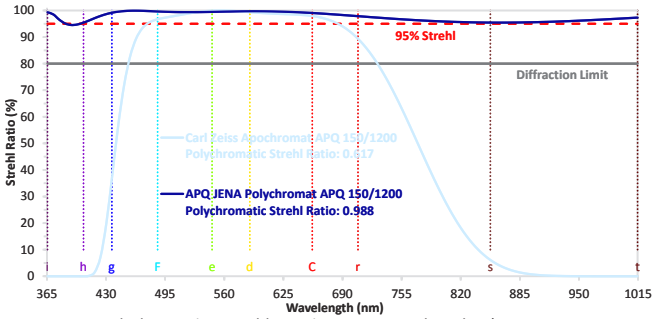
A Polychromat in the basic design is a four lens (quadruplet) objective, of which three lenses consist of special optical glasses and one lens of syntetically grown fluorite (CaF_2).

We source the high-quality fluorite blanks with special parameters in selected quality from a certified manufacturer, which also supplies the global players of precision optical equipment with CaF_2 raw material for the production of stepper lenses for VUV photolithography.

Series from 100mm to 300mm aperture

In the aperture range from 100mm to 300mm we will offer a series of Fluorite Quadruplet Polychromat Refractors – with or without aspheres, completely oil spaced, with or without air gaps – with the respective special focal lens systems (Polychromatic Strehl ratio ≥ 0.95):

- 100/640 f/6.4 (f/4.5)*
- 130/1000 f/7.7 (f/5.4)*
- 150/1200 f/8 (f/5.6)*
- 180/1500 f/8.3 (f/5.8)*
- 200/1700 f/8.5 (f/6)*
- 250/2200 f/8.8 (f/6.2)*
- 300/2700 f/9 (f/6.3)*



Comparing Polychromatic Strehl Ratio vs. Wavelength (365nm – 1014nm): Carl Zeiss Apochromat APQ 150/1200 vs. APQ JENA Polychromat APQ 150/1200

* Focal ratio with 0.7x Reducer

Polychromat 150/1200

In the wavelength range from 365nm to 1014nm, the completely oil spaced Fluorite Quadruplet Polychromat 150/1200 with an asphere has a polychromatic Strehl ratio of ≥ 0.95 and a maximum focal shift range of approx. 60µm or ±0.0025%.

Universal Planetary Refractor System

The Fluorite Quadruplet Polychromat 150/1200 is a universal planetary refractor, a system of the highest possible image quality, in which the basic system represents the polychromatic objective.

Depending on the task of observation, the basic system is combined with a Flat Field Corrector (Flattener), Focal Reducer Corrector (Reducer) or Barlow System (Barlow Lens).

The diffraction-limited correction is maintained in the spectral range from 365nm to 1014nm, so that the UBVRI spectral range of modern CCD and CMOS sensors can be fully utilized.

All glass-to-air-surfaces receive the newly developed ultra broad band AR coating, characterized by an extremely low residual reflectivity R_{AVG} of < 0.7% over the entire spectral range from 365nm (UV) to 1014nm (IR).

With the newly developed Focal Reducer Corrector and Field Corrector with lenses made of CaF_2, vignette-free images are also possible in combination with current CMOS sensors.

Fluorite Flat-Field Corrector

Together with the three lens flattener with a CaF_2 lens, the Polychromat 150/1200 realizes a polychromatic system with diffraction-limited imaging, characterized by a very large image field diameter of approximately 73.6mm or 3,5° and a back focus of 100mm.

According to the optical design, the polychromatic Strehl ratio

Middle: APQ 150/1200 Fluorite Quadruplet Polychromat (with special equipment)

APQ 150/1200 Fluorite Quadruplet Polychromat (Compensation cell)

is ≥ 0.95 and the maximum focal shift range is approx. 68µm or ±0.003%. The focal ratio of the basic system remains unchanged at f/8, the focal length is 1200mm.

0.7x Fluorite Focal Reducer Corrector

The 0.7x Reducer is the most sophisticated focal lens system in current portfolio planning. The Reducer consists of three oil spaced lens groups with a total of six lenses, two of which are made of CaF_2.

The Focal Reducer Corrector increases the focal ratio of the Polychromat 150/1200 by a factor of 0.7, so that the effective focal length is 840 mm and the focal ratio f/5.6. The image field diameter of the polychromatic system with diffraction-limited imaging is approximately 52.3mm or 3,5°, the back focus is 100mm.

According to the optical design, the polychromatic Strehl ratio is ≥ 0.95 and the maximum focal shift range is approx. 31µm or ±0.002%.

Benefits for the users

With visual observations and CCD or CMOS imaging, an almost error-free image is guaranteed. Compared to conventional doublet and triplet apochromats, the APQ JENA Fluorite Quadruplet Polychromats have the following advantages:

- the images are bright, almost free of chromatic aberrations, astigmatism, coma, aperture and Gaussian errors,
- the theoretical resolution is almost reached,
- particularly in demanding planetary observation, highest magnifications are possible due to the brilliant, detailed and high-contrast image quality,
- the usable wavelength range is 365nm to 1014nm and thus up to three times wider compared to the limited visual spectral range of classic apochromatic doublet and triplet lenses (usually from 436nm to 656nm or from 480nm to 707nm),
- by making previously unobservable structures visible in the UV and IR, we open up completely new areas of research and activity for our customers.

To ensure that the lens cell is thermally invariant, free of play, and has high centering accuracy, we have developed a thermally compensated optical lens cell (compensation cell) for our Fluorite Quadruplet Polychromats.

The operating temperature range of the new compensation cell extends from -20°C to 40°C (working temperature interval ≥ 60K) and the storage and transport temperature range from -40°C to 60°C.

The new compensation cell offers the following advantages over classic cells:

- the lenses are each received on six or more surfaces and held by compensation parts in temperature fluctuations in a stable position,
- thermal stresses due to a working temperature interval of at least 60K (operating temperature range from -20°C to 40C) or changing gravitational forces on the lenses must not have any functionally changing influences, in particular no effects on the optical quality of the overall system,
- there is no rattling of lenses in the cell, costly readjustments are not incurred,

The assembly technology used by means of a fluid, optically transparent medium (oil) between the lenses offers several advantages over the classical technology of the individual lenses with air gaps:

- thermal stresses between the lenses are excluded by the oil in between,
- the oil film prevents surface tilting, as is possible with an air gap,
- there are fewer glass-to-air surfaces and thus virtually no stray light, the transparency of the optical system increases,
- the adaptation to the ambient temperature is faster, i.e. the optical system has a better thermal behavior.

Technology

Due to the small-batch character of the production with the possibility of single and special production, both conventional and modern CNC production technologies are used.

However, these advanced CNC technologies can not replace the knowledge and expertise of a precision optics master with decades of experience in his field.

The precision machining of spherical and aspherical optics as well as mechanical parts takes place in close cooperation with our regional manufacturing partners.

With the existing technologies, precision lenses made of optical glasses and CaF_2 up to a diameter of 300mm can be machined, completely assembled objectives can be manufactured, and they can be tested with the most modern measuring and testing technologies.

Wide Field Fluorite Polychromats

From the quadruplet basic lens design we have derived Polychromats with fast focal ratios from f/4 to f/6, very large vignette-free flattened image fields of 5° to 8° and a polychromatic Strehl ratio ≥ 0.95. This is done by adding additional lenses, replacement of fluid, optically transparent media, by air gaps or the execution of glass-to-air surfaces as aspheres and by substitution of the optical glasses by crystalline and special media.

This **Wide Field Fluorite Polychromats** are particularly suitable for astrophotography, optronics, remote sensing etc.:

- 100/400 f/4 8° (56.0mm)
- 130/520 f/4 7° (63.7mm)
- 150/600 f/4 7° (73.4mm)
- 180/900 f/5 5° (78.6mm)
- 200/1000 f/5 5° (87.4mm)
- 250/1250 f/5 5° (109.2mm)
- 300/1800 f/6 5° (157.4mm)

Ordering information

On the one hand, our high quality requirements for the parameters of the CaF_2 blanks greatly limit their availability. On the other hand, the capacity of our small series and special production is limited in particular by the system correction of all polychromats. In the end this leads to the fact that is to be counted with longer delivery times.

As the first representative of the new Fluorite Quadruplet Polychromat refractory series, we offer the APQ 150/1200 as well as the APQ Flattener and the APQ Reducer to order. The APQ 130/1000 and the APQ 100/640 will follow.

We manufacture exclusively on order.

APQ 150/1200 Fluorite Quadruplet Polychromat (Front view)

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