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RESULTS OF CERAMIC GLASS SPACER THICKNESS MEASUREMENT

(Technical note)

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1.Measuring tool and procedure

The spacers have inside diameter 32mm, outside diameter 50mm, and thickness “4mm”, “20mm”, or “40mm”.

Spacer thickness has been measured using a dial gage stand with 1um graduation dial indicator. Anvil of the stand has flatness < 1um. The measurements has been done relative to reference gage blocks with thickness either 4.0004mm or 20.0000mm. A reference gage block for “40mm spacer” measurement has been composed using two spacers with 20mm thickness each.

An optical contact has been provided between anvil and spacer surfaces during a measurement. Presence of the optical contact has been established according to absence of visible Newton rings first of all, and moreover a presence of a considerable force to shift the spacer.

Thickness of each spacer has been measured in 8 points via 45 degree on a middle between inside and outside radii of a spacer. Resolution of the measuring tool was equals to 0.2um (full width). Precision of a measurement has been defined by multiple measurement of an one spacer. Results of this measurement are done in Table 1. The precision was 0.4um (full width). No thickness change within 0.2um between a spacer radius from 18mm to 23mm.

2.Results and discussion

2.1. “4mm spacers”

Thickness of 471 spacers has been measured. Results are done in Figs.1-3. According to Fig.2 we have about 350 spacers with ~< 0.3um parallelism. We need lesser than 300 spacers for full detector. 192 spacers are needed for precision part of the detector (rear PC4 pairs). According to Fig.1 we have about 210 spacers with thickness (4+/-0.0003)mm in order to provide identical cells in the precision part. We need to select 4 spacers with the same thickness per each plane for the rest part of the detector.

2.2. “20mm spacers”

Thickness of 112 spacers has been measured. According to Fig.6 quality of the spacers is not so good, none the less more than 50 spacers have < 0.5um parallelism and can be used to provide the 20mm He gaps and (together with “40mm spacers”) the 60mm He gaps. 48 spacers are needed for it. Spacers with > 0.5um parallelism can be used also for the 40mm He gap providing. We can select spacer pairs with the same parallelism for it. We will be needed turn of the spacers to have 40mm gap with a small parallelism as result.

2.3. “40mm spacers”

Thickness of 57 spacers has been measured. They have very good parallelism according to Fig.8, but thickness distribution have too big spread (Fig.7). One needs to select quadruplets of spacers per each plane with an equal thickness. 56 spacers are needed for the both 40mm and 60mm He gaps providing.

2.4. Conclusion

According to early carried out estimations we need to exclude a systematic shift more than 2um of the "4mm spacer" thickness to reach a systematic error lesser than 5x10^-5 of measured Michel parameters. In practice we have the "4mm spacer" thickness with better than 0.5um precision. Thickness of "20mm (and 40mm) spacers" let to provide the He gaps with precision better than 0.5um also.

We have a reserve about 20-30% of all type of spacers.