Topo-Guided Custom Ablation (TGCA) and Corneal Collagen Cross-Linking (CCL) in treatment of advanced keratoectasia

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The Problem

- **Progressive keratoectasia** with **visually disturbing irregular astigmatism (IA),** occurring in keratoconus, pellucid marginal degeneration and iatrogenic (post-LASIK..), **currently treatable only with invasive procedures** like corneal transplantation and to some extent with intracorneal ring segments

The Goal: To develop a non-invasive treatment with potential for visual recovery in selected patients

- **A: To regularize the distorted corneal optics**
- **B: Halt the progression** of keratoectasia
- **Achieve lasting visual rehabilitation**
  - Aiming for vision correctable with spectacles and/or contact lenses, which allows the patient to function in her/his daily life i.e.
    - Without visual disturbances due to major irregular astigmatism (IA) or high regular astigmatism (> 5 D)
      - Any residual sphere and low astigmatism allowed

Alternatives

- **Corneal Collagen Cross-Linking CCL:**
  - Stiffens and stabilizes the cornea
    - Stops progression of keratoectasia, but
    - IA and/or high astigmatism not addressed – The lost **vision not restorable**
- **Topography guided custom ablation (TGCA):**
    - Regularizes IA and/or significantly reduces high astigm., but
    - Stability probably worsened due to the further thinning of the cornea - **lasting visual rehabilitation probably not achievable**
- **TGCA combined and followed immediately by CCL**
  - Regularizes and stabilizes the cornea
    - **Has potential for achievement of lasting visual rehabilitation**

Methodology (TGCA + CCL)

- 1. TGCA stage
  - iVIS Suite's cTEN (**c**ustom **t**rans**e**pithelial **n**o-touch) with max. abl. depth limited to 60 µ + respecting the minimal postoperative corneal thickness of 400 µm
    - Regularize the cornea (by removing the corneal irregularities and as much as possible of the astigmatism in a most tissue sparing fashion), by allowing low postoperative astigmatism and any residual sphere
    - Epithelial removal happens in the same process
      - Enables permeability for riboflavin (the first part of the CCL stage)

Methodology (TGCA + CCL)

- 2. CCL stage
  - Corneal saturation with 0.1% riboflavin
  - Irradiation with 365 ηm UVA, 3mW/cm^2 for 30 minutes

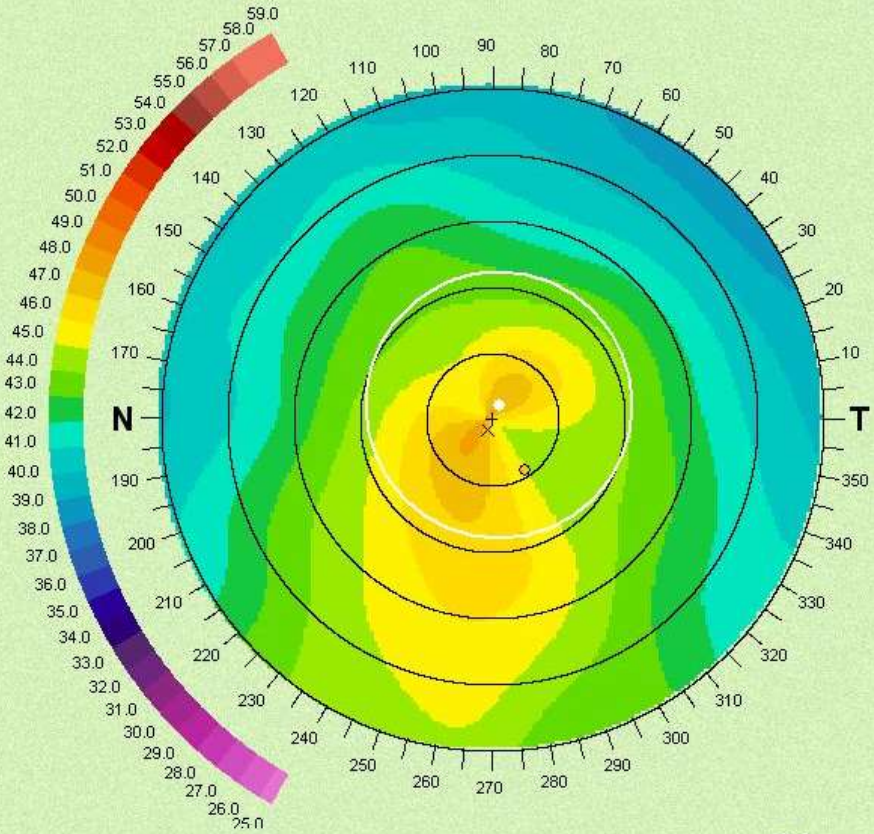
Case presentation

- 29 y.o. male,
  - Progressive, previously untreated keratoconus o.s.
  - HCL intolerant
  - Non satisfactory correction with spectacles due to the high astigmatism power and IA
- Preoperative status
  - BSCVA: -1.25**-6.00** X 140: 20/50
  - mean K: 47.2 D
  - Minimal corneal thickness: 454 µm

Precisio

pre-op curvature maps

Exam 1



Print

Difference

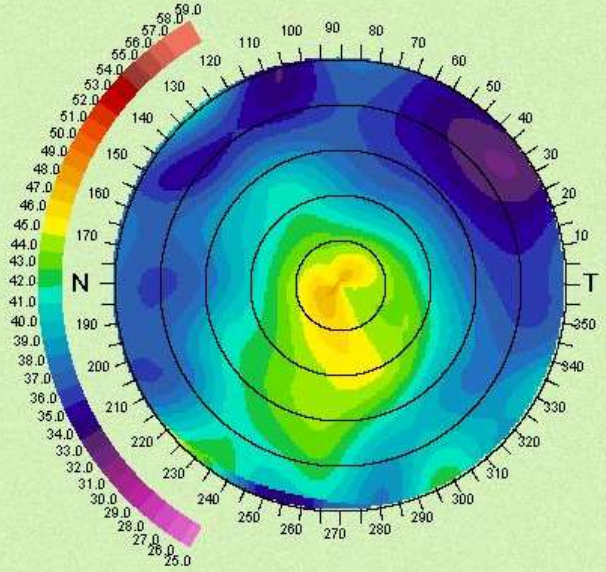
Export

Close

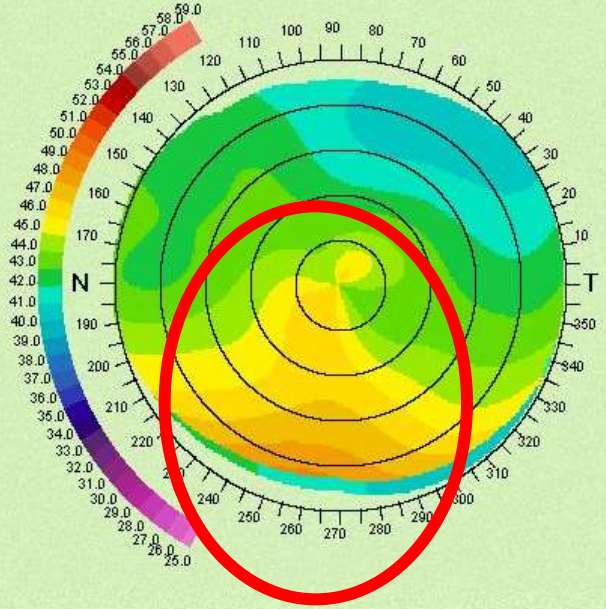
Patient: **Marschhauser Vegard**
Eye: **OS**
Exam Type: **Surgery**

LIGI
CUSTOM REFRACTIVE TECHNOLOGIES

Anterior Tangential Power Map
3mm KMax=44.01@98 KMin=42.48@37 KMed=43.25



Total Power Map
3mm KMax=45.10@62 KMin=43.72@142 KMed=44.41




Center
Apex
0.00
0.00
Axis
Restored Morphological
Pupil Size
Photopic (mm) 3.50
Ideal Pupil Pre (mm) 3.90
Ideal Pupil Post (mm) 3.84
Refractive area
Optical Zone (mm) 4.30
Outer transition (mm) 7.15
Topographic Border (mm) 10.00
LIGI
Statistics
Maximum Depth (µm) 69
Volume (mm3) 0.91
Residual Pachimetry
Min (µm) 396 at X,Y (mm) 0.40,-1.00
Comments
Print
Option
Home
Parameters
Center APEX
Axis R \MORPHOLOGICAL
Optical Zone (mm) 4.30
Transition Limit (mm) 7.15
A value (D) 75.66
Laser Offset (mm) 0.09 N 0.21 I
Procedure PRK
Transepitelial
Depth (µm) 60
Border(mm) 0.20

Result 3,6 and 12 months p.o.

- Patient achieved good and stable vision with use of spectacle correction
- Preoperative parameters change:
  - BSCVA : from 20/50 to 20/25
  - Cylinder: from 6.00 D to 2.00 D
  - Mean K: from 47.2 D to 44.7 D
  - Minimal corneal thickness: 454 µm to 440 µm
- Clear cornea

Precisio

difference map

pre-op & 1m postop

Exam 1

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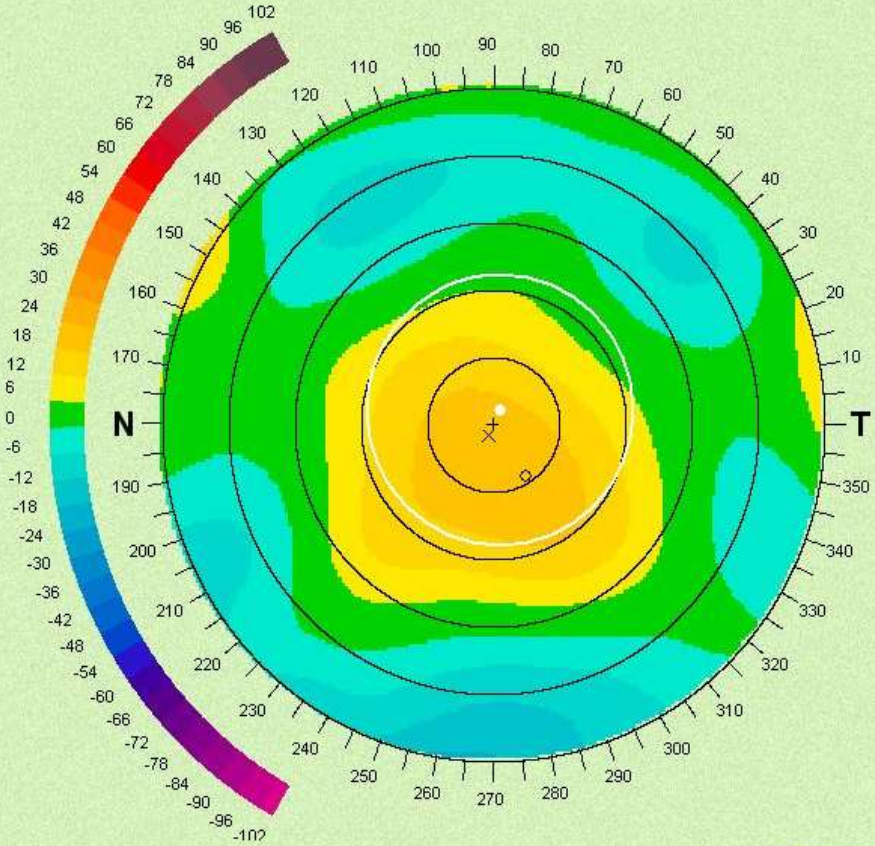
Difference

Export

Close



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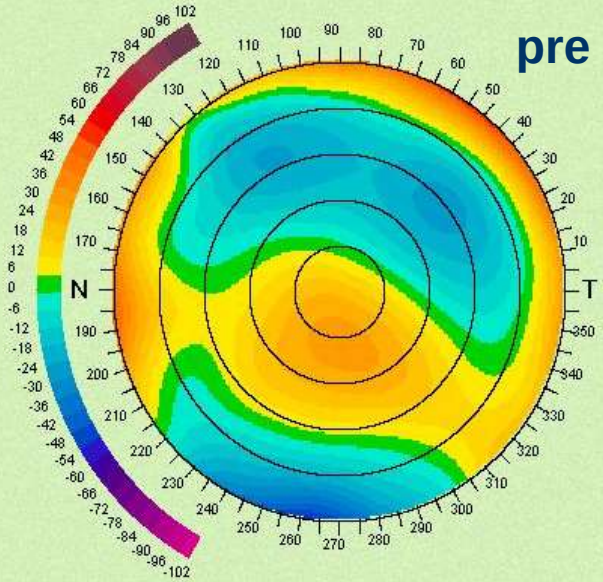
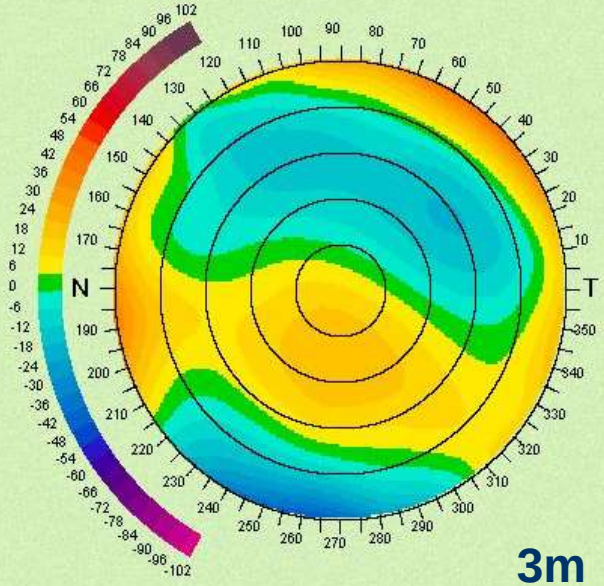
LIGI
CUSTOM REFRACTIVE TECHNOLOGIES

Anterior Elevation Map
Radius: 8.007 mm Power: 46.960 D

pre



Anterior Elevation Map
Radius: 8.088 mm Power: 46.490 D



3m

Precisio

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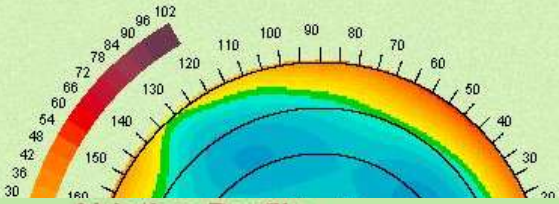
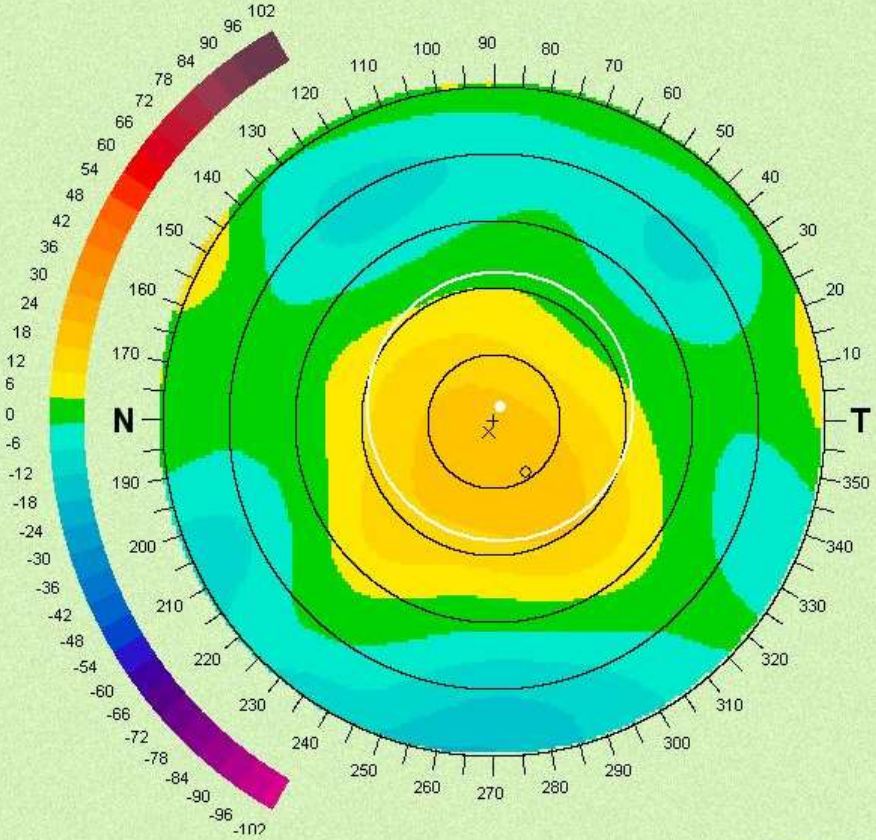
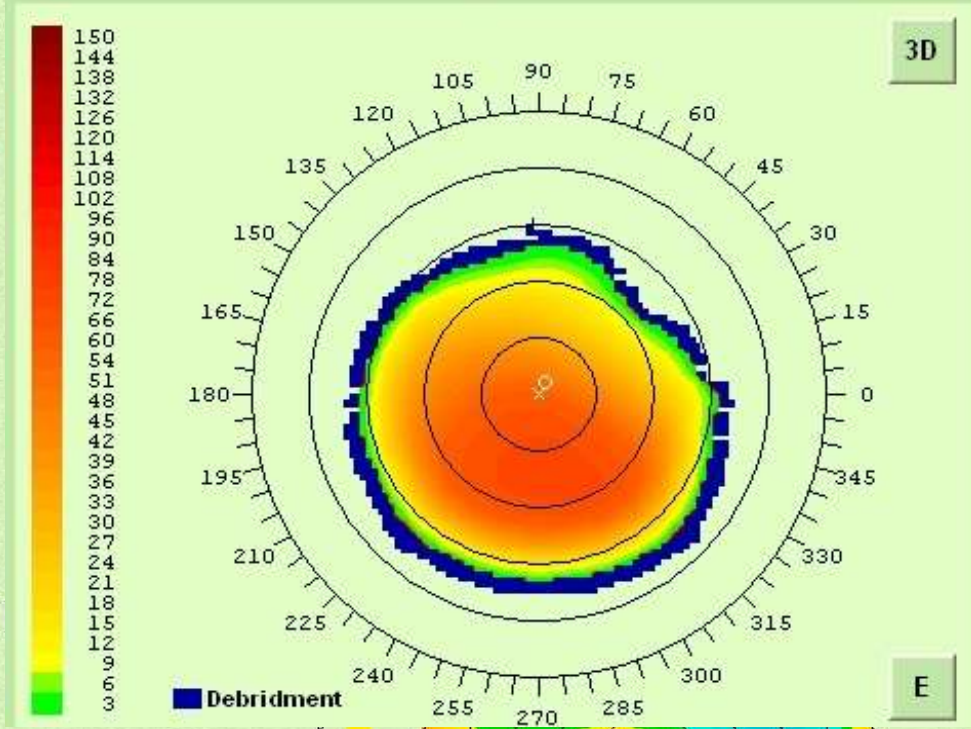


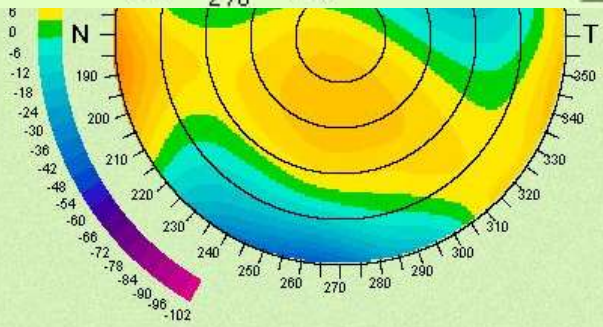
Difference Map
Max local diff. at 6mm: 20.0 um at X= 0.10 Y= -0.65 mm
Total average diff. at 6mm: 8.1 um
Hemi average diff. at 10mm: | 1.3 um -- 0.2 um / 0.8 um \ 1.2 um
Quad average diff. at 10mm: + 0.8 um x 2.2 um

Exam 1



Ablation Profile





Close

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LIGI
CUSTOM REFRACTIVE TECHNOLOGIES

Precisio

difference map

1m & 3m postop

Exam 1

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Difference

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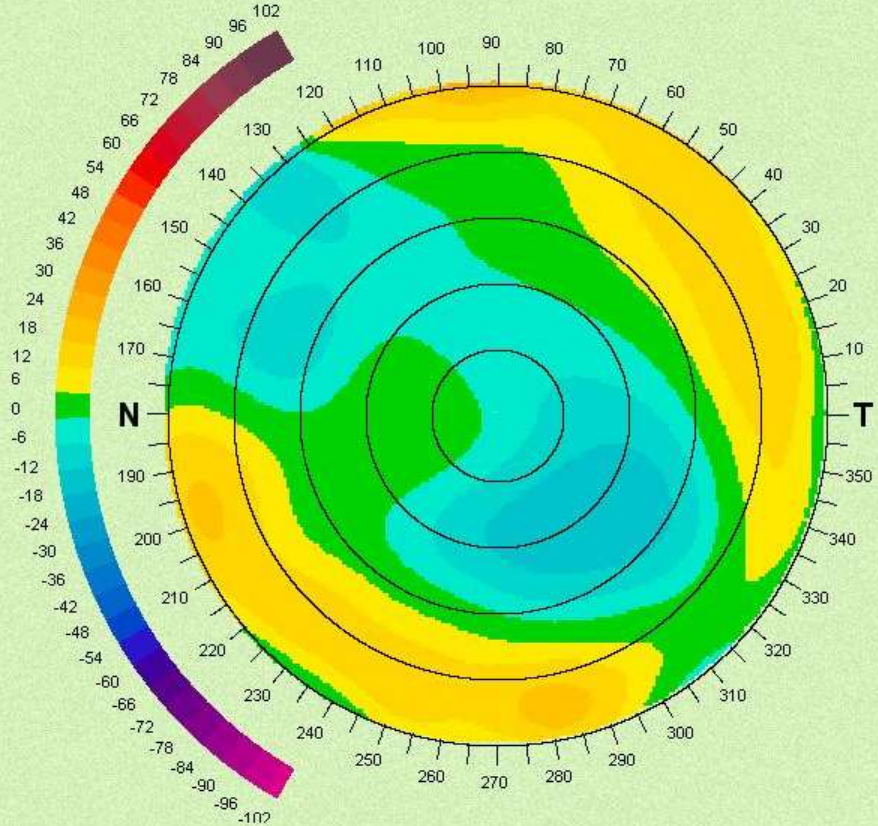

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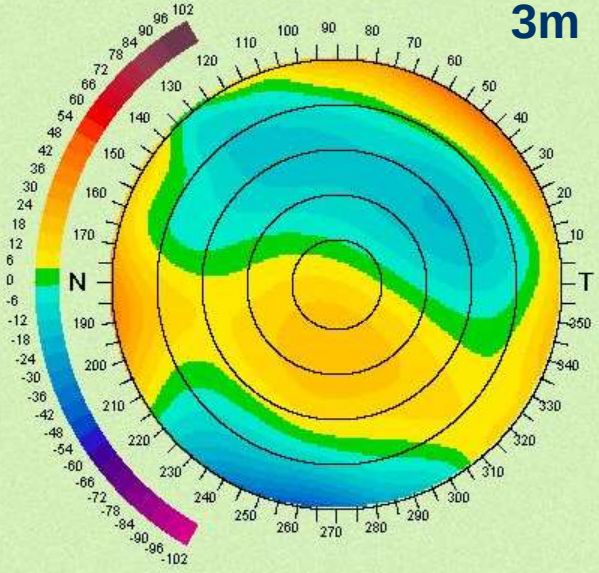
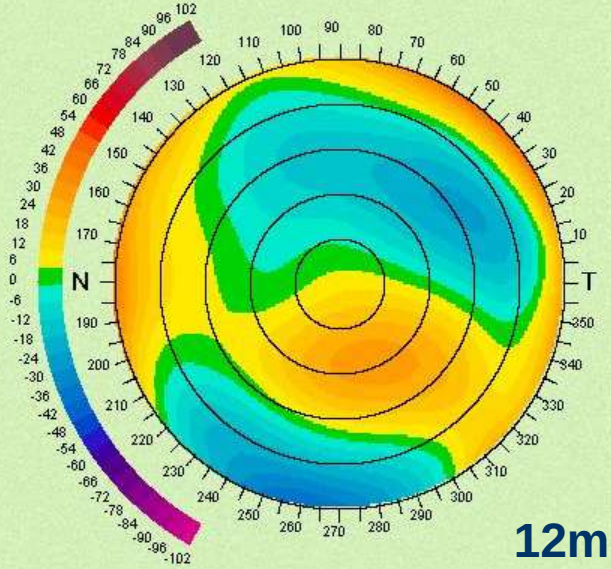
3m



Anterior Elevation Map
Radius: 8.014 mm Power: 46.917 D



12m

Implications - combined treatment

- CCL strengthens the human in vtro corneal stress/strain resistance by a factor of 3
- Laser ablation causes corneal thinning and weakens the cornea by a certain unknown factor
- A combined procedure should result in net strengthening of the cornea to stop the keratoectasia
  - Exact measurements currently under development (ORA...) and one has to use only clinical judgment in case selection

Implications - TGA part

- TGA must be performed as surface ablation
  - Not waste tissue on LASIK flap
- TGA should be performed in “Minimized ablation” mode
  - Aim for a regular corneal surface by using a target sphere/cyl that results in least tissue consumption
- TGA should be performed in transepithelial ablation mode (epithelium included in the ablation plan)
  - Results in most accurate delivery of the ablation plan
  - Only the necessary area of epithelium removed - speeds up reepithelialization

Conclusions

- **TG[illegible]owed b[illegible]resent an opti[illegible]** properly sele[illegible]**ia** who were[illegible]r corneal transplanta[illegible]