Holographic technology and product development update

Demetrios Lignos
InPhase Technologies Inc
2000 Pike Rd, Longmont CO 80501-6764
Phone: +1-720-494-7447  FAX: +1-720-494-9606
E-mail: demetrioslignos@inphase-tech.com

Presented at the THIC Meeting at the National Center for Atmospheric Research, 1850 Table Mesa Drive, Boulder CO 80305-5602

July 19-20, 2005
Agenda

• Technology Overview
  – Opto-Mechanical Assembly (OMA) architecture
  – Polytopic filter and Phase Conjugation
  – Technology roadmap

• Prototype and Product development update
  – Drive development status update
  – Product road map
  – First generation product specifications
  – Partners and potential users
Technology overview
Technology enhancements for our product development:

• Continuing with the use of the Polytopic filter and Phase and Conjugation architecture for our drive development.

• Developing new custom components:
  – New 1200 x 1200 pixel SLM development
  – New 1600 x 1600 pixel camera development (with higher sensitivity)
  – New fast shutter (new development for long life and reliability)
  – New Opto-Mechanical Assembly (OMA) design
  – Blue tunable laser (with Sony’s help)
  – Phase Mask development

• Invented oversampling technique to avoid moving the camera to achieve pixel matching.

• New channel development to support oversampling and a high transfer rate with robust data reliability (10 x E-15 error rate).
Polytopic multiplexing

Need to block neighboring stacks during readout

SLM
PBS
FT lens with NA=0.5

Reference Beam

Aperture Size (d)

2nd FT lens

Camera

Optimized packing of data beam

Beam Waist (w)
At the Fourier/Focus plane of SLM

Beam waist size/Nyquist aperture selection

0th Order

Nyquist Filter

Polytopic Filter Blocks Unwanted Higher SLM Orders
Write

Polytopic Aperture

Reference beam

Media

Camera

SLM

Galvo Mirror

Nyquist Aperture

Polytopic Aperture

Galvo Mirror

Conjugator

Read

Galvo mirror
Opto-Mechanical Assy schematic

WRITE

- Laser
- Pinhole
- Exposure shutter
- Apodizer
- LVR
- Phasemask
- Main Expander (zoom)
- Data Expander
- SLM
- Camera
- Polytopic Filter
- Relay+Storage Lenses
- Galvo
- Scanner lens
- Disk
- Galvo (conjugator)

READ

- Laser
- Pinhole
- Exposure shutter
- Apodizer
- LVR
- Phasemask
- Main Expander (zoom)
- Data Expander
- SLM
- Camera
- Polytopic Filter
- Relay+Storage Lenses
- Galvo
- Scanner lens
- Disk
- Galvo (conjugator)
<table>
<thead>
<tr>
<th></th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Areal density</td>
<td>300 Gb / in²</td>
<td>800 Gb / in²</td>
<td>1600 Gb / in²</td>
</tr>
<tr>
<td>Transfer rate</td>
<td>20 MB/s</td>
<td>80 MB/s</td>
<td>120 MB/s</td>
</tr>
<tr>
<td># of pages per book</td>
<td>144</td>
<td>325</td>
<td>662</td>
</tr>
<tr>
<td>Reference Beam Sweep (degrees)</td>
<td>10</td>
<td>24.5</td>
<td>25</td>
</tr>
<tr>
<td>Hologram pitch (θ, r) (mm)</td>
<td>0.82, 0.48</td>
<td>0.82, 0.48</td>
<td>0.82, 0.48</td>
</tr>
<tr>
<td>Nyquist filter / Beam Waist area</td>
<td>1.2x</td>
<td>1.2x</td>
<td>1.2x</td>
</tr>
<tr>
<td>NA of object beam</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Bragg Null</td>
<td>2nd</td>
<td>2nd</td>
<td>1st</td>
</tr>
<tr>
<td>SLM/Camera Pixels</td>
<td>1200x1200/1600x1600</td>
<td>1200x1200/1600x1600</td>
<td>1200x1200/1600x1600</td>
</tr>
<tr>
<td>Wavelength (nm)</td>
<td>407</td>
<td>407</td>
<td>407</td>
</tr>
<tr>
<td>Material Thickness (mm)</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>M# of media @1.5mm</td>
<td>33.3</td>
<td>90</td>
<td>135</td>
</tr>
</tbody>
</table>

Angle and Polytopic Multiplexing

Compatible with RW media
Product development update
Drive development status

• We completed the development of six prototype drives:
  – Demonstrated read/write and seek functionality
  – Demonstrated cartridge interchange
  – Demonstrated the prototype at the NAB show last April and many other shows and conferences after NAB.

• We are now well into the drive development stage of the program.
  – Developing new components and subassemblies.
  – We are detailing the OMA opto-mechanics. Optics are being fabricated.
  – Very close to signing a drive manufacturing partner.
  – All electronics hardware/firmware development is currently on schedule.

• We see no “show-stoppers” for completing the drive development on time and no new inventions are required.

• Goal: to begin revenue shipments in late 2006.
NAB pictures of the prototype demo
Roadmap for Recordable Products

Two product families planned:

- **Recordable** (starting in 2006)
- **Re-writable** (starting in 2008)
HDS Drive form-factor

Preliminary drive dimensions:

Height:  3 x HH (5.24”)
Width: Standard 5.75”
Length:  27”
InPhase Technologies

Tapestry HDS-300R Specifications

**DRIVE**
- 300 GB Capacity
- 20 MB/s Transfer Rate
- 250 ms avg. access time
- 407 nm Laser
- 1.4 megabits/page
- 5.5 sec. Cartridge load time
- 3.5 sec. Cartridge unload time
- BER <10^-15
- 100K power on hours MTBF

**MEDIA**
- 130 mm disc
- 5.25” X 6” X .25” cartridge FF
- 3 year shelf life (prior to recording)
- >50 year archive life
Significant partnerships

- **Technology and product introduction activities:**
  - Working with several robotics library manufacturers.
  - Also talking with several major potential HDS drive users in the archival and professional video industries.

- **Media partnerships:**
  - Maxell (planning a second media volume production source)
  - Bayer (for chemicals)

- **Drive development relationships and partnerships:**
  - Sanyo- Opto-Mechanical Assembly
  - Sony - Blue Lasers
  - Alps - Loader and drive mechanics
  - DisplayTech – SLM
  - FillFactory - Camera

- **Media and Test Equipment Sales**
  - 23 companies are InPhase media customers
  - We have also sold several “plane wave” and “digital” test equipment to several companies.