Printer Ink Limit Optimization

RICOH
imagine. change.

How can a limit for ink saving be determined that does not affect print quality

Yue Qiao, Larry Ernst, Chao Ma

June 12, 2013

Problem definition

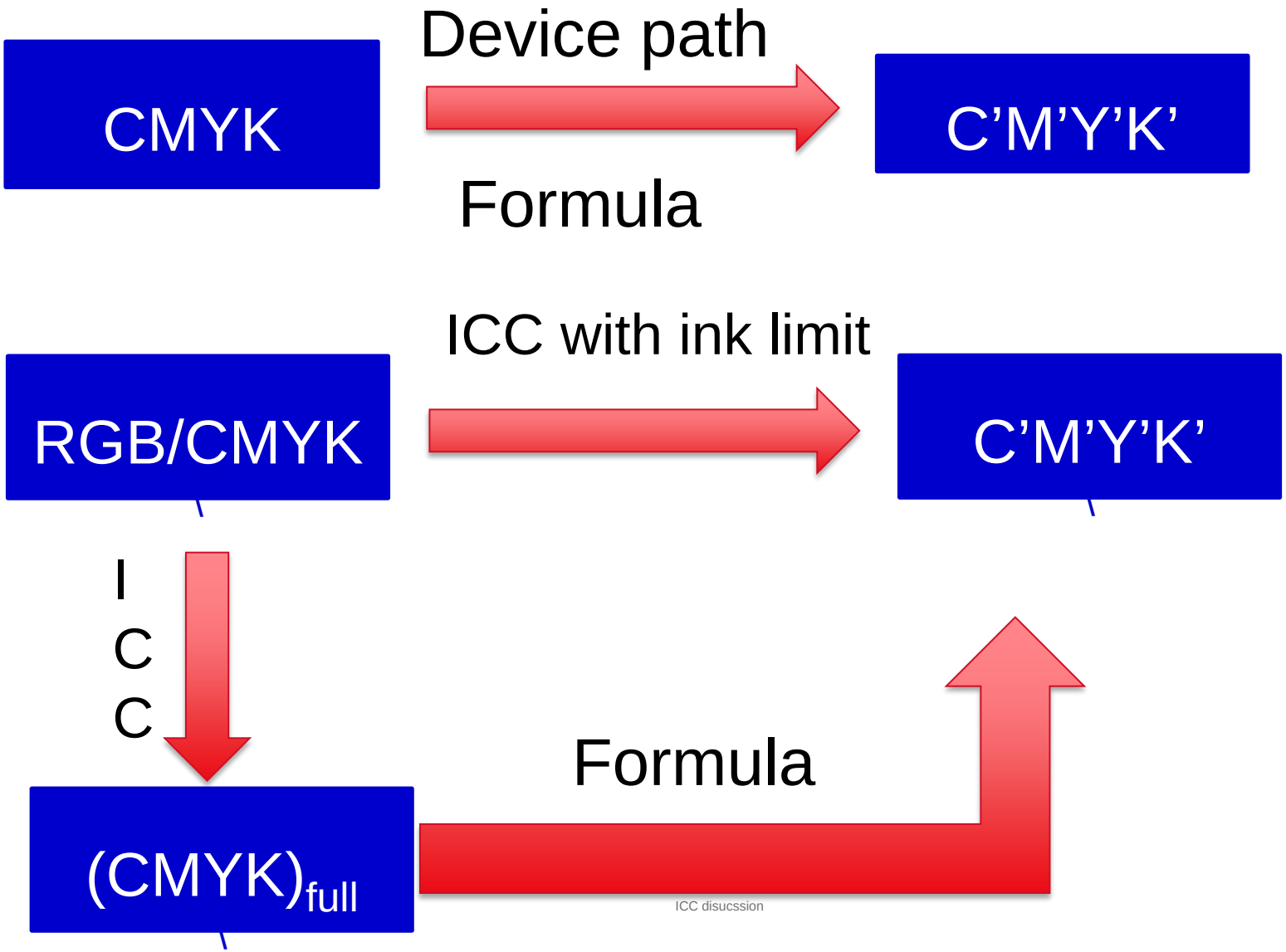
RICOH
imagine. change.

How low is the ink limit too low to have an acceptable color quality?

- One of the challenges for offset to digital initiatives is to reduce the cost per page for the digital printing.
- Customers would like to reduce ink/toner usage with minimum loss of color quality.
- Printers normally have an ink limit defined below 300%
  - Dryer, ink, mechanical, or paper problems.
  - Customers desire a way of reducing ink coverage on a page.

Printer workflow with ink limit applied

RICOH
imagine. change.

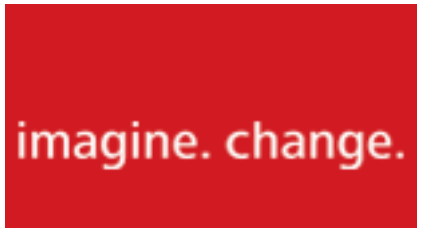


Approach

RICOH
imagine. change.

- Develop an ink saving technology to fully utilize the color capacity at any ink limit for the printer.
- With the help of the technology, determine the minimum ink limit for an acceptable print quality.
- Find a simple attribute that correlates the ink limit for determining the acceptable print quality.

Ricoh ink saving technology



- There could exist multiple sets of printer CMYK values that correlate the same/similar CIELab color.
- Ricoh technology:
  - Creating an accurate color conversion model.
  - Conducting a search algorithm to find possible CMYK combinations for CIELab color.
  - Choosing the CMYK value to satisfy the requirement.

Example of Ricoh ink saving technology

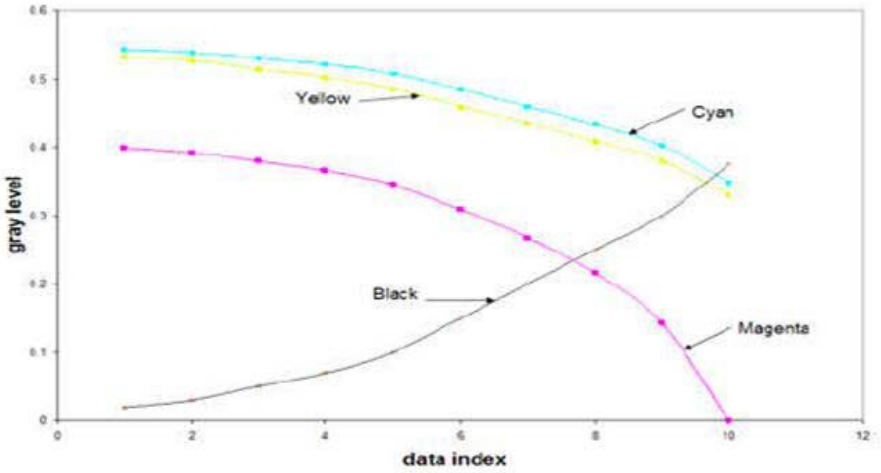


Figure 5.1: The level set of CMYK values for $CMY = \{0.55, 0.4, 0.55\}$.

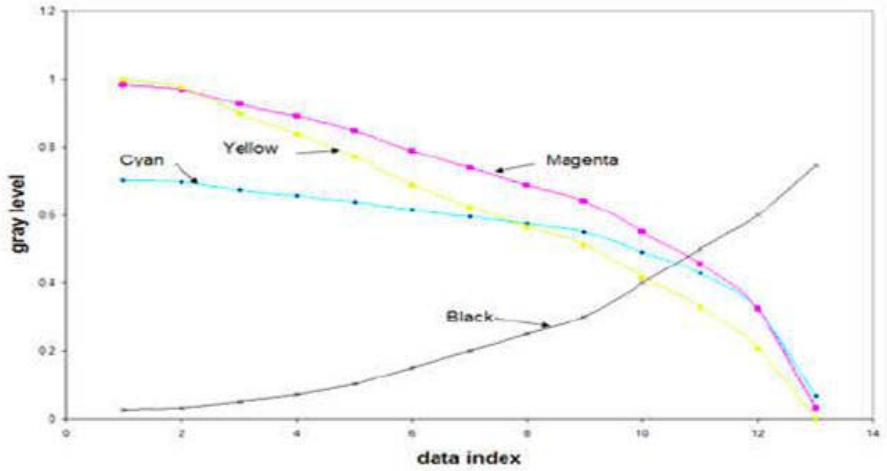


Figure 5.2: The level set of CMYK values for $CMY = \{0.7, 1.0, 1.0\}$.

For CMY=[55 40 55 0], total150% coverage

- 10 sets of CMYK values have the same appearance.
- Minimum ink coverage is [35 0 33 37] total 115%.
- Ink saving 45%.

For CMY=[70 100 100], total 270% coverage

- 13 sets of CMYK values have the same appearance.
- Minimum ink coverage is [3 7 0 74] total 84%.
- Ink saving 186%.

Experiment

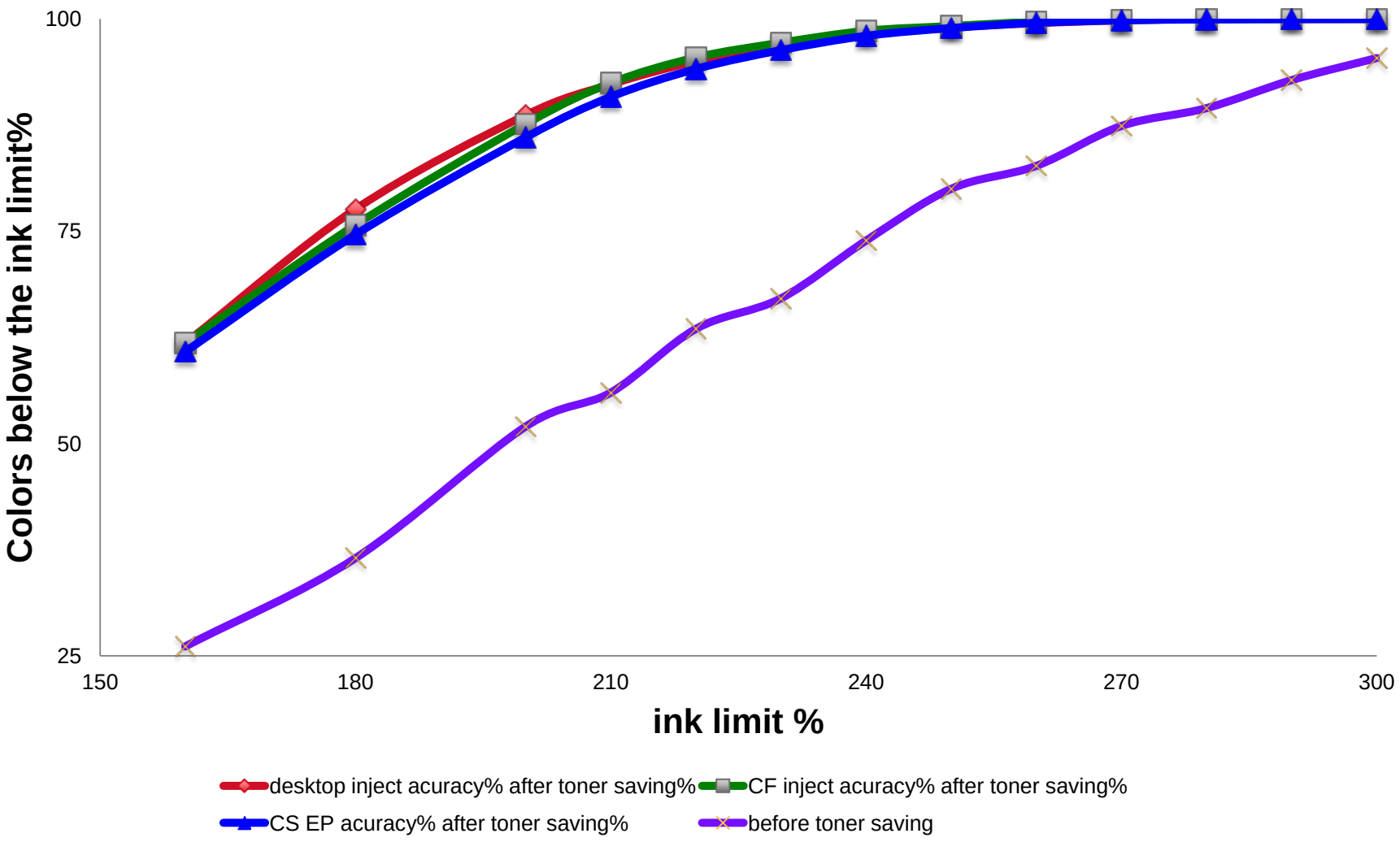
RICOH
imagine. change.

Determine ink limit via ink saving method

- RPPS ink/toner optimization technology was experimented on three printers:
  - Production cut sheet EP printer
  - Production continuous form inkjet printer
  - High end desktop inkjet printer
- Create CMYK to Lab conversion table 17^4
  - Calculate % of CMYK values below the ink limit.
  - Apply the ink saving method to the colors over the ink limit.
  - Replace the original CMYK value above the ink limit with reduced C'M'Y'K' that below the ink limit.
  - Calculate % of CMYK values below the ink limit.

Experiment result

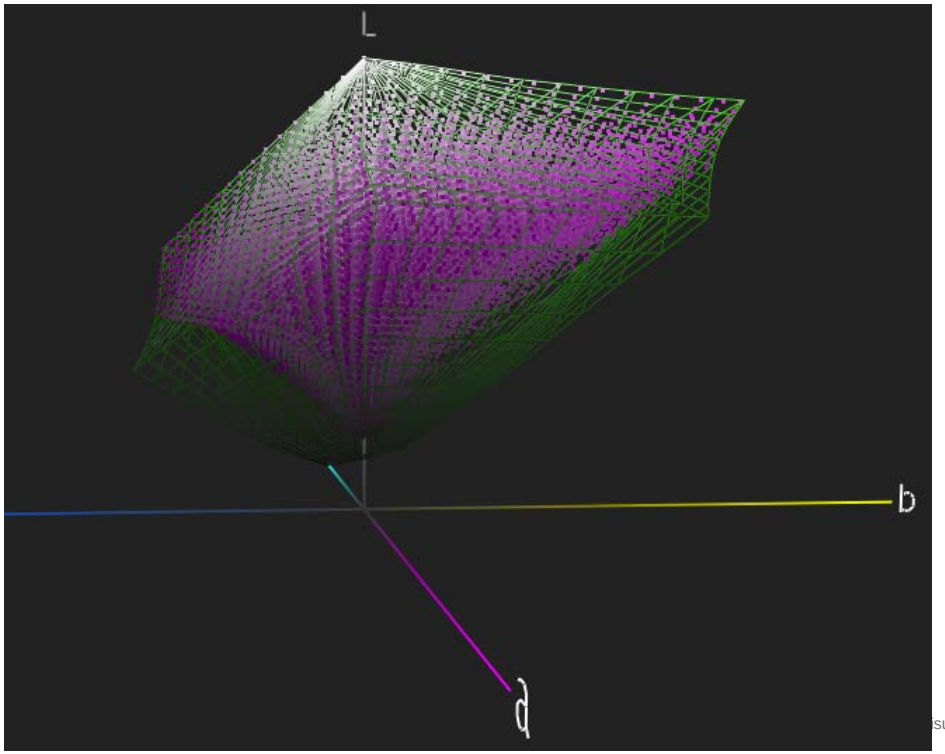
RICOH
imagine. change.

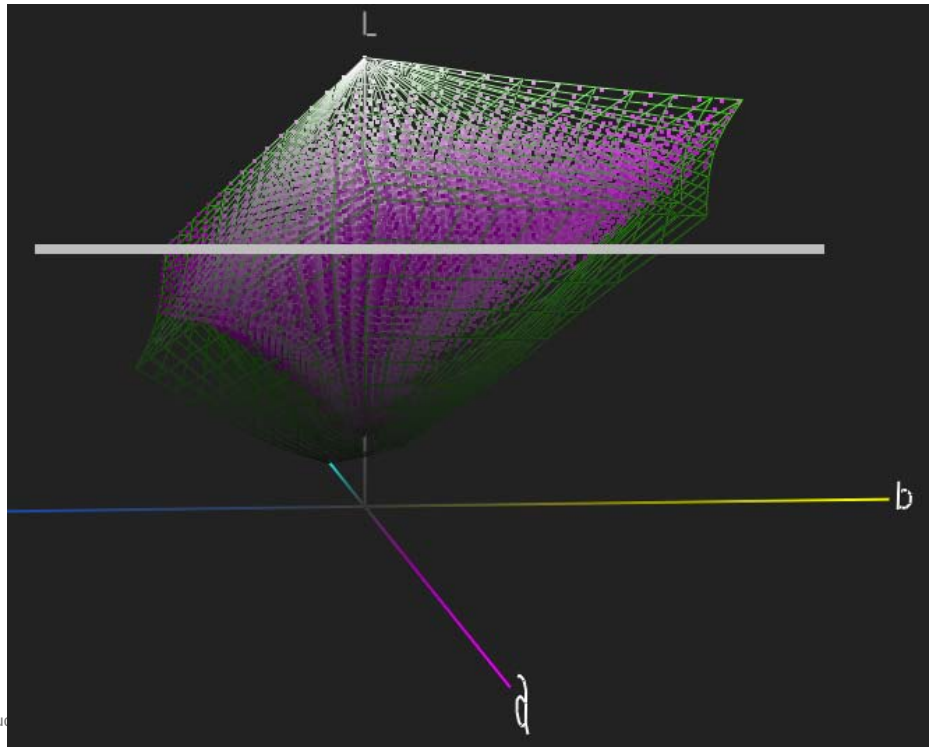


Which attribute correlates ink limit for print quality?

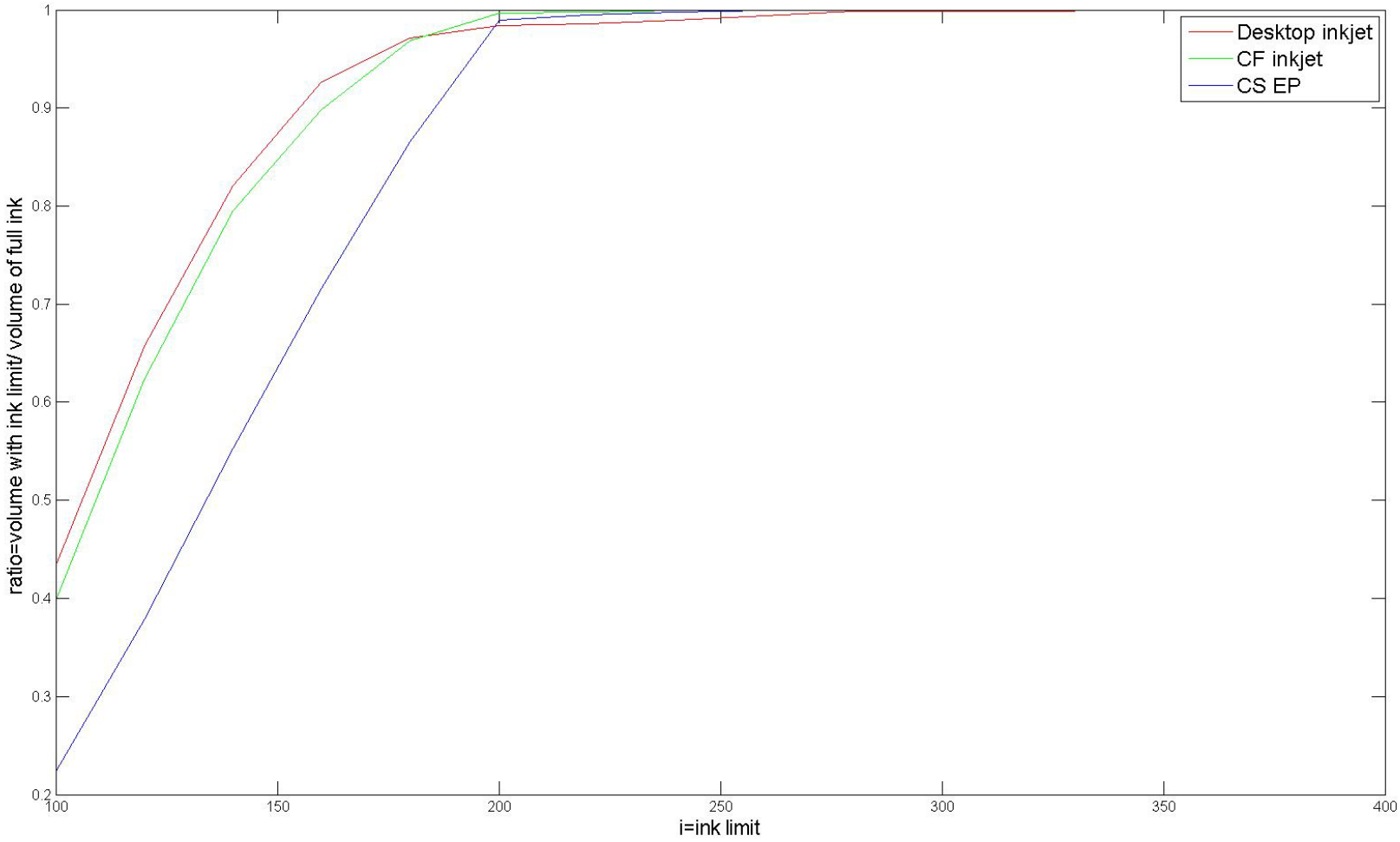
RICOH
imagine. change.

- Gamut ratio $V_{inkLimit}/V_{400}$ at an ink limit
- Divide the gamut volume into top and lower parts
  - Gamut ratio $V_{InkLimit\_top}/V_{400\_top}$ VS. Ink limit
  - Gamut ratio $V_{InkLimit\_lower}/V_{400\_lower}$ VS. Ink limit





Ink limit VS. gamut volume ratio (For the darker color region)



Summary

RICOH
imagine. change.

- Gamut volume ratio (especially darker color region of the gamut) is a good measure to correlate the ink limit for color quality.
- Ink saving technique can enhance the color quality for a printer with an ink limit.

What would we like ICC to help

- Get feedback on our study.
- Other members to share their knowledge and study.
- Possible white paper on printer ink limit recommendation.

RICOH
imagine. change.

Questions?

RICOH

imagine. change.