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WIYN's New Unique Multi-size Fiber IFUs

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Abstract. Two new integral field units (IFUs) were installed recently on the WIYN Observatory's 3.5-meter telescope at Kitt Peak. These unique IFUs contain fibers of different sizes in the same head. This design allows smaller fibers to sample regions of higher surface brightness, providing higher spatial resolution while maintaining adequate signal-to-noise (S/N). Conversely, larger fibers maintain S/N at the expense of spatial resolution in the lower surface brightness regions of galaxies. The new IFUs were built with funds from NSF award ATI-0804576.

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1. Introduction

The first integral field unit (IFU) on the WIYN 3.5-meter telescope (www.wiyn.org) was DensePak (Barden *et al.* 1998), with 91 fibers densely packed in a rectangle, followed by a second IFU called SparsePak containing a densely packed core surrounded by a more sparse square halo of fibers. SparsePak's 82 fibers, each $5''$ in diameter, gave it the largest specific grasp (the product of telescope area and fiber solid angle) of any imaging spectrograph, and among the best combinations of total grasp and spectral power, in the world at the time (Bershady *et al.* 2004). All of the WIYN IFUs feed the Bench Spectrograph located below the telescope (Bershady *et al.* 2008; Knezek *et al.* 2010).

Designers have chosen between high grasp systems with low spatial resolution (e.g., SparsePak) and lower grasp units with high spatial resolution (e.g., NIFS on Gemini). However, a customized design would have small fibers for high surface brightness regions and larger fibers for fainter areas in an astronomical source. The Washburn Astronomy Lab at the University of Wisconsin-Madison designed and built the world's first IFUs with different sized fibers (variable pitch) in the same fiber bundle (M. Bershady, PI).

2. IFU Design

Two new variable pitch IFUs were created (Figure 1; Wood *et al.* 2012). Each has its own light collecting head that can be swapped quickly at the telescope. The first IFU, HexPak, has a central core of $0.9''$ diameter fibers (18 total), surrounded by a hexagonal halo of $2.8''$ fibers (84 total; $40''$ extent on sky). HexPak is designed for spheroidal or face-on disk galaxies, plus AGN host galaxies. The second IFU, GradPak, is an approximately rectangular array ($\sim 35'' \times 55''$), consisting of 11 rows of fibers ranging in size from $1.9'' - 5.6''$ (90 fibers total). It is designed for observing edge-on galaxies, with smaller fibers near the mid-plane and larger fibers sampling fainter emission perpendicular to the disk. Each fiber head contains separate sky fibers of every size.

Figure 1. Top: photographs of HexPak (left) and GradPak (right). Sky fibers are above and to the right in HexPak; they occur in two clumps in GradPak. **Bottom:** fibers from both IFUs are arranged into parallel psuedo-slits on a common foot at the spectrograph entrance.

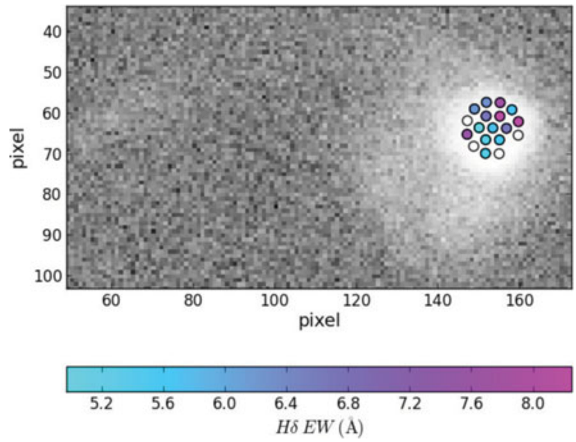

Figure 2. Hδ equivalent width derived from HexPak data of the galaxy G515 ($z = 0.0875$). Only the inner core of small fibers is shown; this entire core is roughly the same size as one SparsePak fiber. Each fiber corresponds to a physical size of 1.5 kpc.

3. Early Results

Preliminary results from early science data already demonstrate the advantages of the new IFUs. Figure 2 shows Hδ strength in the inner HexPak fibers overlaid on an image of the post-merger, post-starburst galaxy G515, which likely hosts a low power radio AGN (Liu *et al.* 2007). The strength and large extent of the $H\delta$ signature is consistent with a strong starburst resulting from a near equal mass merger (e.g., Snyder *et al.* 2011).

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