Modern day gas turbine designers face the problem of hot mainstream gas ingestion into rotor-stator disk cavities. To counter this ingestion, seals are installed on the rotor and stator disk rims and purge air, bled off from the compressor, is injected into the cavities. It is desirable to reduce the supply of purge air as this decreases the net power output as well as efficiency of the gas turbine. Since the purge air influences the disk cavity flow field and effectively the amount of ingestion, the aim of this work was to study the cavity velocity field experimentally using Particle Image Velocimetry (PIV).

Experiments were carried out in a model single-stage axial flow turbine set-up that featured blades as well as vanes, with purge air supplied at the hub of the rotor-stator disk cavity. Along with the rotor and stator rim seals, an inner labyrinth seal was provided which split the disk cavity into a rim cavity and an inner cavity. First, static gage pressure distribution was measured to ensure that nominally steady flow conditions had been achieved. The PIV experiments were then performed to map the velocity field on the radial-tangential plane within the rim cavity at four axial locations.

Instantaneous velocity maps obtained by PIV were analyzed sector-by-sector to understand the rim cavity flow field. It was observed that the tangential velocity dominated the cavity flow at low purge air flow rate, its dominance decreasing with increase in the purge flow rate. Radially inboard of the rim cavity, negative radial velocity near the stator surface and positive radial velocity near the rotor surface indicated the presence of a recirculation region in the cavity whose radial extent increased with increase in the purge air flow rate. Qualitative flow streamline patterns are plotted within the rim cavity for different experimental conditions by combining the PIV map information with ingestion measurements within the cavity as reported in Thiagarajan (2013).