In [1]:
```
import math
import matplotlib.pyplot as plt
import numpy as np
import librosa
import librosa.display
import IPython.display as ipd
```

Loading audio files

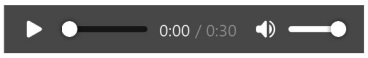
In [2]:
```
debussy_file = "audio/debussy.wav"
redhot_file = "audio/redhot.wav"
duke_file = "audio/duke.wav"
```

In [3]:
```
ipd.Audio(debussy_file)
```

Out[3]:

In [4]:
```
ipd.Audio(redhot_file)
```

Out[4]:



In [5]:
```
# load audio files with librosa
debussy, sr = librosa.load(debussy_file)
redhot, _ = librosa.load(redhot_file)
duke, _ = librosa.load(duke_file)
```

Extract spectrograms

In [6]:
```
FRAME_SIZE = 2048
HOP_SIZE = 512

debussy_spec = librosa.stft(debussy, n_fft=FRAME_SIZE, hop_length=HOP_SIZE)
redhot_spec = librosa.stft(redhot, n_fft=FRAME_SIZE, hop_length=HOP_SIZE)
duke_spec = librosa.stft(duke, n_fft=FRAME_SIZE, hop_length=HOP_SIZE)
```

In [7]:
```
debussy_spec.shape
```

Out[7]:
```
(1025, 1292)
```

Calculate Band Energy Ratio

In [8]:
```
def calculate_split_frequency_bin(split_frequency, sample_rate, num_frequency_bins):
    """Infer the frequency bin associated to a given split frequency."""

    frequency_range = sample_rate / 2
    frequency_delta_per_bin = frequency_range / num_frequency_bins
    split_frequency_bin = math.floor(split_frequency / frequency_delta_per_bin)
    return int(split_frequency_bin)
```

In [9]:
```
split_frequency_bin = calculate_split_frequency_bin(2000, 22050, 1025)
split_frequency_bin
```

Out[9]:
```
185
```

In [10]:
```
def band_energy_ratio(spectrogram, split_frequency, sample_rate):
    """Calculate band energy ratio with a given split frequency."""

    split_frequency_bin = calculate_split_frequency_bin(split_frequency, sample_rate, len(spectrogram[0]))
    band_energy_ratio = []

    # calculate power spectrogram
    power_spectrogram = np.abs(spectrogram) ** 2
    power_spectrogram = power_spectrogram.T

    # calculate BER value for each frame
    for frame in power_spectrogram:
        sum_power_low_frequencies = frame[:split_frequency_bin].sum()
        sum_power_high_frequencies = frame[split_frequency_bin:].sum()
        band_energy_ratio_current_frame = sum_power_low_frequencies / sum_power_high_frequencies
        band_energy_ratio.append(band_energy_ratio_current_frame)

    return np.array(band_energy_ratio)
```

In [11]:
```
ber_debussy = band_energy_ratio(debussy_spec, 2000, sr)
ber_redhot = band_energy_ratio(redhot_spec, 2000, sr)
ber_duke = band_energy_ratio(duke_spec, 2000, sr)
```

In [12]:
```
len(ber_debussy)
```

Out[12]:
```
1292
```

Visualise Band Energy Ratio

In [13]:
```
frames = range(len(ber_debussy))
t = librosa.frames_to_time(frames, hop_length=HOP_SIZE)
```

In [14]:
```
plt.figure(figsize=(25, 10))

plt.plot(t, ber_debussy, color="b")
plt.plot(t, ber_redhot, color="r")
plt.plot(t, ber_duke, color="y")
plt.ylim((0, 20000))
plt.show()
```